Draft Standard 242P

Standard Methods for Quantifying Greenhouse Gas Emissions Factors for Building Operations

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(This foreword is not part of this standard. It is merely informative and does not contain requirements necessary for conformance to the standard. It has not been processed according to the ANSI requirements for a standard and may contain material that has not been subject to public review or a consensus process. Unresolved objectors on informative material are not offered the right to appeal at ASHRAE or ANSI.)

FOREWORD

Standard 242P establishes a single reference and methodologies for evaluating both historical and projected GHG emissions associated with a building, site or region. It provides a common quantification and documentation framework, emissions values for generating sources, and emissions factor data tables. It provides methods for calculating electricity grid emissions based on measured data or using computer simulation. The standard is intended to provide flexibility for AHJs, regulators, and the authors of related standards to calculate emissions, even while data resolution and data availability vary across locations. ***Note to reviewers:*** *The published version of the standard will include a live link to a publicly available website with table values. Access to the Appendix C Tables is available for view and download here: https://files.ashrae.org/secure_share/9q94xl39)*

To allow adaptability for users, data tables for both GWP20-year values and ASHRAE-recommended GWP100-year values are provided. Similarly, to accommodate the needs of various users, site and region boundaries are not specified, though users are required to identify the region for which emissions factors are calculated.

Use of region-specific data with month-hour resolution is recommended where such data are available; however, the standard provides methodologies for any time resolution for which data are available or for which a computer simulation is developed. Calculating grid imports and exports to and from nearby regions is recommended to properly account for on-grid and on-site generation, load reduction, and load-shifting impacts. Given that data availability can vary significantly across countries and regions, the data-based electricity emissions factor calculation methodology (Section 6.2) provides flexibility in how emissions factors are calculated, provided the user documents the parameters of their calculation.

Due to evolving evaluation and modeling of electricity grid emissions, the committee intends to place the document on continuous maintenance once published. The large quantity of data tables requires that the standard be made available online, with periodically updated data tables published as addenda. This will allow the document to be updated and utilized with minimal delay in the future.

The term AHJ (authority having jurisdiction) is used throughout to indicate the user of this standard. AHJ conventionally refers to the entity responsible for enforcing construction codes such as building or energy codes, but this standard might be referenced by:

- *Development committees for other codes and standards, including ASHRAE standards, that require quantification of GHG emissions*
- *AHJs, for adopted codes and standards that limit GHG emissions*
- *Owners, for campuses and building portfolios*
- *Utilities, for emissions analyses and incentive programs*
- *State and local governments, for legislation and tax issues*
- *Manufacturers, for determining GHG emissions for their products*
- *Researchers*

STANDARD 242P
STANDARD METHODS FOR QUANTIFYING GREENHOUSE GAS EMISSIONS FACTORS FOR BUILDING OPERATIONS

1. PURPOSE

To establish standard methods for quantifying *greenhouse gas emissions factors* associated with the energy usage of *buildings* and *sites*.

2. SCOPE

2.1 This standard provides:
a. Calculation procedures for *greenhouse gas emissions factors*,
b. Identification of data requirements for *emissions factor* calculations,
c. Labeling requirements through which *emissions factors* can be consistently identified,
d. *Emissions factors* associated with energy usage and conversion at *buildings* and *sites*.

2.2 This standard does not provide:
a. Methods of measurement or verification,
b. *Greenhouse gas emission* goals or limits, or
c. Design guidance or requirements for buildings.

3. DEFINITIONS

authority having jurisdiction (AHJ): the governmental unit, agency, agent or code official responsible for enforcing this standard.

building: any structure used or intended for supporting or sheltering any use or occupancy.

calculation period: the time period for which *emissions factors* are calculated, which may be a single hour, a year, multiple years or any other period defined for the calculation.

carbon dioxide equivalent (CO2e): The radiative forcing of a *greenhouse gas* equivalent to that of a unit mass of carbon dioxide based on the *global warming potential* of the *greenhouse gas* and a specified *global warming potential time horizon*.

distribution: the delivery of energy sources to retail customers, including but not limited to the delivery of electricity and *fuels* to a *building* or *site*

district thermal energy: thermal energy produced in a centralized plant and distributed as steam, hot water, or chilled water through a network of pipes for use at a *building* or *site*.

electric power plant: a station containing prime movers, electric generators, and auxiliary equipment for converting mechanical, chemical, and/or fission energy into electric energy.

electricity transmission: a specific type of energy *transmission* that includes the movement or transfer of electric energy over interconnected groups of lines and associated equipment between points of supply and points at which it is transformed for *distribution*

emissions factor: the quantity of a pollutant released to the atmosphere with the usage of a specific form of energy or an activity associated with the release of that pollutant. For the purposes of calculating *greenhouse gas emissions* associated with energy usage, these factors are typically expressed as the mass of a *greenhouse gas* per unit of energy; where multiple *greenhouse gases* are emitted for the same usage of energy, these factors are often expressed in terms of CO_2e per unit energy.

> ***emissions factor, average***: the *emissions factor* associated with the total usage of an energy source in a *study region* during a specified *timestep*.
>
> ***emissions factor, location-based***: an *emissions factor* that reflects the operations of the physical systems supplying an energy source in a *study region*, as distinguished from a *market-based emissions factor*.
>
> ***emissions factor, market-based***: an *emissions factor* that reflects the energy usage in a *study region*, excluding *procured energy*; as distinguished from a *location-based emissions factor*. *Market-based emissions factors* are sometimes referred to as residual emissions factors.
>
> ***emissions factor, marginal***: the *emissions factor* associated with an increase or decrease in the total usage of an energy source in a *study region* during a specified *timestep*.

***fuel*:** an energy source used to produce thermal energy or to generate electricity through combustion or other chemical reaction.

> ***fuel, fossil*:** *fuel* derived from a hydrocarbon deposit, such as petroleum, coal, or natural gas derived from living matter of a previous geologic time.

fuel gathering and boosting: the receiving and preparation of a *fuel* from multiple sources of *fuel production* or *fuel refining* to transport it to *fuel processing* facilities or directly to *fuel transmission* networks. *Fuel gathering and boosting* typically applies to natural gas.

fuel processing: the removal of impurities, typically in preparation for *fuel transmission*, and including but not limited to acid gas removal, dehydration, natural gas liquid recovery and compression.

fuel production: the extraction or harvesting of raw materials for *fuels*, including but not limited to biomass, crude oil, unfinished oils, natural gas, natural gas liquids, other hydrocarbons, and oxygenates.

fuel refining: the manufacture of finished *fuel* products from raw materials, including but not limited to biomass, crude oil, unfinished oils, natural gas liquids, other hydrocarbons, and oxygenates

fuel transmission: a specific type of energy *transmission* that includes the transfer of *fuels* from *fuel processing* facilities or other points of supply to points of *fuel distribution*, including through pipelines, overland networks and marine transport

greenhouse gas (GHG): Gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths emitted by the Earth's surface, the atmosphere itself and by clouds. Absorption of emitted infrared radiation causes the greenhouse effect. Carbon dioxide (CO2), nitrous oxide (N2O), methane (CH4), ozone (O3), and water vapor (H2O) are the primary *GHGs* in the Earth's atmosphere.

greenhouse gas (GHG) emissions: The release of *greenhouse gases* into the atmosphere.

> ***direct GHG emissions:*** GHG emissions produced from chemical conversion of a *fuel* (e.g., combustion), including in *buildings*, at *sites*, in electricity generation or to produce thermal energy. Sometimes referred to as on-site emissions.
>
> ***upstream GHG emissions:*** GHG emissions associated with the production, processing, supply and leakage of *fuels* prior to combustion or other chemical reactions to generate electricity or produce thermal energy for use at a *building* or *site*.

global warming potential (GWP): an index describing the relative ability of a chemical compound to affect radiative forcing, if emitted to the atmosphere, over its lifetime in the atmosphere, and thereby to affect the global climate. The *GWP* is defined on a mass basis relative to carbon dioxide. The *GWP* for a compound is calculated for a particular *global warming potential time horizon*.

> ***GWP20:*** *GWP* calculated using a 20-year *global warming potential time horizon*.
>
> ***GWP100:*** *GWP* calculated using a 100-year *global warming potential time horizon*.

global warming potential time horizon: A length of time, typically expressed in years, used for calculating the *global warming potential* of *greenhouse gases* in the atmosphere.

grid operator: an entity responsible for the reliable operation of an electricity grid region and any associated markets, including balancing authorities, regional *transmission* operators (RTOs) and independent system operators (ISOs)

higher heating value (HHV): the upper limit of available thermal energy from complete combustion of a *fuel*, it is the heat released when a *fuel* is combusted and the combustion products return to a temperature of 25°C, including the latent heat of vaporization of water. It is also referred to as the gross calorific value (GCV).

liquefied gas processing: the collection of processes that transform gaseous *fuels* into liquid *fuels*, typically for convenience of transportation or storage and later for combustion as a gas, including but not limited to liquefaction through temperature reduction or pressurization, *fuel* storage, *fuel transmission* between liquefaction and regassification facilities, and regassification

lower heating value (LHV): the heat released when a *fuel* is combusted and the water vapor does not condense, it is equal to the *higher heating value* minus the latent heat of condensed water vapor. It is also referred to as the net calorific value (NCV).

node: A mathematical representation of a region within an electricity grid, generally combining physical characteristics of the grid, such as generators, loads, and *transmission* constraints, in a manner that simplifies computation of a *production cost model* while maintaining accuracy of the simulated performance.

procured electricity: *procured energy* in the form of electricity

procured energy**:** energy from specific production or generation facilities allocated to specific end users or aggregations of end users through market instruments. (***Informative Note:*** Market instruments for procured energy include but are not limited to direct contracts, power purchase agreements and green tariffs, verified through Energy Attribution Certificates [EACs] and Renewable Energy Certificates [RECs], contracts, government databases, utilities*, grid operators*, Regional Generation Attribute Tracking Systems, regional energy production tracking systems, clean energy and carbon offset certification programs or other entities capable of verifying energy supply that are not party to the market instruments.)

production cost model**:** a mathematical optimization program that solves an electricity generation unit commitment problem for a *study region* and adjacent regions in order to minimize total costs to meet the electricity usage at each *node* over a simulation period given constraints on operation of each generator assigned to each *node* in the model regions and on *transmission* flows between each *node* in the model regions.

site: *an area of land that is under the control of a single owner or entity, which contains systems or equipment.*

study region: a geographic area for which an *emissions factor* is being determined.

transmission: the transfer of an energy source from points of supply to points of *distribution*.

verified data: data required for *emissions factor* calculations that is measured or that is provided by government agencies, energy system operators, energy production, energy conversion station operators, electricity generating station operators or other independent source approved by the *authority having jurisdiction.*

4. ADMINISTRATION

4.1 Compliance. *Emissions factors* shall comply with one of the following:

a. *Fuel emissions factors* shall comply with section 5
b. Electricity *emissions factors* shall comply with section 6.
c. *District thermal energy emissions factors* shall comply with section 7.

Informative note: Informative Appendix A contains general criteria for *emissions factors* that comply with this standard, identifying parameters, and guidance for users on selecting those parameters.

4.2 Emissions Factor Identification. *Emissions factors* shall be identified in accordance with the following as applicable:

a. The *calculation period* shall be identified by the following:
    i. Start date and, where applicable, time,
    ii. End date and, where applicable, time,
    iii. Multiple year averaging.
b. The *emissions factor* time granularity shall be identified by the calculation timestep, including but not limited to minute, hour, day, month-hour, month or year.
c. The *study region* shall be identified using a publicly available term for a geographic region or a user defined geographic boundary.
d. The *emissions factor* units shall be identified in unit of mass per unit energy (e.g. kg/MWh, lb/MWh, lb/MMBtu)
e. The emissions representation shall be identified by the specific *greenhouse gas* (e.g. CO_2, CH_4 or N_2O) or *carbon dioxide equivalent* of multiple constituent gases (e.g. *CO_2e)*.
f. The *global warming potential (GWP) time horizon* shall be identified, including but not limited to the most commonly used 100 years or 20 years.
g. The *fuel* heat content basis shall be identified for all *fuel* emissions factors as either *higher heating value (HHV)* or *lower heating value (LHV)*.
h. The electricity *emissions factor* calculation procedure shall be identified as one of the following:
    i. Measured, with the following additional identifiers as applicable
        1. Average Efficiency Alternative
        2. Net Import/Export Alternative
        3. Neighboring Region – Alternative Timestep
        4. Neighboring Region – Alternative Year
        5. Generation-only Method
    ii. Computer simulation
i. The electricity *emissions factor* type shall be identified as one of the following:
    i. Average emissions factors
    ii. Marginal emissions factors
j. Projected electricity *emissions factors* shall be identified as one of the following:
    i. N/A (i.e. *emissions factors* are not projected)
    ii. Historical annual trend
    iii. Energy supplier data basis
    iv. Simulated scenario
k. The electricity *emissions factor* basis shall be identified as one of the following:
    i. *Location-based emissions factor*, or
    ii. Market-based emissions factor

***Informative notes**:*

1. Item (g) is not required for *emissions factors* other than those for *fuels*, but the approach used in developing other *emissions factors* (e.g. for electricity or *district thermal energy*) may be included for informational purposes
2. In the current version of the standard, items (h-k) only apply to electricity.

***Informative note:** An example acceptable emissions factor identifier is:*

a. *Calculation period*: Jan 1, 2023- Dec 31, 2023. No averaging.
b. *Emissions factor* time granularity: month-hours.
c. *Study region*: Lansing, Michigan.
d. *Emissions factor* units: kg/MWh
e. Emissions representation: CO_2e.
f. *Global warming potential time horizon*: 100-yr
g. *Fuel* heat content: N/A
h. Electricity emissions calculation procedure: As-measured, Neighboring Region – Alternative Timestep
i. *Emissions factor* type: Average
j. Projected *emissions factor*: N/A
k. *Emissions factor* basis: Market-based

5. FUEL EMISSIONS FACTORS

5.1 General. *Greenhouse gas emissions factors* for *fuel* usage at a *building* or *site* or to generate electricity or *district thermal energy* for use at a *building* or *site* shall comply with Section 5.2 in accordance with the selections made in Section 4.2.

Informative note: Informative Appendix B contains *emissions factors* that comply with this section for common use cases with identifying information required by Section 4.2.

5.2 Calculating Fuel Emissions Factors. *Fuel emissions factors*, $EF\_fuel_{f,R,t}$, for *fuel* type, *f*, in *study region*, *r*, for timestep, *t* shall be calculated in accordance with Equation 5.2.

$$EF\_fuel_{f,r,t} = EF\_fuel\_direct_{f,r,t} + EF\_fuel\_upstream_{f,r,t}$$

where:

$EF\_fuel\_direct_{f,r,t}$ = *direct GHG emissions* for *fuel* type, *f*, in *study region*, *r*, for timestep, *t*, determined in accordance with Section 5.2.1

$EF\_fuel\_upstream_{f,r,t}$ =*upstream GHG emissions* for *fuel* type, *f*, in *study region*, *r*, for timestep, *t*, determined in accordance with Section 5.2.2

5.2.1 Fuel Emissions Factors – Direct. *Fuel direct GHG emissions factors*, $EF\_fuel\_direct_{f,r,t}$, shall include all *direct GHG emissions* associated with the burning of *fuel* type, *f*, in *study region*, *r*, for timestep, *t*, unless otherwise permitted by Section 5.2.1.1.

5.2.1.1 Alternative Fuels. Where applicable, *direct GHG emissions factors* for *fuels*, $EF\_fuel\_direct_{f,r,t}$, are permitted to be calculated in accordance with one of the following:

a. the net *greenhouse gas emissions* methodology in the U.S. Environmental Protection Agency Renewable Fuel Standard, or
b. the methodology of a clean fuel program approved by the AHJ and applicable to study region, *r*.

5.2.2 Fuel Emissions Factors – Upstream. *Upstream emissions factors* for *fuels*, $EF\_fuel\_upstream_{f,r,t}$, shall be calculated in accordance with Equation 5.2.2 and shall include all *upstream greenhouse gas emissions*, including all venting and flaring, associated with all applicable stages of the *fuel type, f,* supply chain prior to usage at a *building* or *site* or to generate electricity or *district thermal energy* for use at a *building* or *site* in *study region*, *r*, for timestep, *t*.

$$EF\_fuel\_upstream_{f,r,t} = \frac{em\_fuel\_prod_{f,r,t} + em\_fuel\_ref_{f,r,t} + em\_fuel\_GB_{f,r,t} + em\_fuel\_proc_{f,r,t} + em\_fuel\_trans_{f,r,t} + em\_fuel\_LG_{f,r,t}}{fuel\_usage_{f,r,t}}$$

where:

$em\_fuel\_prod_{f,r,t}$ = all *GHG emissions* associated with *fuel production* for *fuel* type, *f,* used in study region, *r*, at timestep, *t*

$em\_fuel\_ref_{f,r,t}$ = all *GHG emissions* associated with *fuel refining* for *fuel* type, *f,* used in study region, *r*, at timestep, *t*

$em\_fuel\_gb_{f,r,t}$ = all *GHG emissions* associated with *fuel gathering and boosting* for *fuel* type, *f,* used in study region, *r*, at timestep, *t*

$em\_fuel\_proc_{f,r,t}$ = all *GHG emissions* associated with *fuel processing* for *fuel* type, *f,* used in study region, *r*, at timestep, *t*

$em\_fuel\_trans_{f,r,t}$ = all *GHG emissions* associated with *fuel transmission* for *fuel* type, *f,* used in study region, *r*, at timestep, *t,* including but not limited to all *GHG emissions* associated *fuel transmission* stations, compressor and pumping stations, storage facilities and pipelines

$em\_fuel\_LG_{f,r,t}$ = all *GHG emissions* associated with *liquefied gas processing* for *fuel* type, *f,* used in study region, *r*, at timestep, *t,* including but not limited to all *GHG emissions* associated liquefaction, storage, *fuel transmission* between liquefaction and regassification facilities, and regassification. Where data is not available on the *GHG emissions* associated with *liquefied gas processing* for region, *r*, at timestep, *t*, the *liquefied gas processing GHG emissions* for natural gas shall be permitted to be calculated in accordance with Section 5.2.2.1.

$em\_fuel\_dist_{f,r,t}$ = all *GHG emissions* associated with *distribution* for *fuel* type, *f,* used in study region, *r*, at timestep, *t*

$em\_fuel\_euleak_{f,r,t}$ =all *GHG emissions* associated with leakage of *fuels* after *distribution* to end users for *fuel* type, *f,* used in study region, *r*, at timestep, *t*

$fuel\_usage_{f,r,t}$ = total usage of fuel type, *f*, in study region, *r*, for timestep, *t*, in units of energy

5.2.2.1 Liquified Natural Gas. Where data is not available on the *GHG emissions* associated with *liquefied gas processing* for *study region*, *r*, at timestep, *t*, the *liquefied gas processing GHG emissions* for natural gas, $em\_fuel\_LG_{NG,r,t}$, shall be permitted to be calculated in accordance with equation 5.2.2.1.

$$em\_fuel\_LG_{NG,r,t} = a + b(Distance) + c \quad (5.2.2.1)$$

Where:

LNG Adder = Additional component *emissions factor* for LNG (kg/MWh)
a = 38 kg/MWh for *GWP*100 or 53 kg/MWh for *GWP* 20
b = 0.0031 kg/MWh-km for *GWP*100 or 0.0036 kg/MWh-km for *GWP*20
Distance = transportation distance between liquefaction and regassification (km)
c = 4 kg/MWh

6. ELECTRICITY EMISSIONS FACTORS

6.1 General. *Greenhouse gas emissions factors* for electricity usage at a *building* or *site* or to generate *district thermal energy* for use at a *building* or *site* shall comply with Sections 6.1.1 through 6.1.3 in accordance with the selections made in Section 4.2.

Informative note: Informative Appendix C contains *emissions factors* that comply with this section for common use cases with identifying information required by Section 4.2.

6.1.1 Calculation Procedure. *Emissions factors* for electricity supply in the *study region* shall comply with one of the following:

a. Where identified as "as-measured" in accordance with Section 4.2, *emissions factor* calculations shall comply with Section 6.2.

b. Where identified as "computer simulation" in accordance with Section 4.2, *emissions factor* calculations shall comply with Section 6.3.

6.1.2 Projected Emissions Factors. Where identified as projected *emissions factors* in accordance with Section 4.2, *emissions factors* for electricity supply in the *study region* shall comply with Section 6.4.

6.1.3 Market-Based Emissions Factors. Where identified as *market-based emissions factors* in accordance with Section 4.2, *emissions factors* for electricity supply in the *study region* shall comply with Section 6.5.

Informative notes:

1. Where quantifying *greenhouse gas emissions* for *buildings* or *sites* includes accounting for *procured electricity* by *buildings* or *sites*, *market-based emissions factors* (sometimes referred to as residual *emissions factors*) should be used for all electricity usage that is not *procured electricity*.
2. *Location-based emissions factors* do not separately account for *procured electricity* and should not comply with Section 6.5.

6.2. Calculating Electricity Emissions Factors Based on Measured Data. *Emissions factors* for electricity in the *study region* shall comply with Sections 6.2.1 and 6.2.2.

6.2.1 As-Measured Emissions Factor Calculations. *Emissions factors* for electricity, $EF\_elec_{r,t}$, shall be calculated in accordance with Equation 6.2.1, for *study region*, *R*, documented in accordance with Section 4.2 and for the timestep, *t*, documented in accordance with Section 4.2.

$$EF\_elec_{r,t} = \frac{\left[\sum_f \sum_{g \in r} \left(fuel\_gen_{f,g,t} \times EF\_fuel_{f,r,t}\right)\right] \times \left(1 - \frac{\sum_{r'} elec\_exp_{r',t}}{\sum_g elec\_gen_{g,t}}\right) + \sum_r \left(elec\_imp_{r',t} \times EF\_elec_{r',t}\right)}{elec\_use_{r,t}} \quad (6.2.1)$$

Where:

$fuel\_gen_{f,g \in r,t}$ = *fuel* usage for electricity generation of *fuel* type, *f*, used by generator, *g*, within study region, *r*, at timestep, *t*, determined in accordance with Section 6.2.2.1

$EF\_fuel_{f,r,t}$ = *emissions factor* for *fuel* type, *f*, in *study region*, *r*, for timestep, *t*, determined in accordance with Section 6.2.2.2

$elec\_exp_{r',t}$ = exports of electricity from *study region*, *r*, to adjacent region, *r'*, for timestep, *t*, in units of energy, determined in accordance with Section 6.2.2.3

$elec\_gen_{g \in r,t}$ = electricity generated by generator, *g*, in *study region*, *r*, at timestep, *t*, in units of energy, determined in accordance with Section 6.2.2.4

$elec\_imp_{r',t}$ = imports of electricity into *study region*, *r*, from adjacent region, *r'*, for timestep, *t*, in units of energy, determined in accordance with Section 6.2.2.3

$EF\_elec_{r',t}$ = electricity *emissions factor* for adjacent region, *r'*, for timestep, *t*, in units of mass of *greenhouse gas emissions* per unit electric energy used, determined in accordance with Section 6.2.2.5

$elec\_use_{r,t}$ = electricity usage within *study region*, *r*, for timestep, *t*, in units of energy used, determined in accordance with Section 6.2.2.6

6.2.2 Data Inputs for Electricity Emissions Factor Calculations. All calculations of *emissions factors* for electricity supply based on measured data shall comply with Sections 6.2.2.1 through 6.2.2.8.

6.2.2.1 Fuel Usage for Electricity Generation. All calculations shall use *verified data* for *fuel* usage for electricity generation at the defined timestep in energy units corresponding to the *fuel*, *study region* and generator. Alternative methods that comply with Sections 6.2.2.1.1 and 6.2.2.1.2 shall be permitted.

6.2.2.1.1 Total Fuel Usage by Fuel Type Alternative. Calculations in accordance with Section 6.2.1, shall be permitted to use the total *fuel* usage for the *fuel* for electricity generation within the *study region*, $fuel\_gen_{f,r,t}$, in accordance with the following substitution in Equation 6.2.1:

$$\sum_f \sum_g \left(fuel\_gen_{f,g \in r,t} \times EF\_fuel_{f,r,t}\right) = \sum_f fuel\_gen_{f,r,t} \times EF\_fuel_{f,r,t}$$

6.2.2.1.2 Average Efficiency Alternative. Where the *emissions factor* is identified as "average efficiency alternative" in accordance with Section 4.2, the value for *fuel* usage for electricity generation is permitted to be calculated in accordance with the following:

$$fuel\_gen_{f,g,t} = elec\_gen_{f,g,t} \times \frac{1}{\eta_G} = elec\_gen_{f,g,t} \times \frac{\sum_{g \in G} fuel\_gen_{f,g,\tau}}{\sum_{g \in G} elec\_gen_{f,g,\tau}}$$

Where:
G = a set of one or more generators with the same *fuel* type and generator type as generator, *g*, and τ is permitted to be a timestep greater than timestep, *t*
η_G = average efficiency of generator type, *G*, defined as the ratio of electricity generated to fuel usage using *verified data* for not more than three years before or after the timestep

6.2.2.2 Fuel Emissions Factor Associated with Electricity Generation. All calculations shall use *fuel emissions factors* associated with electricity generation within the *study region* in accordance with Section 5.1, in units of mass of *greenhouse gas emissions* per unit energy usage.

6.2.2.3 Electricity Imports and Exports. All calculations shall comply with Sections 6.2.2.3.1 and 6.2.2.3.2.

Exception to 6.2.2.3: Where the *emissions factor* is identified as "generation-only" in accordance with Section 4.2 and the calculation is in accordance with Section 6.2.2.3.3.

6.2.2.3.1 Electricity Imports. All calculations shall use *verified data* for electricity imports into the *study region* from adjacent regions at each point of import, in energy units and at the same timestep as the *emissions factor* calculation, unless otherwise permitted by Section 6.2.2.3.1.1. All values for electricity imports shall be no less than zero.

6.2.2.3.1.1 Net Imports-Based Calculation. Where the calculation is identified as "Net Import/Export" in accordance with Section 4.2, the value of the import of electricity into the *study region* from an adjacent region in Equation 6.2.1 shall be permitted to be the greater of:

i. zero or
ii. the sum of all imports into the *study region* from the adjacent region minus the sum of all exports from the *study region* to the adjacent region over all timesteps within the calculation timestep, based on *verified data.*

6.2.2.3.2 Electricity Exports. All calculations shall use *verified data* for electricity exports from the *study region* to adjacent regions at each point of export, in energy units and at the same timestep as the *emissions factor* calculation, unless otherwise permitted by Section 6.2.2.3.2.1. All values for electricity exports shall be no less than zero.

6.2.2.3.2.1. Net Exports-Based Calculation. Where the calculation is identified as "Net Import/Export" in accordance with Section 4.2, the value of the export of electricity from the *study region* to an adjacent region in Equation 6.2.1 shall be permitted to be the greater of:

i. zero or
ii. the sum of all exports from the *study region* to the adjacent region minus the sum of all imports into the *study region* from the adjacent region over all timesteps within the calculation timestep, based on *verified data*.

6.2.2.3.3 Generation-Only Calculations. Where the *emissions factor* is identified as "generation-only" in accordance with Section 4.2, the values for imports and exports of electricity shall be permitted to be set to zero and the *emissions factor* shall be permitted to be calculated in accordance with the following:

$$EF\_elec_{r,t} = \frac{\left[\sum_f \sum_{g \in r} \left(fuel\_gen_{f,g,t} \times EF\_fuel_{f,r,t}\right)\right]}{elec\_use_{r,t}}$$

6.2.2.4 Electricity Generation. All calculations shall use *verified data* for electricity generation at the defined timestep in energy units corresponding to the *study region* and generator unless otherwise permitted by Sections 6.2.2.4.1 through 6.2.2.4.3.

6.2.2.4.1 Total Electricity Generation Alternative. Calculations in accordance with Section 6.2.1, shall be permitted to use verified data for the total electricity generation in the *study region* at the timestep in accordance with the following substitution in Equation 6.2.1:

$$\sum_{g} elec\_gen_{g \in r,t} = elec\_gen_{r,t}$$

6.2.2.4.2 Net Import/Export-Based Calculation. Where the calculation is identified as "Net Import/Export" in accordance with Section 4.2, the value of the electricity generation in the *study region* is permitted to be the sum of all *verified data* for electricity generation over all timesteps within the calculation timestep.

Informative note: A common example is where hourly import and export data is available and the *emissions factor* calculation is for a one-year timestep. In this case, the hourly import and export data is permitted to be summed to net imports or net exports for use in Equation 6.2.1.

6.2.2.4.3 Estimating Electricity Generation from Other Data. Where *verified data* for electricity generation is not available, calculations shall be permitted to estimate the electricity generation based on *verified data* for the electricity usage at the timestep and an *electricity transmission* and *distribution* loss factor, in accordance with the following:

$$elec\_gen_{r,t} = \frac{elec\_use_{r,t} - \sum_{r}\left(elec\_imp_{r',t} - elec\_exp_{r',t}\right)}{\left(1 - TDL_{r,t}\right)}$$

Where $TDL_{r,t}$ is calculated in accordance with Section 6.2.2.7 using *verified data* for no more than three years before or after the timestep.

6.2.2.5 Emissions Factor of Imported Electricity. All calculations with electricity imports from an adjacent region into the *study region* shall use adjacent region *emissions factors* that comply with Sections 6.2.2.5.1 and 6.2.2.5.2.

6.2.2.5.1 Adjacent Region Emissions Factor – Methods. Adjacent region *emissions factors* for electricity supply shall be calculated in accordance with Section 6.2.1 or 6.3.

6.2.2.5.2 Adjacent Region Emissions Factors – Timestep. The timestep for the adjacent region *emissions factor* calculations shall be the same as that for the *study region emissions factor* calculation unless otherwise permitted by Sections 6.2.2.5.2.1 and 6.2.2.5.2.2.

6.2.2.5.2.1 Allowance for Longer Timesteps for Adjacent Region Data. Where identified as "Neighboring Region – Alternative Timestep" in accordance with Section 4.2, *emissions factors* for the adjacent region shall be permitted to be calculated for a longer timestep than the timestep for the *study region* calculation, provided that the timestep for the adjacent region calculation is no longer than one year and includes within it the timestep for the *study region* calculation.

6.2.2.5.2.2 Allowance for Adjacent Region Data from Other Years. Where approved by the *AHJ* and where identified as "Neighboring Region – Alternative Year" in accordance with Section 4.2, the *emissions factor* for the adjacent region shall be permitted to be calculated for a timestep no more than two years before or after the timestep for the *study region* calculation.

6.2.2.6 Electricity Usage. All calculations shall use *verified data* for electricity usage in the *study region* in energy units at the defined timestep unless otherwise permitted by Section 6.2.2.6.1.

6.2.2.6.1 Estimating Electricity Usage from Other Data. Where *verified data* for electricity usage is not available, calculations shall be permitted to estimate the electricity usage based on *verified data* for the electricity usage at the timestep and a *transmission* and *distribution* loss factor, in accordance with the following:

$$elec\_use_{r,t} = \left(\sum_{g} elec\_gen_{r,t} + \sum_{r} \left(elec\_imp_{r',t} - elec\_exp_{r',t} \right) \right) \times (1 - TDL_{r,t})$$

Where $TDL_{r,t}$ is calculated in accordance with Section 6.2.2.7 using *verified data* for no more than three years before or after the timestep.

6.2.2.7 Transmission and Distribution Loss Factor. The *transmission* and *distribution* loss factor, $TDL_{r,\tau}$, shall be calculated in accordance with Equation 6.2.2.7 for a timestep, τ, that is permitted to be greater than the *emissions factor* calculation timestep, *t*, where permitted by the other requirements of Section 6.2.

$$TDL_{r,\tau} = 1 - \frac{elec\_use_{r,\tau}}{\sum_{g} elec\_gen_{r,\tau} + \sum_{r} \left(elec\_imp_{r',\tau} - elec\_exp_{r',\tau} \right)} \quad (6.2.2.7)$$

6.2.2.8 Marginal Emissions Factors. Where identified as "Marginal" in accordance with Section 4.2, *emissions factors* shall be calculated using data required by Section 6.2.1 corresponding to the specific *electric power plant* required to meet the next incremental unit of electricity usage in the *study region*, based on *verified data* from a *grid operator* or electric utility.

6.3. Calculating Electricity Emissions Factors Based on Computer Simulation. *Emissions factors* for electricity supply in the *study region* shall comply with Sections 6.3.1 and 6.3.2.

6.3.1 Production Cost Model. *Emissions factors* shall be calculated using a *production cost model* of the *study region* and adjacent regions. The *production cost model* shall include all of the following based on *verified data*:

a. For each generator and, where applicable, at each timestep:
   1. *Fuel* type and cost per unit energy
   2. Heat rate, efficiency or *fuel* usage as a function of electricity generation
   3. Minimum and maximum electricity generation limits
   4. Minimum up and down time for each generator
   5. Startup cost
   6. Electricity generation based on weather data, where applicable (e.g. intermittent electricity generation from wind and solar resources)
   7. *Node* to which the generator is connected.

b. For each connection between *nodes* and, where applicable, at each timestep:
   1. Maximum *transmission* limit
   2. *Transmission* and *distribution* loss factor

c. For each *node*, electricity usage at each *timestep* in the simulation

6.3.2 Emissions Factor Calculations. *Emissions factor* calculations shall comply with Section 6.3.2.1 and Section 6.3.2.2 based on the outputs of a *production cost model* complying with Section 6.3.1.

6.3.2.1 Calculating Study Region Emissions. Where the *study region* is all *nodes* in a *production cost model*, emissions shall be calculated in accordance with Section 6.3.2.1.1. Where the *study region* is a single *node* or a subset of *nodes* in a *production cost model*, emissions shall be calculated in accordance with Section 6.3.2.1.2.

6.3.2.1.1 Emissions for All Model Nodes. Where the *study region* is all *nodes* in a *production cost model*, *study region* emissions, $em_{i,t}$, at *calculation period* timestep, *t*, shall be calculated in accordance with Equation 6.3.2.1.1 based on a *production cost model* complying with Section 6.3.1 with simulation timestep, τ.

$$em_{r,t} = \sum_{\tau \in t} \sum_{f,g \in r} \left(fuel\_gen_{f,g,\tau} \times EF\_fuel_{f,g,\tau} \right) \quad (6.3.2.1.1)$$

Where:

$fuel\_gen_{f,g \in r,\tau}$ = *fuel* usage for electricity generation of *fuel* type, *f*, used by generator, g, at simulation timestep, τ, in units of energy used

$EF\_fuel_{f,g \in r,\tau}$ = *emissions factor* for *fuel* type, *f*, at generator, g, for simulation timestep, τ, determined in accordance with Section 5 in units of mass of emissions per unit energy

6.3.2.1.2 Allocating Emissions to Study Region. Emissions allocated to the *study region*, $em_{r,t}$, at *calculation period* timestep, *t*, shall be calculated in accordance with Equation 6.3.2.1.2-1 based on a *production cost model* complying with Section 6.3.1 with simulation timestep, τ.

$$em_{r,t} = \sum_{i \in r} \sum_{\tau \in t} em_{i,\tau} \quad (6.3.2.1.2\text{-}1)$$

Where:

$em_{i,\tau}$ = emissions in units of mass allocated to *node*, *i*, calculated in accordance with Equation 6.3.2.1.2-2, where *i*, *j* and *k* designate *nodes* in a *production cost model* complying with Section 6.3.1.

$$em_{i,\tau} = elec\_use_{i,\tau} \sum_{j} \frac{[\boldsymbol{A}_{\tau}^{-1}]_{j,i} \times \sum_{f} \sum_{g \in j} fuel\_gen_{f,g,\tau} \times EF\_fuel_{f,g,\tau}}{elec\_use_{j,\tau} + \sum_{k} elec\_exp_{j-k,\tau}} \quad (6.3.2.1.2\text{-}2)$$

Where:

$elec\_use_{i,\tau}$ = electricity usage at *node*, *i*, for simulation timestep, τ, in units of energy used

$\boldsymbol{A}_{\tau}$ = electricity allocation matrix formed in accordance with Equation 6.3.2.1.2-3 for simulation timestep, τ (dimensionless)

$fuel\_gen_{f,g,\tau}$ = *fuel* usage for electricity generation of *fuel* type, *f*, used by generator, g, at simulation timestep, τ, in units of energy used

$EF\_fuel_{f,g,\tau}$ = *emissions factor* for *fuel* type, *f*, at generator, g, for simulation timestep, τ, determined in accordance with Section 5 in units of mass of emissions per unit energy

$elec\_use_{j,\tau}$ = electricity usage at *node*, *j*, for simulation timestep, τ, in units of energy used

$elec\_exp_{j-k,\tau}$ = exports of electricity from *node*, *j*, to *node*, *k*, for simulation timestep, τ, in units of energy. This value is zero when electricity flows from *k* to *j*.

$$[\boldsymbol{A}_\tau]_{j,i} = \begin{cases} 1 & , \quad j = i \\ \dfrac{-elec\_exp_{j-i,\tau}}{elec\_use_{j,\tau} + \sum_k elec\_exp_{j-k,\tau}} & , \quad where\ j\ and\ i\ are\ connected\ nodes \\ 0 & , \quad else \end{cases}$$

(6.3.2.1.2-3)

Where:

$elec\_exp_{j-i,\tau}$ = exports of electricity from *node*, *j*, to *node*, *k*, for simulation timestep, *t*, in units of energy. This value is zero when electricity flows from *i* to *j*.
$elec\_use_{j,\tau}$ = electricity usage at *node*, *j*, for timestep, *t*, in units of energy
$elec\_exp_{j-k,\tau}$ = exports of electricity from *node*, *j*, to *node*, *k*, for timestep, *t*, in units of energy. This value is zero when electricity flows from *k* to *j*.

6.3.2.2 Emissions Factor Type. *Emissions factor* calculations shall comply with one of Sections 6.3.2.2.1 or 6.3.2.2.2.

6.3.2.2.1 Average Emissions Factors. Where identified as an *average emissions factor* in accordance with Section 4.2, the *emissions factor* for *study region, R*, shall be calculated in accordance with Equation 6.3.2.2.1.

$$EF\_elec_{r,t} = \frac{em_{r,t}}{\sum_{i \in R} \sum_{\tau \in t} elec\_use_{i,\tau}}$$

(6.3.2.2.1)

Where:

$em_{R,t}$ = emissions allocated to *study region*, *r*, calculated in accordance with Section 6.3.2.1, in units of mass
$elec\_use_{i,\tau}$ = electricity usage at *node*, *i*, for simulation timestep, τ, in units of energy used

6.3.2.2.2 Marginal Emissions Factors. Where identified as a *marginal emissions factor* in accordance with Section 4.2, the *emissions factor* shall be calculated in accordance with Equation 6.3.2.2.2-1 using both of the following:

i. a base *production cost model* complying with Section 6.3.1, and
ii. a perturbed *production cost model* modifying the base *production cost model* electricity usage in accordance with Equation 6.3.2.1.2-2 for all *nodes*, *i*, in *study region*, *R*, for all simulation timesteps, τ, in *calculation period* timestep, *t*.

$$EF\_elec_{r,t} = \frac{\sum_{\tau \in t} em'_{r,\tau} - em_{r,\tau}}{\sum_{i \in r} \sum_{\tau \in t} \left(elec\_use'_{i,\tau} - elec\_use_{i,\tau} \right)}$$

(6.3.2.2.2-1)

$$elec\_use'_{i,\tau} = (1 + \varepsilon) \times elec\_use_{i,\tau} \ , \quad for\ all\ i \in r, \tau \in t$$

(6.3.2.1.2-2)

Where:

$em'_{r,\tau}$ = emissions allocated to *study region*, *r*, at simulation timestep, τ, calculated in accordance with Section 6.3.2.1 using a perturbed *production cost model* in accordance with Section 6.3.2.2.2(ii)
$em_{r,t}$ = emissions allocated to *study region*, *r*, at simulation timestep, τ, calculated in accordance with Section 6.3.2.1 for the base *production cost model* complying with Section 6.3.1.

$elec\_use'_{i,t}$ = modified electricity usage at *node*, *i*, for timestep, *t*, calculated in accordance with Equation 6.3.2.1.2-2, in units of energy used
$elec\_use_{i,t}$ = *electricity usage* at *node*, *i*, for timestep, *t*, in units of energy used
ε = perturbation factor of no less than 0.01 and no greater than 0.05

6.4 Calculating Projected Electricity Emissions Factors. Where identified as projected *emissions factors* in accordance with Section 4.2, *emissions factors* for electricity supply in the *study region* shall comply with Section 6.4.1, 6.4.2 or 6.4.3.

6.4.1 Projected Emissions Factors – Historical Annual Trend. Where identified as "Projected – Historical annual trend" in accordance with Section 4.2 and where the *emissions factor* timestep, *t*, is one year, *average emissions factors* shall be permitted to be calculated in accordance with Equation 6.4.1.

$$EF_t = \frac{a}{1 + e^{b(t-c)}} \tag{6.4.1}$$

Where the values of *a*, *b* and *c* minimize the sum of the squares of the deviation of *emissions factors* calculated in accordance with Section 6.2 or 6.3 and Equation 6.4.1 in accordance with the following:

$$\min_{a,b,c} \sum_{\tau=1}^{T} \left[EF_\tau - \frac{a}{1 + e^{b(\tau-c)}} \right]^2$$

Where T is no less than 10 and is permitted to include non-consecutive years.

6.4.2 Projected Emissions Factors – Utility Data. Where identified as "Projected – Energy supplier data basis" in accordance with Section 4.2, *emissions factors* shall be permitted to be calculated in accordance with Section 6.3 using *verified data* for future electricity generators (Section 6.3.1(a)), internodal *transmission* interfaces (Section 6.3.1(b)), and electricity usage (Section 6.3.1(c)), from any of the following:

a. *Grid operators*, including generator and *transmission* capacity additions and retirements.

b. Electric utilities, including planned capacity additions and retirements, demand projections and integrated resource plans.

6.4.3 Projected Emissions Factors – Simulated Scenario. Where identified as "Projected – Simulated Scenario" in accordance with Section 4.2, *emissions factors* shall be permitted to be calculated in accordance with Section 6.3 using *verified data* for future electricity generators (Section 6.3.1(a)), internodal *transmission* interfaces (Section 6.3.1(b)), and electricity usage (Section 6.3.1(c)) based on a publicly available mathematical programming model of the electric power sector that makes investment and operational decisions to minimize the overall cost of the electricity system based on documented technology, market and policy inputs.

6.5 Calculating Market-Based Emissions Factors. Where identified as *market-based emissions factors* in accordance with Section 4.2, *emissions factor* calculations shall comply with Section 6.5.1. Where all *procured electricity* in the *study region* has an *emissions factor* of zero, *emissions factor* calculations shall be permitted to comply with Section 6.5.2.

6.5.1 Market-Based Emissions Factors – General Method. *Emissions factor* calculations shall comply with the following:

a. Where identified as "as-measured" in accordance with section 4.2, *emissions factor* calculations in accordance with Section 6.2 shall be adjusted in accordance with Equation 6.5 for any calculation input, *X*, applicable to *procured electricity* in the *study region*.

b. Where identified as "computer simulation" and as an *average emissions factor* in accordance with Section 4.2, *emissions factor* calculations in accordance with Section 6.3.2.1.1 shall be adjusted in accordance with Equation 6.5 for any calculation input, X, applicable to *procured electricity* in the *study region* and adjacent regions in a *production cost model*.
c. Where identified as "computer simulation" and as a *marginal emissions factor* in accordance with Section 4.2, *emissions factor* calculations shall comply with Section 6.3 without adjustment in accordance with this section.

$$X = X^{(base)} - X^{(PE)} \tag{6.5.1}$$

Where:

X = an input for calculations in accordance with Section 6.2 or a *production cost model* in accordance with Section 6.3.1

$X^{(base)}$ = measured data in accordance with Section 6.2 and *verified data* in accordance with Section 6.3.1, corresponding to calculation input, X, as applicable for the *emissions factor* identified in accordance with Section 4.2

$X^{(PE)}$ = measured data in accordance with Section 6.2 and *verified data* in accordance with Section 6.3.1, attributed to *procured electricity* corresponding to calculation input, X, for the *study region*, any adjacent regions included in the analysis, and *transmission* interfaces between regions included in the analysis

6.5.2 Market-Based Emissions Factors – Simplified Method. Where all *procured electricity* in *the study region* has an *emissions factor* of zero, *study region emissions factor* calculations based on measured data in accordance with Section 6.2 and *average emissions factor* calculations in accordance with Section 6.3.2.1.1 shall be permitted to be adjusted in accordance with Equation 6.5.1 without further adjustments in accordance with Section 6.5.1.

$$elec\_use = elec\_use^{(base)} - elec\_use^{(PE)} \tag{6.5.2}$$

Where:

$elec\_use$ = electricity usage for calculations in accordance with Section 6.2 or a *production cost model* in accordance with Section 6.3.1

$elec\_use^{(base)}$ = electricity usage in a *study region* in accordance with Section 6.2.2.6 or at a *node* in a *production cost model* in accordance with Section 6.3.1(c)

$elec\_use^{(PE)}$ = electricity usage attributed to *procured electricity* for a *study region* or *node* in a *production cost model* corresponding to the same *study region* or *node* in $elec\_dem^{(base)}$

Informative note: When calculating an *average emissions factor* based on computer simulation, the simplified *market-based emissions factor* in Section 6.5.2 does not require adjustment of a *production cost model* in accordance with Equation 6.5. Only after the output of the unadjusted *production cost model* does electricity usage need to be adjusted for the calculation in accordance with Section 6.3.2.1.1.

7. DISTRICT THERMAL ENERGY EMISSIONS FACTORS

7.1 General. *Emissions factors* for *district thermal energy* supplied to a *building* or *site*, including steam, hot water and chilled water, shall comply with Section 7.2 in accordance with the selections made in Section 4.2.

7.2 Calculating Emissions Factors for District Thermal Energy Supplied to Buildings. *Emissions factors* for *district thermal energy* shall comply with Sections 7.2.1 and 7.2.2.

Exception to 7.2: Where an alternative calculation method is approved by the *AHJ*.

7.2.1 District Thermal Energy Emissions Factors – General Method. *District thermal energy emissions factors* shall be calculated in accordance with Equation 7.2.1 unless otherwise permitted by Section 7.2.1.1 or 7.2.1.2.

$$EF\_thermal_t = \frac{1}{1 - TDL\_thermal_t} \sum_s \frac{en\_input\_thermal_{s,t} \times EF\_source_{s,t}}{gen\_thermal_{s,t}} \quad (7.2.1)$$

Where:

$en\_input\_thermal_{s,t}$ = energy input of source, *s*, at time, *t*, to generate *district thermal energy*, determined in accordance with Section 7.2.2.1, in units of energy

$EF\_source_{s,t}$ = *emissions factor* for energy source, *s*, at time, *t*, determined in accordance with Section 7.2.2.2

$gen\_thermal_{s,t}$ = *district thermal energy* generated by source, *s*, at time, *t*, determined in accordance with Section 7.2.2.3, in units of energy

$TDL\_thermal_t$ = *district thermal energy transmission* and *distribution* loss factor at time, t, determined in accordance with Section 7.2.2.5

7.2.1.1 District Thermal Energy Emissions Factors – Average Efficiency Alternative. Where a single energy source is used and *verified data* are not available for energy input and *district thermal energy* generated, thermal energy *emissions factors* are permitted to be calculated in accordance with Equation 7.2.1.1.

$$EF\_thermal_t = \frac{EF\_source_{s,t}}{\eta\_thermal_{s,t} \times (1 - TDL\_thermal_t)} \quad (7.2.1.1)$$

Where:

$\eta\_thermal_{s,t}$ = overall thermal energy conversion efficiency of *district thermal energy* generation from source, *s*, at time, *t*, determined in accordance with Section 7.2.2.4

7.2.1.2 District Thermal Energy Emissions Factors – Annual Values. Where the timestep, *t*, is less than one year, *district thermal energy* efficiency *emissions factors* are permitted to use average annual data for the same year in which timestep, *t*, occurs.

7.2.2 Data Inputs for District Thermal Energy Emissions Factors. All calculations of *emissions factors* for *district thermal energy* shall comply with Sections 7.2.2.1 through 7.2.2.5.

7.2.2.1 Energy Input for District Thermal Energy Generation. All calculations shall use *verified data* for *fuel* or electricity usage by the facility generating the *district thermal energy* at the defined timestep.

7.2.2.2 District Thermal Energy Source Emissions Factors. Where the source energy for *district thermal energy* generation is a *fuel*, *emissions factor* calculations shall use *emissions factors* complying with Section 5. Where the source energy for *district thermal energy* generation is electricity, *emissions factor* calculations shall use *emissions factors* complying with Section 6. All calculations shall use source energy *emissions factors* for a *study region* that includes the facility producing the thermal energy.

7.2.2.3 District Thermal Energy Generated. *Emissions factor* calculations shall use *verified data* for *district thermal energy* generated from a specified source at the defined timestep for the facility generating the *district thermal energy*.

7.2.2.4 District Thermal Energy Generation Efficiency. Where *emissions factor* calculations using average efficiencies are permitted by Section 7.2.1.1, calculations shall use *verified data* for the efficiency of *district thermal energy* generated from a specified energy source at the defined timestep for the facility generating the *district thermal energy*. Where efficiency values are not known for the specific facility, the default values in Table 7.2.2.4 shall be permitted.

Table 7.2.2.4 Default District Thermal Energy Conversion Efficiency

Thermal Energy Output	Energy Input Source	Default Efficiency
Hot Water	*Fuel*	70%
	Electricity – Boiler	90%
	Electricity – Heat Pump	300%
Steam	*Fuel*	70%
	Electricity – Boiler	90%
Chilled Water	Electricity	440%
	Fuel	60%

7.2.2.5 District Thermal Energy Transmission and Distribution Loss Factor. The *transmission* and *distribution* loss factor for *district thermal energy*, $TDL\_thermal_{\tau}$, shall be calculated for a timestep, τ, permitted by the other requirements of Section 7.2 and in accordance with Equation 7.2.2.5 for the facility generating the *district thermal energy*. Calculations are permitted to use a timestep, τ, that is greater than the *emissions factor* calculation timestep, *t*. Where loss factor values are not known for the specific facility, the default values in Table 7.2.2.5 shall be permitted.

$$TDL\_thermal_{\tau} = 1 - \frac{delivered\_thermal_{\tau}}{gen\_thermal_{\tau}} \quad (7.2.2.5)$$

Where:

$delivered\_thermal_{s,t}$ = *district thermal energy* delivered to all end users from the facility at time, *t*, in units of energy

Table 7.2.2.5 Default District Thermal Energy Loss Factors

Thermal Energy Output	Default Loss Factor
Hot Water	10%
Steam – Closed Loop	15%
Steam – Open Loop	25%
Chilled Water	5%

(This appendix is not part of this standard. It is merely informative and does not contain requirements necessary for conformance to the standard. It has not been processed according to the ANSI requirements for a standard and may contain material that has not been subject to public review or a consensus process. Unresolved objectors on informative material are not offered the right to appeal at ASHRAE or ANSI.)

INFORMATIVE APPENDIX A

DESCRIPTIONS OF EMISSIONS FACTOR IDENTIFYING PARAMETERS AND GUIDANCE FOR USERS

A1. General

This informative appendix describes the components of *emissions factors* that comply with this standard, identification information required by Section 4.2 and recommendations for *emissions factor* calculations.

A2. General Emissions Factor Criteria.

A2.1 Greenhouse gases (GHGs). *GHGs* absorb and emit radiation at specific wavelengths emitted by the Earth's surface, causing the greenhouse effect that warms the planet. The primary *GHGs* in the Earth's atmosphere are carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), ozone (O_3) and water vapor (H_2O). It is recommended that all *emissions factors* used to convert energy usage to *GHG emissions* include the three primary *GHGs* associated with energy production, supply and usage: CO_2, N_2O, and CH_4. All *emissions factors* in the informative appendices of this standard include the effects of these three gases, either individually or in combination in CO_2e calculations.

A2.2 Direct and Upstream Emissions Factors. All *emissions factor* calculations require the inclusion of *direct GHG emissions* and *upstream GHG emissions factors*:

A2.2.1 *Direct GHG emissions* occur when a *fuel* is converted from the form at which it is delivered to a *building*, *site*, or *electric power plant*. Values for *combustion GHG emissions* per unit mass, volume or energy of typical *fuels* are published by a number of scientific bodies. *Direct GHG emissions* are a direct result of a *fuel*'s reaction with other chemicals, most commonly oxygen and the other gases in air (i.e. combustion). The *GHG emissions* are sometimes referred to as "combustion emissions" or "on-site emissions."

A2.2.2 *Upstream GHG emissions* occur throughout the *fuel* supply chain prior to usage at a *building*, *site*, or *electric power plant*, including those associated with the *fuel*'s production, processing, supply and leakage. These emissions are sometimes referred to as "precombusion emissions." The constitute a portion of what are sometimes referred to as "indirect emissions."

The inclusion of *upstream GHG emissions* is essential to fully account for the *GHG emissions* associated with energy usage. As such, this standard requires *upstream GHG emissions* for all *emissions factor* calculations even though many sources for *fuel emissions factors* account for only *direct GHG emissions*. *Upstream GHG emissions* include both *GHG emissions* associated with the energy used and the leakage or fugitive emissions associated with *fuel* losses throughout the *fuel* supply chain from extraction or harvesting to their final use at *buildings*, *sites*, *electric power plants* or *district thermal energy* production facilities. A common example of energy usage-related *upstream GHG emissions* is energy for pumps and compressor stations in *fuel* pipeline networks. A common example of fuel loss-related *upstream GHG emissions* is methane leakage into the atmosphere during extraction, processing and transportation of natural gas.

Direct GHG emissions are not likely to vary depending on a given *fuel*'s usage, but *upstream GHG emissions* and the resulting *emissions factors* can vary depending on the user of that *fuel*. The most common distinction is between *fuel* use in *buildings* and *sites* versus *fuel* use in *electric power plants*. *Emissions factors* for *fuel* use in *buildings* and *sites* generally includes all *GHG emissions* in the full *fuel* supply chain, whereas *emissions factors* for *fuel* use in *electric power plants* generally excludes *GHG emissions* associated with *fuel distribution* and

leakage of *fuels* after *distribution* to end users. All *emissions factors* in the informative appendices of this standard include this delineation in the *upstream GHG emissions*.

A3. Emissions Factor Identification. This section provides information and guidance on the *emissions factor* identification parameters required by Section 4.2.

A3.1 Calculation Period. The *calculation period* must be identified for all *emissions factor* calculations. At a minimum, a start date and end date must be included. Where start and end times are applicable, such as for *emissions factor* calculations with a *timestep* of less than one year, the start and end times also must be identified.

Where *emissions factors* are calculated over multiple years – either levelized or *average emissions factors* or year-specific *emissions factors* – the calculation period must be long enough to outlast the measures one is evaluating or to reflect standard practice for lifecycle analysis. A 60-year *calculation period* is appropriate for both of these applications, whereas a 20-year *calculation period* can be used when evaluating the *GHG emissions* associated with *building* or *site* equipment energy usage.

It is recommended that the start year for operational energy-related *GHG emissions* analyses be the first or second full year after a *building* or *site* is occupied.

A3.1.1 Levelized vs. Individual Year Emissions Factors. For analyses in which the same projected energy usage is assumed for every year, a levelized or *average emissions factor* over a specified number of years can be used. Where energy usage is expected to be different in different future years (e.g., operational energy usage changes from equipment degradation reducing energy efficiency or lifecycle analyses that include energy usage in lifecycle modules other than operational), *emissions factors* should not be averaged, but rather year-specific values should be used. Where social costs of *GHG emissions* (SC-GHG) are to be computed, year-specific *emissions factors* need to be used instead of levelized or *average emissions factors* because the climate impacts of *GHG emissions* are different in different years. (***Informative Note:*** See Section A4.1 for additional considerations for levelized *emissions factors*.)

A3.2 Time Granularity. The *timestep* must be identified for all *emissions factor* calculations. At a minimum, the *timestep* should correspond to the *timestep* of the energy data to be used to calculated energy-related *GHG emissions*; this is particularly true for electricity *emissions factors*, which can vary significantly over the course of the day and throughout the year. Where measured data is used to calculate *GHG emissions*, it is recommended that the *timestep* be no greater than one hour. Where computer simulations using a specific year's weather data are used to model a *building* or *site*'s energy usage and to calculate *emissions factors*, it is recommended that the *timestep* be no greater than one hour. Where computer simulations using a single year or a typical meteorological year (TMY) are used to model a *building* or *site*'s energy usage and to calculate *emissions factors*, it is recommended that the *emissions factor timestep* be no greater than month-hour (i.e., a 24-hour array of *average emissions factors* for each month, resulting in a total of 288 *emissions factors* over the course of a year) to reduce the impact of misalignment of specific weather events and days of the week on *GHG emissions* while still capturing seasonal and diurnal *GHG emissions* patterns.

Because *fuel emissions factors* are not expected to vary significantly over a year, this standard allows the use of annual *fuel emissions factors* for use with energy data at a *timestep* of less than one year (e.g. hourly *fuel* usage). While it is not recommended that annual *electricity emissions factors* be used with hourly electricity usage data to compute *GHG emissions*, this standard does allow this approach, recognizing that the data may not be available to calculate *emissions factors* at a higher resolution *timestep* for all *study regions*.

A3.3 Study Region. The *study region* must be identified for all *emissions factor* calculations. The definition of a *study region* can be somewhat subjective; various normative constraints were explored, but no generalizable constraints could be identified. As such, this standard includes requirements for (1) robust and flexible *emissions factor* calculation methodologies and (2) transparency through the *emissions factor* identification information of Section 4.2. However, there are recommendations pertaining to each of the *emissions factor* calculation sections, as described in Sections A3.3.1 through A3.3.3.

A3.3.1 Fuel Emissions Factors (Section 5). National or even global *direct GHG emissions factors* for *fuels* can broadly be used for all *fuel* usage in *buildings*, *sites*, *electric power plants* or *district thermal energy* systems. *Fuel emissions factor* calculations are thus most sensitive to a *study region*'s *upstream GHG emissions*. It is therefore recommended that the *study region* for *fuel emissions factors* be the smallest geographic area containing the *building*, *site*, *electric power plant* or *district thermal energy* system for which data is available. The *study region* may be different for different fuels used in the same *building*, *site*, *electric power plant* or *district thermal energy* system, or even for different *fuels* used in the same territory (e.g., a city or U.S. state). For example, regions used by the U.S. Department of Energy to delineate the data needed to determine natural gas-related *upstream GHG emissions* are different from the Petroleum Administrative Defense Districts (PADD) used to delineate the data needed to determine petroleum-based *fuel upstream GHG emissions*.

A3.3.2 Electricity Emissions Factors (Section 6). Electricity *emissions factors* can vary significantly across regions, depending on the electricity generation *fuel* mix, the amount of renewables, and the amount of imports from adjacent regions that may have different *emissions factors*. Some cities with *GHG emissions* policies create their own *emissions factors*, but generally electricity *emissions factors* correspond to regions that are a larger political territory (e.g. a U.S. state), an entity that maintains electricity demand and resource balance (e.g. a balancing authority [BA] in the U.S.) or an entity that coordinates transmission with regional loads (e.g. an independent system operator [ISO] or regional transmission organization [RTO] in the U.S.). It is recommended that *emissions factors* be calculated for such regions unless sufficient data is available on electricity generation and transmission to calculate *emissions factors* at a higher spatial resolution.

The greatest sensitivity to *emissions factors* for acceptable *study regions* is likely to result from whether *emissions factor* calculations include or exclude imports and exports; *emissions factors* that exclude imports and exports are labeled "generation-only" under Section 4.2(h) in this standard, described further in Section A3.8(1)(e). Constraints on the *study region* for generation-only electricity *emissions factors* were considered but ultimately rejected in lieu of the approach described in Section A3.3 for the following reasons:

1. The effect of constraining a *study region* based on the imports and/or exports as a percentage of generation and/or load ranged widely across regions evaluated, with negligible effects on *emissions factors* with high imports in some regions and significant effects with relative smaller levels of imports in other regions. As such, specific generalized constraint criteria could not be justified.
2. *Study region* constraints considered would exclude many regions for which *emission factors* are useful and necessary, such as large cities, U.S. states, BAs, ISOs and RTOs.
3. *Study region* constraints considered would exclude *emissions factors* from widely available and reputable sources, such as the U.S. EPA's eGRID regions and the U.S. National Renewable Energy Laboratory (NREL) Cambium regions.

Constraints on *study regions* will be further considered in the future as necessary data becomes more readily available, as appropriate for this international standard.

A3.3.3 District Thermal Energy (Section 7). There is no geographic regional definition of a *study region* for a *district thermal energy emissions factor*. However, for *district thermal energy emissions factor* calculations to comply with this standard, the *study region*, must cover the entire region supplied by the *district thermal energy* system. This *study region* will generally be a campus or a specific urban area.

A3.4 Emissions Factor Units. The units must be identified for all *emissions factor* calculations in units of mass per unit energy as the *emissions factors* calculated in accordance with this standard are to be used to compute *GHG emissions* from energy usage. It is recommended that common units for energy and *GHG emissions* be used, such as kg/MWh, lb/MWh or lb/MMBtu; where *emissions factors* are developed for general usage, it is recommended that they be provided in both IP and SI units.

A3.5 Greenhouse Gas Specification. The specific *GHG* must be identified for all *emissions factor* calculations. It is recommended that users of this standard provide *emissions factors* for the three major energy-related GHGs (CO_2, N_2O, and CH_4) or that all three of these gases be included in a CO_2e calculation.

A3.6 Global Warming Potential Time Horizon. The *global warming potential (GWP) time horizon* must be identified for all *CO_2e emissions factor* calculations. *GWPs* were developed to compare the global warming impacts of different *GHGs* and can be used to weigh the benefits of reducing one gas against another. Different *GHGs* have different impacts on the Earth's warming from how they absorb energy and how long they remain in the atmosphere. *GWP100*, a *GWP* calculated using a 100-year *GWP time horizon*, is common in standards, national policies and international treaties. However, the scientific community has developed other metrics that could be used for comparing one GHG to another, such as *GWP20*, which can better capture the global warming impact of CH_4 because of its greater global warming effect but shorter lifespan in the atmosphere than CO_2. ASHRAE requires its standards to use *GWP100*, but recommends inclusion of *GWP20* values. It is recommended that users of this standard provide *emissions factors* for both *GWP100* and *GWP20*.

A3.7 Fuel Heat Content Basis. The *fuel* heat content basis must be identified for all *fuel emissions factor* calculations as either the *higher heating value (HHV)* or *lower heating value (LHV)*. The *HHV* represents the upper limit of available thermal energy from complete combustion of a *fuel* and is sometimes referred to as the gross calorific value (GCV). The *LHV* excludes the latent heat of condensed water vapor reflecting a scenario in which water vapor resulting from *fuel* combustion does not condense. There is no fixed standard for which basis is used for *emissions factors* with some regions generally using *HHV* (e.g., the U.S.) and some using *LHV* (e.g., most of Europe). It is recommended that *emissions factors* use the *fuel* heat content basis most widely used in the *study region*; however, *emissions factors* must use the same *fuel* heat content basis as that used to determine *fuel* energy usage.

While identification of the *fuel* heat content basis is not required for *emissions factors* for energy sources other than fuels (e.g. electricity and *district thermal energy*), it can be helpful for users to provide the *fuel* heat content basis used in calculating *emissions factors* for informational purposes.

A3.8 Electricity Emissions Calculation Procedure. The electricity *emissions factor* calculation procedure must be identified for all electricity *emissions factor* calculations as one of following:

1. Measured, calculated in accordance with Section 6.2, which requires the use of *verified data*, and which requires the following additional identifiers, where applicable:
    a. Average Efficiency Alternative, in which an average efficiency applicable to the *study region* is used for one or more generators of the same generator type, using the same *fuel* type (calculated in accordance with Section 6.2.2.1.2).
    b. Net Import/Export Alternative, in which either net imports or net exports is used in place of imports or exports with an adjacent region to the *study region* at each *timestep* (calculated in accordance with Section 6.2.2.3.1.1 or 6.2.2.3.2.1).
    c. Neighboring Region – Alternative Timestep, in which the *emissions factor* for an adjacent region to the *study region* with a different *timestep* length than the *study region emissions factor timestep*, so long as the *timestep* for the adjacent region is no longer than one year and includes within that year the *timestep* of the *study region emissions factor* (calculated in accordance with Section 6.2.2.5.2.1).
    d. Neighboring Region – Alternative Year, in which the *emissions factor* for an adjacent region to the *study region* for a different *timestep* than the *study region emissions factor timestep*, so long as the method is approved by the *AHJ* and the *timestep* for the adjacent region is no more than two years before or after the *timestep* of the *study region emissions factor* (calculated in accordance with Section 6.2.2.5.2.2).
    e. Generation-only method, in which the values of imports and exports of electricity is set to zero (i.e., imports and exports are excluded from the *emissions factor* calculation in Section 6.2.1). It is highly recommended that generation-only *emissions factors* not be used unless there is no alternative because of data availability. The reasoning behind the allowance of generation-only *emissions factors* in this standard is described further in Section A3.3.2 (calculated in accordance with Section 6.2.2.3.3).
2. Computer simulation, calculated in accordance with Section 6.3 using a *production cost model*.

A3.9 Electricity Emissions Factor Type. The electricity *emissions factor* type must be identified for all electricity *emissions factor* calculations as one of following:

1. *Average emissions factor*: an *emissions factor* associated with all electricity supply in a *study region* at a given *timestep*. An *average emissions factor* is recommended for evaluating *GHG emissions* associated with an entire *study region*, all of a *building*'s energy usage or a large change in a *building*'s energy usage (e.g., from electrification of *fuel*-using systems).
2. *Marginal emissions factor*: an *emissions factor* associated with the last *electric power plant* to come on to meet a load in the *study region*, it is thus associated with a slight increase or decrease in the electricity usage in a *study region*. A *marginal emissions factor* is recommended for evaluating *GHG emissions* associated with a new *building* or an energy efficiency measure in an existing *building*.

A3.10 Projected Electricity Emissions Factor. All electricity *emissions factors* must be identified as one of following related to projected energy usage and related emissions:

1. N/A, if the *emissions factor* is not projected (i.e. it is based on historical or real-time data)
2. Historical annual trend (determined in accordance with Section 6.4.1), in which a curve is fit to historical *emissions factors* and used to calculate *emissions factors* for years beyond the most recent for which an *emissions factor* is calculated by another method compliant with this standard. Historical annual trend *emissions factors* are only allowed for *average emissions factors* with a one-year *timestep*.
3. Energy supplier data basis (determined in accordance with Section 6.4.2), in which *emissions factor* calculations in accordance with the methods of Section 6.2 or 6.3 use *verified data* for future *electric power plants* (including additions and retirements), intermodal *transmission* interfaces and electricity usage from *grid operators* or electric utilities. The information required for these *emissions factors* is typically regularly published by *grid operators* and electric utilities.
4. Simulated scenario (determined in accordance with Section 6.4.3), in which *emissions factor* calculations in accordance with the methods of Section 6.2 or 6.3 use *verified data* for future *electric power plants* (including additions and retirements), intermodal *transmission* interfaces and electricity usage from a publicly available model of the electric power sector for the *study region* (and generally also adjacent regions) that uses a mathematical program to evaluate investment and operational decisions to minimize the overall cost of the electricity system based on documented technology, market and policy inputs. Some government agencies and other parties have developed future energy system scenarios based on policy and market conditions, generally using a computation capacity expansion model to determine the energy resources, generators, transmission limits and energy usage changes under current and projected future conditions.

A3.11 Electricity Emissions Factor Basis. The electricity *emissions factor* basis must be identified for all electricity *emissions factor* calculations as one of following:

1. *Location-based emissions factor*, which represents the *GHG emissions* associated with the physical electricity supply to the customer. *Location-based emissions factors* include (1) *emissions factors* for electricity supply from a direct line connection to an electricity producer and (2) *emissions factors* associated with a connection to an electricity distribution grid. The former generally require the calculation of *GHG emissions* associated with the generation of electricity from the specific source and line losses to supply the end user. The latter generally utilizes a regional electricity grid *emissions factor* or *average emissions factor* corresponding to a political territory (e.g. a nation or a U.S. state). It is recommended for use in electricity usage-related *GHG emissions* calculations for a *building* without consideration of *procured electricity* within the *study region*, whether for the *building* of interest or any other electricity user.

2. *Market-based emissions factor* (determined in accordance with Section 6.5), which account for the consideration of *GHG emissions* associated with *procured electricity*, which is electricity allocated to specific users through market instruments such as direct contracts, power purchase agreements or green tariffs and verified through Energy Attribution Certificates (EACs) or Renewable Energy Certificates (RECs), contracts, government databases, utilities, *grid operators*, Regional Generation Attribute Tracking Systems, clean energy and carbon offset certification programs or other capable third parties. *Market-based emissions factors* are calculated by removing the *GHG emissions* and electricity usage associated with *procured electricity* from *emissions factor* calculations, the results of which then apply to electricity usage that is not *procured electricity.*

It is recommended that *market-based emissions factors* be used wherever the *GHG emissions* of a building or site is allowed to account for *procured electricity* (which is often renewable energy). *Procured electricity* can represent all electricity supplied to a customer or a portion of the electricity supply. In this scenario, after accounting for a *building*'s *procured electricity*, the balance of the *building*'s electricity-related *GHG emissions* should be calculated using a *market-based emissions factor* that represents the residual fuel mix, the remainder of the electricity generation in the *study region* after all contracts, certificates and other market-based procurements are removed.

A4. Additional Considerations

A4.1 Discount Rates for Levelized Emissions Factors. In economic analysis, future costs (e.g., damages caused by climate change) are generally devalued or "discounted" when computing the net present value of accumulated costs over some period of time. As such, investments today to avoid those future costs are more highly valued than the costs themselves. The assumed "discount rate" – a percentage analogous to an annualized interest rate – is the primary driver of the difference between the computed costs in a future year and the present value of those costs. "Levelizing" is the process of averaging costs projected over a period of multiple years to arrive at a single average annual value. If the discount rate is 0%, then the levelized cost is simply the average annual cost over the project time period.

In some cases, when *emissions factors* are computed over a projected time period, they have been levelized using a non-zero discount rate. However, while discounting the projected future social costs of *GHG emissions* (SC-GHG) associated with climate change-related damages is appropriate for an economic analysis, it is not appropriate to discount the *GHG emissions* themselves as part of a physical analysis. As the *emissions factors* calculated in accordance with this standard are associated with *GHG emissions* and not the economic implications of those *GHG emissions*, no discount rate is applied in calculating the *emissions factors*. There has been significant work by others to establish methods for translating *GHG emissions* into SC-GHG that are widely available to users of this standard and that can be used with the *emissions factors* for individual GHGs in its informative appendices.

Qualitative arguments have been made that a discount rate could be used as a proxy for the uncertainty of future *GHG emissions* projections; however, there is no available literature supporting the selection of a particular discount rate to correspond to an assumed level of uncertainty. There has historically been some difference in the approach to discount rates for *GHG emissions* across ASHRAE standards with Standards 189.1 and 90.2 applying a discount rate and Standards 90.1 and 240 not applying a discount rate.

It is recommended that no discount rate be used in calculating *emissions factors*, but that for SC-GHG calculations, discount rates be used in accordance with methods established by others.

(This appendix is not part of this standard. It is merely informative and does not contain requirements necessary for conformance to the standard. It has not been processed according to the ANSI requirements for a standard and may contain material that has not been subject to public review or a consensus process. Unresolved objectors on informative material are not offered the right to appeal at ASHRAE or ANSI.)

INFORMATIVE APPENDIX B

FUEL EMISSIONS FACTORS

B1. Fuel emissions Factors Based on Measured Data for the Contiguous United States. The *emissions factors* in Sections B1.1 through B1.4 are applicable in the U.S. with the exception that *upstream GHG emissions factors* for natural gas apply to the regions shown in Figure B1.

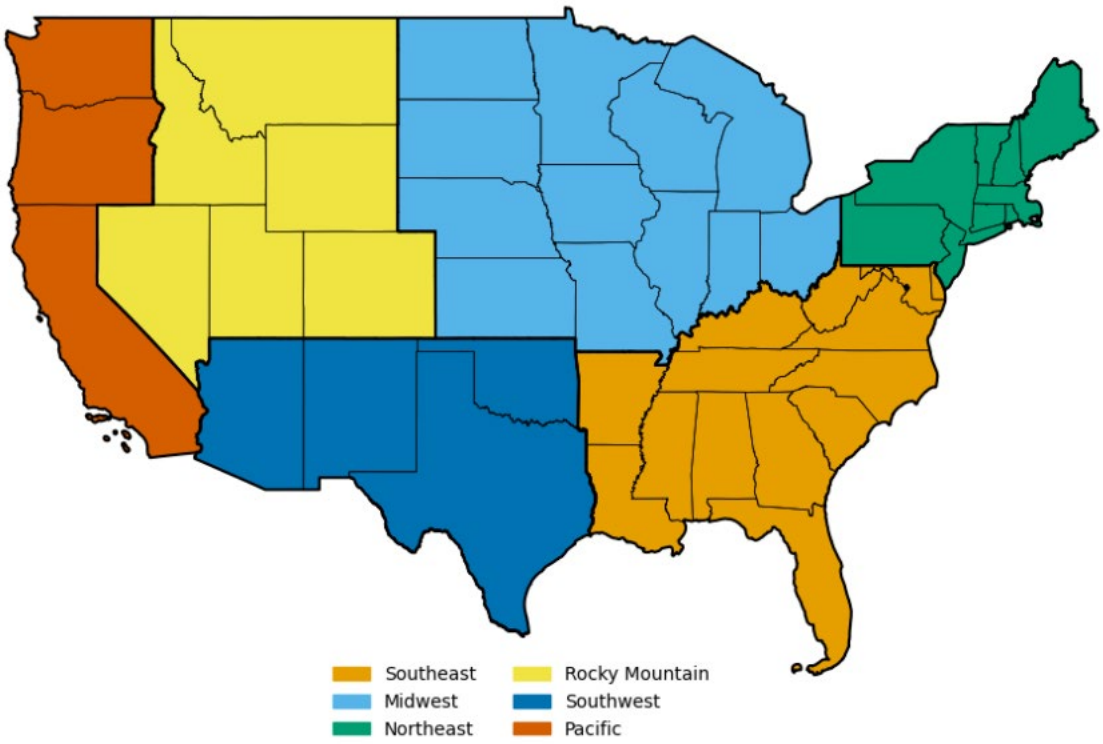

Figure B1 - Geographic Regions for Tables B1.1 through B1.4. *Source:* DOE/NETL-2024/4862, Life Cycle Analysis of Natural Gas Extraction and Power Generation: U.S. 2020 Emissions Profile, December 2024.

B1.1 CO_2e Emissions Factors for Fuels Used in Buildings and at Sites in the United States.

Informative Table B1.1 includes *emissions factors* in carbon dioxide equivalent for *fuels* used in *buildings* and *sites* in the United States, calculated in accordance with Section 5 for the following parameters identified in accordance with Section 4.2:

a. *Calculation period*: 2020
b. *Emissions factor* granularity: Annual
c. *Study region*: United States for all *fuels* other than natural gas; as indicated by Figure B1.1 for natural gas
d. *Emissions factor* units: kg/MWh
e. Emissions representation: *CO_2e*
f. *Global warming potential time horizon*: 20-year and 100-year
g. *Fuel* heat content basis: *HHV*
h. Electricity emissions calculation procedure: N/A
i. *Emissions factor* type: Average
j. Projected *emissions factor*: N/A
k. *Emissions factor* basis: Location-based

Additional Note: See Section B1.3 for constituent *GHG emissions* used to compute the *CO2e* values in Table B1.1.

Table B1.1 – Emissions Factors for Fossil Fuels Used in Buildings or at Sites in the United States

		GHG emissions factor (kgCO_2e/MWh) (*GWP20*)			*GHG emissions factor* (kgCO_2e/MWh) (*GWP100*)		
		Direct	*Upstream*	Total	*Direct*	*Upstream*	Total
Natural Gas	Midwest	183.97	64.32	248.29	183.79	34.78	218.56
	Northeast	183.97	49.49	233.46	183.79	26.22	210.01
	Pacific	183.97	72.70	256.67	183.79	44.34	228.12
	Rocky Mtn.	183.97	81.17	265.14	183.79	45.12	228.90
	Southeast	183.97	76.72	260.69	183.79	39.43	223.22
	Southwest	183.97	70.22	254.19	183.79	37.23	221.02
	US Average	183.97	68.10	252.07	183.79	36.52	220.31
LPG or propane		229.34	65.63	294.96	229.14	46.09	275.23
Fuel oil (residual)		264.51	69.68	334.20	264.39	48.90	313.28
Fuel oil (distillate)		254.99	68.91	323.90	254.85	48.39	303.24
Coal		331.51	50.59	382.10	329.48	23.01	352.50
Gasoline		254.99	81.60	336.59	254.85	57.30	312.14
Other fuels not specified		331.51	50.59	382.10	329.48	23.01	352.50

B1.2 CO_2e Emissions Factors for Fuels Used in Electric Power Plants in the United States. Informative Table B1.2 includes *emissions factors* in carbon dioxide equivalent for *fuels* used in *electric power plants* in the United States and not located in *buildings* or at *sites*, calculated in accordance with Section 5 for the following parameters identified in accordance with Section 4.2:

a. *Calculation period*: 2020
b. *Emissions factor* granularity: Annual
c. *Study region*: United States for all *fuels* other than natural gas; as indicated by Figure B1.1 for natural gas
d. *Emissions factor* units: kg/MWh
e. Emissions representation: CO_2e
f. *Global warming potential time horizon*: 20-year and 100-year
g. *Fuel* heat content basis: *HHV*
h. Electricity emissions calculation procedure: N/A
i. *Emissions factor* type: Average
j. Projected *emissions factor*: N/A
k. *Emissions factor* basis: Location-based

Additional Note: See Section B1.4 for constituent *GHG emissions* used to compute the *CO2e* values in Table B1.2.

Table B1.2 – Emissions Factors for Fossil Fuels Used in Electric Power Plants in the United States and not located at buildings or sites

		GHG emissions factor (kgCO_2e/MWh) (*GWP20*)			*GHG emissions factor* (kgCO_2e/MWh) (*GWP100*)		
Fuel		*Direct*	*Upstream*	Total	*Direct*	*Upstream*	Total
Coal		331.51	50.59	382.10	329.48	23.01	352.50
Petroleum		262.86	82.06	344.92	262.29	52.70	314.99
Natural Gas and Other Gases	Midwest	183.97	53.48	237.45	183.79	30.81	214.59
	Northeast	183.97	39.20	223.16	183.79	22.47	206.26
	Pacific	183.97	64.64	248.61	183.79	42.10	225.89
	Rocky Mtn.	183.97	55.75	239.72	183.79	35.83	219.62
	Southeast	183.97	63.57	247.54	183.79	34.58	218.36
	Southwest	183.97	59.51	243.48	183.79	33.34	217.12
	US Average	183.97	56.29	240.26	183.79	32.26	216.04
Nuclear		0	0	0	0	0	0
Pumped Storage		0	0	0	0	0	0
Hydroelectric		0	0	0	0	0	0
Wood		321.01	28.76	349.77	320.30	18.46	338.76
Biomass Waste		304.41	28.76	333.17	303.70	18.46	322.16
Geothermal		0	9.07	9.07	0	9.07	9.07
Solar		0	0	0	0	0	0
Wind		0	0	0	0	0	0

B1.3 GHG Emissions Factors for Fuels Used in Buildings or at Sites in the United States. Informative Table B1.3 includes *emissions factors* for individual *greenhouse gases* for *fuels* used in *buildings* and *sites* in the United States, calculated in accordance with Section 5 for the following parameters identified in accordance with Section 4.2:

a. *Calculation period*: 2020
b. *Emissions factor* granularity: Annual
c. *Study region*: United States for all *fuels* other than natural gas; as indicated by Figure B1.1 for natural gas
d. *Emissions factor* units: kg/MWh
e. Emissions representation: CO_2, CH_4 and N_2O
f. *Global warming potential time horizon*: N/A
g. *Fuel* heat content basis: *HHV*
h. Electricity emissions calculation procedure: N/A
i. *Emissions factor* type: Average
j. Projected *emissions factor*: N/A
k. *Emissions factor* basis: Location-based

Additional Notes:

1. *Direct* and *upstream GHG emissions* for *fossil fuels* are taken from the National Renewable Energy Laboratory LCI database. Values were first published in Michael Deru and Paul Torcellini, Source Energy and Emission Factors for Energy Use in Buildings, National Renewable Energy Laboratory, Technical Report NREL/TP-550-38617, Revised June 2007. These data were updated by NREL in data provided to SSPC 189.1 in 2021.
2. *Upstream GHG emissions* for natural gas are taken from Appendix F of DOE/NETL-2024/4862, Life Cycle Analysis of Natural Gas Extraction and Power Generation: U.S. 2020 Emissions Profile, December 2024. “US Average” *upstream* values for natural gas are a weighted average of regional values based on total natural gas consumption in 2020, as reported by the U.S. Energy Information Administration.
3. Values for coal are used for “other fuels not specified.”

Table B1.3 - GHG Emission Factors for Fuels used Directly in Buildings or at Sites in the United States

	Direct GHG emissions factor (kg/MWh)			*Upstream GHG emissions factor* (kg/MWh)				Total *emissions factor* (kg/MWh)		
Fuel	CO2	CH4	N20		CO2	CH4	N20	CO2	CH4	N20
				Midwest	18.03	0.5606	0.0001	201.62	0.5641	0.0005
				Northeast	13.03	0.4416	0.0001	196.62	0.4450	0.0005
				Pacific	28.23	0.5382	0.0003	211.81	0.5417	0.0006
Natural Gas	183.59	0.0035	0.0003	Rocky Mtn.	24.67	0.6842	0.0002	208.26	0.6876	0.0006
				Southeast	18.31	0.7075	0.0001	201.90	0.7110	0.0005
				Southwest	18.55	0.6260	0.0001	202.14	0.6295	0.0004
				US Average	18.62	0.5992	0.0001	202.21	0.6027	0.0005
LPG or propane	224.50	0.0037	0.0166		34.86	0.3708	0.0006	259.36	0.3744	0.0173
Fuel oil (residual)	263.98	0.0024	0.0012		36.96	0.3944	0.0007	300.94	0.3968	0.0019
Fuel oil (distillate)	254.41	0.0026	0.0013		36.60	0.3894	0.0007	291.01	0.3920	0.0020
Coal	326.81	0.0385	0.0056		7.39	0.5232	0.0001	334.20	0.5617	0.0057
Gasoline	254.41	0.0026	0.0013		43.33	0.4612	0.0008	297.74	0.4638	0.0021
Other fuels not specified	326.81	0.0385	0.0056		7.39	0.5232	0.0001	334.20	0.5617	0.0057

B1.4 GHG Emissions Factors for Fuels Used in Electric Power Plants in the United States. Informative Table B1.4 includes *emissions factors* for individual greenhouse gases for *fuels* used in *electric power plants* in the United States and not located in *buildings* or at *sites*, calculated in accordance with Section 5 for the following parameters identified in accordance with Section 4.2:

a. *Calculation period*: 2020
b. *Emissions factor* granularity: Annual
c. *Study region*: United States for all *fuels* other than natural gas; as indicated by Figure B1.1 for natural gas
d. *Emissions factor* units: kg/MWh
e. Emissions representation: CO_2, CH_4 and N_2O
f. *Global warming potential time horizon*: N/A
g. *Fuel* heat content basis: *HHV*
h. Electricity emissions calculation procedure: N/A
i. *Emissions factor* type: Average
j. Projected *emissions factor*: N/A
k. *Emissions factor* basis: Location-based

Additional Notes:

1. *Direct* and *upstream GHG emissions* for *fossil fuels* are taken from the National Renewable Energy Laboratory LCI database. Values were first published in Michael Deru and Paul Torcellini, Source Energy and Emission Factors for Energy Use in Buildings, National Renewable Energy Laboratory, Technical Report NREL/TP-550-38617, Revised June 2007. These data were updated by NREL in data provided to SSPC 189.1 in 2021.
2. *Upstream GHG emissions* for natural gas are taken from Appendix F of DOE/NETL-2024/4862, Life Cycle Analysis of Natural Gas Extraction and Power Generation: U.S. 2020 Emissions Profile, December 2024. "US Average" *upstream* values for natural gas are a weighted average of regional values based on total natural gas consumption in 2020, as reported by the U.S. Energy Information Administration.
3. Biomass *emissions factors* were determined from the U.S. Energy Information Agency (EIA), Monthly Energy Reports (MER). Biomass *emissions factors* are taken from Section 11 Sources and Methodology. Electric generation from biomass is taken from Table 10.2c.
4. Emissions at geothermal plants are small, but not zero. A value of 20 lb of CO_2 per MWh (9.07 kg/MWh) of electricity production is assumed based on geothermal plants in the western U.S.

Table B1.4 - GHG Emission Factors for Fuels used in Electric Power Plants in the United States and not located at buildings or sites

	Direct GHG emissions factor (kg/MWh)				*Upstream GHG emissions factor* (kg/MWh)			Total *emissions factor* (kg/MWh) (kg/MWh)		
Fuel	CO2	CH4	N20		CO2	CH4	N20	CO2	CH4	N20
Coal	326.81	0.0385	0.0056		7.39	0.5232	0.0001	334.20	0.5617	0.0057
Petroleum	261.37	0.0109	0.0022		35.93	0.5571	0.0006	297.30	0.5680	0.0028
Natural Gas and Other Gases	183.59	0.0035	0.0003	Midwest	17.95	0.4302	0.0001	201.54	0.4337	0.0005
				Northeast	12.98	0.3174	0.0001	196.57	0.3208	0.0005
				Pacific	29.28	0.4277	0.0003	212.86	0.4311	0.0007
				Rocky Mtn.	24.51	0.3780	0.0002	208.10	0.3814	0.0006
				Southeast	18.14	0.5501	0.0001	201.73	0.5536	0.0005
				Southwest	18.51	0.4967	0.0001	202.10	0.5002	0.0004
				US Average	18.63	0.4560	0.0001	202.22	0.4594	0.0005
Nuclear	0	0	0		0	0	0	0	0	0
Pumped Storage	0	0	0		0	0	0	0	0	0
Hydroelectric	0	0	0		0	0	0	0	0	0
Wood	319.89	0.0136	0.0000		12.59	0.1953	0.0002	332.48	0.2089	0.0002
Biomass Waste	303.29	0.0136	0.0000		12.59	0.1953	0.0002	315.88	0.2089	0.0002
Geothermal	0	0	0		9.07	0	0	9.07	0	0
Solar	0	0	0		0	0	0	0	0	0
Wind	0	0	0		0	0	0	0	0	0

(This appendix is not part of this standard. It is merely informative and does not contain requirements necessary for conformance to the standard. It has not been processed according to the ANSI requirements for a standard and may contain material that has not been subject to public review or a consensus process. Unresolved objectors on informative material are not offered the right to appeal at ASHRAE or ANSI.)

INFORMATIVE APPENDIX C

ELECTRICITY EMISSIONS FACTORS

C1 Historical Electricity Emissions Factors for the United States. Sections C1.1 through C1.4 include electricity *emissions factors* based on measured data for the United States regions shown in Figure C1. All *emissions factors* were developed using plant-level fuel usage data from the U.S. Environmental Protection Agency's (EPA) Emissions & Generation Resource Integrated Database (eGRID), converted to *GHG emissions* using the *fuel emissions factors* from Section B1.4. The specific zip codes corresponding at eGRID regions can be found from the U.S. EPA's Power Profiler through either a search tool or downloadable "Historical Zip Codes (XLSX)" file.

Tables of *emissions factors* and relevant parameters are summarized in Table C1 and can be found in the accompanying "242P_PPR_AppendixCTables.xlsx." (***Note to reviewers*:** The published version of the standard will include a live link to a publicly available website with table values. Access to the Tables is available for view and download here: https://files.ashrae.org/secure_share/9q94xl39) All *emissions factors* were calculated in accordance with Section 6 for the following parameters identified in accordance with Section 4.2:

a. *Calculation periods*: Individual years, 2004-2023 for *location-based emissions factors* and 2018-2023 for *market-based emissions factors*
b. *Emissions factor* time granularity: Annual
c. *Study regions*: "eGRID Subregions" as described in Section C1.
d. *Emissions factor* units: kg/MWh
e. Emissions representation: Either CO_2e, CO_2, CH_4 or N_2O, as indicated in Table C1.
f. *Global warming potential time horizon*: Either 100-year or 20-year for CO_2e *emissions factors*, as indicated in Table C1. This parameter is not applicable to CO_2, CH_4 and N_2O *emissions factors*.
g. *Fuel* heat content basis: *HHV*
h. Electricity emissions calculation procedure: Measured, Generation-only Method
i. *Emissions factor* type: Average
j. Projected emissions factor: N/A
k. *Emissions factor* basis: Location-based or market-based, as indicated in Table C1.

Additional Notes:

1. *Study regions* are eGRID regions shown in Figure C1. The specific zip codes corresponding to eGRID regions can be found from the U.S. EPA's Power Profiler through either a search tool or downloadable "Historical Zip Codes (XLSX)" file.
2. All 2009-2023 *emissions factors* were developed using plant-level fuel usage data from the U.S. Environmental Protection Agency's (EPA) Emissions & Generation Resource Integrated Database (eGRID), converted to *GHG emissions* using the *fuel emissions factors* from Section B1.4.
3. Plant-level fuel usage data is not available for the 2004, 2005 and 2007 eGRID. 2004, 2005 and 2007 *emissions factors* were developed using regional-level electricity generation by fuel type with emissions rates for each fuel source assumed to be the same as those in 2009.
4. No eGRID data is available for the years 2006, 2008, 2011, 2013, 2015 or 2017. *Emissions factors* for these years are the average of the values for the preceding year and the following year.
5. *Procured electricity* data used to calculate *market-based emissions factors* are limited to renewable electricity certified under the Center for Resource Solutions (CRS) Green-e certification program as documented in CRS's Green-e Residual Mix Data. The *market-based emissions factors* in this section are thus only appropriate for use

where *building* and *site GHG emissions* account for the impacts of *procured electricity* from renewable resources and do not account for the impacts of any other *procured electricity*. This data is only available for the years 2018-2023.

Figure C1 - Geographic Regions for Historical Electricity Emissions Factors for the United States. *Source:* U.S. EPA eGRID)

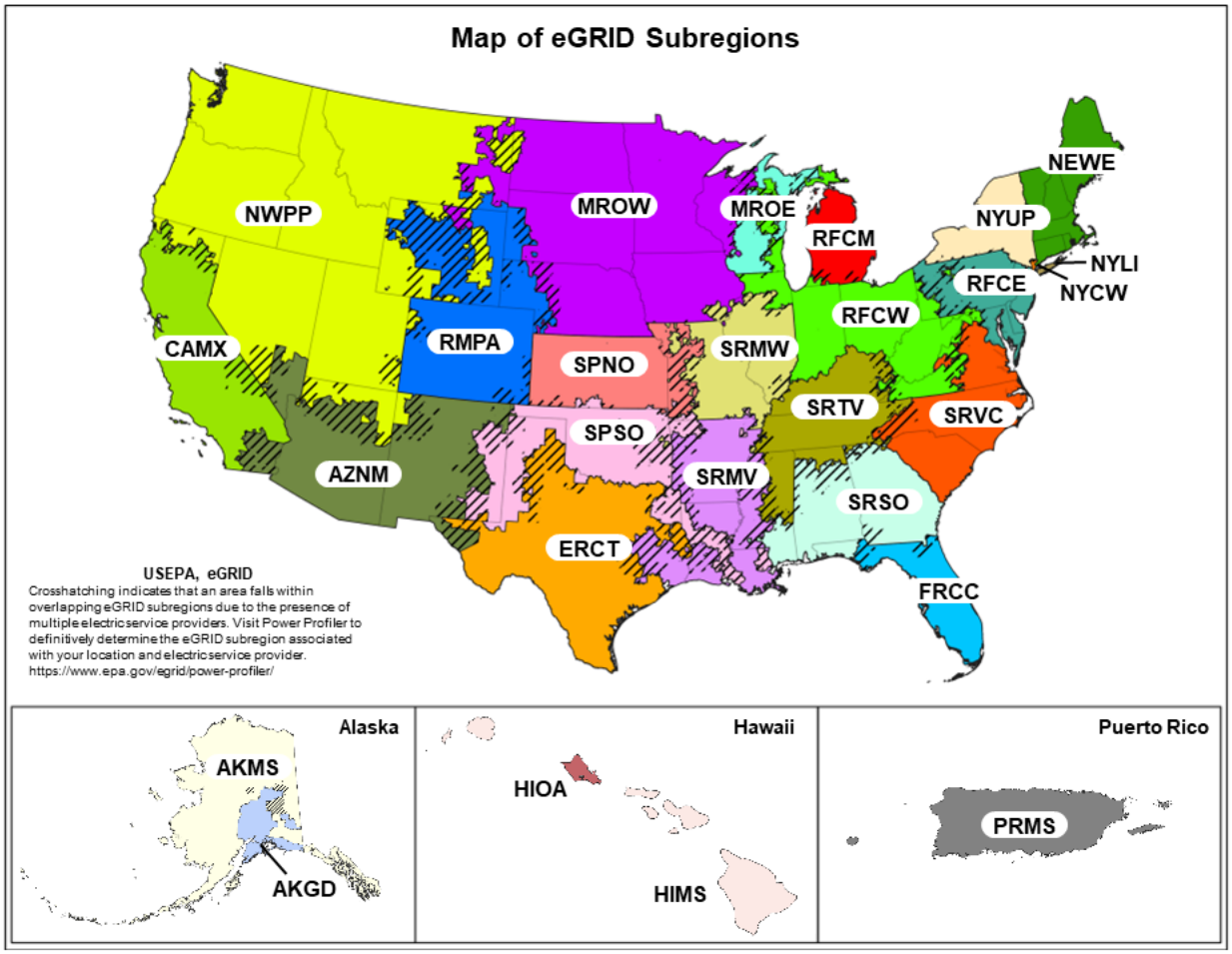

Table	*Calculation Period*(s)	Emissions Representation	*Global Warming Time Horizon*	*Emissions Factor* Basis
Table C1.1 – Historical Electricity Emissions Factors for the United States – Average Location-Based CO2e Emissions Factors with GWP100.	2004-2023	CO2e	100 years	Location-based
Table C1.2 – Historical Electricity Emissions Factors for the United States – Average Location-Based CO2e Emissions Factors with GW20.	2004-2023	CO2e	20 years	Location-based
Table C1.3 – Historical Electricity Emissions Factors for the United States – Average Location-Based CO2 Emissions Factors	2004-2023	CO2	N/A	Location-based
Table C1.4 – Historical Electricity Emissions Factors for the United States – Average Location-Based CH4 Emissions Factors	2004-2023	CH4	N/A	Location-based
Table C1.5 – Historical Electricity Emissions Factors for the United States – Average Location-Based N2O Emissions Factors	2004-2023	N2O	N/A	Location-based
Table C1.6 – Historical Electricity Emissions Factors for the United States – Average Market-Based CO2e Emissions Factors with GWP100.	2018-2023	CO2e	100 years	Market-based
Table C1.7 – Historical Electricity Emissions Factors for the United States – Average Market-Based CO2e Emissions Factors with GW20.	2018-2023	CO2e	20 years	Market-based

Table	***Calculation Period*(s)**	**Emissions Representation**	***Global Warming Time Horizon***	***Emissions Factor* Basis**
Table C1.8 – Historical Electricity Emissions Factors for the United States – Average Market-Based CO2 Emissions Factors	2018-2023	CO2	N/A	Market-based
Table C1.9 – Historical Electricity Emissions Factors for the United States – Average Market-Based CH4 Emissions Factors	2018-2023	CH4	N/A	Market-based
Table C1.10 – Historical Electricity Emissions Factors for the United States – Average Market-Based N2O Emissions Factors	2018-2023	N2O	N/A	Market-based

C2 Projected Electricity Emissions Factors for the Contiguous United States. This section include projected electricity *emissions factors* based on computer simulation for the contiguous United States regions shown in Figure C2. County and zip code mapping can be found in the Cambium 2024 workbook, available along with GIS Shapefiles here: https://data.nlr.gov/submissions/289. The Cambium eGRIDc subregions are based on balancing areas in the United States and do not completely align with EPA eGRID subregions (see Section C1), which are based on utility service territories.

All *emissions factors* were developed using the National Laboratory of the Rockies Cambium 2024 dataset for the Cambium 2024 mid-case scenario. More details on Cambium are described in the documentation report available at https://docs.nrel.gov/docs/fy25osti/93005.pdf.

Tables of projected *emissions factors* and relevant parameters are summarized in Table C2 and can be found in the accompanying "242P_PPR_AppendixCTables.xlsx." (***Note to reviewers*:** The published version of the standard will include a live link to a publicly available website with table values.) All *emissions factors* were calculated in accordance with Section 6 for the following parameters identified in accordance with Section 4.2:

a. *Calculation period*: See Table C2 "Time Representation" column. Levelized emissions factors were calculated with using a 20-year *calculation period* from the start year in each table (e.g. "2025" indicates a *calculation period* beginning January 1, 2025, and ending December 31, 2044); values are averaged over the 20-year *calculation period*. "Individual Year" *emissions factors* use a *calculation period* of one year, as indicated in each table
b. *Emissions factor* time granularity: Either "Annual" or "Month-Hour," as indicated in Table C2.
c. *Study region*: "eGRIDc Subregions" as described in Section C2.
d. *Emissions factor* units: kg/MWh
e. Emissions representation: Either CO_2e, CO_2, CH_4 or N_2O, as indicated in Table C2.
f. *Global warming potential time horizon*: Either 100-year or 20-year for CO_2e *emissions factors*, as indicated in Table C2. This parameter is not applicable to CO_2, CH_4 and N_2O *emissions factors*.
g. *Fuel* heat content basis: N/A
h. Electricity emissions calculation procedure: Computer Simulation
i. *Emissions factor* type: Marginal or Average, as indicated in Table C2. *Note:* Marginal *emissions factors* use Cambium 2024 site end-use long-run marginal emissions rate (LRMER) values.
j. Projected emissions factor: Simulated scenario. *Note*: Cambium 2024 mid-case scenario.
k. *Emissions factor* basis: Location-based

Figure C2 - Geographic Regions for Projected Electricity Emissions Factors for the Contiguous United States.
Source: Cambium 2024, U.S. National Laboratory of the Rockies

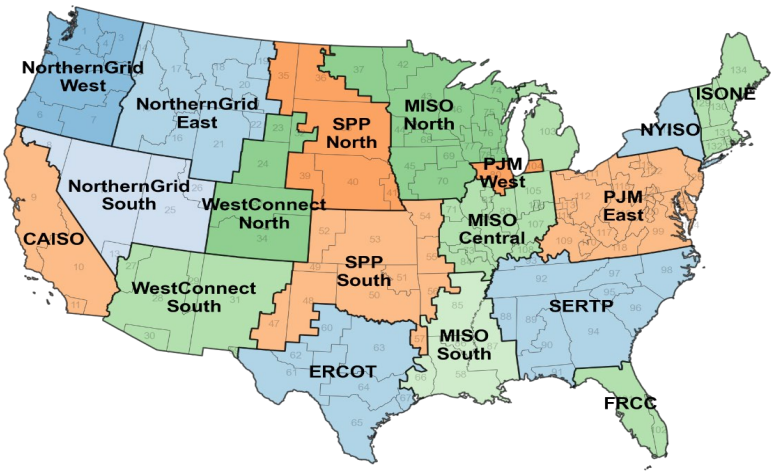

Table C2. Summary of Projected Electricity Emissions Factors for the Contiguous United States.

Table	*Calculation Period*(s)	*Emissions Factor* Time Granularity	Emissions representation	*Global warming potential time horizon*	*Emissions factor* type	Time Representation
Table C2.1 – Projected Annual Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based CO2e Emissions Factors with GWP100	2025–2035	Annual	CO2e	100-year	Marginal	Levelized
Table C2.2 – Projected Annual Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based CO2e Emissions Factors with GWP20	2025–2035	Annual	CO2e	20-year	Marginal	Levelized
Table C2.3 – Projected Annual Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based CO2 Emissions Factors	2025–2035	Annual	CO2	N/A	Marginal	Levelized
Table C2.4 – Projected Annual Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based CH4 Emissions Factors	2025–2035	Annual	CH4	N/A	Marginal	Levelized
Table C2.5 – Projected Annual Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based N2O Emissions Factors	2025–2035	Annual	N2O	N/A	Marginal	Levelized
Table C2.6 – Projected Annual Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2e Emissions Factors with GWP100	2025–2050	Annual	CO2e	100-year	Marginal	Individual Year
Table C2.7 – Projected Annual Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2e Emissions Factors with GWP20	2025–2050	Annual	CO2e	20-year	Marginal	Individual Year
Table C2.8 – Projected Annual Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2 Emissions Factors	2025–2050	Annual	CO2	N/A	Marginal	Individual Year
Table C2.9 – Projected Annual Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CH4 Emissions Factors	2025–2050	Annual	CH4	N/A	Marginal	Individual Year
Table C2.10 – Projected Annual Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based N2O Emissions Factors	2025–2050	Annual	N2O	N/A	Marginal	Individual Year
Table C2.21-1 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based CO2e Emissions Factors with GWP100 for 2025 Start Year	2025	Month-Hour	CO2e	100-year	Marginal	Levelized
Table C2.21-2 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based CO2e Emissions Factors with GWP100 for 2026 Start Year	2026	Month-Hour	CO2e	100-year	Marginal	Levelized
Table C2.21-3 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based CO2e Emissions Factors with GWP100 for 2027 Start Year	2027	Month-Hour	CO2e	100-year	Marginal	Levelized
Table C2.21-4 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based CO2e Emissions Factors with GWP100 for 2028 Start Year	2028	Month-Hour	CO2e	100-year	Marginal	Levelized
Table C2.21-5 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based CO2e Emissions Factors with GWP100 for 2029 Start Year	2029	Month-Hour	CO2e	100-year	Marginal	Levelized
Table C2.21-6 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based CO2e Emissions Factors with GWP100 for 2030 Start Year	2030	Month-Hour	CO2e	100-year	Marginal	Levelized

Table	*Calculation Period*(s)	*Emissions Factor* Time Granularity	Emissions representation	*Global warming potential time horizon*	*Emissions factor* type	Time Representation
Table C2.21-7 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based CO2e Emissions Factors with GWP100 for 2031 Start Year	2031	Month-Hour	CO2e	100-year	Marginal	Levelized
Table C2.21-8 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based CO2e Emissions Factors with GWP100 for 2032 Start Year	2032	Month-Hour	CO2e	100-year	Marginal	Levelized
Table C2.21-9 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based CO2e Emissions Factors with GWP100 for 2033 Start Year	2033	Month-Hour	CO2e	100-year	Marginal	Levelized
Table C2.21-10 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based CO2e Emissions Factors with GWP100 for 2034 Start Year	2034	Month-Hour	CO2e	100-year	Marginal	Levelized
Table C2.21-11 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based CO2e Emissions Factors with GWP100 for 2035 Start Year	2035	Month-Hour	CO2e	100-year	Marginal	Levelized
Table C2.22-1 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based CO2e Emissions Factors with GWP20 for 2025 Start Year	2025	Month-Hour	CO2e	20-year	Marginal	Levelized
Table C2.22-2 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based CO2e Emissions Factors with GWP20 for 2026 Start Year	2026	Month-Hour	CO2e	20-year	Marginal	Levelized
Table C2.22-3 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based CO2e Emissions Factors with GWP20 for 2027 Start Year	2027	Month-Hour	CO2e	20-year	Marginal	Levelized
Table C2.22-4 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based CO2e Emissions Factors with GWP20 for 2028 Start Year	2028	Month-Hour	CO2e	20-year	Marginal	Levelized
Table C2.22-5 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based CO2e Emissions Factors with GWP20 for 2029 Start Year	2029	Month-Hour	CO2e	20-year	Marginal	Levelized
Table C2.22-6 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based CO2e Emissions Factors with GWP20 for 2030 Start Year	2030	Month-Hour	CO2e	20-year	Marginal	Levelized
Table C2.22-7 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based CO2e Emissions Factors with GWP20 for 2031 Start Year	2031	Month-Hour	CO2e	20-year	Marginal	Levelized
Table C2.22-8 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based CO2e Emissions Factors with GWP20 for 2032 Start Year	2032	Month-Hour	CO2e	20-year	Marginal	Levelized
Table C2.22-9 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based CO2e Emissions Factors with GWP20 for 2033 Start Year	2033	Month-Hour	CO2e	20-year	Marginal	Levelized
Table C2.22-10 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based CO2e Emissions Factors with GWP20 for 2034 Start Year	2034	Month-Hour	CO2e	20-year	Marginal	Levelized

Table	*Calculation Period*(s)	*Emissions Factor* Time Granularity	Emissions representation	*Global warming potential time horizon*	*Emissions factor* type	Time Representation
Table C2.22-11 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based CO2e Emissions Factors with GWP20 for 2035 Start Year	2035	Month-Hour	CO2e	20-year	Marginal	Levelized
Table C2.23-1 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based CO2 Emissions Factors for 2025 Start Year	2025	Month-Hour	CO2	N/A	Marginal	Levelized
Table C2.23-2 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based CO2 Emissions Factors for 2026 Start Year	2026	Month-Hour	CO2	N/A	Marginal	Levelized
Table C2.23-3 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based CO2 Emissions Factors for 2027 Start Year	2027	Month-Hour	CO2	N/A	Marginal	Levelized
Table C2.23-4 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based CO2 Emissions Factors for 2028 Start Year	2028	Month-Hour	CO2	N/A	Marginal	Levelized
Table C2.23-5 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based CO2 Emissions Factors for 2029 Start Year	2029	Month-Hour	CO2	N/A	Marginal	Levelized
Table C2.23-6 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based CO2 Emissions Factors for 2030 Start Year	2030	Month-Hour	CO2	N/A	Marginal	Levelized
Table C2.23-7 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based CO2 Emissions Factors for 2031 Start Year	2031	Month-Hour	CO2	N/A	Marginal	Levelized
Table C2.23-8 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based CO2 Emissions Factors for 2032 Start Year	2032	Month-Hour	CO2	N/A	Marginal	Levelized
Table C2.23-9 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based CO2 Emissions Factors for 2033 Start Year	2033	Month-Hour	CO2	N/A	Marginal	Levelized
Table C2.23-10 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based CO2 Emissions Factors for 2034 Start Year	2034	Month-Hour	CO2	N/A	Marginal	Levelized
Table C2.23-11 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based CO2 Emissions Factors for 2035 Start Year	2035	Month-Hour	CO2	N/A	Marginal	Levelized
Table C2.24-1 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based CH4 Emissions Factors for 2025 Start Year	2025	Month-Hour	CH4	N/A	Marginal	Levelized
Table C2.24-2 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based CH4 Emissions Factors for 2026 Start Year	2026	Month-Hour	CH4	N/A	Marginal	Levelized
Table C2.24-3 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based CH4 Emissions Factors for 2027 Start Year	2027	Month-Hour	CH4	N/A	Marginal	Levelized

Table	*Calculation Period*(s)	*Emissions Factor* Time Granularity	Emissions representation	*Global warming potential time horizon*	*Emissions factor* type	Time Representation
Table C2.24-4 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based CH4 Emissions Factors for 2028 Start Year	2028	Month-Hour	CH4	N/A	Marginal	Levelized
Table C2.24-5 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based CH4 Emissions Factors for 2029 Start Year	2029	Month-Hour	CH4	N/A	Marginal	Levelized
Table C2.24-6 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based CH4 Emissions Factors for 2030 Start Year	2030	Month-Hour	CH4	N/A	Marginal	Levelized
Table C2.24-7 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based CH4 Emissions Factors for 2031 Start Year	2031	Month-Hour	CH4	N/A	Marginal	Levelized
Table C2.24-8 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based CH4 Emissions Factors for 2032 Start Year	2032	Month-Hour	CH4	N/A	Marginal	Levelized
Table C2.24-9 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based CH4 Emissions Factors for 2033 Start Year	2033	Month-Hour	CH4	N/A	Marginal	Levelized
Table C2.24-10 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based CH4 Emissions Factors for 2034 Start Year	2034	Month-Hour	CH4	N/A	Marginal	Levelized
Table C2.24-11 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based CH4 Emissions Factors for 2035 Start Year	2035	Month-Hour	CH4	N/A	Marginal	Levelized
Table C2.25-1 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based N2O Emissions Factors for 2025 Start Year	2025	Month-Hour	N2O	N/A	Marginal	Levelized
Table C2.25-2 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based N2O Emissions Factors for 2026 Start Year	2026	Month-Hour	N2O	N/A	Marginal	Levelized
Table C2.25-3 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based N2O Emissions Factors for 2027 Start Year	2027	Month-Hour	N2O	N/A	Marginal	Levelized
Table C2.25-4 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based N2O Emissions Factors for 2028 Start Year	2028	Month-Hour	N2O	N/A	Marginal	Levelized
Table C2.25-5 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based N2O Emissions Factors for 2029 Start Year	2029	Month-Hour	N2O	N/A	Marginal	Levelized
Table C2.25-6 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based N2O Emissions Factors for 2030 Start Year	2030	Month-Hour	N2O	N/A	Marginal	Levelized
Table C2.25-7 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based N2O Emissions Factors for 2031 Start Year	2031	Month-Hour	N2O	N/A	Marginal	Levelized

Table	*Calculation Period*(s)	*Emissions Factor* Time Granularity	Emissions representation	*Global warming potential time horizon*	*Emissions factor* type	Time Representation
Table C2.25-8 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based N2O Emissions Factors for 2032 Start Year	2032	Month-Hour	N2O	N/A	Marginal	Levelized
Table C2.25-9 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based N2O Emissions Factors for 2033 Start Year	2033	Month-Hour	N2O	N/A	Marginal	Levelized
Table C2.25-10 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based N2O Emissions Factors for 2034 Start Year	2034	Month-Hour	N2O	N/A	Marginal	Levelized
Table C2.25-11 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based N2O Emissions Factors for 2035 Start Year	2035	Month-Hour	N2O	N/A	Marginal	Levelized
Table C2.26-1 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2e Emissions Factors with GWP100 for CAISO	2025–2050	Month-Hour	CO2e	100-year	Marginal	Individual Year
Table C2.26-2 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2e Emissions Factors with GWP100 for ERCOT	2025–2050	Month-Hour	CO2e	100-year	Marginal	Individual Year
Table C2.26-3 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2e Emissions Factors with GWP100 for FRCC	2025–2050	Month-Hour	CO2e	100-year	Marginal	Individual Year
Table C2.26-4 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2e Emissions Factors with GWP100 for ISONE	2025–2050	Month-Hour	CO2e	100-year	Marginal	Individual Year
Table C2.26-5 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2e Emissions Factors with GWP100 for MISO Central	2025–2050	Month-Hour	CO2e	100-year	Marginal	Individual Year
Table C2.26-6 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2e Emissions Factors with GWP100 for MISO North	2025–2050	Month-Hour	CO2e	100-year	Marginal	Individual Year
Table C2.26-7 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2e Emissions Factors with GWP100 for MISO South	2025–2050	Month-Hour	CO2e	100-year	Marginal	Individual Year
Table C2.26-8 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2e Emissions Factors with GWP100 for Northern Grid East	2025–2050	Month-Hour	CO2e	100-year	Marginal	Individual Year
Table C2.26-9 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2e Emissions Factors with GWP100 for Northern Grid South	2025–2050	Month-Hour	CO2e	100-year	Marginal	Individual Year
Table C2.26-10 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2e Emissions Factors with GWP100 for Northern Grid West	2025–2050	Month-Hour	CO2e	100-year	Marginal	Individual Year
Table C2.26-11 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2e Emissions Factors with GWP100 for NYISO	2025–2050	Month-Hour	CO2e	100-year	Marginal	Individual Year

Table	*Calculation Period*(s)	*Emissions Factor* Time Granularity	Emissions representation	*Global warming potential time horizon*	*Emissions factor* type	Time Representation
Table C2.26-12 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2e Emissions Factors with GWP100 for PJM East	2025–2050	Month-Hour	CO2e	100-year	Marginal	Individual Year
Table C2.26-13 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2e Emissions Factors with GWP100 for PJM West	2025–2050	Month-Hour	CO2e	100-year	Marginal	Individual Year
Table C2.26-14 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2e Emissions Factors with GWP100 for SERTP	2025–2050	Month-Hour	CO2e	100-year	Marginal	Individual Year
Table C2.26-15 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2e Emissions Factors with GWP100 for SPP North	2025–2050	Month-Hour	CO2e	100-year	Marginal	Individual Year
Table C2.26-16 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2e Emissions Factors with GWP100 for SPP South	2025–2050	Month-Hour	CO2e	100-year	Marginal	Individual Year
Table C2.26-17 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2e Emissions Factors with GWP100 for West Connect North	2025–2050	Month-Hour	CO2e	100-year	Marginal	Individual Year
Table C2.26-18 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2e Emissions Factors with GWP100 for West Connect South	2025–2050	Month-Hour	CO2e	100-year	Marginal	Individual Year
Table C2.27-1 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2e Emissions Factors with GWP20 for CAISO	2025–2050	Month-Hour	CO2e	20-year	Marginal	Individual Year
Table C2.27-2 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2e Emissions Factors with GWP20 for ERCOT	2025–2050	Month-Hour	CO2e	20-year	Marginal	Individual Year
Table C2.27-3 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2e Emissions Factors with GWP20 for FRCC	2025–2050	Month-Hour	CO2e	20-year	Marginal	Individual Year
Table C2.27-4 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2e Emissions Factors with GWP20 for ISONE	2025–2050	Month-Hour	CO2e	20-year	Marginal	Individual Year
Table C2.27-5 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2e Emissions Factors with GWP20 for MISO Central	2025–2050	Month-Hour	CO2e	20-year	Marginal	Individual Year
Table C2.27-6 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2e Emissions Factors with GWP20 for MISO North	2025–2050	Month-Hour	CO2e	20-year	Marginal	Individual Year
Table C2.27-7 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2e Emissions Factors with GWP20 for MISO South	2025–2050	Month-Hour	CO2e	20-year	Marginal	Individual Year
Table C2.27-8 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2e Emissions Factors with GWP20 for Northern Grid East	2025–2050	Month-Hour	CO2e	20-year	Marginal	Individual Year

Table	*Calculation Period*(s)	*Emissions Factor* Time Granularity	Emissions representation	*Global warming potential time horizon*	*Emissions factor* type	Time Representation
Table C2.27-9 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2e Emissions Factors with GWP20 for Northern Grid South	2025–2050	Month-Hour	CO2e	20-year	Marginal	Individual Year
Table C2.27-10 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2e Emissions Factors with GWP20 for Northern Grid West	2025–2050	Month-Hour	CO2e	20-year	Marginal	Individual Year
Table C2.27-11 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2e Emissions Factors with GWP20 for NYISO	2025–2050	Month-Hour	CO2e	20-year	Marginal	Individual Year
Table C2.27-12 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2e Emissions Factors with GWP20 for PJM East	2025–2050	Month-Hour	CO2e	20-year	Marginal	Individual Year
Table C2.27-13 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2e Emissions Factors with GWP20 for PJM West	2025–2050	Month-Hour	CO2e	20-year	Marginal	Individual Year
Table C2.27-14 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2e Emissions Factors with GWP20 for SERTP	2025–2050	Month-Hour	CO2e	20-year	Marginal	Individual Year
Table C2.27-15 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2e Emissions Factors with GWP20 for SPP North	2025–2050	Month-Hour	CO2e	20-year	Marginal	Individual Year
Table C2.27-16 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2e Emissions Factors with GWP20 for SPP South	2025–2050	Month-Hour	CO2e	20-year	Marginal	Individual Year
Table C2.27-17 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2e Emissions Factors with GWP20 for West Connect North	2025–2050	Month-Hour	CO2e	20-year	Marginal	Individual Year
Table C2.27-18 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2e Emissions Factors with GWP20 for West Connect South	2025–2050	Month-Hour	CO2e	20-year	Marginal	Individual Year
Table C2.28-1 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2 Emissions Factors for CAISO	2025–2050	Month-Hour	CO2	N/A	Marginal	Individual Year
Table C2.28-2 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2 Emissions Factors for ERCOT	2025–2050	Month-Hour	CO2	N/A	Marginal	Individual Year
Table C2.28-3 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2 Emissions Factors for FRCC	2025–2050	Month-Hour	CO2	N/A	Marginal	Individual Year
Table C2.28-4 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2 Emissions Factors for ISONE	2025–2050	Month-Hour	CO2	N/A	Marginal	Individual Year
Table C2.28-5 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2 Emissions Factors for MISO Central	2025–2050	Month-Hour	CO2	N/A	Marginal	Individual Year

Table	*Calculation Period*(s)	*Emissions Factor* Time Granularity	Emissions representation	*Global warming potential time horizon*	*Emissions factor* type	Time Representation
Table C2.28-6 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2 Emissions Factors for MISO North	2025–2050	Month-Hour	CO2	N/A	Marginal	Individual Year
Table C2.28-7 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2 Emissions Factors for MISO South	2025–2050	Month-Hour	CO2	N/A	Marginal	Individual Year
Table C2.28-8 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2 Emissions Factors for Northern Grid East	2025–2050	Month-Hour	CO2	N/A	Marginal	Individual Year
Table C2.28-9 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2 Emissions Factors for Northern Grid South	2025–2050	Month-Hour	CO2	N/A	Marginal	Individual Year
Table C2.28-10 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2 Emissions Factors for Northern Grid West	2025–2050	Month-Hour	CO2	N/A	Marginal	Individual Year
Table C2.28-11 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2 Emissions Factors for NYISO	2025–2050	Month-Hour	CO2	N/A	Marginal	Individual Year
Table C2.28-12 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2 Emissions Factors for PJM East	2025–2050	Month-Hour	CO2	N/A	Marginal	Individual Year
Table C2.28-13 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2 Emissions Factors for PJM West	2025–2050	Month-Hour	CO2	N/A	Marginal	Individual Year
Table C2.28-14 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2 Emissions Factors for SERTP	2025–2050	Month-Hour	CO2	N/A	Marginal	Individual Year
Table C2.28-15 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2 Emissions Factors for SPP North	2025–2050	Month-Hour	CO2	N/A	Marginal	Individual Year
Table C2.28-16 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2 Emissions Factors for SPP South	2025–2050	Month-Hour	CO2	N/A	Marginal	Individual Year
Table C2.28-17 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2 Emissions Factors for West Connect North	2025–2050	Month-Hour	CO2	N/A	Marginal	Individual Year
Table C2.28-18 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CO2 Emissions Factors for West Connect South	2025–2050	Month-Hour	CO2	N/A	Marginal	Individual Year
Table C2.29-1 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CH4 Emissions Factors for CAISO	2025–2050	Month-Hour	CH4	N/A	Marginal	Individual Year
Table C2.29-2 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CH4 Emissions Factors for ERCOT	2025–2050	Month-Hour	CH4	N/A	Marginal	Individual Year

Table	*Calculation Period*(s)	*Emissions Factor* Time Granularity	Emissions representation	*Global warming potential time horizon*	*Emissions factor* type	Time Representation
Table C2.29-3 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CH4 Emissions Factors for FRCC	2025–2050	Month-Hour	CH4	N/A	Marginal	Individual Year
Table C2.29-4 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CH4 Emissions Factors for ISONE	2025–2050	Month-Hour	CH4	N/A	Marginal	Individual Year
Table C2.29-5 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CH4 Emissions Factors for MISO Central	2025–2050	Month-Hour	CH4	N/A	Marginal	Individual Year
Table C2.29-6 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CH4 Emissions Factors for MISO North	2025–2050	Month-Hour	CH4	N/A	Marginal	Individual Year
Table C2.29-7 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CH4 Emissions Factors for MISO South	2025–2050	Month-Hour	CH4	N/A	Marginal	Individual Year
Table C2.29-8 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CH4 Emissions Factors for Northern Grid East	2025–2050	Month-Hour	CH4	N/A	Marginal	Individual Year
Table C2.29-9 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CH4 Emissions Factors for Northern Grid South	2025–2050	Month-Hour	CH4	N/A	Marginal	Individual Year
Table C2.29-10 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CH4 Emissions Factors for Northern Grid West	2025–2050	Month-Hour	CH4	N/A	Marginal	Individual Year
Table C2.29-11 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CH4 Emissions Factors for NYISO	2025–2050	Month-Hour	CH4	N/A	Marginal	Individual Year
Table C2.29-12 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CH4 Emissions Factors for PJM East	2025–2050	Month-Hour	CH4	N/A	Marginal	Individual Year
Table C2.29-13 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CH4 Emissions Factors for PJM West	2025–2050	Month-Hour	CH4	N/A	Marginal	Individual Year
Table C2.29-14 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CH4 Emissions Factors for SERTP	2025–2050	Month-Hour	CH4	N/A	Marginal	Individual Year
Table C2.29-15 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CH4 Emissions Factors for SPP North	2025–2050	Month-Hour	CH4	N/A	Marginal	Individual Year
Table C2.29-16 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CH4 Emissions Factors for SPP South	2025–2050	Month-Hour	CH4	N/A	Marginal	Individual Year
Table C2.29-17 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CH4 Emissions Factors for West Connect North	2025–2050	Month-Hour	CH4	N/A	Marginal	Individual Year

Table	*Calculation Period*(s)	*Emissions Factor* Time Granularity	Emissions representation	*Global warming potential time horizon*	*Emissions factor* type	Time Representation
Table C2.29-18 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based CH4 Emissions Factors for West Connect South	2025–2050	Month-Hour	CH4	N/A	Marginal	Individual Year
Table C2.30-1 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based N2O Emissions Factors for CAISO	2025–2050	Month-Hour	N2O	N/A	Marginal	Individual Year
Table C2.30-2 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based N2O Emissions Factors for ERCOT	2025–2050	Month-Hour	N2O	N/A	Marginal	Individual Year
Table C2.30-3 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based N2O Emissions Factors for FRCC	2025–2050	Month-Hour	N2O	N/A	Marginal	Individual Year
Table C2.30-4 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based N2O Emissions Factors for ISONE	2025–2050	Month-Hour	N2O	N/A	Marginal	Individual Year
Table C2.30-5 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based N2O Emissions Factors for MISO Central	2025–2050	Month-Hour	N2O	N/A	Marginal	Individual Year
Table C2.30-6 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based N2O Emissions Factors for MISO North	2025–2050	Month-Hour	N2O	N/A	Marginal	Individual Year
Table C2.30-7 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based N2O Emissions Factors for MISO South	2025–2050	Month-Hour	N2O	N/A	Marginal	Individual Year
Table C2.30-8 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based N2O Emissions Factors for Northern Grid East	2025–2050	Month-Hour	N2O	N/A	Marginal	Individual Year
Table C2.30-9 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based N2O Emissions Factors for Northern Grid South	2025–2050	Month-Hour	N2O	N/A	Marginal	Individual Year
Table C2.30-10 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based N2O Emissions Factors for Northern Grid West	2025–2050	Month-Hour	N2O	N/A	Marginal	Individual Year
Table C2.30-11 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based N2O Emissions Factors for NYISO	2025–2050	Month-Hour	N2O	N/A	Marginal	Individual Year
Table C2.30-12 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based N2O Emissions Factors for PJM East	2025–2050	Month-Hour	N2O	N/A	Marginal	Individual Year
Table C2.30-13 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based N2O Emissions Factors for PJM West	2025–2050	Month-Hour	N2O	N/A	Marginal	Individual Year
Table C2.30-14 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based N2O Emissions Factors for SERTP	2025–2050	Month-Hour	N2O	N/A	Marginal	Individual Year

Table	*Calculation Period*(s)	*Emissions Factor* Time Granularity	Emissions representation	*Global warming potential time horizon*	*Emissions factor* type	Time Representation
Table C2.30-15 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based N2O Emissions Factors for SPP North	2025–2050	Month-Hour	N2O	N/A	Marginal	Individual Year
Table C2.30-16 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based N2O Emissions Factors for SPP South	2025–2050	Month-Hour	N2O	N/A	Marginal	Individual Year
Table C2.30-17 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based N2O Emissions Factors for West Connect North	2025–2050	Month-Hour	N2O	N/A	Marginal	Individual Year
Table C2.30-18 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Marginal Location-Based N2O Emissions Factors for West Connect South	2025–2050	Month-Hour	N2O	N/A	Marginal	Individual Year
Table C2.11 – Projected Annual Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based CO2e Emissions Factors with GWP100	2025–2035	Annual	CO2e	100-year	Average	Levelized
Table C2.12 – Projected Annual Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based CO2e Emissions Factors with GWP20	2025–2035	Annual	CO2e	20-year	Average	Levelized
Table C2.13 – Projected Annual Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based CO2 Emissions Factors	2025–2035	Annual	CO2	N/A	Average	Levelized
Table C2.14 – Projected Annual Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based CH4 Emissions Factors	2025–2035	Annual	CH4	N/A	Average	Levelized
Table C2.15 – Projected Annual Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based N2O Emissions Factors	2025–2035	Annual	N2O	N/A	Average	Levelized
Table C2.16 – Projected Annual Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2e Emissions Factors with GWP100	2025–2050	Annual	CO2e	100-year	Average	Individual Year
Table C2.17 – Projected Annual Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2e Emissions Factors with GWP20	2025–2050	Annual	CO2e	20-year	Average	Individual Year
Table C2.18 – Projected Annual Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2 Emissions Factors	2025–2050	Annual	CO2	N/A	Average	Individual Year
Table C2.19 – Projected Annual Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CH4 Emissions Factors	2025–2050	Annual	CH4	N/A	Average	Individual Year
Table C2.20 – Projected Annual Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based N2O Emissions Factors	2025–2050	Annual	N2O	N/A	Average	Individual Year
Table C2.31-1 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based CO2e Emissions Factors with GWP100 for 2025 Start Year	2025	Month-Hour	CO2e	100-year	Average	Levelized
Table C2.31-2 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based CO2e Emissions Factors with GWP100 for 2026 Start Year	2026	Month-Hour	CO2e	100-year	Average	Levelized
Table C2.31-3 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based CO2e Emissions Factors with GWP100 for 2027 Start Year	2027	Month-Hour	CO2e	100-year	Average	Levelized

Table	*Calculation Period*(s)	*Emissions Factor* Time Granularity	Emissions representation	*Global warming potential time horizon*	*Emissions factor* type	Time Representation
Table C2.31-4 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based CO2e Emissions Factors with GWP100 for 2028 Start Year	2028	Month-Hour	CO2e	100-year	Average	Levelized
Table C2.31-5 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based CO2e Emissions Factors with GWP100 for 2029 Start Year	2029	Month-Hour	CO2e	100-year	Average	Levelized
Table C2.31-6 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based CO2e Emissions Factors with GWP100 for 2030 Start Year	2030	Month-Hour	CO2e	100-year	Average	Levelized
Table C2.31-7 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based CO2e Emissions Factors with GWP100 for 2031 Start Year	2031	Month-Hour	CO2e	100-year	Average	Levelized
Table C2.31-8 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based CO2e Emissions Factors with GWP100 for 2032 Start Year	2032	Month-Hour	CO2e	100-year	Average	Levelized
Table C2.31-9 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based CO2e Emissions Factors with GWP100 for 2033 Start Year	2033	Month-Hour	CO2e	100-year	Average	Levelized
Table C2.31-10 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based CO2e Emissions Factors with GWP100 for 2034 Start Year	2034	Month-Hour	CO2e	100-year	Average	Levelized
Table C2.31-11 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based CO2e Emissions Factors with GWP100 for 2035 Start Year	2035	Month-Hour	CO2e	100-year	Average	Levelized
Table C2.32-1 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based CO2e Emissions Factors with GWP20 for 2025 Start Year	2025	Month-Hour	CO2e	20-year	Average	Levelized
Table C2.32-2 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based CO2e Emissions Factors with GWP20 for 2026 Start Year	2026	Month-Hour	CO2e	20-year	Average	Levelized
Table C2.32-3 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based CO2e Emissions Factors with GWP20 for 2027 Start Year	2027	Month-Hour	CO2e	20-year	Average	Levelized
Table C2.32-4 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based CO2e Emissions Factors with GWP20 for 2028 Start Year	2028	Month-Hour	CO2e	20-year	Average	Levelized
Table C2.32-5 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based CO2e Emissions Factors with GWP20 for 2029 Start Year	2029	Month-Hour	CO2e	20-year	Average	Levelized
Table C2.32-6 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based CO2e Emissions Factors with GWP20 for 2030 Start Year	2030	Month-Hour	CO2e	20-year	Average	Levelized
Table C2.32-7 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based CO2e Emissions Factors with GWP20 for 2031 Start Year	2031	Month-Hour	CO2e	20-year	Average	Levelized

Table	*Calculation Period*(s)	*Emissions Factor* Time Granularity	Emissions representation	*Global warming potential time horizon*	*Emissions factor* type	Time Representation
Table C2.32-8 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based CO2e Emissions Factors with GWP20 for 2032 Start Year	2032	Month-Hour	CO2e	20-year	Average	Levelized
Table C2.32-9 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based CO2e Emissions Factors with GWP20 for 2033 Start Year	2033	Month-Hour	CO2e	20-year	Average	Levelized
Table C2.32-10 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based CO2e Emissions Factors with GWP20 for 2034 Start Year	2034	Month-Hour	CO2e	20-year	Average	Levelized
Table C2.32-11 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based CO2e Emissions Factors with GWP20 for 2035 Start Year	2035	Month-Hour	CO2e	20-year	Average	Levelized
Table C2.33-1 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based CO2 Emissions Factors for 2025 Start Year	2025	Month-Hour	CO2	N/A	Average	Levelized
Table C2.33-2 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based CO2 Emissions Factors for 2026 Start Year	2026	Month-Hour	CO2	N/A	Average	Levelized
Table C2.33-3 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based CO2 Emissions Factors for 2027 Start Year	2027	Month-Hour	CO2	N/A	Average	Levelized
Table C2.33-4 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based CO2 Emissions Factors for 2028 Start Year	2028	Month-Hour	CO2	N/A	Average	Levelized
Table C2.33-5 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based CO2 Emissions Factors for 2029 Start Year	2029	Month-Hour	CO2	N/A	Average	Levelized
Table C2.33-6 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based CO2 Emissions Factors for 2030 Start Year	2030	Month-Hour	CO2	N/A	Average	Levelized
Table C2.33-7 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based CO2 Emissions Factors for 2031 Start Year	2031	Month-Hour	CO2	N/A	Average	Levelized
Table C2.33-8 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based CO2 Emissions Factors for 2032 Start Year	2032	Month-Hour	CO2	N/A	Average	Levelized
Table C2.33-9 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based CO2 Emissions Factors for 2033 Start Year	2033	Month-Hour	CO2	N/A	Average	Levelized
Table C2.33-10 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based CO2 Emissions Factors for 2034 Start Year	2034	Month-Hour	CO2	N/A	Average	Levelized
Table C2.33-11 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based CO2 Emissions Factors for 2035 Start Year	2035	Month-Hour	CO2	N/A	Average	Levelized

Table	*Calculation Period*(s)	*Emissions Factor* Time Granularity	Emissions representation	*Global warming potential time horizon*	*Emissions factor* type	Time Representation
Table C2.34-1 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based CH4 Emissions Factors for 2025 Start Year	2025	Month-Hour	CH4	N/A	Average	Levelized
Table C2.34-2 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based CH4 Emissions Factors for 2026 Start Year	2026	Month-Hour	CH4	N/A	Average	Levelized
Table C2.34-3 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based CH4 Emissions Factors for 2027 Start Year	2027	Month-Hour	CH4	N/A	Average	Levelized
Table C2.34-4 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based CH4 Emissions Factors for 2028 Start Year	2028	Month-Hour	CH4	N/A	Average	Levelized
Table C2.34-5 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based CH4 Emissions Factors for 2029 Start Year	2029	Month-Hour	CH4	N/A	Average	Levelized
Table C2.34-6 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based CH4 Emissions Factors for 2030 Start Year	2030	Month-Hour	CH4	N/A	Average	Levelized
Table C2.34-7 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based CH4 Emissions Factors for 2031 Start Year	2031	Month-Hour	CH4	N/A	Average	Levelized
Table C2.34-8 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based CH4 Emissions Factors for 2032 Start Year	2032	Month-Hour	CH4	N/A	Average	Levelized
Table C2.34-9 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based CH4 Emissions Factors for 2033 Start Year	2033	Month-Hour	CH4	N/A	Average	Levelized
Table C2.34-10 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based CH4 Emissions Factors for 2034 Start Year	2034	Month-Hour	CH4	N/A	Average	Levelized
Table C2.34-11 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based CH4 Emissions Factors for 2035 Start Year	2035	Month-Hour	CH4	N/A	Average	Levelized
Table C2.35-1 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based N2O Emissions Factors for 2025 Start Year	2025	Month-Hour	N2O	N/A	Average	Levelized
Table C2.35-2 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based N2O Emissions Factors for 2026 Start Year	2026	Month-Hour	N2O	N/A	Average	Levelized
Table C2.35-3 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based N2O Emissions Factors for 2027 Start Year	2027	Month-Hour	N2O	N/A	Average	Levelized
Table C2.35-4 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based N2O Emissions Factors for 2028 Start Year	2028	Month-Hour	N2O	N/A	Average	Levelized

Table	*Calculation Period*(s)	*Emissions Factor* Time Granularity	Emissions representation	*Global warming potential time horizon*	*Emissions factor* type	Time Representation
Table C2.35-5 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based N2O Emissions Factors for 2029 Start Year	2029	Month-Hour	N2O	N/A	Average	Levelized
Table C2.35-6 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based N2O Emissions Factors for 2030 Start Year	2030	Month-Hour	N2O	N/A	Average	Levelized
Table C2.35-7 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based N2O Emissions Factors for 2031 Start Year	2031	Month-Hour	N2O	N/A	Average	Levelized
Table C2.35-8 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based N2O Emissions Factors for 2032 Start Year	2032	Month-Hour	N2O	N/A	Average	Levelized
Table C2.35-9 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based N2O Emissions Factors for 2033 Start Year	2033	Month-Hour	N2O	N/A	Average	Levelized
Table C2.35-10 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based N2O Emissions Factors for 2034 Start Year	2034	Month-Hour	N2O	N/A	Average	Levelized
Table C2.35-11 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Levelized Average Location-Based N2O Emissions Factors for 2035 Start Year	2035	Month-Hour	N2O	N/A	Average	Levelized
Table C2.36-1 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2e Emissions Factors with GWP100 for CAISO	2025–2050	Month-Hour	CO2e	100-year	Average	Individual Year
Table C2.36-2 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2e Emissions Factors with GWP100 for ERCOT	2025–2050	Month-Hour	CO2e	100-year	Average	Individual Year
Table C2.36-3 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2e Emissions Factors with GWP100 for FRCC	2025–2050	Month-Hour	CO2e	100-year	Average	Individual Year
Table C2.36-4 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2e Emissions Factors with GWP100 for ISONE	2025–2050	Month-Hour	CO2e	100-year	Average	Individual Year
Table C2.36-5 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2e Emissions Factors with GWP100 for MISO Central	2025–2050	Month-Hour	CO2e	100-year	Average	Individual Year
Table C2.36-6 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2e Emissions Factors with GWP100 for MISO North	2025–2050	Month-Hour	CO2e	100-year	Average	Individual Year
Table C2.36-7 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2e Emissions Factors with GWP100 for MISO South	2025–2050	Month-Hour	CO2e	100-year	Average	Individual Year
Table C2.36-8 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2e Emissions Factors with GWP100 for Northern Grid East	2025–2050	Month-Hour	CO2e	100-year	Average	Individual Year

Table	*Calculation Period*(s)	*Emissions Factor* Time Granularity	Emissions representation	*Global warming potential time horizon*	*Emissions factor* type	Time Representation
Table C2.36-9 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2e Emissions Factors with GWP100 for Northern Grid South	2025–2050	Month-Hour	CO2e	100-year	Average	Individual Year
Table C2.36-10 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2e Emissions Factors with GWP100 for Northern Grid West	2025–2050	Month-Hour	CO2e	100-year	Average	Individual Year
Table C2.36-11 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2e Emissions Factors with GWP100 for NYISO	2025–2050	Month-Hour	CO2e	100-year	Average	Individual Year
Table C2.36-12 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2e Emissions Factors with GWP100 for PJM East	2025–2050	Month-Hour	CO2e	100-year	Average	Individual Year
Table C2.36-13 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2e Emissions Factors with GWP100 for PJM West	2025–2050	Month-Hour	CO2e	100-year	Average	Individual Year
Table C2.36-14 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2e Emissions Factors with GWP100 for SERTP	2025–2050	Month-Hour	CO2e	100-year	Average	Individual Year
Table C2.36-15 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2e Emissions Factors with GWP100 for SPP North	2025–2050	Month-Hour	CO2e	100-year	Average	Individual Year
Table C2.36-16 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2e Emissions Factors with GWP100 for SPP South	2025–2050	Month-Hour	CO2e	100-year	Average	Individual Year
Table C2.36-17 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2e Emissions Factors with GWP100 for West Connect North	2025–2050	Month-Hour	CO2e	100-year	Average	Individual Year
Table C2.36-18 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2e Emissions Factors with GWP100 for West Connect South	2025–2050	Month-Hour	CO2e	100-year	Average	Individual Year
Table C2.37-1 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2e Emissions Factors with GWP20 for CAISO	2025–2050	Month-Hour	CO2e	20-year	Average	Individual Year
Table C2.37-2 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2e Emissions Factors with GWP20 for ERCOT	2025–2050	Month-Hour	CO2e	20-year	Average	Individual Year
Table C2.37-3 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2e Emissions Factors with GWP20 for FRCC	2025–2050	Month-Hour	CO2e	20-year	Average	Individual Year
Table C2.37-4 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2e Emissions Factors with GWP20 for ISONE	2025–2050	Month-Hour	CO2e	20-year	Average	Individual Year
Table C2.37-5 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2e Emissions Factors with GWP20 for MISO Central	2025–2050	Month-Hour	CO2e	20-year	Average	Individual Year

Table	*Calculation Period*(s)	*Emissions Factor* Time Granularity	Emissions representation	*Global warming potential time horizon*	*Emissions factor* type	Time Representation
Table C2.37-6 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2e Emissions Factors with GWP20 for MISO North	2025–2050	Month-Hour	CO2e	20-year	Average	Individual Year
Table C2.37-7 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2e Emissions Factors with GWP20 for MISO South	2025–2050	Month-Hour	CO2e	20-year	Average	Individual Year
Table C2.37-8 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2e Emissions Factors with GWP20 for Northern Grid East	2025–2050	Month-Hour	CO2e	20-year	Average	Individual Year
Table C2.37-9 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2e Emissions Factors with GWP20 for Northern Grid South	2025–2050	Month-Hour	CO2e	20-year	Average	Individual Year
Table C2.37-10 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2e Emissions Factors with GWP20 for Northern Grid West	2025–2050	Month-Hour	CO2e	20-year	Average	Individual Year
Table C2.37-11 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2e Emissions Factors with GWP20 for NYISO	2025–2050	Month-Hour	CO2e	20-year	Average	Individual Year
Table C2.37-12 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2e Emissions Factors with GWP20 for PJM East	2025–2050	Month-Hour	CO2e	20-year	Average	Individual Year
Table C2.37-13 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2e Emissions Factors with GWP20 for PJM West	2025–2050	Month-Hour	CO2e	20-year	Average	Individual Year
Table C2.37-14 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2e Emissions Factors with GWP20 for SERTP	2025–2050	Month-Hour	CO2e	20-year	Average	Individual Year
Table C2.37-15 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2e Emissions Factors with GWP20 for SPP North	2025–2050	Month-Hour	CO2e	20-year	Average	Individual Year
Table C2.37-16 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2e Emissions Factors with GWP20 for SPP South	2025–2050	Month-Hour	CO2e	20-year	Average	Individual Year
Table C2.37-17 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2e Emissions Factors with GWP20 for West Connect North	2025–2050	Month-Hour	CO2e	20-year	Average	Individual Year
Table C2.37-18 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2e Emissions Factors with GWP20 for West Connect South	2025–2050	Month-Hour	CO2e	20-year	Average	Individual Year
Table C2.38-1 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2 Emissions Factors for CAISO	2025–2050	Month-Hour	CO2	N/A	Average	Individual Year
Table C2.38-2 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2 Emissions Factors for ERCOT	2025–2050	Month-Hour	CO2	N/A	Average	Individual Year

Table	*Calculation Period*(s)	*Emissions Factor* Time Granularity	Emissions representation	*Global warming potential time horizon*	*Emissions factor* type	Time Representation
Table C2.38-3 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2 Emissions Factors for FRCC	2025–2050	Month-Hour	CO2	N/A	Average	Individual Year
Table C2.38-4 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2 Emissions Factors for ISONE	2025–2050	Month-Hour	CO2	N/A	Average	Individual Year
Table C2.38-5 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2 Emissions Factors for MISO Central	2025–2050	Month-Hour	CO2	N/A	Average	Individual Year
Table C2.38-6 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2 Emissions Factors for MISO North	2025–2050	Month-Hour	CO2	N/A	Average	Individual Year
Table C2.38-7 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2 Emissions Factors for MISO South	2025–2050	Month-Hour	CO2	N/A	Average	Individual Year
Table C2.38-8 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2 Emissions Factors for Northern Grid East	2025–2050	Month-Hour	CO2	N/A	Average	Individual Year
Table C2.38-9 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2 Emissions Factors for Northern Grid South	2025–2050	Month-Hour	CO2	N/A	Average	Individual Year
Table C2.38-10 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2 Emissions Factors for Northern Grid West	2025–2050	Month-Hour	CO2	N/A	Average	Individual Year
Table C2.38-11 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2 Emissions Factors for NYISO	2025–2050	Month-Hour	CO2	N/A	Average	Individual Year
Table C2.38-12 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2 Emissions Factors for PJM East	2025–2050	Month-Hour	CO2	N/A	Average	Individual Year
Table C2.38-13 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2 Emissions Factors for PJM West	2025–2050	Month-Hour	CO2	N/A	Average	Individual Year
Table C2.38-14 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2 Emissions Factors for SERTP	2025–2050	Month-Hour	CO2	N/A	Average	Individual Year
Table C2.38-15 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2 Emissions Factors for SPP North	2025–2050	Month-Hour	CO2	N/A	Average	Individual Year
Table C2.38-16 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2 Emissions Factors for SPP South	2025–2050	Month-Hour	CO2	N/A	Average	Individual Year
Table C2.38-17 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2 Emissions Factors for West Connect North	2025–2050	Month-Hour	CO2	N/A	Average	Individual Year

Table	*Calculation Period*(s)	*Emissions Factor* Time Granularity	Emissions representation	*Global warming potential time horizon*	*Emissions factor* type	Time Representation
Table C2.38-18 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CO2 Emissions Factors for West Connect South	2025–2050	Month-Hour	CO2	N/A	Average	Individual Year
Table C2.39-1 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CH4 Emissions Factors for CAISO	2025–2050	Month-Hour	CH4	N/A	Average	Individual Year
Table C2.39-2 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CH4 Emissions Factors for ERCOT	2025–2050	Month-Hour	CH4	N/A	Average	Individual Year
Table C2.39-3 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CH4 Emissions Factors for FRCC	2025–2050	Month-Hour	CH4	N/A	Average	Individual Year
Table C2.39-4 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CH4 Emissions Factors for ISONE	2025–2050	Month-Hour	CH4	N/A	Average	Individual Year
Table C2.39-5 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CH4 Emissions Factors for MISO Central	2025–2050	Month-Hour	CH4	N/A	Average	Individual Year
Table C2.39-6 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CH4 Emissions Factors for MISO North	2025–2050	Month-Hour	CH4	N/A	Average	Individual Year
Table C2.39-7 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CH4 Emissions Factors for MISO South	2025–2050	Month-Hour	CH4	N/A	Average	Individual Year
Table C2.39-8 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CH4 Emissions Factors for Northern Grid East	2025–2050	Month-Hour	CH4	N/A	Average	Individual Year
Table C2.39-9 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CH4 Emissions Factors for Northern Grid South	2025–2050	Month-Hour	CH4	N/A	Average	Individual Year
Table C2.39-10 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CH4 Emissions Factors for Northern Grid West	2025–2050	Month-Hour	CH4	N/A	Average	Individual Year
Table C2.39-11 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CH4 Emissions Factors for NYISO	2025–2050	Month-Hour	CH4	N/A	Average	Individual Year
Table C2.39-12 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CH4 Emissions Factors for PJM East	2025–2050	Month-Hour	CH4	N/A	Average	Individual Year
Table C2.39-13 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CH4 Emissions Factors for PJM West	2025–2050	Month-Hour	CH4	N/A	Average	Individual Year
Table C2.39-14 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CH4 Emissions Factors for SERTP	2025–2050	Month-Hour	CH4	N/A	Average	Individual Year

Table	*Calculation Period*(s)	*Emissions Factor* Time Granularity	Emissions representation	*Global warming potential time horizon*	*Emissions factor* type	Time Representation
Table C2.39-15 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CH4 Emissions Factors for SPP North	2025–2050	Month-Hour	CH4	N/A	Average	Individual Year
Table C2.39-16 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CH4 Emissions Factors for SPP South	2025–2050	Month-Hour	CH4	N/A	Average	Individual Year
Table C2.39-17 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CH4 Emissions Factors for West Connect North	2025–2050	Month-Hour	CH4	N/A	Average	Individual Year
Table C2.39-18 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based CH4 Emissions Factors for West Connect South	2025–2050	Month-Hour	CH4	N/A	Average	Individual Year
Table C2.40-1 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based N2O Emissions Factors for CAISO	2025–2050	Month-Hour	N2O	N/A	Average	Individual Year
Table C2.40-2 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based N2O Emissions Factors for ERCOT	2025–2050	Month-Hour	N2O	N/A	Average	Individual Year
Table C2.40-3 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based N2O Emissions Factors for FRCC	2025–2050	Month-Hour	N2O	N/A	Average	Individual Year
Table C2.40-4 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based N2O Emissions Factors for ISONE	2025–2050	Month-Hour	N2O	N/A	Average	Individual Year
Table C2.40-5 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based N2O Emissions Factors for MISO Central	2025–2050	Month-Hour	N2O	N/A	Average	Individual Year
Table C2.40-6 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based N2O Emissions Factors for MISO North	2025–2050	Month-Hour	N2O	N/A	Average	Individual Year
Table C2.40-7 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based N2O Emissions Factors for MISO South	2025–2050	Month-Hour	N2O	N/A	Average	Individual Year
Table C2.40-8 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based N2O Emissions Factors for Northern Grid East	2025–2050	Month-Hour	N2O	N/A	Average	Individual Year
Table C2.40-9 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based N2O Emissions Factors for Northern Grid South	2025–2050	Month-Hour	N2O	N/A	Average	Individual Year
Table C2.40-10 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based N2O Emissions Factors for Northern Grid West	2025–2050	Month-Hour	N2O	N/A	Average	Individual Year
Table C2.40-11 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based N2O Emissions Factors for NYISO	2025–2050	Month-Hour	N2O	N/A	Average	Individual Year

Table	***Calculation Period*(s)**	***Emissions Factor* Time Granularity**	**Emissions representation**	***Global warming potential time horizon***	***Emissions factor* type**	**Time Representation**
Table C2.40-12 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based N2O Emissions Factors for PJM East	2025–2050	Month-Hour	N2O	N/A	Average	Individual Year
Table C2.40-13 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based N2O Emissions Factors for PJM West	2025–2050	Month-Hour	N2O	N/A	Average	Individual Year
Table C2.40-14 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based N2O Emissions Factors for SERTP	2025–2050	Month-Hour	N2O	N/A	Average	Individual Year
Table C2.40-15 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based N2O Emissions Factors for SPP North	2025–2050	Month-Hour	N2O	N/A	Average	Individual Year
Table C2.40-16 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based N2O Emissions Factors for SPP South	2025–2050	Month-Hour	N2O	N/A	Average	Individual Year
Table C2.40-17 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based N2O Emissions Factors for West Connect North	2025–2050	Month-Hour	N2O	N/A	Average	Individual Year
Table C2.40-18 – Projected Month-Hour Electricity Emissions Factors for the Contiguous United States – Individual Year Average Location-Based N2O Emissions Factors for West Connect South	2025–2050	Month-Hour	N2O	N/A	Average	Individual Year
Table C2.1 – Projected Annual Electricity Emissions Factors for the Contiguous United States – Levelized Marginal Location-Based CO2e Emissions Factors with GWP100	2025–2035	Annual	CO2e	100-year	Marginal	Levelized