Production and Domestic Energy Use

Data Collection

Data about production and domestic energy use is collected in the Energy section of FEM separated by facility type except in the case that a facility operates as and only as both a Finished Product Processing and Finished Product Assembler *and* Finished Product Processing represents 5% or less of the total production volume of the facility *and* the facility cannot track the energy use of the two facility types separately. In that case the Finished Product Processing energy use is reported as a part of the Finished Product Assembler facility type data. In the case that the two are combined `energyseparate` will have a value of `No`.

Domestic energy use is either reported as a part of production use, in the case that a facility cannot separate the energy usage, or separately.

You can determine whether a facility is reporting energy values split between domestic and production or combined by looking at the ref_id `ensourcetracksepdomprod` an answer of `No` means the facility is reporting combined (row 3 in the table below) and `Yes` means separated (rows 1 and 2 in the table below). Because a facility will never report using both methods they may safely be summed without risk of double counting.

Raw energy use is reported in the follow ref_ids:

Scope	Usage	Unit of Measure
Domestic	ensourcequantdomestic[1]	ensourceunitdomestic[1]
Production	ensource[2]quantprod[1]	ensource[2]unitprod[1]
Domestic & Production	ensource[2]quant[1]	ensource[2]unit[1]

Where the wildcards `[1]` and `[2]` represent the energy source and facility type which may be any of the following values:

Index	Kind	Reference	Value
1	Energy Source	ensourceelectricpurch	Purchased Electricity
1	Energy Source	ensourcesteampurch	Purchased Steam
1	Energy Source	ensourcechilledwater	Purchased Chilled Water
1	Energy Source	ensourcedistrictheating	Purchased Heating (District Heating)

Index	Kind	Reference	Value
1	Energy Source	ensourcebiodiesel	Biodiesel
1	Energy Source	ensourcebiogas	Biogas
1	Energy Source	ensourcemicrohydro	Mini or Micro-Hydro (Onsite)
1	Energy Source	ensourcepurchrenew	Purchased Renewables
1	Energy Source	ensourcesolarphoto	Solar Photovoltaic (Onsite)
1	Energy Source	ensourcesolarthermal	Solar Thermal (Onsite)
1	Energy Source	ensourcewind	Wind (Onsite)
1	Energy Source	ensourcecng	CNG - Compressed Natural Gas
1	Energy Source	ensourcecoal	Coal - commercial mix
1	Energy Source	ensourcecoalwaterslurry	Coal Water Slurry
1	Energy Source	ensourcediesel	Diesel
1	Energy Source	ensourcefabricwaste	Fabric Waste
1	Energy Source	ensourcefueloil	Fuel Oil - Blended
1	Energy Source	ensourcelng	LNG - Liquid Natural Gas
1	Energy Source	ensourcelpg	LPG - Liquid Petroleum Gas
1	Energy Source	ensourcenaturalgas	Natural Gas
1	Energy Source	ensourcepetrol	Petrol/Gasoline
1	Energy Source	ensourcepropane	Propane
1	Energy Source	ensourcebiomasscert	Biomass - Certified
1	Energy Source	ensourcebiomassgen	Biomass - Not Certified
2	Facility Type	finalProductAssembly	Finished Product Assembler
2	Facility Type	printingProductDyeingAndLaundering	Finished Product Processing
2	Facility Type	hardComponentTrimProduction	Component / Sub-Assembly Manufacturing
2	Facility Type	materialProduction	Material Production
2	Facility Type	rawMaterialProcessing	Raw Material Processing
2	Facility Type	rawMaterialCollection	Raw Material Collection & Bulk Refining

So the raw value for energy usage of coal water slurry in Raw Material Collection & Bulk Refining for pro-

duction would be found in either the ref_id `ensourcerawMaterialCollectionquantprodensourcecoalwaterslurry` or `ensourcerawMaterialCollectionquantensourcecoalwaterslurry` the former if `ensourcetracksepdomprod` is `Yes` the latter if it is no and then combined with domestic energy use but never both.

Conversion to MJ

All domestic and production energy sources are converted into MJ from the reported unit in calculations with the ref_id form of

Scope	Usage
Domestic	ensourcequantdomestic[1]_mj
Production	ensource[2]quantprod[1]_mj
Domestic & Production	ensource[2]quant[1]_mj

The wild cards `[1]` and `[2]` are the energy source and facility type as above.

Most energy sources are converted to MJ using the following energy densities which, where possible, represent the lower heating value (LHV) of the source and, regardless, use either the best available energy density or a proxy deemed as sufficiently representative. Sources and conversion formulas used to convert from the source data to the numbers in the following table are available in the Excel FEM 2023 Emission Factors but are left out here for space:

Density Kind	Reference	Name	Density
Volumetric (MJ per liter)	biodiesel	Biodiesel	35.6645
Gravimetric (MJ per kg)	biodiesel	Biodiesel	40.7719
Volumetric (MJ per liter)	biogas	Biogas	0.0220
Gravimetric (MJ per kg)	biogas	Biogas	19.1304
Volumetric (MJ per liter)	biomasscert	Biomass - Certified	3.0000
Gravimetric (MJ per kg)	biomasscert	Biomass - Certified	15.0000
Volumetric (MJ per liter)	biomassgen	Biomass - Not Certified	3.0000
Gravimetric (MJ per kg)	biomassgen	Biomass - Not Certified	15.0000
Volumetric (MJ per liter)	cng	CNG - Compressed Natural Gas	0.0383

Density Kind	Reference	Name	Density
Gravimetric (MJ per kg)	cng	CNG - Compressed Natural Gas	52.2257
Volumetric (MJ per liter)	coal	Coal - commercial mix	22.3889
Gravimetric (MJ per kg)	coal	Coal - commercial mix	24.8766
Volumetric (MJ per liter)	coalwaterslurry	Coal Water Slurry	18.0000
Gravimetric (MJ per kg)	coalwaterslurry	Coal Water Slurry	15.0000
Volumetric (MJ per liter)	diesel	Diesel	38.2903
Gravimetric (MJ per kg)	diesel	Diesel	45.5837
Gravimetric (MJ per kg)	fabricwaste	Fabric Waste	21.7568
Volumetric (MJ per liter)	fabricwaste	Fabric Waste	8.7027
Volumetric (MJ per liter)	fueloil	Fuel Oil - Blended	38.7416
Gravimetric (MJ per kg)	fueloil	Fuel Oil - Blended	46.1209
Volumetric (MJ per liter)	lng	LNG - Liquid Natural Gas	24.5909
Gravimetric (MJ per kg)	lng	LNG - Liquid Natural Gas	53.9279
Volumetric (MJ per liter)	lpg	LPG - Liquid Petroleum Gas	25.6419
Gravimetric (MJ per kg)	lpg	LPG - Liquid Petroleum Gas	46.6216
Gravimetric (MJ per kg)	naturalgas	Natural Gas	55.1867
Volumetric (MJ per liter)	naturalgas	Natural Gas	0.0382
Volumetric (MJ per liter)	muniwaste	Municipal Solid Waste	4.2366
Gravimetric (MJ per kg)	muniwaste	Municipal Solid Waste	11.5753
Volumetric (MJ per liter)	petrol	Petrol/Gasoline	34.6537
Gravimetric (MJ per kg)	petrol	Petrol/Gasoline	46.2050
Volumetric (MJ per liter)	propane	Propane	25.6419
Gravimetric (MJ per kg)	propane	Propane	46.6216

The exceptions are `districtheating`, `steampurch`, `diesel`, and `biodiesel`.

When reported in a non energy unit the energy density of district heating is calculated using the difference between the temperature of the heated water received at the facility and the temperature of the water exiting. These values may be found in `ensourcedistrictheatingrectemp` and

`ensourcedistrictheatingexittemp` respectively.

When reported as a mass unit (volume is not allowed) the energy density of steam is calculated using the reported pressure and temperature of the steam. These values may be found in `ensteampressure` and `ensteamtemp` respectively.

The MJ values of diesel and biodiesel are adjusted based on the reported mixtures of biodiesel and diesel in each energy source so that the reported MJ only represent biodiesel and diesel rather than blends. The mix values for production/domestic use may be found in `endieselmix` and `enbiodieselmix` where the latter is the mixture of reported biodiesel usage and the former is the mixture of reported diesel usage.

Sources without listed energy densities may only be reported as energy units and conversion to MJ is straight forward.

For secondary energy sources the assumed efficiency of the generation source is accounted for *during* the conversion to MJ. Restated, the reported MJ for secondary sources includes an assumption about generation efficiency.

Conversion to kg CO2e

The kg CO2e emitted through the use of all domestic and production energy sources is calculated and reported with the ref_id form of

Scope	Usage
Domestic	ensource[2]quantdomestic[1]_kgco2e
Production	ensource[2]quantprod[1]_kgco2e
Domestic & Production	ensource[2]quant[1]_kgco2e

The wild cards `[1]` and `[2]` are the energy source and facility type as above.

In most cases the kg CO2e emissions are calculated using a single default emission factor from the following table. Sources for the data in the following table are available in the Excel FEM 2023 Emission Factors but are left out here for space:

Reference	Value	kg CO2e / MJ
biodiesel	Biodiesel	0.0712

Reference	Value	kg CO2e / MJ
biogas	Biogas	0.0550
biomasscert	Biomass - Certified	0.1100
biomassgen	Biomass - Not Certified	0.1100
chilledwater	Purchased Chilled Water	0.0778
cng	CNG - Compressed Natural Gas	0.0563
coal	Coal - commercial mix	0.0950
coalwaterslurry	Coal Water Slurry	0.0950
diesel	Diesel	0.0750
districtheating	Purchased Heating (District Heating)	0.0778
electricpurch	Purchased Electricity	N/A
fabricwaste	Fabric Waste	0.1100
fueloil	Fuel Oil - Blended	0.0778
geotherm	Geo thermal (Offsite)	0.0000
hydro	Hydro (Large Scale, Offsite)	0.0000
lng	LNG - Liquid Natural Gas	0.0563
lpg	LPG - Liquid Petroleum Gas	0.0582
microhydro	Mini or Micro-Hydro (Onsite)	0.0000
muniwaste	Municipal Solid Waste	0.1012
naturalgas	Natural Gas	0.0563
petrol	Petrol/Gasoline	0.0729
propane	Propane	0.0582
purchrenew	Purchased Renewables	0.0000
renewablepurch	Purchased Renewables (electricity)	0.0000
renewother	Other Renewable Source	0.0000
renewunknown	Source Unknown	0.0000
solarphoto	Solar Photovoltaic (Onsite)	0.0000
solarthermal	Solar Thermal (Onsite)	0.0000

Reference	Value	kg CO2e / MJ
steampurch	Purchased Steam	0.0778
wind	Wind (Onsite)	0.0000

The exceptions are `electricpurch`, `chilledwater`, `districtheating`, `purchrenew`, and `steampurch` which may have their emissions calculated based on different factors.

`electricpurch` is based on the facility's country grid emission factor by default but is overridden as specified by the facility in the question `enghgefelecpurchwquant` if the answer `enghgefelecpurch` is `Yes`. The country grid emission factors are updated when possible for each FEM cadence and may not be disclosed as they are licensed from IEA.

The rest may either have their specific emission factor reported by the facility and/or the mix of sources used to generate the energy. If the specific emission factor is reported that value is used. If there is no specific reported emission factor but the source mix is reported those values are used to calculate an emission factor based on the emission factors in the table above. Otherwise, the default value from the table above is used.

Because of data quality issues with self reported emission factors values great than 1.6 kg CO2e / KWh or less than 0 kg CO2e / kWh are not used to generate emission values in FEM calculations. In those cases default values are used to prevent implausible data form being reported. Facilities taking FEM, and verifiers, are warned in the assessment if the values entered are unlikely to be correct.

Vehicle Energy Use

Raw vehicle energy use is reported in the ref_ids `ensourcequantvehicle[1]` for the quantity `ensourceunitvehicle[1]` and the unit of measure. The wildcard `[1]` is energy source as found in the following table:

Reference	Value
envehicleelectricpurch	Purchased Electricity
envehiclebiodiesel	Biodiesel
envehiclebiogas	Biogas
envehicleethenol	Ethenol

Reference	Value
envehiclehydrogenr	Hydrogen - Renewable Source
envehiclerenewablepurch	Purchased Renewables (electricity)
envehiclesolarphoto	Solar Photovoltaic (electricity)
envehiclewind	Wind (electricity)
envehiclecng	CNG - Compressed Natural Gas
envehicldiesel	Diesel
envehiclehydrogennr	Hydrogen -Non- Renewable Source
envehiclelng	LNG - Liquid Natural Gas
envehiclelpg	LPG - Liquid Petroleum Gas
envehiclepetrol	Petrol/Gasoline
envehiclepropane	Propane

The MJ used and kg CO2e emissions are calculated as per the ”Production and Domestic Energy Use” section with the following ref_id formats `ensourcequantvehcile[1]_mj` and `ensourcequantdomestic[1]_kgco2e`. The wildcard `[1]` represents the energy source.

The following special cases modify the MJ calculations:

The mix of ethanol with petrol may be reported in `enethanolvehiclemix` in which case the MJ of ethanol includes the volume mixed into petrol.

The MJ values of diesel and biodiesel are adjusted based on the reported mixtures of biodiesel and diesel in each energy source so that the reported MJ only represent biodiesel and diesel rather than blends. The mix values for vehicle use may be found in `endieselvehiclemix` and `enbiodieselvehiclemix` where the latter is the mixture of reported biodiesel usage and the former is the mixture of reported diesel usage.

Vehicle energy sources use the same energy densities and emission factors as production/domestic sources. Several sources are reported for vehicles only and have the following values for

Energy Density

Density Kind	Reference	Name	Density
Volumetric (MJ per liter)	ethenol	Ethenol	23.4122

Density Kind	Reference	Name	Density
Gravimetric (MJ per kg)	ethenol	Ethenol	29.6666
Gravimetric (MJ per kg)	hydrogenr	Hydrogen - Renewable Source	141.9162
Gravimetric (MJ per kg)	hydrogennr	Hydrogen -Non- Renewable Source	141.9162

Emission Factor

Reference	Value	kg CO2e / MJ
ethenol	Ethenol	0.0719
hydrogennr	Hydrogen -Non- Renewable Source	0.0000
hydrogenr	Hydrogen - Renewable Source	0.0000

Note: FEM reports on emissions from scope 1 and 2 only so the scope 3 emissions for hydrogen are not in scope.

Wastewater Treatment

Biogenic carbon emissions from waste water treatment expressed in terms of kg CO2e may be found in the aggregate calculation under the ref_id `biogenicCO2e`.

[The US EPA reference for estimating biogenic emissions](https://www.epa.gov/air-emissions-factors-and-quantification/greenhouse-gas-emissions-estimation-methodologies-biogenic was used as the source for the calculations performed in FEM 2023.

The following emission formulas were used:

CO2 Emission Formula:

$$CO2 = 10^{-6} \times Qww \times OD \times EffOD \times CFCO2 \times [(1 - MCFww \times BGCH4)(1 - \lambda)]$$

CH4 Emission Formula:

$$CH4 = 10^{-6} \times Qww \times OD \times EffOD \times CFCH4 \times [(MCFww \times BGCH4)(1 - \lambda)]$$

Where

```
CO2   = CO2 emission rate (Mg CO2/hr)
CH4   = CH4 emission rate (Mg CH4/hr)
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10^-6 = Units conversion factor (Mg/g)
QWW   = Wastewater influent flow rate (m3/hr)
OD    = Oxygen demand of influent wastewater to the biological treatment
 ↪  unit determined as either BOD5 or COD (mg/L = g/m3)
EffOD = Oxygen demand removal efficiency of the biological treatment unit
CFCO2 = Conversion factor for maximum CO2 generation per unit of oxygen
 ↪  demand
44/32 = 1.375 g CO2/ g oxygen demand
CFCH4 = Conversion factor for maximum CH4 generation per unit of oxygen
 ↪  demand
16/32 = 0.5 g CH4/ g oxygen demand
MCFWW = methane correction factor for wastewater treatment unit, indicating
 ↪  the fraction of the influent oxygen demand that is converted
 ↪  anaerobically in the wastewater treatment unit
BGCH4 = Fraction of carbon as CH4 igenerated biogas (default is 0.65)
λ     = Biomass yield (g C converted to biomass/g C consumed in the
 ↪  wastewater treatment process).
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Wastewater Treatment Processes	MCF	λ	Assumptions	Additional Values
Aerated treatment process (e.g., activated sludge system), well managed	0	0.65	assume that the treatment plant is well managed	MCFWW = 0 λ = 0.65 CFCO2 = 1.375 g CO2/ g oxygen demand CFCH4 = 0.5 g CH4/ g oxygen demand
Anaerobic treatment process (e.g., anaerobic reactor)	0.8	0.1		MCFWW = 0.8 λ = 0.1 CFCO2 = 1.375 g CO2/ g oxygen demand CFCH4 = 0.5 g CH4/ g oxygen demand

Wastewater Treatment Processes	MCF	λ	Assumptions	Additional Values
Facultative lagoon, shallow (< 2 m deep)	0.2	0	assume that manufacturing facilities will not have lagoons that are more than 2 m deep	MCFWW = 0.2 λ = 0 CFCO2 = 1.375 g CO2/ g oxygen demand CFCH4 = 0.5 g CH4/ g oxygen demand
AR6 CH4 GWP (Feedback Included) - Non Fossil Origin	27.2			

For a given facility the treatment type used to assign values from table 2.3 are determined by applying the following logic to the values given for `wwbiologicalp[1]process` where the wild card `[1]` represents the waste water type (domestic, industrial, or combined).

Facility Selection	Treatment Type
Aerobic; Anaerobic; Facultative	Facultative
Aerobic; Anaerobic	Anaerobic
Facultative; Anaerobic	Anaerobic
Aerobic; Facultative	Facultative
Otherwise	Selected Option

For sub process calculations the process type given by the facility is used.

Refrigerants

Refrigerant use is reported in the Air Emissions section of FEM. Usage information can be found in the following ref_ids:

Kind	Reference
Usage	airrefrig[1]quant
Unit of Measure	airrefrig[1]uom

The wildcard `[1]` represents the refrigerant being reported on. The possible values may be found in the emission factor table for refrigerants that follows.

To calculate the kg of CO2e emissions due to refrigerant usage the quantity of refrigerant used is converted to kg and then multiplied by the emission factor found in the following table:

Reference	Value	kg CO2e per KG
r10	R-10 (PCC)	2200.0000
r11	R-11 (CFC)	5560.0000
r12	R-12 (CFC)	11200.0000
r12B1	R-12B1 (H)	1930.0000
r12B2	R-12B2 (H)	216.0000
r13	R-13 (CFC)	16200.0000
r13B1	R-13B1 (H)	7200.0000
r14	R-14 (PFC)	7380.0000
r20	R-20 (HCC)	16200.0000
r21	R-21 (HCFC)	160.0000
r22	R-22 (HCFC)	1960.0000
r22B1	R-22B1 (H)	380.0000
r23	R-23 (HFC)	14800.0000
r30	R-30 (HCC)	11.2000
r31	R-31 (HCFC)	79.4000
r32	R-32 (HFC)	771.0000
r40	R-40 (HCC)	5.5400
r41	R-41 (HFC)	135.0000
r50	R-50 (HC)	27.9000

Reference	Value	kg CO2e per KG
r110	R-110 (PCC)	
r111	R-111 (CFC)	
r112	R-112 (CFC)	4620.0000
r112A	R-112a (CFC)	3550.0000
r113	R-113 (CFC)	6520.0000
r113A	R-113a (CFC)	3930.0000
r114	R-114 (CFC)	9430.0000
r114A	R-114a (CFC)	7420.0000
r114B2	R-114B2 (H)	2170.0000
r115	R-115 (CFC)	9600.0000
r116	R-116 (PFC)	12400.0000
r120	R-120 (HCC)	
r121	R-121 (HCFC)	58.3000
r121A	R-121a (HCFC)	
r122	R-122 (HCFC)	56.4000
r122A	R-122a (HCFC)	245.0000
r122B	R-122b (HCFC)	772.0000
r123	R-123 (HCFC)	90.4000
r123A	R-123a (HCFC)	395.0000
r123B	R-123b (HCFC)	90.4000
r124	R-124 (HCFC)	597.0000
r124A	R-124a (HCFC)	2070.0000
r125	R-125 (HFC)	3500.0000
re125	R-E125 (HFC)	14900.0000
r130	R-130 (HCC)	9.0000
r130A	R-130a (HCC)	128.0000
r131	R-131 (HCFC)	30.0000

Reference	Value	kg CO2e per KG
r131A	R-131a (HCFC)	181.0000
r131B	R-131b (HCFC)	128.0000
r132	R-132 (HCFC)	122.0000
r132A	R-132a (HCFC)	70.4000
r132B	R-132b (HCFC)	332.0000
r132C	R-132c (HCFC)	342.0000
r132BB2	R-132bB2 (H)	
r133	R-133 (HCFC)	275.0000
r133A	R-133a (HCFC)	388.0000
r133B	R-133b (HCFC)	834.0000
r134	R-134 (HFC)	1260.0000
r134A	R-134a (HFC)	1530.0000
re134	R-E134 (HFC)	840.0000
r140	R-140 (HCC)	2.0000
r140A	R-140a (HCC)	161.0000
r141	R-141 (HCFC)	46.6000
r141B2	R-141B2 (H)	
r141A	R-141a (HCFC)	46.6000
r141B	R-141b (HCFC)	860.0000
r142	R-142 (HCFC)	189.0000
r142A	R-142a (HCFC)	175.0000
r142B	R-142b (HCFC)	2300.0000
r143	R-143 (HFC)	353.0000
r143A	R-143a (HFC)	4470.0000
r143M	R-143m (HFC)	607.0000
re143A	R-E143a (HFC)	5810.0000
r150	R-150 (HCC)	1.0000

Reference	Value	kg CO2e per KG
r150A	R-150a (HCC)	4.0000
r151	R-151 (HCFC)	12.0000
r151A	R-151a (HCFC)	58.0000
r152	R-152 (HFC)	21.5000
r152A	R-152a (HFC)	164.0000
r160	R-160 (HCC)	0.4810
r161	R-161 (HFC)	4.8400
r170	R-170 (HC)	0.4370
re170	R-E170 (HC)	0.0000
r211	R-211 (CFC)	
r212	R-212 (CFC)	
r213	R-213 (CFC)	
r214	R-214 (CFC)	
r215	R-215 (CFC)	
r216	R-216 (CFC)	
r216Ca	R-216ca (CFC)	7540.0000
r217	R-217 (CFC)	
r217Ba	R-217ba (CFC)	
r218	R-218 (PFC)	9290.0000
r221	R-221 (HCFC)	110.0000
r222	R-222 (HCFC)	500.0000
r222C	R-222c (HCFC)	73.0000
r223	R-223 (HCFC)	695.0000
r223Ca	R-223ca (HCFC)	90.0000
r223Cb	R-223cb (HCFC)	258.0000
r224	R-224 (HCFC)	1095.0000
r224Ca	R-224ca (HCFC)	142.0000

Reference	Value	kg CO2e per KG
r224Cb	R-224cb (HCFC)	116.0000
r224Cc	R-224cc (HCFC)	1180.0000
r225	R-225 (HCFC)	1560.0000
r225Aa	R-225aa (HCFC)	1040.0000
r225Ba	R-225ba (HCFC)	350.0000
r225Bb	R-225bb (HCFC)	1650.0000
r225Ca	R-225ca (HCFC)	137.0000
r225Cb	R-225cb (HCFC)	568.0000
r225Cc	R-225cc (HCFC)	1580.0000
r225Da	R-225da (HCFC)	1620.0000
r225Ea	R-225ea (HCFC)	1700.0000
r225Eb	R-225eb (HCFC)	1270.0000
r226	R-226 (HCFC)	2455.0000
r226Ba	R-226ba (HCFC)	1630.0000
r226Ca	R-226ca (HCFC)	509.0000
r226Cb	R-226cb (HCFC)	2610.0000
r226Da	R-226da (HCFC)	2630.0000
r226Ea	R-226ea (HCFC)	2680.0000
r227Ca	R-227ca (HFC)	3180.0000
r227Ca2	R-227ca2 (HFC)	3640.0000
r227Ea	R-227ea (HFC)	3220.0000
r227Me	R-227me (HFC)	6930.0000
r231	R-231 (HCFC)	350.0000
r232	R-232 (HCFC)	690.0000
r232Ca	R-232ca (HCFC)	27.0000
r232Cb	R-232cb (HCFC)	278.0000
r233	R-233 (HCFC)	1495.0000

Reference	Value	kg CO2e per KG
r233Ca	R-233ca (HCFC)	71.0000
r233Cb	R-233cb (HCFC)	372.0000
r233Cc	R-233cc (HCFC)	501.0000
r234	R-234 (HCFC)	3490.0000
r234Aa	R-234aa (HCFC)	464.0000
r234Ab	R-234ab (HCFC)	291.0000
r234Ba	R-234ba (HCFC)	260.0000
r234Bb	R-234bb (HCFC)	376.0000
r234Bc	R-234bc (HCFC)	695.0000
r234Ca	R-234ca (HCFC)	199.0000
r234Cb	R-234cb (HCFC)	116.0000
r234Cc	R-234cc (HCFC)	900.0000
r234Cd	R-234cd (HCFC)	665.0000
r234Da	R-234da (HCFC)	195.0000
r234Fa	R-234fa (HCFC)	3700.0000
r234Fb	R-234fb (HCFC)	3310.0000
r235	R-235 (HCFC)	5320.0000
r235Ca	R-235ca (HCFC)	583.0000
r235Cb	R-235cb (HCFC)	410.0000
r235Cc	R-235cc (HCFC)	1560.0000
r235Da	R-235da (HCFC)	491.0000
r235Fa	R-235fa (HCFC)	580.0000
r236Cb	R-236cb (HFC)	1340.0000
r236Ea	R-236ea (HFC)	1370.0000
r236Fa	R-236fa (HFC)	9810.0000
r236Me	R-236me (HFC)	988.0000
rfe36	R-FE-36 (HFC)	2630.0000

Reference	Value	kg CO2e per KG
r241	R-241 (HCFC)	450.0000
r242	R-242 (HCFC)	1025.0000
r243	R-243 (HCFC)	2060.0000
r243Ca	R-243ca (HCFC)	213.0000
r243Cb	R-243cb (HCFC)	95.0000
r243Cc	R-243cc (HCFC)	2060.0000
r243Da	R-243da (HCFC)	125.0000
r243Ea	R-243ea (HCFC)	105.0000
r243Ec	R-243ec (HCFC)	119.0000
r244	R-244 (HCFC)	3360.0000
r244Ba	R-244ba (HCFC)	388.0000
r244Bb	R-244bb (HCFC)	1770.0000
r244Ca	R-244ca (HCFC)	487.0000
r244Cb	R-244cb (HCFC)	315.0000
r244Cc	R-244cc (HCFC)	3620.0000
r244Da	R-244da (HCFC)	313.0000
r244Db	R-244db (HCFC)	177.0000
r244Ea	R-244ea (HCFC)	201.0000
r244Eb	R-244eb (HCFC)	137.0000
r244Ec	R-244ec (HCFC)	284.0000
r244Fa	R-244fa (HCFC)	197.0000
r244Fb	R-244fb (HCFC)	976.0000
r245Ca	R-245ca (HFC)	787.0000
r245Cb	R-245cb (HFC)	4550.0000
r245Ea	R-245ea (HFC)	255.0000
r245Eb	R-245eb (HFC)	325.0000
r245Fa	R-245fa (HFC)	962.0000

Reference	Value	kg CO2e per KG
r245Mc	R-245mc (HFC)	649.0000
r245Mf	R-245mf (HFC)	
r245Qc	R-245qc (HFC)	
r251	R-251 (HCFC)	
r252	R-252 (HCFC)	
r252Ca	R-252ca (HCFC)	136.0000
r252Cb	R-252cb (HCFC)	77.0000
r252Dc	R-252dc (HCFC)	50.0000
r252Ec	R-252ec (HCFC)	65.0000
r253	R-253 (HCFC)	
r253Ba	R-253ba (HCFC)	233.0000
r253Bb	R-253bb (HCFC)	722.0000
r253Ca	R-253ca (HCFC)	285.0000
r253Cb	R-253cb (HCFC)	319.0000
r253Ea	R-253ea (HCFC)	81.0000
r253Eb	R-253eb (HCFC)	93.0000
r253Ec	R-253ec (HCFC)	102.0000
r253Fa	R-253fa (HCFC)	157.0000
r253Fb	R-253fb (HCFC)	65.0000
r253Fc	R-253fc (HCFC)	143.0000
r254Cb	R-254cb (HFC)	
r254Pc	R-254pc (HFC)	
r261	R-261 (HCFC)	
r261Ba	R-261ba (HCFC)	90.0000
r262	R-262 (HCFC)	
r262Ca	R-262ca (HCFC)	214.0000
r262Fa	R-262fa (HCFC)	40.0000

Reference	Value	kg CO2e per KG
r262Fb	R-262fb (HCFC)	49.0000
r263	R-263 (HFC)	
r271	R-271 (HCFC)	
r271B	R-271b (HCFC)	362.0000
r271D	R-271d (HCFC)	4.0000
r271Fb	R-271fb (HCFC)	22.0000
r272	R-272 (HFC)	
r281	R-281 (HFC)	
r290	R-290 (HC)	20.0000
rc316	R-C316 (CFC)	
rc317	R-C317 (CFC)	
rc318	R-C318 (PFC)	10200.0000
r3110	R-3-1-10 (PFC)	10000.0000
r329Ccb	R-329ccb (HFC)	2360.0000
r338Eea	R-338eea (HFC)	1320.0000
r347Ccd	R-347ccd (HFC)	3060.0000
r347Mcc	R-347mcc (HFC)	
r347Mmy	R-347mmy (HFC)	
r365Mfc	R-365mfc (HFC)	914.0000
r4112	R-4-1-12 (PFC)	9220.0000
r5114	R-5-1-14 (PFC)	8620.0000
r400	R-400 (CFC)	
r401A	R-401A (HCFC)	16.0000
r401B	R-401B (HCFC)	14.0000
r401C	R-401C (HCFC)	19.0000
r402A	R-402A (HCFC)	2100.0000
r402B	R-402B (HCFC)	1330.0000

Reference	Value	kg CO2e per KG
r403A	R-403A (HCFC)	3124.0000
r403B	R-403B (HCFC)	3444.0000
r404A	R-404A (HFC)	4728.0000
r405A	R-405A (HCFC)	5328.0000
r406A	R-406A (HCFC)	1943.0000
r406B	R-406B (HCFC)	1839.0000
r407A	R-407A (HFC)	2262.0000
r407B	R-407B (HFC)	3001.0000
r407C	R-407C (HFC)	1908.0000
r407D	R-407D (HFC)	1748.0000
r407E	R-407E (HFC)	1672.0000
r407F	R-407F (HFC)	1965.0000
r408A	R-408A (HCFC)	3000.0000
r409A	R-409A (HCFC)	1600.0000
r409B	R-409B (HCFC)	1560.0000
r410A	R-410A (HFC)	2256.0000
r410B	R-410B (HFC)	2404.0000
r411A	R-411A (HCFO)	14.0000
r411B	R-411B (HCFO)	4.0000
r411C	R-411C (HCFO)	1730.0000
r412A	R-412A (HCFC)	2286.0000
r413A	R-413A (HFC)	2183.0000
r414A	R-414A (HCFC)	0.0000
r414B	R-414B (HCFC)	0.0000
r415A	R-415A (HCFC)	1507.0000
r415B	R-415B (HCFC)	546.0000
r416A	R-416A (HCFC)	1084.0000

Reference	Value	kg CO2e per KG
r417A	R-417A (HFC)	2508.0000
r417B	R-417B (HFC)	3235.0000
r418A	R-418A (HCFC)	1741.0000
r419A	R-419A (HFC)	3171.0000
r420A	R-420A (HCFC)	1548.0000
r421A	R-421A (HFC)	2812.0000
r421B	R-421B (HFC)	3409.0000
r422A	R-422A (HFC)	3359.0000
r422B	R-422B (HFC)	2700.0000
r422C	R-422C (HFC)	3296.0000
r422D	R-422D (HFC)	2917.0000
r423A	R-423A (HFC)	2513.0000
r424A	R-424A (HFC)	2608.0000
r425A	R-425A (HFC)	1638.0000
r426A	R-426A (HFC)	1614.0000
r427A	R-427A (HFC)	2397.0000
r428A	R-428A (HFC)	4061.0000
r429A	R-429A (HFC)	16.0000
r430A	R-430A (HFC)	125.0000
r431A	R-431A (HFC)	48.0000
r432A	R-432A (HO)	
r433A	R-433A (HO)	20.0000
r433B	R-433B (HO)	20.0000
r433C	R-433C (HO)	20.0000
r434A	R-434A (HFC)	3654.0000
r435A	R-435A (HFC)	33.0000
r436A	R-436A (HC)	0.0000

Reference	Value	kg CO2e per KG
r436B	R-436B (HC)	0.0000
r437A	R-437A (HFC)	1930.0000
r438A	R-438A (HFC)	2425.0000
r439A	R-439A (HFC)	2143.0000
r440A	R-440A (HFC)	185.0000
r441A	R-441A (HC)	20.0000
r500	R-500 (HCFC)	8100.0000
r501	R-501 (HCFC)	0.0000
r502	R-502 (CFC)	0.0000
r503	R-503 (HCFC)	4692.0000
r504	R-504 (HCFC)	313.0000
r505	R-505 (HCFC)	0.0000
r506	R-506 (HCFC)	0.0000
r507A	R-507[A] (HFC)	3300.0000
r508A	R-508[A] (HFC)	10175.0000
r508B	R-508B (HFC)	10350.0000
r509A	R-509[A] (HCFC)	3920.0000
r510A	R-510[A] (HC)	0.0000
r511A	R-511[A] (HC)	0.0000
r600	R-600 (HC)	0.0060
r600A	R-600a (HC)	0.0000
r601	R-601 (HC)	20.0000
r601A	R-601a (HC)	20.0000
r610	R-610 (HC)	
r611	R-611 (HC)	25.0000
r630	R-630	
r631	R-631	

Reference	Value	kg CO2e per KG
r702	R-702	5.8000
r704	R-704	
r717	R-717	
r718	R-718	
r720	R-720	
r728	R-728	
r729	R-729	
r732	R-732	
r740	R-740	
r744	R-744	1.0000
r744A	R-744A	298.0000
r764	R-764	
r784	R-784	
r1112A	R-1112a (CFO)	
r1113	R-1113 (CFO)	12.0000
r1114	R-1114 (PFO)	6.5000
r1120	R-1120 (HCO)	
r1130	R-1130 (HCO)	
r1132A	R-1132a (HFO)	1.7000
r1140	R-1140 (HCO)	
r1141	R-1141 (HFO)	0.0200
r1150	R-1150 (HO)	6.8000
r1216	R-1216 (PFO)	8.7000
r1218	R-1218 (PFO)	
r1233Zd	R-1233zd (HCFO)	
r1234Yf	R-1234yf (HFO)	
r1234Ze	R-1234ze (HFO)	1.4000

Reference	Value	kg CO2e per KG
r1270	R-1270 (HO)	20.0000

Empty values result in a value of 0 kg CO2e per kg of refrigerant.

Aggregates

Note: No aggregate calculations documented here incorporate biogenic emissions from waste water or account for EACs reported in the FEM Energy Section Question 3 `ensourcepurcheac` and its children.

Aggregates Existing Prior to FEM 2023

`ensource[1]total`

Total MJ of energy across all facility types, domestic and vehicle usage from the source represented by the wild card `[1]`

`ensource[1]totalghg`

Total kg CO2e of energy across all facility types, domestic and vehicle usage from the source represented by the wild card `[1]`

`totalRenewableEmissions`

Total kg CO2e of energy across all facility types, domestic and vehicle usage from all renewable energy sources (includes biomass)

`totalNonRenewableEnergyEmissions`

Total kg CO2e of energy across all facility types, domestic and vehicle usage from all sources (does not include refrigerants)

`totalRefrigerantEmissions`

Total kg CO2e of emissions from refrigerants

`totalNonRenewableEmissions`

Total kg CO2e of energy across all facility types, domestic and vehicle usage from all non-renewable sources (does include refrigerants)

`totalGHGemissions`

Total kg CO2e emissions from all energy sources and refrigerants

Aggregates Added in FEM 2023

`domestic_total_mj`

Total MJ of energy used for domestic purposes. Only has a value if the facility reported production and domestic usage separately.

`domestic_total_kgco2e`

Total kg CO2e of emissions from energy used for domestic purposes. Only has a value if the facility reported production and domestic usage separately.

`vehicle_total_mj`

Total MJ of energy used by vehicles.

`vehicle_total_kgco2e`

Total kg CO2e of emissions from vehicles.

`[2]_mj`

Total MJ of energy used across all sources for the facility type represented by the wild card `[2]`

`[2]_total_mj`

Total MJ of energy used across all sources for the facility type represented by the wild card `[2]`. Includes domestic and vehicle usage added evenly across each facility type.

`[2]_normalized_mj`

Total MJ of energy used per unit produced across all sources for the facility type represented by the wild card `[2]`. Includes domestic and vehicle usage added evenly across each facility type. The unit total and unit of measure can be found in `sipfacilityannualprodvolquant[2]` and `sipfacilityannualprodvolunits[2]` respectively.

`[2]_kgco2e`

Total kg CO2e of emissions across all energy sources for the facility type represented by the wild card `[2]`

`[2]_total_kgco2e`

Total kg CO2e of emissions produced across all energy sources for the facility type represented by the wild card `[2]`. Includes domestic and vehicle usage added evenly across each facility type.

`[2]_normalized_kgco2e`

Total kg CO2e of emissions per unit produced across all energy sources for the facility type represented by the wild card `[2]`. Includes domestic and vehicle usage added evenly across each facility type. The unit total and unit of measure can be found in `sipfacilityannualprodvolquant[2]` and `sipfacilityannualprodvolunits[2]` respectively.

Aggregates Added in FEM 2024

No new aggregate calculations have been added in FEM 2024.

Additional Aggregates

Additional aggregations may be found in exports and other reporting. They are documented in the data dictionary or report specific documentation as appropriate.