# Boulder County, Colorado
# Greenhouse Gas Inventory
# Final Report

Version 3, December 27, 2006

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# EXECUTIVE SUMMARY

Fundamental to any comprehensive plan to respond to climate change is the development of an emissions inventory that identifies and quantifies the primary anthropogenic sources of greenhouse gases (GHG). As such, a comprehensive GHG inventory and an accompanying inventory maintenance system have been developed for Boulder County. This inventory adheres to both 1) a comprehensive and detailed methodology for estimating sources of GHGs, and 2) a common and consistent methodology to compare the relative contribution of different emission sources and greenhouse gases to climate change.

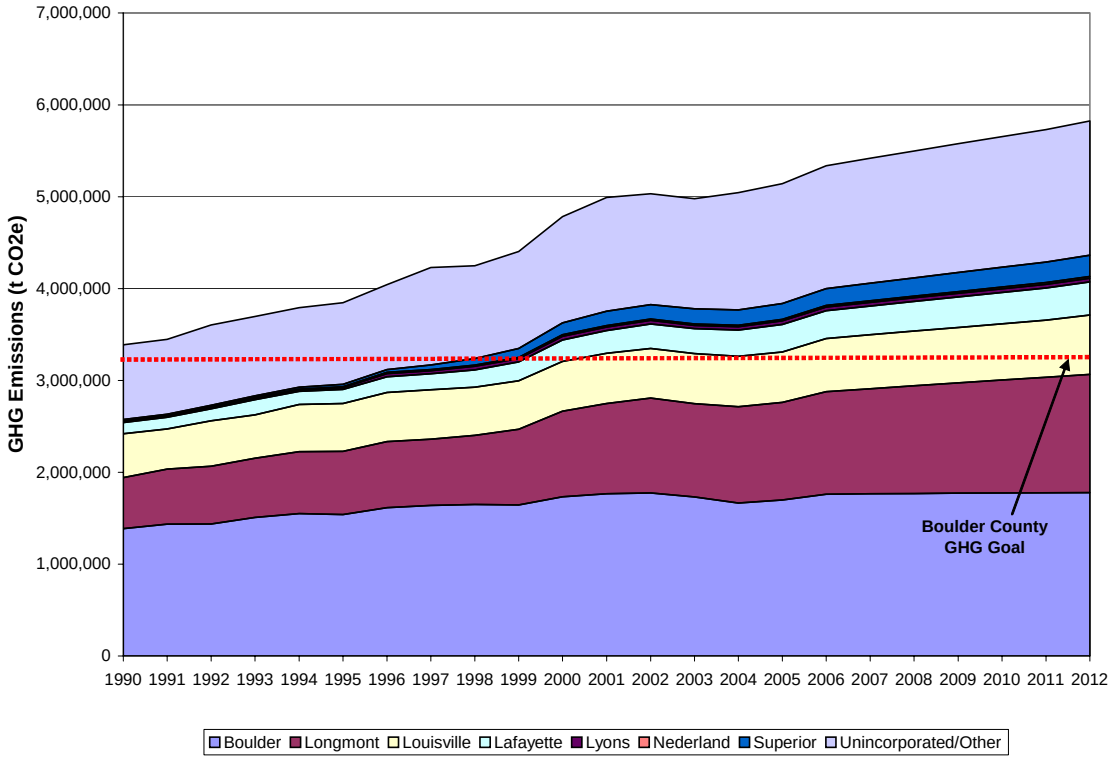
The overarching philosophical framework within which Boulder's GHG inventory was developed is that the County Commissioners recognize and acknowledge the environmental imperative that man-made climate change is real, it is happening now, and decisive action must be taken to mitigate it. Man-made climate change, in fact, is recognized as a direct threat to the very lifeblood of Boulder County, as capsulated in statements contained in the summer 2002 edition of US EPA's biannual report to the United Nations on climate change: "snow-fed streams in the USA will be permanently diminished" and "alpine meadows in the US Rocky Mountains will permanently disappear" as the result of man-made climate change. Clearly, Boulder County's water supply, quality of life, and tourism industry are threatened by climate change.

The first step in the GHG planning process is to develop a clear picture of historical and current sources and magnitudes of Boulder County's GHG emissions. In general, the process for developing a GHG emissions inventory and inventory management system involves 1) the development of a historical inventory of GHG emissions for the period of 1990 through the present; 2) development of a projected Business-As-Usual (BAU) emissions trend line out to 2012, based on the historical emissions data; 3) disaggregating of the overall inventory into sector- and source-specific emissions.

This document reports the results of the Boulder County GHG Inventory. The results of the work provide insight into the magnitude of the challenge facing Boulder County with respect to the County's Kyoto goal of achieving emissions by 2012 that are 7% below the 1990 level. It comes as no surprise that meeting this goal will be a daunting enterprise requiring substantial community mobilization, substantial County government commitment, and substantial budgets.

The following figures present the results of Boulder County's GHG inventory. In 2012, the BAU trajectory is approximately 5,830,000 $tCO_2e$, about 85% or 2,680,000 $tCO_2e$ above the Kyoto goal, as depicted in Figure 1. Details of the inventory are presented in the accompanying sections of this report.

**Figure 1: Boulder GHG Emissions Profile, 1990-2012**

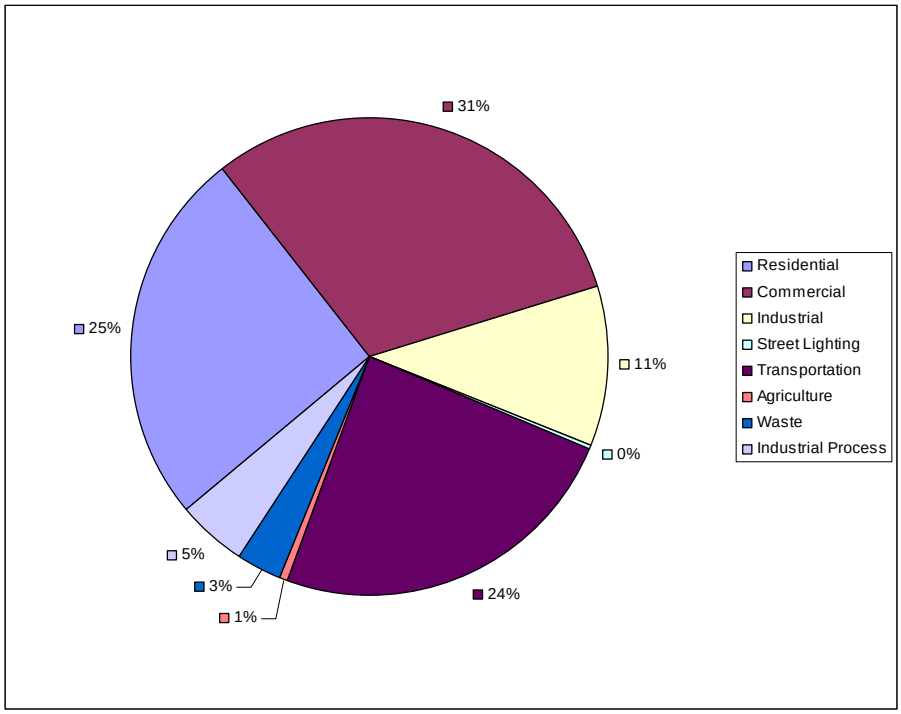



***If Business-As-Usual continues, Boulder County will be 85% above its Kyoto target in 2012***

In 2005, the dominant sectors of emissions are Commercial, Residential, Transportation and Industrial. As shown in Figure 2, together these four sectors account for 91% of the County's GHG emissions. The dominant sources of these emissions are from electricity and natural gas consumption along with vehicles fuel consumption in the Transportation sector. These three sources constitute 86% of the emission sources from within Boulder County, as shown in Figure 3. Finally, a breakdown of emissions by municipality has been provided in Figure 4. This figure demonstrates that the largest quantities of emissions are produced by the Boulder (33%), Unincorporated/Other areas (25%) and Longmont (21%).

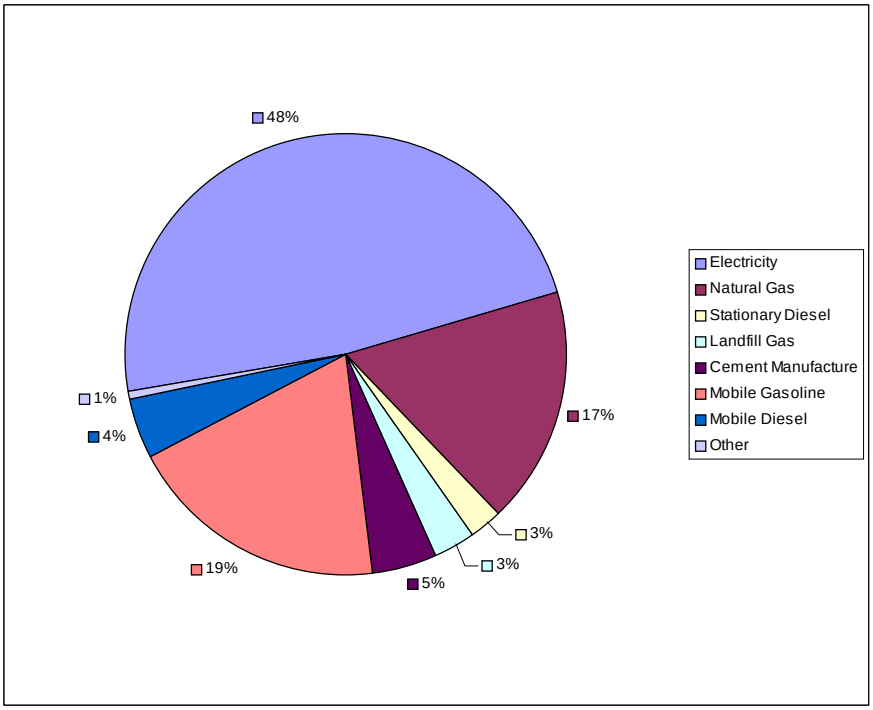
Note that the BAU projection probably represents a conservative estimate of GHG emissions trends. Since it is impossible to forecast many crucial variables, such as conventional energy prices and federal and state policies and regulations, to which emissions trends are highly sensitive, forecasts have been based on extrapolations of historical energy usage trends. Consequently, it is believed that the resulting BAU projections comprise a "worst-case" scenario. While this conservative BAU picture may overstate the magnitude of the challenge facing Boulder County, it is clear that the Kyoto-compliance goal is a high bar.

**Figure 2: GHG Emissions by Sector, 2005**



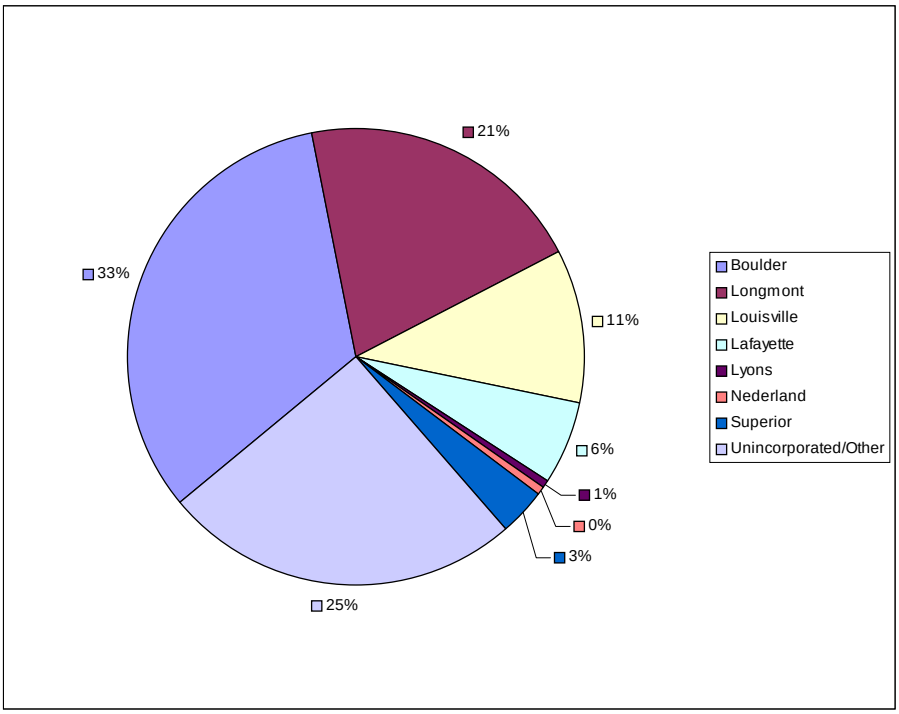

***The commercial buildings sector in Boulder County is the greatest producer of GHG emissions, contributing 31% of total county-wide emissions in 2005.***

**Figure 3: GHG Emissions by Source, 2005**




***Electricity usage is the largest cause of GHG emissions in Boulder County.***

**Figure 4: GHG Emissions by Municipality, 2005**




***Together the City of Boulder and Unincorporated/Other contribute 58% of the county's total GHG emissions.***

The unexpected result that Unincorporated/Other is the second-largest source of emissions in the County has to do with the "Other" and not with the "Unincorporated". "Other" includes all incorporated municipalities in Boulder County that are not explicitly disaggregated in the GHG inventory. These include but are not limited to Erie, Gunbarrel, Niwot, and Ward, and comprise 10% of the Unincorporated/Other total.

In addition, note that transportation emissions for Unincorporated/Other is more than double that of Longmont. Next note that Cemex is a large contributor to the Unincorporated/Other total as "cement manufacture" is 21% of the Unincorporated/Other total. Furthermore, Cemex natural gas use is estimated to contribute roughly 5% of the Unincorporated/Other total. Lastly, note that if Cemex and "Other" were removed from the Unincorporated/Other total, Unincorporated/Other would only be 18.5% of the County's Inventory. The following table compares the emissions components of Unincorporated/Other versus Longmont to help illustrate why the former has totals that are larger than the latter.

| Source | Longmont | Unincorporated/Other |
|---|---|---|
| Electricity | 652,747 | 389,117 |
| Natural Gas | 197,569 | 160,912 |
| Stationary Diesel | 711 | 151 |
| Mobile Gasoline | 142,594 | 315,464 |
| Mobile Diesel | 32,626 | 72,179 |
| Landfill Gas | 42,211 | 26,764 |
| Cement Manufacture | - | 244,204 |
| Enteric Fermentation | - | 12,951 |
| Manure Management | - | 513 |
| Soil Management | - | 27,562 |
| Aviation Fuel | 1,122 | - |
| **Grand Total** | **1,069,579** | **1,249,814** |

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# 1. OVERVIEW

Fundamental to any comprehensive plan to respond to climate change is the development of an emissions inventory that identifies and quantifies the primary anthropogenic sources of greenhouse gases. Toward this end, a comprehensive GHG inventory and an Inventory Maintenance System (IMS) have been developed for Boulder County. This inventory adheres to both 1) a comprehensive and detailed methodology for estimating sources of GHGs, and 2) a common and consistent methodology to compare the relative contribution of different emission sources and greenhouse gases to climate change.

The objective of this report is to convey the results of the GHG inventory, which provide insight into the magnitude of the challenge facing Boulder County with respect to the County's Kyoto goal of reducing emissions by 2012 to a level that is 7% below the 1990 level.

The overarching philosophical framework within which Boulder's GHG inventory was developed is that the County Commissioners recognize and acknowledge the environmental imperative that man-made climate change is real, it is happening now, and decisive action must be taken to mitigate it. Man-made climate change, in fact, is recognized as a direct threat to the very lifeblood of Boulder County, as capsulated in statements contained in the summer 2002 edition of US EPA's biannual report to the United Nations on climate change: "snow-fed streams in the USA will be permanently diminished" and "alpine meadows in the US Rocky Mountains will permanently disappear" as the result of man-made climate change. Clearly, Boulder County's water supply, quality of life, and tourism industry are threatened by climate change.

The first step in the GHG planning process is to develop a clear picture of historical and current sources and magnitudes of Boulder's GHG emissions. In general, the process for developing a GHG emissions inventory and inventory management system involves 1) the development of a historical inventory of GHG emissions for the period of 1990 through the present; 2) development of a projected Business-As-Usual (BAU) emissions trend line out to 2012, based on the historical emissions data; 3) disaggregating of the overall inventory into sector-, source- and municipality-specific emissions. Each of the sectors, sources, and municipalities disaggregated in the inventory are listed below.

**Table 1: Sector, Source and Municipality List**

| SECTOR | SOURCE | MUNICIPALITY |
|---|---|---|
| Residential | Electricity | Boulder |
| Commercial | Natural Gas | Longmont |
| Industrial | Stationary Diesel | Louisville |
| Street Lighting | Landfill Gas | Lafayette |
| Transportation | Industrial Process | Lyons |
| Agriculture | Mobile Gasoline | Nederland |
| Waste | Mobile Diesel | Superior |
| Industrial Process | Voluntary RECs | Unincorporated/Other |
| Offsets | Amendment 37 Projects | |
| | Municipal Renewable Energy | |
| | Enteric Fermentation | |
| | Manure Management | |
| | Soil Management | |
| | Refrigerant | |
| | Aviation Fuel | |
| | Electricity | |

Amalgamating the sector, source, and municipality inventories into an aggregated county-wide inventory provides the context in which to compare and contrast the emissions. Thus, a comprehensive picture of the problem guides limited resources to be focused to specific mitigation strategies on those emissions-intensive individual sectors, sources, and/or municipalities.

# 2. METHODOLOGY

The methodology for the inventory is based upon the *GHG Protocol Corporate Accounting and Reporting Standard*, developed by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD), and keeps with a similar approach other cities and counties with climate change objectives have used. A complete description of the methodology, including calculations, assumptions, and sources of data for the IMS, are thoroughly outlined in the Inventory Management Plan (IMP), a separate stand-alone document that has also been developed.

The primary basis for the GHG inventory is the historical sales of electricity and natural gas and the estimated vehicle miles traveled within the county. Each of these sources was disaggregated by sector and municipality. The necessary historical data were acquired from a variety of sources, as described in the IMP. For the most part, annual data were available for the period from 1990 – 2005. Using standard methodologies provided by the Intergovernmental Panel on Climate Change (IPCC) of the United Nations Framework Convention on Climate Change (UNFCCC), these historical data were translated into greenhouse gas emissions on an annual basis. Thus, an annual county-wide GHG inventory was created for the for the 1990 through 2003 period. Furthermore, the historical data were used to forecast annual Business-As-Usual (BAU) GHG emissions for the 2006 through 2012 period. BAU emissions are those that would occur in the absence of new emissions mitigation efforts. This forecasting is based solely on continuation of past trends, and does not attempt to incorporate other future trends that will affect future GHG emissions, such as future energy cost increases, commercial and industrial growth, shifts in transportation modes, increased availability of low-emissions technology, and so forth.

The inventory process considered all the predominant greenhouse gases: carbon dioxide ($CO_2$), methane ($CH_4$), nitrous oxide ($N_2O$), halocarbons (HFCs, PFCs), and sulfur hexafluoride ($SF_6$). Using the Global Warming Potential (GWP)[1] of these gases, quantified emissions were converted to the standard unit of metric tons of $CO_2$-equivalent (tCO2e). Note that the inventory does not include $SF_6$ and PFC emissions, which were considered but determined to be de minimis. The reasoning behind this omission is that, in the bigger picture, fossil fuel-related $CO_2$ and solid waste-related $CH_4$ comprise the vast majority of the county's climate change-inducing emissions, with the other GHGs contributing only marginally to the overall inventory. Additionally, the inventory does not include the emissions related to the production of most goods bought or consumed in the county.[2]

The inventory credits the county for GHG emission reductions achieved through the generation and purchase of renewable electricity. These credits are realized through

[1] The GWP measures the heat-trapping potency of a greenhouse gas, and is defined as the ratio of the time-integrated radiative forcing from the instantaneous release of 1 kg of a trace substance relative to that of 1 kg of a reference gas (IPCC 2001). The reference gas used is $CO_2$, so a substance with a GWP of 100 would have 100 times more heat-trapping capability than $CO_2$. GWP-weighted emissions are measured in terms of $CO_2$-equivalent ($CO_2e$).

[2] To avoid double counting, emissions from goods bought or consumed in the County should be included in inventories done by the communities in which the goods were made.

municipally-owned renewable energy generation and voluntary and regulatory renewable energy certificates (RECs).

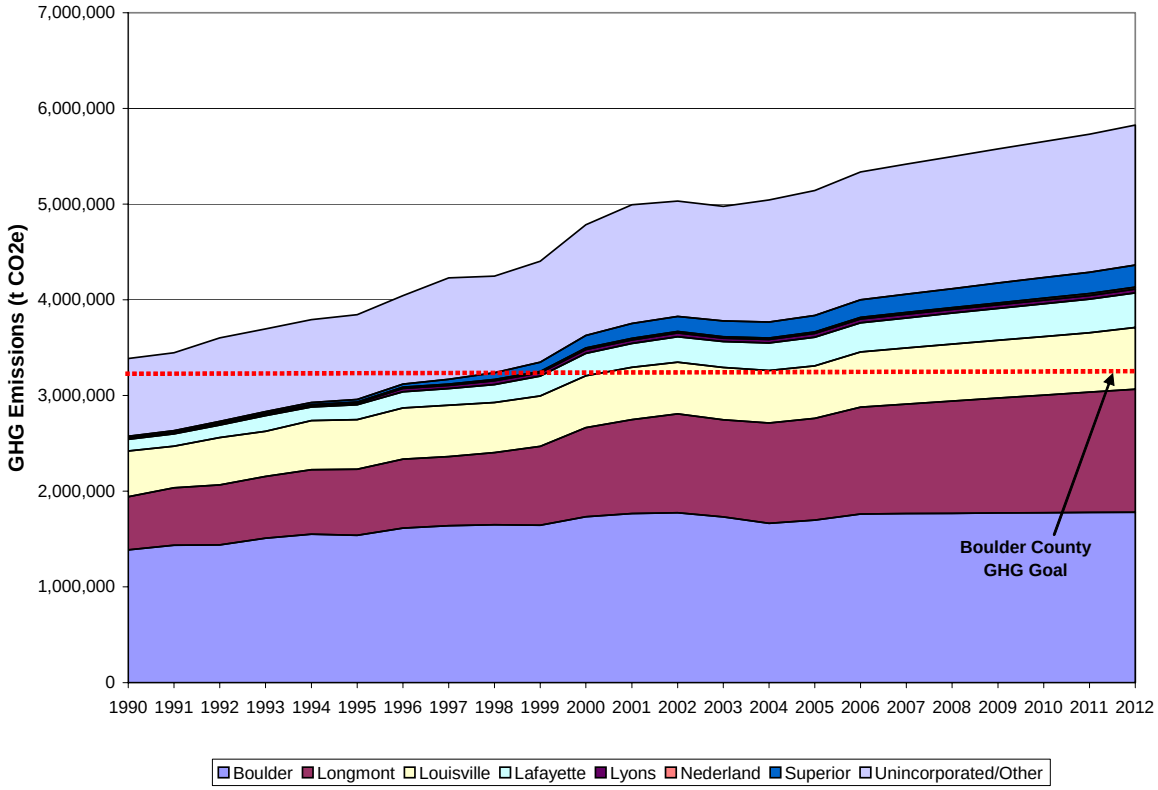
Utilizing the results of the inventory for guidance, the County can develop policies and programs that will minimize GHG emissions.

# 3. AGGREGATED EMISSIONS INVENTORY

Boulder County's 1990 base-year emissions were 3,387,000 metric tons of $CO_2$-equivalent ($tCO_2e$). The County's goal is to achieve by 2012 a level of emissions that is 7% below the 1990 emissions. The 2012 target level emissions are 3,150,000 $tCO_2e$. In 2005, Boulder County greenhouse gas emissions were 5,067,000 $tCO_2e$, or 61% above the goal.

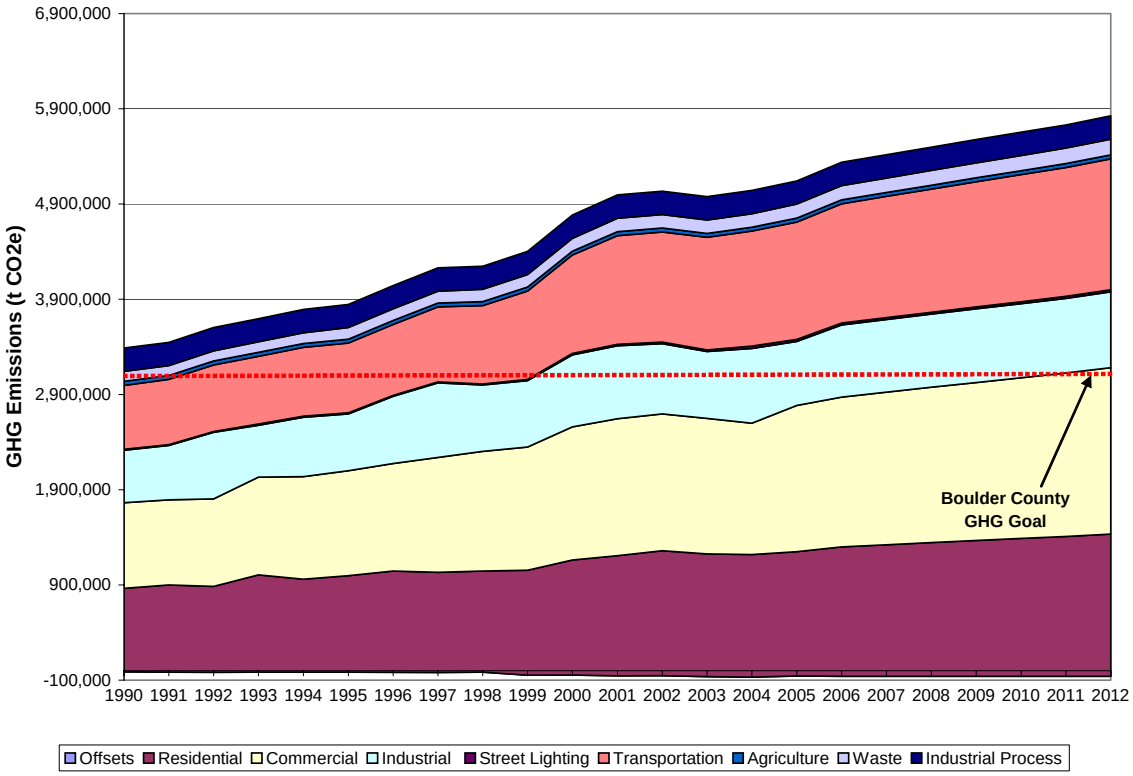
Table 15, in the Appendix, details the emissions for each sector and presents the county's historical and forecast inventory for the 1990-2012 period. Figure 5 further illustrates the county's GHG emissions growth rate between 1990 and 2005. Moreover, Figure 5 illustrates that by 2012, emissions are projected to reach 5,851,000 $tCO_2e$, or 86% above the target, unless action is taken to counteract the business-as-usual trend. Figure 6 illustrates the county's emissions trends by Sector.

**Figure 5: Boulder County GHG Emissions Profile by Municipality, 1990-2012**




***If Business-As-Usual continues, Boulder County will be 86% above its Kyoto target in 2012***

**Figure 6: Boulder County GHG Emissions Profile by Sector, 1990-2012**



## EMISSIONS BY SOURCE

Table 2 presents the county's historical and forecast inventory grouped by emissions source. Figure 7 portrays the county's 2005 inventory disaggregated by emissions source. The figure shows that electricity is the foremost contributing source of GHG emissions with natural gas and mobile gasoline a distant second and third. Furthermore, the figure draws attention to the insignificant impact agriculture (including enteric fermentation, manure management and soil management), refrigerants, and aviation fuel have on the county's inventory. These sources combined represent less than 1% of emissions. In relation to the impacts of electricity, natural gas, and mobile gasoline, the effect from stationary diesel, landfill gas, cement manufacturing, and mobile diesel is also quite small.

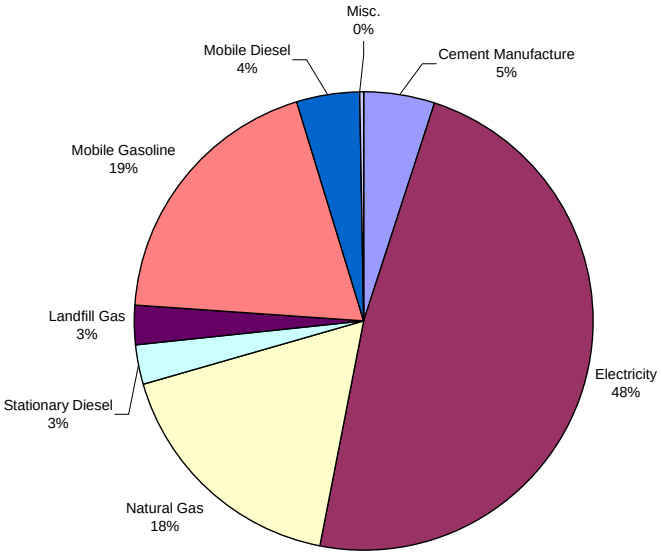
Figure 8 highlights the trends seen for each. Furthermore, this figure illustrates the relative magnitude of each source as well the trend. Emissions produced through the use of $SF_6$ are presently not included in the inventory due the inability of Xcel Energy to provide their actual $SF_6$ consumption or the total miles of transmission lines within the county.

**Table 2: Historical and Forecast GHG Emissions by Source ($tCO_2e$)**

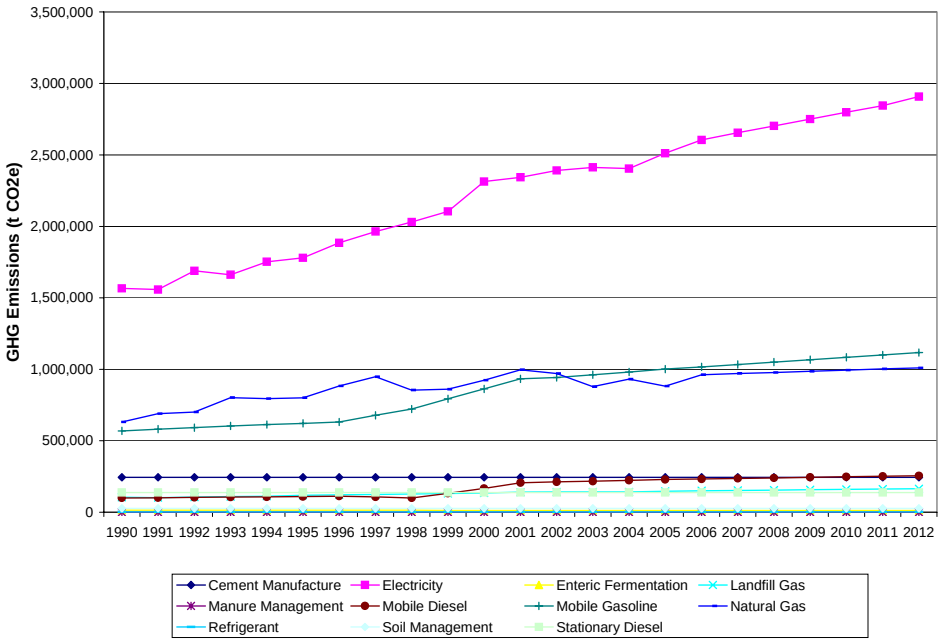
| Source | 1990 | 1995 | 2000 | 2005 | 2012 |
|---|---|---|---|---|---|
| Electricity | 1,566,539 | 1,780,234 | 2,313,239 | 2,511,850 | *2,908,324* |
| Natural Gas | 630,982 | 800,490 | 923,864 | 806,110 | *1,035,504* |
| Stationary Diesel | 138,837 | 138,837 | 138,837 | 138,837 | *138,837* |
| Mobile Gasoline | 569,296 | 622,247 | 862,926 | 1,001,001 | *1,117,271* |
| Mobile Diesel | 99,753 | 109,788 | 167,472 | 229,030 | *255,633* |
| Aviation Fuel | 1,229 | 1,229 | 1,397 | 2,287 | *2,100* |
| Enteric Fermentation | 14,164 | 14,164 | 13,436 | 12,951 | *12,951* |
| Manure Management | 508 | 508 | 511 | 513 | *513* |
| Soil Management | 27,562 | 27,562 | 27,562 | 27,562 | *27,562* |
| Landfill Gas | 104,483 | 119,916 | 134,919 | 147,328 | *164,906* |
| Industrial Process | 244,204 | 244,204 | 244,204 | 244,204 | *244,204* |
| Refrigerant | 2,125 | 2,125 | 2,125 | 2,125 | *2,125* |
| Amendment 37 Projects | - | - | - | - | - |
| Municipal Renewable | (12,459) | (14,814) | (12,652) | (26,401) | *(25,568)* |
| Voluntary RECs | - | - | (33,738) | (29,948) | *(33,207)* |
| **Total** | 3,387,223 | 3,846,488 | 4,784,101 | 5,067,448 | *5,851,154* |

*Note – italics indicates forecast*

## Figure 7: GHG Emissions by Source, 2005




## Figure 8: Historical and Forecast Source Trends, 1990-2012



# 4. EMISSIONS BY MUNICIPALITY

Table 3 presents the county's historical and forecast inventory grouped by municipality. Figure 9 presents the county's 2005 inventory disaggregated by municipality. The figure shows that the City of Boulder and the Unincorporated/Other regions of the county are the largest producers of emissions, contributing 34% and 25% of the county's overall emissions, respectively. Figure 10 highlights the historical and forecast emissions by municipality. This figure illustrates the relative magnitude of each municipality as well the historical and forecast annual growth rate. It is instructive to note the significant growth expected for Unincorporated/Other region of the county.

Figure 11 through Figure 18 displays each municipality's emissions production by sector.

**Table 3: Historical and Forecast GHG Emissions by Municipality ($tCO_2e$)**

| Municipality | 1990 | 1995 | 2000 | 2005 | 2012 |
|---|---|---|---|---|---|
| Unincorporated/Other | 813,280 | 889,825 | 1,179,167 | 1,249,836 | *1,506,379* |
| Boulder | 1,388,582 | 1,540,499 | 1,733,574 | 1,697,549 | *1,780,535* |
| Longmont | 554,748 | 687,626 | 931,987 | 1,065,348 | *1,286,142* |
| Louisville | 476,466 | 521,149 | 541,455 | 548,181 | *645,250* |
| Lafayette | 122,631 | 153,316 | 234,091 | 300,094 | *360,342* |
| Lyons | 12,391 | 15,782 | 17,694 | 19,239 | *22,445* |
| Superior | 8,912 | 25,622 | 129,360 | 171,404 | *231,548* |
| Nederland | 10,213 | 12,669 | 16,773 | 15,797 | *18,513* |
| **Total** | 3,387,223 | 3,846,488 | 4,784,101 | 5,067,448 | *5,851,154* |

*Note – italics indicates forecast*

The unexpected result that Unincorporated/Other is the second-largest source of emissions in the county has to do with the "Other" and not with the "Unincorporated". "Other" includes all incorporated municipalities in Boulder County that are not explicitly disaggregated in the GHG inventory. These include but are not limited to Erie, Gunbarrel, Niwot, and Ward, and comprise 10% of the Unincorporated/Other total.

In addition, note that transportation emissions for Unincorporated/Other are more than double those of Longmont. Next note that Cemex is a large contributor to the Unincorporated/Other total, as "cement manufacture" is 21% of the Unincorporated/Other total. Furthermore, Cemex natural gas use is estimated to contribute roughly 5% of the Unincorporated/Other total. Lastly note that if Cemex and "Other" were removed, the Unincorporated/Other total would only be 18.5% of the county's inventory. The following

table compares the 2005 emissions components of Unincorporated/Other versus Longmont to help illustrate why the former has totals that are larger than the latter.

| Source | Longmont | Unincorporated/Other |
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| Manure Management | - | 513 |
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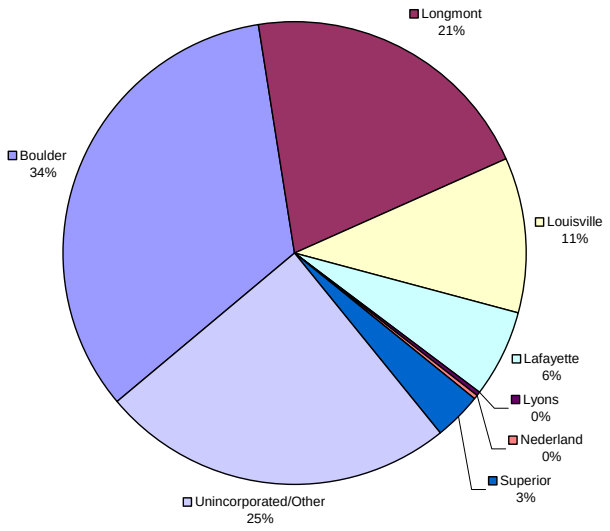
| Aviation Fuel | 1,122 | - |
| **Grand Total** | **1,069,579** | **1,249,814** |

## Figure 9: GHG Emissions by Municipality, 2005




## Figure 10: Historical and Forecast Municipality Trends, 1990-2012

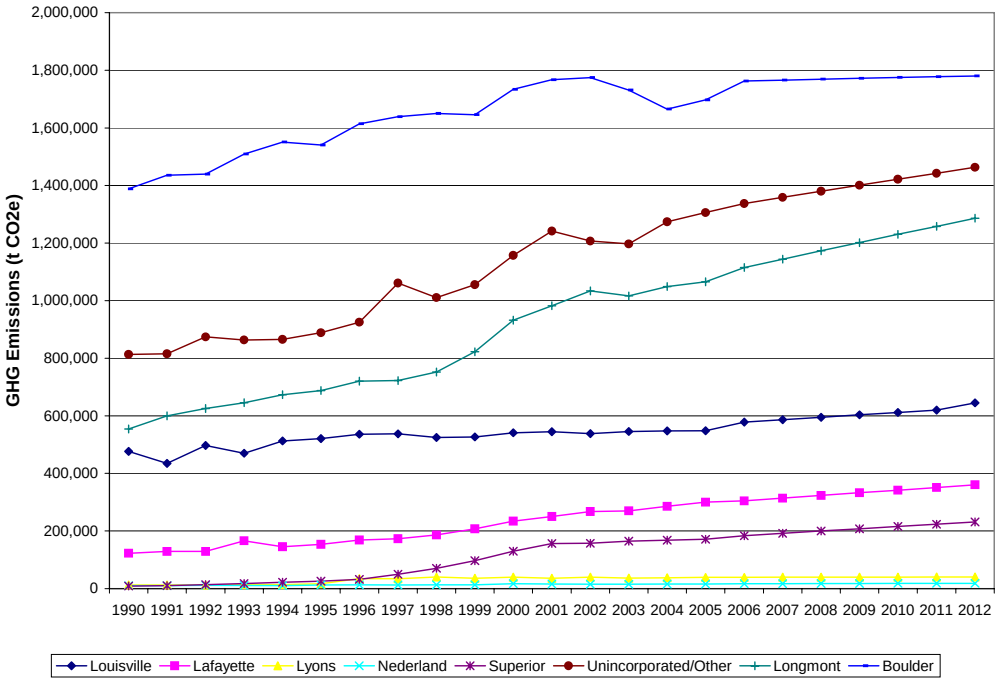


**Figure 11: GHG Emissions by Sector for Boulder, 2005**

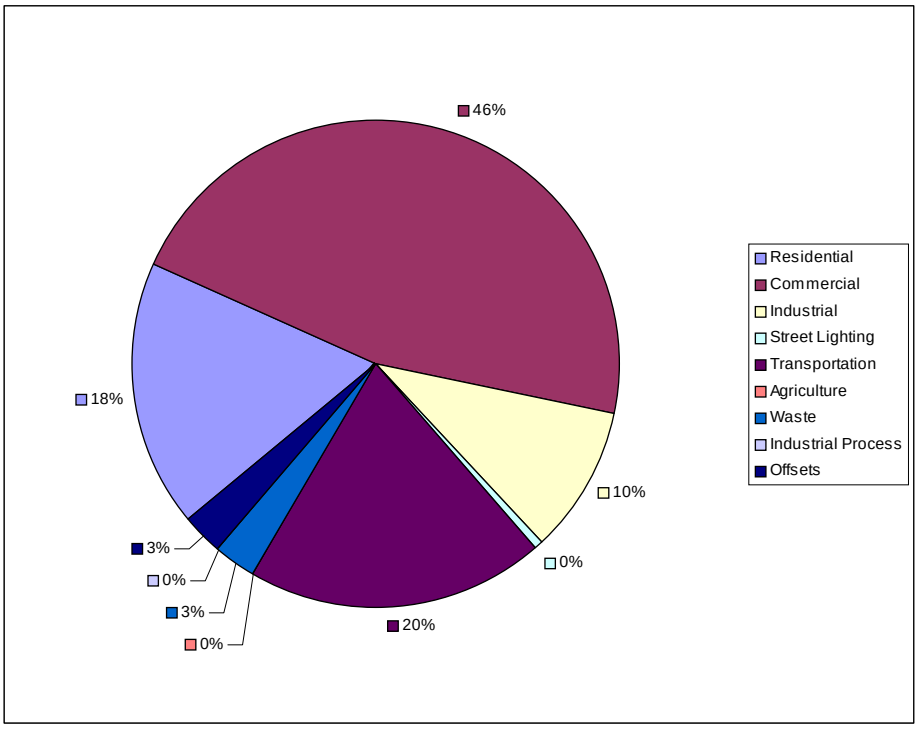



**Figure 12: GHG Emissions by Sector for Lafayette, 2005**

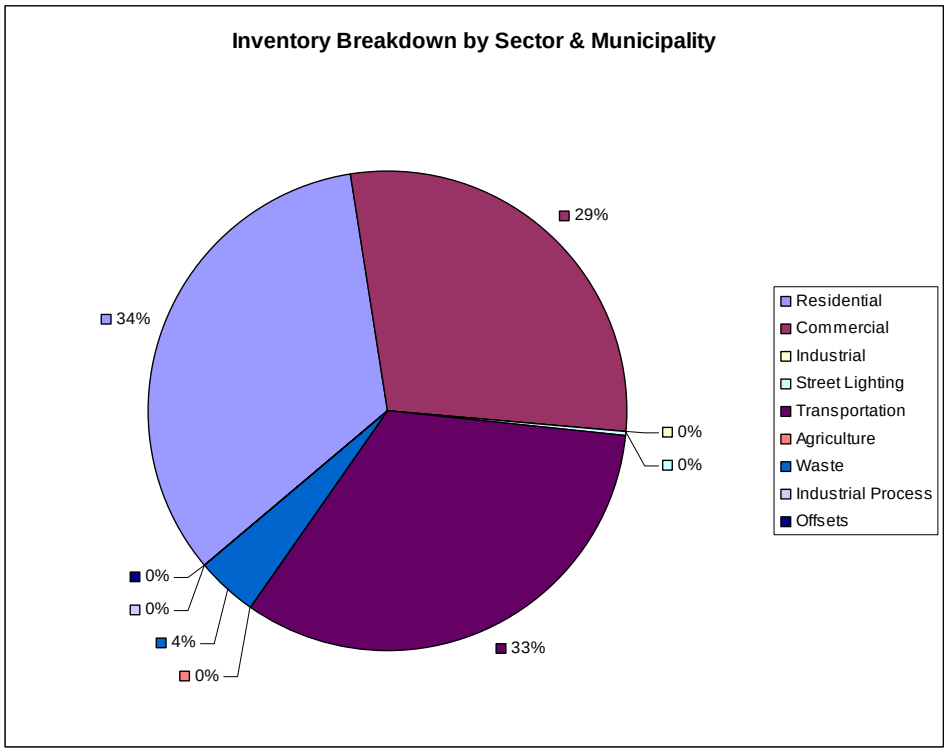


**Figure 13: GHG Emissions by Sector for Louisville, 2005**

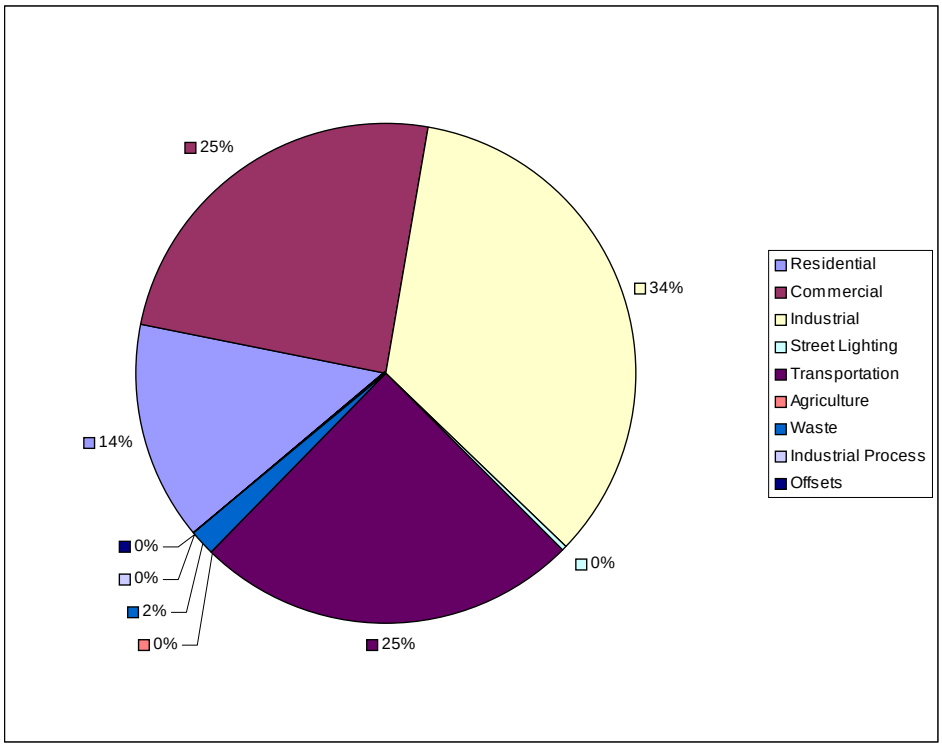



**Figure 14: GHG Emissions by Sector for Longmont, 2005**

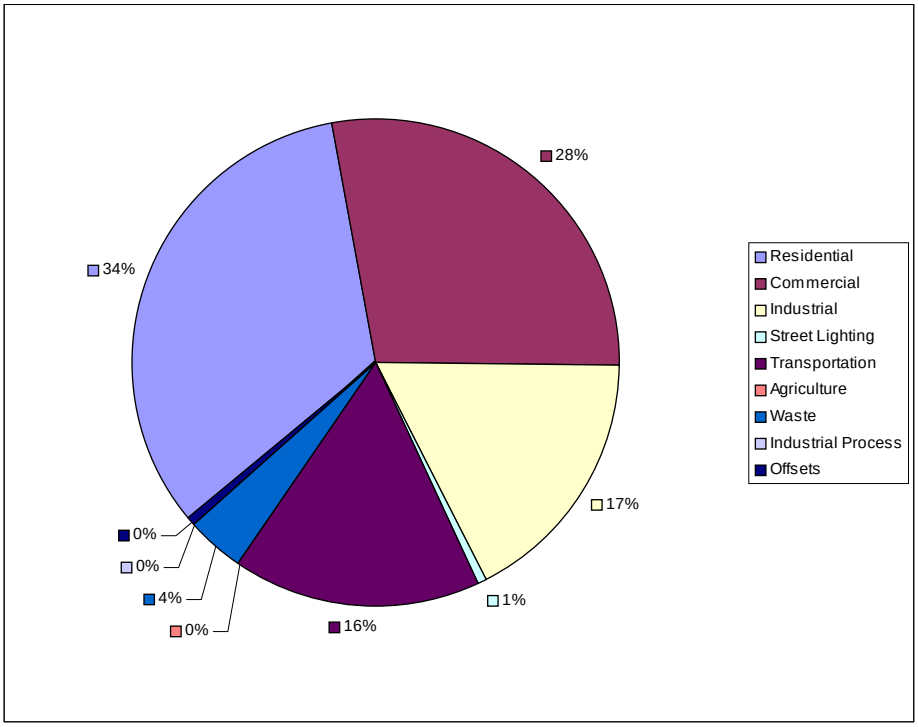


**Figure 15: GHG Emissions by Sector for Lyons, 2005**

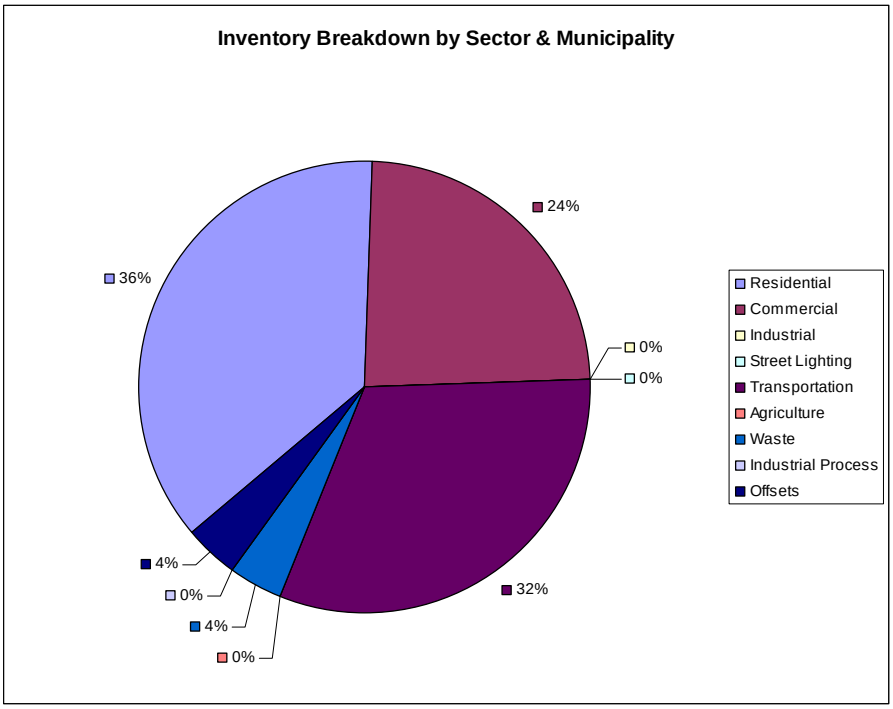



**Figure 16: GHG Emissions by Sector for Nederland, 2005**

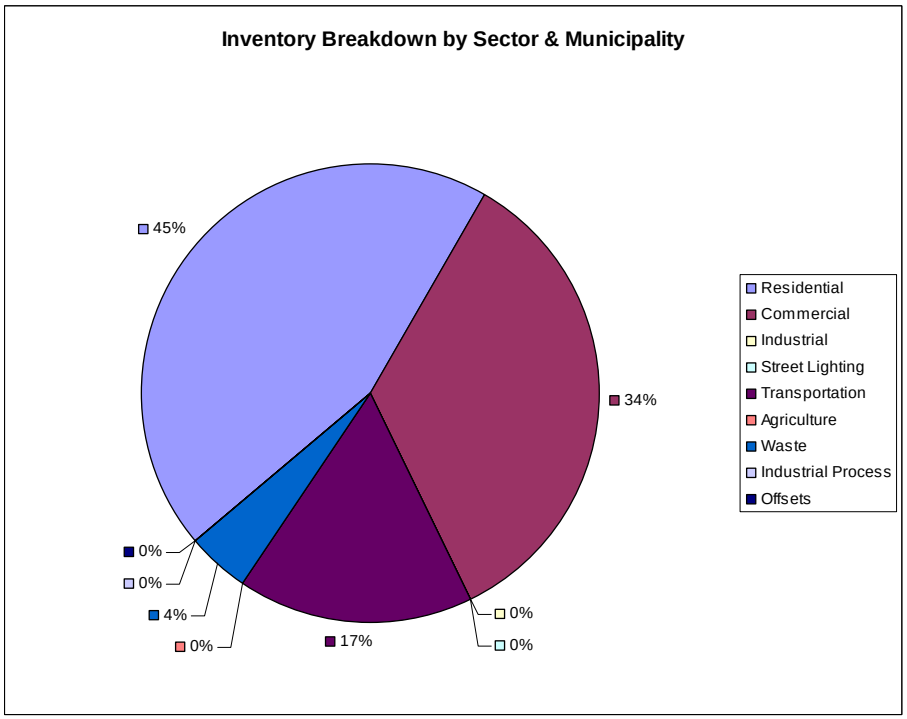


**Figure 17: GHG Emissions by Sector for Superior, 2005**

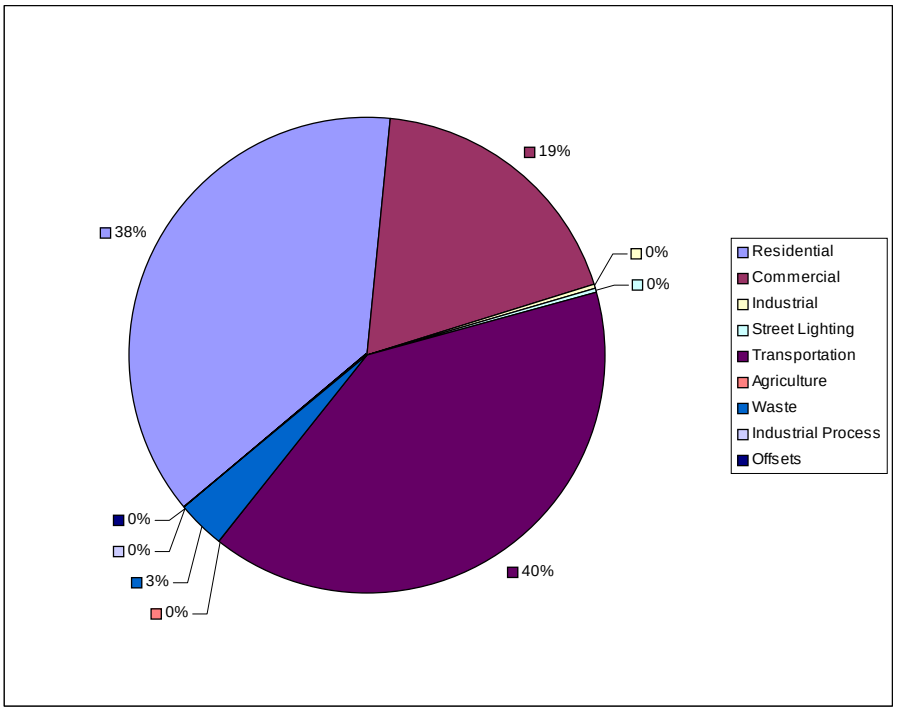
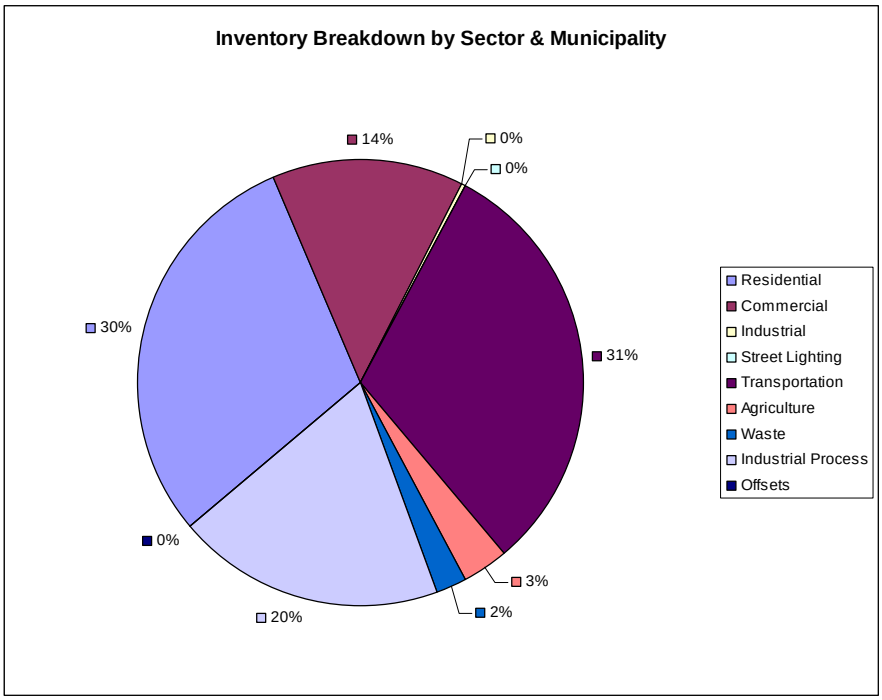



**Figure 18: GHG Emissions by Sector for Unincorp/Other, 2005**




NOTE: The majority (71%) of the Commercial GHG emissions emanating from Unincorporated/Other come from electricity consumed in commercial buildings located in incorporated municipalities not explicitly broken out in the GHG inventory (Erie, Niwot, Gunbarrel, Ward, and others).

## EMISSIONS BY SECTOR

Table 4 presents the county's historical and forecast inventory grouped by sector. Figure 19 illustrates the county's 2005 inventory disaggregated by sector. The figure shows that the Commercial sector is the most dominant contributor of GHGs in the county, responsible for 29% of overall county-wide emissions. The Residential building sector is a close second comprising 25% of the emissions in the county and transportation contributes another 23% of the county's GHG emissions. Combined, the street lighting, agriculture, and waste sectors represent only 4% of the 2005 GHG emissions, highlighting the minimum impact of these sectors. Figure 20 presents the historical and forecast emissions by sector. This figure illustrates the relative magnitude of each sector as well the historical and forecast annual growth rate.

**Table 4: Historical and Forecast GHG Emissions by Sector ($tCO_2e$)**

| Sector | 1990 | 1995 | 2000 | 2005 | 2012 |
|---|---|---|---|---|---|
| Residential | 877,863 | 1,012,283 | 1,208,808 | 1,304,999 | *1,493,188* |
| Commercial | 899,503 | 1,109,902 | 1,514,794 | 1,591,317 | *1,945,865* |
| Industrial | 548,918 | 589,204 | 639,346 | 542,752 | *623,767* |
| Transportation | 670,278 | 733,264 | 1,031,795 | 1,232,318 | *1,375,003* |
| Agriculture | 42,233 | 42,233 | 41,508 | 41,025 | *41,025* |
| Industrial Process | 244,204 | 244,204 | 244,204 | 244,204 | *244,204* |
| Street Lighting | 12,200 | 10,296 | 15,118 | 19,855 | *21,971* |
| Waste | 104,483 | 119,916 | 134,919 | 147,328 | *164,906* |
| Offsets | (12,459) | (14,814) | (46,390) | (56,349) | *(58,775)* |
| **Grand Total** | 3,387,223 | 3,846,488 | 4,784,101 | 5,067,448 | *5,851,154* |

*Note – italics indicates forecast*

**Figure 19: GHG Emissions by Sector, 2005**

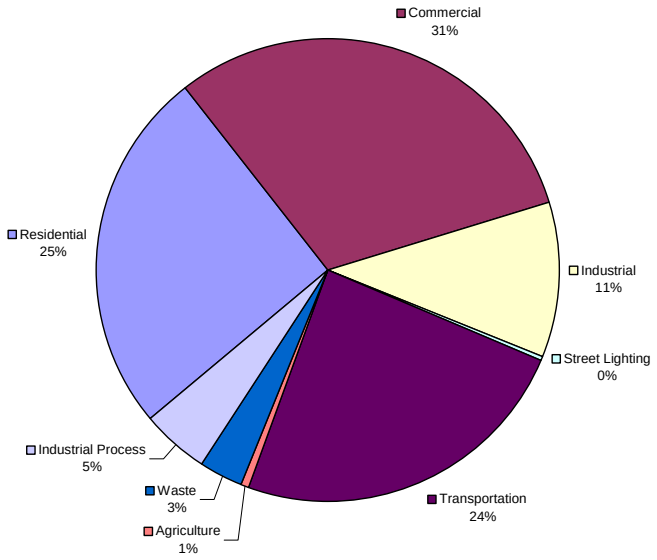
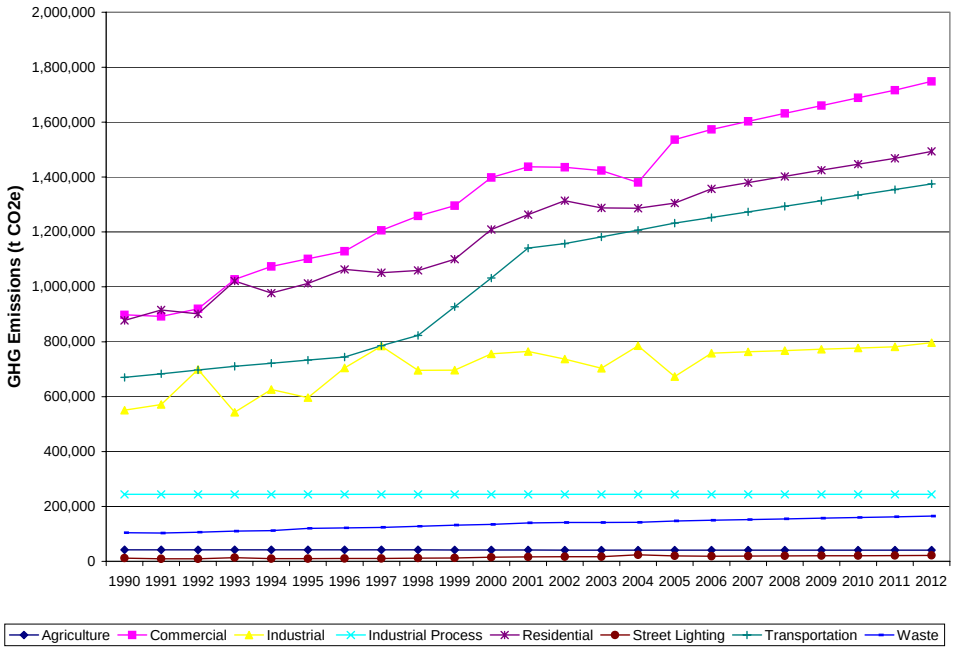



**Figure 20: Historical and Forecast Sector Trends, 1990-2012**




## 4.1 RESIDENTIAL BUILDINGS

Residential sector emissions are produced indirectly through the consumption of electricity and directly through the consumption of natural gas. Electricity and natural gas are

consumed in buildings for heating and cooling, water heating, lighting, appliances, and miscellaneous equipment loads, such as televisions and computers. The residential sector provides the second-largest contribution to Boulder's GHG emissions. In 1990, residential accounted for emissions of 878,000 mtCO2/yr, 26% percent of the county's GHG emissions inventory. By 2005, emissions from the residential sector rose to 1,305,000 $tCO_2e$/yr, a 49% increase. As illustrated in Figure 21, residential building emissions are forecasted to increase another 14% from 2005 to 2012, resulting in 2012 emissions of 1,493,000 $tCO_2e$/yr.

**Figure 21: Residential GHG Emissions, 1990-2012**

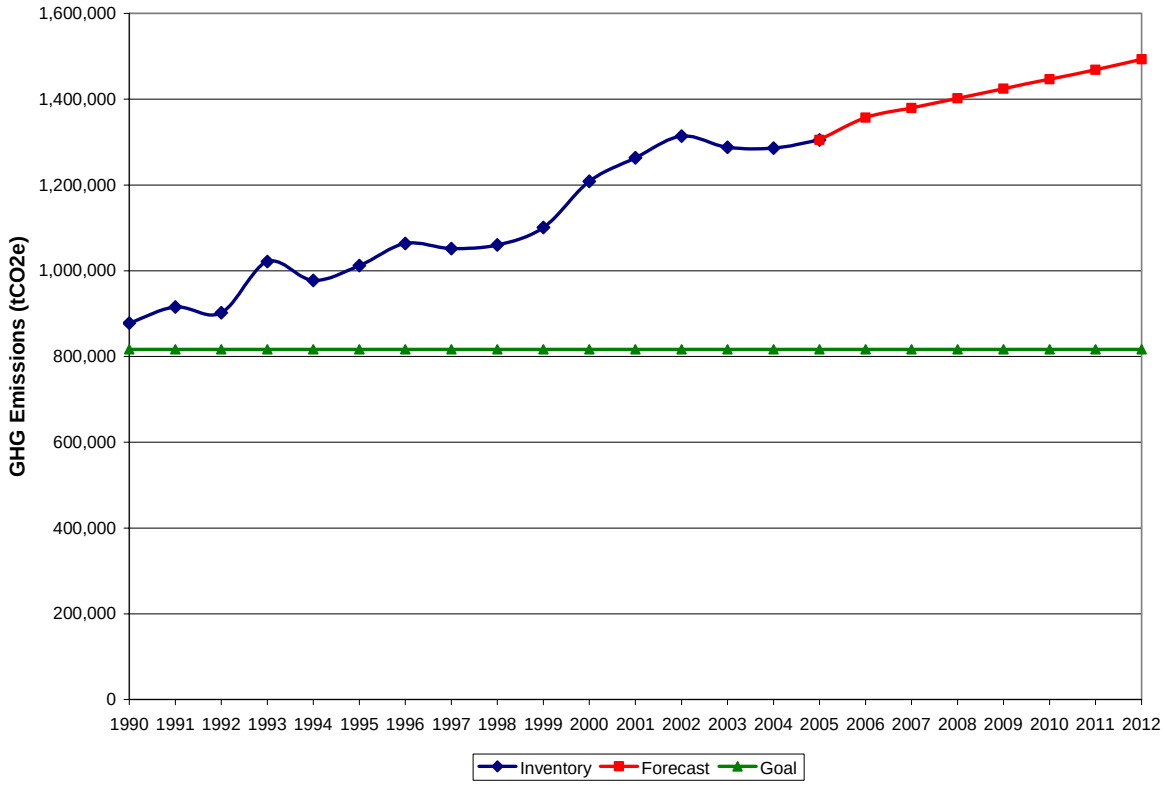



Table 5 breaks down the sources of residential emissions, along with the impact each municipality's residential sector has on the overall inventory. Unincorp/Other has the greatest impact on the emissions from the residential sector, contributing slightly more than 28% of the county-wide sector total. The second-highest is Longmont, at just under 28%, with Boulder contributing 24%.

**Table 5: Residential GHG Emissions by Municipality, 2005 ($tCO_2e$)**

| Municipality | Electricity | Natural Gas | Residential Total |
|---|---|---|---|
| Boulder | 207,758 | 109,717 | 317,476 |
| Longmont | 240,639 | 118,650 | 359,289 |
| Louisville | 50,668 | 26,540 | 77,207 |
| Lafayette | 67,785 | 32,870 | 100,654 |
| Lyons | 5,233 | 2,422 | 7,656 |
| Nederland | 4,520 | 2,514 | 7,034 |
| Superior | 41,849 | 22,753 | 64,603 |
| Unincorporated/Other | 267,178 | 103,902 | 371,080 |
| County | 885,631 | 419,368 | 1,304,999 |
| **Percentage of Column** | | | |
| **Municipality** | **Electricity** | **Natural Gas** | **Residential Total** |
| Boulder | 23% | 26% | 24% |
| Longmont | 27% | 28% | 28% |
| Louisville | 6% | 6% | 6% |
| Lafayette | 8% | 8% | 8% |
| Lyons | 1% | 1% | 1% |
| Nederland | 1% | 1% | 1% |
| Superior | 5% | 5% | 5% |
| Unincorporated/Other | 30% | 25% | 28% |

## 4.2 COMMERCIAL BUILDINGS

Commercial Buildings sector emissions are produced indirectly through the consumption of electricity and directly through the consumption of natural gas. Electricity and natural gas are used for the building's heating, ventilation, and air-conditioning (HVAC) systems; lighting systems; and various electrical equipment. Refrigerant leakage from cooling equipment represents a third and relatively insignificant source of GHG emissions.

The commercial buildings sector provides the largest contribution to Boulder County's GHG emissions. In 1990, Commercial accounted for 27% of the county's GHG inventory. By 2005, that figure had risen to 31% percent, and in 2012 commercial buildings are forecasted to comprise roughly 33% percent of the overall county-wide inventory if the Business-As-Usual (BAU) trend line continues.

**Figure 22: Commercial GHG Emissions, 1990-2012**

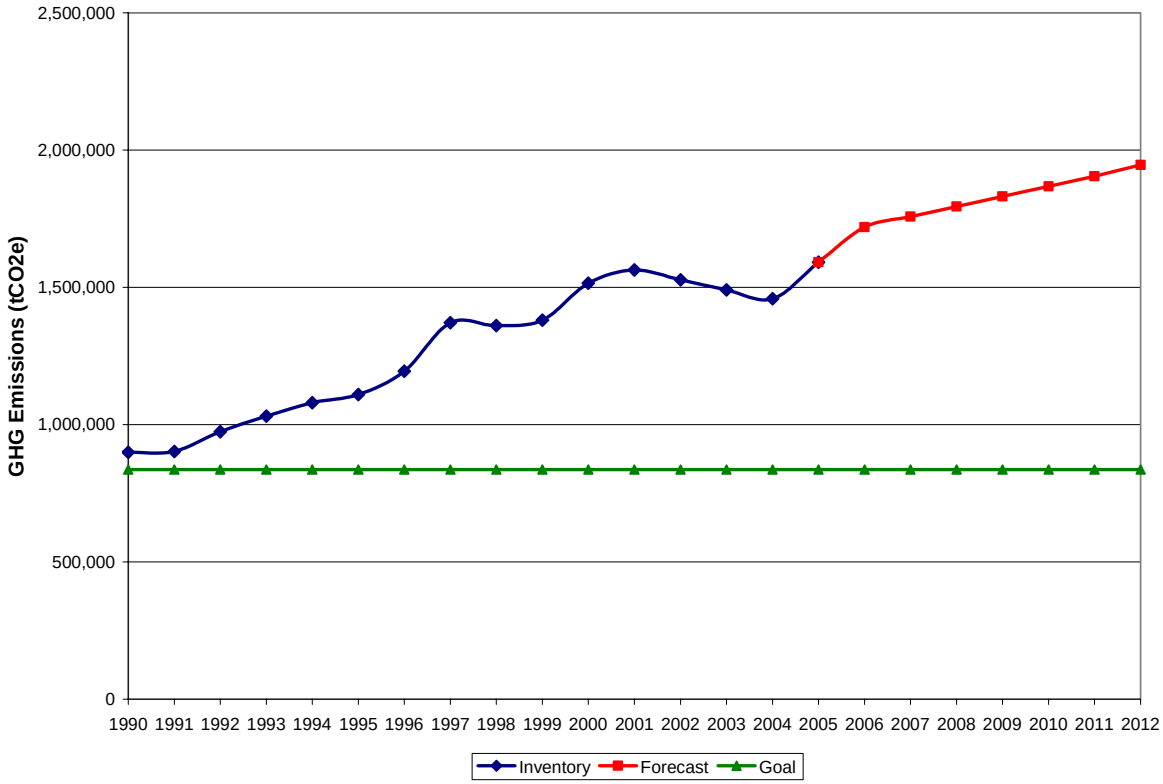



Table 6 outlines the sources of emissions and percentage of emissions for the Commercial Buildings sector, by municipality. In 2005, the Boulder accounted for 53% of county-wide commercial building emissions, Longmont produced 19%, and the Unincorporated/Other region produced 11% of sector emissions. These three regions of the county are responsible for 83% of county-wide commercial building emissions.

**Table 6: Commercial GHG Emissions by Municipality, 2005 ($tCO_2e$)**

| Municipality | Electricity | Natural Gas | Refrigerant | Commercial Total |
|---|---|---|---|---|
| Boulder | 673,069 | 168,348 | 996 | 842,413 |
| Longmont | 255,250 | 49,760 | 694 | 305,705 |
| Louisville | 123,508 | 14,098 | 250 | 137,857 |
| Lafayette | 68,007 | 18,573 | 115 | 86,695 |
| Lyons | 3,948 | 1,036 | 5 | 4,990 |
| Nederland | 4,088 | 1,343 | 6 | 5,438 |
| Superior | 29,602 | 3,103 | 33 | 32,738 |
| Unincorporated/Other | 118,950 | 56,508 | 24 | 175,481 |
| County | **1,276,422** | **312,769** | **2,125** | **1,591,317** |
| **Percentage by Column** | | | | |
| **Municipality** | **Electricity** | **Natural Gas** | **Refrigerant** | **Commercial Total** |
| Boulder | 53% | 54% | 47% | 53% |
| Longmont | 20% | 16% | 33% | 19% |
| Louisville | 10% | 5% | 12% | 9% |
| Lafayette | 5% | 6% | 5% | 5% |
| Lyons | 0% | 0% | 0% | 0% |
| Nederland | 0% | 0% | 0% | 0% |
| Superior | 2% | 1% | 2% | 2% |
| Unincorporated/Other | 9% | 18% | 1% | 11% |

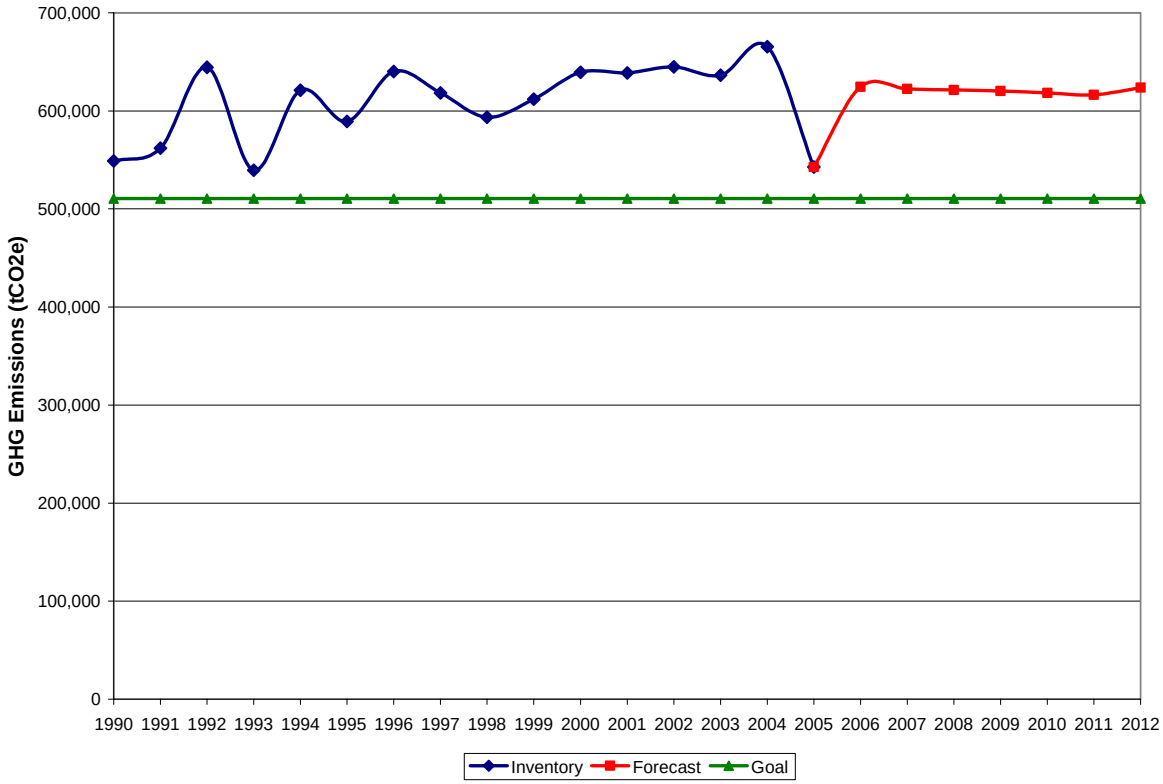
## 4.3 INDUSTRIAL

Industrial sector emissions are produced indirectly through the consumption of electricity and directly through the consumption of natural gas and stationary diesel fuel. This inventory does not include under Industrial Emissions the fugitive emissions from industrial processes, which are accounted for separately as Industrial Process Emissions. Rather, this inventory assigns to Industrial only the emissions associated with the *energy consumption* of industrial buildings and processes.

In 1990, industrial energy usage accounted for 16% of total county-wide GHG emissions. Industrial energy consumption produced 11% of the overall county-wide GHG emissions in 2005. The projected BAU trajectory for industrial energy usage would produce 11% of total county-wide emissions in 2012.

Louisville leads the county's industrial energy emissions, accounting for 34% of the county-wide emissions for this sector in 2005. Longmont contributed another 33% and Boulder was responsible for 32% of total GHG emissions attributable to industrial energy usage.

## Figure 23: Industrial GHG Emissions, 1990-2012




## Table 7: Industrial GHG Emissions by Municipality, 2005 ($tCO_2e$)

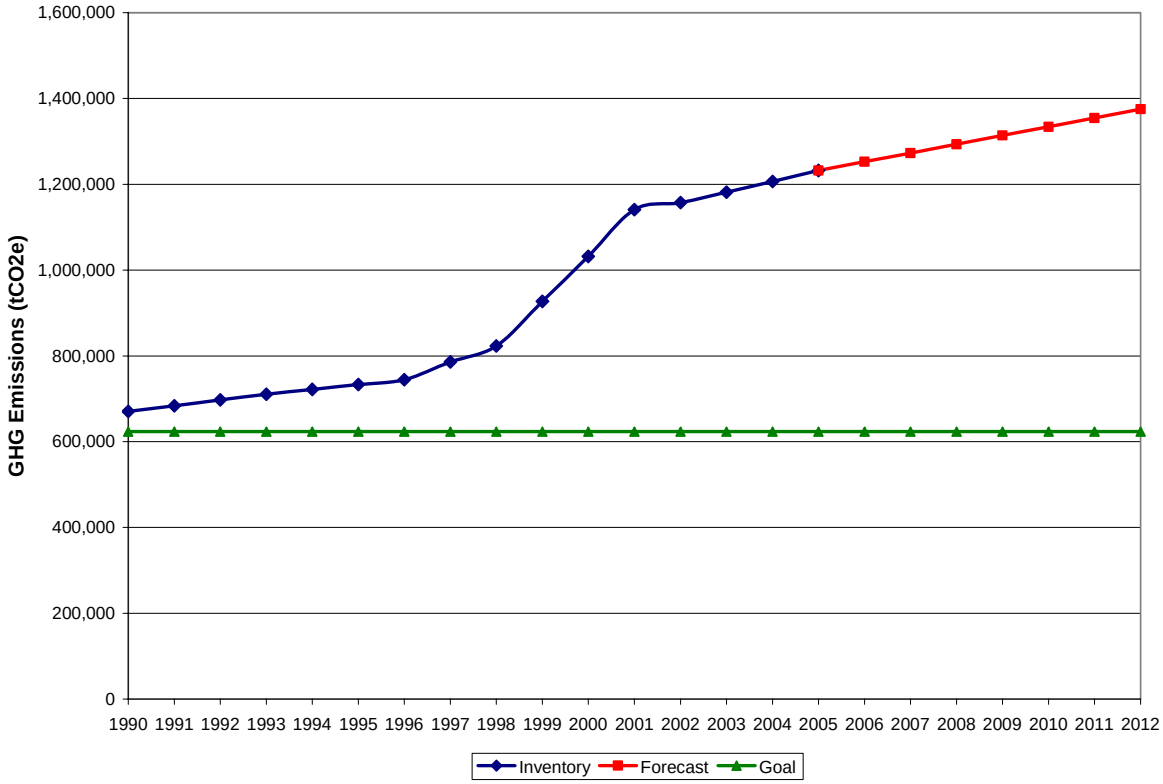
| Municipality | Electricity | Natural Gas | Stationary Diesel | Industrial Total |
|---|---|---|---|---|
| Boulder | 130,492 | 38,886 | 4,600 | 173,978 |
| Longmont | 149,571 | 29,158 | 711 | 179,441 |
| Louisville | 47,532 | 5,426 | 133,375 | 186,333 |
| Lafayette | 0 | 0 | 0 | 0 |
| Lyons | 0 | 0 | 0 | 0 |
| Nederland | 0 | 0 | 0 | 0 |
| Superior | 0 | 0 | 0 | 0 |
| Unincorporated/Other | 2,348 | 502 | 151 | 3,001 |
| **By Percentage by Column** | | | | |
| **Municipality** | **Electricity** | **Natural Gas** | **Stationary Diesel** | **Industrial Total** |
| Boulder | 40% | 53% | 3% | 32% |
| Longmont | 45% | 39% | 1% | 33% |
| Louisville | 14% | 7% | 96% | 34% |
| Lafayette | 0% | 0% | 0% | 0% |
| Lyons | 0% | 0% | 0% | 0% |
| Nederland | 0% | 0% | 0% | 0% |
| Superior | 0% | 0% | 0% | 0% |
| Unincorporated/Other | 1% | 1% | 0% | 1% |

## 4.4 TRANSPORTATION

Transportation is the third-largest sector in terms of its contribution to overall county-wide GHG emissions. Transportation sector emissions are produced directly through the consumption of mobile gasoline, mobile diesel, and aviation fuel. In 1990, Transportation accounted for 20% of the county's GHG inventory. By 2005, that figure had risen to 24%, and in 2012, transportation is forecasted to contribute 23% to the inventory. Under the BAU scenario, transportation emissions are forecasted to continue, as depicted in Figure 24.

This increase in Transportation's emissions is further highlighted by the noteworthy rate in the growth of vehicle miles traveled (VMT) that has occurred over recent years. If current trends were to continue unmitigated, forecasts indicate that Boulder County will experience approximately a 15% increase in 2012 VMT relative to 2003.

**Figure 24: Transportation GHG Emissions, 1990-2012**




Unincorporated/Other contributes 31% of the total transportation emissions within the county. Table 8 demonstrates the insignificant impact emissions from aviation fuel have on the total emissions of the county. It is also instructive to note that emissions from the consumption of mobile diesel is only 19% of Transportation emissions, indicating that the largest impact on emissions in the Transportation sector is from the consumption of mobile gasoline.

**Table 8: Transportation GHG Emissions by Municipality, 2005 ($tCO_2e$)**

| Municipality | Mobile Gasoline | Mobile Diesel | Aviation Fuel | Transportation Total |
|---|---|---|---|---|
| Boulder | 288,584 | 66,028 | 1,165 | 355,777 |
| Longmont | 142,594 | 32,626 | 1,122 | 176,341 |
| Louisville | 110,848 | 25,362 | 0 | 136,210 |
| Lafayette | 80,825 | 18,493 | 0 | 99,318 |
| Lyons | 5,359 | 1,226 | 0 | 6,585 |
| Nederland | 2,147 | 491 | 0 | 2,638 |
| Superior | 55,180 | 12,625 | 0 | 67,805 |
| Unincorporated/Other | 315,464 | 72,179 | 0 | 387,643 |

**Percentage of Column**

| Municipality | Mobile Gasoline | Mobile Diesel | Aviation Fuel | Transportation Total |
|---|---|---|---|---|
| Boulder | 29% | 29% | 51% | 29% |
| Longmont | 14% | 14% | 49% | 14% |
| Louisville | 11% | 11% | 0% | 11% |
| Lafayette | 8% | 8% | 0% | 8% |
| Lyons | 1% | 1% | 0% | 1% |
| Nederland | 0% | 0% | 0% | 0% |
| Superior | 6% | 6% | 0% | 6% |
| Unincorporated/Other | 32% | 32% | 0% | 31% |

## 4.5 AGRICULTURE

Agricultural activities contribute directly to emissions of greenhouse gases ($CH_4$ and $N_2O$) through a variety of processes. For purposes of carbon accounting, $CH_4$ and $N_2O$ emissions are converted into $CO_2e$ emissions by multiplying these emissions by there respective global warming potentials. GHG emissions related to land-use activities, such as conversion of grassland to cultivated lands, are not occurring in Boulder County and therefore are not included in the inventory. The production of $CH_4$ derives from enteric fermentation and manure management. $N_2O$ is related to agricultural soil management.

From 1990 through 2003 there was a 3% decrease in emissions in the Agriculture sector. In 2003, Agricultural emissions were 41,025 $tCO_2e$/yr or approximately 1% of the total Boulder County emissions. If agricultural practices follow the BAU trend, then agricultural emissions are estimated to remain constant through 2012.

**Figure 25: Agricultural GHG Emissions Profile, 1990-2012**

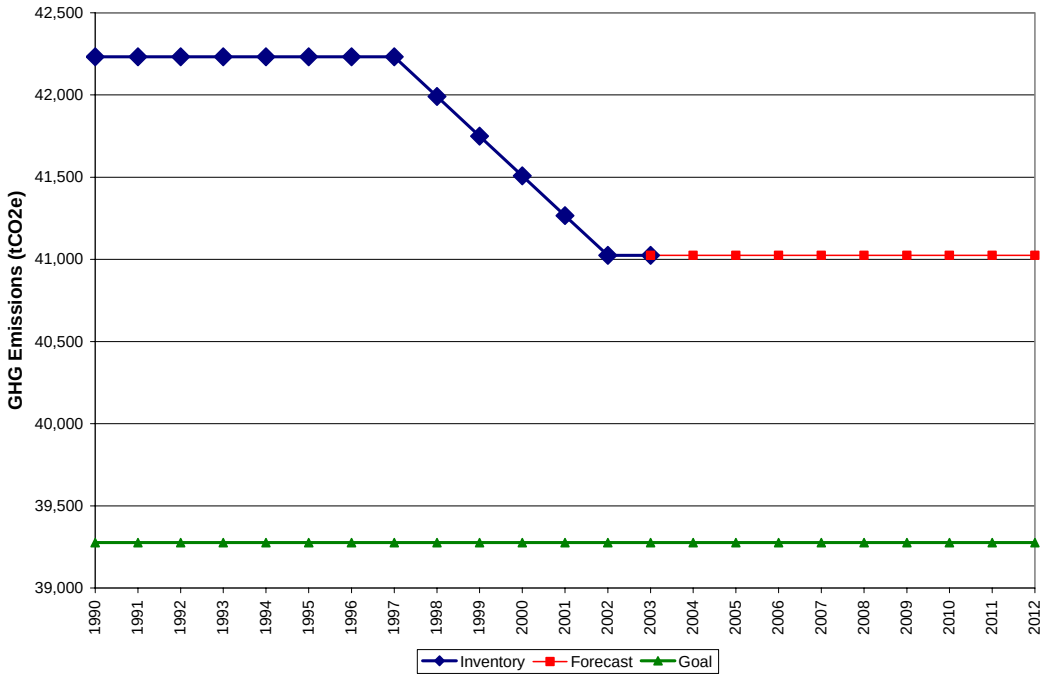



**Table 9: Agriculture GHG Emissions by Municipality, 2005 ($tCO_2e$)**

| Municipality | Enteric Fermentation | Manure Management | Soil Management | Agriculture Total |
|---|---|---|---|---|
| Boulder | 0 | 0 | 0 | 0 |
| Longmont | 0 | 0 | 0 | 0 |
| Louisville | 0 | 0 | 0 | 0 |
| Lafayette | 0 | 0 | 0 | 0 |
| Lyons | 0 | 0 | 0 | 0 |
| Nederland | 0 | 0 | 0 | 0 |
| Superior | 0 | 0 | 0 | 0 |
| Unincorporated/Other | 12,951 | 513 | 27,562 | 41,025 |
| **Percentage of Column** | | | | |
| **Municipality** | **Enteric Fermentation** | **Manure Management** | **Soil Management** | **Agriculture Total** |
| Boulder | 0% | 0% | 0% | 0% |
| Longmont | 0% | 0% | 0% | 0% |
| Louisville | 0% | 0% | 0% | 0% |
| Lafayette | 0% | 0% | 0% | 0% |
| Lyons | 0% | 0% | 0% | 0% |
| Nederland | 0% | 0% | 0% | 0% |
| Superior | 0% | 0% | 0% | 0% |
| Unincorporated/Other | 100% | 100% | 100% | 100% |

## 4.6 WASTE

Waste management activities are a source of GHG emissions. The production of methane ($CH_4$) occurs once the solid waste is placed in a landfill and the organic matter within the solid waste has been broken down through fermentation into gases and short-chain organic compounds that form the substrates for the growth of methanogenic bacteria, methane-producing bacteria that thrive in anaerobic conditions. Such bacteria convert these fermentation products into stabilized organic materials and biogas consisting of approximately 50 percent $CO_2$ and 50 percent $CH_4$, by volume. Significant $CH_4$ production typically begins one or two years after waste disposal in a landfill and may last from 10 to 60 years.[1]

Although, Boulder County does not have an active landfill within county borders, the waste generated within the county on an annual basis contributes to methane production and is therefore included in the Boulder County greenhouse gas emissions inventory. The waste-related methane emissions calculated based upon the total amount of municipal solid waste (MSW) generated annually within the county.

Figure 26 depicts the growth in MSW emissions from 1990 through 2012. Solid waste emissions are calculated based upon population and therefore coincides with population growth. For this forecast, the waste per capita is assumed to remain constant during the 1990 – 2012 period: about 0.78 tons/year of MSW per person, according to recorded data taken by the City of Boulder from 1999 - 2003. The GHG emissions are then calculated by converting the resulting $CH_4$ into equivalent metric tons of $CO_2$ emissions, based on the global warming potential of methane.

[1] US EPA. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2003

**Figure 26: Solid Waste GHG Emissions, 1990-2012**

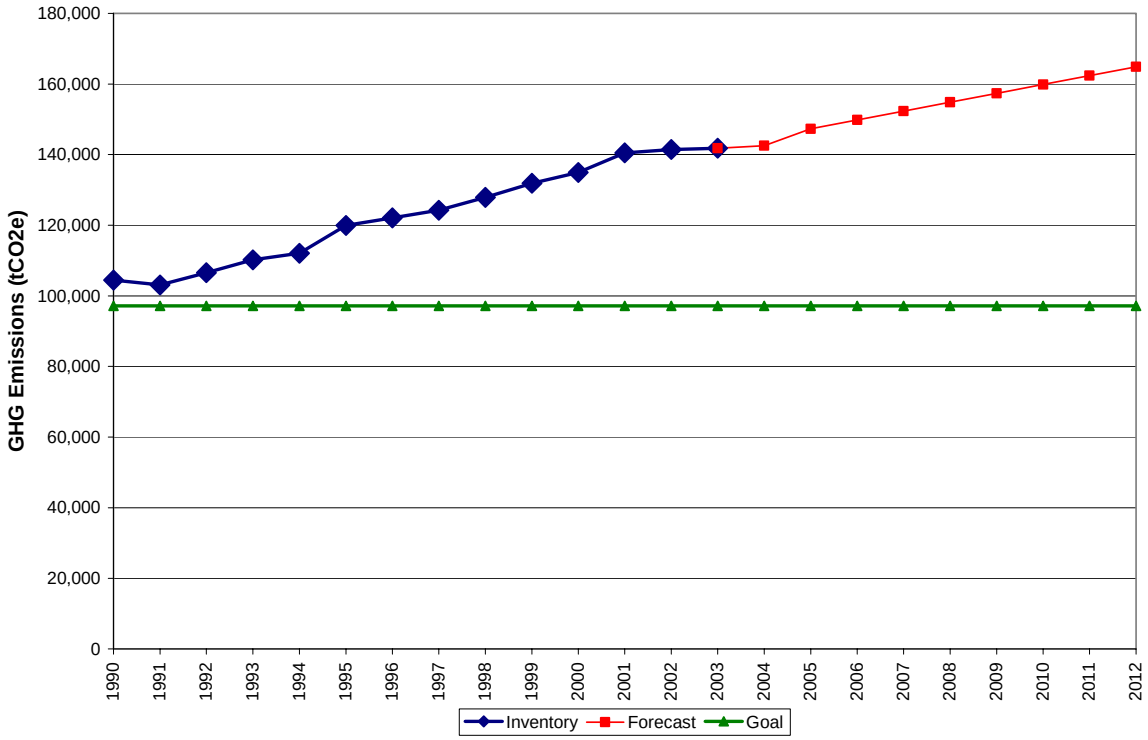



**Table 10: Solid Waste GHG Emissions by Municipality, 2003 ($tCO_2e$)**

| Municipality | Landfill Gas |
|---|---|
| Boulder | 48,886 |
| Longmont | 39,563 |
| Louisville | 9,222 |
| Lafayette | 11,754 |
| Lyons | 799 |
| Nederland | 688 |
| Superior | 5,105 |
| Unincorporated/Other | 25,804 |

**Percentage of Column**

| Municipality | Landfill Gas |
|---|---|
| Boulder | 34% |
| Longmont | 28% |
| Louisville | 7% |
| Lafayette | 8% |
| Lyons | 1% |
| Nederland | 0% |
| Superior | 4% |
| Unincorporated/Other | 18% |

## 4.7 INDUSTRIAL PROCESS

In the Industrial Process category, greenhouse gas emissions are produced as a by-product of various non-energy-related industrial activities. The sole industrial process that emits a significant quantity of emissions in Boulder County is the manufacture of cement. One step of cement production involves the conversion of calcium carbonate ($CaCO_3$) into lime (CaO), which releases $CO_2$ as a byproduct. There were no other industrial process emissions identified in the county that were large enough to quantify.

Only one year of data was available for cement manufacturing process emissions. As a result, it is assumed that these industrial process emissions stayed constant from 1990 through 2003, as depicted in Figure 27. Consequently, the projected BAU trend line assumes that there will not be any growth in industrial process emissions through 2012. In the future, as more data become available, these assumptions can be modified.

**Figure 27: Industrial Process GHG Emissions Profile, 1990-2012**

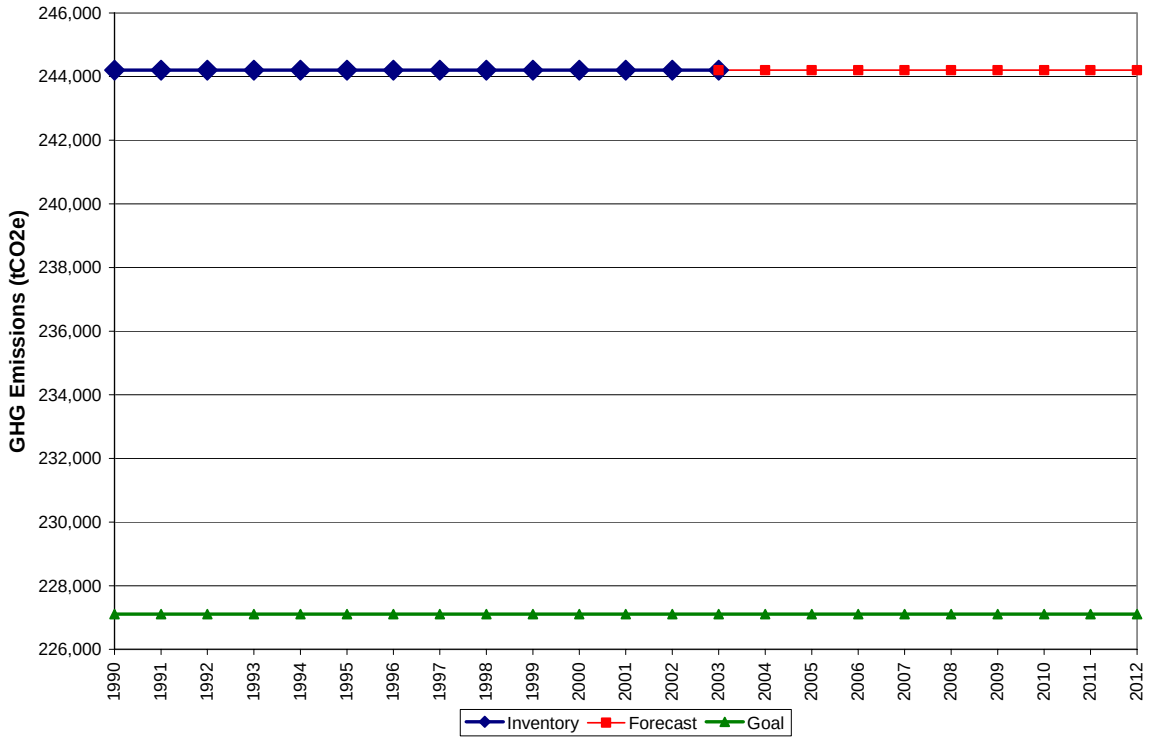



Table 11 depicts the breakdown of industrial process emissions sources and demonstrates that the main source of industrial process emissions is cement production.

**Table 11: Industrial Process GHG Emissions by Municipality, 2003 ($tCO_2e$)**

| Municipality | Industrial Process |
|---|---|
| Boulder | 0 |
| Longmont | 0 |
| Louisville | 0 |
| Lafayette | 0 |
| Lyons | 0 |
| Nederland | 0 |
| Superior | 0 |
| Unincorporated/Other | 244,204 |

**Percentage of Column**

| Municipality | Industrial Process |
|---|---|
| Boulder | 0% |
| Longmont | 0% |
| Louisville | 0% |
| Lafayette | 0% |
| Lyons | 0% |
| Nederland | 0% |
| Superior | 0% |
| Unincorporated/Other | 100% |

## 4.8 STREET LIGHTING

In 2003, street lighting was less than 1% of the total GHG emissions within the county. The BAU trend line indicates that by 2012 street lighting will be 86% above its 1990 levels. Longmont produces the majority of emissions from street lighting, 57%, and Boulder is the second-largest source in the county, producing 22% of total 2003 county-wide emissions associated with electricity consumption by street lighting.

**Figure 28: Street Lighting GHG Emissions, 1990-2012**

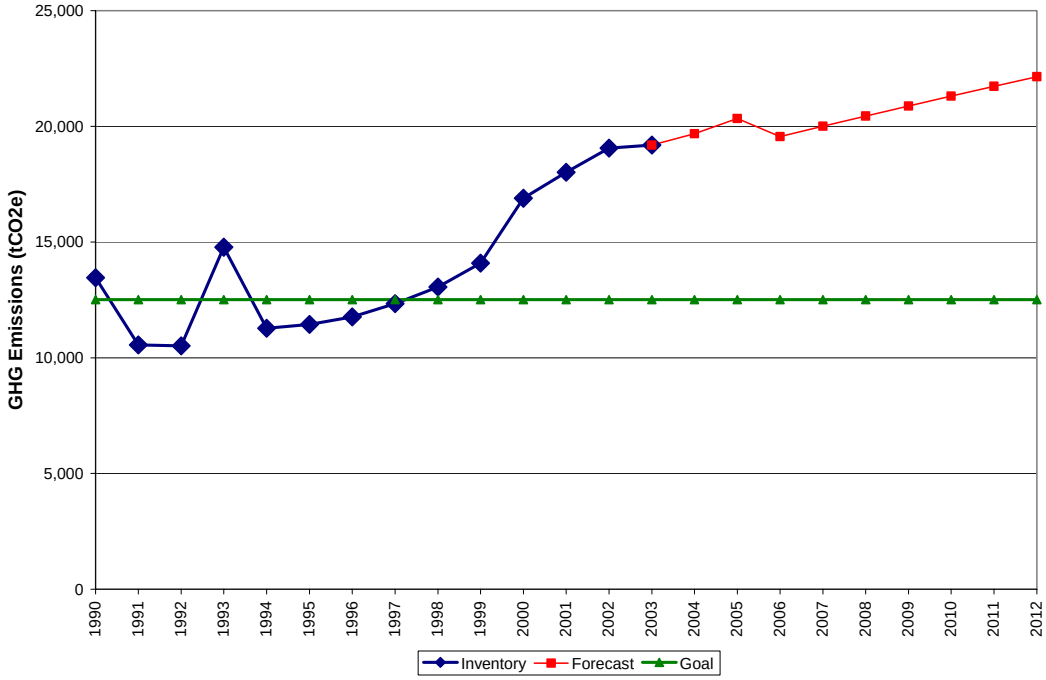



**Table 12: Street Lighting GHG Emissions by Municipality, 2003**

| Municipality | % Of County |
|---|---|
| Boulder | 22% |
| Longmont | 57% |
| Louisville | 5% |
| Lafayette | 4% |
| Lyons | 0% |
| Nederland | 0% |
| Superior | 0% |
| Unincorporated/Other | 11% |

## 4.9 OFFSETS

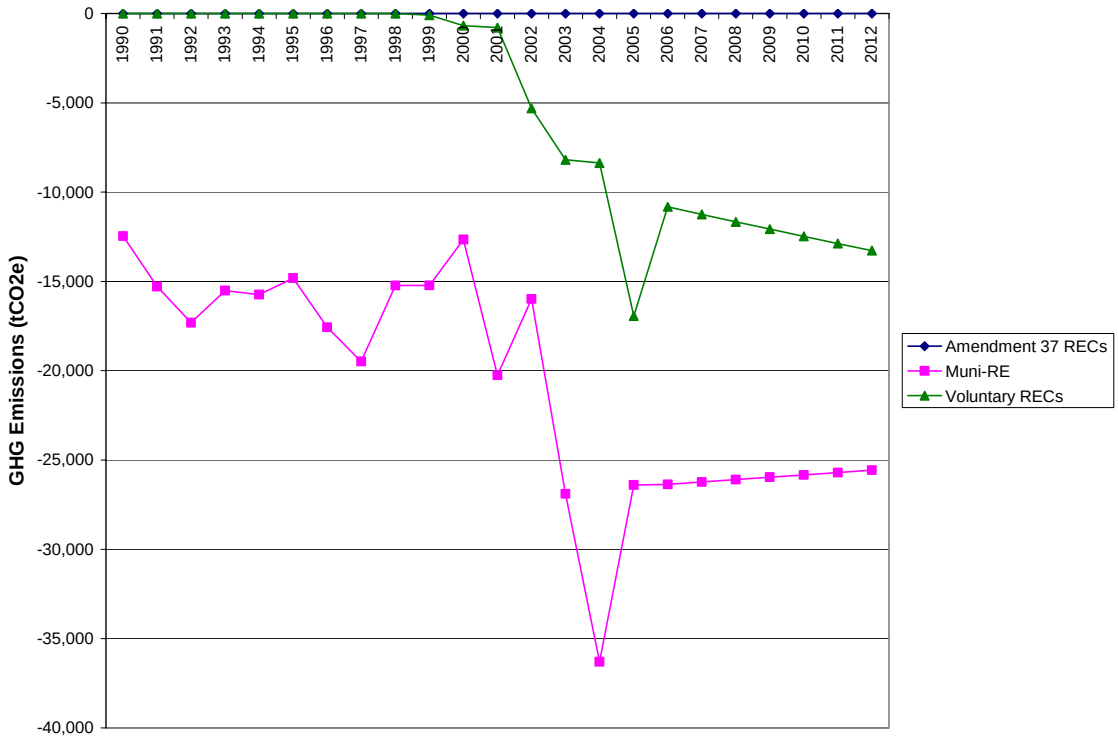
Presently there are three main options for creating offsets within Boulder County: voluntary RECs, regulatory RECs produced by Amendment 37 projects, and municipally owned renewable energy generation. Voluntary RECs are available for purchase by all sectors. Presently, there are four suppliers from which Boulder County customers can purchase voluntary RECs: Clean and Green, Renewable Choice Energy, Community Energy, and Xcel Energy. Xcel offers the WindSource program, whereby Xcel customers can purchase green power.

Amendment 37 Projects generate RECs produced by renewable electricity projects that have been mandated by law and are thus considered to be regulatory RECs. For purposes of the Boulder County GHG inventory, a regulatory REC is defined as a REC created by a project that is installed within the county political boundary and which contributes toward meeting the requirements of Amendment 37. An example of regulatory RECs are the RECs produced by a customer-owned photovoltaic system for which the customer receives a payment from Xcel. Presently, Xcel has not logged Amendment 37 projects and thus there are not yet any data by which to track these regulatory RECs. However, in future years Xcel data on Amendment 37 projects will enable the County to quantify the contribution of these projects toward GHG emissions offsets within Boulder County.

The final option for creating offsets is generation of renewable electricity by municipally owned power plants. Presently, the cities of Boulder, Longmont and Lyons own renewable power generation (hydro and wind).

As demonstrated by Table 13, Boulder produces the largest quantity of offsets in the county, mostly from their municipally owned hydroelectric power. Municipally owned power generation historically has been the largest producer of offsets. However, there has been significant growth in the voluntary REC market in recent years as demonstrated by Figure 29. Note that Figure 29 registers no regulatory RECs since these data are not yet available from Xcel.

## Figure 29: GHG Offsets Profile, 1990-2012




## Table 13: GHG Offsets by Municipality, 2005

| Municipality | Amendment 37 Projects | Municipal Renewable | Voluntary RECs | Offsets Total |
|---|---|---|---|---|
| Boulder | 0 | -23,322 | -27,255 | -50,577 |
| Longmont | 0 | -2,268 | -2,658 | -4,926 |
| Louisville | 0 | 0 | -15 | -15 |
| Lafayette | 0 | 0 | -3 | -3 |
| Lyons | 0 | -811 | -1 | -812 |
| Nederland | 0 | 0 | -14 | -14 |
| Superior | 0 | 0 | 0 | 0 |
| Unincorporated/Other | 0 | 0 | -2 | -2 |

**By Percentage of Column**

| Municipality | Amendment 37 Projects | Municipal Renewable | Voluntary RECs | Offsets Total |
|---|---|---|---|---|
| Boulder | 0% | 88% | 91% | 90% |
| Longmont | 0% | 9% | 9% | 9% |
| Louisville | 0% | 0% | 0% | 0% |
| Lafayette | 0% | 0% | 0% | 0% |
| Lyons | 0% | 3% | 0% | 1% |
| Nederland | 0% | 0% | 0% | 0% |
| Superior | 0% | 0% | 0% | 0% |
| Unincorporated/Other | 0% | 0% | 0% | 0% |

# 5. COUNTY OPERATIONS INVENTORY

In addition to the economy-wide GHG inventory presented in previous sections, an inventory was also developed exclusively for Boulder County government operations. Similar to the economy-wide inventory, the methodology for the County operations inventory is based upon the *GHG Protocol Corporate Accounting and Reporting Standard*, developed by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD).

The primary basis for the County operations inventory is the historical usage records of electricity, natural gas, wind energy purchases, and mobile use of gasoline and diesel fuel. Refrigerant emissions were also estimated based on the square footage of buildings operated by the County. Note that the County does not have emissions related to industrial processes, agriculture, stationary combustion of fuel oil, or aviation. Emissions associated with livestock raised on County Open Space land are captured in the county-wide inventory. The County does however have minor emissions resulting from waste disposed of in landfills. As of the writing of this report, landfill gas emissions have not been included in the County operations inventory due to a lack of sufficient data to make a credible estimate.

The necessary historical data was acquired from County staff. Annual data for electricity and natural gas usage was available for the period from 1995 – 2005. This data provided sufficient information to extrapolate estimated usage data back to 1990 and to forecast usage out to 2012. Unfortunately, at the writing of this report, gasoline and diesel fuel usage were only available for a single year, 2005. Without additional data points, the estimates of mobile fuel usage going backward and forward were assumed to be constant at the 2005 value.

Beginning in October 2005, the County started to purchase wind energy for approximately 40% of its annual electricity usage. The inventory credits the County for GHG emissions offsets achieved through the purchase of renewable electricity.

This inventory represents a new tool the County can now use to develop policies and programs that will further minimize GHG emissions within its operations.

## 5.1 COUNTY OPERATIONS INVENTORY SUMMARY

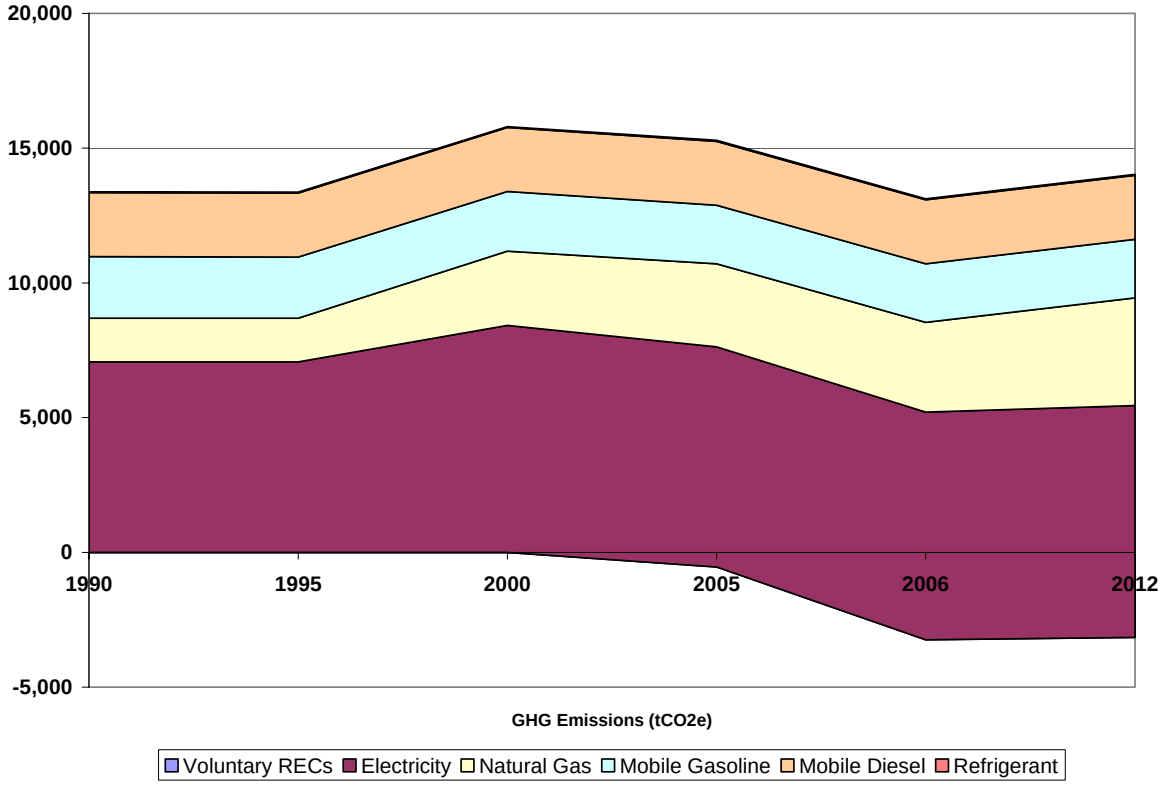
Table 14 presents the results of County operations GHG inventory. In 2005, the County operations inventory is 15,292 $tCO_2e$, or 14% above the 1990 inventory. Note however that the County had only purchased wind energy for two months during this year. The 2006 inventory shows that purchasing wind energy for roughly 40% of the County's electricity for a full year will decrease the County operations inventory to 13,117 $tCO_2e$, or 2% below the 1990 inventory.

Figure 30 illustrates the County's historical and forecast inventory trend for the period of 1990 through 2012. Note the impact of the wind energy purchases on the inventory as well as the expected steady growth in emissions associated with electricity and natural gas usage.

**Table 14: County Operations Inventory Summary, ($tCO_2e$)**

| Sector | 1990 | 1995 | 2000 | 2005 | 2006 | 2012 |
|---|---|---|---|---|---|---|
| Electricity | 7,068 | 7,068 | 8,426 | 8,174 | 8,451 | 8,597 |
| Natural Gas | 1,620 | 1,620 | 2,748 | 3,079 | 3,331 | 3,998 |
| Mobile Gasoline | 2,283 | 2,267 | 2,215 | 2,172 | 2,172 | 2,172 |
| Mobile Diesel | 2,376 | 2,376 | 2,376 | 2,376 | 2,376 | 2,376 |
| Refrigerant | 36 | 36 | 36 | 36 | 36 | 36 |
| Wind Energy Purchase | 0 | 0 | 0 | -544 | -3,248 | -3,150 |
| **Grand Total** | **13,383** | **13,367** | **15,800** | **15,292** | **13,117** | **14,029** |

**Figure 30: County Operations Trend**

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# Appendix

**Table 15: Boulder County Economy-Wide Historical and Forecast GHG Emissions ($tCO_2e$), 1990-2012**

| Year | Residential | Commercial | Industrial | Street Lighting | Transportation | Agriculture | Waste | Industrial Process | Offsets | Boulder County Total |
|---|---|---|---|---|---|---|---|---|---|---|
| 1990 | 877,863 | 899,503 | 548,918 | 12,200 | 670,278 | 42,233 | 104,483 | 244,204 | -12,459 | 3,387,223 |
| 1991 | 915,850 | 902,119 | 561,911 | 9,296 | 683,739 | 42,233 | 103,065 | 244,204 | -15,291 | 3,447,127 |
| 1992 | 901,898 | 974,153 | 644,540 | 9,378 | 697,200 | 42,233 | 106,567 | 244,204 | -17,307 | 3,602,866 |
| 1993 | 1,021,408 | 1,030,550 | 539,430 | 13,692 | 710,661 | 42,233 | 110,171 | 244,204 | -15,508 | 3,696,843 |
| 1994 | 977,357 | 1,079,453 | 621,204 | 10,257 | 722,002 | 42,233 | 112,070 | 244,204 | -15,738 | 3,793,042 |
| 1995 | 1,012,283 | 1,109,902 | 589,204 | 10,296 | 733,264 | 42,233 | 119,916 | 244,204 | -14,814 | 3,846,488 |
| 1996 | 1,063,378 | 1,194,558 | 640,175 | 10,509 | 744,328 | 42,233 | 122,087 | 244,204 | -17,571 | 4,043,901 |
| 1997 | 1,051,608 | 1,371,622 | 618,345 | 10,978 | 785,889 | 42,233 | 124,219 | 244,204 | -19,477 | 4,229,621 |
| 1998 | 1,060,053 | 1,360,527 | 593,510 | 11,649 | 823,293 | 41,991 | 127,875 | 244,204 | -15,236 | 4,247,868 |
| 1999 | 1,100,690 | 1,380,602 | 611,846 | 12,350 | 927,333 | 41,750 | 131,892 | 244,204 | -46,906 | 4,403,761 |
| 2000 | 1,208,808 | 1,514,794 | 639,346 | 15,118 | 1,031,795 | 41,508 | 134,919 | 244,204 | -46,390 | 4,784,101 |
| 2001 | 1,263,204 | 1,563,503 | 638,622 | 16,080 | 1,141,097 | 41,266 | 140,495 | 244,204 | -54,110 | 4,994,361 |
| 2002 | 1,313,869 | 1,527,485 | 644,909 | 16,803 | 1,157,077 | 41,025 | 141,471 | 244,204 | -53,045 | 5,033,797 |
| 2003 | 1,287,721 | 1,490,865 | 636,414 | 16,752 | 1,181,588 | 41,025 | 141,820 | 244,204 | -63,125 | 4,977,263 |
| 2004 | 1,286,037 | 1,458,461 | 665,432 | 24,134 | 1,206,689 | 41,025 | 142,510 | 244,204 | -67,102 | 5,001,390 |
| 2005 | 1,304,999 | 1,591,317 | 542,752 | 19,855 | 1,232,318 | 41,025 | 147,328 | 244,204 | -56,349 | 5,067,448 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| *2006* | *1,356,806* | *1,719,396* | *624,509* | *19,118* | *1,252,541* | *41,025* | *149,839* | *244,204* | *-57,737* | *5,349,700* |
| *2007* | *1,379,768* | *1,757,593* | *622,511* | *19,603* | *1,272,952* | *41,025* | *152,350* | *244,204* | *-57,922* | *5,432,082* |
| *2008* | *1,402,302* | *1,794,542* | *621,396* | *20,081* | *1,293,362* | *41,025* | *154,862* | *244,204* | *-58,102* | *5,513,671* |
| *2009* | *1,424,603* | *1,831,095* | *620,287* | *20,554* | *1,313,772* | *41,025* | *157,373* | *244,204* | *-58,277* | *5,594,635* |
| *2010* | *1,446,672* | *1,868,009* | *618,427* | *21,021* | *1,334,183* | *41,025* | *159,884* | *244,204* | *-58,448* | *5,674,975* |
| *2011* | *1,468,509* | *1,904,570* | *616,526* | *21,482* | *1,354,593* | *41,025* | *162,395* | *244,204* | *-58,614* | *5,754,691* |
| *2012* | *1,493,188* | *1,945,865* | *623,767* | *21,971* | *1,375,003* | *41,025* | *164,906* | *244,204* | *-58,775* | *5,851,154* |

*Note – italics indicates forecast*