METHODOLOGY FOR ELECTRIC VEHICLE CHARGING SYSTEMS

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The EVCCC seeks to open up access to the carbon capital markets for EV charging systems in order to strengthen their business case fundamentals and accelerate deployment. Beyond GM's business case development, founding members include:

- Electrify America LLC/Audi of America
- Exelon
- EVgo
- Siemens
- Connecticut Green Bank
- Carbon Neutral Cities Alliance (including Portland, San Francisco, Seattle, Palo Alto, NYC, Minneapolis, Vancouver BC, Sydney, Adelaide, AU)

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1 SOURCES

This methodology uses the latest versions of the following modules:

- *Activity Method for Determining Additionality of Electric Vehicle Charging Systems, v1.0*

This methodology is based upon approaches used in the following methodologies:

- CDM methodology *AMS-III.C. Emission Reductions by Electric and Hybrid Vehicles*[1].

2 SUMMARY DESCRIPTION OF THE METHODOLOGY

Additionality and Crediting Method	
Additionality	Projects eligible to apply module VMD00XX (module referenced in Section 1 above): Activity method All other projects: Project method
Crediting Baseline	Project method

This methodology applies to the charging of electric vehicles (EVs) through EV charging systems, including their associated infrastructure, whose GHG emission reductions are achieved through the displacement of emissions from conventional fossil fuel vehicles used for passenger and freight transportation as a result of the electricity delivered by the project chargers.

This methodology provides easy-to-use monitoring parameters to quantify emission reductions, and also establishes default factors for the estimation of certain parameters for projects located in the United States and Canada as an alternative to project-specific calculations.

Finally, this methodology is applicable globally, and provides a positive list for determining additionality for regions with less than five percent market penetration of electric vehicles. The positive list is found in *Activity Method for Determining Additionality of Electric Vehicle Charging Systems, v1.0.*

3 DEFINITIONS

In addition to the definitions set out in VCS document *Program Definitions*, the following definitions apply to this methodology:

Applicable Fleets
The class of EVs eligible and technically able to charge at EV chargers associated with the project. For LDV projects, these applicable fleets comprise[2] BEVs and PHEVs for L1 and L2

[1] This methodology was based on AMS.III.C.,version 15.0. See CDM website: https://cdm.unfccc.int/methodologies/index.html
[2] There may be a very few PHEVs which also have the plug capability to charge at DCFC's (e.g. Mitsubishi Outlander): these are considered de minimis. Similarly the BMW i3 REX (with range extender) is a technically a

chargers, and BEVs for DCFCs. For HDV projects, these applicable fleets comprise the MDV/HDV electric vehicles eligible to charge at the project's set of EV chargers.

Associated Infrastructure (AI)

Stationary battery storage devices[3] and dedicated renewable energy systems (e.g., solar or biofuel from on-site or other locations which use dedicated direct transmission lines) integrated as part of EV charging systems and managed by their control units. Associated infrastructure includes on-site battery storage systems which can store and dispatch electricity to and/or from any on-site renewable power systems, the grid, and/or the EV batteries. Associated infrastructure also includes the EV batteries themselves and thus includes EV vehicle-to-grid (V2G) and EV to on-site battery exchanges of electricity.

Associated Infrastructure Metering Systems

Systems used to track electricity flows between AI devices, whether using meters and/or associated measurement systems within or external to the EV charger. These may include upstream metering, on the grid-side of the adequate metering system (e.g., where meters are installed grid-side of an on-site battery) and/or downstream metering (e.g., where metering takes place within the charger unit itself, downstream of the on-site battery).

Battery Electric Vehicle (BEV)

An EV which relies exclusively upon electricity delivered from an external EV charging system for its power in order to propel its motion

Charging Networks

A collection of charging systems which service any given applicable fleet

Closed Charging Networks

A collection of charging systems for which composition of the applicable fleet is constrained to a particular sub-set of EVs whose composition and operating characteristics of both the applicable and comparable fleets can be specifically identified and documented (e.g., a transit agency's e-bus charging network)

Comparable Fleets

Those fossil-fuel vehicles whose travel characteristics have been defined to be comparable to the EVs in each applicable fleet as determined in Section 4 below

PHEV but only 5% of i3's use the range extender in practice and Argonne National Laboratory's and California's classification of the REX as a BEV, it is included in the BEV category for default factor calculation purposes in this methodology.

[3] For larger powered systems (e.g. 150kw, 320kw) stationary battery systems may become a more typical integrated part of the EV charging system infrastructure over time (e.g to mitigate demand peak charges from utilities); they are controlled by the charging system's control unit and are located close to the site within the charging system's metering to the utility.

DC Fast Charger (DCFC)

A charger which provides direct current charging (typically at 200-1000V) from an off board[4] charger with a power rating above 11kw. Typical DCFC ratings are 50kw, with the newest systems for passenger vehicles in the 150kw and 320 kw ranges. DCFC classifications are defined as:

- DCFC 50kw: capable of delivering maximum power from 11kw to 62.5kw
- DCFC 100kw: capable of delivering maximum power from 63kw to 110kw (i.e., 200A)
- DCFC 150kw: capable of delivering maximum power from 111kw to 160kw (i.e., 200A@800V or 350A@400V, some with cooled connectors)
- DCFC 320kw: capable of delivering maximum power from 161kw and 360kw (i.e., cooled connectors)
- DCFC 500kw: capable delivering maximum power from 361kw and above (i.e., different connectors)

Where no kw classification is specified in this methodology, DCFC includes all classes defined above.

Dedicated Renewable Energy

Renewable power (e.g., solar, wind, and bio-fuel) supplied either from sources on-site within the associated infrastructure of the project, or received from a dedicated supply source via a direct transmission line. These renewable sources represent a distinct segment, differentiated from the renewable electricity supplied via the broader grid. These dedicated renewables may also be delivered in part for use on the main grid.

Electric Vehicle (EV)

Vehicles, including BEVs and PHEVs, spanning both passenger cars, LDVs and HDVs, powered by the external electricity sources of charging systems. EVs do not include hybrid-only vehicles since they do not consume electricity from externally generated sources.

EV Chargers

Charging dispensers and their metering systems including L1, L2 and/or DCFC units which provide electricity to EVs within an applicable fleet and which may form part of an EV charging system

EV Charging Credits

Credits issued for emission reductions under this methodology for reductions arising from delivered EV charging system services

[4]See SAE standards: http://grouper.ieee.org/groups/earthobservationsSCC/IEEE_SAE_J1772_Update_10_02_08_Gery_Kissel.pdf

EV Charging Systems

A set of EV chargers including L1, L2 and/or DCFC and their associated infrastructure (if any) which, when located at a given charging site, provide electricity to EVs within a given applicable fleet, and which may form part of a charging network

EV Fleet Credits

Credits issued for emission reductions achieved by EV fleets under separately certified GHG projects[5]

EV Market Share

The number of EVs on the road within a geographic region, expressed as a percentage of total vehicles on the road within a geographic region, segmented for applicable fleets across LDV and HDV sectors

Heavy Duty Vehicles (HDV)

Vehicles consistent with definitions provided by the governing national regulatory system(s) of the project location. HDVs may also include medium duty vehicles (MDVs). These must be consistent with the data sources used in the standardized tests and default ER factors applied, if any[6].

Kwh/100 mile ratings

Ratings as provided by credible national government/regulatory sources which establish the kwh consumed to travel 100 miles, sourced for each EV model within applicable fleets, and used to calculate the weighted average Applicable Fleet's Electricity Consumption (AFEC) rating

Level 1 Charger (L1)

A charger which provides 120V alternating current charging services to the vehicle's on-board charger with a power rating up to 1.8kw

Level 2 Charger (L2)[7]

A charger which provides 240V alternating current charging services to the vehicle's on-board charger with a power rating up to 20kw (typically from 3.3kw to 6.6 kw)

Light Duty Vehicles (LDV)

Cars and trucks consistent with definitions provided by the governing national regulatory system(s) of the project location. These must be consistent with the data sources used in the standardized tests and default ER factors applied, if any[8].

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[5] For example, credits issued from projects that utilize other methodologies focused on issuance of EV fleet credits such CDM methodology AMS-III.C

[6] For example, in the United States, HDVs are specified as including both HDVs and those MDVs with GVWR of more than 14,000lbs (typically from class 4 and above), consistent with the IHS Markit data sources applied in the development of the default factors. HDV vehicles include both e-buses and e-trucks.

[7] Note: in London UK, L2 chargers have been referenced as fast chargers. And DCFC are referenced as rapid chargers. Regardless of nomenclature, the chargers will be defined against the technical criteria provided here

[8] For example, in the United States, LDVs are specified as including vehicles with Gross Vehicle Weight Ratings (GVWR) up to and including 14,000lbs, (classes 1, 2, and 3) and must therefore include those Medium Duty Vehicles

Medium and Heavy Duty Electric Vehicle (HDV EV)

Medium duty and heavy duty vehicles (collectively defined as *HDV*) comprising both BEV and PHEV HDV electric vehicles, including e-buses and e-truck categories, which rely upon electricity delivered from external EV charging systems for their power

Miles per gallon (MPG) ratings

Mile per gallon ratings as provided by credible national government/regulatory sources establish the miles traveled per gallon of fuel consumed, for those fossil fuel vehicles deemed comparable per Section 4 to the EV's applicable fleet [9]

Plug in Hybrid Electric Vehicle (PHEV)

A vehicle combining an internal combustion engine and one or more electric motors, which must also be capable of receiving delivered electricity by plugging into an external EV charging system for its power in order to propel its motion

Private Charging Networks

Charging systems where charger access is limited to a defined applicable fleet. For example, residential chargers would be considered private since access is restricted, as would a city's chargers if their use was limited to the charging of the city's own EV fleet vehicles. Private refers to the limited degree of access to the chargers, not the charging system's owner's status (since public city chargers can use private charging networks). The composition of those EVs accessing the network need not be known (that is, both open (e.g. residential) and closed (e.g. e-bus transit agency charging) networks can be private if access is limited).

Open Charging Networks

A charging network where the applicable fleet is not constrained to a particular sub-set of EVs whose composition and operating characteristics of both the applicable and comparable fleets can be identified and documented as with a closed charging network

4 APPLICABILITY CONDITIONS

This methodology applies to project activities which install EV charging systems, including their associated infrastructure, in order to charge EV applicable fleets whose GHG emission reductions are achieved through the displacement of conventional fossil fuel vehicles used for passenger and freight transportation as a result of the electricity delivered by project chargers.

(MDVs) up to this same weight limit[8], consistent with the IHS Markit data sources applied in the development of the default factors. This 14,000lbs GVWR values is based upon definitions used and supplied by IHS Markit data for light duty vehicles, whose data forms the basis for most US EV market analysis publications. Commercial applications in the 8500-14000 lb Class 2b and 3 are a de minimis proportion of total LDV's. See also: http://changingears.com/rv-sec-tow-vehicles-classes.shtml and https://en.wikipedia.org/wiki/Truck_classification. Lighter MDV's include the kind of vehicles which also use the main LDV charging networks e.g. retirement home vans etc

[9] For countries using other metrics, e.g. ratings in Europe for CO2 per km, conversion guidance is given in section 8.

Projects must comply with all applicability conditions set out below:

1) The applicable fleets of projects applying this methodology are limited to all LDV BEVs and PHEVs[10], and HDV EVs. For LDV projects, these applicable fleets comprise[11] BEVs and PHEVs for L1 and L2 chargers, and BEVs for DCFCs. For HDV projects, these applicable fleets comprise the MDV/HDV electric buses and trucks, both BEV and PHEV, eligible to charge at the project's set of EV charging systems.

2) Project proponents must demonstrate that the EV models comprising the applicable fleet of the project are comparable to their conventional fossil fuel baseline vehicles using the following means:

   - Project and baseline vehicles belong to the same vehicle category (e.g., car, motorcycle, bus, truck, LDV, MDV, HDV);
   - Project and baseline vehicles have comparable passenger/load capacity (comparing the baseline vehicle with the respective project vehicle).
   - Where project proponents apply the baseline emission default factors for MPG and AFEC determined for the US and Canada, this comparability requirement between applicable and comparable fleet models has already been completed and satisfied.

3) In order to demonstrate that double counting of emission reduction will not occur, the project proponent must maintain an inventory of EV chargers included in the project, including their L1/L2/DCFC classifications and unique identifiers; other measures may include disclosure of credit ownership to EV drivers. Double counting relative to any issued EV fleet credits will be addressed using the emission reduction discount adjustments in section 8.4 below[12]. Where associated infrastructure and/or renewable power (on-site and/or direct transmission) are included in an EV charging system, this must be referenced and described in the charging system's inventory. Project documentation must also include the following for each EV charger:

   - Classification using the performance voltage, AC/DC basis and kw power specifications given for L1, L2 and DCFC 50/100/150/320/500 definitions
   - Unique identifiers, including the geo-spatial coordinates and one other unique reference such as NEMA codes, customer codes, equipment serial numbers, charger ID codes, or AFDC ID codes

[10] Hybrid-only vehicles, which do not have batteries capable of receiving electricity to propel their motion, are not eligible for this methodology

[11] There may be a very few PHEVs which also have the plug capability to charge at DCFC's (e.g. Mitsubishi Outlander): these are considered de minimis. Similarly the BMW i3 REX (with range extender) is a technically a PHEV but only 5% of i3's use the range extender in practice and Argonne National Laboratory's and California's classification of the REX as a BEV, it is included in the BEV category for default factor calculation purposes in this methodology.

[12] Double counting related to any jurisdictional emission trading systems or commitments (e.g., cap-and-trade programs, etc.) must still be assessed per the VCS rules.

4) Where EV charging system AI is utilized to provide electricity to EVs to store and dispatch electricity to and from multiple sources, both on site and regionally, the AI must include adequate metering systems (e.g., meters/sub-meters and/or associated measurement systems). These metering systems must measure and accurately trace all electricity deliveries and receipts from all such interrelated associated infrastructure sources. This includes electricity sourced from/returned to the grid, dedicated renewable energy generated on-site (including RE sourced from direct transmission lines), on-site storage batteries, and/or the EV's on-board battery.

5) Projects with estimated annual emission reductions of over 60,000 $tCO2_e$[13] (large-scale) are permitted where project proponents can demonstrate that the project is located in a country with credible national data sources for GHG emission calculations. Otherwise, projects are limited to annual emission reductions equal to or under 60,000 $tCO2_e$ (small-scale). Projects located in Annex I and II countries, and countries referenced by EIA data sources, are automatically eligible to be of any scale. All regions listed in *Activity Method for Determining Additionality of Electric Vehicle Charging Systems, v1.0* meet these criteria and thus are not limited in scale.

6) Project proponents must demonstrate proof of ownership of emission reductions which may be achieved with the charging system owners through contractual agreements, terms of service, utility program participation rules, or other means and with EV drivers through disclosure of credit ownership (e.g. through dispenser notices, screen displays, terms of service, etc.).

5 PROJECT BOUNDARY

The project boundary is comprised of the following:

1) The applicable fleets for the project EV chargers;
2) The geographic boundaries where the EV charging systems are located;
3) The EV charging systems of the project activity including their electricity supply sources and associated infrastructure.

The greenhouse gases included in or excluded from the project boundary are shown in Table 1 below.

Table 1: GHG Sources Included In or Excluded From the Project Boundary

Source		Gas	Included?	Justification/Explanation
Baseline	Fossil fuel combustion of vehicles	CO_2	Yes	Main emission source
		CH_4	Optional	May be excluded for simplification
		N_2O	Optional	May be excluded for simplification

[13] The small and large scale boundary was drawn from CDM AMS-III.C

Source		Gas	Included?	Justification/Explanation
	displaced by project activities	Other	Optional	May be excluded for simplification
Project	Electricity consumption via grid	CO_2	Yes	Main emission source
		CH_4	Optional	May be excluded for simplification. Where included in the baseline, source must also be accounted in project emissions.
		N_2O	Optional	May be excluded for simplification. Where included in the baseline, source must also be accounted in project emissions.
		Other	Optional	May be excluded for simplification. Where included in the baseline, source must also be accounted in project emissions.
	Renewables via on-site/direct transmission	CO_2	Yes	Main emission source
		CH_4	Optional	May be excluded for simplification. Where included in the baseline, source must also be accounted in project emissions.
		N_2O	Optional	May be excluded for simplification. Where included in the baseline, source must also be accounted in project emissions.
		Other	Optional	May be excluded for simplification. Where included in the baseline, source must also be accounted in project emissions.
	On-site battery storage	CO_2	Yes	Main emission source
		CH_4	Optional	May be excluded for simplification. Where included in the baseline, source must also be accounted in project emissions.
		N_2O	Optional	May be excluded for simplification. Where included in the baseline, source must also be accounted in project emissions.
		Other	Optional	May be excluded for simplification. Where included in the baseline, source must also be accounted in project emissions.
	EV battery storage in vehicle	CO_2	Yes	Main emission source
		CH_4	Optional	May be excluded for simplification. Where included in the baseline, source must also be accounted in project emissions.

Source		Gas	Included?	Justification/Explanation
		N_2O	Optional	May be excluded for simplification. Where included in the baseline, source must also be accounted in project emissions.
		Other	Optional	May be excluded for simplification. Where included in the baseline, source must also be accounted in project emissions.

6 BASELINE SCENARIO

The baseline scenario is the operation of comparable fleets (the comparability of baseline and project applicable fleet vehicles to be demonstrated as per indicators set out in applicability conditions in Section 4 above), that would have been used to provide the same transportation service in the absence of the project.

7 ADDITIONALITY

Project proponents applying this methodology must determine additionality using the procedure described below:

Step 1: Regulatory Surplus

Project proponents must demonstrate regulatory surplus in accordance with the rules and requirements regarding regulatory surplus set out in the latest version of the *VCS Standard*.

Step 2: Positive List

The applicability conditions of VCS module *Activity Method for Determining Additionality of Electric Vehicle Charging Systems, v1.0* represent the positive list. The positive list was established using the activity penetration option (Option A in the *VCS Standard*). Projects that meet all applicability conditions of this methodology and the VCS module *Activity Method for Determining Additionality of Electric Vehicle Charging Systems, v1.0* are deemed additional.

Step 3: Project Method

Where Step 2 is not applicable, project proponents may apply the following[14]:

- Where the project is small-scale, the project proponent must demonstrate that the project activity would otherwise not be implemented due to the existence of one or more barrier(s) listed in the latest version of the CDM methodological tool *Demonstration of additionality of small-scale project activities*.

[14] When applying either tool, regardless of which entity is implementing the project, project proponents may demonstrate that barriers apply for charging service providers and/or their associated partners (e.g. installation customers, utilities, end-users, charging system network service providers, EV manufacturer/retailer).

- Where the project is large-scale, the project proponent must apply the latest version of the CDM *Tool for the demonstration and assessment of additionality*.

8 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

8.1 Baseline Emissions

Baseline emissions are calculated by converting the electricity used to charge project applicable fleet vehicles at the EV chargers into distance travelled, and multiplying this by the emission factor for fossil fuels used by baseline comparable fleet vehicles to travel the same distance. Baseline emissions must be calculated as follows:

$$BE_y = \sum_{i,f} EC_{iy} * EF_{ify} * 100 * IR_i^{y-1} / (AFEC_{iy} * MPG_{iy}) \quad (1)$$

Where:

BE_y = Baseline emissions in year *y* (tCO_2e)
$EC_{i,y}$ = Electricity consumed by project charging systems serving applicable fleet *i* in project year *y* (kwh)
$EF_{j,f,y}$ = Emission factor for the fossil fuel *f* used by comparable fleet vehicles *j* in year *y* (tCO_2e/gallon)
$IR_{i,}$ = Technology improvement rate factor for applicable fleet *i*
$AFEC_{i,y}$ = Weighted average electricity consumption per 100 miles rating for EVs in applicable fleet *i* in project year *y* (kwh/100 miles)
$MPG_{i,y}$ = Weighted average miles per gallon rating for the fossil fuel vehicles comparable to each EV in applicable fleet *i*, in project year y (miles per gallon)

Default values for $MPG_{i,y}$, $AFEC_{i,y}$, $EF_{j,f,y}$, and $IR_{i,}$ across both LDV and HDV applicable fleets can be found in the parameter tables in Section 9.1 below for the United States and Canada.

The weighted average electricity consumption per 100 miles rating for EVs in applicable fleet *i,* is calculated as follows:

$$AFEC_{iy} = \sum_a (EV_{aiy} * EVR_{aiy}) / \sum_a EVR_{aiy} \quad (2)$$

Where:

$AFEC_{i,y}$ = Weighted average electricity consumption per 100 miles rating for EVs in applicable fleet *i* in project year *y* (kwh/100 miles)
$EV_{a,j,y}$ = Electricity consumption per 100 miles rating for model a EV in applicable fleet *i* in project year *y* (kwh/100 miles)
$EVR_{a,j,y}$ = Total number of model a EV in applicable fleet *i* on the road by project year *y* (cumulative number of EVs)

The weighted average miles per gallon rating for the comparable fleet associated with each applicable fleet *i*, is calculated as follows:

$$\boldsymbol{MPG_{iy}} = \sum_a (\boldsymbol{MGP_{aiy}} * \boldsymbol{EVR_{aiy}}) / \sum_a \boldsymbol{EVR_{aiy}} \quad (3)$$

Where:

$MPG_{i,y}$ = Weighted average miles per gallon rating for fossil fuel vehicles comparable to each EV in applicable fleet i in project year y (miles per gallon)

$MPG_{a,j,y}$ = Mile per gallon rating for the fossil fuel vehicle model deemed comparable to each EV model a from applicable fleet i in project year y (miles/gallon)

$EVR_{a,i,y}$ = Total number of EV models within applicable fleet *i* on the road by project year y (cumulative number of EVs)

8.2 Project Emissions

Project emissions include the electricity consumption associated with the operation of the applicable fleet and must be calculated as follows:

$$\boldsymbol{PE_y} = \sum_{ij} \boldsymbol{EC_{ijy}} * \boldsymbol{EFkw_{ijy}} \quad (4)$$

Where:

PE_y = Project emissions in year *y* (tCO_2e)

$EC_{i,j,y}$ = Electricity consumed by project chargers sourced from region *j* serving applicable fleet *i* in project year y (kwh/year)

$EFkw_{i,j,y}$ = Emission factor for the electricity sourced from region *j* consumed by project charging systems serving applicable fleet *i* in year *y* (tCO_2e/kwh)

Where “time-of-day” estimates (i.e., estimates segmented by time periods within a single 24-hour day) for project emissions are available, Equation 5 may be applied, thus replacing Equation 4, provided that:

1) There are no time periods in which electricity is provided but not accounted for within *PEy* (i.e., the sum of all such time-of-day time periods *t* equals 24 in any given full day within the project).
2) Time-of-day estimates for electricity emission factors $EFkwTOD_{i,j,t,y}$ are drawn from credible, applicable sources and are provided on at least an hourly basis (e.g., the regional Independent System Operation (ISO) or applicable utility generation sources).

$$\boldsymbol{PE_y} = \sum_{ijt} \boldsymbol{ECTOD_{ijty}} * \boldsymbol{EFkwTOD_{ijty}} \quad (5)$$

Where:

PE_y = Project emissions in year *y* (tCO_2e)

$ECTOD_{i,j,t,y}$ = Electricity consumed by project chargers sourced from region *j* serving applicable fleet *i* during time of day period *t* in project year *y* (kwh/time period *t*)

$EFkwTOD_{j,,j,t,y}$ = Emission factor for the electricity sourced from region *j* consumed by project chargers serving applicable fleet *i* during time of day period *t* in year *y* (tCO_2e/kwh)

Where ISO does not provide greenhouse emission factors on an hourly basis in region *j*, but does provide fuel consumption data for electricity generation on an hourly basis, $EFkwTOD_{ji,j,t,y}$ may be estimated on a weighted average basis as follows:

1) Projects must combine the hourly fuel consumption figures (typically given as the percentage of each type of fuel consumed that hour (e.g., 50% coal, 50% natural gas)) with the emission factors for these same fuels to create a weighted average emission rate for each hourly period.

2) Emission rates for each fuel must be drawn from the same source (e.g., ISO) or consistent publication sources for region *j.*

Equations supporting these fuel-consumption based time-of-day calculations for $EFkwTOD_{j,,jy}$ are given in the equation below:

$$\mathbf{EFkwTOD_{ijty}} = \sum\nolimits_{\mathbf{f}} \mathbf{F\%_{ijtfy}} * \mathbf{EFkwF_{ijtfy}} \quad (6)$$

Where:

$EFkwTOD_{j,j,t,y}$ = Emission factor for the electricity sourced from region *j* consumed by project chargers serving applicable fleet *i* during time of day period *t* in year *y* (tCO_2e/kwh)

$EFkwF_{i,j,t,f,y}$ = Emission factor applicable for the fuel type *f* used to generate the kwh sourced from region *j* consumed by project charging systems serving applicable fleet *i* during time of day period t in year y (tCO_2e/kwh)

$F\%_{i,j,t,f,y}$ = Percentage of fuel type *f* used to generate the kwh during each time of day period *t*, sourced from region *j* and consumed by EV charging systems serving applicable fleet *i* in year *y* (%)

Where projects include associated infrastructure within their charging systems, project emissions must be quantified for all such sources *s* following Equation 7, which must replace Equation 4, where the following applies:

1) The electricity emissions factor for the on-site battery must be calculated using the net weighted average of the grid and on-site renewable emission factors as provided in Equation 8 below.

2) The charging system's metering system must adequately and accurately measure and trace such net electricity kwh provided to the charging system (i.e., deliveries minus receipts) from all electricity sourced from/returned to the grid and the dedicated

renewables. This includes, for example, electricity sourced from the grid, dedicated renewables (e.g., on site) and delivered to the EV directly and/or via on-site batteries, net of kwh returned back to such sources from the EV batteries[15].

$$\boldsymbol{PE_y = \sum_{ijs} NEC_{ijsy} * EFkwAI_{ijsy} - \sum_{ij} LEC_{ijy} * EFkwonsitebatt_{ijy}} \quad (7)$$

Where:

PE_y = Total project emissions in year y (tCO_2e)

$NEC_{i,j,s,y}$ = Electricity consumed by EV charging systems supplied from associated infrastructure source *s* net of any kwh EV/charger returned to this same source within region *j* serving applicable fleet *i* in project year *y* (kwh/year)

$EFkwAI_{j,,j,s,y}$ = Emission factor for the electricity from each associated infrastructure source *s* within region *j* consumed by project chargers serving applicable fleet *i* in year *y* (tCO_2e/kwh)

$LEC_{j,,j,y}$ = Electricity provided to the grid and/or building from on-site storage battery within region *j* serving applicable fleet *i* in project year *y* (kwh/year)

$EFkwonsitebatt_{i,j,y}$ = Emission factor for the electricity from the on-site battery associated infrastructure source *s* within region *j* consumed by project charging systems serving applicable fleet *i* in year *y* (tCO_2e/kwh)

Where projects include associated infrastructure, the emission factor for electricity from on-site battery associated infrastructure must be calculated using the net weighted average of the grid and on-site renewable emission factors as follows:

$$\boldsymbol{EFkwonsitebatt_{ijy} = \sum_{z} ECB_{ijzy} * EFkwAIZ_{ijzy}} \quad (8)$$

Where:

$EFkwonsitebatt_{i,j,y}$ = Emission factor for the electricity from the on-site battery associated infrastructure source *s* within region *j* consumed by project charging systems serving applicable fleet *i* in year *y* (tCO_2e/kwh)

$ECB_{i,j,z,y}$ = Electricity consumed by on-site battery from associated infrastructure sources *z*, which comprise only the grid-connected and dedicated renewable sources, within region *j* serving applicable fleet *i* in project year *y* (kwh/year)

$EFkwAI\text{-}Z_{i,j,z,y}$ = Emission factor for the electricity from the associated infrastructure sources *z*, which comprise only the grid-connected and dedicated renewable sources,

[15] It should be noted that metering systems for associated infrastructure can include “downstream” meters close to the EV, such as those provided by DCFC onboard meters, and “upstream” meters, located grid-side such as meters monitoring kwh delivered to the on-site batteries. Guidance provided in Appendix 2 is designed to assist the application of Eq 7 given the particular features of a project’s adequate metering systems.

within region *j* consumed by on-site batteries serving applicable fleet *i* in year *y* (tCO_2e/kwh)

Guidance for sourcing the emission factors for the other associated infrastructure sources *s* is provided in the monitoring parameter boxes found in Section 9.

Where projects include associated infrastructure and estimates for time-of-day project emissions are available, Equation 9 may be followed, thus replacing Equations 4, 5 and 7, provided that:

- There are no time periods in which electricity is provided but not accounted for within *PEy* (i.e., the sum of all such time-of-day time periods, t, equals 24 in any given full day within the project)
- Time-of-day estimates for electricity emission factors, $EFkwTODAI_{j,j,s,t,y}$ are drawn from credible, applicable sources (e.g., the regional ISO or applicable utility generation source).
- Equation 7 must be applied to calculate $EFkwTODAI_{j,j,s,t,y}$ where electricity generation's hourly fuel consumption data is relied up to provide time-of-day emission rates for each associated infrastructure source (e.g., grid-derived electricity)
- The electricity emissions factor for the on-site battery must be calculated using the net and time weighted average of the grid and on-site renewable emission factors given in Equation 8.
- The provisions regarding the charging system's adequate metering systems as given for Equation 7 and 8 (including guidance offered in Appendix 2) also apply for Equation 9 in order to adequately and accurately measure and trace net electricity consumption (NECT) from sources *s*, but are applied during each time-of day period *t* provided that:
    - For time-of-day applications of associated infrastructure calculations pertaining to the NECT for an on-site battery's kwh delivered to the EV charger, metering must be applied "upstream", on the grid-side of the on-site battery. That is, for the calculation of NECT for an on-site battery, Equation 9 will, using upstream meters, calculate the kwh delivered to EV chargers via the on-site battery from grid and/or dedicated renewable sources during the time of day period t taking into account *when* these kwh are actually delivered *to the on-site battery* (i.e., not when delivered from this battery to the EV charger), since the GHG impacts for these kwh arise on the grid system when they are first delivered into this associated infrastructure system (that is, are delivered to the on-site battery)
    - For these applications, kwh supplied by the EV to the on-site battery can be set aside (since they return to the EV at a later date) unless, during a given time period *t*, the LECT less the kwh received by the on-site battery from grid and renewable sources less the on-site battery's stored kwh is greater than zero – that is, LECT is so large that it must have drawn upon the kwh delivered to the on-site battery from the EV

- o In the context of these NECT calculations for the on-site battery, note that the electricity supplied from the grid to the EV charging system directly, and the electricity supplied by the EV back to the grid during any time period *t* are considered separately in the calculation of NECT for the grid.

$$PE_y = \sum_{ijst} NECT_{ijsty} * EFkwTODAI_{ijsty} - \sum_{ijt} LECT_{ijty} * EFkwonsitebatt_{ijty} \quad (9)$$

Where:

PE_y	= Project emissions in year *y* (tCO_2e)
$NECT_{i,j,s,t,y}$	= Electricity consumed by project chargers supplied from associated infrastructure source s net of any kwh EV/charger returned to this same source during time-of-day period *t*, within region *j* serving applicable fleet *i* in project year y (kwh/time period *t*)
$EFkwTODAI_{i,j,s,t,y}$	= Emission factor for the electricity from associated infrastructure source *s* within region *j* consumed by project chargers serving applicable fleet *i* during time-of-day period *t* in year *y* (tCO_2e/kwh)
$LECT_{i,j,t,y}$	= Electricity provided to the grid and/or building from on-site storage battery during time-of-day period *t* within region *j* serving applicable fleet *i* in project year *y* (kwh/year)
$EFkwTODonsitebatt_{i,j,t,y}$	= Emission factor for the electricity from the on-site battery associated infrastructure source *s* during time-of-day period *t* within region *j* consumed by project chargers serving applicable fleet *i* in year *y* (tCO_2e/kwh)

8.3 Leakage

Leakage is not considered an issue under this methodology, and is therefore set at zero.

8.4 Net GHG Emission Reductions and Removals

Net GHG emission reductions must be calculated as follows, including application of a discount factor, D_y, to adjust pro-rata where EV fleet credits have been issued within the project region:

$$\mathbf{ER_y} = (\mathbf{BE_y} - \mathbf{PE_y} - \mathbf{LE_y}) * \mathbf{D_y} \quad (10)$$

Where:

ER_Y	= Net GHG emissions reductions and removals in year *y* (tCO_2e)
BE_Y	= Baseline emissions in year *y* (tCO_2e)
PE_y	= Project emissions in year *y* (tCO_2e)
LE_y	= Leakage in year *y* (tCO_2e)
D_y	= Discount factor to be applied in year *y* (%)

Where:

$$\mathbf{D_y} = \mathbf{ERC_y}/(\mathbf{ERF_y} + \mathbf{ERC_y}) \quad (11)$$

Where:

D_y = Discount factor to be applied in year *y* (%)

ERC_y = Sum of all EV charging projects' credits (whether via this project or others) across the project's applicable fleet *i* categories issued within the total project region in project year y-1 (tCO_2e)

ERF_y = Sum of all EV fleet projects' credits issued (from other projects using other EV fleet based methodologies) for these same applicable fleet i categories located within the project's total region, in project year y-1 (tCO_2e)

Where there are no EV fleet credits issued in the project region, D_y will be 1 (i.e., there is no discount applied).

Where project proponents can demonstrate that the charging systems included in the project are comprised of a private or closed charging network (e.g., a private charging network that is in secure garages, or a closed charging network for e-buses owned by a transit agencies where chargers are reserved exclusively for its own public agency fleet), and can demonstrate that relative to this closed or private charging network, no fleet credits have been issued for EVs using the network, then D_y will be 1 (i.e., there is no discount applied)[16].

Where fleet credits have been issued for a region larger than the proposed EV charging project (e.g., an EV Fleet Credit project introducing a fleet of EVs US-wide, while the EV charging system project is confined to one state), then a sensible pro-rata share of the issued fleet credits can be made for the EV charging system project's region (e.g., using the pro-rata number of EV's on the road in the EV charging project state compared to the total in the US, using sources such as ZEVFacts.com).

9 MONITORING

Project proponents must follow the monitoring procedures provided below, noting that Sections 9.1., 9.2 and 9.3 below set out parameters and requirements for monitoring projects.

[16] This is allowed as private and closed charging networks, even if publicly owned, are not subject to the risk that EV fleets with issued certified credits would have access to its charging network, and the EV fleets that do use the network have not issued separate EV fleet based credits. Public charging system operating as open networks would not normally be able to demonstrate such lack of access and therefore must determine if a discount factor must be applied.

9.1 Data and Parameters Available at Validation

Data / Parameter:	$EF_{j,f,y}$
Data unit	tCO_2e/gallon
Description	Emission factor for the fossil fuel *f* used by the fossil fuel vehicles deemed comparable to each EV in applicable fleet *i* in year *y*
Equations	1
Source of data	Use values from credible international or national government sources such as, for the US, the EPA ratings[17].
Value applied	For LDV projects located in the US and Canada: L1/L2 (BEV and PHEV average) = 0.0088 DCFC (BEV average) = 0.0088 For HDV projects located in the US: e-buses = 0.010 e-trucks = 0010
Justification of choice of data or description of measurement methods and procedures applied	International and national government transportation fuel emission rates have been widely established and peer reviewed. US & Canada default values calculated in Appendix 1.
Purpose of Data	Calculation of baseline emissions
Comments	Calculated annually, based on the fuels consumed by the fossil fuel vehicles deemed comparable to the EV models on the road each year in the applicable fleet, unless default values for baseline calculations for LDVs and/or HDVs are used.

Data / Parameter:	$AFEC_{iy}$
Data unit	kwh/100 miles
Description	Weighted average electricity consumption per 100 miles rating for EVs in applicable fleet *i* in project year *y*
Equations	1 and 2
Source of data	Calculated in Equation 2
Value applied	For LDV projects located in the US: L1/L2 (BEV and PHEV average) = 33.32 DCFC (BEV average) = 31.88 For HDV projects located in the US:

[17] https://www.epa.gov/sites/production/files/2015-11/documents/emission-factors_nov_2015.pdf

	e-buses = 300 e-trucks = 140 <u>For LDV projects located in Canada:</u> L1/L2 (BEV and PHEV average) = 35.91 DCFC (BEV average) = 32.82
Justification of choice of data or description of measurement methods and procedures applied	Analysis calculations can be found in Appendix 1. Changes in the value of $AFEC_{iy}$ are very gradual over time. Default values for $AFEC_{iy}$ must be updated each 5 years alongside the activity method updates US & Canada default values calculated in Appendix 1.
Purpose of Data	Calculation of baseline emissions
Comments	Calculations for AFEC for open networks (where the exact EV models charging are not known) must be established using such data sources which must be compiled on a national basis (that is, for example, the number of BEV's of each model on the road in the US for open DCFC networks). Calculations for AFEC for closed networks (e.g. where the composition and operating characteristics of both the applicable and comparable fleets are known and documented, such as with transit agency e-bus fleets) may be made using the specific composition of these fleets (that is, for example, EVR must be the number of e-buses on the road for that particular transit agency fleet). For both open and closed networks, the individual EV model's EV ratings (kwh/100 miles) must be used as applicable to the government rating agencies from which they have been sourced, (e.g. nationally for US; supra-nationally for EU), including in the periodic update of default values. Note again that if EVs are rated using slightly different variables such as kwh/100 km in Europe simple conversions must be made during validation.

Data / Parameter:	MPG_{iy}
Data unit	miles per gallon
Description	Weighted average miles per gallon rating for fossil fuel vehicles deemed comparable to each EV in applicable fleet *i* in project year *y*
Equations	1 and 3
Source of data	Derived in Equation 3

Value applied	For LDV projects located in the US: L1/L2 (BEV and PHEV average) = 29.18 DCFC (BEV average) = 29.10 For HDV projects located in the US: e-buses = 4.34 e-trucks = 8.60 For LDV projects located in Canada: L1/L2 (BEV and PHEV average) = 33.87 DCFC (BEV average) = 31.73
Justification of choice of data or description of measurement methods and procedures applied	US & Canada default values calculated in Appendix 1 For LDV projects, changes in the value of MPG_{iy} are very gradual over time given that a particular EV model's comparable fossil fuel vehicle rating must remain relatively steady for many years until the vehicle is significantly re-engineered. Thus for LDV projects, the default equivalent MPG's are taken from specific comparable vehicles (rather than classes of vehicles) whose MPG's are only likely to change with major model upgrades (and thus remain static for many years). For HDV projects, the class average MPG has been taken as the source data (see Appendix 1) so the discount rate IR_i of 0.99 must still apply. Default values for MPG_{iy} must be updated each 5 years with the activity method updates.
Purpose of Data	Calculation of baseline emissions
Comments	Consistent with guidance provided in AFEC above, weighted average is calculated for project year y based upon the number of EVs of each EV model type a in applicable fleet i on the road in project year *y* (EVR_{aiy}) combined with the mile per gallon ratings for each of these EV model's comparable fossil fuel vehicle ($MPG_{a,l,y}$). Calculations for comparable fleet's average MPG for open networks (where the exact EV models charging are not known) must be established using such data sources which must be compiled on a national basis (that is, for example, the number of BEV's of each model on the road in the US for open DCFC networks). Calculations for these fleet's MPG for closed networks (e.g. where the composition and operating characteristics of both the applicable and comparable fleets are known and documented, such as with transit agency e-bus fleets) may be made using the

	specific composition of these fleets (that is, for example, EVR must be the number of e-buses on the road for that particular transit agency fleet). For HDV closed networks, if the composition and operating characteristics of both the applicable and comparable fleets are known and documented (e.g. for transit agency EV charging infrastructure where the MPG's for the agency's own baseline bus operations can be established as the agency's comparable fleet of fossil fuel buses) using any of the CDM AMS-III.C Approach 1, Options 1 – 5, paragraphs 32 - 37. For both open and closed networks, the individual fossil fuel model's MPG ratings must be used as applicable to the government rating agencies from which they have been sourced (e.g., nationally for US; supra-nationally for EU), including in the periodic update of default values. MPG_{iy} is calculated annually unless the default values for baseline calculations for LDVs and/or HDVs is used following Equation 4, which employs the default value $DMPG_{iy}$. US & Canada default values calculated in Appendix 1. If standard emission values are provided using different parameters (such as CO_2/km as fossil fuel vehicle emission factors in Europe) conversions to given variable units will be made.

Data / Parameter:	EV_{aiy}
Data unit	kwh/100 miles
Description	Electricity kwh consumption per 100 miles rating for EV model a within applicable fleet *i* in project year *y*
Equations	2
Source of data	Use values from credible national governmental sources such as the ratings for the US provided by US DoE Fuel Economy program[18].
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	National, governmental ratings provide independent third party public source.

[18] https://www.fueleconomy.gov/feg/evsbs.shtml

Purpose of Data	Calculation of baseline emissions
Comments	See guidance for AFEC above. For both open and closed networks, the EV_{aiy} ratings must be used as applicable to the government rating agencies from which they have been sourced, e.g. nationally for US; supra-nationally for EU.

Data / Parameter:	EVR_{aiy}
Data unit	Cumulative number of EVs
Description	Total number of EV model *a* within applicable fleet *i* on the road by project year *y*
Equations	2 and 3
Source of data	Use values from credible national governmental sources such as the statistics provided for the US provided by the Argonne National Laboratory's monthly email updates[19] Closed networks may also use the number of EV's on the road using their known composition and operating characteristics of the applicable fleets they serve.
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	Argonne National Laboratory is an independent, trusted government source of EV data for the US market.
Purpose of Data	Calculation of baseline emissions
Comments	This value is calculated for project year y based upon the cumulative number of EVs of each EV model type *a* in applicable fleet *i* on the road by project year *y*, consistent with AFEC guidance above. In the USA, statistics for the number of EVs on the road by model type is available from several sources including Argonne National Laboratory, in their monthly emails[20], which draws upon data from hybridcars.com[21].

[19] Such as the *U.S. E-Drive vehicle monthly updates_February 2017* provided by Yan Zhou, yzhou@anl.gov
[20] See U.S. E-Drive vehicle monthly updates_February 2017 provided by Yan Zhou, yzhou@anl.gov
[21] Argonne National Lab's (ANL) monthly emails uses data sourced from the hybridcars.com web site: http://www.hybridcars.com/december-2016-dashboard/ The main ANL web link is found here including the email address for the database manager: https://www.anl.gov/energy-systems/project/light-duty-electric-drive-vehicles-monthly-sales-updates

Data / Parameter:	$MPG_{a,l,y}$
Data unit	miles/gallon
Description	Mile per gallon rating for fossil fuel vehicle model(s) deemed comparable to EV model a from applicable fleet *i* in project year *y*
Equations	3
Source of data	See guidance for MPG_{iy} above. Use values from credible national government sources such as the US rating found in the *2016 Fuel Economy Guide*[22] For both open and closed networks, the $MPG_{a,l,y}$ ratings must be used as applicable to the government rating agencies from which they have been sourced (e.g., nationally for US; supra-nationally for EU.)
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	National governmental ratings such as those found in the US Fuel Economy Guides for the US market are independent, trusted government sources of fuel consumption ratings.
Purpose of Data	Calculation of baseline emissions
Comments	If standard emission values are provided using parameters which already incorporate fuel emission factors such as CO_2/km ratings for fossil fuel vehicle emission factors in Europe then conversions to the appropriate combination of variables must be made to establish equivalence to the parameters in these equations. For example, in Europe, fossil fuel vehicle are rated in terms of CO_2 per km (given here as EFEU). Therefore, if the EV ratings are still given as kwh per 100 miles, then such a conversion would be: CO_2 per mile = $EF_{j,f,y}$ / $MPG_{a,l,y}$ = EFEU / 0.62.

Data / Parameter:	IR_i
Data unit	Number
Description	Technology improvement factor for applicable fleet *i* in *year y* for default value *BE* calculations.
Equations	1

[22] https://www.fueleconomy.gov/feg/pdfs/guides/FEG2016.pdf

Source of data	CDM AMS-III.C which uses the same discount rate in baseline calculations
Value applied	If baselines are calculated using updated BE_y parameters for each project year y, IR_i = 1 If default values are used for these BE_y parameter calculations, For LDV applicable fleets, IR_i = 1 For HDV applicable fleets, IR_i = 0.99
Justification of choice of data or description of measurement methods and procedures applied	If the baseline is calculated each year using the applicable fleet and conventional fleet statistics in each project year y, then no technology improvement rates need to be applied (since annual accurate data is used each year) $IR_{i,y}$ is therefore set to be 1. IR_i when applied to LDV projects using default values is 1 because default values for MPG factors use individual, specific MPG figures for each fossil fuel vehicle comparable to each EV model in the applicable fleet (see Appendix 1). These MPG figures change only when a fossil fuel model is substantially updated by manufacturers which takes place on a 7-10 year cycle: this timeframe is longer than the Verra five year update cycle for parameter updates. CDM technology discount rate is not applicable for LDV projects, therefore IR_i = 1. IR_i when applied to HDV projects using default values is 0.99 because the defaults values use market-wide, class based comparable MPG factors for default calculations rather than individual, specific MPG figures for the fossil fuel vehicles comparable to each EV model (see Appendix 1) provided that: • This 0.99 improvement rate is applied to each calendar year. • This rate is taken to be 0.99 consistent with the IR default in CDM-III.C. • For project year 1, IR^(y-1) must be 1 (since any number to power 0 is 1). See justification in MPG above.
Purpose of Data	Calculation of baseline emissions
Comments	For LDV projects, the default equivalent MPG are taken from specific comparable vehicles (rather than classes of vehicles) whose MPG are only likely to change with major model upgrades (and thus remain static for many years).

9.2 Data and Parameters Monitored

Data / Parameter:	$EC_{i,y}$
Data unit	Kwh/year
Description	Quantity of electricity consumed by project chargers serving applicable fleet *i* in project year *y*
Equations	1, 4
Source of data	kwh consumption for project charging network using systems' actual or estimated kwh values, as below
Value applied	Measured value based on kwh consumed by charging systems in year y
Description of measurement methods and procedures to be applied	The kwh supplied by the charging systems for each applicable fleet i must be sourced using the following hierarchy, where projects must apply first those listed highest on the list: 1) Actual kwh sourced using smart charger measurement systems or on-site electricity meters 2) Estimates for network chargers based upon the portions of the project which has such smart network project averages, with applicable segmenting (e.g. for applicable fleets and settings (public, workplace etc)) 3) Investments to upgrade chargers to provide actual "smart" data results e.g. EMotorWerks Juicebox 4) Use of reasonable regionally applicable pilot project data (such as local utility project results) for non-metered project chargers that don't have smart actual measurements when this pilot data reasonably corresponds to comparable utilization rates to those in the project 5) In the US, use of the Department of Energy/Idaho National Laboratory's (DoE/INL) EV Project data[23] to apply average kwh per charging event data which is provided across a) different settings (public, residential, non-private residential) and b) for each US state Use calibrated electricity meters/smart charging system measurement systems. Calibration must be conducted according to the equipment manufacturer's specifications.
Frequency of monitoring/recording	Measured actual data must be monitored and recorded on at least an annual basis; monitoring periods for metered data can be consistent with utility reports. Estimated consumption can be

[23] https://avt.inl.gov/project-type/ev-project

	made on annual basis from sources which monitoring using measured/actual or metered sources.
QA/QC procedures to be applied	The consistency of metered electricity consumption should be cross-checked with receipts from electricity purchases where applicable
Purpose of Data	Calculation of baseline and project emissions
Calculation method:	
Comments	N/A

Data / Parameter	$EFkw_{i,j,y}$
Data unit	tCO_2e/kwh
Description	Emission factor for the electricity sourced from region *j* consumed by project chargers serving applicable fleet *i* in year *y*
Equations	4
Source of data	Use credible government data sources such as, for the US, the regional eGRID emission rates published by EPA[24]
Description of measurement methods and procedures to be applied	The emission factor must be consistent with the region j from which electricity is sourced (e.g. for the US with the utility's eGRID region[25]). Published utility specific emission factors are allowed for the kwh consumed from that source consistent with VCS practices which allow well documented more local electricity sources' GHG emission factors to be applied. Average emission factors (not marginal) must be used Grid-sourced and dedicated renewable kwh is treated as having zero tCO2e/kwh. Biofuels used on-site to generate electricity are considered dedicated renewables.
Frequency of monitoring/recording	Annual updates from these published sources
QA/QC procedures to be applied	
Purpose of data	Calculation of project emissions
Calculation method:	Look up value

[24] https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid
[25] https://www.epa.gov/sites/production/files/2017-02/documents/egrid2014_summarytables_v2.pdf

Comments:	Region *j* represents any region from which electricity is sourced, each of which must have a well-documented emissions factor for the electricity provided. For US projects, electricity emissions must be estimated using the EPA regional eGRID emission rates, unless other more accurate local/regional sources are available (e.g. from utilities directly serving the charging network).

Data / Parameter	$ECTOD_{i,j,t,y}$
Data unit	Kwh/time period t
Description	Quantity of electricity consumed by project chargers sourced from region j serving applicable fleet i during time of day period t in project year y
Equations	5
Source of data	kwh consumption for project charging network using systems' actual values provided these are generated using time-of-day metering
Description of measurement methods and procedures to be applied	The kwh supplied by the charging systems applying time of day calculations in equation 6 must be sourced as follows: 1. Using actual time-of-day kwh measurements using smart charger measurement systems or on-site electricity meters, capable of recording/monitoring kwh consumption on at minimum an hourly basis 3. Investments to upgrade chargers to provide such time-of-day actual data results are permitted provided they supply comparable hourly reporting Electricity meters' calibration must be conducted according to the equipment manufacturer's specifications.
Frequency of monitoring/recording	Data must be monitored continuously and recorded on at least an hourly basis.
QA/QC procedures to be applied	The consistency of metered electricity generation should be cross-checked with receipts from electricity purchases where applicable
Purpose of data	Calculation of project emissions
Calculation method:	

Comments:	The sum of all such time-of-day time periods, t, must equal 24 in any given full day within the project (i.e. there are no time periods in which electricity is provided but not accounted for within PEy). This is applicable only if PE emissions are to be calculated on a time-of-day basis

Data / Parameter	*$EFkwTOD_{j,j,t,y}$*
Data unit	tCO_2e/kwh
Description	Emission factor for the electricity sourced from region j consumed by project chargers serving applicable fleet i during time of day period t in year y
Equations	5
Source of data	Use credible governmental or regional utility data sources such as, for the US, those published in the US by ISO's which rely upon utilities' hourly fuel consumption figures (e.g. see PJM publications[26]) Time of day estimates for electricity emission factors, $EFkw_{i,j,t,y}$ must be drawn from credible, applicable sources (e.g. the regional ISO or applicable utility generation sources).
Description of measurement methods and procedures to be applied	If $EFkwTOD_{j,j,y}$ has already been published by utilities in region j on an hourly basis, then these figures must be used. If in region j, the ISO provides fuel consumption data on an hourly basis, $EFkwTOD_{j,j,y}$ may be estimated on a weighted average basis using equation 6 Grid-sourced and dedicated renewable kwh is treated as having zero tCO2e/kwh Biofuels used on-site to generate electricity are considered dedicated renewables.
Frequency of monitoring/recording	Source data (for emission factor $EFkwTOD_{j,j,y}$) must be monitored continuously and recorded on at least an hourly basis.
QA/QC procedures to be applied	
Purpose of data	Calculation of project emissions

[26] http://www.monitoringanalytics.com/data/marginal_fuel.shtml

Calculation method:	If $EFkwTOD_{j,j,y}$ is estimated using hourly fuel consumption reports (e.g. from an ISO), the weighted average calculations are given in equation 6
Comments:	The sum of all such time-of-day time periods, t, must equal 24 in any given full day within the project (i.e. there are no time periods in which electricity is provided but not accounted for within PEy). This is applicable only if PE emissions are to be calculated on a time-of-day basis

Data / Parameter	$EFkwF_{j,j,t,f,y}$
Data unit	tCO_2e/kwh
Description	Emission factor applicable for the fuel type f used to generate the kwh during time of day period t sourced from region j consumed by project chargers serving applicable fleet i in year y
Equations	6
Source of data	Use credible governmental or regional utility data sources such as, for the US, those published in the US by ISO's which rely upon utilities' hourly fuel consumption figures (e.g. see PJM publications[27])
Description of measurement methods and procedures to be applied	If in region j, the ISO provides fuel consumption data on an hourly basis, $EFkwF_{j,j,t,f,y}$ may be estimated on a weighted average basis using equation 6 as follows: • Projects must combine the hourly fuel consumption figures (typically given as the percentage of each type of fuel consumed that hour (50% coal, 50% natural gas)) with the emission factors for these same fuels to create a weighted average emission rate for each hourly period. • Emission rates for each fuel must be drawn from the same (e.g. the ISO) or consistent publication sources for region j (noting that these need not be generated on an hourly basis but must be updated on at least an annual basis)
Frequency of monitoring/recording	Each fuel's emission rate need not be generated on an hourly basis but averages must be generated on at least an annual basis.
QA/QC procedures to be applied	

[27] http://www.monitoringanalytics.com/data/marginal_fuel.shtml

Purpose of data	Calculation of project emissions
Calculation method:	
Comments:	Applicable only if PE emissions are to be calculated on a time-of-day basis using utility/ISO hourly fuel consumption inputs

Data / Parameter	$F\%_{ijtfy}$
Data unit	%
Description	Percentage of fuel type f used to generate the kwh DURING EACH time of day period t, sourced from region j and consumed by project chargers serving applicable fleet I in year y
Equations	6
Source of data	Use credible governmental or regional utility data sources such as, for the US, those published in the US by ISO's which rely upon utilities' hourly fuel consumption figures (e.g. see PJM publications[28])
Description of measurement methods and procedures to be applied	The hourly fuel consumption figures are typically given as the percentage of each type of fuel consumed that hour (50% coal, 50% natural gas)).
Frequency of monitoring/recording	This fuel sourced parameter data must be monitored and recorded on at least an hourly basis. Since the emission factors for each fuel type f need not be generated on an hourly but can be supplied on an annual basis, the percentage of each fuel type f used to generate the kwh during each time period will be supplied for each such time period.
QA/QC procedures to be applied	Typically a look up value
Purpose of data	Calculation of project emissions
Calculation method:	
Comments:	Applicable only if PE emissions are to be calculated on a time-of-day basis using utility/ISO hourly fuel consumption inputs

Data / Parameter	$NEC_{i,j,s,y}$
Data unit	kwh/year

[28] http://www.monitoringanalytics.com/data/marginal_fuel.shtml

Description	Electricity consumed by project chargers supplied from associated infrastructure source s net of any kwh EV/charger returned to this same source within region j serving applicable fleet i in project year y
Equations	7
Source of data	Net kwh consumption/generation for project chargers must be secured for each associated infrastructure source (whether derived from the grid, dedicated renewables or the on-site battery) as actual net kwh values using chargers' adequate metering systems
Description of measurement methods and procedures to be applied	Projects must track the net kwh consumption/generation for charging systems from across all potential associated infrastructure sources, s, (whether grid, dedicated renewable sources, on-site battery), net of kwh supplied back from the EV battery to such sources, using the charger's metering system to track such net kwh calculations. To apply equation 7, such net kwh values must be sourced as follows: 1) Using actual kwh consumption and generation measurements using on-site or smart chargers' metering systems, capable of recording/monitoring kwh both consumed and generated on at minimum a yearly basis 2) Investments to upgrade chargers to provide such net metered actual data results are permitted provided they supply comparable reporting Associated infrastructure sources, s, for which NEC is calculated include: • grid-connected electricity from region j • and/or dedicated renewable energy generated on-site (including RE sourced from direct transmission lines) • and/or the EV vehicle's on-board battery Each of the grid and renewables sources, s, must have a well-documented emissions factor for the electricity sourced and/or dispatched Project metering systems' calibration must be conducted according to the equipment manufacturer's specifications. Projects must incorporate adequate metering systems when applying Eq 7. Guidance for the design/application of such metering systems is provided in Appendix 2.

Frequency of monitoring/recording	Measured actual data must be monitored and recorded on at least an annual basis. Monitoring periods for metered net data can be consistent with reports which the charging systems' metering system provides.
QA/QC procedures to be applied	The consistency of net metered electricity generation should be cross-checked with receipts and invoices from electricity purchases and sales where applicable
Purpose of data	Calculation of project emissions
Calculation method:	
Comments:	The charging system's metering system must adequately and accurately measure and traces such electricity deliveries and receipts from these associated infrastructure sources, (including for example electricity sourced from/returned to the grid, on-site/dedicated renewables, on-site batteries, EV batteries). Applicable only if PE emissions are to be calculated on a net metered basis integrating multiple associated infrastructure sources, s. Note: time of day, hourly monitoring of EV charging/associated infrastructure deliveries and receipts is not a necessary requirement to apply Equation 7. For combined associated infrastructure metering and time of day PE estimates, see parameters for equation 9.

Data / Parameter	$EFkwAI_{i,,j,s,y}$
Data unit	(tCO_2e/kwh)
Description	Emission factor for the net electricity from each associated infrastructure source s within region j consumed by project chargers serving applicable fleet i in year y
Equations	7
Source of data	Each of associated infrastructure source, s, must have a well-documented emissions factor for the electricity it supplies and/or dispatches as follows: • Grid-connected electricity from region j must follow the same procedures as for parameter $EFkw_{i,j,y}$ in Equation 4 (see above) • Dedicated renewable energy generated on-site, including renewable energy sourced via direct transmission lines, must set emission factors at zero

	• On-site storage batteries must assume the weighted average emission factor based upon the proportionate net consumption of grid and dedicated renewable energy at the charging system (see equation 8)
Description of measurement methods and procedures to be applied	For grid-connected electricity, see procedures for parameter $EFkw_{i,j,y}$ in Equation 4 For dedicated renewables, emission factors are set at zero. For on-site storage batteries, the calculations are given in equation 8. Projects must incorporate adequate metering systems when applying Eq 7 and 8. Guidance for the design/application of such metering systems is provided in Appendix 2.
Frequency of monitoring/recording	Annual, per procedures for parameter $EFkw_{i,j,y}$ in Equation 4
QA/QC procedures to be applied	
Purpose of data	Calculation of project emissions
Calculation method:	For on-site batteries see equation 8
Comments:	Applicable only if PE emissions are to be calculated on a net metered basis integrating multiple associated infrastructure sources, s. Note: time of day, hourly monitoring of EV charging/associated infrastructure deliveries and receipts is not a necessary requirement to apply Equation 7. For combined associated infrastructure metering and time of day PE estimates, see parameters for equation 9.

Data / Parameter	$LEC_{j,j,y}$
Data unit	kwh/year
Description	Electricity provided to the grid and/or building from on-site storage battery within region j serving applicable fleet i in project year y (kwh/year)
Equations	7
Source of data	From on-site battery/charging system's adequate measurement systems

Description of measurement methods and procedures to be applied	LEC arises if on-site batteries provide kwh back to the grid or local building (for example if used as back up generators/sources of power). These kwh are not supplied to the EV charging system and do not result in EV miles drive and so are deducted out in Eq 7. Projects must incorporate adequate metering systems when applying Eq 7. Guidance for the design/application of such metering systems is provided in Appendix 2. Project metering systems' calibration must be conducted according to the equipment manufacturer's specifications.
Frequency of monitoring/recording	Measured actual data must be monitored and recorded on at least an annual basis.
QA/QC procedures to be applied	The consistency of such kwh should be cross-checked with other information sources where applicable
Purpose of data	Calculation of project emissions
Calculation method:	
Comments:	Applicable only if PE emissions are to be calculated on a net metered basis integrating multiple associated infrastructure sources, s. Note: time of day, hourly monitoring of EV charging/associated infrastructure deliveries and receipts is not a necessary requirement to apply Equation 7. For combined associated infrastructure metering and time of day PE estimates, see parameters for equation 9.

Data / Parameter	$EFkwonsitebatt_{i,j,s,y}$
Data unit	(tCO_2e/kwh)
Description	Emission factor for the electricity from the on-site batteries as associated infrastructure sources s within region j consumed by project chargers serving applicable fleet i in year y
Equations	8
Source of data	See data sources for Equation 8 variables below
Description of measurement methods and procedures to be applied	The emission factors for the on-site battery as an associated infrastructure source are calculated using the net weighted average of the grid and on-site renewable emission factors given using equation 8 • On-site storage batteries must assume the weighted average emission factor based upon the proportionate net

	consumption of grid and dedicated renewable energy at the charging system (using equation 8) Projects must incorporate adequate metering systems when applying Eq 8. Guidance for the design/application of such metering systems is provided in Appendix 2.
Frequency of monitoring/recording	Annual
QA/QC procedures to be applied	As for equation 8 variables below
Purpose of data	Calculation of project emissions
Calculation method:	
Comments:	Applicable only if PE emissions are to be calculated on a metered basis integrating multiple associated infrastructure sources, s.

Data / Parameter	$ECB_{i,j,z,y}$
Data unit	kwh/year
Description	Electricity consumed by on-site battery from associated infrastructure sources z, which comprise only the grid-connected and dedicated renewable sources, within region j serving applicable fleet i in project year y
Equations	8
Source of data	As for $NEC_{i,j,s,y}$ in equation 7
Description of measurement methods and procedures to be applied	As for $NEC_{i,j,s,y}$ in equation 7 Projects must incorporate adequate metering systems when applying Eq 8. Guidance for the design/application of such metering systems is provided in Appendix 2. In particular, metering systems must need to measure the kwh delivered to the onsite battery from grid and/or renewable sources as distinct from those delivered directly to the EV charger from the grid and/or dedicated renewable sources
Frequency of monitoring/recording	As for $NEC_{i,j,s,y}$ in equation 7
QA/QC procedures to be applied	
Purpose of data	Calculation of project emissions
Calculation method:	As for $NEC_{i,j,s,y}$ in equation 7

Comments:	Applicable only if PE emissions are to be calculated on a metered basis integrating multiple associated infrastructure sources, s, when these sources are grid-connected electricity and dedicated renewable energy.

Data / Parameter	$EFkwAI\text{-}Z_{j,,j,z,y}$
Data unit	(tCO_2e/kwh)
Description	Emission factor for the electricity from the associated infrastructure sources, z, which comprise only the grid-connected and dedicated renewable sources, within region j consumed by on site battery serving applicable fleet i in year y
Equations	8
Source of data	As for $EFkwAI_{j,,j,s,y}$ for grid connected and renewable energy in equation 7
Description of measurement methods and procedures to be applied	As for $EFkwAI_{j,,j,s,y}$ for grid connected and renewable energy in equation 7 Projects must incorporate adequate metering systems when applying Eq 8. Guidance for the design/application of such metering systems is provided in Appendix 2.
Frequency of monitoring/recording	As for $EFkwAI_{j,,j,s,y}$ for grid connected and renewable energy in equation 7
QA/QC procedures to be applied	
Purpose of data	Calculation of project emissions
Calculation method:	As for $EFkwAI_{j,,j,s,y}$ for grid connected and renewable energy in equation 7
Comments:	Applicable only if PE emissions are to be calculated on a metered basis integrating multiple associated infrastructure sources, s, when these sources are grid-connected electricity and dedicated renewable energy.

Data / Parameter	$NECT_{i,j,s,t,y}$
Data unit	Kwh/time period t
Description	Electricity consumed by project chargers supplied from associated infrastructure source s net of any kwh EV/charger returned to this same source during time-of-day period t, within region j serving applicable fleet i in project year y

Equations	9
Source of data	Net electricity consumed by project chargers during time-of-day period t from associated infrastructure sources s, within region j serving applicable fleet i in project year y
Description of measurement methods and procedures to be applied	Follow those for parameters $EC_{i,j,t,y}$ in equation 5 and $NEC_{i,j,s,y}$ in equation 7 Projects must incorporate adequate metering systems when applying Eq 9. Guidance for the design/application of such metering systems, considered as applied to each time period t, is provided in Appendix 2. In addition, for time of day applications of associated infrastructure calculations pertaining to the NECT for an on-site battery's kwh delivered to the EV charger, metering must be applied "upstream", on the grid-side of the on-site battery. That is for the calculation of NECT for an on-site battery, Eq 9 must, using upstream meters, calculate the kwh delivered to EV chargers via the on-site battery from grid and/or dedicated renewable sources during the time of day period t taking into account *when* these kwh are actually delivered *to the on-site battery* (not when delivered from this battery to the EV charger) since the GHG impacts for these kwh arise on the grid system when they are first delivered into this associated infrastructure system (that is are delivered to the on site battery) For these applications, kwh supplied by the EV to the on-site battery can be set aside (since they return to the EV at a later date) unless, during a given time period t, the LEC less the kwh received by the on site battery from grid and renewable sources less the on-site battery's stored kwh is greater than zero – that is LEC is so large that it must have drawn upon the kwh delivered to the on-site battery from the EV In the context of these NECT calculations for the on-site battery, it should be noted that the kwh supplied from the grid to the EV charging system directly – and those kwh supplied by the EV back to the grid – during any time period t are still considered separately in the calculation of NECT for the grid.
Frequency of monitoring/recording	Follow those for parameters $EC_{i,j,t,y}$ in equation 5 and $NEC_{i,j,s,y}$ in equation 7
QA/QC procedures to be applied	Follow those for parameters $EC_{i,j,t,y}$ in equation 5 and $NEC_{i,j,s,y}$ in equation 7
Purpose of data	Calculation of project emissions

Calculation method:	
Comments:	Follow those for parameters $EC_{i,j,t,y}$ in equation 5 and $NEC_{i,j,s,y}$ in equation 7 Applicable only if PE emissions are to be calculated on a time-of-day basis when also incorporating charging systems' associated infrastructure sources on a metered basis.

Data / Parameter	$EFkwTOD\text{-}AI_{i,j,s,t,y}$
Data unit	tCO_2e/kwh
Description	Emission factor for the electricity from associated infrastructure source s within region j consumed by project chargers serving applicable fleet i during time-of-day period t in year y
Equations	9
Source of data	Follow those for parameters $EFkwTOD_{j,,j,t,y}$ in equation 5 and $EFkwAI_{j,,j,s,y}$ in equation 7
Description of measurement methods and procedures to be applied	Follow those for parameters $EFkwTOD_{j,,j,t,y}$ in equation 5 and $EFkwAI_{j,,j,s,y}$ in equation 7 Projects must incorporate adequate metering systems when applying Eq 9. Guidance for the design/application of such metering systems, considered as applied to each time period t, is provided in Appendix 2.
Frequency of monitoring/recording	Follow those for parameters $EFkwTOD_{j,,j,t,y}$ in equation 5 and $EFkwAI_{j,,j,s,y}$ in equation 7
QA/QC procedures to be applied	
Purpose of data	Calculation of project emissions
Calculation method:	Follow those for parameters $EFkwTOD_{j,,j,t,y}$ in equation 5 and $EFkwAI_{j,,j,s,y}$ in equation 8
Comments:	Follow those for parameters $EFkwTOD_{j,,j,t,y}$ in equation 5 and $EFkwAI_{j,,j,s,y}$ in equation 8 Applicable only if PE emissions are to be calculated on a time-of-day basis when also incorporating charging systems' associated infrastructure sources on a net metered basis.

Data / Parameter	$LECT_{j,,j,t,\ y}$

Data unit	kwh/time period *t*
Description	Electricity provided to the grid and/or building from on-site storage battery during time-of-day period t within region j serving applicable fleet i in project year y (kwh/year)
Equations	9
Source of data	From on-site battery/charging system's adequate measurement systems
Description of measurement methods and procedures to be applied	Project metering systems' calibration must be conducted according to the equipment manufacturer's specifications. Projects must incorporate adequate metering systems when applying Eq 9. Guidance for the design/application of such metering systems, considered as applied to each time period t, is provided in Appendix 2.
Frequency of monitoring/recording	Measured actual data must be monitored and recorded on at least an annual basis.
QA/QC procedures to be applied	The consistency of such kwh should be cross-checked with other information sources where applicable
Purpose of data	Calculation of project emissions
Calculation method:	
Comments:	Applicable only if PE emissions are to be calculated on a net metered basis integrating multiple associated infrastructure sources, s.

Data / Parameter	$EFkwTODonsitebatt_{i,j,s,t,y}$
Data unit	tCO_2e/kwh
Description	Emission factor for the electricity from the on-site battery during time-of-day period t (both on-site infrastructure and EV on-board batteries) associated infrastructure source s within region j consumed by project chargers serving applicable fleet i in year y
Equations	9
Source of data	See data sources for Equation 8 variables above
Description of measurement methods and procedures to be applied	The emission factors for one associated infrastructure source -- for the on-site battery -- are calculated using the net weighted average of the grid and on-site renewable emission factors given using equation 8, but this time applied for each time-of-day period t

	• On-site storage battery must assume the weighted average emission factor based upon the proportionate net consumption of grid and dedicated renewable energy at the charging system (using equation 9 applied during each time of day period basis) Projects must incorporate adequate metering systems when applying Eq 9. Guidance for the design/application of such metering systems, considered as applied to each time period t, is provided in Appendix 2.
Frequency of monitoring/recording	Hourly
QA/QC procedures to be applied	As for equation 8 variables
Purpose of data	Calculation of project emissions
Calculation method:	
Comments:	Applicable only if PE emissions are to be calculated on a metered basis integrating multiple associated infrastructure sources, s, on a time-of-day basis.

Data / Parameter	D_y
Data unit	%
Description	Discount factor to be applied in year y
Equations	10 and 11
Source of data	See data sources for data parameters in equation 13
Description of measurement methods and procedures to be applied	Discount factor applied if credits have been issued in the project region for EV *fleet* credits (e.g. using the CDM AMS-III.C EV fleet methodology)
Frequency of monitoring/recording	Annual
QA/QC procedures to be applied	
Purpose of data	Calculation of emission reductions
Calculation method:	Look up value
Comments:	If there are no EV *fleet* credits issued in the project region, D_y must be 1 (ie there is no discount applied). Private networks can also demonstrate that D = 1 if there is no access to chargers

	beyond a defined set of EV's for which it can be demonstrated that no EV fleet credits have been issued. See guidance in section 8.4 regarding open and closed networks. If fleet credits have been issued for a region larger than the proposed EV charging project (e.g. the fleet project is US-wide while the EV charging project is confined to one state), then a sensible pro-rata share of the issued fleet credits can be made (e.g. using the pro-rata number of EV's on the road in the EV charging project state compared to the total in the US, using sources such as ZEVFacts.com).

Data / Parameter	ERC_y
Data unit	tCO_2e
Description	Sum of *all* EV charging projects' credits (whether via this project or others) across all this project's applicable fleet i categories issued within the total project region in project year y-1
Equations	11
Source of data	VCS (and other voluntary and regulated credit registries if they develop similar EV charging methodologies), with EV *charging system* credits issued within this same project's region (e.g. for complementary charging networks)
Description of measurement methods and procedures to be applied	Simple tallies of the total VCS EV charging systems' credits issued from project year 1 through year y-1 within this project's region EV charging system credits are those issued under this VCS charging methodology (or similar ones developed by other certification groups) whose credits arise within the same region as this project but cover credits issued from complementary charging network systems (e.g. workplace chargers from a complementary project located in the same region as this project's residential chargers).
Frequency of monitoring/recording	Annual
QA/QC procedures to be applied	
Purpose of data	Calculation of emission reductions
Calculation method:	Look up values

Comments:	N/A

Data / Parameter	ERF_y
Data unit	tCO_2e
Description	Sum of *all* EV *fleet* projects' credits issued (from other projects using other EV fleet-based methodologies) for these same applicable fleet i categories located within this project's total region, in project year y-1
Equations	11
Source of data	VCS and other voluntary and regulated credit registries, with EV *fleet-based* credits issued within the project region
Description of measurement methods and procedures to be applied	Simple tallies of the total EV fleet credits issued within this project's region from project year 1 through year y-1 EV fleet credits are those issued under EV fleet methodologies such as CDM AMS-III.C whose credit potentially double count with those issued through EV charging system certified projects.
Frequency of monitoring/recording	Annual
QA/QC procedures to be applied	
Purpose of data	Calculation of emission reductions
Calculation method:	
Comments:	If fleet credits have been issued for a region larger than the proposed EV charging project (e.g. the fleet project is US-wide while the EV charging project is confined to one state), then a sensible pro-rata share of the issued fleet credits can be made (e.g. using the pro-rata number of EV's on the road in the EV charging project state compared to the total in the US, using sources such as ZEVFacts.com).

Data Unit / Parameter	y
Data unit	number
Description	Project year
Equations	Throughout
Source of data	

Description of measurement methods and procedures to be applied	y is the project year determined by counting the number of years since the project start date (i.e., the first project year = 1, the second project year = 2, etc.)
Frequency of monitoring/recording	Annually
QA/QC procedures to be applied	
Purpose of data	Calculation of baseline, project and emission reductions
Comments	N/A

9.3 Description of the Monitoring Plan

The project proponent must establish, maintain and apply a monitoring plan and GHG information system that includes criteria and procedures for obtaining, recording, compiling and analyzing data, parameters and other information important for quantifying and reporting GHG emissions.

All data collected as part of monitoring should be archived electronically and be kept at least for two years after the end of the last project crediting period. All data must be monitored unless indicated otherwise in the tables above.

Project reporting must include the following information for EV charging systems included in a project:

1) Inventory and geographic location for each EV charging system included in the project.
2) Data on electricity consumption consistent with guidance provided in the parameter boxes above for each EV charger, which must be reported in a consistent manner with supporting data, such as invoices or utility or on site meter record. Where projects include LDV and HDV applicable fleets, electricity consumption must be monitored separately.
3) Supporting documentation used to determine parameters for use in quantification of baseline emissions if default factors (per Appendix 1) are not used.
4) Where EV charging systems' AI is utilized to provide electricity to EVs, in order to store and dispatch electricity to and from multiple sources, both on site and regionally, the monitoring plan must include plans for how data will be processed from the AI's metering systems (e.g., meters/sub-meters and/or associated measurement systems). Guidance for such metering is provided in Appendix 2.
5) Review of any previously issued VCUs for EV charging projects to verify that there is no overlap of ownership with chargers included in the project description, for example, using the unique EV charging identifiers supplied in the project description's EV charging system inventory. For grouped projects, such verification must apply to any new project activity instances and for new chargers subsequently added to the grouped project (e.g.,

by referencing the unique EV charging identifiers for these new project activity instances in project monitoring reports).

6) Review of any previously issued EV Fleet credits to confirm the value established for the discount factor, Dy.

The project proponent must establish and apply quality management procedures to manage data and information. Written procedures must be established for each measurement task outlining responsibility, timing and record location requirements. Record keeping practices must include:

- Electronic recording of values of logged parameters for each monitoring period
- Offsite electronic back-up of all logged data
- Maintenance of all documents and records in a secure and retrievable manner for at least two years after the end of the project crediting period.

Quality assurance/quality control procedures must also be applied to add confidence that all measurements and calculations have been made correctly. These may include, but are not limited to:

- Protecting monitoring equipment (sealed meters and data loggers)
- Protecting records of monitored data (hard copy and electronic storage)
- Checking data integrity on a regular and periodic basis (manual assessment, comparing redundant metered data, and detection of outstanding data/records)
- Comparing current estimates with previous estimates to identify any abnormal readings
- Providing sufficient training to project participants to install and maintain project devices
- Establishing minimum experience and requirements for operators in charge of project and monitoring
- Performing recalculations to make sure no mathematical errors have been made

10 REFERENCES

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US Department of Energy (2018). *Model Year 2016 Fuel Economy Guide.*

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APPENDIX 1: CALCULATION OF BASELINE DEFAULT VALUES FOR THE US AND CANADA

This appendix outlines the basis for the calculation of the optional default values used in the baseline emission calculations for US LDV and HDV projects. Values used to calculate the default value results were presented to the VVB via a separate Excel workbook during the approval process of the methodology.

LDV Weighted Averages in the United States

Weighted averages for LDVs are based upon:

- The total number of each BEV and PHEV model on the road by end of 2015, based upon cumulative US sales data for 2010-2015 sourced from Argonne National Laboratories' monthly emails and web site[29]
- Kwh/100 mile and MPG ratings sourced from www.fueleconomy.gov or the 2016 Fuel Economy Guide, https://www.fueleconomy.gov/feg/pdfs/guides/FEG2016.pdf
- Gasoline was the fuel which the comparable fossil fuel cars consumed

The simple weighted average has been calculated for each applicable fleet (BEV+PHEV and BEV) based upon the number of EV models of each type on the road by end of 2015 multiplied by its corresponding kwh/100 mile value (AFEC) and equivalent fossil fuel vehicle's MPG value (MPG), which are listed in the table below.

Table A1: LDV Project Default Value Table

Applicable fleet	$AFEC_{iy}$	MPG_{jy}	EF_{jy}
L1/L2 (BEV and PHEV average)	33.32	29.18	19.56 lbs CO2/gal = 0.0088 tCO2e/gal
DCFC (BEV average)	31.88	29.10	19.56 lbs CO2/gal = 0.0088 tCO2e/gal

HDV Weighted Averages in the United States

Each of these e-bus and e-truck weighted averages are based upon:

- The total number of each e-bus and e-truck models on the road in the US by beginning of 2017, based upon on data sourced from IHS Markit
- The corresponding GWV classification for each model of e-bus and e-truck on the road, based upon data sourced from IHS Markit
- Kwh/mile data sourced for e-buses from commercial sources (confidential) and for e-trucks from Smith Electric and NREL reports for e-delivery truck vehicles as follows:

[29] Argonne National Lab's (ANL) monthly emails uses data sourced from the hybridcars.com web site: http://www.hybridcars.com/december-2016-dashboard/ The main ANL web link is found here including the email address for the database manager: https://www.anl.gov/energy-systems/project/light-duty-electric-drive-vehicles-monthly-sales-updates

  - http://insideevs.com/smith-electric-vehicles-distance-energy-consumption/
  - http://www.nrel.gov/docs/fy17osti/66382.pdf

- Average MPG ratings for the corresponding class of MDV/HDV, as sourced from independent academic sources, specifically: https://www.nap.edu/read/12845/chapter/4#18
- Diesel fuel was the dominant baseline bus and truck fuel

The simple weighted average is calculated for each applicable fleet (e-bus and e-truck) based upon the number of EV models of each type on the road by beginning of 2017 multiplied by its corresponding kwh/100 mile value (AFEC) and equivalent GWV class of fossil fuel vehicle's average MPG value (MPG), which are listed in the table below.

Table A2: HDV Project Default Value Table

Applicable fleet	$AFEC_{iy}$	MPG_{jy}	EF_{jy}
e-buses	300	4.34	22.4 lbs CO2/gal = 0.010 tCO2e/gal
e-trucks	140	8.60	22.4 lbs CO2/gal = 0.010 tCO2e/gal

LDV Weighted Averages in Canada

These weighted averages are based upon:

- The total number of each BEV and PHEV model on the road by end of 2016, based upon cumulative Canada data; kwh/100 mile and MPG ratings, all sourced from Natural Resources Canada
- Gasoline was the fuel which the comparable fossil fuel cars consumed

The simple weighted average has been calculated for each applicable fleet (BEV+PHEV and BEV) based upon the number of EV models of each type on the road by beginning of 2017 multiplied by its corresponding kwh/100 mile value (AFEC) and equivalent fossil fuel vehicle's MPG value (MPG), which are listed in the table below.

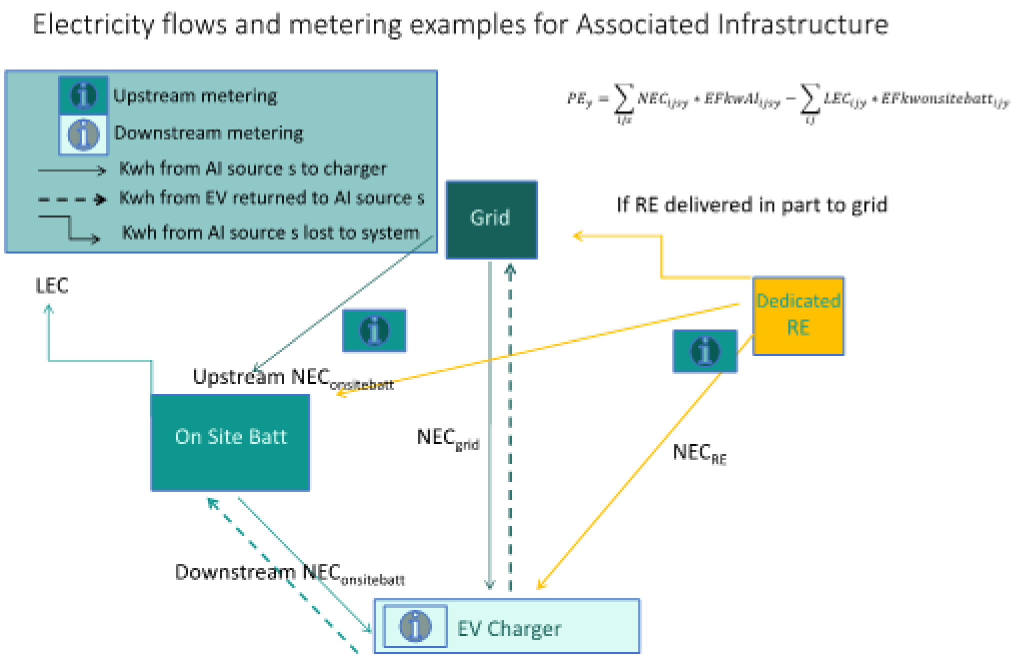
Table A3: LDV Project Default Value Table for Canada

Applicable fleet	$AFEC_{iy}$	MPG_{jy}	EF_{jy}
L1/L2 (BEV and PHEV average)	35.91	33.87	19.56 lbs CO2/gal = 0.0088 tCO2e/gal
DCFC (BEV average)	32.82	31.73	19.56 lbs CO2/ga = 0.0088 tCO2e/gall

APPENDIX 2: GUIDANCE FOR DESIGN OF ADEQUATE METERING SYSTEMS FOR ASSOCIATED INFRASTRUCTURE PROJECTS

This appendix outlines guidance for the design and application of metering systems of charging systems to adequately measure electricity exchanges when associated infrastructure is incorporated into projects when they apply to the determination of project emissions, as shown in Figure A4.

Figure A4: Examples of Associated Infrastructure and Electricity Flows



When incorporating associated infrastructure, the charging system's metering system must adequately and accurately measure and trace the net electricity kwh provided to the charging system (i.e., deliveries minus receipts) from all electricity sourced from and returned to the grid, and the dedicated renewables. This may include dedicated renewable energy (e.g., on site) delivered to the EV directly and/or via on-site batteries, and net of kwh returned back to such sources from the EV batteries.

Note that metering systems for associated infrastructure can include "downstream" meters close to the EV, such as those provided by DCFC onboard meters, and "upstream" meters, located grid-side such as meters monitoring electricity (in kwh) delivered to the on-site batteries.

Where the system's meters are located further "upstream", in order to not include any electricity lost to the EV charging system, any electricity sourced from associated infrastructure sources (notably from solar and the on-site battery) but delivered outside the EV charging system (e.g. delivered to the grid or the local building when the on-site battery is used as a back up generator source), must be sensibly taken into account for quantification. This includes the following examples:

1) Where the metered kwh to the on-site battery is located “upstream” on the grid side (rather than downstream of the on-site battery in the charger where electricity delivered to the EV is measured), any electricity that the on-site battery provides back to the grid, or its building in a given year must be measured and subtracted -- as LEC_{ijy} -- since these kwh represent losses to the overall charging system and do not result in EV miles driven.

2) Where the on-site battery is not connected to the grid or building (i.e., it does not serve as a power back up system), then the on-site battery does not need to be accounted for as a separate source, since it merely acts as a flow through for the grid and renewables sources. Any electricity received from the EV would also be returned to the EV. Therefore, the on-site battery would supply electricity consistent with the change in stored power between the year’s starting and end points which, compared to the kwh supplied by the grid and/or dedicated renewables, would be *de minimis*.

3) Any transfer of electricity from the EV to the onsite battery represent internal flows within the system and can be set aside since the electricity must either be returned downstream to the EV at a later date or tracked via LEC if subsequently delivered back to the grid via the on-site battery. Therefore, transfers of electricity from the EV to the onsite battery can be set aside.

4) Projects must be able to measure or sensibly estimate the electricity supplied from the grid and/or from dedicated renewable sources to the charger system and this may be a subset of the total electricity from this source. For example, the electricity delivered to the charging system may be less than the total electricity generated by the onsite renewables if these renewables also provide power back to the grid within a particular associated infrastructure system[30]. Similarly, the total grid electricity delivered to the system may be shared across both the EV charger if delivered directly whilst also supplying in parallel electricity to the on-site battery – the former contributing to NEC from the grid source and latter to NEC for the on-site battery.

Where the systems meters are located “downstream”, in order to not include any electricity lost to the EV charging system, any electricity sourced from associated infrastructure sources must be sensibly taken into account for quantification. This includes the following examples:

1) Where meters are located downstream for the measurement of NEC pertaining to the on-site battery, then the electricity measured must already be net of any LEC losses from the on-site battery to the grid – and thus LEC must be set at zero. This basis for such on-site battery net electricity measurements would be consistent with DCFC’s measurement systems which track the electricity exchanges close the point of delivery to the EV. Additionally, for downstream metering, the electricity provided by the EV to the onsite battery must be measured for the calculation of NEC for the on-site battery (that is, it cannot be set aside for downstream metering).

[30] At a future date, projects may wish to consider issuing carbon credits for the subset of kwh delivered from the dedicated renewables to the grid (but not to the EV charger) using methodologies such as AMS-I.F http://cdm.unfccc.int/filestorage/Y/P/1/YP1U4E0H976Z3WDMV2NGSTBLQIRCK5/EB81_repan26_AMS-I.F_ver03.0.pdf?t=QXB8b3N4dzA0fDCj0z7j2ttQEdzCtcKQbgnr

2) Where the EV is delivering vehicle-to-grid (V2G) services where electricity from the car's on-board battery is returned directly to the grid, these EV-sourced electricity are netted out in the grid-sourced net-kwh (that is, in the calculation of NEC for the grid source *s*).

3) In simple associated infrastructure settings, such as residences using L1/L2 systems where "upstream" metering systems apply and where the associated infrastructure system elements can be limited (e.g. no on-site battery). See Box A1 below.

Box A1: Simplified Associated Infrastructure Settings

Note that the quantification of emissions from project associated infrastructure systems can be simplified using sensible estimates. For example, where a household residence has a solar panel that is grid-connected – which, while its total solar kwh production and grid-sales are metered, does not have a separate sub-meter to establish the solar kwh supplied to the EV charging system specifically -- it is acceptable to assume that the kwh delivered to the EV charger is the same weighted average as the solar/grid kwh mix the household itself consumed (i.e., sources whose electricity would have been separately metered). Utility-style modeling is also acceptable for settings where only the net electricity consumption/generation is measured for a household in order to establish the electricity delivered by both the grid and the on-site renewables and thus the required weighted average.