



Greenhouse Gases

Climate Change Impacts

Emissions Reporting/Calculations

Federal and State Actions

PENC

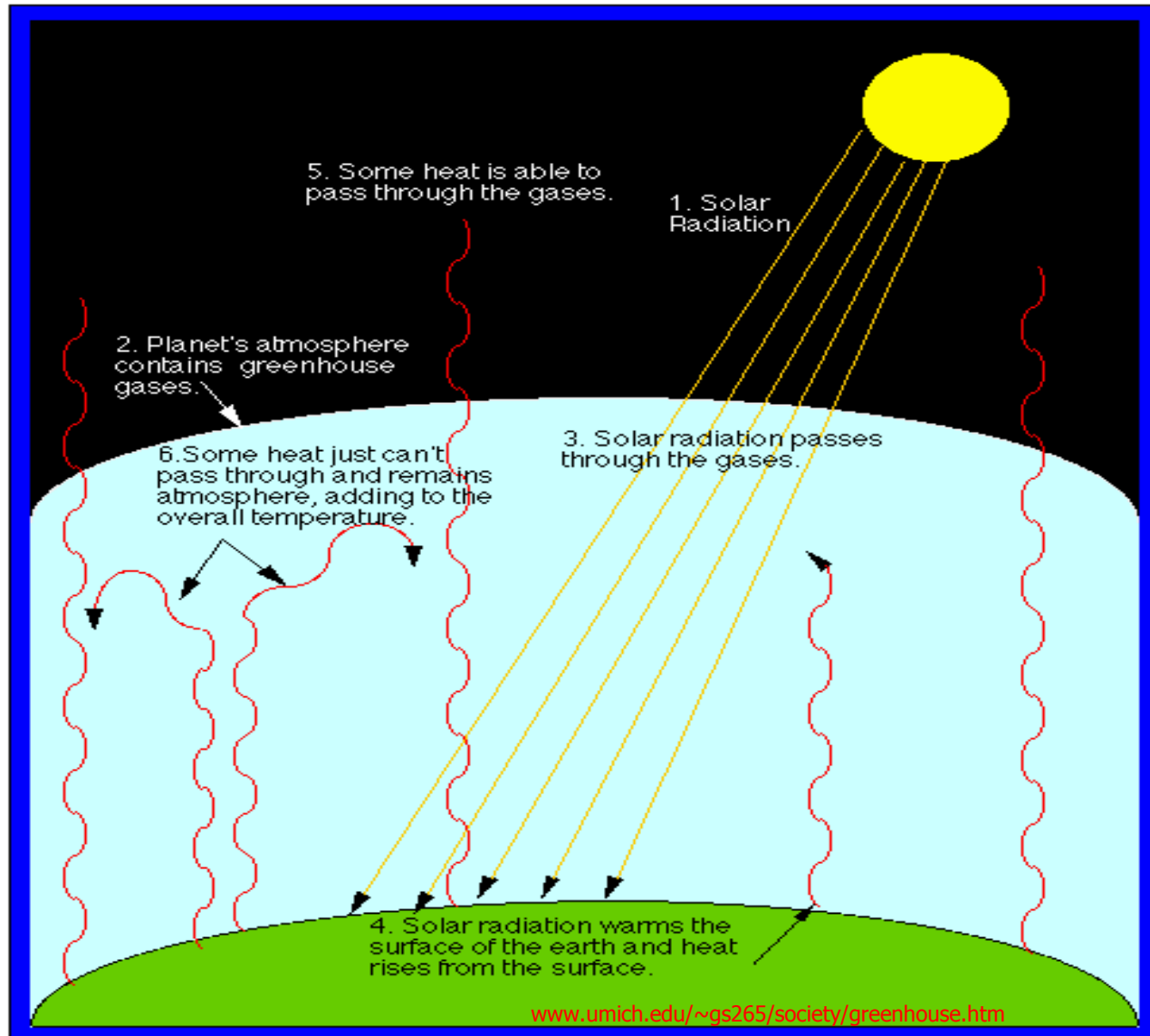
December 15, 2009

Raleigh, NC

North Carolina Division of Air Quality

1641 Mail Service Center - Raleigh, NC 27699-1641 (919) 733-3340 www.ncair.org

Warming Mechanism





Key GHGs

- **Carbon Dioxide (CO₂)**
- **Methane (CH₄)**
- **Nitrous Oxide (N₂O)**
- Sulfur Hexafluoride (SF₆)
- Perfluorocarbons (PFCs)
- Hydrofluorocarbons (HFCs)
- Other Fluorinated Gases

"Kyoto gases"
& Covered
by EPA
Endangerment
Finding

Covered by reporting rule



Other GHGs and aerosols have climatic warming effects

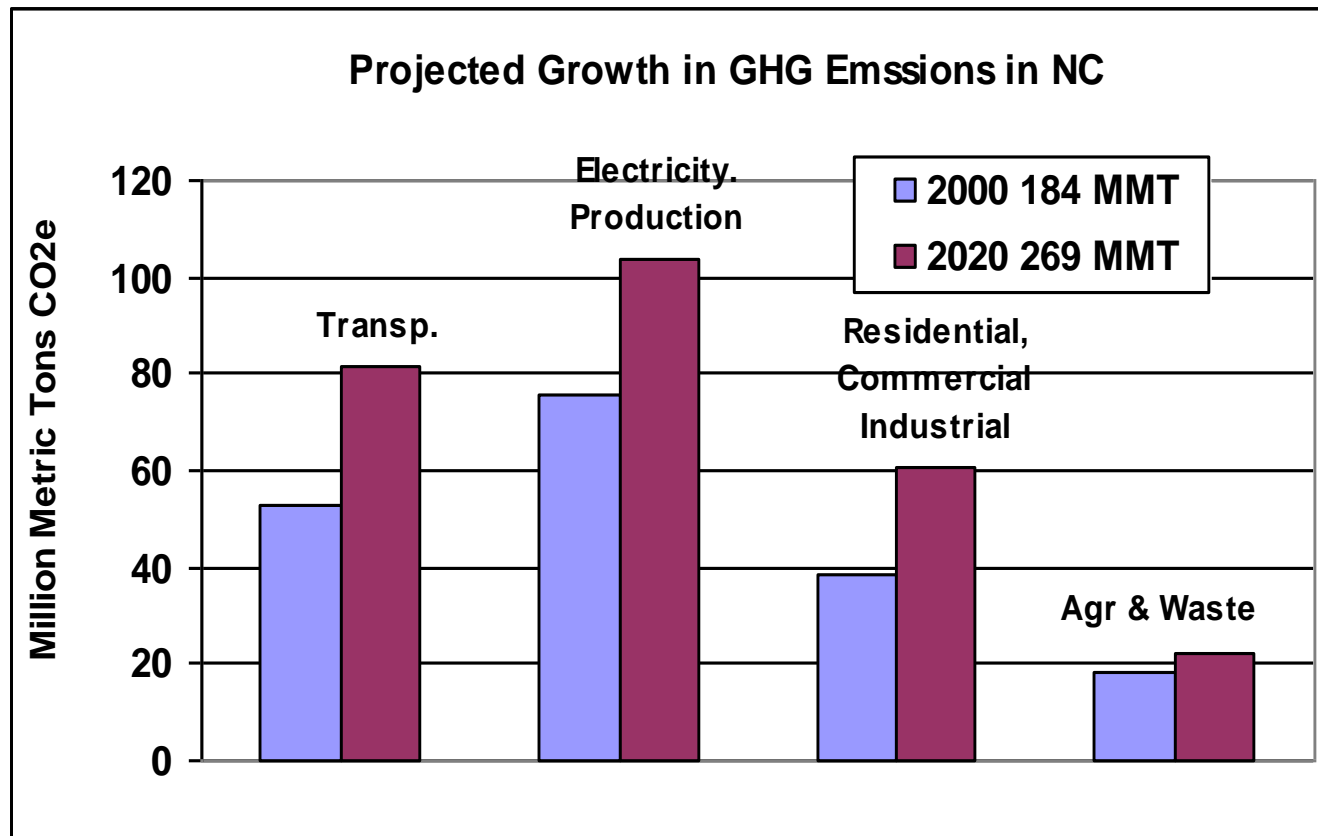
- Water vapor – not considered an anthropogenic forcing agent of climate change
- CFCs, HCFCs other ozone depleters – Being phased out
 - HCFC-22 or “R-22” is a common example
- Tropospheric ozone (“smog”) – covered as a public health issue
- Black Carbon (light absorbing aerosols)- emerging as a potent warmer, comes from biomass burning, diesel exhaust, cooking with solid fuels



NC Has A Significant GHG Signature

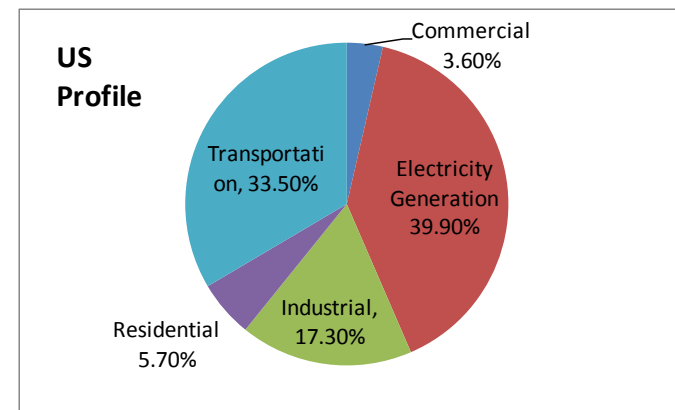
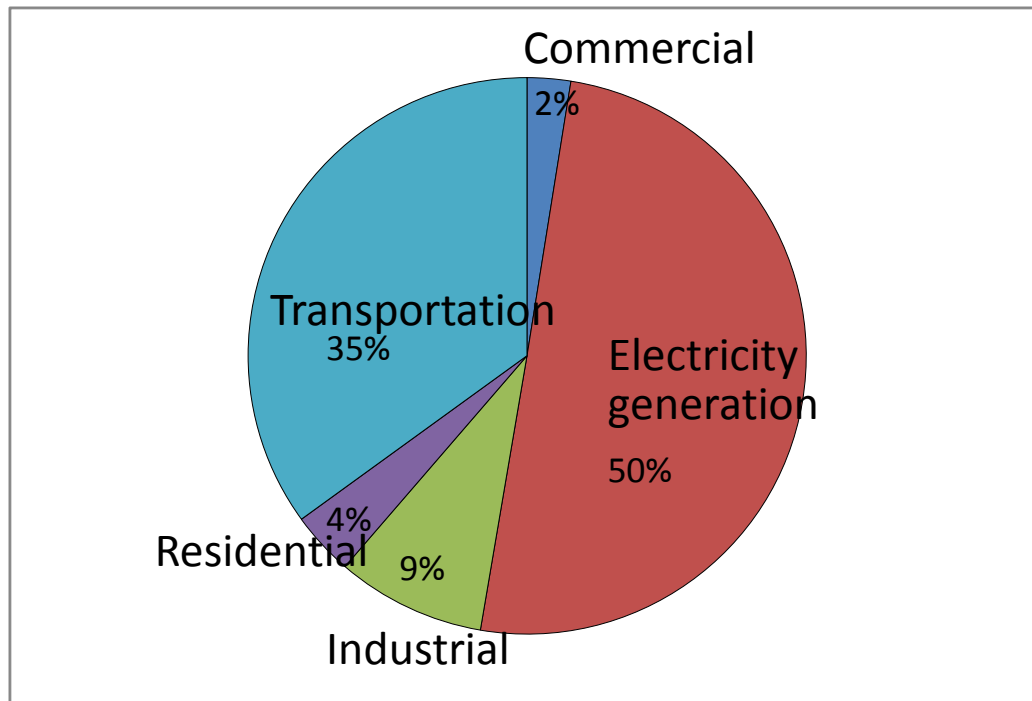
- 9+ Million Citizens (~13M in 2030)
- 3.4 million Homes (~ 5 M in 2030)
- 7 million Cars and Trucks (~10 M in 2030)
- Commercial, Industrial, and Institutional Heated and Cooled Spaces (Growing Daily)
- Coal Fired Power Plants
- Growth Increases Electricity Demands and Mobile Emissions – Emissions rose

GHG Emissions in NC



NC's Combustion Emissions

Ranked 13th in the Nation (2007)



NC's contribution from electricity and transportation is higher than national average.

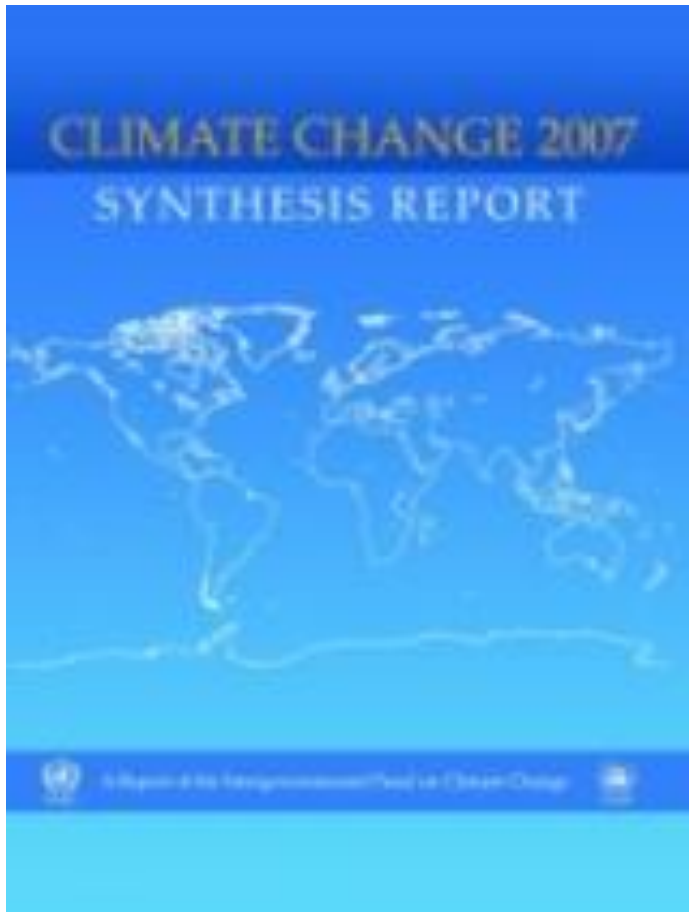


GHGs from Combustion Still Increasing in North Carolina

However, per-capita emissions has recently been decreasing

- From 1990 - 2007
 - Total up by 39% (US → up by 19%)
 - Per capita up by 2% (US → down by 2%)
- From 2004 -2007
 - Total up by 3% (US → 0.3%)
 - Per capita down by 3% (US → down by 2%)

Climate Change Impacts: Major References



Intergovernmental Panel
On Climate Change
(IPCC), 4th Assessment
Report, 2007



US Global Change
Research Program
(June 2009)



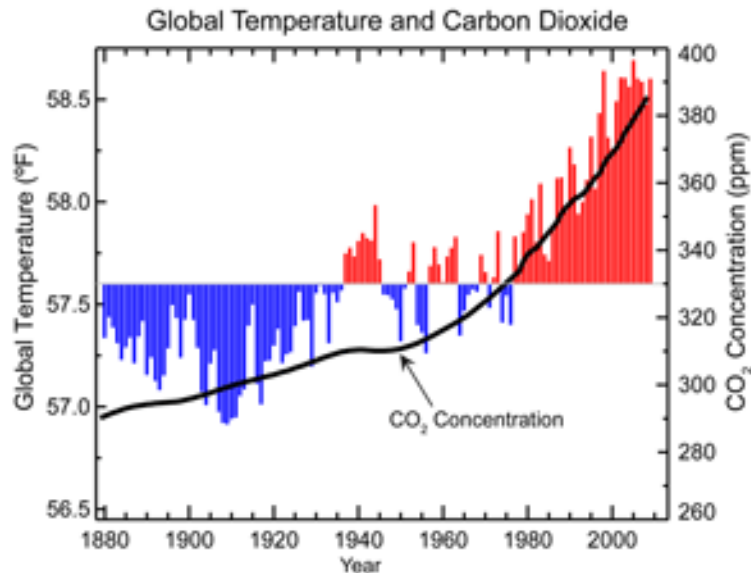
Pew Center on Global
Climate Change (Jan
2009)



Summary of
Climate Science:
2008

Greenhouse Gases (GHGs)- Impacts

- GHGs have experienced increasing levels -- CO₂ up from 280 ppm to over 380 ppm, and currently climbing at 2 ppm per year
- Global average temperature has risen by 1.5°F since 1900

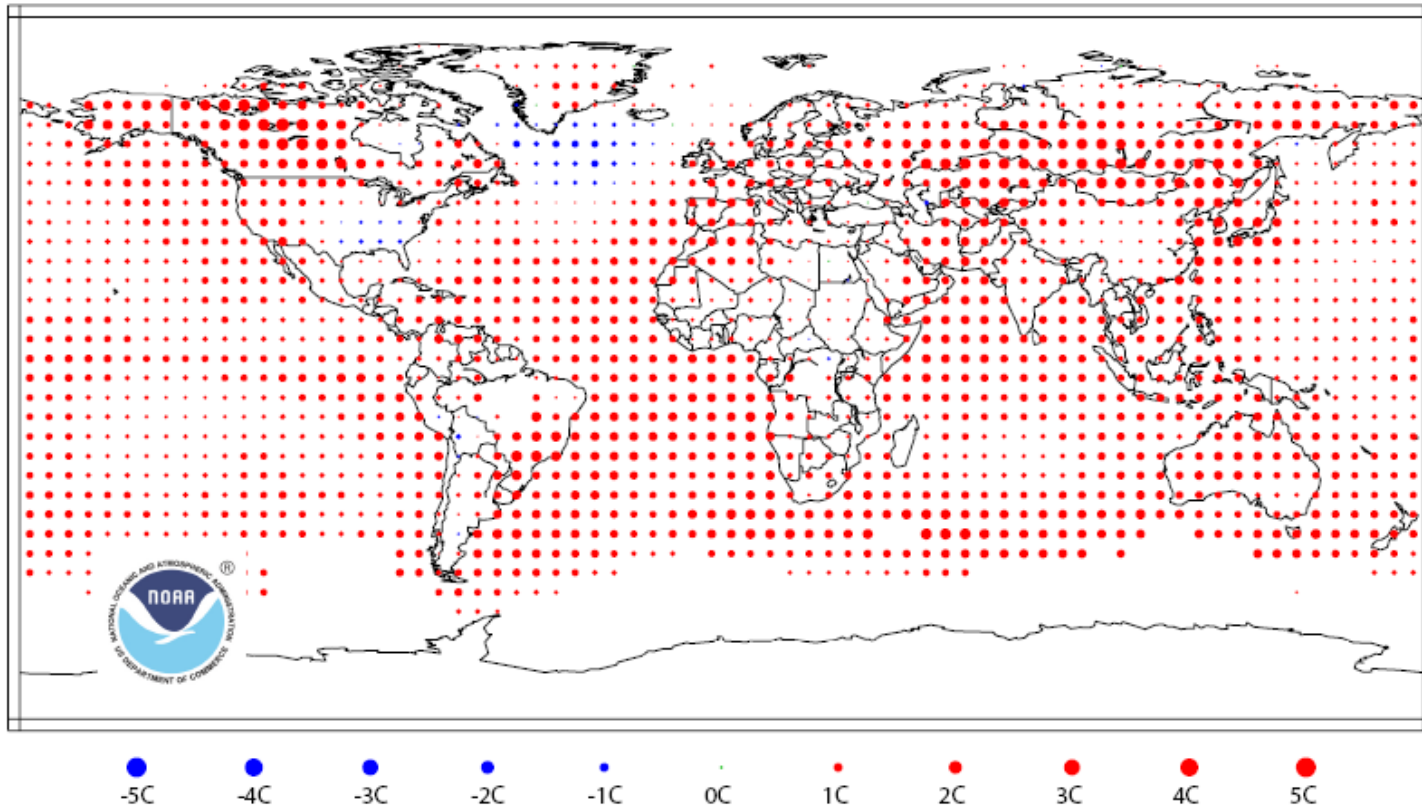


From NOAA:
<http://www.ncdc.noaa.gov/indicators/>

- Temperature projected to rise another 2 to 11.5° F by 2100

Annual Temperature Trends

1901-2003



<http://www.ncdc.noaa.gov/oa/climate/research/trends.html>



Greenhouse Gases (GHGs)- Impacts

- Global mean sea level rise
 - 1.7 mm/year over the past 100 years
- North Carolina sea level rise
 - Recent study (journal Geology) finds larger impact of 3.3 mm/yr in North Carolina
 - Some scenarios project future sea level rise as high as 3 feet
 - North Carolina Sea Level Rise Forum January 14-15, 2010 (<http://dcm2.enr.state.nc.us/slr.html>) will provide updated projections
- Increase in ground-level ozone (component of smog)
- Bleaching of coral, and more ocean acidification
- Recession of Glaciers

Sea-level Rise and Salt Water Intrusion: Alligator River National Wildlife Refuge



Ditches promote salt water intrusion



Building oyster reefs can buffer ocean currents

Planting cypress trees and other salt-tolerant species can help ecosystems hold together



Emissions Reporting Concepts and Terminology



Metric Tons of CO₂ Equivalent (CO₂e)

GHG Emissions *usually* reported in metric tons of CO₂e

metric tons CO₂e = tonnes CO₂e = mtCO₂e = MT CO₂e

1 metric ton = 1000 kilograms = 1 megagram

1 metric ton = 1.10231 ton (short)

where, 1 short ton = 2,000 pounds

25,000 metric tons = 27,557 short tons

25,000 short tons = 22,680 metric tons.



CO₂e: Carbon Dioxide Equivalent

- CO₂ is the most abundant GHG – used as the basis for quantifying all GHGs
- GHG emissions are converted to the *equivalent amount of CO₂*, hence “carbon dioxide equivalent” or **CO₂e**
- Each GHG has a unique conversion factor for calculating CO₂e
- The conversion factor is called the Global Warming Potential, or GWP
- GWP incorporates both the heat-trapping ability and atmospheric lifetime of each GHG, and is used to develop comparable numbers by adjusting all GHGs relative to the GWP of CO₂.



Some GWPs

- CO_2 : GWP = 1
- CH_4 : GWP = 21
- N_2O : GWP = 310
- SF_6 : GWP = 23,900
- HFCs and PFCs: multiple compounds, each has unique GWP
 - E.g., HFC-134a, GWP = 1,300



Converting GHG Emissions Into CO₂e

- Multiply amount of any GHG by its GWP to get CO₂e
- CH₄ has a GWP of 21
- 1 metric ton CH₄ x 21 = 21 metric tons CO₂e

If a landfill generates 1,080 short tons of CH₄
(= 1,191 metric ton CH₄) then it generates 25,000 metric
tons CO₂e

CO₂e Emissions (metric tons)

Hybrid Car,
20,000 miles
4 mtons



truck, 20,000
miles
14 mtons



House, 10 mtons/yr



<http://www.terrapass.com/carbon-footprint-calculator/#residential>

*includes direct & indirect emissions

Reporting threshold for
most facilities under
EPA Reporting rule:
25,000 mtons/yr

One 500-MW coal-
fired power plant:
3 million mtons/yr

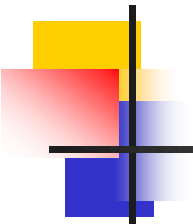


NC GHG Inventory
(2005): 192 million
mtons



USA GHG
Inventory (2007):
7,150 million
mtons





Biogenic CO₂ Vs. Anthropogenic CO₂

- Biogenic CO₂ comes from combustion of biomass
- Biomass is non-fossilized, biodegradable **organic material** originating from **plants, animals, and micro-organisms**.
 - wood, landfill gas, digester gas, animal fat, black liquor solids from pulp mill...
- Biogenic CO₂ tracked separately from anthropogenic CO₂
- CH₄, N₂O, and the fluorinated gases are always anthropogenic



Direct, Indirect & Upstream Emissions

- **“Direct emissions”** refers to emissions from combustion devices and processes at a facility such as boilers, dryers, lime kilns, digesters, etc.
 - Includes fugitive emissions.
- **“Indirect emissions”** means emissions associated with the purchase of electricity, heating, cooling or steam.
- **“Upstream emissions”** refers to the GHG emissions potential of a quantity of industrial gas or fossil fuel supplied into the economy.



Why Report

“What gets measured gets managed”



Status of GHG Reporting

■ Voluntary

- DOE - 1605(b) program (from the Energy Policy Act of 1992) and CHP Partnership
- EPA – Climate Leaders and non-CO₂ voluntary partnership programs
- SmartWay Transport Partnership program
- The Climate Registry (TCR)
- Others

■ Mandatory

- Acid Rain Program CAA “Part 75” – reqmts for continuous emissions monitoring of SO₂, NO_x, and CO₂
- EPA Mandatory Reporting Rule, published Oct 30 2009
- Numerous (1-2 dozen) States have programs



Status of NC GHG Reporting Rule

- DAQ will not pursue state rule at this time
 - EPA rule expected to provide timely and complete data
 - Eliminate duplicate reporting burden for facilities
- Continue to encourage **voluntary reporting using NC's Air Emissions Reporting On-line (AERO) tool**
 - DAQ found about 30% of Title V sources reported voluntarily in 2008; reporting burden found to be low, particularly for combustion sources
- Will align calculation guidance for voluntary reporting with EPA's required calculation methods
- Review the EPA's reporting/data exchange system to determine if it will provide state the necessary information
- May pursue the rule depending upon outcome of **review**



EPA Mandatory Reporting Rule

- Directed by Congress in 2008 Appropriations Act
- Provides accurate and timely data to inform future climate change policies and programs
- Does not require control of GHG
- Covers about 10,000 sources
 - 25 source categories
 - 5 types of suppliers of fuel and industrial GHG
 - Motor vehicle and engine suppliers (except light duty sector)



Summary of EPA Mandatory Reporting Rule: Overview

- Sources Affected
 - Direct emitters – generally, 25,000 metric tons CO₂e/yr threshold
 - Fossil fuel suppliers and GHG suppliers
 - Vehicle and engine manufacturers (heavy-duty and off-road)
- Most Small Businesses/Commercial Bldgs Not Affected
- Specific calculations monitoring and sampling methods are provided for all source categories covered by the rule
- Annual Reports Submitted electronically to EPA
 - First emissions report due Mar. 31, 2011 for 2010 emissions
 - Reporting for Vehicle/Engine Manufacturers starts model year 2011
- Can cease reporting if emissions go below reporting thresholds
 - After 5 consecutive years of emissions < 25,000 mtCO₂e/yr
 - After 3 consecutive years of emissions < 15,000 mtCO₂e/yr

Summary of EPA Mandatory Reporting Rule: Applicability (1)

Table 1: If the facility contains any of the source categories listed in this table in any calendar year starting in 2010, the rule requires the facility to report emissions from all source categories for which calculation methodologies are provided in any subpart of the rule.

NO THRESHOLD

Adipic Acid Production
 Aluminum Production
 Ammonia Manufacturing
 Cement Production *
 Lime Manufacturing
 Nitric acid production
 Phosphoric Acid Production ✓
 Petrochemical Production
 Petroleum Refineries
 Titanium Dioxide Production
 Silicon carbide production
 Soda Ash Production
 HCFC-22 Production

PRODUCTION-BASED or OTHER THRESHOLD

Municipal Landfills - ✓

that generate CH₄ in amounts greater or equal to 25,000 metric tons of CO₂e annually

HFC-23 destruction processes-

that are not collocated with a HCFC-22 production facility and that destroy more than 2.14 metric tons of HFC-23 per year

Manure Management Systems-

that emit CH₄ and N₂O in amounts more than or equal to or greater than 25,000 metric tons CO₂e

Electricity Generating Facilities-

that report CO₂ emissions year round through 40 CFR part 75

Source: General Provisions, fact sheet, EPA-430-F-09-006R

✓ Means this category is present in NC

* May have in the future

◆ EPA will not be implementing the manure management rule due to a Congressional restriction prohibiting expenditure of funds for this purpose

North Carolina Division of Air Quality

1641 Mail Service Center - Raleigh, NC 27699-1641 (919) 733-3340 www.ncair.org

Summary of EPA Mandatory Reporting Rule: Applicability (2)

Table 2: If a facility is not covered in Table 1 & emits $\geq 25,000$ mtCO₂e combined emissions from any of below categories, stationary source combustion*, and miscellaneous carbonate use: Report emissions from ALL source categories for which there are calculation

Ferroalloy Production

Glass Production ✓

Hydrogen Production ✓

Iron and Steel Production ✓

Lead Production

Pulp and Paper Manufacturing ✓

Zinc Production

Table 3: If a facility is not covered in Tables 1 or 2 & emits $\geq 25,000$ mTCO₂e¹ from ALL stationary combustion sources combined,* report emissions from stationary source combustion devices only.

Boilers ✓

Stationary Engines ✓

Process Heaters ✓

Combustion Turbines ✓

Incinerators ✓

Other Fuel Combustion Equipment² ✓

¹ If the maximum combined heat input capacity is less than 30 million Btu per hour, no reporting required.

² Excludes portable equipment, emergency generators, emergency equipment, agricultural irrigation pumps, and hazardous waste combustors (except co-fired fossil fuels), and flares

* Excludes CO₂ emissions from combustion of biogenic fuels

✓ Means this category is present in NC



Summary of EPA Mandatory Reporting Rule: Do NOT have to report at this time

- Electronics Manufacturing ✓
- Ethanol Production
- Fluorinated GHG Production
- Food Processing ✓
- Industrial Landfills ✓
- Magnesium Production
- Oil and Natural Gas Systems ✓
- SF6 From Electrical Equipment ✓
- Underground Coal Mines
- Wastewater Treatment ✓

✓ Means this category is present in NC



Additional Resources for EPA's Rule

- Federal Register version on EPA's website

www.epa.gov/climatechange/emissions/ghgrulemaking.html

- Information & Training Resources

- On-line applicability tool to assist facilities to assess if they need to report
- Webinars & Training Sessions
- Guidance documents/Information sheets



Stationary Source Combustion Calculations

- Expected GHGs
 - Carbon Dioxide (CO₂)
 - Methane (CH₄)
 - Nitrous Oxide (N₂O)
- Methodology: EPA rule Subpart C
- DAQ will update Spreadsheets to assist in calculations (currently Utilize DAQ methodology)



Stationary Source Combustion GHG Emission Estimation Methods

- Direct Measurement via Continuous Emission Monitoring System (CEMS)
- Calculation using Emission Factors (EFs)
 - 3 calculation tiers
 - Tier required is based on upon unit size, fuel type, & more



Calculation Method for CO₂: Tier 1 (Easiest)

annual FUEL used * default HHV * Emission Factor (EF)

- Can use company records (which includes supplier billing records) for annual fuel use. HHV and EF from Table C-1
- Can use for
 - any unit ≤ 250 mm Btu/hr for fuel listed in Table C-1
 - any sized unit burning biofuel
 - Any unit combusting municipal solid waste and not creating steam (unless CEM is reqd)
 - CANNOT be used if you routinely perform analysis of HHV or if you receive it from your supplier



Default HHV's and Efs

Provided for a large number of fuels

Generally, you don't need to compute emissions if fuel isn't in C-1

- Coal (different types) and Coke
- Natural Gas
- Petroleum products - distillate & residual oils, LPG, gasoline, aviation gas, jet fuels and more
- Fossil fuel-derived fuels— tires, municipal waste, blast furnace gas, coke oven gas
- Biomass fuels— wood, biogas (captured methane), ethanol, biodiesel, rendered animal fat, vegetable oil and more

Tier 1 Calculation Example

- Natural Gas Boiler
- 500 million scf (mmscf)
- 100 mmBtu/hr

Table C-1:

HHV = 1.028×10^{-3} mmBTU/scf
EF (based on Carbon Content) = 53.02 kgCO₂/mmBTU

$$\begin{array}{c} \text{FUEL} \\ \downarrow \\ 500 \text{ mm scf} \end{array} * \begin{array}{c} \text{HHV} \\ \downarrow \\ 1.028 \times 10^{-3} \text{ mmBTU} \\ \text{scf} \end{array} * \begin{array}{c} \text{EF} \\ \downarrow \\ 53.02 \text{ kgCO}_2 \\ \text{mmBtu} \end{array} * \frac{1\text{E6 scf}}{\text{mmscf}} * \frac{1 \text{ mton}}{1000\text{kg}}$$

=27,345 metric tons



Calculation Method for CO₂: Tiers 2&3

TIER 2: Same as Tier 1 except you need to use a measured value for HHV

$\text{annual FUEL used} * \text{measured HHV} * \text{Emission Factor (EF)}$

(Note: Different calculation for burning MSW or other solid fuel and producing steam)

TIER 3: Calculation based on annual fuel use and measured carbon content of that fuel.

$\text{Fuel} * \text{measured Carbon Content} * 44/12$

Tier 3 generally applies to larger units > 250mmBtu/hr



Calculation Method for CH₄/N₂O

Emission Factor (EF) * annual FUEL used * HHV

- If fuel isn't in C-2, no need to compute CH₄/N₂O
- For Tiers 1 and 3, use default HHV
- For Tier 2, used measured HHV

Calculation for CEMs (measure Heat Input continuously)

Annual Heat Input * EF



CH₄/N₂O Calculation Example

- Natural Gas Boiler
- 500 million scf (mmscf)
- 100 mmBtu/hr

Table C-1:

$$\text{HHV} = 1.028 \times 10^{-3} \text{ mmBTU/scf}$$

Table C-2:

$$\text{EF} = 1.0 \times 10^{-3} \text{ kgCH}_4/\text{mmBTU}$$

$$\text{EF} = 1.0 \times 10^{-4} \text{ kgN}_2\text{O}/\text{mmBTU}$$

CH₄:

$$500 \text{ mm scf} * 1.028 \times 10^{-3} \frac{\text{mmBTU}}{\text{scf}} * 1.0 \times \frac{10^{-3} \text{ kgCH}_4}{\text{mmBtu}} * \frac{1\text{E}6 \text{ scf}}{\text{mmscf}} * \frac{1 \text{ mton}}{1000\text{kg}}$$

$$\text{CH}_4 = 0.514 \text{ metric tons} \rightarrow 21 * 0.514 = 11 \text{ mtons CO}_2\text{e}$$

$$\text{N}_2\text{O} = 0.0514 \text{ metric tons} \rightarrow 310 * 0.0514 = 16 \text{ mtons CO}_2\text{e}$$

Recall that **CO₂** = 27,345 mtons



Federal and State Actions

EPA vs Congressional

legislation: "I do not believe this is an 'either-or' proposition. I actually see this as a 'both-and.' I believe the Clean Air Act can complement legislative efforts."

-Administrator Jackson, at Copenhagen Meeting



Other Significant EPA Actions

- Final Endangerment Finding and Cause or Contribute Findings for GHGs Under the CAA- December 7, 2009
 - Current and projected concentrations of the mix of six key greenhouse gases threaten the public health and welfare of current and future generations.
 - Motor vehicles contribute to GHG pollution
- Proposed Light-Duty Vehicle Greenhouse Gas Emissions Standards and Corporate Average Fuel Economy Standards –Sept 2009
 - Sets g/mile and fuel economy standards
- Proposed Prevention of Significant Deterioration (PSD) and Title V GHG Tailoring Rule –Oct 2009
 - Purpose is to limit the number of sources subject to PSD and Title V
 - Once GHGs become a “regulated pollutant” permit programs are triggered; threshold is 250/100 tons per year
 - Tailoring rule sets threshold to 25,000 short tons CO₂e



Federal Legislative Actions

- Waxman/Markey “House” Bill: American Clean Energy and Security Act
- Kerry/Boxer “Senate” Bill: Clean Energy Jobs and American Power Act
- Both have CAP and Trade program to get to set reduction targets
 - House: 17% reduction by 2020; 83% reduction by 2050 (2005 baseline)
 - Senate: 20% reduction by 2020; 83% reduction by 2050 (2005 baseline)
- Address energy efficiency, clean coal, alternative energy, transportation
- Include adaptation
- Address potential regulations to reduce black carbon



Key State Actions

- Climate Action Plan Advisory Group (CAPAG) Final Report Oct 2008
- Renewable Portfolio Standard Passed in 2007
- Legislative Commission on Global Climate Change –extended to October 2010
- Energy Plan, Petroleum Displacement Plan
- Climate Change Part of DENR Strategic Plan - <http://www.enr.state.nc.us/>
 - Mitigation
 - Adaptation

Climate Change Adaptation Workshop

**Planning for North Carolina's Future:
*Ask the Climate Question***

**March 2-3, 2010 in Raleigh at
McKimmon Center at N.C. State University**





For More Information

- Climate Change (by January)
<http://www.onencnaturally.org/>
Sign up for the NC1-list listserv
- DAQ Climate Change Website
<http://daq.state.nc.us/monitor/eminv/gcc/>
CAPAG reports, GHG inventory, regulations, etc.

More on website

NCDENR - Division of Air Quality - Climate Change - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://daq.state.nc.us/monitor/eminv/gcc/

Vopak Logo Most Visited Getting Started Latest Headlines

AVG nc climate change denr Search Total Protection AVG Info Get More

NCDENR - Division of Air Quality - Cli...

North Carolina Department of Environment and Natural Resources

Division of Air Quality

Home Public Notices Staff Directory Contact DAQ Search

Climate Change

Greenhouse Gas Emissions Reporting
NC Reporting Rule, EPA Mandatory Reporting Rule, Instructions for Reporting GHG Emissions and Workshop Material

Greenhouse Gas Emissions Inventories and Trends
NC, US

Legislative Commission on Global Climate Change (LCGCC)
Authority, Members, Meeting Documents, Schedule

NC Related Rules/Legislation

Clean Smokestacks Act
Legislation, Press Releases, CO₂ Reports

The Climate Registry
Description, Reporter requirements, DENR activities, Contacts

NC Climate Action Plan Advisory Group (CAPAG)
Members, Climate Action Plan Development Documents and Reports, Meeting Documents

Federal Climate Initiatives
Regulations/Policy, Federal Legislation, Studies

Links to Other Resources NC, U.S. and International Programs and Organizations

Climate Change Awareness (under development)

Email us  Last Modified: Thu September 17 10:06:53 2009 [Top of Page](#)

North Carolina Department of Environment and Natural Resources (NCDENR)

North Carolina Division of Air Quality - 1641 Mail Service Center - Raleigh, NC 27699-1641 - (919) 733-3340

Done

Glacier National Park: “In fact, only 26 named glaciers presently exist of the 150 glaciers present in 1850.”



The End