**Draft PDS-03 New Standard:**

**RESNET/ICC 1580: CO2e Emissions Based on Metered Data, for Operational Ratings**

**Foreword:**

This new standard provides a method and the data to calculate operational CO2e emissions based on metered energy consumption, rather than simulated energy consumption l (which is addressed in ANSI/RESNET/ICC 301). This standard is appropriate for measuring emissions for users or end uses that are strongly dependent on improvements in operations and maintenance, and cases in which emissions may vary substantially from year to year due to changes in operation.

Strategic Energy Management programs in North America tend to be based directly or indirectly on ISO 50001, and the ISO standard development process is considering management of Greenhouse Gas (GHG) emissions as well as energy consumption.

Energy used at a facility is generated from a specific generation facility at a given time, whether that be imported from the grid, from a different supplier of energy, or produced on-site. CO2e emissions are generated by measurements and calculations that count all sources of energy, including on-site generation and metered energy. A facility complying with emissions reduction mandates can use this standard to quantify their emissions from metered energy and on-site generation. (Note that procured renewables will be emission-free.).

But there is a gap: there is an absence of standards on how to calculate GHG emissions based on metered data.

This standard is intended to fill the gap and allow calculation of carbon emissions that balances 1) the desire to be able to compare performance in a given year with that of previous years with 2) the desire to have up to date emissions data that do not assume that the metered results will be stable over decades.

This Standard is very similar in structure and philosophy to ANSI/RESNET/ICC 301, in that it relies on long-run marginal emissions rates from the same data source and using the same methodology, but it differs by selecting a different time period over which to levelize the data. See note below.

ANSI/RESNET/ICC 301 Addendum B addresses how to calculate CO2e emissions based on simulations that are used for asset ratings, such as the HERS Index/ERI. Asset ratings are designed to be stable over time: they normalize over changes in operations. This normalization is achieved by assuming standardized and unchanging operations--in order to to *measure efficiency*. Thus ANSI/RESNET/ICC 301 is based on levelized future emissions--specifically projections for the years 2025-2050--using simulated hourly energy consumption by fuel type as input.

The long look-ahead period was chosen because the house is an efficiency asset that will last to 2050 and beyond, and it matters therefore what the grid will look like then.

The ANSI/RESNET/ICC 301 method is not as appropriate, however, for operational ratings or other carbon emission calculations that are based on meter readings that are expected to change from year to year, perhaps in a known direction (e.g., continuing reductions) rather than projected constant energy consumption. For such uses, which are common in the industrial sector where most organizations do not have the ability to employ simulation models, energy management is based on metered results.

Thus ANSI/RESNET/ICC 301’s look-ahead to the year 2050 is inappropriate to typical users, and this standard must find a more appropriate, shorter look-ahead period. Too long a choice would assume incorrectly that metered results will be predictive of future results over decades. But too short a period would make the emissions calculations unstable over time, making it harder to compare emission performance in, say, 2025, with performance in 2024 or 2023. It would also reduce the accuracy of the underlying Cambium database, which was designed to focus on longer-term changes in the grid. However, this source of error is minimized by the selection of the Cambium mid-range case of 2023, which includes assumptions about Inflation Reduction Act incentives and current problems with transmission capacity that may delay the utilization of new renewable resources.

The question of how long a period of time to consider is answered here by looking at evaluations of Strategic Energy Management programs run by utilities. The savings obtained from this program are mostly O&M improvements. Evaluation of such programs shows a persistence period of 8 years. Thus the grid characteristics are considered here over an 8 year forward-looking period. The 8 year period is also long enough that the errors in relying on Cambium are reduced. This effect is enhanced by the observation that the 8 year persistence lifetime is calculated conservatively—in other words, that it may be longer.

This standard is written to support possible future RESNET or government standards on embodied carbon, and more generally is applicable for a building using operational ratings, such as EnergyStar Portfolio Manager, or for an industrial facility that uses an Energy Management System. It can also be used for an organization that is responsible for many different plants or buildings, or whose energy consumption is distributed over many locations such as a railroad or an airline, by applying it separately to each location.

This standard is based on the best evidence RESNET could find on how incremental changes in electricity consumption, as reflected in hourly bills, affect the grid over the next 8 years. These calculations, from Cambium, are less reliable than the 25-year projections in ANSI/RESNET/ICC 301. But they are based on the best choice we could make for 2024. Therefore, we anticipate that the values of the hourly emission factors may be changed through the continuous maintenance process of RESNET standards over the next 5 years if more reliable data are identified.

NOTE: there is a potential confusion over the use of the words “long-run” in the explanatory material for this standard and for ANSI/RESNET/ICC 301. In both standards, the term is used in the economics context, meaning that it evaluates the effect of incremental reductions or increase in electricity generation’s emissions by looking at induced changes in the capital stock of generating equipment, as well as considering the effect on the dispatch of resources. Thus, for example, an additional kWh at 11 am in summer will trigger the construction of new solar or wind resources and could also cause a solar resource that is already built but is being curtailed to instead be dispatched. Both of these effects are included in the Cambium data on which both RESNET standards rely. There are also considerations of how long the capital upgrades in the grid take to be implemented, which is another source of potential inaccuracy in an 8-year calculation. But this is mitigated by the fact that a wind turbine or solar farm has a much longer life than 8 years, even if the change in electricity demand that triggered it does not.

Thus, long-run implies that the accounting is consequential (considering feedback that impacts the entire system) rather than attributional (considering only the past data).

The term long-run can also refer to the use of emission factors that are averaged over long periods of time in the future. In this case, this Standard and ANSI/RESNET/ICC 301 take different approaches because they use different methods (simulated results versus metered results).

**1. Purpose:**

The provisions of this standard provide requirements on how to estimate CO2e, emissions from measured data on electricity and fuel consumption of a facility or organization. It is intended for the purposes of complying with standards on disclosure of emissions and of reducing emissions year after year using an Energy Management System such as that required by ISO 50001 and used in many utility-sponsored Strategic Energy Management programs. And it can be used in conjunction with Building Performance Standards that are in effect in many cities, as well as with Energy Star Portfolio Manager.

**2. Scope:**

This standard applies toany facility of any type that consumes electricity or other fuels. It supports emissions calculations that can be used in conjunction with calculations of the embodied emissions impacts of materials used in constructing residential buildings. It also supports compliance with the recommendations of ISO 50010, and with ISO 50001, which has been widely used for industrial facilities.

**3. Definitions:**

***Carbon emission*~~:~~** – Emission of carbon dioxide and other greenhouse gases, based on equivalent warming effect to CO2.[[1]](#footnote-1)

~~NOTE: Energy policy discussions, particularly those focused on net zero energy or carbon, almost always use the word “carbon” as a shorthand for “greenhouse gas”.~~

***On-Site Power Production (OPP)*** – Electric power produced on the site of a facility. OPP shall be the net electrical power production, such that it equals the gross electrical power production minus any purchased fossil fuel energy used to produce the on-site power, converted to equivalent electric energy use at a 40% conversion efficiency.

*Real Social Discount Rate (SDR****)*** – Rate at which CO2e emission rates are discounted over time. The SDR does not include the time value of money that is included in nominal discount rates used in financial assessments, which include the general inflation rate such that the nominal rate equals (1 + real rate) times (1 + inflation rate) – 1.

***Renewable Energy*~~:~~**– Energy that relies on naturally-occurring resources that are not depleted as a result of their use, and that satisfies the requirements of Section 4.3

**4. Methods:**

**~~[Normative Text:]~~**

**4.1. Emissions**. The emissions for the facility or organization shall be calculated in accordance with Sections 4.1.1 and 4.1.2.

**~~4.1.1. Emissions~~**~~. Emissions for all facilities or organizations shall be calculated in accordance with Sections 4.1.1.1 and 4.1.1.2.~~

**4.1.1.~~1.~~** For electricity use, metered consumption data shall be collected on an hourly or shorter (e.g., 15-minute) basis. Data for the sub-region annual total output emission rates published by Environmental Protection Agency’s 2020 eGRID database[[2]](#footnote-2) for electricity generation shall be used to calculate emissions[[3]](#footnote-3) except CO2e emissions, which shall be calculated using the provisions of Section 4.2 to calculate the annual hourly CO2e emissions.

**4.1.2.~~1.1.~~** For imported renewable electricity or on-site generated renewables, power shall be metered, calculated or simulated on an hourly or shorter basis.

**4.1.1.1~~.2~~**For on-site battery storage systems, the provisions of ANSI/RESNET/ICC 301 shall apply.

**4.1.3.~~1.2.~~** For fossil fuel use, consumption of each fuel shall be derived from metered consumption or invoiced fuel deliveries on an annual basis, and emissions shall be calculated using the annual average emission factors given in Table 4.1.1(1).

**Table ~~4~~.1.3~~1~~(1) Emission Factors for ~~Household~~ Combustion Fuels[[4]](#footnote-4)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Fuel Type** | **Units** | **MBtu per Unit** | **CO2e lb/MBtu** | **NOx lb/MBtu** | **SO2 lb/MBtu** |
| Natural Gas | Therm | 0.1000 | 147.3 | 0.0922 | 0.0006 |
| ~~Fuel Oil #2~~ | ~~Gallon~~ | ~~0.1385~~ | ~~195.9~~ | ~~0.1300~~ | ~~0.0015~~ |
| Liquid Petroleum Gas (LPG) | Gallon | 0.0915 | 177.8 | 0.1421 | 0.0002 |
| Residual Fuel Oil | Gallon | 0.150 | 202.5 | 0.3667 | 0.0012 |
| Distillate Fuel Oil | Gallon | 0.140 | 196.0 | 0.1429 | 0.0013 |
| Coal | ton | 24.6 | 227.8 | 0.1220 | 0.1427 |
| Gasoline | MBtu | 1 | 201.7 | 1.6300 | 0.0840 |
| **~~Fuel Type~~** | **~~Units~~** | **~~MBtu per Unit~~** | **~~CO~~~~2~~~~e lb/MBtu~~** | **~~NOx lb/MBtu~~** | **~~SO~~~~2~~ ~~lb/MBtu~~** |
| ~~Natural Gas~~ | ~~Therm~~ | ~~0.1000~~ | ~~147.3~~ | ~~0.0922~~ | ~~0.0006~~ |
| ~~Fuel Oil #2~~ | ~~Gallon~~ | ~~0.1385~~ | ~~195.9~~ | ~~0.1300~~ | ~~0.0015~~ |
| ~~Liquid Petroleum Gas (LPG)~~ | ~~Gallon~~ | ~~0.0915~~ | ~~177.8~~ | ~~0.1421~~ | ~~0.0002~~ |

**~~Table 4.1.1 (2) Emission factors for commercial and industrial facilities~~**

**4.~~1.~~2. Emission Savings**. Estimated emission savings for the facility or organization shall be calculated in accordance with Sections 4.1.2.1. through 4.1.2.3.

**4.~~1.~~2.1.** The baseline shall be based on normalized metered energy consumption from the previous year(s) by applying the emission factors determined in accordance with Section 4.1.1 to its Purchased Energy.

NOTE: see ISO 50001 and 50004 for guidance on how to normalize energy data and how to construct an energy baseline. Normalization is intended to make the data for different years mutually comparable, by netting out the effect of changes in production and possibly of weather for an industrial facility, and netting out the effects of changes in occupancy and weather for a building.

**4.~~1.~~2.2.** The normalized emissions of the facility or organization shall be determined by fuel type by applying the emission factors determined in accordance with Section 4.1.1 to the normalized energy use of the facility or organization. When renewable energy is employed, the emissions in each hour shall be the electricity consumption in that hour less the renewable energy production in that hour. Renewable energy production may be summed over many sources, both on-site and off-site.[[5]](#footnote-5)

**~~NOTE:~~** ~~for some hours this may be a negative number.~~

**4.~~1.~~2.3.** Renewable energy shall be credited according to the equations and restrictions in ASHRAE 90.2-2024.

**4.~~1.~~2~~.3~~.4** Estimated emission savings with respect to the facility or organization shall be the difference between the emissions of the baseline and the normalized emissions of the facility or organization, based on metered energy consumption by hour.

**4.2 Emissions Factors.** The CO2e emission factors for electricity use shall be the levelized CO2e combined combustion and pre-combustion, end-use emission rates having 100-year IPCC 6th Assessment Report Global Warming Potential as calculated using the 2023 Cambium database[[6]](#footnote-6),[[7]](#footnote-7) for the Mid-case Scenario for the Long-Run Marginal month-hour CO2e emission rates (lrmer\_co2e) for the applicable Cambium Grid and Emission Assessment (GEA) region in accordance with the local ZIP Code using equation 4-2 with a starting year of 2024 and an ending year of 2031.[[8]](#footnote-8),[[9]](#footnote-9),[[10]](#footnote-10)

**(Equation ~~4~~-2)**

where:

*LRMERt* = long-run marginal emission rate for year *t*

*d* = real social discount rate = 0.03

*n* = evaluation period in years = 8

**~~4.3~~***~~Real Social Discount Rate (SDR~~****~~)~~*** ~~– Rate at which CO~~~~2~~~~e emission rates are discounted over time. The SDR does not include the time value of money that is included in nominal discount rates used in financial assessments, which include the general inflation rate such that the nominal rate equals (1 + real rate) times (1 + inflation rate) – 1.~~

**4.~~4.~~3** Renewable Energy. Renewable energy shall be limited to sources that are not counted toward a renewable energy portfolio or toward a renewables acquisition goal of another organization, and comes from any combination of photovoltaic, geothermal energy (not including ground source heat pumps), or wind systems. Renewable Energy shall not include renewable Energy Credits (RECs) for which the time of production and the grid into which they are supplied is not known. RECs associated with on-site and off-site renewable energy production used for estimating CO2e emissions shall be retained and retired on behalf of the project.[[11]](#footnote-11)

~~Notes on Renewable Energy:~~

~~Note 1: Geothermal energy that releases high levels of SO2 gases to the atmosphere does not qualify under this requirement.~~

~~Note 2: Wood pellet or solid wood combustion does not qualify if the GHG emissions associated with producing the wood-derived fuels are not at least 90% lower than those from gas-fired generation.~~

~~Note 3: For additional information on Renewable Energy Credits (RECs), see:~~

~~[EPA Overview of Renewable Energy Certificates](https://www.epa.gov/green-power-markets/renewable-energy-certificates-recs" \t "_blank)~~

~~[National Renewable Energy Laboratory (NREL) REC Resources](https://www.nrel.gov/docs/fy15osti/64558.pdf" \t "_blank)~~

5. Normative References**:**

ANSI/RESNET/ICC ~~301-2022~~ 301-2025 “Standard for the Calculation and Labeling of the Energy Performance of Dwelling and Sleeping Units using an Energy Rating Index” and ANSI approved Addenda. Residential Energy Services Network. Oceanside, CA.

ASHRAE 90.2-2024, “Energy-Efficient Design of Low-Rise Residential Buildings”, American Society of Heating Refrigerating and Air Conditioning Engineers, Atlanta, GA.

1. (Informative Note): Energy policy discussions, particularly those focused on net zero energy or carbon, almost always use the word “carbon” as a shorthand for “greenhouse gas”. [↑](#footnote-ref-1)
2. (Informative Reference) http://www.epa.gov/cleanenergy/energy-resources/egrid/index.html [↑](#footnote-ref-2)
3. (Informative Note) RESNET will compile and publish annual total output emission rate data for NOx, SO2 and CO2e in accordance with the provisions of this section that can be used by Approved Software Rating Tools for the calculation of emissions. [↑](#footnote-ref-3)
4. (Informative Note) Developed from ASHRAE Standard 189.1-2020, Addendum m, Appendix J, Table J-6 using combined pre-combustion and combustion values for 100-year GWP time horizon. [↑](#footnote-ref-4)
5. Informative Note: for some hours this may be a negative number. [↑](#footnote-ref-5)
6. (Normative Note) <https://cambium.nrel.gov/> [↑](#footnote-ref-6)
7. (Normative Note) Gagnon, Pieter; Frazier, Will; Hale, Elaine, Cole, Wesley (2022): Long-run Marginal Emission Rates for Electricity - Workbooks for 2021 Cambium Data. National Renewable Energy Laboratory, Golden, CO. <https://data.nrel.gov/submissions/183> [↑](#footnote-ref-7)
8. (Informative note) National Renewable Energy Laboratory (NREL) provides a spreadsheet tool for the calculation of levelized CO2e emission rates that can be accessed at https://data.nrel.gov/submissions/183. [↑](#footnote-ref-8)
9. (Informative Note) RESNET provides a spreadsheet of the hourly emission factors and ZIP code mappings that meet these criteria that can be accessed at <https://www.resnet.us/wp-content/uploads/RESNET_2021_CO2e_GEAdata.xlsx>. [*To be developed*] [↑](#footnote-ref-9)
10. (Informative Note) These Cambium CO2e emission data are provided in units of kg/MWh. [↑](#footnote-ref-10)
11. (Informative Note):

    1. Geothermal energy that releases high levels of SO2 gases to the atmosphere does not qualify under this requirement.
    2. Wood pellet or solid wood combustion does not qualify if the GHG emissions and other air pollutants and associated with producing and combusting the wood-derived fuels are not at least 90% lower than those from gas-fired generation.
    3. For additional information on Renewable Energy Credits (RECs), see:
       1. [EPA Overview of Renewable Energy Certificates](https://www.epa.gov/green-power-markets/renewable-energy-certificates-recs" \t "_blank)
       2. National Renewable Energy Laboratory (NREL) REC Resources

    [↑](#footnote-ref-11)