

# Measurabl GHG Calculation Methodology

<b>Background</b>	<b>1</b>
<b>Scope 1 Emissions</b>	<b>2</b>
Example scope 1 emissions calculation:	3
<b>Scope 2 Emissions</b>	<b>3</b>
Electric	3
Example electric emissions calculation	4
District	4
Example district emissions calculation	4
Scope 2 Emissions CDP Calculations	4
Location-based and Market-based methods	5
Scope 2 Estimations	6
<b>Appendix 1: Energy and Water Conversion Factors</b>	<b>7</b>
<b>Appendix 2: Global Warming Potential Values</b>	<b>13</b>
<b>Appendix 3: Measurabl Emissions Factors 2020</b>	<b>14</b>

## Background

Measurabl displays greenhouse gas (GHG) emission metrics for sites in the “Portfolio/Subgroup Trends” tab, Portfolio/Subgroup Overview tab, in the app’s GRESB and CDP modules, and within exports available on the Reporting tab, including the Data Quality Report, the Portfolio Sustainability Report, and the CDP Scope 1 and Scope 2 reports. Measurabl reports GHG emissions in metric tons of CO<sub>2</sub> equivalent (MT CO<sub>2</sub>e). Measurabl uses the 100-year Global Warming Potential (GWP) values from the IPCC (Intergovernmental Panel on Climate Change) Fifth Assessment Report to calculate CO<sub>2</sub>e (see Appendix 2). Measurabl uses industry standard emissions factors across fuels and global regions.

Within Portfolio Trends, Portfolio Overview, and the Portfolio Sustainability Report, Measurabl does not break out tenant emissions as scope 3, so all fuel usage emissions are scope 1 and



electric/district emissions are scope 2. Elsewhere, Measurabl categorizes emissions by scope according to the guidelines of each supported reporting framework.

<b>Area in Measurabl</b>	<b>Tenant Space paid by Tenant</b>	<b>Tenant Space paid by Landlord</b>
<b>GRESB and Data Quality Report</b>	Scope 3	Scope 3
<b>CDP</b>	Scope 3	Scope 1/2

The “Portfolio/Subgroup Trends” page follows logic from GRESB and CDP by zeroing out emissions from sites for time periods after their “Sold Date” and before their “Bought Date”. So if you have a site that was sold on 12/31/2017 or bought on 1/1/2019, its carbon emissions (and usage) for 2018 will appear as 0, even if the site has complete utility data entered for that year. The app does calculate emissions for sites undergoing new construction or major renovation.

## Scope 1 Emissions

Measurabl calculates scope 1 emissions based on actual energy data entered under the “Fuel” category, which includes Natural Gas, Diesel, Fuel Oils #2, #5, and #6, Propane, Compressed Natural Gas, Biodiesel (B100 and B20), and Renewable Diesel.

Measurabl first calculates the total usage of each fuel. The thermal units for each fuel (as entered by the user when each meter was created) are converted into a common unit: megawatt hours (MWh). To do this, the app uses the thermal conversion factors in Appendix 1.

Measurabl then multiplies the usage (in MWh) of each fuel by its emissions factor (listed in Appendix 3). The emissions for all scope 1 fuel types consumed at the site during the evaluation period are summed, and the result is displayed in the app as “Scope 1 Emissions.” Reminder: this total does not include emissions from fuel meters marked as tenant paid.



Example scope 1 emissions calculation:

Fuel Type	Usage (kBTU)	Conversion Factor (kBTU to MWh)	Usage (MWh)	Emissions factor (MT CO2e per MWh)	Emissions (MT CO2e)
Natural Gas	296,448	0.000293083235638921	86.883939038686853	0.18121132	15.74

## Scope 2 Emissions

Measurabl calculates scope 2 emissions as a sum of emissions from energy usage entered under the “Electric” and “District” categories.

### Electric

Measurabl assigns zero emissions for electric meters that are entered as “On-site Renewable” or “Off-site Renewable”.

Nonrenewable electric meters are assigned an emissions factor based on the country designated for their site. Countries outside the U.S. and Canada have country-wide emissions factors for electricity. The U.S. has different emissions factors for each eGRID subregion (learn more about eGRID subregions [here](#)). Sites in the U.S. are mapped to eGRID subregions by their zip code, and you can learn more about the mapping [here](#). Sites that cannot be mapped to an eGRID subregion have their emissions calculated using a state-specific emissions factor.

Canada has different emissions factors for each province. All of the current emissions factors are listed in Appendix 3.

Measurabl sums nonrenewable electric usage across meters for the evaluation period. Depending on the emissions factor used, the summed electricity may be converted to MWh.

Measurabl then multiplies the total nonrenewable electric usage by the region-specific emissions factor. Nonrenewable electricity usage emissions for sites outside the U.S. (which are often given in kilograms based on their emissions factors) are then converted to MT CO2e.



## Example electric emissions calculation

Electric Usage (kWh)	eGRID subregion	Emissions Factor (MT CO <sub>2</sub> e per kWh)	Emissions (MT CO <sub>2</sub> e)
1,038,764.51	RFC West	.00056783	589.84

## District

Measurabl uses the same process to calculate scope 2 emissions from energy usage entered under the “District” category as is used to calculate scope 1 emissions from “Fuel” energy usage. “District” energy includes steam, hot water, and chilled water (from various generation methods).

Measurabl totals usage for each district emissions source during the evaluation period, then converts each total to a common unit of MWh. Measurabl then multiplies each usage by its emissions factor, then sums the emissions, in MT CO<sub>2</sub>e.

## Example district emissions calculation

Fuel Type	Usage (kBtu)	Conversion Factor (kBtu to MWh)	Usage (MWh)	Emissions Factor (MT CO <sub>2</sub> e per MWh)	Emissions (MT CO <sub>2</sub> e)
Steam	9,179,481	0.0002930832356389210	2,690.35	.2265	609.36

## Scope 2 Emissions CDP Calculations

Per CDP guidelines, there are some additional steps Measurabl uses to calculate scope 2 emissions within the “Carbon Emissions” tab of the app’s CDP report.



## Location-based and Market-based methods

CDP requires organizations to report scope 2 carbon emissions from electricity using two different methods.

**The Location-based method** assigns the same, regional grid emission factors for all purchased electricity. The intent is to have a simple accounting method available where all offsite purchased electricity is located by one emission factor, since many organizations do not have supplier-specific emissions data.

Location-based emissions example:

Usage Type	Usage (MWh)	Emission Factor (WECC California)	Emissions
Offsite nonrenewable (grid)	1,000	0.206498382	226.2
Offsite renewable	1,000	0.206498382	226.2
Onsite renewable	1,000	0	0
Total	3,000		452.4

Let's say you have one site, in Washington, DC, that used 100,000 kWh of grid electricity and 100,000 kWh of offsite renewable electricity. Under the location-based method, all 200,000 kWh are multiplied by the regional grid emissions factor.

**The Market-based method** assigns different emissions factors depending on the source of the electricity. Renewable electricity is assigned zero emissions. For certain utility providers, Measurabl can assign provider-specific emission factors, rather than regional grid emission factors.

Example market-based emissions example:

Usage Type	Usage (MWh)	Emission Factor (WECC California)	Emissions
Offsite nonrenewable (grid)	1,000	0.206498382	226.2
Offsite renewable	1,000	0.206498382	0
Onsite renewable	1,000	0	0
Total	3,000		226.2



To revisit the site above, the 100,000 kWh of offsite renewable electricity will contribute 0 carbon emissions, while the 100,000 kWh of grid electricity will be multiplied by the utility provider's (Pepco) specific emissions factor, rather than the regional grid emissions factor. The site's market-based emissions will be substantially lower than its location-based emissions because the market-based method assumes no emissions from the 100,000 kWh of renewable electricity.

## Scope 2 Estimations

**Method 1:** If a site has actual usage data for the reporting period but some months (fewer than six) are missing data, the estimate for the missing months is the average of the actual months. If January has no data, average monthly usage from February-December is used as an estimate.

**Method 2 (if method 1 cannot be used):** If a month with no actual data has prior year usage, that prior year usage becomes the estimate. If January 2018 has no actual data, January 2017 actual usage (if entered) is the estimate.

If a site is missing more than six months of electricity data during the reporting period, the app estimates energy use by multiplying the common floor area by an average energy intensity figure. That intensity figure comes from the [CBECS 2012 survey](#) for the specific property type. For example: offices have a different energy intensity figure used for estimates than hotels. Estimates are only applied for periods where the site was owned/leased. If a site has no 2018 data, but was sold on 6-30-2018, only six months of estimated usage/emissions will be applied.

**-Leased sites and owned sites with no common area** that have fewer than six months of electricity data have estimates applied for the whole site's floor area.

**-Owned sites with common area** and fewer than six months of electricity data have estimates applied only for the site's common area.

-Measurabl uses the property type with the majority of the site's floor area when applying these energy use estimates. The app does not prorate estimated energy use based on the percent of total floor area of each property type in a mixed use site.

For example: if a site contains 90 percent office space with 10 percent data center space, the app will only use the CBECS 2012 figure for office when estimating common area energy use. If you need emissions estimates for each property type within a mixed use site, you'll need to split each property type out as its own separate site within Measurabl. The app then calculates emissions by multiplying the estimated energy use (however it was derived) by the appropriate emissions factors.



## Appendix 1: Energy and Water Conversion Factors

Measurabl Meter Type	Input Unit Options	Multiplier to get to kBtu	Multiplier to get to MWh	Source
District Steam	kg	2.632	0.000771395076201641	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
District Stream	kLbs	1,194	0.349941383352872	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
District Stream	kBtu	1	0.000293083235638921	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
All District	MWh	3,412	1.0	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
All District	kWh	3.412	0.001	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
All District	MBtu/MMBtu	1,000	0.293083235638922	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
All District	MLbs (Million Pounds)	1,194,000	349.941383352872	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
All District	Lbs	1.194	0.000349941383352872	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
All District	therms	100	0.0293083235638921	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
District Chilled Water	Ton Hours	12	0.00351699882766706	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
All District	GJ	947.817	0.277789273153576	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
Electricity	GJ	947.817	0.277789273153576	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
Electricity	kBtu	1	0.000293083235638921	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
Electricity	kWh	3.412	0.001	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
Electricity	MBtu/MMBtu	1,000	0.293083235638922	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>



Electricity	MWh	3,412	1.0	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
Natural Gas	CCF (Hundred cubic feet)	102.6	0.0300703399765533	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
Natural Gas	CF (Cubic feet)	1,026	0.000300703399765533	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
Natural Gas	KcF (Thousand cubic feet)	1,026	0.3007033997655330	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
Natural Gas	McF (Million cubic feet)	1,026,000	300.7033997655330	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
Natural Gas	Cubic meters	36.303	0.0106398007033998	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
All Fuel	GJ	947.817	0.277789273153576	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
All Fuel	MWh	3412	1.0	
All Fuel	kWh	3,412	0.001	
All Fuel	kBtu	1	0.000293083235638921	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
All Fuel	MBtu/MMBtu	1,000	0.2930832356389220	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
All Fuel	Therms	100	0.0293083235638921	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
Propane	CCF (HUNDRED CUBIC FEET)	251.6	0.0737397420867526	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
Propane	CF (CUBIC FEET)	2,516	0.000737397420867526	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
Propane	KCF (THOUSAND CUBIC FEET)	2,516	0.7373974208675260	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
Propane	MCF (MILLION CUBIC FEET)	2,516,000	737.3974208675260	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>



Propane	CM (CUBIC METERS)	89	0.0260409410251326	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
Propane	Gallons (US)	92	0.0269636576787808	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
Propane	Gallons (UK)	110.484	0.0323810082063306	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
Propane	liters	24.304	0.00712309495896835	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
Diesel	Gallons (US)	138	0.0404454865181712	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
Diesel	Gallons (UK)	165.726	0.0485715123094959	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
Diesel	liters	36.456	0.0106846424384525	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
Kerosene	Gallons (US)	135	0.0395662368112544	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
Kerosene	Gallons (UK)	162.123	0.0475155334114889	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
Kerosene	liters	35.663	0.0104522274325909	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
Fuel Oil No. 1	Gallons (US)	139	0.0407385697538101	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
Fuel Oil No. 1	Gallons (UK)	166.927	0.0489235052754982	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
Fuel Oil No. 1	liters	36.72	0.0107620164126612	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
Fuel Oil No. 2	Gallons (US)	138	0.0404454865181712	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
Fuel Oil No. 2	Gallons (UK)	165.726	0.0485715123094959	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
Fuel Oil No. 2	liters	36.456	0.0106846424384525	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
Fuel Oil No. 4	Gallons (US)	146	0.0427901524032825	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
Fuel Oil No. 4	Gallons (UK)	175.333	0.051387162954279	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>



Fuel Oil No. 4	liters	38.569	0.0113039273153576	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
Fuel Oil No. 5 & No. 6	Gallons (US)	150	0.0439624853458382	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
Fuel Oil No. 5 & No. 6	Gallons (UK)	180.137	0.0527951348182884	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
Fuel Oil No. 5 & No. 6	liters	39.626	0.0116137162954279	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
Compressed Natural Gas (CNG)	CCF (HUNDRED CUBIC FEET)	102.60	0.0300703399765533	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
Compressed Natural Gas (CNG)	CF (CUBIC FEET)	1.0260000000	0.000300703399765533	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
Compressed Natural Gas (CNG)	KCF (THOUSAND CUBIC FEET)	1,026.00	0.3007033997655330	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
Compressed Natural Gas (CNG)	MCF (MILLION CUBIC FEET)	1,026,000.00	300.7033997655330	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
Compressed Natural Gas (CNG)	CM (CUBIC METERS)	36.23	0.01063980070339980	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
Renewable Diesel	Gallons (US)	138	0.0404454865181712	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
Renewable Diesel	Gallons (UK)	165.726	0.0485715123094959	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
Renewable Diesel	liters	36.456	0.0106846424384525	<a href="#">U.S. EPA ENERGY STAR Portfolio Manager</a>
Biodiesel (B100)	GALLONS (US)	126.2	0.0369871043376319	US Department of Energy <a href="https://tedb.ornl.gov/wp-content/uploads/2020/02/TEDB_Ed_38.pdf#page=387">https://tedb.ornl.gov/wp-content/uploads/2020/02/TEDB_Ed_38.pdf#page=387</a>
Biodiesel (B100)	GALLONS (UK)	151.5662	0.0444215123094959	US Department of Energy <a href="https://tedb.ornl.gov/wp-content/">https://tedb.ornl.gov/wp-content/</a>

				<a href="https://tedb.ornl.gov/wp-content/uploads/2020/02/TEDB_Ed_38.pdf#page=387">uploads/2020/02/TEDB_Ed_38.pdf#page=387</a>
Biodiesel (B100)	Liters	33.33851111	0.00977095870611492	US Department of Energy <a href="https://tedb.ornl.gov/wp-content/uploads/2020/02/TEDB_Ed_38.pdf#page=387">https://tedb.ornl.gov/wp-content/uploads/2020/02/TEDB_Ed_38.pdf#page=387</a>
Biodiesel (B20)	GALLONS (US)	135.93	0.0398388042203986	U.S. EPA ENERGY STAR Portfolio Manager <a href="https://afdc.energy.gov/files/u/publication/biodiesel_handling_use_guide.pdf">https://afdc.energy.gov/files/u/publication/biodiesel_handling_use_guide.pdf</a>
Biodiesel (B20)	GALLONS (UK)	163.24011	0.0478429396248535	U.S. EPA ENERGY STAR Portfolio Manager <a href="https://afdc.energy.gov/files/u/publication/biodiesel_handling_use_guide.pdf">https://afdc.energy.gov/files/u/publication/biodiesel_handling_use_guide.pdf</a>
Biodiesel (B20)	Liters	35.90916	0.0105243728018757	U.S. EPA ENERGY STAR Portfolio Manager US Department of Energy <a href="https://afdc.energy.gov/files/u/publication/biodiesel_handling_use_guide.pdf">https://afdc.energy.gov/files/u/publication/biodiesel_handling_use_guide.pdf</a>
Liquefied Petroleum Gas (LPG)	GALLONS (US)	91.3	0.0267584994138335	<a href="https://tedb.ornl.gov/wp-content/uploads/2020/02/TEDB_Ed_38.pdf#page=387">https://tedb.ornl.gov/wp-content/uploads/2020/02/TEDB_Ed_38.pdf#page=387</a>
Liquefied Petroleum Gas (LPG)	GALLONS (UK)	109.6513	0.0321369577960141	<a href="https://tedb.ornl.gov/wp-content/uploads/2020/02/TEDB_Ed_38.pdf#page=387">https://tedb.ornl.gov/wp-content/uploads/2020/02/TEDB_Ed_38.pdf#page=387</a>
Liquefied Petroleum Gas (LPG)	Liters	24.118907	0.00706884730482006	<a href="https://tedb.ornl.gov/wp-content/uploads/2020/02/TEDB_Ed_38.pdf#page=387">https://tedb.ornl.gov/wp-content/uploads/2020/02/TEDB_Ed_38.pdf#page=387</a>
Liquefied Natural Gas (LNG)	GALLONS (US)	80.51725769	0.023598258408	UK Department of Business, Energy, and Industrial Strategy <a href="https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2020">https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2020</a>
Liquefied Natural Gas (LNG)	GALLONS (UK)	96.70122648	0.028341508348008	UK Department of Business, Energy, and Industrial Strategy <a href="https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2020">https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2020</a>



				<a href="#">porting-conversion-factors-2020</a>
Liquefied Natural Gas (LNG)	Liters	21.270408	0.006234	UK Department of Business, Energy, and Industrial Strategy <a href="https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2020">https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2020</a>

Meter Type in Measurabl	Units	Multiplier to get Cubic Meters (m <sup>3</sup> )	Source
Water	CCF (HUNDRED CUBIC FEET)	2.831685	U.S. EPA ENERGY STAR Portfolio Manager
Water	CF (CUBIC FEET)	0.02831685	U.S. EPA ENERGY STAR Portfolio Manager
Water	CM	1	U.S. EPA ENERGY STAR Portfolio Manager
Water	CM (CUBIC METERS)	1	U.S. EPA ENERGY STAR Portfolio Manager
Water	CUBIC METERS	1	U.S. EPA ENERGY STAR Portfolio Manager
Water	GALLONS (UK)	0.004546092	U.S. EPA ENERGY STAR Portfolio Manager
Water	GALLONS (US)	0.003785412	U.S. EPA ENERGY STAR Portfolio Manager
Water	GALLONS	0.003785412	U.S. EPA ENERGY STAR Portfolio Manager
Water	KCF (THOUSAND CUBIC FEET)	28.31685	U.S. EPA ENERGY STAR Portfolio Manager
Water	KCM	1000	U.S. EPA ENERGY STAR Portfolio Manager
Water	KCM (THOUSAND CUBIC METERS)	1000	U.S. EPA ENERGY STAR Portfolio Manager
Water	KGAL (THOUSAND GALLONS) (UK)	4.546092	U.S. EPA ENERGY STAR Portfolio Manager
Water	KGAL (THOUSAND GALLONS) (US)	3.785412	U.S. EPA ENERGY STAR Portfolio Manager
Water	KGAL (THOUSAND GALLONS)	3.785412	U.S. EPA ENERGY STAR Portfolio Manager



Water	CGAL (HUNDRED GALLONS) (US)	0.3785412	U.S. EPA ENERGY STAR Portfolio Manager
Water	CGAL (HUNDRED GALLONS)	0.3785412	U.S. EPA ENERGY STAR Portfolio Manager
Water	CGAL (HUNDRED GALLONS) (UK)	0.4546092	U.S. EPA ENERGY STAR Portfolio Manager
Water	LITERS	0.001	U.S. EPA ENERGY STAR Portfolio Manager
Water	KILOLITERS	1	U.S. EPA ENERGY STAR Portfolio Manager
Water	MCF(MILLION CUBIC FEET)	28316.85	U.S. EPA ENERGY STAR Portfolio Manager
Water	MCF (MILLION CUBIC FEET)	28316.85	U.S. EPA ENERGY STAR Portfolio Manager
Water	MGAL (MILLION GALLONS) (UK)	4546.092	U.S. EPA ENERGY STAR Portfolio Manager
Water	MGAL (MILLION GALLONS) (US)	3785.412	U.S. EPA ENERGY STAR Portfolio Manager
Water	MGAL (MILLION GALLONS)	3785.412	U.S. EPA ENERGY STAR Portfolio Manager
Water	MILLION GALLONS PER DAY	3785.412	U.S. EPA ENERGY STAR Portfolio Manager

## Appendix 2: Global Warming Potential Values

Greenhouse Gas	GWP (CO <sub>2</sub> e)	Source
Carbon Dioxide (CO <sub>2</sub> )	1	<a href="#">IPCC Fifth Assessment Report (AR5)</a>
Methane (CH <sub>4</sub> )	28	<a href="#">IPCC Fifth Assessment Report (AR5)</a>
Nitrous Oxide (N <sub>2</sub> O)	265	<a href="#">IPCC Fifth Assessment Report (AR5)</a>

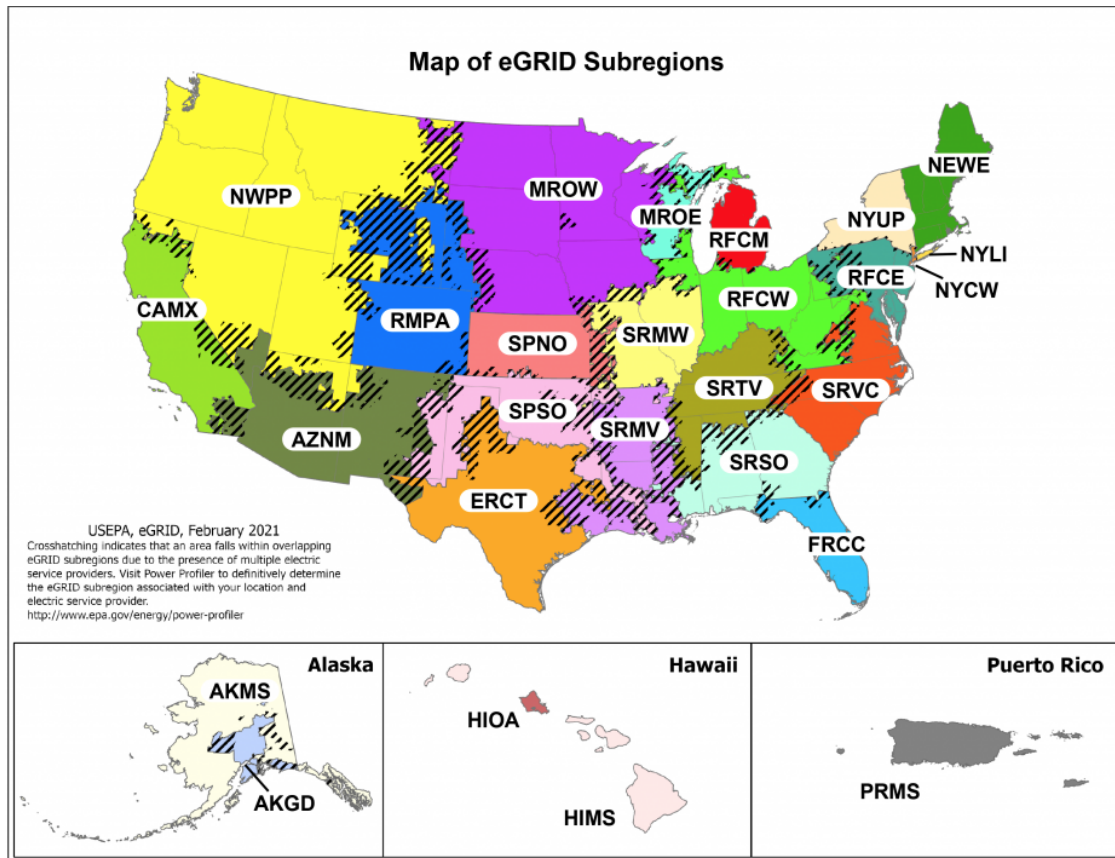
## Appendix 3: Measurabl Emissions Factors 2020

Fuel/Material/ Energy	Emission Factor	Unit	Reference
Steam/District (US)	0.2265	metric tonnes CO2e per MWh	<a href="#">The US Environmental Protection Agency: - ENERGY STAR Portfolio Manager</a>
Steam/District (Canada + Intl)	0.3021	metric tonnes CO2e per MWh	<a href="#">The US Environmental Protection Agency: - ENERGY STAR Portfolio Manager</a>
Hot Water (US)	0.2265662288	metric tonnes CO2e per MWh	<a href="#">The US Environmental Protection Agency: - ENERGY STAR Portfolio Manager</a>
Hot Water (Denmark)	0.0863	metric tonnes CO2e per MWh	Danish Energy Agency
Chilled Water: Electric-driven Chiller (US)	0.1798198834	metric tonnes CO2e per MWh	<a href="#">The US Environmental Protection Agency: - ENERGY STAR Portfolio Manager</a>
Chilled Water: Absorption Chiller using Natural Gas (US)	0.2521231723	metric tonnes CO2e per MWh	<a href="#">The US Environmental Protection Agency: - ENERGY STAR Portfolio Manager</a>
Chilled Water: Engine-driven Chiller using Natural Gas (US)	0.168252722	metric tonnes CO2e per MWh	<a href="#">The US Environmental Protection Agency: - ENERGY STAR Portfolio Manager</a>
Hot Water (Canada)	0.3021110526	metric tonnes CO2e per MWh	<a href="#">The US Environmental Protection Agency: - ENERGY STAR Portfolio Manager</a>
Chilled Water: Electric-driven Chiller (Canada)	0.05865472097	metric tonnes CO2e per MWh	<a href="#">The US Environmental Protection Agency: - ENERGY STAR Portfolio Manager</a>
Chilled Water: Absorption Chiller using Natural Gas (Canada)	0.2520208081	metric tonnes CO2e per MWh	<a href="#">The US Environmental Protection Agency: - ENERGY STAR Portfolio Manager</a>

Chilled Water: Engine-driven Chiller using Natural Gas (Canada)	0.1681844792	metric tonnes CO2e per MWh	<a href="#">The US Environmental Protection Agency: - ENERGY STAR Portfolio Manager</a>
Coke (US)	0.390401040	metric tonnes CO2e per MWh	<a href="#">The US Environmental Protection Agency: - ENERGY STAR Portfolio Manager</a>
Coal (anthracite US)	0.356349280	metric tonnes CO2e per MWh	<a href="#">The US Environmental Protection Agency: - ENERGY STAR Portfolio Manager</a>
Coal (bituminous US)	0.320830360	metric tonnes CO2e per MWh	<a href="#">The US Environmental Protection Agency: - ENERGY STAR Portfolio Manager</a>
Wood (US)	0.324310600	metric tonnes CO2e per MWh	<a href="#">The US Environmental Protection Agency: - ENERGY STAR Portfolio Manager</a>
Kerosene (US)	0.265078280	metric tonnes CO2e per MWh	<a href="#">The US Environmental Protection Agency: - ENERGY STAR Portfolio Manager</a>
Natural Gas	0.181211320	metric tonnes CO2e per MWh	<a href="#">The US Environmental Protection Agency: - ENERGY STAR Portfolio Manager</a>
Compressed Natural Gas (CNG)	0.18141	metric tonnes CO2e per MWh	2018 Climate Registry Default Emission Factors
Diesel	0.253204520	metric tonnes CO2e per MWh	<a href="#">The US Environmental Protection Agency: - ENERGY STAR Portfolio Manager</a>
Fuel Oil #2	0.253204520	metric tonnes CO2e per MWh	<a href="#">The US Environmental Protection Agency: - ENERGY STAR Portfolio Manager</a>
Fuel Oil #4	0.256889480	metric tonnes CO2e per MWh	<a href="#">The US Environmental Protection Agency: - ENERGY STAR Portfolio Manager</a>
Fuel Oil #5 or #6	0.257094200	metric tonnes CO2e per MWh	<a href="#">The US Environmental Protection Agency: - ENERGY STAR Portfolio Manager</a>

Propane	0.219221000	metric tonnes CO2e per MWh	<a href="#">The US Environmental Protection Agency: - ENERGY STAR Portfolio Manager</a>
Liquefied Natural Gas (LNG)	0.19077	metric tonnes CO2e per MWh	2020 Climate Registry Default Emission Factors
Biodiesel (B100)	0.25345	metric tonnes CO2e per MWh	2020 Climate Registry Default Emission Factors
Biodiesel (B20)	0.25378	metric tonnes CO2e per MWh	2020 Climate Registry Default Emission Factors
Renewable Diesel	0.25386	metric tonnes CO2e per MWh	2020 Climate Registry Default Emission Factors
Vehicle fuel (gas)	0.008871238	metric tonnes CO2e per gallon	World Resources Institute (2008). GHG Protocol tool for mobile combustion. Version 2.2
Vehicle fuel (diesel)	0.010156986	metric tonnes CO2e per gallon	World Resources Institute (2008). GHG Protocol tool for mobile combustion. Version 2.2
Electricity, City of Palo Alto	0	metric tonnes CO2e per MWh	Supplier website
Electricity, PEPCO	0.52	metric tonnes CO2e per MWh	Supplier website
Electricity, Baltimore Gas and Electric	0.503	metric tonnes CO2e per MWh	Supplier website





US eGRID Subregion Electricity Emission Factors			
eGRID subregion	Emission Factor	Unit	Source
Electricity, ASCC Alaska Grid	0.508392225	metric tonnes CO <sub>2</sub> e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, ASCC Miscellaneous	0.2500545874	metric tonnes CO <sub>2</sub> e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, WECC Southwest	0.4340348278	metric tonnes CO <sub>2</sub> e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, WECC California	0.20649838	metric tonnes CO <sub>2</sub> e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)

Electricity, ERCOT All	0.3957089941	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, FRCC All	0.3921464796	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, HICC Miscellaneous	0.5423141304	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, HICC Oahu	0.7745434448	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, MRO East	0.6861033653	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, MRO West	0.5018763706	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, NPCC New England	0.2239970665	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, WECC Northwest	0.3265289002	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, NPCC NYC/Westchester	0.2517691665	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, NPCC Long Island	0.5528973476	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, NPCC Upstate NY	0.1057069803	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, RFC East	0.3168274666	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, RFC Michigan	0.5429487061	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)

Electricity, RFC West	0.4873441783	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, WECC Rockies	0.5672412991	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, SPP North	0.4887897771	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, SPP South	0.4566414179	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, SERC Mississippi Valley	0.3672265684	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, SERC Midwest	0.7239066606	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, SERC South	0.4417903501	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, SERC Tennessee Valley	0.4334469721	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, SERC Virginia/Carolina	0.3080536293	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)

US State Electric Emission Factors			
These state factors are only used if a site's zip code cannot be mapped to an eGRID subregion			
State	Emission Factor	Unit	Source
Electricity, Alaska	0.4422208093	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, Alabama	0.3563299189	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, Arkansas	0.5116263386	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, Arizona	0.3961331029	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, California	0.1756232546	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, Colorado	0.6037645567	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, Connecticut	0.2165549765	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, District of Columbia	0.3618270048	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, Delaware	0.3227209922	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, Florida	0.3979270608	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, Georgia	0.3995908376	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)

Electricity, Hawaii	0.7088356005	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, Iowa	0.3907507759	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, Idaho	0.09588398391	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, Illinois	0.3292060023	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, Indiana	0.7412579295	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, Kansas	0.4053473783	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, Kentucky	0.8076815426	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, Louisiana	0.3748101792	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, Massachusetts	0.3540651322	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, Maryland	0.3350682301	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, Maine	0.0968714545	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, Michigan	0.4596841155	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, Minnesota	0.3995817657	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)

Electricity, Missouri	0.725212553	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, Mississippi	0.3798191998	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, Montana	0.5727646934	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, North Carolina	0.3535933961	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, North Dakota	0.6565713268	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, Nebraska	0.5740796577	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, New Hampshire	0.1162266945	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, New Jersey	0.247293117	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, New Mexico	0.6018585616	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, Nevada	0.335352179	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, New York	0.1715699532	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, Ohio	0.5635690153	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, Oklahoma	0.3330479297	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)

Electricity, Oregon	0.1805891839	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, Pennsylvania	0.3441663859	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, Rhode Island	0.3865895195	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, South Carolina	0.2442105033	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, South Dakota	0.2232205163	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, Tennessee	0.3195004864	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, Texas	0.414322157	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, Utah	0.7265737837	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, Virginia	0.2884158013	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, Vermont	0.02325250566	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, Washington	0.1356676635	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, Wisconsin	0.5592734955	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
Electricity, West Virginia	0.882346929	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)

Electricity, Wyoming	0.9384789848	metric tonnes CO2e per MWh	The US Environmental Protection Agency: - eGRID2019 (Year 2019 Data)
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Canadian Electricity Emission Factors			
Region	Emission Factor	Unit	Source
Electricity, Canada, Alberta	.67	metric tonnes CO2e per MWh	Environment and Climate Change Canada, 2021 National Inventory Report 1990-2019 Greenhouse Gas Sources and Sinks in Canada Annex 13 Tables A13-2 - 13-12.
Electricity, Canada, British Columbia	.0197	metric tonnes CO2e per MWh	Environment and Climate Change Canada, 2021 National Inventory Report 1990-2019 Greenhouse Gas Sources and Sinks in Canada Annex 13 Tables A13-2 - 13-12.
Electricity, Canada, Manitoba	.0013	metric tonnes CO2e per MWh	Environment and Climate Change Canada, 2021 National Inventory Report 1990-2019 Greenhouse Gas Sources and Sinks in Canada Annex 13 Tables A13-2 - 13-12.
Electricity, Canada, New Brunswick	.27	metric tonnes CO2e per MWh	Environment and Climate Change Canada, 2021 National Inventory Report 1990-2019 Greenhouse Gas Sources and Sinks in Canada Annex 13 Tables A13-2 - 13-12.
Electricity, Canada, Newfoundland and Labrador	.028	metric tonnes CO2e per MWh	Environment and Climate Change Canada, 2021 National Inventory Report 1990-2019 Greenhouse Gas Sources and Sinks in Canada Annex 13 Tables A13-2 - 13-12.
Electricity, Canada, Northwest Territories	.2	metric tonnes CO2e per MWh	Environment and Climate Change Canada, 2021 National Inventory Report 1990-2019 Greenhouse Gas Sources and Sinks in Canada Annex 13 Tables A13-2 - 13-12.
Electricity, Canada, Nova Scotia	.76	metric tonnes CO2e per MWh	Environment and Climate Change Canada, 2021 National Inventory Report 1990-2019 Greenhouse



			Gas Sources and Sinks in Canada Annex 13 Tables A13-2 - 13-12.
Electricity, Canada, Nunavut	.89	metric tonnes CO2e per MWh	Environment and Climate Change Canada, 2021 National Inventory Report 1990-2019 Greenhouse Gas Sources and Sinks in Canada Annex 13 Tables A13-2 - 13-12.
Electricity, Canada, Ontario	.03	metric tonnes CO2e per MWh	Environment and Climate Change Canada, 2021 National Inventory Report 1990-2019 Greenhouse Gas Sources and Sinks in Canada Annex 13 Tables A13-2 - 13-12.
Electricity, Canada, Prince Edward Island	.27	metric tonnes CO2e per MWh	Environment and Climate Change Canada, 2021 National Inventory Report 1990-2019 Greenhouse Gas Sources and Sinks in Canada Annex 13 Tables A13-2 - 13-12.
Electricity, Canada, Quebec	.0015	metric tonnes CO2e per MWh	Environment and Climate Change Canada, 2021 National Inventory Report 1990-2019 Greenhouse Gas Sources and Sinks in Canada Annex 13 Tables A13-2 - 13-12.
Electricity, Canada, Saskatchewan	.71	metric tonnes CO2e per MWh	Environment and Climate Change Canada, 2021 National Inventory Report 1990-2019 Greenhouse Gas Sources and Sinks in Canada Annex 13 Tables A13-2 - 13-12.
Electricity, Canada, Yukon	.113	metric tonnes CO2e per MWh	Environment and Climate Change Canada, 2021 National Inventory Report 1990-2019 Greenhouse Gas Sources and Sinks in Canada Annex 13 Tables A13-2 - 13-12.

Electricity emission factors for the following countries are sourced from the International Energy Agency (IEA) 2020 proprietary dataset subject to IEA Terms and Conditions (<https://www.iea.org/terms>). For more information, see IEA's website: <https://webstore.iea.org/emissions-factors-2020>.

Albania  
Algeria

Angola  
Argentina  
Armenia  
Australia  
Austria  
Azerbaijan  
Bahrain  
Bangladesh  
Belarus  
Belgium  
Bosnia and Herzegovina  
Brazil  
Bulgaria  
Cameroon  
Canada  
Chile  
China  
Colombia  
Costa Rica  
Cote d'Ivoire  
Croatia  
Cyprus  
Czech Republic  
Denmark  
Dominican Republic  
Ecuador  
Egypt  
El Salvador  
Estonia  
Finland  
France  
Georgia  
Germany  
Greece  
Guatemala  
Honduras  
Hong Kong  
Hungary  
Iceland  
India  
Indonesia  
Iraq  
Ireland

Israel  
Italy  
Jamaica  
Japan  
Jordan  
Kazakhstan  
Kenya  
Kuwait  
Latvia  
Lebanon  
Libya  
Lithuania  
Luxembourg  
Malaysia  
Malta  
Mexico  
Morocco  
Namibia  
Netherlands  
New Zealand  
Nigeria  
Norway  
Oman  
Pakistan  
Panama  
Paraguay  
Peru  
Philippines  
Poland  
Portugal  
Qatar  
Romania  
Russia  
Saudi Arabia  
Senegal  
Serbia  
Singapore  
Slovakia  
Slovenia  
South Africa  
Spain  
Sri Lanka  
Sweden

Switzerland  
Syrian Arab Republic  
Thailand  
Trinidad and Tobago  
Tunisia  
Turkey  
Ukraine  
United Arab Emirates  
United Kingdom  
Uruguay  
Vietnam