# Greenhouse Gas Emissions Inventory Report

City of Wilmington, NC Fiscal Year 2011-2012

The Greenhouse Gas Emissions Inventory Report is a part of an annual effort to understand, track and report on the city's operational greenhouse gas emission impact.

Prepared by Keenen Altic, Cape Fear Community College
Edited by Suzanne Murphy Gooding, City of Wilmington NC
May 21, 2014

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## Introduction

Greenhouse gas emissions are airborne particles that trap heat in the earth's atmosphere. As more particles exist, global average temperatures increase. NASA's surface temperature analysis indicates a 0.77°C (1.4°F) increase in global mean temperature since 1951.[1]

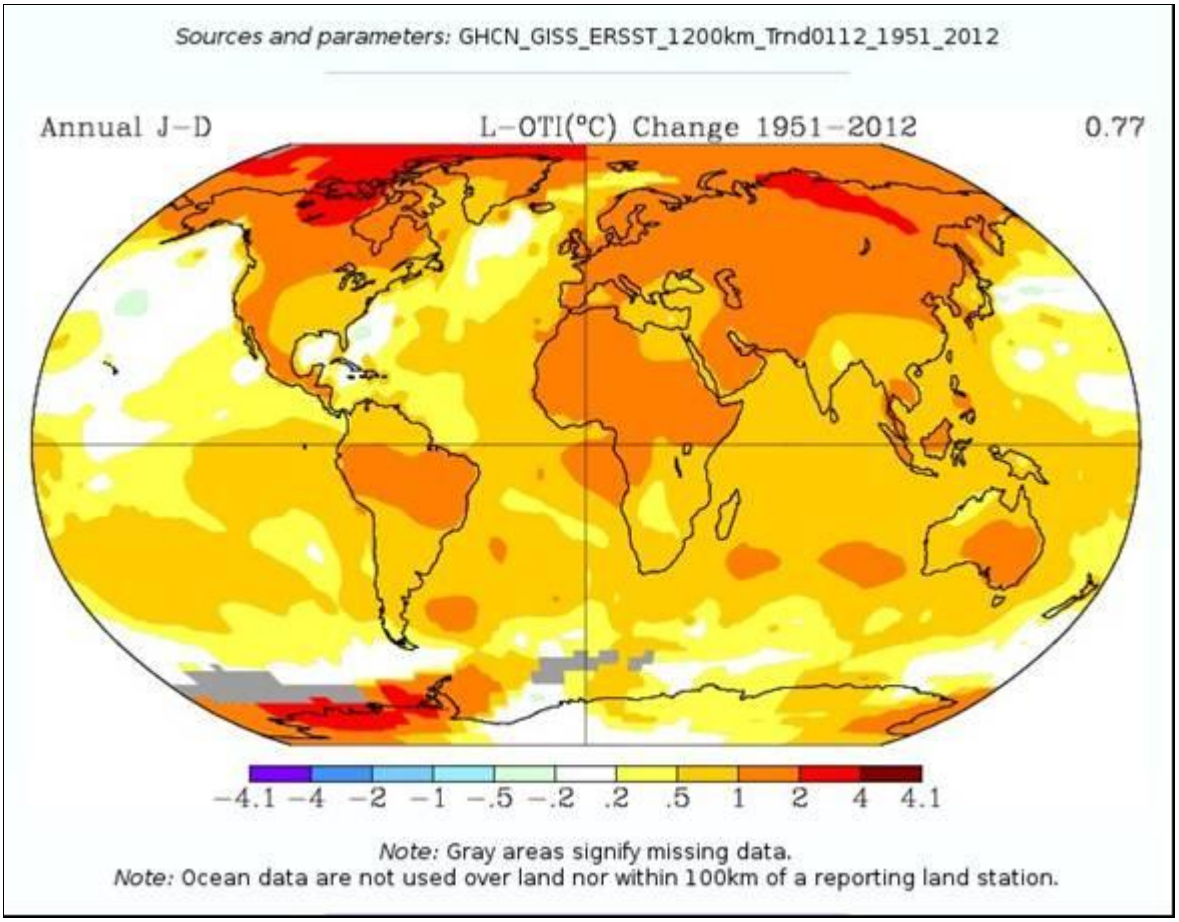



*Image 1: http://data.giss.nasa.gov/gistemp/maps/*

Climate instability increases as the planet attempts to maintain balance. Climate instability can lead to seasonal abnormalities in weather, such as hot and cold extremes, drought and or flooding. In 2012, there were 3,527 monthly weather records broken related to either heat, rain or snow in the U.S., according to the National Climatic Data Center (NCDC).[2] The Natural Resources Defense Council publishes extreme weather data on an interactive website.[3]

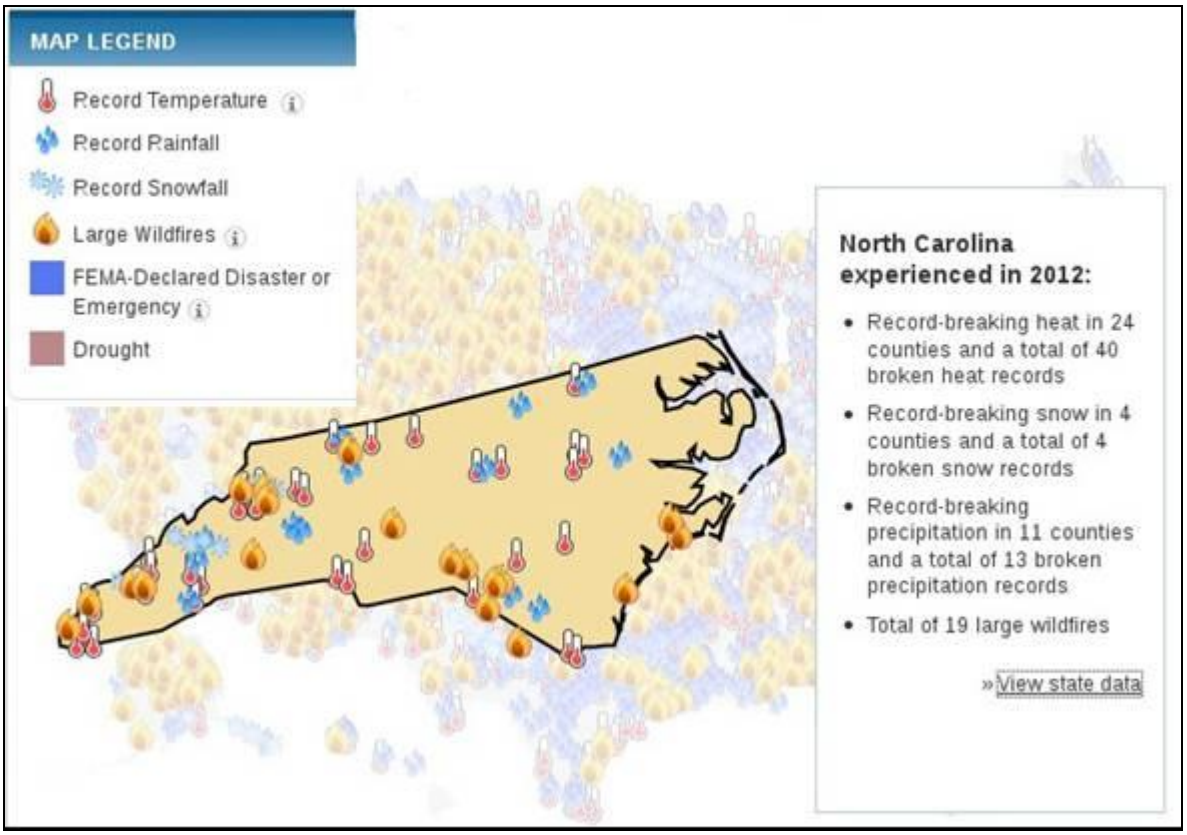



*Image 2: http://www.nrdc.org/health/extreme-weather/*

In 2009, the City of Wilmington, NC City Council authorized the Mayor to sign the U.S. Conference of Mayors Climate Protection Agreement. As a part of this agreement, Wilmington established a baseline emissions level for 2007 based on the city's operational control. A reduction goal was established per resolution to reduce emissions by 58% by the year 2050 (Appendix). In order to track the changes and understand impacts, greenhouse gas emissions should be tracked on a regular basis. This report and subsequent spreadsheet tool will assist the city in this effort.

The resolution passed by City Council was based on research into reduction targets set by other cities of similar population size. A consistent trend between each city was an annual rate of reduction at 1.34% according to the GHG Reduction Target Brief (Appendix).

| Year | 2007 Baseline | 2010 | 2020 | 2030 | 2040 | 2050 |
|---|---|---|---|---|---|---|
| Emissions | 9704 | 9314 | 8066 | 6985 | 6049 | 5238 |
| % Reduction | | 4 | 17 | 31 | 44 | 58 |

*Image 3: Greenhouse Reduction Target brief, 2009; pg 1*

The 2012 target for the City of Wilmington was 9.071 metric tons $CO^2e$ and the actual total calculated for FY 2011-2012 is 8,255 metric tons $CO^2e$, 5 years ahead of reduction targets. Significant reductions in output from the local coal-fired power plant as well as a reduction in

fossil fuel use in city government operations are the main drivers of the reduced emissions. City government annual electricity consumption, however, has increased by approximately 2,500 MWh since 2007.

# Methodology

Greenhouse gas emissions can be human induced, known as anthropogenic or independent of human action, known as biogenic.[4]

This report and inventory, as well as the baseline inventory, focused on the city's operationally controlled anthropogenic greenhouse gas emissions. The Local Government Operations Protocol (LGOP) set by The Climate Registry established standards to perform a greenhouse gas emission inventory. These standards have been defined to enable accurate comparisons of data for enhancement of coordinated efforts at reducing greenhouse gas emissions. The LGOP references the six compounds cited in the Kyoto Protocol as requirements to follow even though the U.S. is no longer a signatory to the Kyoto Protocol. The six compounds cited include

1. Carbon dioxide ($CO_2$)
2. Methane ($CH_4$)
3. Nitrous oxide ($N_2O$)
4. Hydrofluorocarbons (HFCs)
5. Perfluorocarbons (PFCs) and
6. Sulfur hexafluoride ($SF_6$)

Each of these compounds has a different degree of effect on global warming per unit mass. This requires multiplying the mass of each compound by a global warming potential (GWP) to yield the $CO_2$ equivalent expressed as a unit $CO_2e$ (Appendix). The base compound used for comparison is $CO_2$; therefore, its GWP is 1.

To help define climate policy and goals, emissions are categorized into control approach, scopes and local government sectors.

## *Control Approach*

To maintain consistency, one of two control approaches must be chosen and applied across all facilities of which the City has control.

1. Operational control is the full authority to introduce and implement operating policies (recommended by LGOP)
2. Financial control is when the City owns an asset but contracts out for operations and maintenance.

This inventory and report applied the operational control approach. Choosing operational control allows the most flexibility in developing greenhouse gas emission reduction plans since it only includes activities managed internally. Assets with operations and maintenance handled through contracts depend on finding contractors amenable or accountable to the reduction plan. Although the operational control approach was employed, an exception of the scope 3 city fuel card does exist. The use of a city fuel card falls under the financial control.

## *Scopes*

**Scope 1** emissions are considered to be directly from sources under the local operational control of the organization undergoing the inventory. The LGOP defines these emissions as the following:

1. Stationary combustion to produce electricity, steam, heat or power using equipment in a fixed location.
2. Mobile combustion of fuels in fleet transportation sources and emissions from off-road equipment such as in construction, agriculture and forestry.
3. Process emissions from physical or chemical processing, other than fuel combustion (from the manufacturing of cement, aluminum, adipic acid, ammonia, etc.);
4. Fugitive emissions that are not physically controlled but result from intentional or unintentional releases, commonly arising from the production, processing, transmission, storage, and use of fuels and other substances, often through joints, seals, packing, gaskets, etc. (HFCs from refrigeration leaks, $SF_6$ from electrical power distributors, and $CH_4$ from solid waste landfills).

**Scope 2** emissions are indirectly emitted because of energy used at a facility but generated by sources at a different location. For example, the electricity the city uses purchased from Duke Energy Progress is considered Scope 2. In general, this means electricity supplied from the grid which produces $CO_2$, $N_2O$, and $CH_4$ emissions when sourced from coal, natural gas, oil, biomass, or waste-to-energy.

**Scope 3** emissions are attributable to outsourced activities not under operational or financial control of the City. An example of scope 3 emissions is employees commuting in vehicles not owned by the City. This scope is considered optional and is not included in the inventory or report, with the exception of the city fuel card (explanation in scope 3 application section).

## *Local Government Sectors*

Local government sectors and operational control vary dependent on localized factors. For the purposes of this inventory and report, a few items are worth noting.

The Mayor and City Council appoint the City Manager who hire department heads. These departments are considered under the operational control of city government. In cases where the City Council partners with other governments and organizations who also have the power to make appointments, operational control is not considered exclusive and is not included in this inventory and report. For example, authorities such as the Cape Fear Public Transportation Authority, who run WAVE transit services, are not included. Although the city is involved in this authority, the board members are not exclusively city appointees. Another example is the Wilmington port. Wilmington, NC boasts an international port, but the port is under the operational control of the State of North Carolina. The landfill that services the City of Wilmington is under the operational control of New Hanover County and its emissions will not be included. The Wilmington airport is run by a private corporation, making it outside the operational control of the City of Wilmington.

The city does however hold operational control over the items in the following table. These items will be included in the inventory.

| City Activity | Scope |
|---|---|
| Vehicle fuel consumption(Fire, Fleet) | Scope 1 |
| Generator fuel | Scope 1 |
| Refrigerant loss | Scope 1 |
| Natural Gas purchased from Piedmont | Scope 1 |
| Electricity purchased from Duke | Scope 2 |
| Solar energy produced | Scope 2 |
| Streetlight and traffic signal electricity | Scope 2 |
| City fuel card; city business in city-owned vehicles | Scope 3 |

The Solar energy produced is included as a scope 2 reduction because all the electricity produced is sold to the grid and is not directly used by city-owned facilities. The city fuel card is administered to employees on official business trips, traveling in city-owned vehicles.

## General LGOP Notes

Scope 1, fugitive emissions includes refrigerant loss from leaks, typically seen in HVAC maintenance and repair. The City of Wilmington contracts out maintenance of HVAC systems, so this potential HFC emission compound is not under operational control, but under financial control. The FY 2011-2012 inventory is under the operational control approach, so does not include refrigerant loss factors.

As a note, according to the LGOP, greenhouse gas emissions from biomass or biofuel combustion is considered biogenic, even when released by humans, because the carbon released was recently contained within living matter as opposed to fossil fuels, which derive from carbon trapped deep in the earth for millions of years. This becomes critical to measuring greenhouse gas emissions because combustion of biodiesel, for example, has slightly higher greenhouse gas emission than propane but it is not a fossil fuel like propane.

Another important distinction to be made is the carbon sequestered by carbon stocks is not deducted from anthropogenic data. Carbon stocks are plants and trees that break carbon from $CO_2$ and release oxygen. This is a biogenic process and should not mix with anthropogenic data. While sequestering anthropogenic emissions is desirable, the source of this carbon is from deep within the earth. Deducting these emissions from the inventory would not account for a disruption in the biogenic carbon cycle. In fact, using carbon stocks to deduct emissions from the inventory may inadvertently incentivize more anthropogenic emissions. Carbon sequestration may be reported independently of emissions but it is not required by the LGOP and not included in this report.

# Application

## *Scope 1 application*

Appendix G of the LGOP includes a series of tables defining default units for emission measurements from fuels per unit energy as well as per unit volume. The annual consumption of each fuel used by the vehicle fleet was requested from Fleet Management and the Fire Department and compiled by the Sustainability Project Manager. Generator fuel totals were retrieved from the Facilities Maintenance division. Natural Gas and propane consumption was retrieved from the individual vendors.
City users are likely to report their fuel use in units by which they are purchased. Expressing energy in MMBtu is a unit common to all these fuel types . This unit (MMBtu) is helpful in analyzing efficiency and emissions comparisons for adjustments to the reduction plan, when developed. For example, diesel has more energy per gallon than gasoline, but more $CO_2$ emissions per unit energy than gasoline. The technology a fuel type uses needs to be considered in a reduction plan.

Scope 1 emissions totaled **5,359 metric tons $CO_2e$ in FY 2011-2012** compared to 5,628 metric tons $CO_2e$ in 2007.

| Energy Type | Consumption | Units | MMBtu | Metric Tons $Co_2e$ |
|---|---|---|---|---|
| **Stationary Combustion** | | | | |
| Natural Gas (Piedmont) | 36,647 | Therms | 3,665 | 195 |
| Propane and Generator fuel | 10,893 | gallons | 991 | 63 |
| **Stationary Total** | | | | **257** |
| **Vehicles** | | | | |
| Fire Department Gasoline | 15,751 | gallons | 1,969 | 140 |
| Fire Department Diesel | 31,556 | gallons | 4,355 | 319 |
| Fire Boat Diesel | 1,066 | gallons | 147 | 11 |
| Fleet Unleaded Gasoline | 330,684 | gallons | 41,335 | 2,948 |
| Fleet Diesel | 166,641 | gallons | 22,996 | 1,684 |
| **Vehicle Fuel Total** | **545,697** | **gallons** | **70,803** | **5,102** |
| Diesel Total | 199,262 | gallons | 27,498 | 2,013 |
| Unleaded Gasoline Total | 346,435 | gallons | 43,304 | 3,088 |
| | | | **Scope 1 Emissions** | **5,359** |
| | | | **Total GHG Emissions** | **8,255** |

| | baseline | | Target |
|---|---|---|---|
| Year | Scope 1 | Year | Metric Tons $Co_2e$ |
| 2007 | 5,628 | 2012 | 9,071 |

*Table 1: Scope 1 consumption compiled in the GHG Inventory Tool*

## *Scope 2 application*

Quantifying scope 2 emissions requires a verified default emission factor and an analysis of local grid characteristics if significant changes to local power plant energy mix have occurred. There have been many changes in the electrical energy mix for the Wilmington area since the last default emission factor was verified. To account for efficiency losses, it is recommended by the LGOP to use data that is expressed in electrical rather than heat energy. The United States Energy Information Agency (US EIA) publishes a spreadsheet named eGRID that includes emission measurements from electric power plants around the country.[7] This enables calculations of emission for a target area. Using data from Brunswick, LV Sutton, WASTEC and Progress Energy 1 power plants, an initial calculation reveals a scope 2 emission factor of 0.151 metric ton/MWh. However, since electrical energy is often traded between areas within sub regions, the US EIA recommend using table G.8 which gives the default emission factors for sub region SRVC (region including Wilmington, NC) as of year 2005 (Appendix).

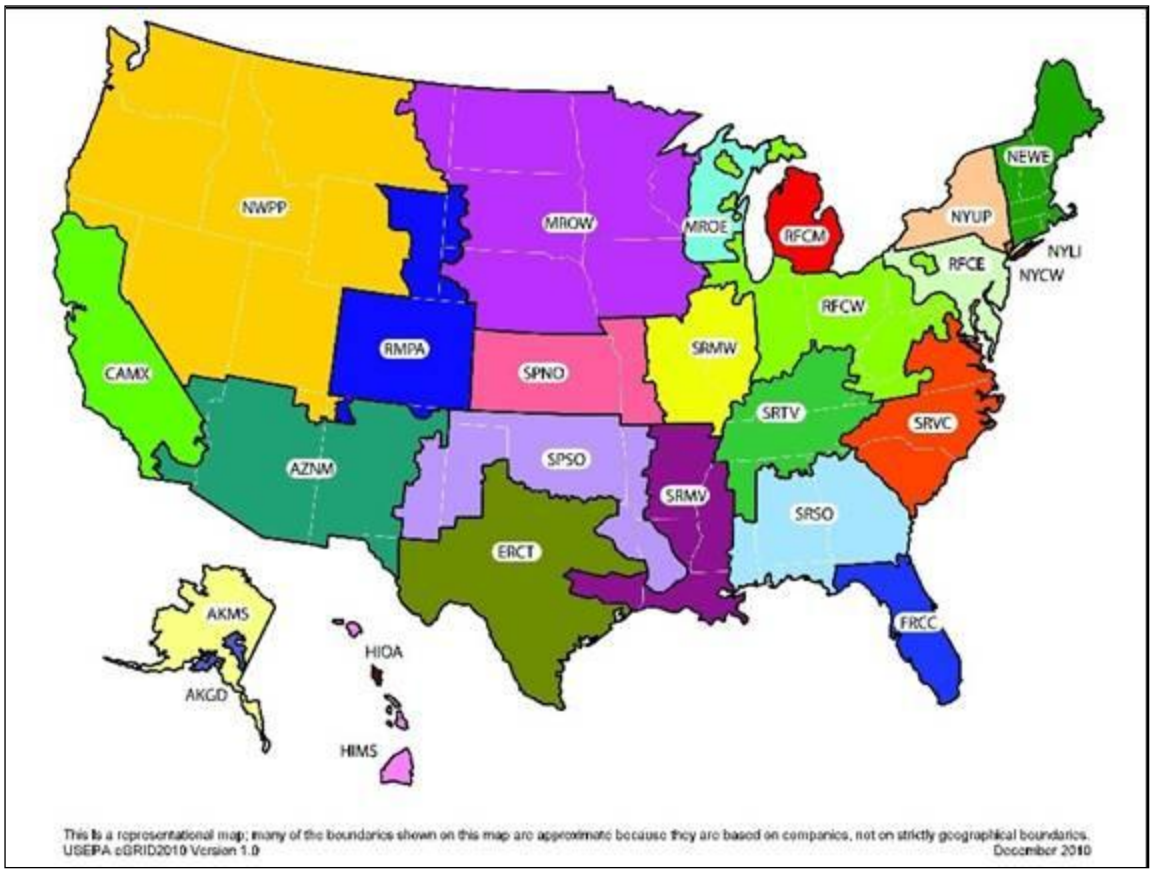



*Image 5: Local Government Operations Protocol For the quantification and reporting of greenhouse gas emissions inventories, Version 1.1; May 2010. pg 210*

Using this method, the scope 2 emission factor is 0.518 metric ton/MWh. Further research should be conducted to account for changes in the grid since 2005. City staff conducting future ghg emissions inventories, should decide if the 2005 rate is reasonable or if it should be adjusted. Using this emission factor and $CO_2e$ data from 2007 annual energy output (AEO) from the local power plants should only be 5,816,602 MWh but in fact it was 18,082,193 MWh. This

difference indicates that a significant amount of energy services rural areas and towns across the eastern Carolina regions. The AEO estimations based on the emission factor can be divided by the total AEO to indicate the Cape Fear area consumes 32% of the energy produced by the power plants that service the region. The entire city is not a part of this inventory, but localized and regional power mixes affect the emissions where the city holds operational control. In this effort, finding a current emission factor is key to calculating the scope 2 emissions. The annual $CO_2e$ emissions from coal and petroleum can be divided by an Annual Energy Output (AEO) adjusted by a series of variables from all power plants to derive an accurate current emission factor. The following formula generates a current emission factor based on a previous verified emission factor, changes in energy sources and changes in AEO.

**Scope 2 Emssions Factor Formula**

$$EF_2 = \frac{CO_2e2}{\left[\left\{\left(\frac{\frac{CO_2e1}{EF_1} - A1}{B1}\right)\right\} \times B2\right] + A2}$$

**Where:**

- 1 = previous
- 2 = current
- A = AEO sum of GHG emitters
- B = AEO sum of GHG non-emitters
- EF = emission factor

$CO_2e$ = carbon dioxide equivalent

Utilizing this formula, and entering it into the ghg inventory updating tool, after compiling the consumption data, scope 2 operational emissions include the following:

| Energy Type | Consumption | Units | MMBtu | Metric Tons Co2e |
|---|---|---|---|---|
| Building Electricity* | 9,119,366 | kWh | N/A | 2,506 |
| Golf Electricity | 168,965 | kWh | N/A | 46 |
| Streetsweeper Electricity | 11,650 | kWh | N/A | 3 |
| Parking Electricity | 668,850 | kWh | N/A | 184 |
| Clinic Electricity | 15,636 | kWh | N/A | 4 |
| Streetlights Metered | 464,942 | kWh | N/A | 128 |
| **Electricity Total** | **10,449,409** | **kWh** | **N/A** | **2,871** |
| Solar PV | Production | | | |
| Engineering | 17,114 | kwh | N/A | |
| Fleet | 50,927 | kwh | N/A | |
| Streetsweeper | 8,001 | kwh | N/A | |
| **Solar Electricity Production** | **76,042** | **kwh** | **N/A** | **-21** |
| | | | **Scope 2 Emissions** | **2,850** |
| | | | **Total GHG Emissions** | **8,255** |

| Baseline Year | Baseline Scope 2 | Target Year | Target Metric Tons $Co_2e$ |
|---|---|---|---|
| 2007 | 4,076 | 2012 | 9,071 |

Baseline Consumption
7,991,529 kWh

*Table 1: Scope 2 consumption compiled in the GHG Inventory Tool with current emission factor formula*

Scope 2 emissions must consider the regional power mix makeup. A majority of the scope 2 operational emissions derive from electricity purchased from Duke Energy Progress, generated offsite. A coal plant (LV Sutton) and a 1.2 MW solar array operated by Duke Energy Progress, solar arrays operated by the city and tied to the grid, a now defunct waste-to-energy plant (WASTEC) and a nuclear power plant located in Brunswick County all account for the varied energy mix the City of Wilmington utilized in FY 2011-2012 to operate and serve the citizens of Wilmington, NC.

Table G.8 (Appendix) is based on data prior to the installation of the 1.2 MW solar array and the phase out of coal at the LV Sutton power plant. In addition, the City installed a 74 kw solar array on City Fleet Maintenance, a 27 kw solar array on City Engineering building, and an 8kw solar array on the City Streetsweeper building. The baseline data already approved by city Council of 9,704 metric tons of $CO_2e$ in 2007 can be used to find an estimation of electric energy use not shown in the GHG reduction target brief (Appendix). This baseline data will help in analyzing energy use for updating the GHG reduction plan when developed. Buildings, traffic signals and streetlights were 42% of the $CO_2e$ baseline emissions. This means scope 2 emissions for the year 2007 were 4,076 metric tons $CO_2e$. Applying the default emission factor from 2005 estimates City government electricity baseline consumption at 7,991 MWh for the year 2007. The LV Sutton coal plant and WASTEC produced 3,013,763 metric tons of $CO_2e$ emissions in 2007, as well as 3,060,030 MWh of electricity, while Brunswick produced 15,022,163 MWh of electricity. The default emission factor is based on 2005 data when the Sutton plant produced 3,072,561 MWh at 3,184,779 metric tons $CO_2e$ and Brunswick produced 14,536,748 MWh. The trend shows less demand on the Sutton plant as well as minor losses in efficiency. Recently, a

new online database called EPA Flight has been launched listing the latest reports filed by power plants and industries across the country.[8] The latest report for the LV Sutton plant is for year 2012. The EPA Flight tool also shows data that reflects the fact that WASTEC has been decommissioned and that LV Sutton had not yet converted to natural gas. The annual energy output for 2012 consisted of 1,271,198 MWh from coal plus 10,659 MWh from petroleum. Additionally, comparisons with previous years are possible, showing emissions from LV Sutton progressively decreasing.

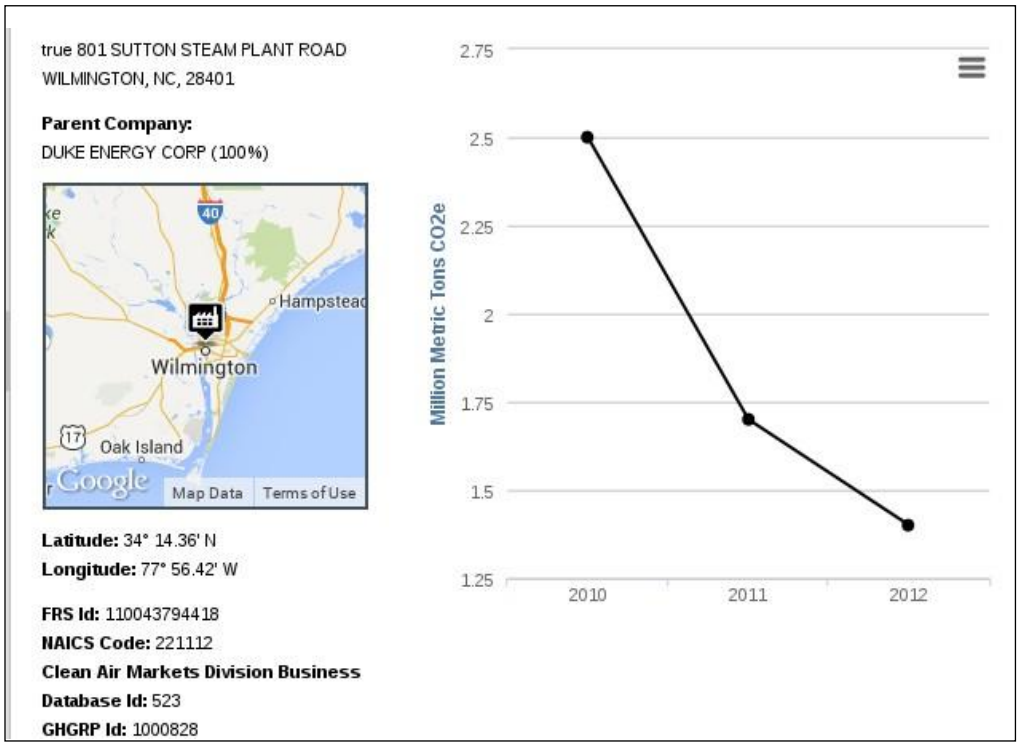



*Image 6: http://ghgdata.epa.gov/ghgp/main.do*

The three-unit, 575-megawatt coal-fired LV Sutton plant is located near Wilmington, N.C., on a site including three small combustion turbines. A new, gas-fired 625-megawatt combined-cycle unit began operation in 2013. Due to the timing, the conversion and subsequent natural gas emissions from this plant are not included in this inventory. The coal-fired units were retired in 2013.

*Image 7: Duke Energy LV Sutton outside of Wilmington, NC*

The two-unit, 1,870 megawatt Brunswick nuclear power plant is located approximately two miles north of Southport, NC in Southeastern North Carolina. The plant houses two boiling water nuclear reactors. Brunswick nuclear power plant was the first nuclear power plant built in North Carolina, beginning operation in 1975 with an additional unit becoming operational in 1977. Between 2002 and 2005, an additional 244 megawatts were added as a part of an extended power uprate program, including upgrades to much of the plant's equipment. Brunswick nuclear annual energy output was 14,303,075 MWh for 2012. Although nuclear power plants create large amounts of warm water vapor, is not considered to be a cause of anthropogenic global warming because it does not persist in the atmosphere for more than a few days.[9]

*Image 8: Duke Energy Brunswick Nuclear*

SunE LV Sutton, the solar array located on the LV Sutton power plant site, boasts an annual energy output of 1,865 MWh for 2012.

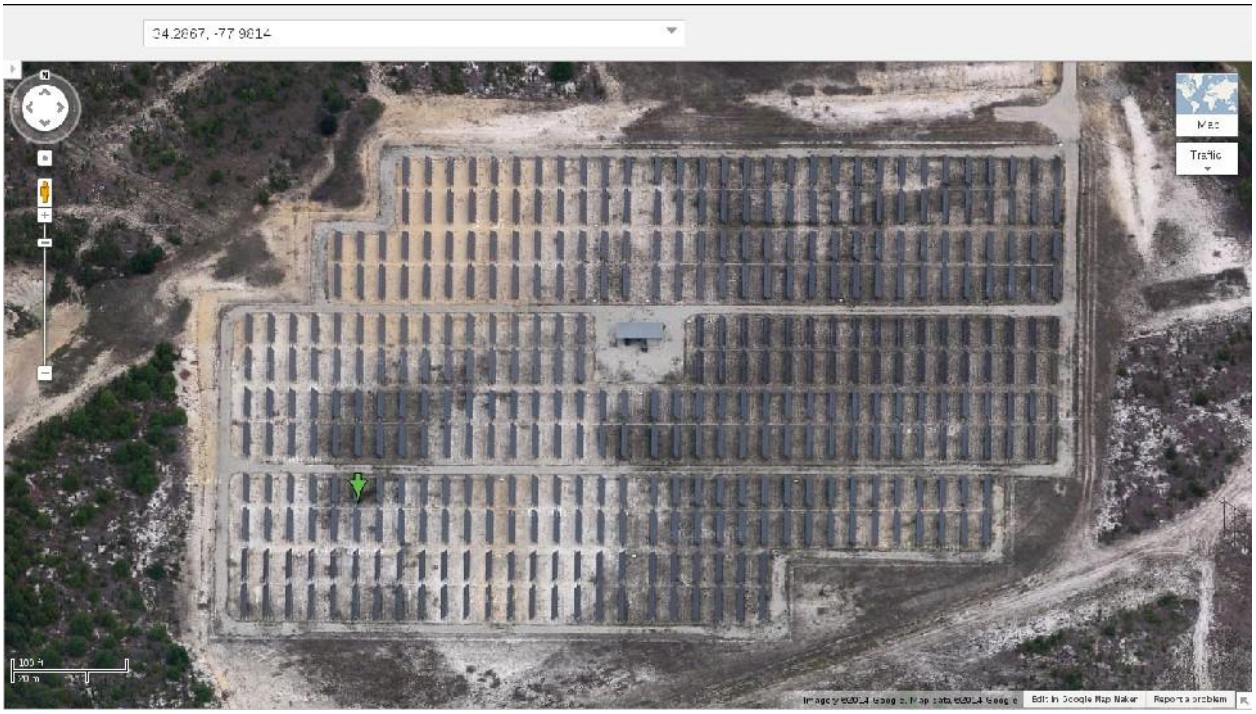



*Image 9: Duke Energy LV Sutton Solar PV. Google Maps*

The total annual output from the sources listed (LV Sutton, WASTEC, Brunswick Nuclear, SunE LV Sutton) is 15,586,797 MWh but only 32% of this is used by the Cape Fear area, or 4,987,679 MWh. The City of Wilmington government operations consumed 10,450 MWh of electricity in FY 2011-2012, which is approximately 0.2% of the consumption for the Cape Fear area.

The EPA online Power Profiler tool is based on 2009 data and produced the following results using an estimated average of 600 MWh electricity per month for City government operations.[10] The tool indicates Wilmington's emission factor is 1036 lbs/MWh or 0.470 tonne/MWh. The online tool can be used for calculating year 2009 scope 2 emission for City government but does not reflect the latest changes to the grid.

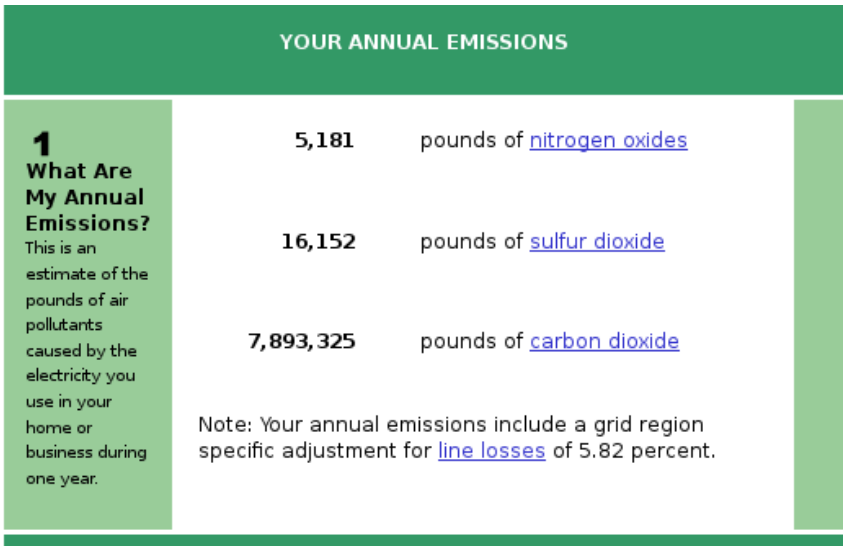



*Image 10: EPA Power Profiler*

Scope 2 emissions also include solar produced onsite and tied to the grid. The energy produced onsite by solar arrays on the fleet, engineering and streetsweeper buildings can be fully deducted from the energy consumed by city-owned buildings and infrastructure. The combined installed capacity of city-owned solar arrays is 108 kW having an AEO of 76 MWh is 2012, resulting in a 21 metric tons reduction in annual $CO_2e$ scope 2 emissions.

*Image 8: City of Wilmington, NC Fleet Management 74 kw solar array*

## *Scope 3 application*

City of Wilmington employees utilize a city fuel card when traveling away from the city's fleet fuel station and using city-owned vehicles for business. The consumption associated with this card is tracked by the city's fleet management division and is a significant source of emissions. This consumption is considered scope 3 due to the internally controlled policies associated with the fuel card deeming this use under the operational control of city department heads. The fleet manager tracks each transaction, including gallons purchased, price, fuel type and/or grade and driver identification. The fleet manager aggregated all information so as to protect personal information and supplied the data needed. This data was received as a spreadsheet and can be loaded into the inventory tool. FY 2011-2012 resulted in 45 metric tons $CO_2e$ from this source.

| Energy Type | Consumption | Units | MMBtu | Metric Tons Co2e |
|---|---|---|---|---|
| Fuel Card unleaded gasoline | 5,099 | gallons | 637 | 45 |
| Fuel Card Gasohol | 11 | gallons | 1 | 0 |
| Fuel Card Diesel | 198 | gallons | 28 | 0 |
| | | | **Fuel Card Emissions** | **45** |
| | | | **Total GHG Emissions** | **8,255** |

| ACCOUNT_NAME | TRANSAC | TPRODUCT_DES | UNITS | COST_PE | RGROS |
|---|---|---|---|---|---|
| CITY OF WILMINGTON | 7/5/2011 | UNLEADED SUPER | 4.30 | $3.71 | $15.96 |
| CITY OF WILMINGTON | 7/5/2011 | UNLEADED SUPER | 4.54 | $3.59 | $16.31 |
| CITY OF WILMINGTON | 7/7/2011 | UNLEADED SUPER | 3.39 | $3.79 | $12.84 |
| CITY OF WILMINGTON | 7/7/2011 | UNLEADED | 3.89 | $3.82 | $14.86 |
| CITY OF WILMINGTON | 7/8/2011 | UNLEADED SUPER | 3.51 | $3.62 | $12.71 |
| CITY OF WILMINGTON | 7/9/2011 | UNLEADED | 14.15 | $3.62 | $51.22 |
| CITY OF WILMINGTON | 7/10/2011 | UNLEADED | 9.55 | $3.56 | $34.01 |
| CITY OF WILMINGTON | 7/12/2011 | UNLEADED SUPER | 1.21 | $3.66 | $4.43 |
| CITY OF WILMINGTON | 7/13/2011 | UNLEADED SUPER | 4.15 | $3.70 | $15.37 |
| CITY OF WILMINGTON | 7/14/2011 | UNLEADED | 7.07 | $3.68 | $26.01 |
| CITY OF WILMINGTON | 7/15/2011 | UNLEADED SUPER | 3.50 | $3.76 | $13.15 |
| CITY OF WILMINGTON | 7/16/2011 | UNLEADED SUPER | 36.25 | $3.76 | $136.27 |
| CITY OF WILMINGTON | 7/18/2011 | UNLEADED | 12.51 | $3.60 | $45.01 |
| CITY OF WILMINGTON | 7/19/2011 | UNLEADED | 14.94 | $3.56 | $53.20 |
| CITY OF WILMINGTON | 7/19/2011 | UNLEADED | 10.27 | $3.46 | $35.55 |

| TPRODUCT_DESCRIPT | UNITS |
|---|---|
| UNLEADED | 3868.89 |
| UNLEADED SUPER | 1204.76 |
| UNLEADED PLUS | 24.88 |
| 10% GASOHOL | 10.57 |
| DIESEL | 198.37 |

*Table 3: City fuel card consumption entered into GHG Inventory Tool*

## Greenhouse gas emission inventory tool

As a part of this project, a greenhouse gas inventory tool was created to allow for annual greenhouse gas emission updates by city staff. Instructions and tool are located in Public Services department, Administration, Sustainability files.

## Conclusion

The City of Wilmington's government operational emission actual for FY 2011-2012 are ahead of reduction targets established by the 2009 resolution (Appendix). A majority of this reduction is attributed to the LV Sutton power plant reducing its output by almost half over the course of two years in preparation of the natural gas conversion occurring today. City of Wilmington's electricity consumption increased, but the scope 2 emission factor from regional energy mixes decreased by approximately 1,150 metric tons $CO_2e$.

The total greenhouse gas emissions for FY 2011-2012 of 8,255 metric tons CO2e represent an **average annual reduction rate of 3.18%**. In 2014, when the LV Sutton plant runs on natural gas, the scope 2 emission factor will stay low while increasing output, assuming demand begins to rise. The current reduction targets set in 2009 were aggressive at the time, but the City of Wilmington is ahead of these targets, the annual reduction rate of 1.34% will present little challenge to meet.

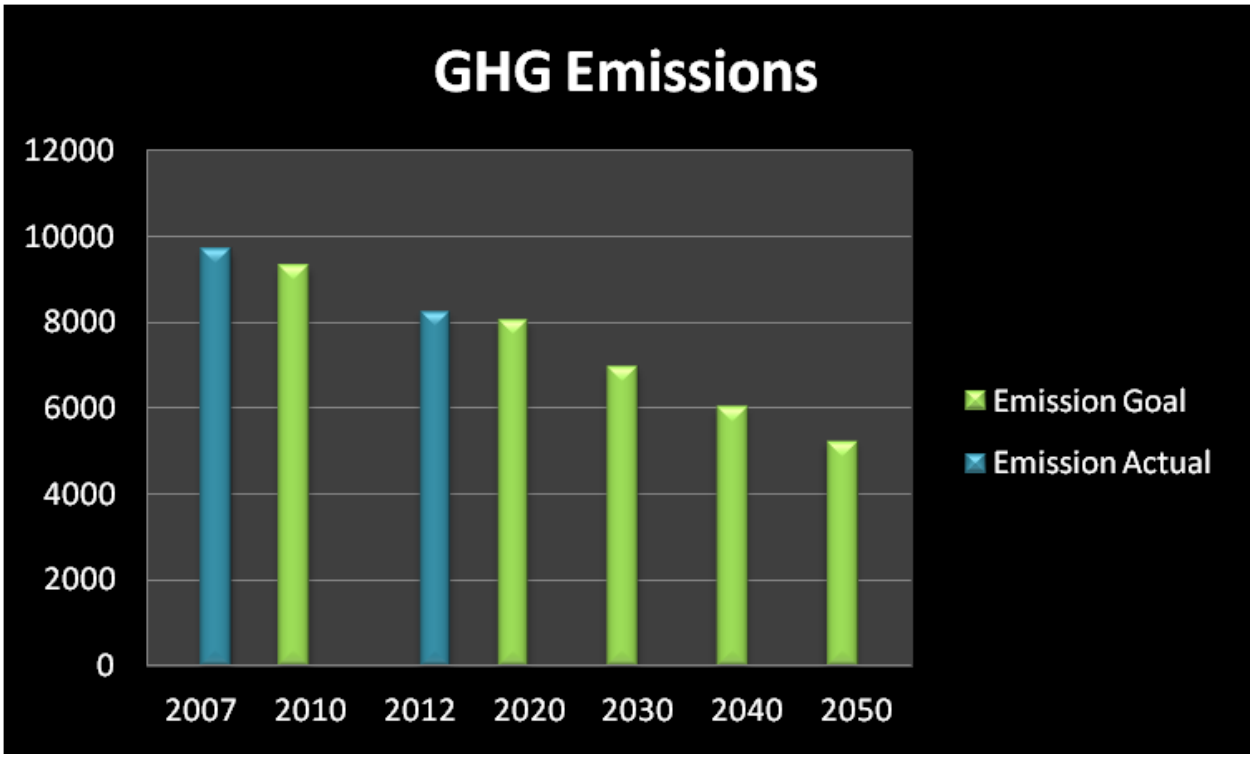



*Image 9: City emission goals and actual to date. (May 2014)*

**Appendix**

- Resolution Establishing a Goal for Reducing Greenhouse Gas Emissions from Municipal Operations in Keeping with the Principles of the U.S. Conference of Mayors Climate Protection Initiative, City of Wilmington, NC, October 10, 2009
- 2009 Greenhouse Gas Emissions Reduction Target Brief
- Local Government Operations Protocol, Appendix E Global Warming Potentials, May 2010
- Local Government Operations Protocol, Table E.2 GWP Factors for refrigerant blends, May 2010
- Local Government Operations Protocol, Table G.1 U.S. Default Factors for Calculating Carbon Dioxide Emissions from Fossil Fuel Combustion Continued, May 2010
- Local Government Operations Protocol, Table G. 8 2007 eGRID Electricity Emission Factors by eGRID Subregion (2005 data)

KC
(Revised)

# Resolution

City Council
City of Wilmington
North Carolina

**Introduced By:** Sterling B. Cheatham, City Manager **Date:** 10/20/2009

**Resolution Establishing a Goal for Reducing Greenhouse Gas Emissions from Municipal Operations in Keeping with the Principles of the US Conference of Mayors Climate Protection Initiative**

**LEGISLATIVE INTENT/PURPOSE:**

In 2005, the United States Conference of Mayors unanimously adopted a Climate Protection Agreement to encourage cities to reduce their greenhouse gas emissions. On November 21, 2006 Council passed a resolution authorizing the Mayor to sign the US Conference of Mayors Climate Protection Agreement. To date, 999 cities from all fifty states, Puerto Rico, and Washington, DC - representing a total population of nearly 86 million citizens - have joined Wilmington in endorsing the Agreement. The Mayors Council on Climate Protection was created to provide an opportunity for cities across the country to work together cooperatively to implement the activities specified in the US Conference of Mayors Climate Protection Agreement and to share information on best practices and successful city efforts.

CERTIFIED TO BE A TRUE COPY.
CITY CLERK

The City of Wilmington already has initiatives and plans in place that demonstrate a commitment to many of the areas outlined in the Agreement. One important and major step is to inventory municipal operations and establish a baseline of greenhouse gas emissions from which to set reduction targets. This inventory has been completed by Planning staff and a proposed target is established based on benchmarking other municipalities in North Carolina, the Southeast, and across the country.

**THEREFORE, BE IT RESOLVED:**

THAT the City Council hereby acknowledges and establishes a baseline measure of greenhouse gas emissions from municipal operations of an estimated 9,708 metric tons of carbon dioxide equivalents following the Local Government Operations Protocol established in 2008,

FURTHER BE IT RESOLVED THAT City Council establishes a goal for reduction of greenhouse gas emissions by 58% by the year 2050 in keeping with the 2006 resolution to endorse the US Conference of Mayors Climate Protection Initiative, and

FURTHER BE IT RESOLVED THAT City Council directs the City Manager to establish a protocol for tracking progress toward the goal on a regular basis and reporting back to City Council.

Bill Saffo, Mayor

Adopted at a regular meeting on October 20, 2009.

ATTEST:

City Clerk

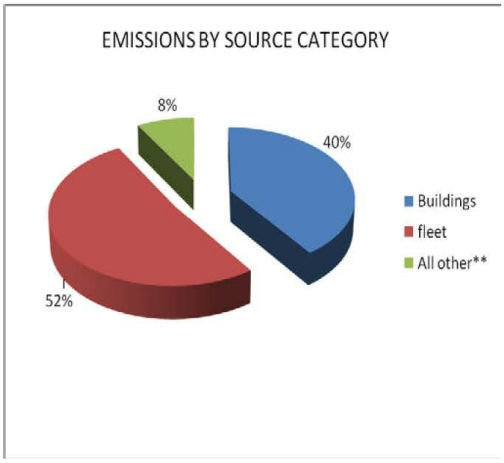
## *About the Greenhouse Gas Emissions Reduction Target*

A reduction target provides a tangible goal for Wilmington's municipal emissions reduction efforts, fosters public and political will, and creates a framework that guides the planning and implementation of reduction measures. The emissions reduction target represents a percentage by which the City aims to decrease emissions, below the baseline, by a target year. The baseline year for this greenhouse gas emissions analysis is 2007, selected because it is the most recent year in which most of the data required by the Protocol could be readily obtained.

The following table displays the emissions for the City's buildings, fleet, and other non building entities estimated in accordance with the *Local Government Operations Protocol.* The emissions are divided into $CO_2$, $CH_4$, and $N_2O$ (metric tons), and their totals are reported in $CO_2$ equivalent as suggested by the Protocol.

***Total Aggregated Emissions Summary***

| Emission type | Emissions (metric tons) | | | |
|---|---|---|---|---|
| | Buildings | fleet | All other** | Total |
| $CO_2$ | 3886.15 | 4946.69 | 807.89 | 9640.7 |
| $CH_4$ | 0.18 | 0.08 | 0.014 | 0.2 |
| $N_2O$ | 0.06 | 0.13 | 0.015 | 0.2 |
| Grand Total ($CO_2e$ Equivalent) | 3908.18 | 4988.19 | 807.92 | 9704.3 |




As shown, the greatest emissions come from the City's transportation fleet. This was estimated from an aggregation of all the gallons of fuel used and mileage recorded for every department under the City's control.

**The category "All other" includes all non-building entities; these include diesel generators, parks and playgrounds, golf course, traffic signals, and street lights.

Many factors were considered when selecting the proposed reduction target. The suggested target is both aggressive and achievable given local circumstances. Several programs and policies currently in place, including efforts to reduce energy usage, fleet use policies, and higher efficiency building systems will enable Wilmington to immediately make progress towards this goal.

The International Panel on Climate Change IPCC research suggests that we would need to achieve as much as an 80% reduction below 1990 levels in order to reverse global warming and stabilize the climate.

Local factors considered in selecting the target reduction percentage include estimation of the effects of implemented and planned programs and policies, an assessment of future opportunities to reduce emissions, targets adopted by benchmark communities, and outside factors from regional energy providers that may contribute to reducing emissions.

A benchmark study was conducted in order to examine the goals and initiatives that other cities are establishing to reduce their greenhouse gas emissions. The cities that were chosen were those that are signatories of the U.S. Conference of Mayors' Climate Protection Agreement. The cities that were chosen were either comparable in population size to Wilmington, or they demonstrated exemplary greenhouse gas emission management strategies. For the cities studied the percent reduction and target year established varied greatly, but the annual rate of reduction was very consistent with the most frequent percentage being 1.34% and the most frequent target year being 2050.

After reviewing the baseline data, benchmark study, and local factors, a goal of 58% reduction of municipal operations $CO_2$ equivalent emissions by the year 2050 is recommended, which is based on a 1.34% per year rate of reduction. The table below shows effects of a 58% reduction from FY 2007 baseline emissions levels, with an average annual and total reduction of eCO2 tons by the year 2050.

| Year | 2007 Baseline | 2010 | 2020 | 2030 | 2040 | 2050 |
|---|---|---|---|---|---|---|
| Emissions | 9704 | 9314 | 8066 | 6985 | 6049 | 5238 |
| % Reduction | | 4 | 17 | 31 | 44 | 58 |

This is rigorous, yet achievable and sets the City in step with other municipalities in the state and region. This framework is consistent with the APA Policy Guide on Planning and Climate Change, the recommendations of the NC Climate Action Plan Advisory Group, and draft federal legislative requirements. Communities participating in the ICLEI – a sustainability council of over 1100 local governments - have, on average, chosen between 1% and 2% reduction per year. Tracking of progress will be essential to determine progress toward the goal and whether it is necessary to adjust the goal in the future if conditions require it.

# Appendix E Global Warming Potentials

Global Warming Potential (GWP) factors represent the ratio of the heat-trapping ability of each greenhouse gas relative to that of carbon dioxide. For example, the GWP of methane is 21 because one metric ton of methane has 21 times more ability to trap heat in the atmosphere than one metric ton of carbon dioxide. To convert emissions of non-$CO_2$ gases to units of $CO_2$ equivalent, multiply the emissions of each gas in units of mass (e.g., metric tons) by the appropriate GWP factors in the following table.

Note: Since the Second Assessment Report (SAR) was published in 1995, the IPCC has published updated GWP values in its Third Assessment Report (TAR) and Fourth Assessment Report (AR4) that reflect new information on atmospheric lifetimes of greenhouse gases and an improved calculation of the radiative forcing of $CO_2$.

However, GWP values from the SAR are still used by international convention to maintain consistency in GHG reporting, including by the United States when reporting under the United Nations Framework Convention on Climate Change. TAR GWP values are often used for gases that were not reported in the SAR.

If more recent GWP values are adopted as standard practice by the international community, the Protocol will likewise update its GWP requirements to reflect international practices.

**Table E.1 GWP Factors for Greenhouse Gases**

| Common Name | Formula | Chemical Name | GWP |
|---|---|---|---|
| Carbon dioxide | $CO_2$ | | 1 |
| Methane | $CH_4$ | | 21 |
| Nitrous oxide | $N_2O$ | | 310 |
| Sulfur hexafluoride | $SF_6$ | | 23,900 |
| **Hydrofluorocarbons (HFCs)** | | | |
| HFC-23 | $CHF_3$ | trifluoromethane | 11,700 |
| HFC-32 | $CH_2F_2$ | difluoromethane | 650 |
| HFC-41 | $CH_3F$ | fluoromethane | 150 |
| HFC-43-10mee | $C_5H_2F_{10}$ | 1,1,1,2,3,4,4,5,5,5-decafluoropentane | 1,300 |
| HFC-125 | $C_2HF_5$ | pentafluoroethane | 2,800 |
| HFC-134 | $C_2H_2F_4$ | 1,1,2,2-tetrafluoroethane | 1,000 |
| HFC-134a | $C_2H_2F_4$ | 1,1,1,2-tetrafluoroethane | 1,300 |
| HFC-143 | $C_2H_3F_3$ | 1,1,2-trifluoroethane | 300 |
| HFC-143a | $C_2H_3F_3$ | 1,1,1-trifluoroethane | 3,800 |
| HFC-152 | $C_2H_4F_2$ | 1,2-difluoroethane | 43* |
| HFC-152a | $C_2H_4F_2$ | 1,1-difluoroethane | 140 |
| HFC-161 | $C_2H_5F$ | fluoroethane | 12* |
| HFC-227ea | $C_3HF_7$ | 1,1,1,2,3,3,3-heptafluoropropane | 2,900 |
| HFC-236cb | $C_3H_2F_6$ | 1,1,1,2,2,3-hexafluoropropane | 1,300* |
| HFC-236ea | $C_3H_2F_6$ | 1,1,1,2,3,3-hexafluoropropane | 1,200* |
| HFC-236fa | $C_3H_2F_6$ | 1,1,1,3,3,3-hexafluoropropane | 6,300 |
| HFC-245ca | $C_3H_3F_5$ | 1,1,2,2,3-pentafluoropropane | 560 |
| HFC-245fa | $C_3H_3F_5$ | 1,1,1,3,3-pentafluoropropane | 950* |
| HFC-365mfc | $C_4H_5F_5$ | 1,1,1,3,3-pentafluorobutane | 890* |
| **Perfluorocarbons (PFCs)** | | | |
| Perfluoromethane | $CF_4$ | tetrafluoromethane | 6,500 |
| Perfluoroethane | $C_2F_6$ | hexafluoroethane | 9,200 |
| Perfluoropropane | $C_3F_8$ | octafluoropropane | 7,000 |
| Perfluorobutane | $C_4F_{10}$ | decafluorobutane | 7,000 |
| Perfluorocyclobutane | c-$C_4F_8$ | octafluorocyclobutane | 8,700 |
| Perfluoropentane | $C_5F_{12}$ | dodecafluoropentane | 7,500 |
| Perfluorohexane | $C_6F_{14}$ | tetradecafluorohexane | 7,400 |

Source: Intergovernmental Panel on Climate Change (IPCC) Second Assessment Report published in 1995, unless no value was assigned in the document. In that case, the GWP values are from the IPCC Third Assessment Report published in 2001 (those marked with *). GWP values are from the Second Assessment Report (unless otherwise noted) to be consistent with international practices. Values are 100-year GWP values.

**Table E.2 GWP Factors for Refrigerant Blends**

| Refrigerant Blend | Global Warming Potential |
|---|---|
| R-401A | 18 |
| R-401B | 15 |
| R-401C | 21 |
| R-402A | 1,680 |
| R-402B | 1,064 |
| R-403A | 1,400 |
| R-403B | 2,730 |
| R-404A | 3,260 |
| R-406A | 0 |
| R-407A | 1,770 |
| R-407B | 2,285 |
| R-407C | 1,526 |
| R-407D | 1,428 |
| R-407E | 1,363 |
| R-408A | 1,944 |
| R-409A | 0 |
| R-409B | 0 |
| R-410A | 1,725 |
| R-410B | 1,833 |
| R-411A | 15 |
| R-411B | 4 |
| R-412A | 350 |
| R-413A | 1,774 |
| R-414A | 0 |
| R-414B | 0 |
| R-415A | 25 |
| R-415B | 105 |
| R-416A | 767 |
| R-417A | 1,955 |
| R-418A | 4 |
| R-419A | 2,403 |
| R-420A | 1,144 |
| R-500 | 37 |
| R-501 | 0 |
| R-502 | 0 |
| R-503 | 4,692 |
| R-504 | 313 |
| R-505 | 0 |
| R-506 | 0 |
| R-507 or R-507A | 3,300 |
| R-508A | 10,175 |
| R-508B | 10,350 |
| R-509 or R-509A | 3,920 |
| Source: ASHRAE Standard 34 | |

**Table G.1. U.S Default Factors for Calculating Carbon Dioxide Emissions from Fossil Fuel Combustion Continued**

| Fuel Type | Heat Content | Carbon Content (Per Unit Energy) | Fraction Oxidized | $CO_2$ Emission Factor (Per Unit Energy) | $CO_2$ Emission Factor (Per Unit Mass or Volume) |
|---|---|---|---|---|---|
| **Petroleum Products** | **MMBtu / gallon** | **kg C / MMBtu** | | **kg $CO_2$ / MMBtu** | **kg $CO_2$ / gallon** |
| Distillate Fuel Oil No. 1 | 0.139 | 19.98 | 1 | 73.25 | 10.18 |
| Distillate Fuel Oil No. 2 | 0.138 | 20.17 | 1 | 73.96 | 10.21 |
| Distillate Fuel Oil No. 4 | 0.146 | 20.47 | 1 | 75.04 | 10.96 |
| Residual Fuel No. 5 | 0.140 | 19.89 | 1 | 72.93 | 10.21 |
| Residual Fuel No. 6 | 0.150 | 20.48 | 1 | 75.10 | 11.27 |
| Still Gas | 0.143 | 18.20 | 1 | 66.72 | 9.54 |
| Kerosene | 0.135 | 20.51 | 1 | 75.20 | 10.15 |
| LPG | 0.092 | 17.18 | 1 | 62.98 | 5.79 |
| Propane | 0.091 | 16.76 | 1 | 61.46 | 5.59 |
| Ethane | 0.096 | 17.08 | 1 | 62.64 | 6.01 |
| Propylene | 0.091 | 17.99 | 1 | 65.95 | 6.00 |
| Ethylene | 0.100 | 18.39 | 1 | 67.43 | 6.74 |
| Isobutane | 0.097 | 17.70 | 1 | 64.91 | 6.30 |
| Isobutylene | 0.103 | 18.47 | 1 | 67.74 | 6.98 |
| Butane | 0.101 | 17.77 | 1 | 65.15 | 6.58 |
| Butylene | 0.103 | 18.47 | 1 | 67.73 | 6.98 |
| Naphtha (<401d F) | 0.125 | 18.55 | 1 | 68.02 | 8.50 |
| Natural Gasoline | 0.110 | 18.23 | 1 | 66.83 | 7.35 |
| Other oil (>401 d F) | 0.139 | 20.79 | 1 | 76.22 | 10.59 |
| Pentanes Plus | 0.110 | 19.10 | 1 | 70.02 | 7.70 |
| Petrochemical Feedstocks | 0.129 | 19.36 | 1 | 70.97 | 9.16 |
| Petroleum Coke | 0.143 | 27.93 | 1 | 102.41 | 14.64 |
| Special Naphtha | 0.125 | 19.73 | 1 | 72.34 | 9.04 |
| Unfinished Oils | 0.139 | 20.32 | 1 | 74.49 | 10.35 |
| Heavy Gas Oils | 0.148 | 20.43 | 1 | 74.92 | 11.09 |
| Lubricants | 0.144 | 20.26 | 1 | 74.27 | 10.69 |
| Motor Gasoline | 0.125 | 19.15 | 1 | 70.22 | 8.78 |
| Aviation Gasoline | 0.120 | 18.89 | 1 | 69.25 | 8.31 |
| Kerosene Type Jet Fuel | 0.135 | 19.70 | 1 | 72.22 | 9.75 |
| Asphalt and Road Oil | 0.158 | 20.55 | 1 | 75.36 | 11.91 |
| Crude Oil | 0.138 | 20.32 | 1 | 74.49 | 10.28 |
| Waxes* | 0.132 | 19.81 | 1 | 72.64 | 9.58 |

**Table G.8 2007 eGRID Electricity Emission Factors by eGRID Subregion (2005 data)**

| eGRID 2007 | eGRID 2007 | 2005 Emission Rates | | |
|---|---|---|---|---|
| Subregion | Subregion Name | (lbs $CO_2$/MWh) | (lbs $CH_4$/MWh) | (lbs $N_2O$/MWh) |
| AKGD | ASCC Alaska Grid | 1,232.36 | .0256 | .00651 |
| AKMS | ASCC Miscellaneous | 498.86 | .02075 | .00408 |
| AZNM | WECC Southwest | 1,311.05 | .01745 | .01794 |
| CAMX | WECC California | See Table G.7 | | |
| ERCT | ERCOT All | 1,324.35 | .01865 | .01511 |
| FRCC | FRCC All | 1,318.57 | .04592 | .01694 |
| HIMS | HICC Miscellaneous | 1,514.92 | .31468 | .04688 |
| HIOA | HICC Oahu | 1,811.98 | .10947 | .02362 |
| MROE | MRO East | 1,834.72 | .02759 | .03036 |
| MROW | MRO West | 1,821.84 | .028 | .03071 |
| NEWE | NPCC New England | 927.68 | .08649 | .01701 |
| NWPP | WECC Northwest | 902.24 | .01913 | .0149 |
| NYCW | NPCC NYC/Westchester | 815.45 | .03602 | .00546 |
| NYLI | NPCC Long Island | 1,536.80 | .11541 | .01809 |
| NYUP | NPCC Upstate NY | 720.8 | .02482 | .01119 |
| RFCE | RFC East | 1,139.07 | .03027 | .01871 |
| RFCM | RFC Michigan | 1,563.28 | .03393 | .02717 |
| RFCW | RFC West | 1,537.82 | .01823 | .02571 |
| RMPA | WECC Rockies | 1,883.08 | .02288 | .02875 |
| SPNO | SPP North | 1,960.94 | .02382 | .03209 |
| SPSO | SPP South | 1,658.14 | .02498 | .02261 |
| SRMV | SERC Mississippi Valley | 1,019.74 | .02431 | .01171 |
| SRMW | SERC Midwest | 1,830.51 | .02115 | .0305 |
| SRSO | SERC South | 1,489.54 | .02627 | .02547 |
| SRTV | SERC Tennessee Valley | 1,510.44 | .02005 | .02564 |
| SRVC | SERC Virginia/Carolina | 1,134.88 | .02377 | .01979 |
| US Territories (not an eGRID Region)* | n/a | 1,891.57 | .0759 | .01713 |

Source: U.S. EPA eGRID2007 Version 1.1 (2005 data: eGRID subregion annual $CO_2$ output emission rate). Except * from Department of Energy guidance on Voluntary Reporting of Greenhouse Gases. Factors do not include emissions from transmission and distribution losses.

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