



# ChargeX KPIs Transition to SAE

January 2025

*Changing the World's Energy Future*

Casey W Quinn



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# **ChargeX KPIs Transition to SAE**

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# ChargeX KPIs Transition to SAE

Defining the Charging Experience



**CHARGE**X  
consortium



LED BY



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INL/MIS-25-82718

# Antitrust Guidelines for ChargeX Consortium Meetings

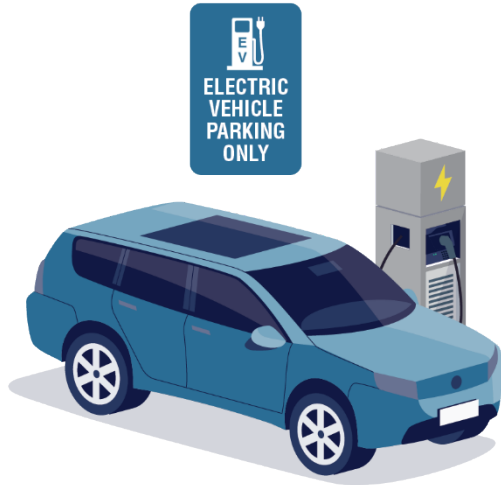
- **Do not discuss prohibited topics, such as**
  - Pricing, production capacity, or cost information which is not publicly available
  - Confidential market strategies or business plans
  - Other competitively sensitive information
- **Do not disparage** other manufacturers, suppliers, service providers, or other organizations
- **Be accurate, objective, and factual** in any discussions of goods and services offered in the market by others, including your competitors, suppliers, and customers
- **Do not suggest or influence anti-competitive actions to others** or advise others on their business decisions, and do not discuss yours, except to the extent that they are already public
- **Do not engage in or agree to take prohibited actions, such as**
  - to discriminate against or refuse to deal with (i.e., “boycott”) a supplier
  - to do business only on certain terms and conditions; or to set price, divide markets, or allocate customers
- **Consult with your organization’s legal counsel** if at any time you believe discussions are touching on sensitive antitrust subjects such as pricing, bids, allocation of customers or territories, boycotts, tying arrangements and the like

# Defining the Charging Experience

## FINDING A CHARGER



## ACCESSING A CHARGER



## STARTING A CHARGE

CHARGE ATTEMPT ▶ START OF POWER TRANSFER ▶ END OF POWER TRANSFER ▶ DISCONNECT



power delivery  
◀ event ▶



## FEELING SAFE AND COMFORTABLE



## GETTING HELP



# Measuring the Charging Experience

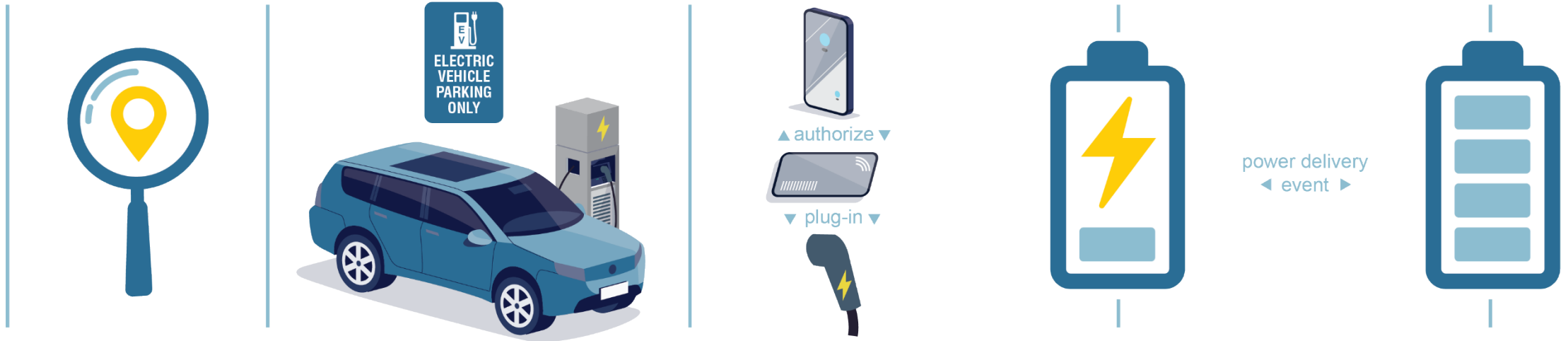
FINDING A CHARGER

ACCESSING A CHARGER

STARTING A CHARGE

COMPLETING A CHARGE

CHARGE ATTEMPT ▶ START OF POWER TRANSFER ▶ END OF POWER TRANSFER ▶ DISCONNECT



Defined Key Performance Indicators (KPIs) to measure and improve performance:

Interim set of KPIs (for near-term implementation)

Ideal set of KPIs (requires development for long-term implementation)

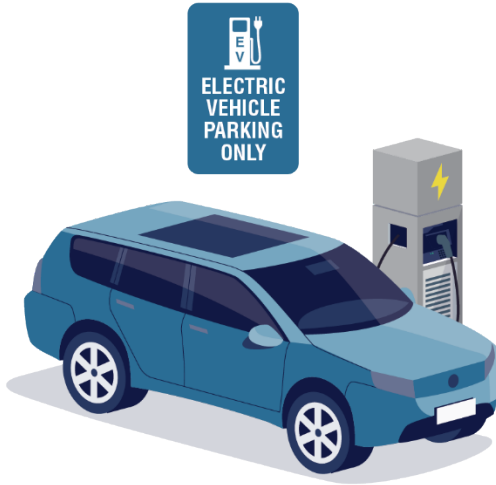
# ChargeX KPIs

## FINDING A CHARGER



LOCATION ACCURACY

## ACCESSING A CHARGER



WAIT TIME

## STARTING A CHARGE

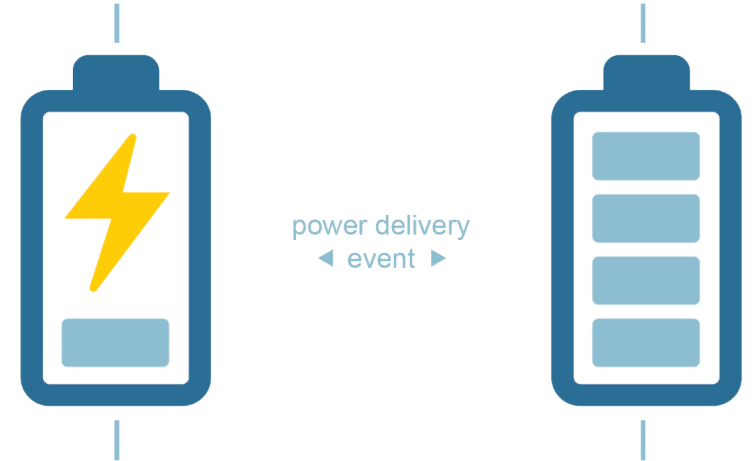
CHARGE ATTEMPT ▶ START OF POWER TRANSFER ▶ END OF POWER TRANSFER ▶ DISCONNECT



CHARGE START SUCCESS\*

CHARGE START TIME\*

## COMPLETING A CHARGE



CHARGE END SUCCESS\*

EXTENDED CHARGE TIME

SESSION SUCCESS

FIRST TIME SESSION SUCCESS

VISIT SUCCESS



\* Included in both interim and ideal sets

# KPI Importance and Implementation

		Interim Set of KPIs <i>CSO currently generating necessary data</i>	Ideal Set of KPIs <i>CSO not currently generating necessary data; requires significant tech or process development</i>
<b>Importance for Improving the Charging Experience</b>	Higher Importance	<ul style="list-style-type: none"> <li>• Charge Start Success<sup>14</sup></li> <li>• Charge End Success<sup>14</sup></li> <li>• <i>Session Success</i> (proxy for First-Time Session Success)<sup>14</sup></li> </ul>	<ul style="list-style-type: none"> <li>• First-Time Session Success<sup>15</sup></li> <li>• Visit Success<sup>15</sup></li> </ul>
	Lower Importance	<ul style="list-style-type: none"> <li>• Charge Start Time<sup>14</sup></li> </ul>	<ul style="list-style-type: none"> <li>• Wait Time<sup>15</sup></li> <li>• Extended Charge Time<sup>16</sup></li> <li>• Location Accuracy<sup>15</sup></li> </ul>

Note that some KPIs are in both sets. KPIs in the ideal set that are not in the interim set cannot be calculated today, given the state of the industry. The ideal set of KPIs is meant to be implemented in the long term. They are published here to guide the industry into maturity.

<sup>14</sup> Data sources have been identified in OCPP 1.6J and/or OCPP 2.0.1

<sup>15</sup> Likely requires data from EVs or other sources; to be investigated by ChargeX Consortium's Diagnostics Task Force.

<sup>16</sup> Likely requires modifications to ISO15118-2; to be investigated by ChargeX Consortium's WG2 Communication Task Force

# Interim KPIs

# Charge Start Success\*

- **Background:** This KPI addresses the effort required to start a charging session. This KPI is also included in the ideal set of KPIs.
- **Definition:** Percent of charge attempts that result in an EVSE starting to deliver power to an EV.

$$\left( \frac{\sum \text{EVSE port charge attempts that successfully start power delivery}}{\sum \text{EVSE charge attempts}} \right) \times 100$$

Charge attempt = a customer's attempt to start a charging session by either (a) plugging the EVSE connector into the EV or (b) presenting valid credentials and/or payment or taking another appropriate action to authorize a charging session

Start of power delivery = the instant when electricity starts being transferred from EVSE to EV

# Charge Start Time\*

- **Background:** This KPI addresses the time required to start a charging session. This KPI is also included in the ideal set of KPIs
- **Definition:** Mean time required for an EVSE to begin delivering power after a charge attempt is initiated.

$$(t_{power,i} - t_{attempt,i})$$

$t_{power}$  = timestamp when power delivery begins

$t_{attempt}$  = timestamp when a charge attempt begins

A charge attempt = a customer's attempt to start a charging session by either (a) plugging the EVSE connector into the EV or (b) presenting valid credentials and/or payment or taking another appropriate action to authorize a charging session

Start of power delivery = the instant when electricity starts being transferred from EVSE to EV

*Only use time associated with sessions that successfully start delivering power*

# Charge End Success\*

- **Background:** This KPI addresses the effort required to receive a complete charge. This KPI is also included in the ideal set of KPIs
- **Definition:** Percent of charging sessions that successfully complete.

$$\left( \frac{\sum \text{EVSE port charge attempts that result in a charging session ending successfully}}{\sum \text{EVSE port charge attempts that start power delivery}} \right) \times 100$$

Charge attempt = a customer's attempt to start a charging session by either (a) plugging the EVSE connector into the EV or (b) presenting valid credentials and/or payment or taking another appropriate action to authorize a charging session

Start of power delivery = the instant when electricity starts being transferred from EVSE to EV

A session ending successfully = a charging session that has a termination due to customer intervention as defined in OCPP or by reaching an energy or SOC limit and the EV can be disconnected from the EVSE

Only sessions that successfully started power delivery are included in this KPI.

# Session Success\*

- **Background:** This KPI encompasses both charge start success and charge end success; thus, it provides an assessment of the overall effort required to complete a charging session. This KPI is also included in the ideal set of KPIs.
- **Definition:** Percent of charge attempts that successfully start a charging session (i.e., that result in an EVSE starting to deliver power to an EV) and the charging session goes on to successfully complete.

$$\left( \frac{\sum \text{EVSE port charge attempts that result in a successful session ending success}}{\sum \text{EVSE port charge attempts}} \right) \times 100$$

Charge attempt = a customer's attempt to start a charging session by either (a) plugging the EVSE connector into the EV or (b) presenting valid credentials and/or payment or taking another appropriate action to authorize a charging session

A session ending successfully = a charging session that has a termination due to customer intervention as defined in OCPP or by reaching an energy or SOC limit and the EV can be disconnected from the EVSE

# Ideal KPIs

# Location Accuracy

- **Background:** This KPI addresses the effort to locate an EVSE. There is no interim proxy measure for this KPI.
- **Definition:** Difference between the geolocation of EVs charging at the EVSE or charging station and the EVSE or charging station geolocation published by the CSO.

$$6378137 \times \arccos[(\sin(EVSE \text{ lat}) \times \sin(EV \text{ lat})) + \cos(EVSE \text{ lat}) \times \cos(EV \text{ lat}) \times \cos(EV \text{ long} - EVSE \text{ long})]$$

EVSE lat (radians) = EVSE port or charging station latitude provided by the CSO

EV lat (radians) = Latitude of an EV when connected to the EVSE port, or any EVSE port at the charging station

EVSE long (radians) = EVSE port or charging station longitude provided by the CSO

EV long (radians) = Longitude of the EV when connected to the EVSE port, or any EVSE port at the charging station

# Wait Time

- **Background:** This KPI addresses the time required to access an available, functional charger.
- **Definition:** Time to access a functional charging port at a site.

$$(t_{attempt,i} - t_{arrival,i})$$

$t_{arrival}$  = timestamp when a vehicle arrives at a charging station

$t_{attempt}$  = timestamp when a charge attempt is made

# Extended Charge Time

- **Background:** This KPI addresses the time required to complete a charging session. There is no interim proxy measure for this KPI.
- **Definition:** The time a charging session is extended due to power limitations of the EVSE.

$$\left( T - \left( \frac{E}{\left( \frac{E}{T} - SPE \right)} \right) \right) \times 3600$$

session power error (SPE) = error between power delivered by EVSE port and power an EV can accept throughout the session (kW)

E = charging energy delivered to EV (kWh)

T = total time during a session when electricity is transferred from EVSE to EV (hours)

# First-Time Session Success

- **Background:** This KPI encompasses both charge start success and charge end success; thus, it provides an assessment of the overall effort required to complete a charging session. Session success is the interim proxy measure for this KPI.
- **Definition:** Percent of ***first*** charge attempts that successfully start a charging session (i.e., that result in an EVSE starting to deliver power to an EV) and the charging session goes on to successfully complete the ***first*** charge attempt by a customer at a charging port for each EV visit to a charging station.

$$\left( \frac{\sum \text{FirstTime EVSE port charge attempts that result in charging session ending successfully}}{\sum \text{EVSE port charge attempts}} \right) \times 100$$

Charge attempt = a customer's attempt to start a charging session by either (a) plugging the EVSE connector into the EV or (b) presenting valid credentials and/or payment or taking another appropriate action to authorize a charging session

A session ending successfully = a charging session that has a termination due to customer intervention as defined in OCPP or by reaching an energy or SOC limit and the EV can be disconnected from the EVSE

# Visit Success

- **Background:** This KPI encompasses both charge start success and charge end success; thus, it provides an assessment of the overall effort required to complete a charging session. Session success is the interim proxy measure for this KPI.
- **Definition:** Percent of visits to a charging station where at least one charge attempt successfully starts a charging session (i.e., result in an EVSE starting to deliver power to an EV) and where the charging session goes on to successfully complete.

$$\left( \frac{\sum EV \text{ visits to a charging station that result in charging session ending successfully}}{\sum EV \text{ station visits}} \right) \times 100$$

EV station visit = a distinct visit to a charging station (i.e., period of time the customer's EVs spends at the station between arrival and departure), during which the customer makes at least one charge attempt

Charge attempt = a customer's attempt to start a charging session by either (a) plugging the EVSE connector into the EV or (b) presenting valid credentials and/or payment or taking another appropriate action to authorize a charging session

A session ending successfully = a charging session that has a termination due to customer intervention as defined in OCPP or by reaching an energy or SOC limit and the EV can be disconnected from the EVSE