U.S. Department of ENERGY | Office of Energy Efficiency & Renewable Energy

Best Practices for Determining Greenhouse Gas Emissions Factors for Building Technology Office Tools

January 2025

Disclaimer

Authors

The authors of this report are:

Leo Rainer, Lawrence Berkeley National Laboratory

Eric Wilson, National Renewable Energy Laboratory

Joshua Kace, Lawrence Berkeley National Laboratory

Harry Bergmann, U.S. Department of Energy

Paul Mathew, Lawrence Berkeley National Laboratory

Acknowledgments

The authors would like to thank the following individuals for their thoughtful comments and suggestions for the development of these metrics and preparation of this document: Colby Tucker at the U.S. Environmental Protection Agency; Eric Bonnema, Ardelia Clarke, Matthew Dahlhausen, Pieter Gagnon, David Goldwasser, Nicholas Long, and Elaina Present at the National Renewable Energy Laboratory; and Juan Gonzalez, Sarah Newman, and Karen Studarus at the Pacific Northwest National Laboratory.

The authors would also like to thank the industry experts that participated in the stakeholder meetings for this effort.

List of Acronyms

AER	average emission rates
BTO	Building Technologies Office
Btu	British thermal units
CO_2e	equivalent CO_2 emissions
CSV	comma-separated value
DOE	U.S. Department of Energy
eGRID	Emissions & Generation Resource Integrated Database
EIA	Energy Information Administration
EPA	U.S. Environmental Protection Agency
GEA	Generation and Emission Assessment region
GHG	greenhouse gas
HVAC	heating, ventilation, and air conditioning
LRMER	long-run marginal emission rates
MWh	megawatt-hour
NREL	National Renewable Energy Laboratory
NYSERDA	New York State Energy Research and Development Authority
RESNET	Residential Energy Services Network
TCFD	Task Force for Climate-Related Financial Disclosure
TOU	time-of-use

Table of Contents

1 Introduction

This document provides specifications for calculating standardized greenhouse gas (GHG) metrics. The intent is to have all relevant U.S. Department of Energy (DOE) Building Technologies Office (BTO) tools use consistent methods to calculate these metrics. Note that each tool may also have additional metrics or alternative calculation approaches. This document does not cover all metrics and calculation approaches for GHG metrics.

This document is primarily intended for the developers of BTO tools and resources that involve the calculation of building-level GHG metrics. It also may be useful for other organizations and stakeholders who are looking to standardize the calculation of building-level GHG metrics in tools, guidelines, and standards. These specifications are not intended as a formal DOE Standard.

1.1 Emission Rates

All emission rates are provided in terms of total equivalent CO_2 emissions (CO_2e). CO_2e includes the GHG effect of other gases (such as nitrous oxide and methane) by converting them to the equivalent amount of carbon dioxide with the same global warming potential. Emission rates are provided in units of kilograms per megawatt-hour (kg/MWh) for electricity and kg/million British thermal units (Btu) for fuels and district utilities.

Electricity emission rates vary in both time frame (future or historical years) and time resolution (yearly or hourly). Electricity emission rates can be average or marginal (long-run or short-run). Average emission rates (AER) represent the total generation that is allocated to a region's end-use load. Long-run marginal emission rates (LRMER) represent the mixture of generation that would be either induced or avoided by an electric sector intervention, considering how the intervention may influence the structure of the grid, including changes in generation infrastructure. Short-run marginal emission rates represent the mixture of generation that would be either induced or avoided by an electric sector intervention, with a fixed structure of the grid and set of generation facilities. Short-run marginal emission rates are appropriate for measures with lifetimes less than five years and that are unanticipated in capacity planning.[1, 2] Most building technologies and programs do not fall into this category; therefore, short-run marginal emissions rates are not provided in this dataset.[3]

Electricity emission rates were obtained from two different sources, depending on the time frame. Emission rates for historical years come from the U.S. Environmental

---

[1] EPA. "AVERT Question and Answers." www.epa.gov/avert/avert-questions-and-answers#B6.
[2] Clean Energy Buyers Institute. *Applying the Consequential Emissions Framework for Emissions-Optimized Decision-Making for Energy Procurement and Management.* cebi.org/wp-content/uploads/2022/11/Applying-The-Consequential-Emissions-Framework-For-Emissions-Optimized-Decision-Making-For-Energy-Procurement-And-Management.pdf.
[3] For example, see Table 3 of NYSERDA. August 2022. *Projected Emission Factors for New York State Grid Electricity.* White paper. www.nyserda.ny.gov/-/media/Project/Nyserda/Files/Publications/Energy-Analysis/22-18-Projected-Emission-Factors-for-New-York-Grid-Electricity.pdf.

Protection Agency's (EPA's) Emissions & Generation Resource Integrated Database (eGRID).[4] Emission rates for future years come from the "Mid-case (without tax credit phaseout)" scenario of the National Renewable Energy Laboratory's (NREL's) Cambium 2022 tool (Cambium).[5] Both sources provide rates in units of CO_2e using a 100-year global warming potential time frame. All electricity emission rates are available in comma-separated value (CSV) tables located in the BTO Carbon Metrics download folder[6] (see Figure 1 for folder structure).

Fuel emissions rates are provided both with and without precombustion emissions. Emission rates without precombustion emissions are sourced from the ENERGY STAR portfolio Manager Technical Reference: Greenhouse Gas Emissions,[7] except for gasoline, which is from the Energy Information Administration's (EIA's) Carbon Dioxide Emissions Coefficients by Fuel.[8] Emission rates with precombustion emissions are sourced from the Residential Energy Services Network (RESNET) ERI 301.[9] Electrical emission rates are provided both with transmission and distribution (T+D) losses (accounting for energy produced at the generator) and without T+D losses (only accounting for energy consumed at the load). Emission rates that include T+D losses will be higher than rates that exclude T+D, as shown in Figure 2. To align with existing protocols and platforms such as the World Resources Institute GHG Protocols and ENERGY STAR Portfolio Manager, use the rates without T+D losses.

[4] EPA. "Emissions & Generation Resource Integrated Database (eGRID)." www.epa.gov/egrid.
[5] NREL. Cambium 2022. cambium.nrel.gov/.
[6] BTO Carbon Metrics Download folder: go.lbl.gov/bto_carbon_metrics.
[7] ENERGY STAR. December 2022. *Greenhouse Gas Emissions.* Portfolio Manager® Technical Reference. portfoliomanager.energystar.gov/pdf/reference/Emissions.pdf.
[8] EIA. Carbon Dioxide Emissions Coefficients by Fuel. www.eia.gov/environment/emissions/xls/co2_vol_mass.xls.
[9] RESNET. "Draft PDS-01, BSR/RESNET/ICC 301-2022 Addendum B, CO_2 Index." www.resnet.us/about/standards/resnet-ansi/draft-pds-01-bsr-resnet-icc-301-2022-addendum-b-co2-index/.

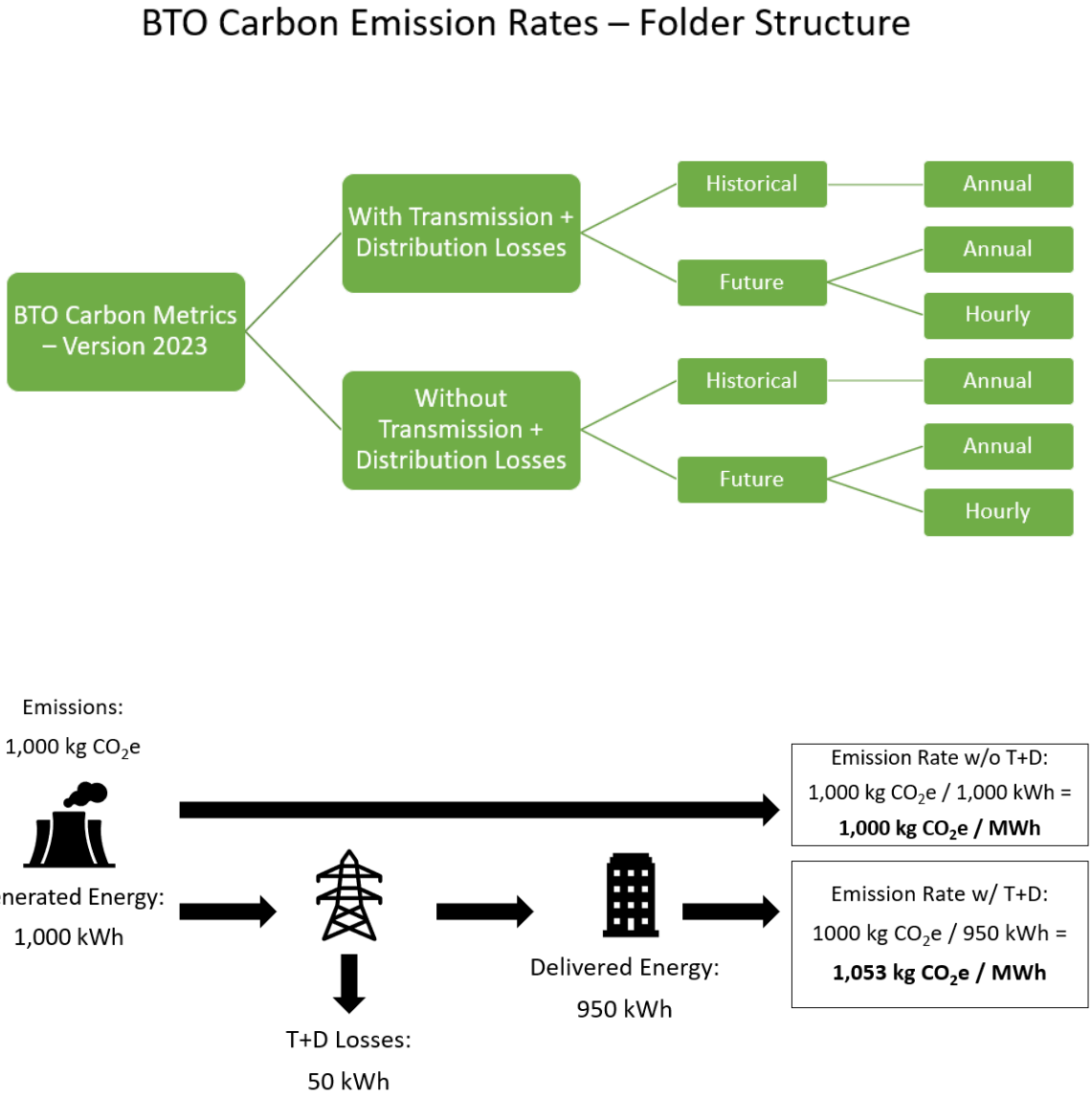

Figure 1. BTO-provided emission rates – folder structure

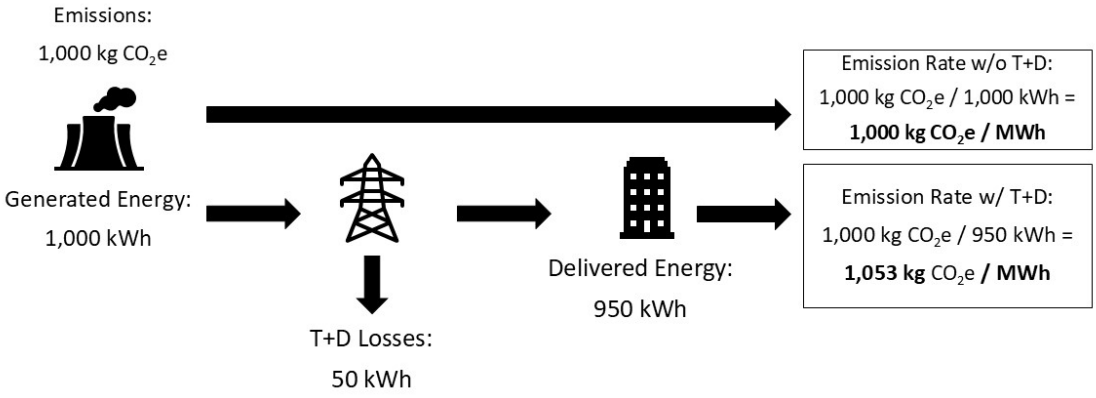

Figure 2. Diagram of example T+D adjustments to emission rates

1.2 Application Guidance

The metrics described in this document are the product of many considerations across varied applications and reflect a balance of accuracy and applicability. According to stakeholders surveyed prior to the development of this guidance, the two most critical use cases are: (1) GHG accounting/benchmarking and (2) measure impact assessments.

BTO recommends that:

(1) **GHG accounting and benchmarking**, that is, estimating the GHG emissions attributable to a set of buildings or an organization, use AER for CO_2e emissions.

(2) **Measure impact assessments**, that is, evaluating the expected GHG impacts of energy efficiency, electrification, and demand flexibility measures, use LRMER.

GHG accounting and benchmarking efforts may be most interested in present-day CO_2e emissions, and thus would use historical AER for a recent historical year. Forward-looking accounting/benchmarking efforts—for example, how the baseline emissions of a set of buildings would be expected to change in the future—would use forecasting AER for a range of modeled future electric grid scenarios. Note that all application guidance and recommended metrics are focused on location-based emissions. Market-based emission calculations/methodologies are considered out of scope of this document.

Measure impact assessments may be forward-looking (prospective) or backward-looking (retrospective). In both cases, they should use emissions rates that are levelized over the measures' expected lifetimes. Forward-looking impact evaluations would use forecasted LRMER for a range of modeled future electric grid scenarios. Retrospective measure impact assessment is a less mature application area and thus, not a major focus for this document.[10] Organizations with GHG inventory goals may choose to evaluate measures solely based on how each measure influences their GHG inventory reporting, and thus may choose to use AER as in (1) above instead of LRMER for measure impact assessments.

This guidance on electricity emissions factors is consistent with recommendations made by key buildings industry stakeholders, such as the New York State Energy Research and Development Authority (NYSERDA)[11] and RESNET.[12] Both AER and LRMER are available as either hourly or annual rates. Use of hourly rates is preferrable, but where hourly data are unavailable for a savings calculation (e.g., weather bin calculations or annualized rule of thumbs savings estimates), annual rates are an acceptable substitute given the lack of granularity in hourly savings.

1.3 Versioning and Alternative Emissions Factors

Note that emissions factors may change in future versions of these sources. In general, a tool should use the latest version of these sources and identify which version is being used. Websites to check for the latest versions of each source are included throughout this document as footnotes.

While the emissions factors specified below should be used as the "default," tools should be designed to easily add the option to use alternative emission factors for states and other jurisdictions. As the need arises, BTO will amend this specification to include such alternative emissions factors. Tools may assume that the emissions factor data will be available as a CSV file with a single value for each year and region.

1.4 Addressing Uncertainty in Future Projected Rates

To address uncertainty in projected emission rates, it may be advisable to use multiple projected scenarios to serve as a range of outcomes for critical calculations. Cambium provides multiple scenarios for reflecting different future conditions. As noted previously,

[10] For long-lived assets such as building technologies, it is likely that a portion of the measure's lifetime occurs in the past and a portion occurs in the future. LRMER are not available for historical periods, so retrospective impact evaluations could use a combination of SRMER for historical years (such as EPA AVERT) and LRMER for future years covering the lifetime of the measure. However, this approach would not account for the measure's structural impact during the historical years. See Gagnon and O'Shaughnessy (2024) for further discussion of the challenges of retrospective consequential emissions analysis (www.nrel.gov/docs/fy25osti/91580.pdf).

[11] NYSERDA. August 2022. *Projected Emission Factors for New York State Grid Electricity*. White paper. www.nyserda.ny.gov/-/media/Project/Nyserda/Files/Publications/Energy-Analysis/22-18-Projected-Emission-Factors-for-New-York-Grid-Electricity.pdf.

[12] RESNET. "Draft PDS-01, BSR/RESNET/ICC 301-2022 Addendum B, CO_2 Index." www.resnet.us/about/standards/resnet-ansi/draft-pds-01-bsr-resnet-icc-301-2022-addendum-b-co2-index/.

Cambium's "Mid-case" is recommended as the default scenario. It is also recommended that the "High Renewable Energy Cost" scenario and the "Mid-case with 100% Decarbonization by 2035" scenario be sued to establish high and low uncertainty bounds on projected emission rates.

1.5 Recommended Electricity Emission Rates by Application

Table 1 and the following guidance help to match the appropriate emission rates to specific applications. Once the appropriate emission rate has been identified, the following sections provide detailed information on the characteristics and sources for each emission rate type.

Table 1. Recommended Type and Source of Electricity Emissions Rate, Depending on the Application and Time Resolution of Available Electricity Use Data

Application Type	Time Frame	Time Resolution	Recommended Type	Recommended Source
GHG Accounting and Benchmarking	Historical	Annual	Average	eGRID
	Future	Annual	Average	Cambium
		Hourly	Average	Cambium
Prospective Measure Impact Assessments[13]	Future	Annual	Long-run marginal	Cambium
		Hourly	Long-run marginal	Cambium

1.5.1 GHG Accounting and Benchmarking, Historical/Present

Examples of standard GHG accounting and benchmarking are:

- Submittals to GHG reporting frameworks (e.g., Carbon Disclosure Project, Task Force for Climate-Related Financial Disclosure, Global Real Estate Sustainability Benchmark)
- Individual building historical carbon footprint development

[13] Retrospective measure impact assessment is a less mature application area, and necessary data are not readily available, so it is not a major focus for this document. For long-lived assets such as building technologies, it is likely that a portion of the measure's lifetime occurs in the past and a portion occurs in the future. LRMER are not available for historical periods, so retrospective impact evalutions could use a combination of SRMER for historical years (such as EPA AVERT) and LRMER for future years covering the lifetime of the measure. However, this approach would not account for the measure's structural impact during the historical years. See Gagnon and O'Shaughnessy (2024) for further discussion of the challenges of retrospective consequential emissions analysis. Organizations with GHG inventory goals may choose to evaluate measures solely based on how each measure influences their GHG inventory reporting, and thus may choose to instead use average emissions rates.

- Portfolio historical carbon footprint development.

Historical Annual Average CO_2e emission rates should be used for these applications*.

1.5.2 GHG Accounting and Benchmarking, Forward-Looking Projections – Only Annual Data Available

Examples of standard GHG building stock projections are:

- Reporting to future target-based programs/frameworks (Science Based Targets Initiative, Carbon Risk Real Estate Monitor)
- Developing baseline scenarios for future carbon reduction plans and management strategies
- Understanding how the emissions footprint of a home, building, portfolio, city, etc., is expected to change in the future.

Future Annual Average CO_2e emission rates should be used for these applications.*

1.5.3 GHG Accounting and Benchmarking, Forward-Looking Projections – Hourly Data Available

Examples of time-of-use (TOU) dependent GHG building stock projections are:

- Advanced reporting + projections of existing building portfolios, existing microgrids, existing energy storage installations, etc., for which baseline hourly data are comprehensively available.

Future Hourly Average CO_2e emission rates should be used for these applications*.

**Because of the specifics of how power plants are modeled and assigned to different grid regions in Cambium versus eGRID, there are sometimes large discrepancies between near-term AERs from Cambium and historical eGRID values. Caution is advised when using AERs from the Cambium 2022 dataset for years prior to 2030 (2024, 2026, and 2028) in concert with historical eGRID values. Future releases of Cambium data may help to address some of these discrepancies by including historical AERs derived from eGRID data but using Cambium regions.*

1.5.4 Measure Impact Calculations – Only Annual Data Available

Examples of Standard Measure Impact Assessments are:

- Energy efficiency upgrades to existing buildings or new building designs
- Building electrification
- Electric vehicles.

Future Annual Long-Run Marginal CO_2e emission rates should be used for these applications.

1.5.5 Measure Impact Calculations – Hourly Data Available

Examples of Right-of-Use Dependent Measure Impact Calculations are:

- Energy efficiency upgrades to existing buildings or new building designs
- Building electrification
- Electric vehicles
- Demand response or load shifting.

Future Hourly Long-Run Marginal CO_2e emission rates should be used for these applications.

2 Historical Annual Average Electricity CO_2e Emission Rates

2.1 Description

This metric is a measure of the total CO_2e for a facility over the course of one year or multiple years. It is calculated using AER for delivered electricity.

2.2 Purpose

This metric is primarily intended for use cases involving total building emissions (e.g., benchmarking, GHG accounting) or lower time resolution data.

2.3 Emission Rates

AER for historical years were obtained from eGRID. We used the "eGRID subregion annual CO_2 equivalent total output emission rate (lb/MWh)" from the subregion tab. A table of emission rates for all subregions and years can be obtained by downloading the *historical_annual_co2e.csv* file from the BTO Carbon Metrics download folder. Use the emission rate (in kg/MWh) corresponding to the desired eGRID subregion and year. Data from eGRID is available for the following historical years: 2007, 2009, 2010, 2012, 2014, 2016, 2018, 2019, 2020, and 2021. If the desired year is not available, use the later year (e.g., for 2015, use 2016). The desired eGRID subregion can be determined using one of three methods:

1. Use the eGRID subregion map (see Figure 3).

2. Look up the subregion with a zip code using the eGRID Power Profiler.[14]
3. Use the zip-subregion mapping in the Power Profile Zip Code spreadsheet.[15]

Methods 2 and 3 can return more than one subregion. In this case, the emission factor should be calculated as the average of the returned subregions. The one exception is if you know the utility provider, in which case you can use the Power Profiler web page (method 2) to select the subregion corresponding to the utility provider.

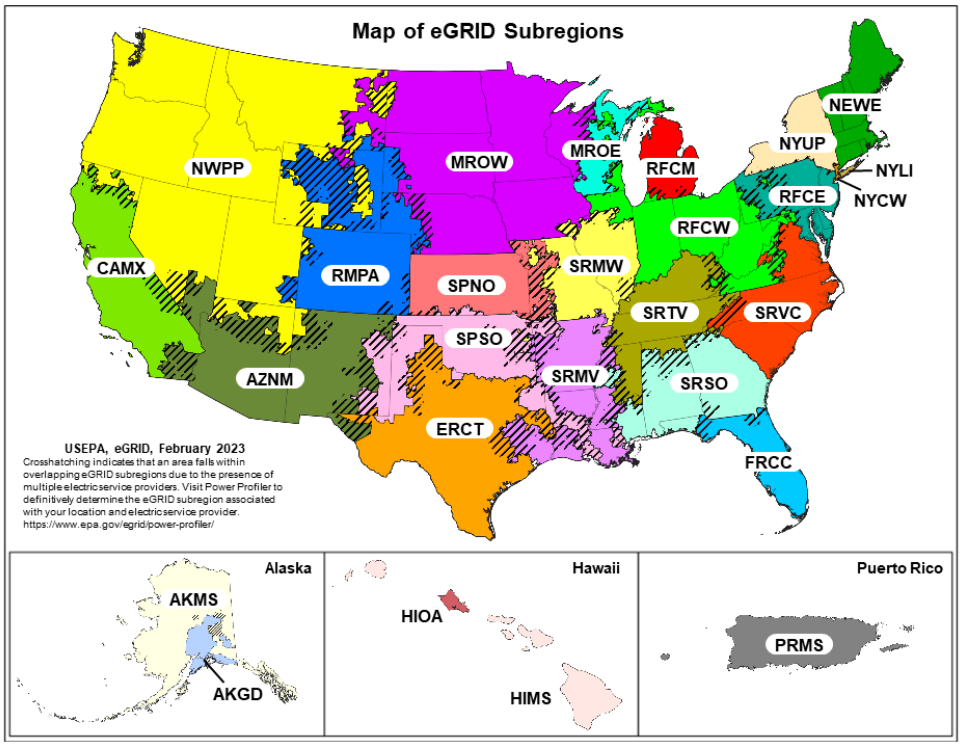

Figure 3. Map of eGRID subregions (source: EPA eGRID Maps)

3 Future Annual Average Electricity CO_2e Emission Rates

3.1 Description

This metric is a measure of the total CO_2e for a facility over the course of one year or multiple years. It is calculated using AER for delivered electricity.

[14] EPA. "Power Profiler: Fuel Mix." www.epa.gov/egrid/power-profiler#/.
[15] EPA. September 2021. Power Profiler ZIP Code Tool with eGRID 2019 Data. Version 10.0. www.epa.gov/sites/production/files/2020-11/power_profiler_zipcode_tool.xlsx.

3.2 Purpose

This metric is primarily intended for use cases involving total building emissions (e.g., benchmarking, GHG accounting) or lower time resolution data.

3.3 Emission Rates

Annual AER for future years are based on Cambium's average emission rate of generation induced by a region's load (aer_load_co2e). A table of emission rates for all regions and future years can be obtained by downloading the *future_annual_average_co2e.csv* file from the BTO Carbon Metrics download folder. Use the emission rate (in kg/MWh) corresponding to the desired Cambium Generation and Emission Assessment region (GEA) and years. Data from Cambium GEAs are similar to the eGRID subregions but are not identical (see Figure 4). First, identify the eGRID subregion using one of the methods in section 2. Then use the corresponding Cambium GEA. Except for the three New York subregions (NYCW, NYLI, NYUP), in which case the NYSTc GEA.

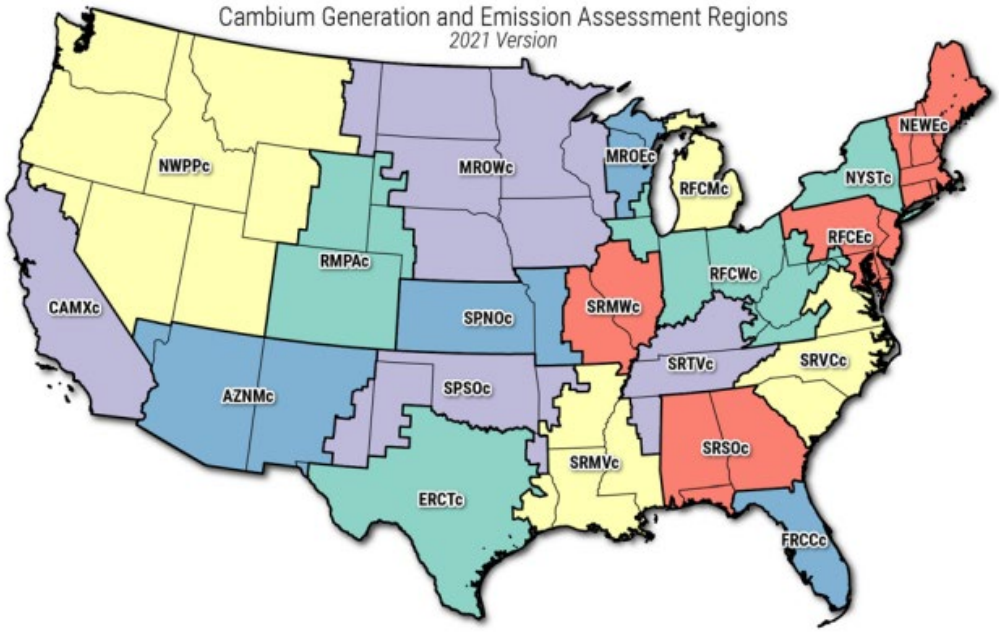

Figure 4. Map of Cambium Generation and Emission Assessment regions (source: Ganon et al. December 2021. Cambium Documentation: Version 2021. NREL.)

4 Future Annual Long-Run Marginal Electricity CO_2e Emission Rates

4.1 Description

This metric is a measure of the total long-run marginal CO_2e for a facility over the course of one year or multiple years. It is calculated using LRMER for delivered electricity.

4.2 Purpose

This metric is primarily intended for use cases involving detailed savings calculations for "baseload" affecting measures or standard savings calculations for measure impacts involving small/medium seasonal loads (e.g., heating, ventilation, and air conditioning [HVAC]).

4.3 Emission Rates

Annual LRMER for future years are based on Cambium's LRMER for a region's load (lrmer_co2e). A table of emission rates for all regions and future years can be obtained by downloading the *future_annual_marginal_co2e.csv* file from the BTO Carbon Metrics download folder. Use the emission rate (in kg/MWh) corresponding to the desired Cambium GEA and years. Data from Cambium are available for every two years from 2024 to 2030 and every five years from 2030 to 2050. The Cambium GEAs are similar to the eGRID subregions but are not identical. First, identify the eGRID subregion using one of the methods in the Historical Annual Average CO_2e Emission Rates section. Then use the corresponding Cambium GEA, except for the three New York subregions (NYCW, NYLI, NYUP), in which case use the NYSTc GEA.

5 Future Hourly Average Electricity CO_2e Emission Rates

5.1 Description

This metric is a measure of the hourly CO_2e for a facility over the course of one year. It is calculated using hourly AER for delivered electricity.

5.2 Purpose

This metric is primarily intended for use cases involving TOU-dependent advanced reporting + projections of existing building portfolios, microgrids, and energy storage projects for which baseline hourly data are comprehensively available.

5.3 Emission Rates

Hourly AER for future years are based on Cambium's average emission rate of generation induced by a region's load (aer_load_co2e). Tables of hourly emission rates by region and year can be obtained by downloading the *future_hourly_average_co2e_YYYY.csv* file (where YYYY is the desired year) from the BTO Carbon Metrics download folder. Use the emission rate column (in kg/MWh) corresponding to the desired Cambium GEA. Data from Cambium are available for every two years from 2024 to 2030 and every five years from 2030 to 2050. The Cambium GEAs are similar to the eGRID subregions but are not identical. First, identify the eGRID subregion using one of the methods in the Historical Annual Average CO_2e Emission Rates section. Then use the corresponding Cambium GEA, except for the three New York subregions (NYCW, NYLI, NYUP), in which case use the NYSTc GEA.

6 Future Hourly Long-Run Marginal Electricity CO_2e Emission Rates

6.1 Description

This metric is a measure of the hourly long-run marginal CO_2e for a facility over the course of one year. It is calculated using LRMER for delivered electricity.

6.2 Purpose

This metric is primarily intended for savings calculations for large retrofit projects with seasonal loads and/or load shifting components (e.g., whole-building electrification projects, thermal energy storage installations, large HVAC system upgrades).

6.3 Emission Rates

Hourly LRMER for future years are based on Cambium's LRMER for a region's load (lrmer_co2e). Tables of hourly emission rates by region and year can be obtained by downloading the *future_hourly_marginal_co2e_YYYY.csv* file (where YYYY is the desired year) from the BTO Carbon Metrics download folder. Use the emission rate column (in kg/MWh) corresponding to the desired Cambium GEA. Data from the Cambium are available for every two years from 2024 to 2030 and every five years from 2030 to 2050. The Cambium GEAs are similar to the eGRID subregions but are not identical. First, identify the eGRID subregion using one of the methods in the Historical Annual Average CO_2e Emission Rates section. Then use the corresponding Cambium GEA, except for the three New York subregions (NYCW, NYLI, NYUP), in which case use the NYSTc GEA.

7 Fuel and District Utility Emission Rates

7.1 Fuels

Table 2 shows the emissions rates for various fuels. Fuel emission rates are assumed not to vary by either location or time. Two rates are provided:

- CO_2e emissions, combustion (kg/million Btu): These rates, sourced from ENERGY STAR's technical reference, represent all CO_2e emissions associated with the direct combustion of each fuel type.
- CO_2e emissions, combustion, and precombustion (kg/million Btu): These rates, sourced from BSR/RESNET/ICC 301-2022, represent all CO_2e emissions associated with direct combustion, in addition to precombustion emissions. Precombustion emissions represent emissions associated with all activities to obtain, transport, and serve those fuels to end users.

Most benchmarking and GHG reporting frameworks do not currently call for precombustion emissions accounting. Moving forward, however, the precombustion emissions are anticipated to become a more relevant component of GHG accounting processes and associated analysis, as they represent a more holistic view on generated emissions. Therefore, **it is recommended that combustion-only emission rates be used for historical reporting to align with existing platforms and frameworks, and combustion + precombustion emissions be utilized for future-looking analyses.**

Table 2. CO_2e Emissions Factors for Fuels Burned on Site

Fuel Type	CO_2e Emissions, Combustion (kg/million Btu)[a]	CO_2e Emissions, Combustion and Precombustion (kg/million Btu)[b]
Natural Gas	53.11	66.81
Propane	64.25	80.65
Fuel Oil (No. 1)	73.50	N/A
Fuel Oil (No. 2)	74.21	88.86
Fuel Oil (No. 4)	75.29	N/A
Fuel Oil (No. 5,6)	75.35	N/A
Diesel Oil	74.21	N/A
Kerosene	77.69	N/A
Gasoline	71.30	N/A
Coal (anthracite)	104.44	N/A
Coal (bituminous)	94.03	N/A

Fuel Type	CO_2e Emissions, Combustion (kg/million Btu)[a]	CO_2e Emissions, Combustion and Precombustion (kg/million Btu)[b]
Coke	114.42	N/A
Wood	95.05	N/A

[a] Source: ENERGY STAR Technical Reference Greenhouse Gas Emissions—except for gasoline, which is from EIA Carbon Dioxide Emissions Coefficients by Fuel.

[b] Source: RESNET. ERI 301.

7.2 District Utilities

Table 3 shows the factors to be used for district utilities. District utility emission factors are assumed not to vary by either location or time so there is only one rate for each district utility.

Table 3. Indirect CO_2e Emissions Factors for District Fuels

Fuel Type	CO2e Emissions (kg/million Btu)
District steam	66.40
District hot water	66.40
District chilled water – electric-driven chiller	52.70
District chilled water – absorption chiller using natural gas	73.89
District chilled water – engine-driven chiller using natural gas	49.31

Source: ENERGY STAR Technical Reference. Greenhouse Gas Emissions.

8 Calculations

Annual emissions is the sum of emissions from grid electricity, fuels burned on site, and district utilities:

$$C_{TOT} = \Sigma E_i \times Cf_i$$

Where

E_i is the annual energy use of each delivered energy *i*

Cf_i is the annual emission factor for each delivered energy *i*

For hourly emissions the emission factors for electricity vary with time, so the calculation is different than for fuels:

$$C_{TOT} = \Sigma C_f + C_e$$

Electrical emissions:

$$C_e = \sum_{1}^{8760} \Delta E_h \times Cf_h$$

Where

ΔE_h is the hourly electrical energy change at hour *h*

Cf_h is the hourly electrical emission factor at hour *h*

Fuel emissions:

$$Cf = \Delta E_f \times Cf_f$$

Where

ΔE_f is the annual energy change of each delivered fuel *f*

Cf_f is the annual emission factor for each delivered fuel *f*

If a 12-month period straddles two calendar years, use a weighted average value for the two years, weighted by the number of days in each calendar year. An alternative is to use hourly or monthly data, with relevant emission factors for the time period.

9 Reporting

Use the full name, short name, and units as indicated above when reporting the emissions for a site.

If using emission factors for an alternative jurisdiction, it should clearly state that, as follows:

e.g., total CO_2e using annual average emission factors for <jurisdiction>

Notes:

- The site boundary may be defined in any form based on the purpose and scope of the analysis—a building, part of a building, or multiple buildings. The same site boundary must be used for all fuels.
- On-site versus off-site green power: Follow the protocol as specified in the Portfolio Manager technical reference.
- These metrics do not account for energy consumed for on-site vehicle use, industrial or manufacturing processes, or fugitive refrigerant emissions from refrigeration or air conditioning equipment.

For more information, visit: energy.gov/eere

DOE/EE-2966 • January 2025

U.S. Department of ENERGY | Office of Energy Efficiency & Renewable Energy