**TRN Resource: Emissions Factors**

In this action TRN users evaluate the emissions impact of each resilience solution to help prioritize resilience solutions according to risk reduction potential, emissions impact, and other user-defined prioritization criteria.

This action’s approach is to evaluate each solution’s emissions changes associated with 1) changes in energy used, and 2) changes in the sources of electricity supply. This resource provides background on the emissions factors used to evaluate the impact of each solution. Emissions factors are used to estimate emissions associated with energy usage. Emissions factors for this action are quantified in terms of pounds of carbon dioxide (CO2) per megawatt-hour (MWh) for electricity and pounds of CO2 per million British thermal units (MMBtu) for natural gas.

**Average and Marginal Emissions Factors**

While the CO2 emissions factor associated with natural gas usage is constant (116.65 lbs/MMBtu), emissions factors associated with electricity usage vary with the mix of generation resources supplying the electricity, and thus vary across the United States.[[1]](#footnote-2) The U.S. Environmental Protection Agency (EPA) provides estimates of emissions factors for different parts of the country, known as subregions. Each subregion is defined such that, for the most part, the electricity produced within that region is also used within that region. The TRN uses emissions factors from the EPA’s [Emissions & Generation Resource Integrated Database](https://www.epa.gov/egrid) (eGRID).

In general, there are two types of emissions factors:

* *Average emissions factors* reflect the overall generation mix of the grid
* *Marginal emissions factors* reflect the marginal plant, or the one that is used to address incremental changes in electricity needs (e.g., this is the plant that would ramp up or down if electricity demand increased or decreased, respectively).

Marginal emissions factors are appropriate for evaluating the impact on emissions from adding or reducing grid loads. Average factors are used to assess the current emissions associated with electricity usage at the site.

The EPA sometimes refers to average factors as “total output” factors, and marginal factors as “non-baseload” factors. The TRN allows users to directly import the eGRID average and marginal CO2 emissions factors for their site based on the zip code provided for their framework. For sites with zip codes that fall in a zone covered by more than one subregion, the relevant emissions factors can be determined simply by selecting the utility that serves the site. Users can manually overwrite these values if they know of more granular or alternative emissions factors that they would prefer to use for evaluation of resilience solutions. For example, if the electricity used at the site includes significant on-site generation that has a higher or lower emissions factor than electricity from the grid, this would be a good reason to overwrite the auto-populated emissions factors.

**Technology-Specific Emissions Factors**

For sites that currently have or are developing solutions that would allow them to use a significant amount of electricity from on-site generation, the EPA eGRID emissions factors discussed above may not be representative of the emissions associated with electricity use at the site. Below is a table of emissions factors associated with different electricity generation technologies. These can be used to inform either the emissions factors describing the current site electricity usage if the onsite generation technology is currently in place or can be used to inform the emissions factor associated with a solution that shifts electricity to a new source.

Note that the emissions factors in the table below reflect ongoing emissions from generation only (e.g., emissions per MWh generated). For some technologies, a significant fraction of their life-cycle emissions are associated with either upstream or downstream emissions such as production or disposal of the necessary equipment. These upstream and downstream emissions are generally quantified as emissions per MW capacity for the equipment and are not included in the table below.

|  |  |  |
| --- | --- | --- |
| Technology | C02 (lbs/MWh) | Source |
| Coal | 2,297a  [2,146–2,448] | Based on PNNL analysis of 2020 eGRID power plant data |
| Diesel Generator | 1,538.79b | Compilation of Air Pollutant Emissions Factors (AP-42) (EPA)[[2]](#footnote-3) |
| Energy Storage | Variesc | eGrid Technical Guide with Year 2020 Data, Section 3.1[[3]](#footnote-4) |
| Fuel Cell | 0 | eGrid Technical Guide with Year 2020 Data, Section 3.1 |
| Geothermal | 154a  [0–154] | Based on PNNL analysis of 2020 eGRID power plant data |
| Hydro | 0 | eGrid Technical Guide with Year 2020 Data, Section 3.1 |
| Hydrogen | 0 | eGrid Technical Guide with Year 2020 Data, Section 3.1 |
| Natural Gas | 1,009a  [814–1,321] | Based on PNNL analysis of 2020 eGRID power plant data |
| Nuclear | 0 | eGrid Technical Guide with Year 2020 Data, Section 3.1 |
| Oil | 1,815a  [1,594–2,671] | Based on PNNL analysis of 2020 eGRID power plant data |
| Purchased Steam | 0 | eGrid Technical Guide with Year 2020 Data, Section 3.1 |
| Solar | 0 | eGrid Technical Guide with Year 2020 Data, Section 3.1 |
| Waste Heat | 0 | eGrid Technical Guide with Year 2020 Data, Section 3.1 |
| Wind | 0 | eGrid Technical Guide with Year 2020 Data, Section 3.1 |
| a For emissions factors based on analysis of eGRID power plant data for the specific resource type: Median [25% quartile – 75% quartile]  b Assumes an average brake-specific fuel consumption of 7000 Btu/hp-hr in conversion to lbs/MWh  c The eGRID Technical Guide considers the CO2 emissions of energy storage to be zero. The deployment of energy from energy storage does not result in emissions. However, given that energy storage is not actually a generation technology, the emissions associated with the stored energy are dependent on the generation technologies supplying the stored energy. | | |

1. The natural gas CO2 emissions factor was obtained from: <https://www.eia.gov/environment/emissions/co2_vol_mass.php> [↑](#footnote-ref-2)
2. United Stated Environmental Protection “Chapter 3: Stationary Internal Combustion Sources, 3.3 Gasoline and Diesel Industrial Engines”. *Compilation of Air Pollutant Emissions Factors (AP-42), Volume 1*. Accessed: <https://www.epa.gov/air-emissions-factors-and-quantification/ap-42-fifth-edition-volume-i-chapter-3-stationary-0> [↑](#footnote-ref-3)
3. United Stated Environmental Protection Agency, Office of Atmospheric Programs, Clean Air Markets Division. January 2022. “The Emissions & Generation Resource Integrated Database: eGRID Technical Guide with Year 2020 Data.” Accessed: <https://www.epa.gov/egrid/egrid-technical-guide> [↑](#footnote-ref-4)