

Progress Update from the EV Charging Working Group (#982)



Stephen Frank, PhD – NREL

(Coauthored by Rick Jennings, PE – SkyFoundry)

Agenda

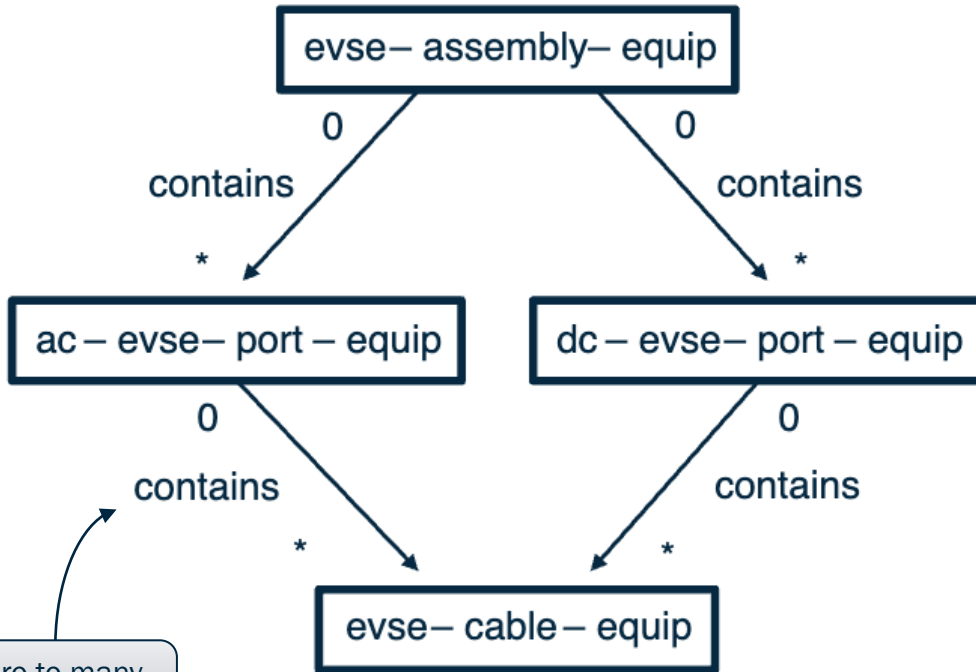
1. Working Group objective
2. Existing EVSE equip model
3. Proposed EVSE equip taxonomy
4. evseCableType and EVSE-level tags
5. EVSE data points
6. Summary of active proposals
7. What's next?

EVSE Working Group's Objective

Define the equipment, points, relationships, and operational data related to Level 1-2 (AC*) and Level 3 (DC) Electric Vehicle Supply Equipment (EVSE)

*AC = Alternating Current, DC = Direct Current

Existing Equip Model



Zero-to-many relationships

Strengths:

- Simple
- Captures most AC Level 2 use cases

Limitations:

- evse-assembly-equip can't model 1 vs. multiple equipment enclosures
- Difficult to capture nameplate data
- Tricky to define electrical references
- assembly vs. system confusion?

Limitations preclude advanced analytics and control use cases:
we need a more flexible model!

Goals for Updated Model / Taxonomy

1. Align with industry terminology and practice
2. Capture both simple and complex installations
3. Allow tracing of energy flows

Inspiration from NEVI*

*National Electric Vehicle Infrastructure (NEVI) Program

Note: An AC EVSE is not technically a “charger” because the AC/DC power conversion happens onboard the vehicle. (We want to be precise to avoid tagging conflicts!)

Some EVSE’s consist of multiple enclosures (equipment). In Haystack, we accommodate this by using evse as an adjective.

- “*Charger* means a device with one or more charging ports and connectors for charging EVs. Also referred to as Electric Vehicle Supply Equipment (EVSE).”
- “*Charging port* means the system within a charger that charges one EV. A charging port may have multiple *connectors*, but it can provide power to charge only one EV through one connector at a time.”

The evse-port conjunct (already in Haystack) follows this definition

Source: “National Electric Vehicle Infrastructure Standards and Requirements,” 23 CFR Part 680

Inspiration from NEVI*

*National Electric Vehicle Infrastructure (NEVI) Program

- “*Charging station* means the area in the immediate vicinity of a group of chargers and includes the chargers, supporting equipment, parking areas adjacent to the chargers, and lanes for vehicle ingress and egress. A charging station could comprise only part of the property on which it is located.”

Haystack does not currently model a “charging station” in this sense. Future work is needed to decide how to handle it. (Is it a site? Is it a system?)

Source: “National Electric Vehicle Infrastructure Standards and Requirements,” 23 CFR Part 680

Inspiration from OCPP* 2.0.1

*Open Charge Point Protocol

Doesn't quite match NEVI

Term	Meaning
Charging Station	The Charging Station is the physical system where EVs can be charged. A Charging Station has one or more EVSEs.
Connector	The term Connector, as used in this specification, refers to an independently operated and managed electrical outlet on a Charging Station. In other words, this corresponds to a single physical Connector. In some cases an EVSE may have multiple physical socket types and/or tethered cable/Connector arrangements (i.e. Connectors) to facilitate different vehicle types (e.g. four-wheeled EVs and electric scooters).
EVSE	An EVSE is considered as an independently operated and managed part of the Charging Station that can deliver energy to one EV at a time.
Local port Smart Meter	The Local port on a Smart Meter is a port (for example serial) on a digital electricity meter that provides access to information about meter readings and usage.

evse-cable-equip

Delivery to one EV at a time matches the NEVI definition for "port"

Source: Open Charge Alliance, "Open Charge Point Protocol 2.0.1"

NEVI ↔ Haystack (Existing) ↔ OCPP

Charging Station

Charging Station

Charger

evse-assembly-equip

Only sort of...

Charging Port

evse-port-equip

EVSE

Connector

evse-cable-equip

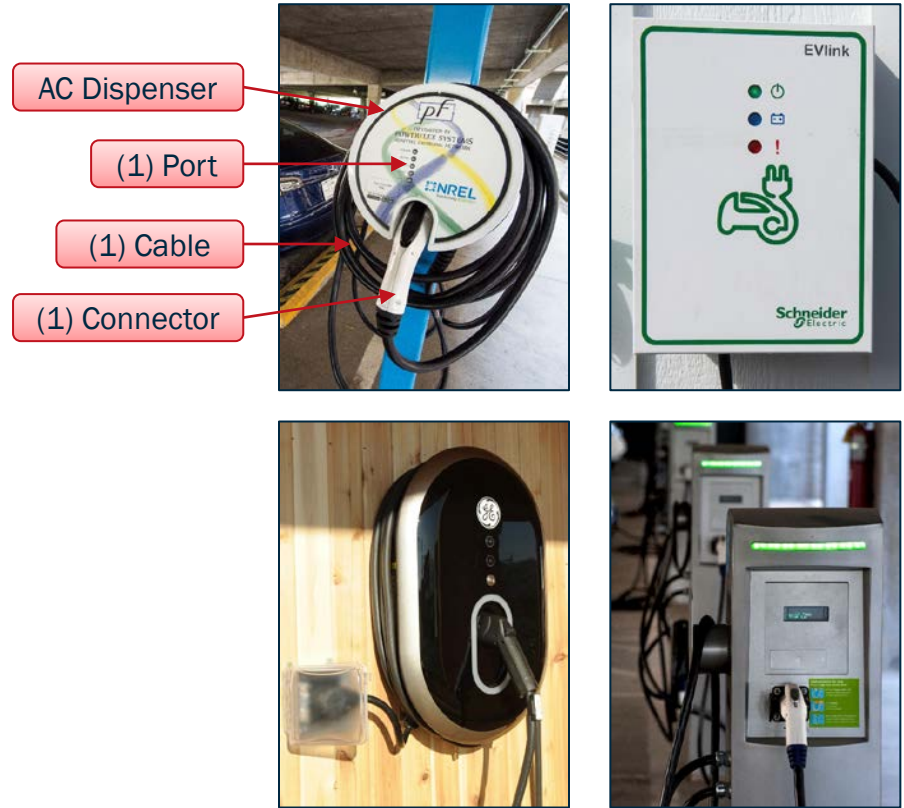
Connector

We thought about using connector but it is far too generic. An EVSE connector generally has a single cable, so this works pretty well.

Introducing the EVSE dispenser

Definition: The physical EVSE enclosure and its contents to which an EVSE cable attaches. Dispenses electricity to an EV.

- An evse-dispenser often contains one or more evse-port
- In simple cases, dispenser directly replaces assembly



Photos: Dennis Schroeder / NREL (21660,48406, 56649), Thomas Kelsey / U.S. DOE Solar Decathlon (37699)

Level 3 (DC) EVSE Dispensers



This Signet EVSE has a nameplate that labels it as a “dispenser”

Electrify America’s dispensers have “Charger ID XX” for EV drivers to use when they report issues



Photos: Rick Jennings

Revisiting evse-port

- An evse-port delivers electricity to a single EV at a time
- An evse-port is typically comprised of a software-controlled electrical contactor or circuit breaker
- An evse-port is typically (but not always) contained within an evse-dispenser
- More than one evse-cable may be connected to a single evse-port, but only one may be energized at any given time

Introducing the evse-powerConverter



Power Converter: converts one electrical waveform to another using power electronic circuitry. Has clearly defined inputs and outputs. May convert:

- AC → DC
- AC → AC*
- DC → DC
- DC → AC



The evse-powerConverter may be either within the evse-dispenser or in a separate equipment enclosure.

*An AC/AC power converter performs the same task as a power transformer but using power electronics.

Photos: Rick Jennings

New EVSE Equipment Taxonomy: Option 1

evse-system
(Not yet formally proposed)

evse-powerConverter-equip

0 ↑
elecRef
*

evse-dispenser-equip

0 ↑
equipRef
*

evse-port-equip

0 ↑
equipRef
*

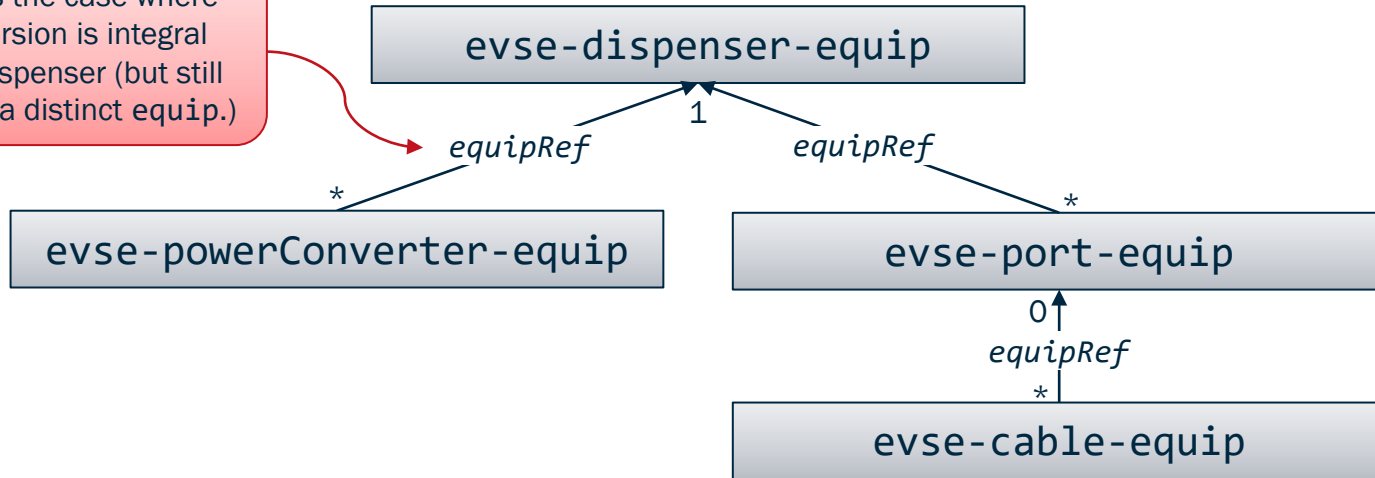
evse-cable-equip

This handles the case where power conversion is separate from the dispenser.

Any element can be omitted; hence the “zero” option for each relationship.

New EVSE Equipment Taxonomy: Option 2

This handles the case where power conversion is integral within the dispenser (but still modeled as a distinct equip.)



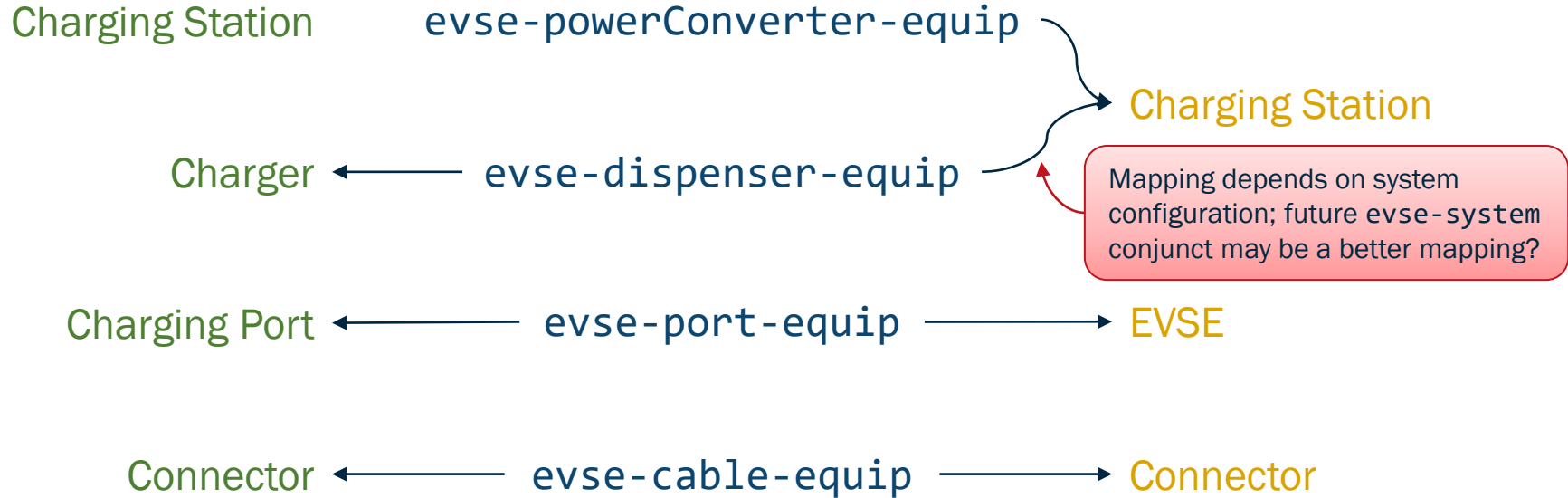
New EVSE Equipment Taxonomy: Option 3

evse-dispenser-powerConverter-port-cable-equip
evse-dispenser-port-cable-equip
evse-dispenser-port-equip
evse-dispenser-equip
etc.

Different elements can also be collapsed into a single equip, or some elements may be omitted from the model in simple applications.

These options cover the majority of the use cases. We anticipate this taxonomy will also accommodate evse-port located in a separate equipment enclosure than the evse-dispenser.

NEVI ↔ Haystack (Proposed) ↔ OCPP



evseCableType tag on evse-cable-equip

- Enum that defines the cable type
- Based on OCPP 2.0.1 ConnectorEnumType but limited to physical cables only
- Values
 - ccs1
 - ccs2
 - chademo
 - nacs
 - saeJ1772
 - iecType2
 - saeJ3068
 - mcs
 - gbt

This is near-final; just need to review the list for completeness and consistency

Note: Since OCPP 2.0.1 was published Tesla open-sourced their connector and called it the “North American Charging Standard” (NACS)

Preview: Introducing EVSE Level Tags

- Proposal to add marker tags:
 - evseLevel1 = 120 V_{AC} Charging
 - evseLevel2 = 208 V_{AC} or 240 V_{AC} Charging
 - evseLevel3 = DC Fast Charging

Still working on the correct labels for these markers.

Preview: Points on ac-evse-port-equip

	evse, session, sensor, point	evse, status, sensor, point	total, import, ac, elec, active, power, sensor, point	total, import, ac, elec, active, energy, hisTotalized, sensor, point	import, ac, elec, current, magnitude, sensor, point
ts1	-	“Available”	-	-	-
ts2	-	“Preparing”	-	-	-
ts3	"1234"	-	-	0kWh	-
ts4	-	“Charging”	-	-	-
ts5	-	-	9.44kW	0.17kWh	40.62A
...					
tsX1	-	-	9.39kW	29.37kWh	40.41A
tsX2	stop	-	9.38kW	29.41kWh	40.38A
tsX3	-	“Finishing”	-	-	-
tsX4	-	“Available”	-	-	-

Stores the EV charging session ID

Ongoing work related to total and import tags

Preview: Points on dc-evse-port-equip

	evse, session, sensor, point	evse, status, sensor, point	total, import, dc, elec, active, power, sensor, point	total, import, dc, elec, active, energy, hisTotalized, sensor, point	elec, vehicle, battery, level, sensor, point
ts1	-	“Available”	-	-	-
ts2	-	“Preparing”	-	-	-
ts3	"1234"	-	-	0kWh	-
ts4	-	“Charging”	-	-	-
ts5	-	-	9.44kW	0.17kWh	40.2%
...					
tsX1	-	-	9.39kW	29.37kWh	90.8%
tsX2	stop	-	9.38kW	29.41kWh	90.9%
tsX3	-	“Finishing”	-	-	-
tsX4	-	“Available”	-	-	-

Stores the EV charging session ID

Ongoing work related to total and import tags

Preview: evse, status, sensor, point

- An enum based on OCPP 2.0.1 ConnectorStatusEnumType
- Possible values
 - available
 - occupied
 - reserved
 - unavailable
 - fault / faulted
- For OCPP 1.6J: Map “Preparing”, “Charging”, “SuspendedEVSE”, “SuspendedEV”, “Finishing” to “occupied”

Preview: elec-vehicle

- Electric vehicle location and state of charge data can be important when developing EV charging strategies
- Work in progress – defining this new taxonomy
- Very simple and limited scope for now
- Points
 - Location tracking: kind: “Coord”, point
 - elec, vehicle, battery, level, sensor, point

Ready to Propose - Equip

- Remove
 - evse-assembly
- Add
 - evse-dispenser
 - evse-powerConverter
- Modify
 - evse-cable

Proposal to limit the scope of the evse-cable definition to physical EVSE cables

Work in Progress - Tags

- Add enum
 - `evseCableType`
- Add marker tags
 - `evseLevel1`
 - `evseLevel2`
 - `evseLevel3`

Proposal to limit scope of `evseCableType` to types of physical EVSE cables

Work in Progress – Points

- Add points on evse-port-equip
 - evse, session, sensor, point
 - evse, status, sensor, point
- Add points on ac-evse-port-equip
 - total, import, ac, elec, active, power, sensor, point
 - total, import, ac, elec, active, energy, hisTotalized, sensor, point
 - import, ac, elec, current, magnitude, sensor, point
- Add points on dc-evse-port-equip
 - total, import, dc, elec, active, power, sensor, point
 - total, import, dc, elec, active, energy, hisTotalized, sensor, point

Work involves defining enum values to:
evse, status, sensor, point

Ongoing work related to
total and import tags

Future Work - Equips

- evse-system
- evse-chiller
- elec-vehicle
- Sockets, pantographs, & wireless charging
- Related electrical distribution equipment (separate WG?)

Future Work – Points

- Add points on elec-vehicle
 - Location tracking: kind: “Coord”, point
 - elec, vehicle, battery, level, sensor, point
- Points that model generic and vendor-specific errors codes
 - The #1 industry challenge right now is equipment reliability!
 - Therefore, we need a clean and efficient way to capture and express error codes within Haystack
- Other EVSE points: setpoints, OCPP configuration settings, etc.

Introducing these points depends
on a vehicle proposal

How To Get Involved

1. Join the working group
2. Review WG proposals
3. Beta test proposed tags and relationships
4. Share examples of real-world systems and data

Q&A and Contact Info

Stephen.Frank@nrel.gov

rick@skyfoundry.com

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References

1. “National Electric Vehicle Infrastructure Standards and Requirements,” 23 CFR Part 680. *Federal Register*, Vol. 88, No. 39. pp. 12724–12757. Accessed: May 23, 2023. [Online]. Available: <https://www.federalregister.gov/documents/2023/02/28/2023-03500/national-electric-vehicle-infrastructure-standards-and-requirements>
2. Open Charge Alliance, “Open Charge Point Protocol 2.0.1.” Mar. 31, 2020. Accessed: May 23, 2023. [Online]. Available: <https://www.openchargealliance.org/>