



*Preparing a Greenhouse Gas  
Inventory 101*

April 11, 2018

*Department of Environmental Quality*



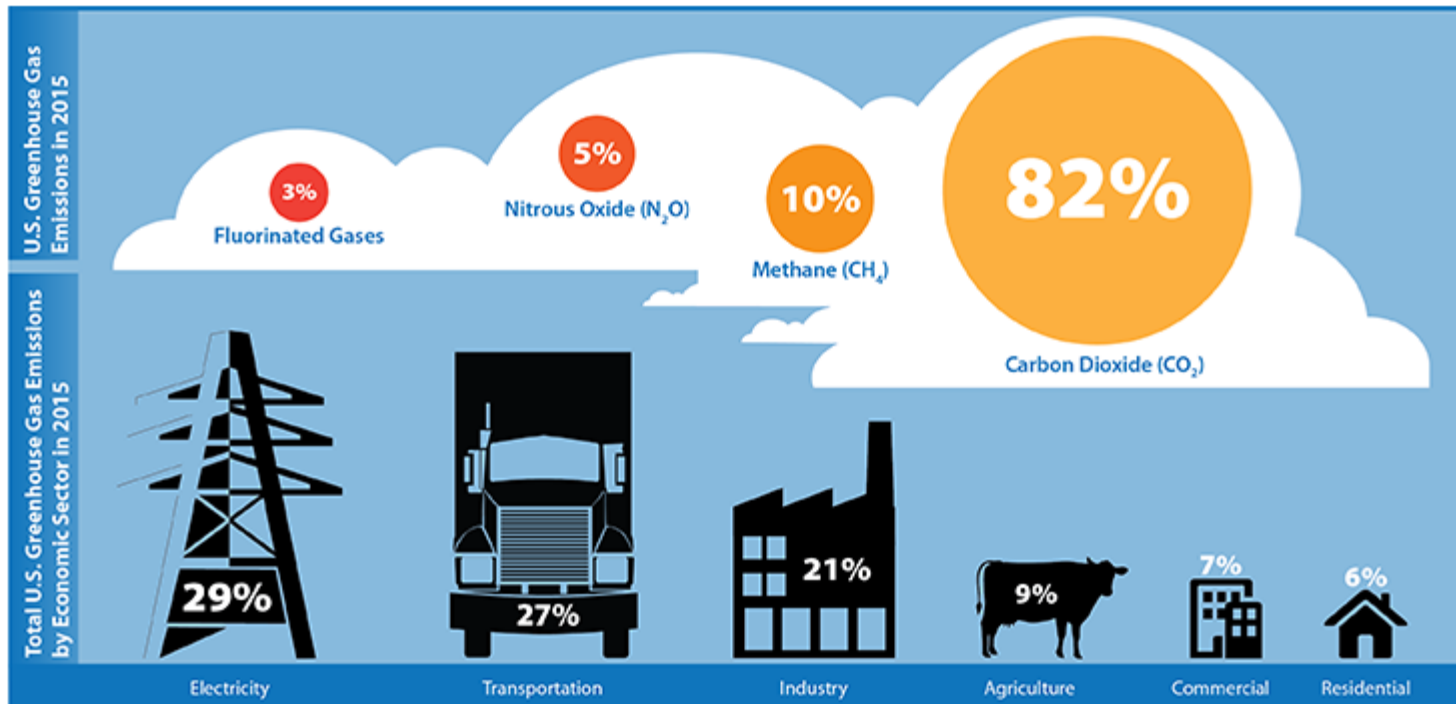
# *Outline*

- GHG Pollutants
- CO<sub>2</sub>e: Carbon Dioxide Equivalent
- Preparing a GHG Inventory
  - Emission Calculation Methods
  - NC DAQ Emissions Calculation Spreadsheets
- Reporting GHG emissions



# GHG Pollutants

- Carbon Dioxide (CO<sub>2</sub>)
- Methane (CH<sub>4</sub>)
- Nitrous Oxide (N<sub>2</sub>O)
- Sulfur Hexafluoride (SF<sub>6</sub>)
- Perfluorocarbons (PFCs)
- Hydrofluorocarbons (HFCs)
- Other Fluorinated Gases



Source: [https://www.epa.gov/sites/production/files/2018-02/documents/fastfacts\\_20170817-508\\_0.pdf](https://www.epa.gov/sites/production/files/2018-02/documents/fastfacts_20170817-508_0.pdf)



# *CO<sub>2</sub>e: Carbon Dioxide Equivalent*

CO<sub>2</sub> is the most abundant GHG –

- Used as the basis for normalizing all GHG emissions
- GHG emissions are converted to the *equivalent amount of CO<sub>2</sub>*, or “carbon dioxide equivalent” (**CO<sub>2</sub>e**)

Each GHG has a unique conversion factor for calculating CO<sub>2</sub>e, called the **Global Warming Potential (GWP)**

- GWP incorporates both the heat-trapping ability and atmospheric lifetime of each GHG
  - Generally uses 100 year time horizon values
- It is used to adjust all GHG emissions relative to the GWP of CO<sub>2</sub>, which allows for summing and comparing emissions data of various GHGs



# Convert GHG Emissions to CO<sub>2</sub>e using GWP

- Multiply emissions of any GHG by its GWP to get CO<sub>2</sub>e
- Example:
  - CH<sub>4</sub> has a GWP of 25
  - 1 MTCH<sub>4</sub> x 25 = 25 MTCO<sub>2</sub>e

Pollutant	GWP Value for 100-year time horizon
Carbon Dioxide (CO <sub>2</sub> )	1
Methane (CH <sub>4</sub> )	25
Nitrous Oxide (N <sub>2</sub> O)	298
Sulfur Hexafluoride (SF <sub>6</sub> )	22,800
Perfluorocarbons (PFCs)	6,288-17,340*
Hydrofluorocarbons (HFCs)	12-14,800*
Other Fluorinated Gases	0.003-17,700*

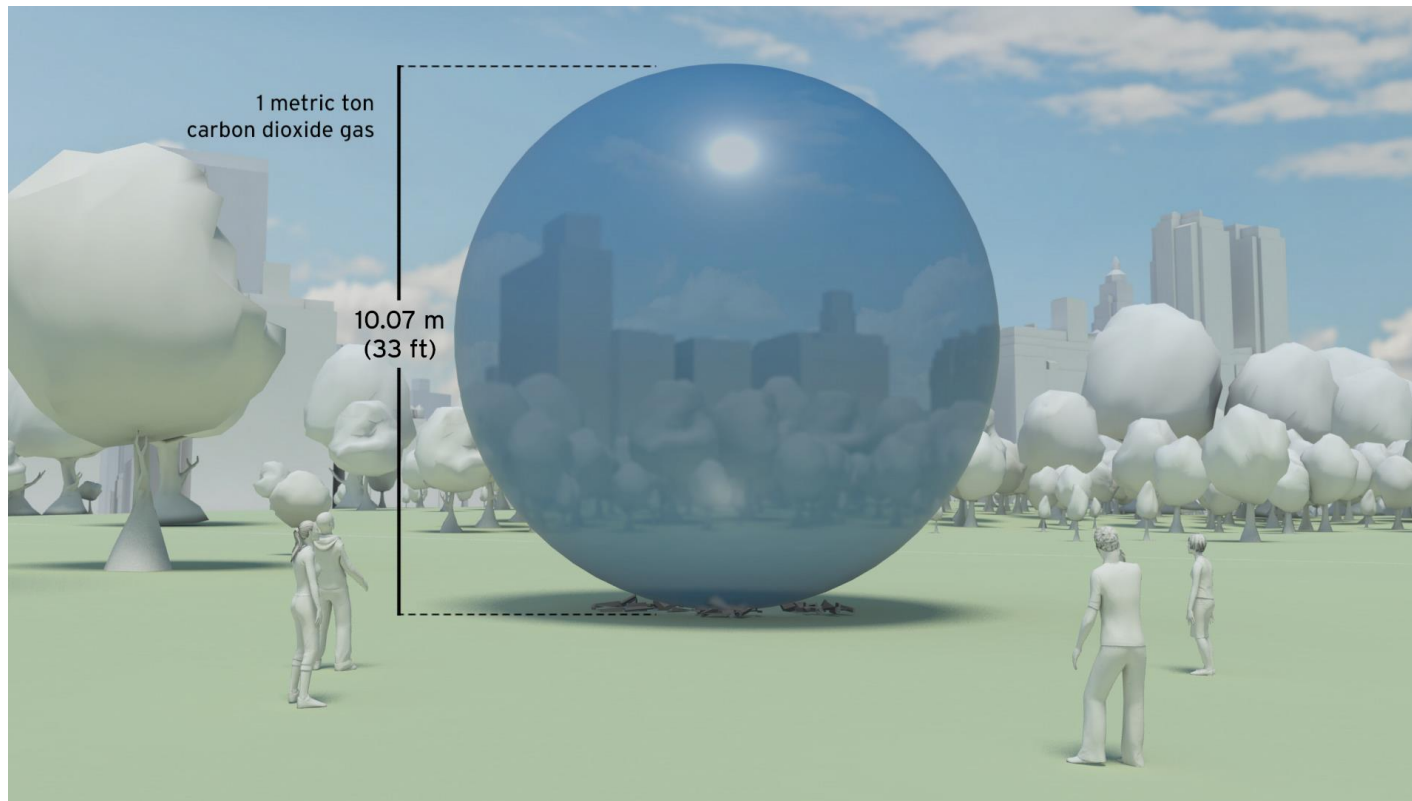
\*Note: Detailed data can be found in Table A-1 to Subpart A of Part 98 - Global Warming Potentials (link below)  
Source: "Table A-1 to Subpart A of Part 98 - Global Warming Potentials," [https://www.ecfr.gov/cgi-bin/text-id.x?SID=ba63cadd5e6df5f73729ced3d17407d3&mc=true&node=pt40.23.98&rgn=div5#ap40.23.98\\_19.1](https://www.ecfr.gov/cgi-bin/text-id.x?SID=ba63cadd5e6df5f73729ced3d17407d3&mc=true&node=pt40.23.98&rgn=div5#ap40.23.98_19.1)



# *CO<sub>2</sub>e Common Measurement Units*

## **GHG Emissions *usually* reported in metric tons of CO<sub>2</sub>e**

- Metric tons CO<sub>2</sub>e = tonnes CO<sub>2</sub>e = MTCO<sub>2</sub>e = 1000 kilograms CO<sub>2</sub>e
- 1 MTCO<sub>2</sub>e = 10<sup>-6</sup> MMTCO<sub>2</sub>e
- 1 metric ton = 1.10231 short ton
- 1 short ton = 2,000 pounds

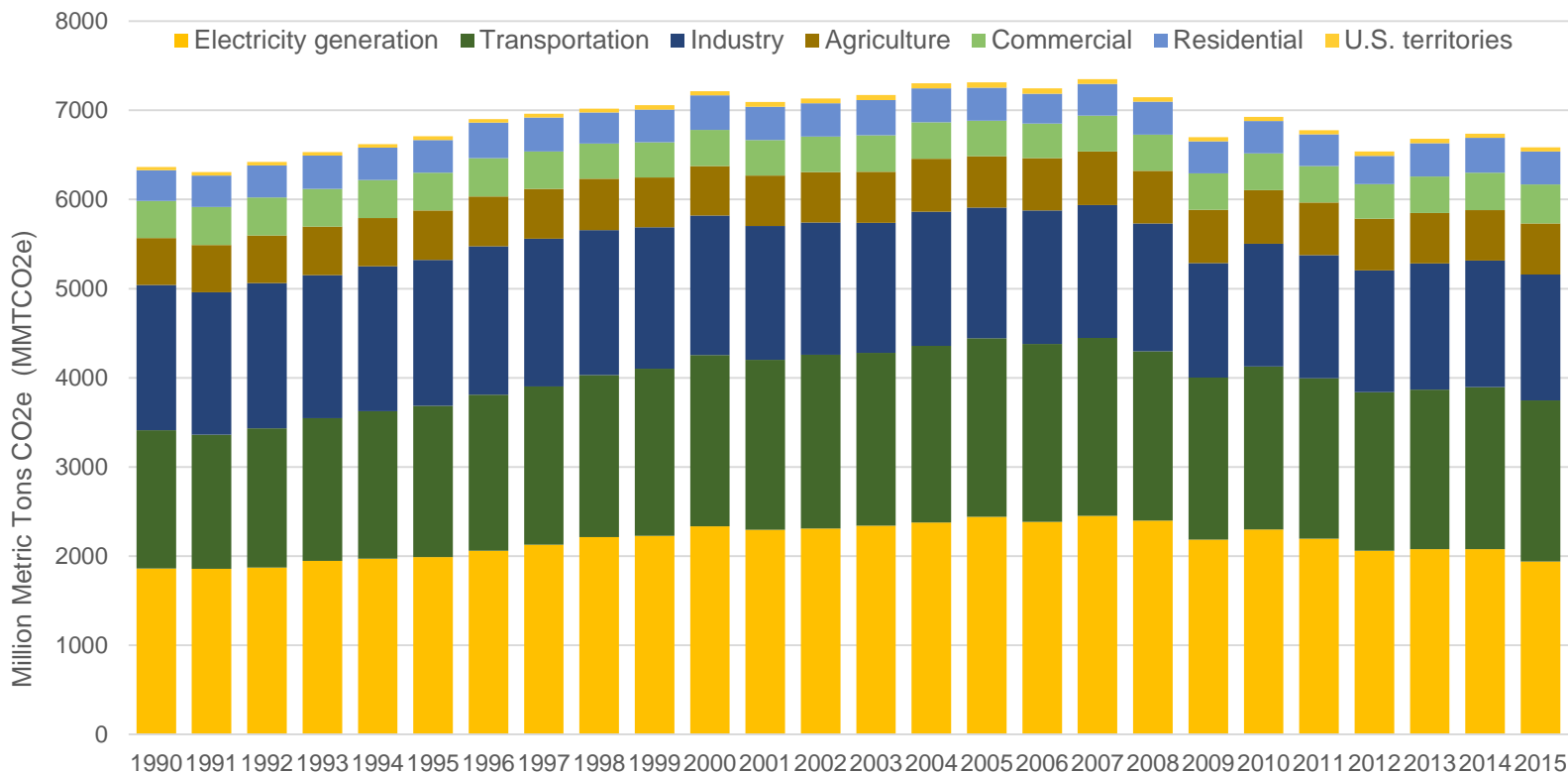


Source: <http://www.carbonvisuals.com/projects/wbcsl>



# Preparing a GHG Inventory: Top-down method

- Start from annual emissions assessed at a national level for each sector
- Allocate emissions to each state based on state level activity data for each sector
  - Eg. Local energy use, population, fuel sales, etc.
- Main reason for top-down method:
  - Some activity data may be confidential or difficult to obtain



U.S. GHG Emissions by Economic Sector, 1990-2015



Source: U.S. EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2015  
<https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks>

# *Preparing a GHG Inventory: Bottom-up method*

- Direct Measurement approach:
  - Direct Measurement via Continuous Emission Monitoring System (CEMS)
- Activity Data Approach:
  - Start from local or facility level activity data (Fuel usage; Coal, Diesel, Natural Gas, etc.)
  - Use the activity data and appropriate emission factors for each GHG to calculate GHG emissions in MT for primary sources in a facility.
  - Common GHG emission sources include: Combustion – boilers, turbines, engines, ovens, furnaces, kilns, incinerators, etc
- Always ensure all emissions are in units of MTCO<sub>2</sub>e





# GHG Emission Calculation Methods

## Calculation using Published Emission Factors (EFs)

- CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O Default Emission Factors according to fuel type and combustion source can be found in “Emission Factors for Greenhouse Gas Inventories” from the EPA Center for Corporate Climate Leadership
- Fluorinated Gas Emissions: [https://www.ecfr.gov/cgi-bin/text-idx?SID=ba63cadb5e6df5f73729ced3d17407d3&mc=true&node=pt40.23.98&rgn=div5#se40.23.98\\_1123](https://www.ecfr.gov/cgi-bin/text-idx?SID=ba63cadb5e6df5f73729ced3d17407d3&mc=true&node=pt40.23.98&rgn=div5#se40.23.98_1123)

**Table 1** Stationary Combustion

Fuel Type	Heat Content (HHV)	CO <sub>2</sub> Factor	CH <sub>4</sub> Factor	N <sub>2</sub> O Factor	CO <sub>2</sub> Factor	CH <sub>4</sub> Factor	N <sub>2</sub> O Factor
	mmBtu per short ton	kg CO <sub>2</sub> per mmBtu	g CH <sub>4</sub> per mmBtu	g N <sub>2</sub> O per mmBtu	kg CO <sub>2</sub> per short ton	g CH <sub>4</sub> per short ton	g N <sub>2</sub> O per short ton
<b>Coal and Coke</b>							
Anthracite Coal	25.09	103.69	11	1.6	2,602	276	40
Bituminous Coal	24.93	93.28	11	1.6	2,325	274	40
Sub-bituminous Coal	17.25	97.17	11	1.6	1,676	190	28
Lignite Coal	14.21	97.72	11	1.6	1,389	156	23
Mixed (Commercial Sector)	21.39	94.27	11	1.6	2,016	235	34
Mixed (Electric Power Sector)	19.73	95.52	11	1.6	1,885	217	32
Mixed (Industrial Coking)	26.28	93.90	11	1.6	2,468	289	42
Mixed (Industrial Sector)	22.35	94.67	11	1.6	2,116	246	36
Coal Coke	24.80	113.67	11	1.6	2,819	273	40
<b>Other Fuels - Solid</b>							
Municipal Solid Waste	9.95	90.70	32	4.2	902	318	42
Petroleum Coke (Solid)	30.00	102.41	32	4.2	3,072	960	126
Plastics	38.00	75.00	32	4.2	2,850	1,216	160
Tires	28.00	85.97	32	4.2	2,407	896	118
<b>Biomass Fuels - Solid</b>							
Agricultural Byproducts	8.25	118.17	32	4.2	975	264	35
Peat	8.00	111.84	32	4.2	895	256	34
Solid Byproducts	10.39	105.51	32	4.2	1,096	332	44
Wood and Wood Residuals	17.48	93.80	7.2	3.6	1,640	126	63
	mmBtu per scf	kg CO <sub>2</sub> per mmBtu	g CH <sub>4</sub> per mmBtu	g N <sub>2</sub> O per mmBtu	kg CO <sub>2</sub> per scf	g CH <sub>4</sub> per scf	g N <sub>2</sub> O per scf
<b>Natural Gas</b>							
Natural Gas	0.001026	53.06	1.0	0.10	0.05444	0.00103	0.00010

\*Source: [https://www.epa.gov/sites/production/files/2018-03/documents/emission-factors\\_mar\\_2018\\_0.pdf](https://www.epa.gov/sites/production/files/2018-03/documents/emission-factors_mar_2018_0.pdf)

# *Emission Factor Method*

$$\frac{\text{Tons GHG emissions}}{\text{year}} =$$

*Activity data* (Quantity of fuel combusted in tons, SCF, gallons, etc.)

\* *Emission Factor* (tons GHG emitted per unit of fuel)

- **CO<sub>2</sub> Emissions:**

- Activity Data: Based on quantity of fuel combusted
- Emission Factor: Based on fuel carbon content and heating value

- **CH<sub>4</sub> and N<sub>2</sub>O Emissions:**

- Activity Data: Based on quantity of fuel combusted
- Emission Factor: Based on fuel type and combustor technology type



# *NC DAQ Emission Calculation Spreadsheets*

## **Spreadsheets available with GHG emissions calculations:**

- Coal Combustion
- Fuel Oil Combustion
- Internal Combustion (large gasoline and diesel engines)
- Internal Combustion (small gasoline and diesel engines)
- LPG Combustion
- Natural Gas Combustion
- Wood Waste Combustion

All spreadsheets can be found and downloaded here:

<https://deq.nc.gov/about/divisions/air-quality/air-quality-permits/application-forms-instructions/application-forms-air-quality-permit-construct-operate-non-title-v-title-v-facilities/spreadsheets>



# Internal Combustion (Small Gasoline and Diesel Engines) Emission Estimation Spreadsheet Input, Part 1

**GAS & DIESEL INTERNAL COMBUSTION ENGINES with power rating of <= 600 HP for diesel engines and <= 250 HP for gasoline engines  
EMISSIONS CALCULATOR REVISION S 6/22/2015 - INPUT SCREEN**



Instructions: Enter emission source / facility data on the "INPUT" tab/screen. The air emission results and summary of input data are viewed/printed on the "OUTPUT" tab/screen. The different tabs are on the bottom of this screen.

This spreadsheet is for your use only and should be used with caution. DENR does not guarantee the accuracy of the information contained. This spreadsheet is subject to continual revision and updating. It is your responsibility to be aware of the most current information available. DENR is not responsible for errors or omissions that may be contained herein.

### FIELDS

COMPANY NAME:  
FACILITY ID NUMBER:  
PERMIT NUMBER  
FACILITY CITY:  
FACILITY COUNTY:  
SPREADSHEET PREPARED BY:

EMISSION SOURCE ID NO.:

RATING and FUEL TYPE

SULFUR CONTENT OF DIESEL FUEL (%)

### SELECTIONS

FACILITY NAME, INC
1800250
9999R02
ANYTOWN
ANYCOUNTY
initials
ES-1

HP POWER OUTPUT, DIESEL ▼

### FUEL HEATING VALUE

FUEL HEATING VALUE (BTU/GAL):  BTU/GAL is equal to  mm Btu/gal

DEFAULT VALUES BY FUEL TYPE (not used for Greenhouse Gas calcs --See below for GHG defaults):

116,485 BTU/GALLON GASOLINE

140,000 BTU/GALLON DIESEL

### USAGE DATA

ACTUALS (GALLONS COMBUSTED OR HRS OF OPERATION)  GALS COMBUSTED ▼

REQUESTED ANNUAL LIMITATION (GALLONS COMBUSTED OR HRS OF OPERATION)  GALS COMBUSTED ▼

# Internal Combustion (Small Gasoline and Diesel Engines) Emission Estimation Spreadsheet Input, Part 2

## ADDITIONAL INFORMATION FOR GREENHOUSE GAS (GHG) EMISSIONS

ENTER CALCULATION TIER

from EPA Mandatory Reporting Rule (MRR) Subpart C -  
[www.epa.gov/climatechange/emissions/ghgrulemaking.html](http://www.epa.gov/climatechange/emissions/ghgrulemaking.html)

NOTE: EF is "Emission Factor"

TIER 1: DEFAULT HIGH HEAT VALUE AND DEFAULT EF ▼

SELECT FUEL TYPE (more detailed fuel type needed for GHGs)

DISTILLATE #2 ▼

SINCE TIER 3 IS NOT BEING USED,  
FUEL CARBON CONTENT WILL NOT BE USED

7.0000

kg Carbon/gal

### HIGH HEAT VALUE (HHV) FOR GHGs

FOR TIER 1 and TIER 3, the FUEL HEATING VALUE entered above is overridden with the EPA DEFAULT from Table C-1 of the EPA MRR:

GASOLINE (Motor)	0.125 mm Btu/gal	
DISTILLATE #1	0.139 mm Btu/gal	
DISTILLATE #2	0.138 mm Btu/gal	THIS VALUE WILL BE USED
DISTILLATE #4	0.146 mm Btu/gal	
RESIDUAL #5	0.14 mm Btu/gal	
RESIDUAL #6	0.15 mm Btu/gal	

FOR TIER 2, the FUEL HEATING VALUE entered above is used. The value entered must be the annual average HHV of the fuel determined using procedures in the EPA MRR (see 98.33(a)(2) )

### HHV TO BE USED FOR GHG IS:

DISTILLATE #2	DEFAULT HHV OF	0.1380	mm Btu/gal	THIS VALUE WILL BE USED
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# *Internal Combustion (Small Gasoline and Diesel Engines) Emission Estimation Spreadsheet GHG Output*

GREENHOUSE GAS EMISSIONS INFORMATION (FOR EMISSIONS INVENTORY PURPOSES) - CONSISTENT WITH EPA MANDATORY REPORTING RULE (MRR) METHOD				GHG - POTENTIAL TO EMIT NOT BASED ON EPA MRR METHOD			
DISTILLATE #2	ACTUAL EMISSIONS			POTENTIAL EMISSIONS - utilize max heat input capacity or horsepower and EPA MRR Emission Factors		POTENTIAL EMISSIONS With Requested Emission Limitation - utilize requested fuel limit and EPA MRR Emission Factors	
GREENHOUSE GAS EMITTED	EPA MRR CALCULATION METHOD: TIER 1			short tons/yr	short tons/yr, CO2e	short tons/yr	short tons/yr, CO2e
	metric tons/yr	metric tons/yr, CO2e	short tons/yr				
CARBON DIOXIDE (CO <sub>2</sub> )	285.78	285.78	315.02	2,499.61	2,499.61	319.59	319.59
METHANE (CH <sub>4</sub> )	1.16E-02	2.90E-01	1.28E-02	1.01E-01	2.53E+00	1.28E-02	3.19E-01
NITROUS OXIDE (N <sub>2</sub> O)	2.32E-03	6.91E-01	2.56E-03	2.03E-02	6.04E+00	2.56E-03	7.62E-01
	<b>TOTAL</b>	<b>286.76</b>		<b>TOTAL</b>	<b>2,508.19</b>	<b>TOTAL</b>	<b>320.67</b>

NOTE: CO2e means CO2 equivalent.

NOTE: The DAQ Air Emissions Reporting Online (AERO) system requires short tons be reported. The EPA MRR requires metric tons be reported.

NOTE: Do not use greenhouse gas emission estimates from this spreadsheet for PSD (Prevention of Significant Deterioration) purposes.

- Always make sure CH<sub>4</sub> and N<sub>2</sub>O emissions are converted into units of CO<sub>2</sub>e using the proper GWP
- Double check your entries in the Input tab
  - Units
  - Fuel Type



# *GHG Emissions Reporting*

- State Voluntary Reporting for NC
  - NC DAQ Air Emissions Reporting On-Line (AERO) System:  
<https://xapps.ncdenr.org/aq/aero/>
  - Report units of Short Tons
- EPA Mandatory GHG Reporting Rule
  - Resources by Subpart for GHG Reporting:  
<https://www.epa.gov/ghgreporting/resources-subpart-ghg-reporting>
  - EPA electronic Greenhouse Gas Reporting Tool (e-GGRT):  
<https://ghgreporting.epa.gov/ghg/login.do>
  - Report units of Metric Tons



# *Need Help?*

If you are unsure if your sources emit GHGs or need help calculating, contact the appropriate Regional Office or Central Office





# Questions?



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