CITY OF RALEIGH

Community-Wide Greenhouse Gas Emissions Inventory: Years 2007 and 2010

Prepared by:
CH2MHILL | Raleigh, NC

SUSTAINABLE Raleigh

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Community-wide Greenhouse Gas Emissions Inventory for the City of Raleigh – Years 2007 and 2010

In July 2010, the City of Raleigh developed the "City of Raleigh Greenhouse Gas Inventory: Municipal Operations" report. The purpose of the inventory was to quantify emissions from municipal operations and to identify the City's emission sources for its operations.

In 2012, the City of Raleigh developed a baseline greenhouse gas (GHG) emissions inventory for selected community-wide activities for the year 2007 and one subsequent year, 2010. In accordance with the International Council for Local Environmental Initiatives (ICLEI) *International Local Government GHG Analysis Protocol* (IEAP), community-wide emissions analysis must include all GHG emissions associated with activities occurring within the local government's geopolitical boundary. While the City may not have operational control over the activities, the activities that occur within the community boundary can be controlled or influenced by the implementation of policies, the provision of rebates or auditing services, educational programs and the choice of services offered to the community in areas such as waste management. The baseline 2007 and year 2010 community-wide emissions inventories accounted for the following:

- Electricity usage by the City's residents and businesses
- Natural gas consumption in stationary combustion sources by the City's residents and businesses
- Commuter emissions from residential and commercial vehicles

The baseline 2007 and year 2010 community-wide GHG emissions inventories *did not* include emissions from the following sources:

- Other fossil-fuels (e.g. fuel oil, diesel, etc.) consumption in stationary combustion sources [(typically used for comfort and/or space heating)] in residential and commercial buildings and equipment
- Fugitive emissions from refrigerant usage (e.g. coolant for cooling systems)
- Industrial process emissions (e.g. large manufacturing operations, steel production, paper-making, etc.) from commercial and/or manufacturing businesses
- Agricultural emissions from livestock and managed soils

The baseline 2007 and year 2010 community-wide GHG emissions inventories did not include these source categories due to limitations on data availability. In order to quantify emissions for other fossil-fuel and refrigerant usage, community-wide usage data would be required from multiple vendors that distribute and/or supply these fuels and refrigerants to residents and businesses. As the usage of these fuels is generally low compared to natural gas usage, emissions are expected to be minimal compared to current total emissions. The level of effort to collect this data would have been greater than the benefit of its use within the analyses. Industrial process and agricultural emission sources were not identified for inclusion in the community-wide inventory as these entities, although some may be located inside of the geopolitical boundary of the City of Raleigh, are estimated to be minimal.

This report contains recommendations for subsequent year data collection methodologies for the requisite data. An established method for data collection will assist with consistently updating the inventory on an annual basis. This report also identifies other emission sources that could be considered for inclusion in the community-wide GHG emissions inventory.

Inventory Boundary Conditions

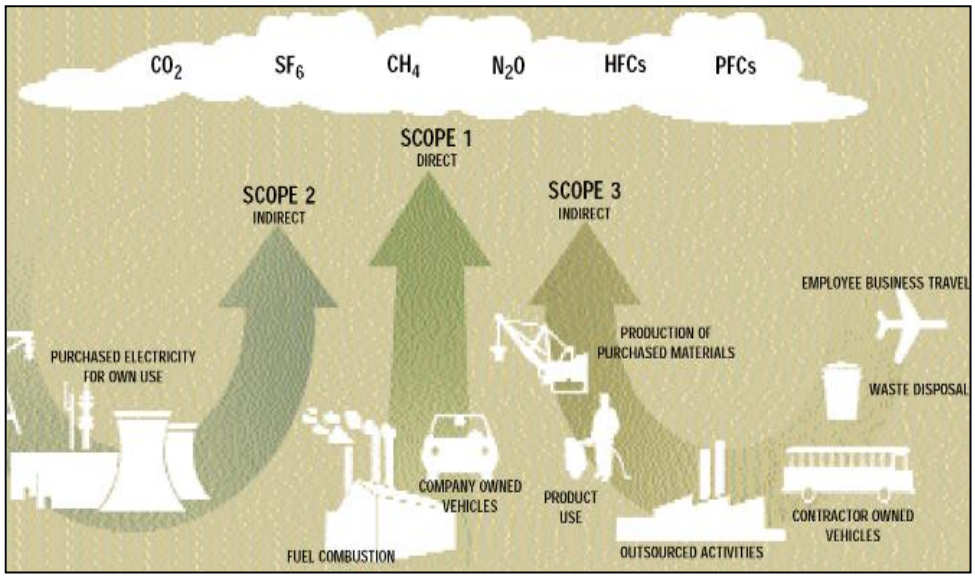
Operational Boundaries

Greenhouse gas emissions are defined by the three categories shown below and as depicted in **Exhibit 1**.

- Scope 1 - Direct emissions
- Scope 2 - Indirect emissions
- Scope 3 - Optional or other indirect emissions

The community-wide baseline 2007 and year 2010 inventories include Direct (Scope 1) and Indirect (Scope 2) emissions.

EXHIBIT 1



Scopes Included

The Scope 1 and Scope 2 emissions included in the community-wide GHG baseline 2007 and year 2010 inventories are:

- Scope 1 - Direct Emissions
    - Mobile Combustion – Commuter transportation
    - Stationary Combustion – Natural gas use
- Scope 2 - Indirect Emissions
    - Electricity Use

Scope 1 – Direct Emissions

Direct emissions result from sources, processes, or facilities within community residential and industrial/ commercial/institutional buildings within the City. The community-wide GHG inventory utilized the following source categories for direct emissions:

- Mobile Combustion Emissions – Emissions resulting from the combustion of fossil-fuels in transportation sources both in the on- and off-road categories. Mobile sources within the community (e.g. passenger vehicles, light and heavy trucks used for commuting and/or material transport) are included in the emissions inventory.
- Stationary Combustion Emissions – Emissions that are the result of combusting fossil- fuels using equipment in a fixed location including heaters, boilers, incinerators, and generators. Residential, commercial, industrial and institutional stationary sources are included in this category.

Scope 2 – Indirect Emissions

Indirect emissions result from activities owned and/or controlled by another entity, but are being completed on behalf of the reporting entity. For this category, only emissions resulting from the use of purchased electricity are included.

Physical Boundaries

The geographical boundary for this inventory is the City of Raleigh jurisdiction within Wake County. The City occupies a 144-square-mile area and is home to over 400,000 citizens, as well as university and college campuses, and state and county government complexes. The community-wide emissions account for electrical use and natural gas consumption by residents and businesses within the City's geographical boundary as well as commuter emissions from vehicles within that boundary. The usage of fuel oil and propane are not considered significant and are not included in this analysis.

Greenhouse Gases Evaluated

All six of the Kyoto GHGs – carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoroide (SF_6) – were evaluated for inclusion. However, community activities within the City of Raleigh emit only CO_2, CH_4, and N_2O. There were no emissions of PFCs or SF_6 identified in the community-wide emissions analysis as these emissions are generally associated with the transmission and distribution of electricity from generation facilities and/or the manufacture of semi-conductors. Fugitive emissions of HFCs are associated with refrigerant usage. These emissions are not included in the community-wide emissions analysis at this time.

Total emissions for the GHG inventory are expressed as carbon dioxide equivalents (CO_2-eq). Carbon dioxide equivalents represent the universal unit for comparing emissions of the various GHGs to one unit of CO_2 based upon their global warming potential (GWP) value. GWPs indicate the degree of warming to the atmosphere that would result from the emission of one unit of a given GHG compared to one unit of CO_2. To obtain CO_2-eq emissions, the mass rate of emissions for each GHG is multiplied by its respective GWP. The GWP values for the six Kyoto GHGs are shown in **Exhibit 2**.

EXHIBIT 2
Greenhouse Gas Global Warming Potentials

Greenhouse Gas (GHG)	Global Warming Potential (GWP) ([a])
Carbon Dioxide (CO_2)	1
Methane (CH_4)	21
Nitrous Oxide (N_2O)	310
Hydrofluorocarbons (HFCs)	1300 (for R-134a)
Perfluorocarbons (PFCs)	varies
Sulfur Hexafluoride (SF_6)	2600

([a]) Based upon the Second Assessment Report (SAR) of the Intergovernmental Panel on Climate Change

Greenhouse Gas Emissions Inventory Data and Results

The community-wide GHG baseline 2007 and year 2010 emissions inventories for the City of Raleigh were developed following the *International Local Government GHG Emissions Analysis Protocol (IEAP), v1.0, 2009*. This inventory includes Scope 1 and 2 GHG emissions as defined in the above protocol and was comprised of only electricity use, natural gas consumption, and commuter vehicle emissions.

Scope 1 – Direct Emissions

Mobile Combustion Sources – Commuter Transportation

Commuter vehicle emissions were determined using the USEPA's Mobile6 Vehicle Emission Modeling software which requires the input of regional air quality data and vehicle mix information. For the community-wide mobile combustion sources, the following data were obtained from the Capital Area Metropolitan Planning Organization (CAMPO):

- Vehicle category (e.g. car, truck, motorcycle, etc.)
- Average annual meteorological data
- Average annual speed, by vehicle type
- Geographical category (e.g. urban, rural, other)
- Annual vehicle miles traveled (VMT)
- Traffic demand (e.g. AM, PM, off-peak)

CAMPO calculates vehicle miles traveled (VMT) using vehicle counts and traffic demand models that include all of Wake County. CAMPO provided the VMT data based on the 2030 Long-Range Transportation Plans and 2004-10 TIPs (June 2005). **Exhibit 3** presents the scaling factors developed to apply to the County-wide data to determine the emissions attributed to just the City of Raleigh community, for the baseline year of 2007 and for year 2010.

EXHIBIT 3
Comparison of 2007 and 2010 Population and Development of Scaling Factor (Ratio) for Wake County and City of Raleigh

Year	Wake County Population	City of Raleigh Population	Ratio for City of Raleigh as percentage of Wake County
2007	831,750	378,180	45.5%
2010	900,990	403,890	44.8%

The CO_2 emissions from community vehicles were calculated by multiplying VMT by the CO_2 emissions factors generated by MOBILE6. VMT data were also multiplied by emission factors for CH_4 and N_2O to determine non-CO_2 emissions. Total CO_2 emissions for the baseline year of 2007 and for 2010 are presented in **Exhibits 4 and 5**.

EXHIBIT 4
Year 2007 Baseline Commuter Mobile Combustion Emissions

Urban Year 2007		Rural Year 2007			
Urban Vehicle Miles Traveled	Urban CO_2 (ton/day)	Rural Vehicle Miles Traveled	Rural CO_2 (ton/day)	Total Wake County CO_2-eq (tonne/yr) ([a])	Total Raleigh Community-Wide CO_2-eq (tonne/yr) (@45.5%) ([b])
6,717,569,870	11,090	2,358,849,000	3,930	5,061,400	**2,301,350**

([a]) Tonne = metric ton
([b]) Percentage from Exhibit 3 for Year 2007

EXHIBIT 5
Year 2010 Commuter Mobile Combustion Emissions

Urban Year 2010		Rural Year 2010			
Urban Vehicle Miles Traveled	Urban CO_2 (ton/day)	Rural Vehicle Miles Traveled	Rural CO_2 (ton/day)	Total Wake County CO_2-eq (tonne/yr) ([a])	Total Raleigh Community-Wide CO_2-eq (tonne/yr) @ 44.8% ([b])
7,263,928,150	12,010	2,714,488,940	4,530	5,575,260	**2,499,240**

([a]) Tonne = metric ton
([b]) Percentage from Exhibit 3 for Year 2010

Stationary Combustion Sources – Natural Gas Use

The most accurate information to collect to quantify this source category is measured data as presented in utility bills. Meter readings from gauges located at the specific pieces of equipment or for the buildings are the primary data source because they provide individual fuel usage. The data required for assessing stationary combustion source emissions are:

- Fuel type
- Annual fuel usage, by fuel type, a grouped category
- Fuel heat content and/or carbon content, if measured, by fuel type

Natural gas use data for customers within the City of Raleigh were obtained from PSNC Energy. The usage data was provided in the following categories: company, residential, commercial, and industrial. Natural gas used directly by City of Raleigh Operations was included within the PSNC Energy's 'company' category, and CH2M HILL deducted this usage from the total because direct usage by the City has been accounted for within the CEAP Plan.

Exhibits 6 and 7 present the data for 2007 and 2010, respectively. The largest users of natural gas in the community were residential customers, followed by commercial entities.

EXHIBIT 6
Year 2007 Stationary Combustion Emissions – Natural Gas

Grouped Source Category	Fuel Usage (therms)	Total CO_2-eq (tonne/yr) ([a])
Company	8,500	47
Residential	37,795,870	207,090
Commercial	28,965,700	158,710
Industrial	5,158,510	28,260
Commercial Interruptible	16,368,550	89,690
Industrial Interruptible	811,770	4,450
City of Raleigh - Operations	-519,730	-2,850
TOTALS	**88,589,170**	**485,400**

([a]) Tonne = metric ton

EXHIBIT 7
Year 2010 Stationary Combustion Emissions – Natural Gas

Grouped Source Category	Fuel Usage (therms)	Total CO_2-eq (tonne/yr) ([a])
Company	24,770	140
Residential	57,994,580	317,760
Commercial	35,162,690	192,660
Industrial	6,080,700	33,320
Commercial Interruptible	15,941,970	87,350
Industrial Interruptible	8,120,380	44,490
City of Raleigh - Operations	-878,280	-4,810
TOTALS	**122,446,800**	**670,910**

([a]) Tonne = metric ton

Scope 2 – Indirect Emissions

Electricity Usage

Indirect emissions included in this community-wide GHG emissions inventory are solely from purchased electricity usage.

The most accurate information to collect to quantify this source category is metered data as presented in utility bills, and grouped by category for non-residential customers. Annual usage data from meters directly connected to buildings, facilities, and large pieces of equipment is the primary source of data. If actual electricity usage is not known for a building and/or facility, the type of operations being conducted in the space along with the total square footage can be used to determine electricity usage based on US industry standard averages for energy use per square foot.

Progress Energy provides electricity for the vast majority of City of Raleigh residents, businesses, and commercial/industrial/institutional facilities. Usage data was provided by Progress Energy, but only on a "per capita" basis as generated from a mix of residential, industrial, and commercial use based on metered data from these categories. Overall electricity usage and the associated GHG emissions are detailed in **Exhibit 8** below.

It is noted that for the development of inventories in the future, an improved level of detail is desirable – a breakdown of electricity use by grouped source (residential, commercial, and industrial/institutional).

EXHIBIT 8
Year 2007 and Year 2010 Indirect Emissions – Purchased Electricity

Year	Population	Usage (kWh/person/month)	Electricity Use (kWh/yr)	Electricity Use (MWh/yr)	Total CO_2-eq (tonne/yr) ([a])
2007	378,180	973	4,423,942,990	4,423,940	2,090,430
2010	403,890	966	4,681,916,060	4,681,920	2,212,330

([a]) Tonne = metric ton

Conclusions and Considerations

Conclusions

Exhibit 9 illustrates the community-wide GHG emissions for the baseline 2007 and year 2010, respectively. **Exhibit 10** shows the comparison between the 2007 and 2010 community-wide GHG emissions for the City of Raleigh.

EXHIBIT 9
Baseline Year 2007 and Year 2010 Community-wide GHG Emissions

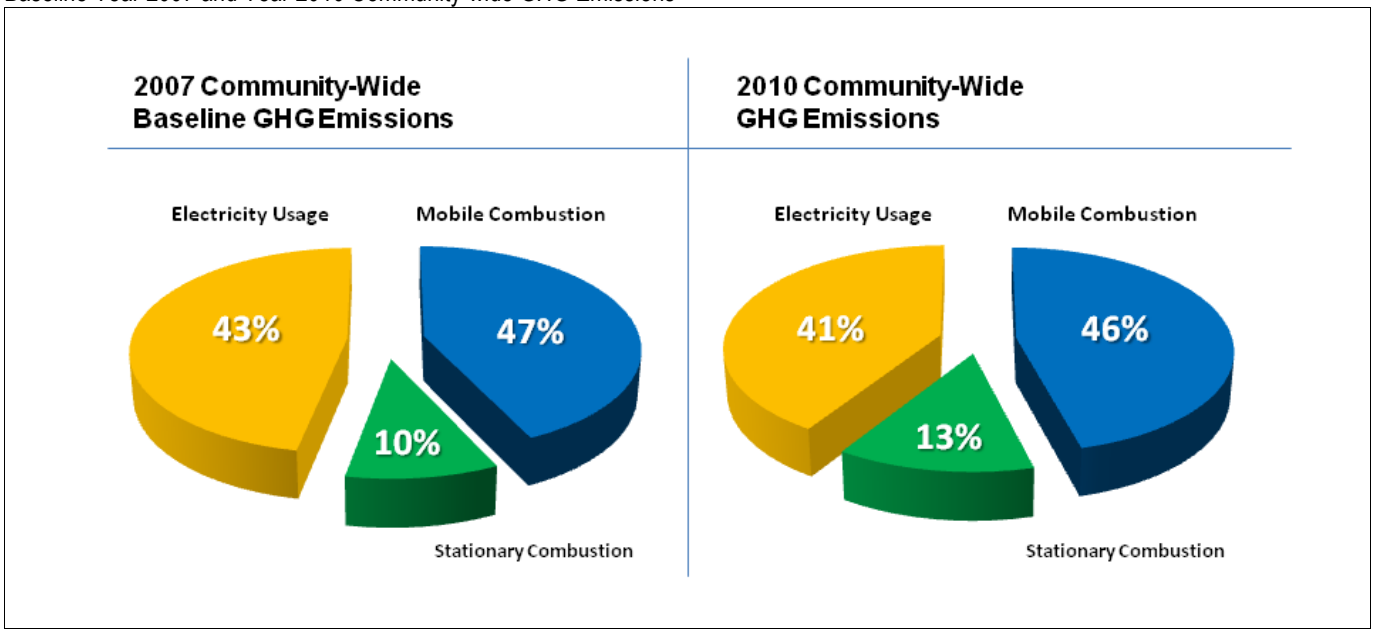


EXHIBIT 10
Comparison of Baseline Year 2007 and Year 2010 Community-wide GHG Emissions

Emission Source	2007 Baseline		2010		Increase/ Decrease from 2007 to 2010
	Total CO_2-eq (tonne/yr) ([a])	% of Total	Total CO_2-eq (tonne/yr) ([a])	% of Total	
Mobile Combustion (Commuter)	2,301,350	47%	2,499,240	**46%**	**9%**
Stationary Combustion (Natural Gas)	485,400	10%	670,910	**13%**	**38%**
Purchased Electricity Usage	2,090,430	43%	2,212,330	**41%**	**6%**

([a]) Tonne = metric ton

Trends

Based upon the data collected and the emissions quantified for the community-wide inventory, the following trends were observed:

- Direct emissions resulting from mobile combustion (commuter traffic) account for nearly half of the overall community-wide GHG emissions inventory total for years 2007 and 2010
- Indirect emissions associated with purchased electricity usage within residential, commercial, institutional and industrial facilities comprised over 40% of the overall GHG emissions in 2007 and 2010
- Although a relatively small percentage of the overall GHG emissions, natural gas consumption increased nearly 40% between 2007 and 2010, possibly due to extended periods of cold weather

Energy Conservation and Fuel Efficiency Initiatives

To reduce community-wide GHG emissions, the City of Raleigh may consider focusing on energy conservation and fuel efficiency initiatives such as:

Energy Audits

- Energy audits for both residential and commercial entities. Audits are usually conducted by the utility-provider, and could be encouraged by the City of Raleigh. Following an audit, energy saving measures could be undertaken at relatively low costs, such as weather-proofing and HVAC system optimization in order to reduce natural gas usage.

Transportation

- Increasing Mass Transit Routing and Methods such as Light Rail

  The City of Raleigh's Capital Area Transit (CAT) system provides bus service throughout Raleigh as well as the R-Line service which connects employees, resident and visitors to retail, restaurant and entertainment venues in Raleigh's downtown Central Business District.

  The City's website provides extensive information about the City's bus services. In September 2012, the City initiated a program to increase awareness of CAT, and to heighten environmental awareness and alternative commute methods during "Try Transit Week". Most busses are equipped with bike racks that hold two bicycles, encouraging commuters to combine cycling and mass transit transportation methods.

  In March, 2012, the Raleigh City Council endorsed the proposal of four passenger rail stations throughout the Raleigh area that would support a proposed light rail system that would travel between Garner and Durham. The light rail system could be operational by 2019. The projected ridership for the entire system is nearly 7,000 passengers per day.

  Since direct emissions resulting from commuter traffic (mobile combustion) account for nearly half of the overall community-wide GHG emissions inventory total for year 2010, continued focus on mass transit could help reduce this percentage as well as offset potential increases as the City continues to grow.

- Continued Development of Walking and Bike Riding Paths

  Raleigh has been ranked as the 36th Most Walkable Large City in the US by Walk Score (www.walkscore.com). The City has invested extensively in the Capital Area Greenway System which is a 77-mile network of trails in both urban and suburban areas of the City. Increased commuting via the Greenway System by walking or bicycling could also reduce commuter traffic GHG emissions.

Considerations for Developing Future Inventories

General Considerations

It should be noted that data provided by CAMPO and by PSNC Energy were sufficiently detailed to complete the emissions calculations.

However, utilizing a much more detailed breakdown of information about purchased electricity usage would provide more accurate data for use in the emissions calculations. Ideally, a breakdown of electricity use by grouped source (residential, commercial, and industrial/institutional) should be obtained. In addition, the aggregation of data by such grouped sources would allow energy efficiency and conservation efforts to be focused on the area(s) of highest use.

Scope 1 – Direct Emissions

- *Other Stationary Combustion Sources* – Currently, the community-wide GHG emissions inventory only includes combustion of natural gas. However, fuel oil, propane, and other fuels used for space heating could be included if quantities used could be accurately documented.
- *Process-Related Sources* – Process emissions result from physical or chemical processes and refer to emissions other than those resulting from fuel combustion. Process-related emissions from manufacturing operations within the community were not included in the inventory because there is relatively little manufacturing in Raleigh at this time. However, as land use changes may occur in the future, industrial/manufacturing may become significant and these emissions should be re-considered for inclusion at that time. If detailed data were provided in the future by commercial and industrial facilities, process emissions could be included in the analysis.

Scope 2 – Indirect Emissions

Indirect emissions resulting only from the use of purchased electricity are included in this community-wide inventory. However, if there are entities within the City that purchase large quantities of steam and/or hot or chilled water, emissions associated with these purchases could be considered under the Scope 2 emissions category. It would be necessary to define the data that would be required as well as determining if quantities could be accurately documented.

Other indirect emissions that could be included are those generated from agricultural sources/farms within the City boundary. Individual farm animal counts, by type, would be needed to assess emissions from agricultural sources.

Employee and Residential Commuting

Enter Data into the Yellow Shaded Cells Only
Data
Emission Factor/Constant
Results
Quantification Methodology: Emissions = Activity Data x Emission Factor x Conversion Factor
CO2 (tonnes/yr) = veh.miles/yr / fuel economy (mi/gal) x emission factor (CO2 kg/gal) x tonne/1000 kg = tonne/yr
CH4 and N2O (tonnes/yr) = veh. mile/yr x CO2 g/mile x 1 tonne/1000000 g = tonne/yr

2007

Community-Based

		Wake County Calculated 2007										
Entity	Vehicle Type	Urban Vehicle Miles Traveled	Urban CO2 (ton/day)	Rural Vehicle Miles Traveled	Rural CO2 (ton/day)	Total CO2 (tonne/year)	Total CH4 (tonne/yr)	Total N2O (tonne/yr)	Total CO2-eq (tonne/yr)	Wake County	City of Raleigh Population	Ratio of Total CO2-eq
Community	various	6,717,569,865	11,085.37	2,358,849,000	3,926.02	4,972,012.41	1,616.06	178.86	5,061,395.00	831,746	378,184	45.47%
					Total:	4,972,012.41	1,616.06	178.86	5,061,395.00			
					COR Total:	**2,260,708.85**	**734.80**	**81.32**	**2,301,349.94**			

2010

Community-Based

		Wake County Calculated 2010										
Entity	Vehicle Type	Urban Vehicle Miles Traveled	Urban CO2 (ton/day)	Rural Vehicle Miles Traveled	Rural CO2 (ton/day)	Total CO2 (tonne/year)	Total CH4 (tonne/yr)	Total N2O (tonne/yr)	Total CO2-eq (tonne/yr)	Wake County	City of Raleigh Population	Ratio of Total CO2-eq
Community	various	7,263,928,145	12,009.84	2,714,488,940	4,526.16	5,476,989.86	1,776.66	196.63	5,575,255.13	900,993	403,892	44.83%
					Total:	5,476,989.86	1,776.66	196.63	5,575,255.13			
					COR Total:	**2,455,193.76**	**796.43**	**88.14**	**2,499,243.55**			

Wake County CO2 Emisisons
Calculated Using MOBILE6

Roadway Description	2007 CO2 Emissions			2010 CO2 Emissions		
	CO2 Emission Factor (g/mile)[a]	Daily Vehicle Miles Traveled (VMT)[b]	CO2 Emissions (g/day)[c]	CO2 Emission Factor (g/mile)[a]	Daily Vehicle Miles Traveled (VMT)[b]	CO2 Emissions (g/day)[c]
Rural Interstate-Wake-AM Peak[d]	602.8	55044	33180523.2	603	78507	47339721
Rural Principal Arterial-Wake-AM Peak	573.3	388440	222692652	573.7	423667	243057757.9
Rural Minor Arterial-Wake-AM Peak	560.6	317337	177899122.2	561.1	369507	207330377.7
Rural Major Collector-Wake-AM Peak	521.6	248236	129479897.6	522.3	284965	148837219.5
Rural Minor Collector-Wake-AM Peak	525.6	280348	147350908.8	526.3	305200	160626760
Rural Local-Wake-AM Peak	549.5	559092	307221054	550	688027	378414850
Urban Interstate-Wake-AM Peak	602.8	1446403	871891728.4	603	1537101	926871903
Urban Freeway Expressway-Wake-AM Peak	557.1	972611	541841588.1	557.6	1117374	623047742.4
Urban Principal Arterial-Wake-AM Peak	525.8	1008497	530267722.6	526.4	1067818	562099395.2
Urban Minor Arterial-Wake-AM Peak	505	1108312	559697560	505.8	1186703	600234377.4
Urban Collector-Wake-AM Peak	498.4	402366	200539214.4	499.1	456938	228057755.8
Urban Local-Wake-AM Peak	526.1	568766	299227792.6	526.7	593150	312412105
Rural Interstate-Wake-PM Peak[d]	602.8	62941	37940834.8	603	87349	52671447
Rural Principal Arterial-Wake-PM Peak	573.3	433064	248275591.2	573.7	476967	273635967.9
Rural Minor Arterial-Wake-PM Peak	560.6	341922	191681473.2	561.1	381993	214336272.3
Rural Major Collector-Wake-PM Peak	521.6	261080	136179328	522.3	295929	154563716.7
Rural Minor Collector-Wake-PM Peak	525.6	314053	165066256.8	526.3	332880	175194744
Rural Local-Wake-PM Peak	549.5	607684	333922358	550	742769	408522950
Urban Interstate-Wake-PM Peak	602.8	1440432	868292409.6	603	1569178	946214334
Urban Freeway Expressway-Wake-PM Peak	557.1	972188	541605934.8	557.6	1127693	628801616.8
Urban Principal Arterial-Wake-PM Peak	525.8	995212	523282469.6	526.4	1053804	554722425.6
Urban Minor Arterial-Wake-PM Peak	505	1137572	574473860	505.8	1199690	606803202
Urban Collector-Wake-PM Peak	498.4	431372	214995804.8	499.1	461793	230480886.3
Urban Local-Wake-PM Peak	526.1	575759	302906809.9	526.7	599276	315638669.2
Rural Interstate-Wake-Off Peak[d]	602.8	92186	55569720.8	603	135722	81840366
Rural Principal Arterial-Wake-Off Peak	573.3	606953	347966154.9	573.7	656016	376356379.2
Rural Minor Arterial-Wake-Off Peak	560.6	455868	255559600.8	561.1	527732	296110425.2
Rural Major Collector-Wake-Off Peak	521.6	346414	180689542.4	522.3	384382	200762718.6
Rural Minor Collector-Wake-Off Peak	525.6	379539	199485698.4	526.3	399729	210377372.7
Rural Local-Wake-Off Peak	549.5	712399	391463250.5	550	865615	476088250

Wake County CO2 Emisisons
Calculated Using MOBILE6

Roadway Description	2007 CO2 Emissions: CO2 Emission Factor (g/mile)[a]	2007 CO2 Emissions: Daily Vehicle Miles Traveled (VMT)[b]	2007 CO2 Emissions: CO2 Emissions (g/day)[c]	2010 CO2 Emissions: CO2 Emission Factor (g/mile)[a]	2010 CO2 Emissions: Daily Vehicle Miles Traveled (VMT)[b]	2010 CO2 Emissions: CO2 Emissions (g/day)[c]
Urban Interstate-Wake-Off Peak	602.8	2159628	1301823758	603	2358159	1421969877
Urban Freeway Expressway-Wake-Off Peak	557.1	1315416	732818253.6	557.6	1519451	847245877.6
Urban Principal Arterial-Wake-Off Peak	525.8	1350104	709884683.2	526.4	1439861	757942830.4
Urban Minor Arterial-Wake-Off Peak	505	1370174	691937870	505.8	1430197	723393642.6
Urban Collector-Wake-Off Peak	498.4	496514	247462577.6	499.1	502535	250815218.5
Urban Local-Wake-Off Peak	526.1	652975	343530147.5	526.7	680452	358394068.4
	Urban VMT/yr	**6,717,569,865.00**		Urban VMT	**7,263,928,145.00**	
	Rural VMT/yr	**2,358,849,000.00**		Rural VMT	**2,714,488,940.00**	
		Urban Total ton/day	**11,085.37**		Urban Total ton/yr	**12,009.84**
		Rural Total ton/day	**3,926.02**		Rural Total ton/yr	**4,526.16**
		Total g/day	13,618,104,152.70		Total g/day	15,001,213,222.90
		Total ton/day	15,011.39		Total ton/day	16,536.01
		Total ton/yr	5,479,157.68		Total ton/yr	6,035,642.83
		Total Metric ton CO2 per year	**4,972,012.41**		**Total Metric ton CO2 per year**	**5,476,989.86**
	Wake Population 2007		831,746	**Wake Population 2010**		900,993
	Raleigh Population 2007		378,184	**Raleigh Population 2010**		403,892
	Raleigh approx Total Metric ton CO2- 2007			**Raleigh approx Total Metric ton CO2- 2010**		
			2,260,708.85			**2,455,193.76**

Notes:
[a] CO2 emission factor from EPA MOBILE6.2 model using inputs from CAMPO regional conformity modeling
[b] VMT from 2030 Long-Range Transportation Plans and 2004-10 TIPs (June 2005) - http://www.triangleair.org/
[c] CO2 emissions (g/day) for each roadway type = CO2 emission factor * daily VMT
[d] Rural interstate inputs not available for MOBILE6.2. Assumed rural interstate emission factor equal to urban interstate emission factor.

Stationary Combustion

Enter Data into the Yellow Shaded Cells Only
Data
Emission Factor/Constant
Results
Quantification Methodology: Emissions = Activity Data x Emission Factor x Conversion Factor
CO2 (tonnes/yr) = fuel gal/yr x heat content Btu/gal x MMBtu/1000000 Btu x kg/MMBtu x 1 tonne/1000 kg = tonne/yr
CH4 and N2O (tonnes/yr) = fuel gal/yr x fuel Btu/gal x MMBtu/1000000 Btu x g/MMBtu x 1 tonne/1000000 g = tonne/yr

2007

Entity	Facility Name	No. of Units	Equipment Name	Fuel Type	Heat Content	Units	Fuel Usage	Units	Heat Output (MMBtu/yr)	Data Source	Percent Equity (%)	CH4 and N2O Emission Factor Name	CO2 Emission Factor	CO2 Emission Factor Units	CH4 Emission Factor	CH4 Emission Factor Units	N2O Emission Factor	N2O Emission Factor Units	CO2 tonne/yr	CH4 tonne/yr	N2O tonne/yr	Total CO2 eq (tonne/yr)
Community-Based																						
Company	Various		various	Natural Gas - Unspecified (Weighted U.S. Average)	103000.00	Btu/therm	8,496.00	therms	8.75E+02	PSNC	100	Natural Gas - Residential/ Commercial End Use	53.06	kg/MMBtu	5.0	g/MMBtu	0.1	g/MMBtu	46.43	0.0044	0.0001	46.55
Residential	Various		various	Natural Gas - Unspecified (Weighted U.S. Average)	103000.00	Btu/therm	37,795,869.00	therms	3.89E+06	PSNC	100	Natural Gas - Residential/ Commercial End Use	53.06	kg/MMBtu	5.0	g/MMBtu	0.1	g/MMBtu	206,561.23	19.4649	0.3893	207,090.67
Commercial	Various		various	Natural Gas - Unspecified (Weighted U.S. Average)	103000.00	Btu/therm	28,965,705.00	therms	2.98E+06	PSNC	100	Natural Gas - Residential/ Commercial End Use	53.06	kg/MMBtu	5.0	g/MMBtu	0.1	g/MMBtu	158,302.79	14.9173	0.2983	158,708.54
Industrial	Various		various	Natural Gas - Unspecified (Weighted U.S. Average)	103000.00	Btu/therm	5,158,514.00	therms	5.31E+05	PSNC	100	Natural Gas - Residential/ Commercial End Use	53.06	kg/MMBtu	5.0	g/MMBtu	0.1	g/MMBtu	28,192.21	2.6566	0.0531	28,264.47
Commercial Interruptible	Various		various	Natural Gas - Unspecified (Weighted U.S. Average)	103000.00	Btu/therm	16,368,545.00	therms	1.69E+06	PSNC	100	Natural Gas - Residential/ Commercial End Use	53.06	kg/MMBtu	5.0	g/MMBtu	0.1	g/MMBtu	89,457.04	8.4298	0.1686	89,686.34
Industrial Interruptible	Various		various	Natural Gas - Unspecified (Weighted U.S. Average)	103000.00	Btu/therm	811,770.00	therms	8.36E+04	PSNC	100	Natural Gas - Residential/ Commercial End Use	53.06	kg/MMBtu	5.0	g/MMBtu	0.1	g/MMBtu	4,436.47	0.4181	0.0084	4,447.84
City of Raleigh - Operations	Various		various	Natural Gas - Unspecified (Weighted U.S. Average)	103000.00	Btu/therm	-519,731.00	therms	-5.35E+04	PSNC	100	Natural Gas - Residential/ Commercial End Use	53.06	kg/MMBtu	5.0	g/MMBtu	0.1	g/MMBtu	-2,840.42	-0.2677	-0.0054	-2,847.70
						Total	**88,589,168.00**	**therms**										**Total**	**484,155.75**	**45.62**	**0.9125**	**485,396.71**

2010

Entity	Facility Name	No. of Units	Equipment Name	Fuel Type	Heat Content	Units	Fuel Usage	Units	Heat Output (MMBtu/yr)	Data Source	Percent Equity (%)	CH4 and N2O Emission Factor Name	CO2 Emission Factor	CO2 Emission Factor Units	CH4 Emission Factor	CH4 Emission Factor Units	N2O Emission Factor	N2O Emission Factor Units	CO2 tonne/yr	CH4 tonne/yr	N2O tonne/yr	Total CO2 eq (tonne/yr)
Community-Based																						
Company	Various		various	Natural Gas - Unspecified (Weighted U.S. Average)	103000.00	Btu/therm	24,769.00	therms	2.55E+03	PSNC	100	Natural Gas - Residential/ Commercial End Use	53.06	kg/MMBtu	5.0	g/MMBtu	0.1	g/MMBtu	135.37	0.0128	0.0003	135.71
Residential	Various		various	Natural Gas - Unspecified (Weighted U.S. Average)	103000.00	Btu/therm	57,994,579.00	therms	5.97E+06	PSNC	100	Natural Gas - Residential/ Commercial End Use	53.06	kg/MMBtu	5.0	g/MMBtu	0.1	g/MMBtu	316,950.81	29.8672	0.5973	317,763.20
Commercial	Various		various	Natural Gas - Unspecified (Weighted U.S. Average)	103000.00	Btu/therm	35,162,691.00	therms	3.62E+06	PSNC	100	Natural Gas - Residential/ Commercial End Use	53.06	kg/MMBtu	5.0	g/MMBtu	0.1	g/MMBtu	192,170.44	18.1088	0.3622	192,662.99
Industrial	Various		various	Natural Gas - Unspecified (Weighted U.S. Average)	103000.00	Btu/therm	6,080,707.00	therms	6.26E+05	PSNC	100	Natural Gas - Residential/ Commercial End Use	53.06	kg/MMBtu	5.0	g/MMBtu	0.1	g/MMBtu	33,232.16	3.1316	0.0626	33,317.34
Commercial Interruptible	Various		various	Natural Gas - Unspecified (Weighted U.S. Average)	103000.00	Btu/therm	15,941,970.00	therms	1.64E+06	PSNC	100	Natural Gas - Residential/ Commercial End Use	53.06	kg/MMBtu	5.0	g/MMBtu	0.1	g/MMBtu	87,125.74	8.2101	0.1642	87,349.05
Industrial Interruptible	Various		various	Natural Gas - Unspecified (Weighted U.S. Average)	103000.00	Btu/therm	8,120,368.00	therms	8.36E+05	PSNC	100	Natural Gas - Residential/ Commercial End Use	53.06	kg/MMBtu	5.0	g/MMBtu	0.1	g/MMBtu	44,379.27	4.1820	0.0836	44,493.02
City of Raleigh - Operations	Various		various	Natural Gas - Unspecified (Weighted U.S. Average)	103000.00	Btu/therm	-878,281.00	therms	-9.05E+04	PSNC	100	Natural Gas - Residential/ Commercial End Use	53.06	kg/MMBtu	5.0	g/MMBtu	0.1	g/MMBtu	-4,799.96	-0.4523	-0.0090	-4,812.27
						Total	**122,446,803.00**	**therms**										**Total**	**669,193.82**	**63.06**	**1.2612**	**670,909.05**

Indirect Emissions - Electricity Usage

Enter Data into the Yellow Shaded Cells Only
Data
Emission Factor/Constant
Results
Quantification Methodology: Emissions = Activity Data x Emission Factor x Conversion Factor
CO2 (tonnes/yr) = MWh/yr x lb/MWh x 1 tonne/2204.6 lb **OR** kWh/yr x MWh/1000 kWh x lb/MWh x 1 tonne/2204.6 lb = tonne/yr
CH4 and N2O (tonnes/yr) = MWh/yr x lb/MWh x 1 tonne/2204.6 lb **OR** kWh/yr x MWh/1000 kWh x lb/MWh x 1 tonne/2204.6 lb = tonne/yr

2007

Entity	Facility ID No.	City	Bldg Type	Population	Usage (kWh/person/month)	Electricity Use (kWh/yr)	Electricity Use (MWh/yr)	eGrid Region	Data Source	Percent Equity (%)	CO2 Emission Factor (lb/MWh)	CH4 Emission Factor (lb/MWh)	N2O Emission Factor (lb/MWh)	CO2 (tonne/yr)	CH4 (tonne/yr)	N2O (tonne/yr)	Total CO2-eq (tonne/yr)
Community-Based																	
Residential	Various	Raleigh	Various	378,892	973	4,423,942,992	4,423,943	SRVC - SERC Virginia/Carolina	Progress Energy	100	1035.87	0.02151	0.01745	2,078,667.25	43.16	35.02	2,090,428.87
					Total:	**4,423,942,992**	**kWh**						**Total**	**2,078,667.25**	**43.16**	**35.02**	**2,090,428.87**

2010

Entity	Facility ID No.	City	Bldg Type	Population	Usage (kWh/person/month)	Electricity Use (kWh/yr)	Electricity Use (MWh/yr)	eGrid Region	Data Source	Percent Equity (%)	CO2 Emission Factor (lb/MWh)	CH4 Emission Factor (lb/MWh)	N2O Emission Factor (lb/MWh)	CO2 (tonne/yr)	CH4 (tonne/yr)	N2O (tonne/yr)	Total CO2-eq (tonne/yr)
Community-Based																	
Residential	Various	Raleigh	Various	403,892	966	4,681,916,064	4,681,916	SRVC - SERC Virginia/Carolina	Progress Energy	100	1035.87	0.02151	0.01745	2,199,880.43	45.68	37.06	2,212,327.90
					Total:	**4,681,916,064**	**kWh**						**Total**	**2,199,880.43**	**45.68**	**37.06**	**2,212,327.90**