UA and carbon neutrality

a baseline inventory of greenhouse gases

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Carbon is the basis for all life on earth.

- C has four valence electrons, which allows for easy bonding with N, O and H.
- C has molecules of multiple carbon atoms form *chains* and *rings* that allow complex functions.
- Proteins, nucleic acids, fats, enzymes, hormones and fuels are all C-based molecules.

Silicon ***also has four valence electrons, could also possibly support life.***

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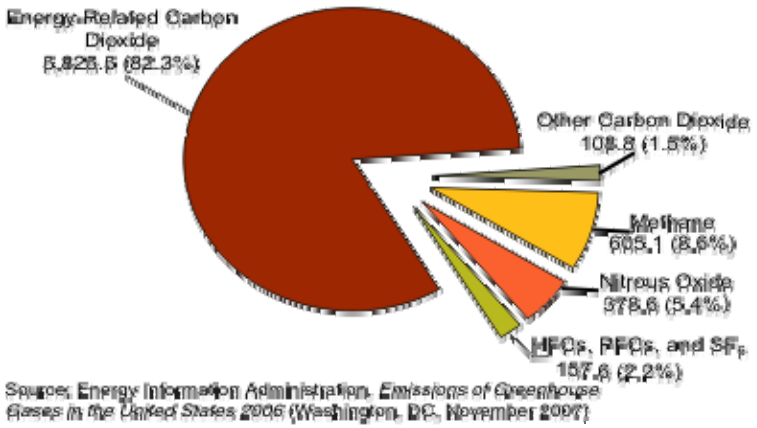
Key characteristics of atmospheric GHG

- Sources
  - combustion, respiration, agriculture, industry/consumerism, landfills
- Sinks
  - soils, biota, oceans
- Greenhouse gases (GHG)
  - H_2O vapor, CO_2, CH_4, NO_X, CFCs, PFCs, O_3
- Sequestration
  - vegetation, soils, underground

National GHG emissions mix



Source: Energy Information Administration, *Emissions of Greenhouse Gases in the United States 2006* (Washington, DC, November 2007)

UA's footprint is 99% CO_2

- *few livestock*
- *little solid waste compared to fossil fuels uses*
- *few fugitive emissions*

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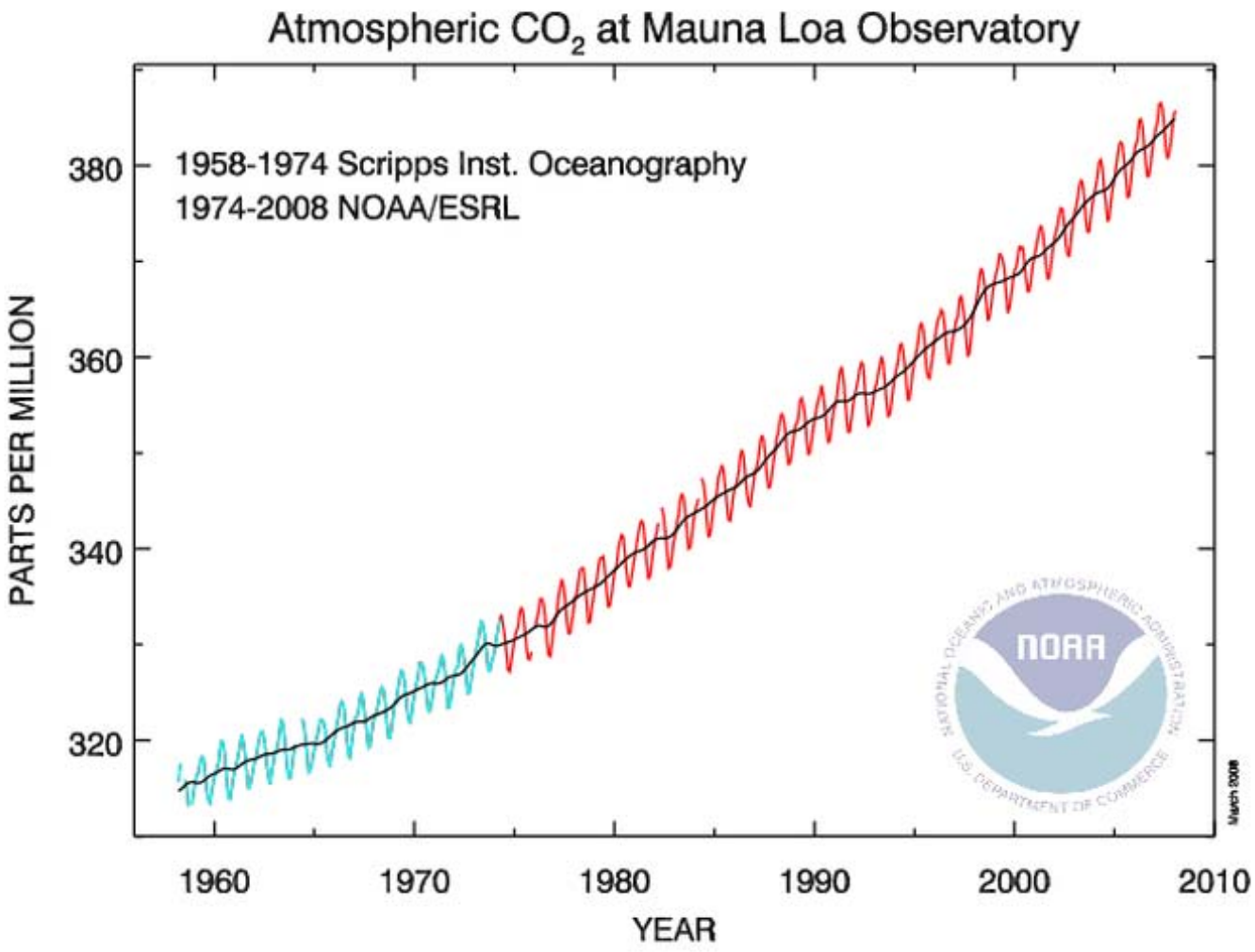
Atmospheric carbon dioxide

- Fossil fuel burning, other industry, deforestation, and agriculture add about 30 GT yr^{-1} CO_2 into the atmosphere.
- A coal-fired power plant releases 5 – 15 MT yr^{-1} of CO_2
- Humans respire 2 GT yr-1 (demotechnic respiration= several hundred power plants).
- Global electrical production is 4,000 GW, from about 16,000 power plants
- 2,000 power plants are planned or under construction.
- Capacity is growing by about 100 GW yr^{-1}.


Atmospheric CO_2 at Mauna Loa Observatory
1958-1974 Scripps Inst. Oceanography
1974-2008 NOAA/ESRL
PARTS PER MILLION
380
360
340
320
1960
1970
1980
1990
2000
2010
YEAR
NOAA
March 2008

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CO_2 emissions by fuel type

fuel type	unit	CO_2 per unit
Gasoline	gallon	8.7 kg
Diesel	gallon	9.95 kg
Heating oil	gallon	11.26 kg
Coal-fired electricity	kWh	0.90 kg
Gas-fired electricity	kWh	0.60 kg
Nuclear electricity	kWh	~0.20 kg?
Wind electricity	kWh	0.008 kg

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C footprint

On the east coast of the U.S., the C footprint of *French wine delivered by boat* is smaller than of a *California wine delivered by truck.*

Water from Fiji or Iceland requires several ounces of petroleum to deliver to Fayetteville.

Ocean ship transport requires 60X less energy than air transport.

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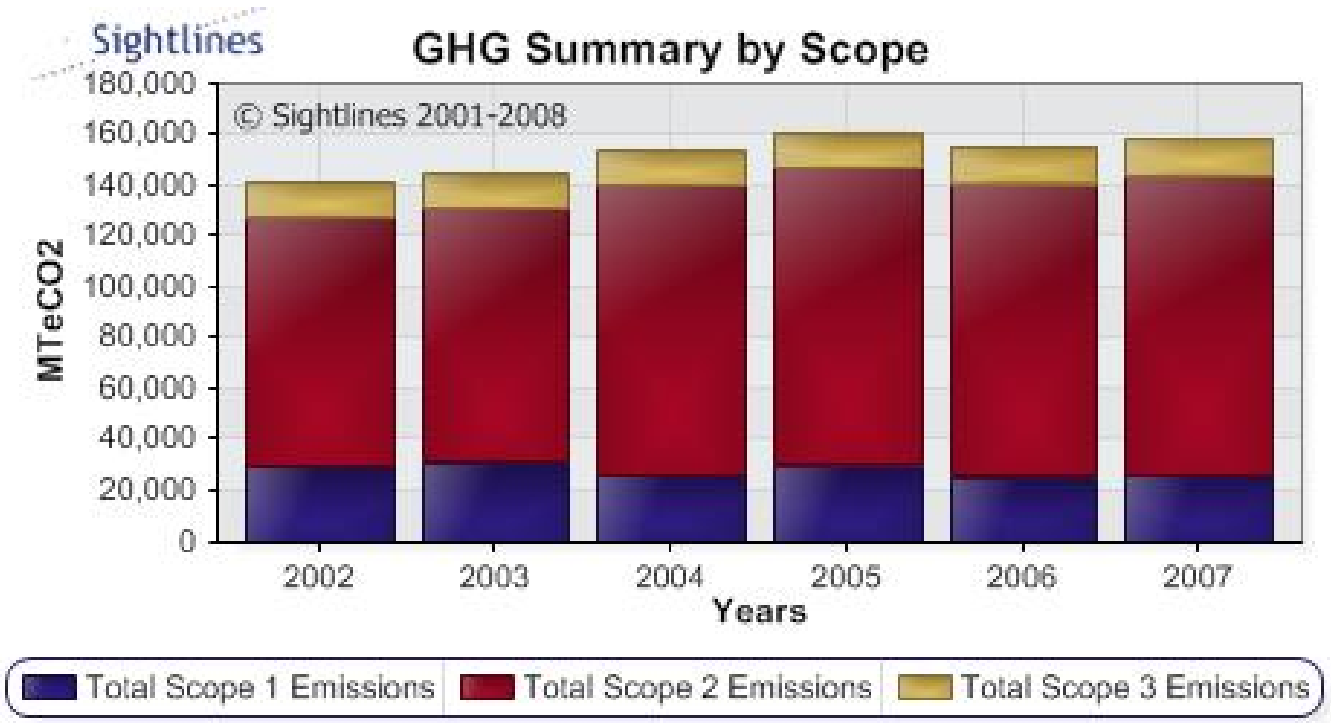
UA greenhouse gas emissions



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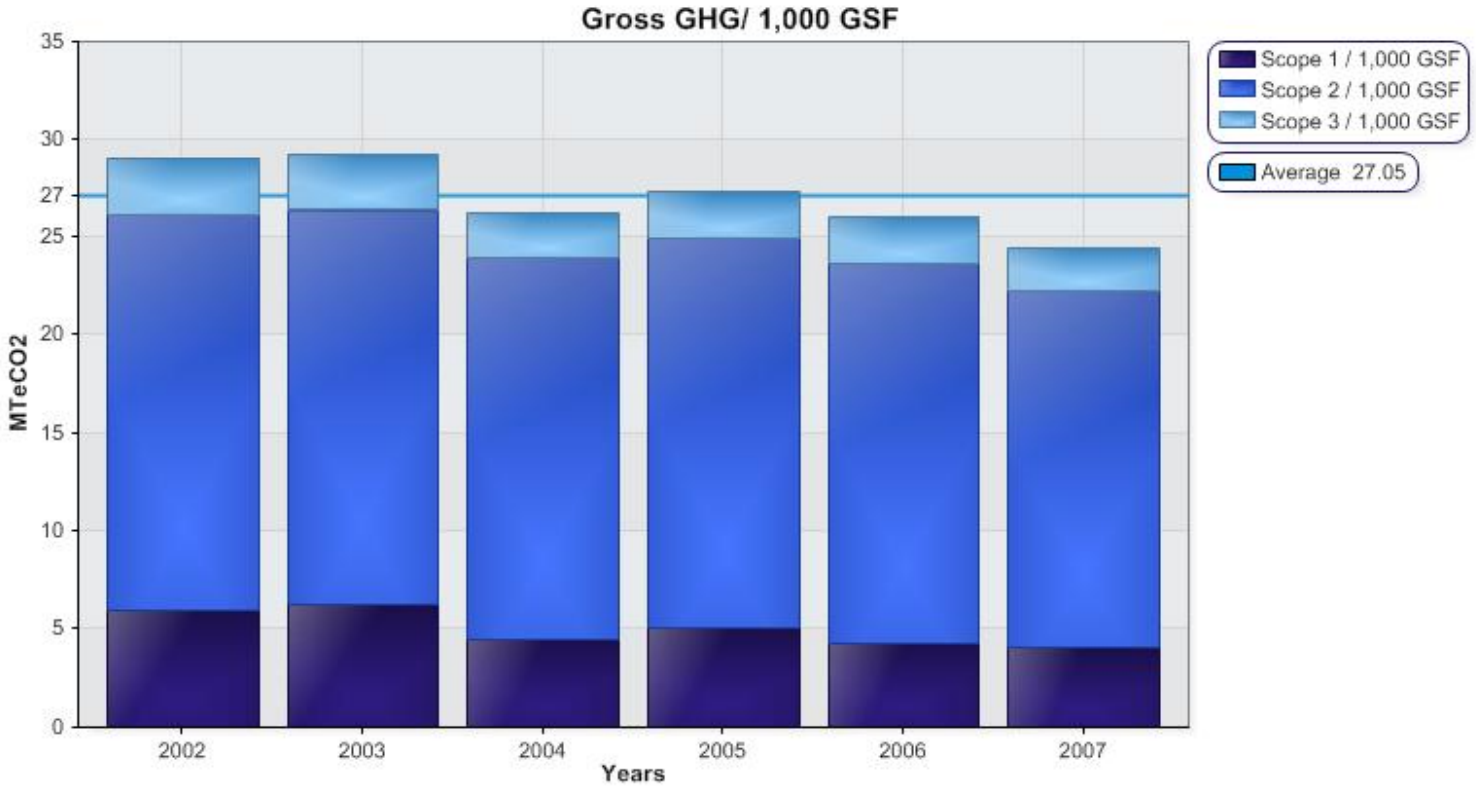
Emissions per sqft



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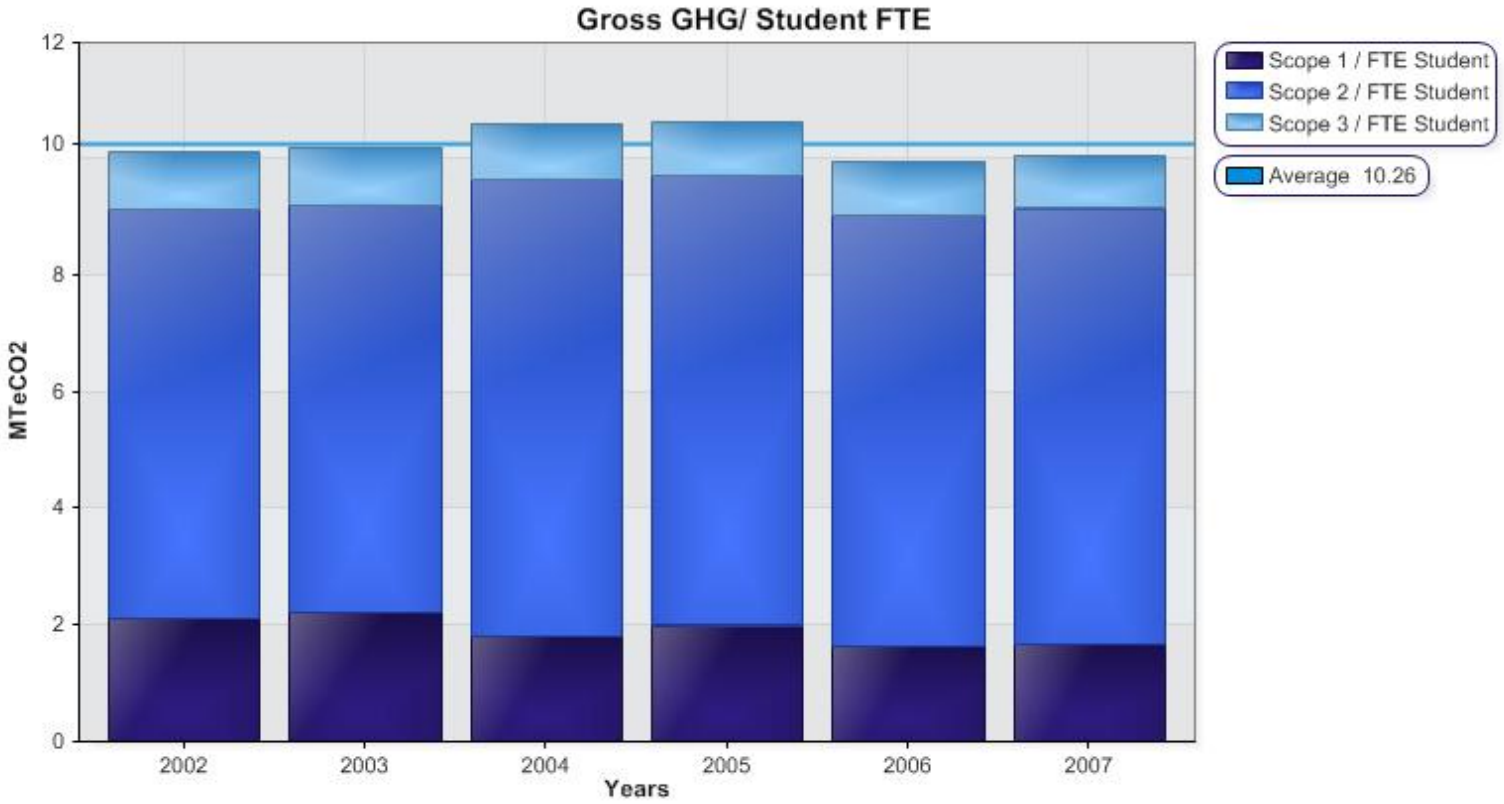
Emissions per student



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UA greenhouse gas emissions

- 158,000 MT CO_2 e yr^{-1}
  - the City of Fayetteville's footprint is 47,000 MT CO_2 yr^{-1}
- 91% of UA GHG is from building energy
- 112,000 MWh yr^{-1} (FY2007) purchased electricity
- 74% of CO_2 comes from purchased electricity
- 80% of purchased electricity is coal-generated
  - The density of our footprint is determined by SWEPCO's fuel mix.

Renewable energy project 1

Rated capacity = 5 MW (perhaps a biomass source)
design energy output with full energy input

Capacity factor = 0.90
hours of full output, dependent on fuel availability and maintenance

Annual production under this scenario =
5 x 0.90 x 365 x 24 = 40 MWh

UA used 115 MWh last year, plus gas.

Renewable energy project 2

Rated capacity = 20 MW (perhaps a wind farm)

design energy output with full energy input

Capacity factor = 0.20

hours of full output, dependent on fuel availability and maintenance

Annual production under this scenario =

20 x 0.20 x 365 x 24 = 35 MWh

UA used 115 MWh last year, plus gas.

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Renewable energy project 3

Forest management *(ex: 20,000 acres)*

1MWh = 1 MT CO_2

Sequestration capacity = 5 T ac^{-1} yr^{-1} x 20,000 acres = 100 MT C yr^{-1}

Annual offset under this scenario =

100 MT = 100 MWh equiv

UA used 115 MWh last year, plus gas.

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C sequestration in forests

- Interior Highlands have not been studied
- large variability among successional phases
- large variability among community types
- belowground, herbaceous, and soil components are not well understood
- *additionality* is key to C credit markets

Source	Land use	CO_2e ac^{-1} yr^{-1}	notes
Stavins, R.N. and K.R. Richards. 2005. The cost of forest-based carbon sequestration. .	loblolly	5.9	year 5, SE plains states
ibid.	loblolly	16.5	year 15
ibid.	loblolly	9.5	year 25
EPA, http://www.epa.gov/sequestration/faq.html#4	pine forest	3.7	in About 100T in 90 yrs.
Lal, R. et al. 1999. The Potential of Cropland to Sequester Carbon and Mitigate the Greenhouse Effect. Lewis Publishers.	Row crops, conservation tillage	0.3 – 1.0	N inputs also influence overall climate impact
Big Sky Carbon Sequestration Partnership http://www.bigskyco2.org	aspen plantation	7.25	, Pac northwest
Climate Initiative http://www.tufts.edu/tie/tci/sequestration.htm	maple-beech-birch	0.87	each yr for the 1st 25 yrs
ibid.	maple-beech-birch	1.95	avg over 120 yrs
ibid.	red-white pine	4.9	25 yr avg
ibid.	red-white pine	3.75	120 yr avg
Chastain, R.A., W.S. Currie and P.A. Townsend. 2006. Carbon sequestration and nutrient cycling implications of the evergreen understory layer in Appalachian forests. Forest Ecology and Management Volume 231, Issues 1-3, 1 August 2006, Pages 63-77. (http://www.sciencedirect.com/science/journal/03781127)	hardwood	5.4	aboveground only, at yr 50; understory included

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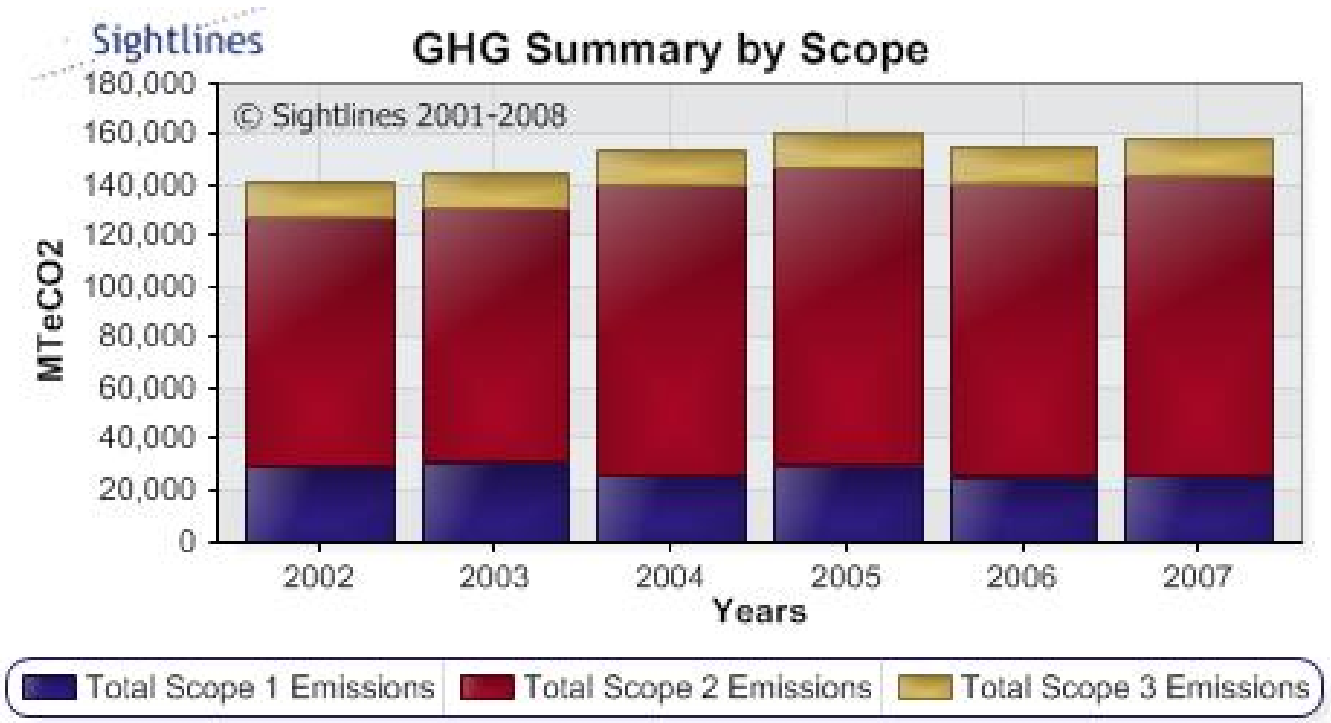

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