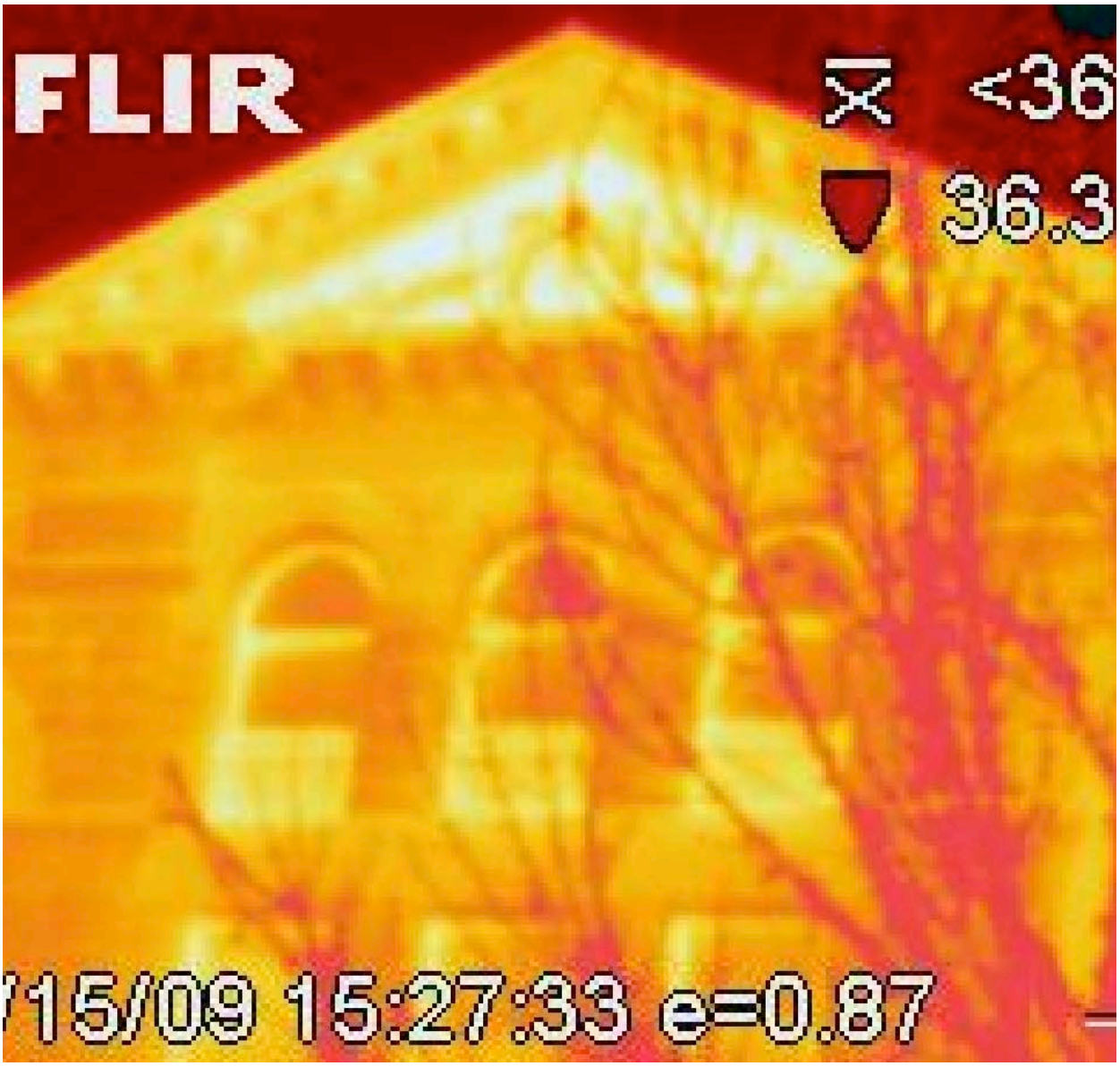
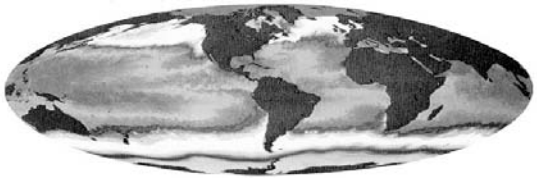
Aspen QuickTracker^{tm}:

Early detection of major drivers of greenhouse gas emissions for the City of Aspen's Canary Initiative



Climate Mitigation Services
Old Snowmass, Colorado

19 March 2009



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Dedicated to Phil Overeynder for dramatically increasing Aspen's non-carbon electricity sources

This work was done in July 2008 – April 2009 under contract with the City of Aspen.
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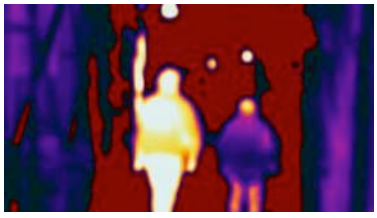
Note on units: common US units are used throughout. The spreadsheets present emissions results in both US and metric units. Emissions of methane and nitrous oxide are expressed in CO_2-equivalent terms (CO_2e). See Appendix A for conversions and emissions factors.



IR image of people in the street of Aspen

Cover image: Infrared image of Wheeler Opera House, 15Jan09, by Eileen Wysocki, Holy Cross Energy

Table of Contents

List of worksheets:

List of Tables:

The Aspen *QuickTracker* concept

It was realized that the City of Aspen's decision to re-assess its greenhouse gases emissions inventory every three years — for 2004, 2007, 2010, etc — created a knowledge gap of measuring the impact of reduction measures, policies, and other changing conditions that influenced the community's total emissions. A quicker way to acquire a sense of changing emissions intensities and trends was needed. CMS proposed to develop a scheme that would establish an "early warning system" and an emissions trend assessment by following the main emission drivers. These three drivers are building energy, commuting, and air travel (via Aspen Pitkin Airport only), and comprised 64 percent of 2007 total emissions. Of the remaining 36 *excluded* from the QuickTracker (QT) trends, most are strongly linked to the trends within QT, such as commercial air travel at other regional airports (5.5 percent of 2007), general aviation operations (17 percent), and non-commuting transportation fuel (11.3 percent). The linkage between QT and non-QT trends is not immutable; indeed, an effort to encourage visitors and second homeowners to fly on commercial air carriers rather than charter or fly owned aircraft will clearly lower overall carbon emissions accounted for in the Aspen inventory.

This report describes the QuickTracker concept, assesses QT sources in the context of Aspen's overall emissions, interpolates QT emissions between the known quantities from the 2004 and 2007 inventories, analyzes QT trends, and forecasts emissions for 2008 based on these trends. CMS also "backcasts" QT emissions from 1998 to 2003. A full description of the methodology employed is included to enable Canary Initiative staff to complete future updates and forecasts of Aspen's emissions trends.

The objective is to create a repeatable, easily updateable, and reasonably reliable estimate of emissions trends built upon pertinent indicators of emissions growth in Aspen. Any such scheme cannot duplicate the thoroughness of a full inventory, and uncertainties are inevitable. For example, residential and commercial floor area added to Aspen's total building stock ignores existing buildings demolished to pave way for new construction. Why? Because no one in the City knows the ratio of demolition and "scrape and build" to virgin construction, nor does the Tax Assessor database of properties track this information. The assumption that new construction will consume as much energy per square foot of heated floor area per year as Aspen existing building stock is known to be inaccurate.[1] Nonetheless, CMS and the City concur on the concept of tracking the three principal indicators of growing or shrinking energy consumption and emissions. The City's Canary Initiative staff will evaluate the veracity and usefulness of the QuickTracker trends against the full inventories done in future years.

An essential component of the QT system is to track *existing* data from established sources and to establish routine sharing of such data and/or create an easy protocol for accessing the data. Thus, for each of the three QT trends we propose to tap into existing resources as follows:

[1] While Aspen energy building code is quite progressive and demanding, the code chiefly covers the building envelope and water heating. Auxiliary energy uses such as heated driveways and spas, or buildings not meeting the energy code, stipulate Renewable Energy Mitigation Program (REMP) fees to fund offsetting efficiencies elsewhere in the community. The net result is that new buildings can be more consumptive than comparable older buildings. More research is needed to evaluate the energy intensity of newer vs older buildings.

Building emissions:	Residential and commercial heated floor area added within City limits.
Commuting:	Vehicle counts at Castle Creek Bridge.
Air travel (ASE):	Passenger arrivals and departures at Aspen Pitkin County Airport.

CMS has created a folio of worksheets as a template for data entry, entered the requisite data on floor area added, passenger arrivals at ASE, and traffic counts at the entrance to Aspen for 1998 through 2008, and integrated each of these sources to actual 2004 and 2007 inventory results. Based on the analysis of underlying trends, CMS forecasts 2008 emissions to *rise* by 1.9 percent — from 760,268 tons CO_2e in 2007 to 774,763 tons CO_2e in 2008.

The following chapters discuss the rationale and methodology for each of the three energy and emissions drivers.

This approach necessarily ignores several variables revealed only by a full inventory, such as the changing carbon intensity of electricity sources,[2] colder vs warmer winters (measured in Heating Degree Days (HDD)),[3] and the load factor of the U.S. airline fleet (which, more than the fuel efficiency of the fleet, determines the fuel and emissions per passenger-mile flown).[4]

Table 1. Summary of Aspen's GHG emissions 2004 and 2007, and forecast 2008

SOURCE	2004	2007	2008
Commuting on Hwy 82	**125,714**	**117,336**	**113,246**
Buildings (electricity, gas, & propane)	**273,324**	**262,475**	**258,002**
Air Travel via ASE	**136,946**	**105,681**	**123,501**
Subtotal of QT sources	**535,984**	**485,492**	**494,749**
Sources not in QuickTracker	**292,664**	**274,775**	**280,014**
Total	**828,648**	**760,268**	**774,763**

2004 GA adjusted from **157,856 to 145,616, and total from 840,888 to 828,648 tons CO_2e.**

[2] Aspen's two electric utilities differ in carbon intensity. The City of Aspen Electric Dept's emission factor declined by 53 percent from 1.26 lb CO_2/kWh delivered in 2004 to 0.60 lb CO_2/kWh delivered in 2007. Holy Cross' emission factor declined 4 percent from 1.79 lb CO_2/kWh delivered in 2004 to 1.72 lb CO_2/kWh delivered in 2007.

[3] HDD data for Aspen (from Jim Ashby, Western Regional Climate Center, Desert Research Institute, Reno, NV) www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?coasp1) show a 4.8 percent decrease in heating requirements in 2007 compared to 2004. CMS does not have data for heated floor area added within the geographic boundary of the inventory, but the Tax Assessor's database indicate that 9.3 percent of heated floor area was added to the estimated baseline of building stock between Jan04 and Dec07 (756,530 SF added to 8.15 million SF). Whether construction within the Pitkin County portion of our inventory boundary experienced a similar increase has not been determined.

[4] Fuel and emissions from commercial air travel via the Aspen Pitkin County Airport are driven chiefly by the number of enplaning and deplaning passengers, although the fuel and carbon intensity is recomputed in each inventory. The U.S. aviation fleet load factor increased significantly from 2004 to 2007 in addition to improved fleet fuel efficiency. As a result, emissions per passenger decreased from 0.574 lb CO_2/passenger-mile in 2004 to 0.509 lb CO_2/passenger-mile in 2007. The number of passengers enplaning in Aspen is roughly the same in 2004 and 2007, enplanements rose sharply in 2008 and will drive a commensurate increase in 2008 air travel emissions.

The Aspen *QuickTracker* methodology

Overview

CMS has identified three critical drivers of energy use and emissions in the Aspen inventory and has ascertained that the requisite data is readily available from official sources. These drivers — Commuting, Building Energy, and Air Travel — comprise 15.4 percent, 34.5 percent, and 13.9 percent of total 2007 emissions, respectively; see Table 1. The principal emissions sources *not* included in the QT are general aviation (17 percent), tourist driving to Aspen (5.2 percent), and driving around town (5.0 percent). QT tracks 63.9 percent of total 2007 emissions.

Caveats

The QT methodology uses proxy data as indicators of trends relevant to actual emissions changes. Whereas the full inventories are based on resource flows — such as electricity and gasoline consumption — the QT sources assume, for example, that traffic counts are a quick and reliable indicator of commuting energy and emissions, or that new construction is a good indicator of additional energy consumption in Aspen's buildings sector. More traffic and additional floor area tend to drive consumption of resources, and thus emissions. And the rationale for developing the QuickTracker system is that the proxy data are readily available, and the CMS worksheets and methodology makes it easy to approximate emissions trends between the tri-annual inventories.

However, the QT indicators also obscure underlying variables that may skew the results. QT assumes that additional floor area through new construction is a good indicator of energy and emissions growth. But energy intensity may be higher in new buildings (counter-intuitive, but likely given new Aspen homes' plethora of energy-intensive heated driveways, spas, multiple refrigerators, high ceilings, heated towel racks, and so forth) than in older homes. Also, while QT does account for decreasing carbon intensity of Aspen's electricity sources in inventory years, QT is not set up to calculate this rapidly changing factor.[5] Floor area added within City Limits may or may not correlate to new construction within the wider geographic boundary of Aspen's inventory (modified Urban Growth Boundary, or UGB), although it is a fair assumption that there is a good correlation.[6] Higher traffic counts may drive fuel consumption, but QT does not account for increasing (or decreasing) fuel economy of vehicles.

Such internal variables change relatively slowly, however, and CMS has confidence that the QT drivers and the resulting emissions estimates comprise a useful early warning system for changing emissions trends in Aspen. In any case, future users of the QuickTracker will revise the methodology once the next full inventory is completed for 2010.

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[5] To be specific, estimated emissions per square foot of heated floor area are accounted for in inventory years (2004 and 2007). Since the QuickTracker does not include the complicated calculation of both local utilities' carbon factor — or QT would be neither quick nor easy — CMS instead assumes continued reduction on overall energy intensity.

[6] The QT data source is the Tax Assessor's property database, and while it is easy to derive a list of new buildings within Aspen city limits, the search options do not include new buildings within the UGB (which extends into Pitkin County). That said, there has been high level of construction in both the city and the surrounding contiguous areas around Aspen. Total heated floor area within the City of Aspen is ~7.09 million square feet, whereas the UGB inventory area heated floor area totals ~12.6 million SF.

Data acquisition
CMS has identified three critical drivers of energy use and emissions in the Aspen inventory and has ascertained that the requisite data is readily available from official sources. The following chapter as well as the QT worksheets identify the data sources, the contacts (or websites), and the process of acquiring the data needed to update the QT forecast to 2009 and beyond.

Data sources
For energy and emissions in the building sector (electricity, natural gas, and propane):

- Tax Assessor's database is downloaded from www.pitkinassessor.org and analyzed for residential and commercial properties, heated floor area of each property, and by "Year Built." Future QuickTracker users will access the data using the instructions in the following chapter, and enter the data for 2009 or later in the attached worksheet, which will flow through to estimated emissions in the buildings sector in the "QT trend analysis" worksheet.

For energy and emissions in commuting and Highway 82 transportation:

- Traffic counts at the Castle Creek Bridge are collected by the Aspen Transportation Dept, and are sent to the Aspen City Council via Randy Ready in the spring of each year. The data for 1999 through 2008 has been entered on the "QT trend analysis" and backed up by fuel and emissions calculations in the "AADT commuting" worksheet.

For energy and emissions in air travel:

- Data posted at the Aspen Pitkin County Airport website summarizes passenger enplanements and deplanements (www.aspenairport.com/pdf/passenger_report.pdf). CMS has entered data for 1998 through 2008 in the "Air Travel Pax" worksheet, and estimated emissions in the "QT trend analysis" worksheet.

Specific instructions for accessing, analyzing, and entering these data on the QuickTracker worksheets are provided in the following chapter.

Data entry
QuickTracker data entry is designed to be easy using the attached template worksheets. Data on AADT traffic counts and passenger enplanements are entered directly into their respective worksheets. Data on new floor area added within city limits require some work with the Tax Assessor's property database, such as downloading the required dataset, sorting for properties completed in the last year, and summing such properties and their heated floor area in one of the attached worksheets. The results of each QT source are then linked to the "QT trend analysis" worksheet.

Data analysis
Inventory results for each QT source are entered for 2004 and 2007, and a "correlation" to the source data is calculated. This correlation has only computational value; for example, total commuting emissions are divided by daily traffic counts to yield tons CO_2 per AADT, which has no actual value, since emissions from commuting are calculated from *annual* traffic counts and the vehicle types counted at Castle Creek Bridge. Similarly, air travel emissions are calculated from a combination of enplanements and deplanements at Aspen Pitkin County Airport as well

as regional airports, not merely enplanements at Aspen. While internal variables are obscured by this approach (changing fuel economy of road vehicles, or air carrier load factors), these computations provide reasonable approximations for short-term forecasts and for interpolation between 2004 and 2007. Full future inventories may trigger modification of the computational values used for interpolations and forecasts.

Trend analysis

The 2004 and 2007 actual emissions for each QT source are the basis for interpolation of 2005 and 2006 emissions. Each QT emissions source is estimated using its own specific driver, and each source is forecasted to 2008, since data for each driver — traffic counts, added floor area, and passenger enplanements — has already been completed and posted. Estimated commuting emissions are down 3.5 percent from 2007, building emissions are down 1.7 percent, and air travel is up 16.9 percent.

See the "QT trends analysis" worksheet for details.

Summary and correlation analysis

The sum of the three QT sources is up 1.9 percent, from 485,492 tons CO_2e in 2007 to 494,749 tons CO_2e in 2008. Assuming that non-QT sources follow the growth trend of QT sources, emissions in 2008 are projected to total 774,763 tons CO_2e, an increase of 14,495 tons CO_2e.

See Table 1 for details.

QuickTracker manual for Canary Initiative staff

Introduction

This chapter provides a detailed description of how to enter the acquired QT data on the attached source worksheets and how to complete the summary ""QT trend analysis" worksheet. Users should also read the guidelines on each worksheet, and, if necessary, consult the formulas in the pertinent cell computations.

Commuting

The QuickTracker worksheet estimates annual Hwy 82 and commuting emissions based on annual AADT data supplied by John Krueger of the Aspen Transportation Dept.

Worksheet instructions:

1. For each future year, get AADT data for the Castle Creek Bridge traffic counter from Aspen Transportation Dept (John Krueger prepares a memo for City Council in the 1st quarter). Krueger: 970-920-5042, johnk@ci.aspen.co.us.

2. Enter average annual daily traffic (AADT) at "Valley traffic across Castle Creek Bridge" row on the "AADT Commuting" worksheet.

3. If deemed necessary, conduct a vehicle type survey at Castle Creek Bridge or elsewhere near the entrance to Aspen (such as the round-about), and revise the vehicle type distribution in column B. If no survey is done, use the distribution from 2007.

4. The worksheet calculates everything else and provides an estimate of total commuting fuel use and emissions.

5. Each year's total CO_2 is linked to the summary analysis worksheet for trend analysis.

Buildings

CMS has created a worksheet "Tax Assessor Parcels" for tabulation of new residential and commercial buildings and heated square feet of floor added each year, as described below. The worksheet also documents the total residential and commercial floor area within Aspen city limits on the Tax Assessor's property database — 7.04 and 2.05 million SF, respectively — as of year-end 2008. CMS has not been able to document new construction within the modified Urban Growth Boundary used in the Aspen community-wide emissions inventory. Nonetheless, CMS considers the construction activity within city limits to be reasonably indicative of overall construction in the Aspen area, and thus a good indicator of the chief driver of increased energy use and emissions in buildings.[7]

Worksheet instructions:

Step 1: Select "Assessor Subset query" at www.pitkinassessor.org/assessor/

[7] As noted above, an unknown proportion of total electricity, natural gas, and propane is consumed outside of buildings, e.g., in street lighting, water pumping, ski lifts, snow-making compressors, and the like. CMS does not have data to disaggregate building vs non-building energy use.

Step 2: Change only "Tax Area" to 001: 1-AFS at www.pitkinassessor.org/assessor/subset.asp?

Step 3: For QuickTracker update data only, enter range for "First Res Year Built" from 2007 to future year, and "First Comm Year Built" from 2007 to future year;

Step 4: Select "Preview search";

Step 5: At the bottom of the next page, select "Parcel Detail Data" & check "Output Field Names in First Row" (for column headers);

Step 6: Then select "Generate Text File", then "Download Text File," and wait for download (cvs file) (www.pitkinassessor.org/assessor/SubsetMultipleResults.asp);

Step 7: Sort the resulting worksheet by "FirstResYearBuilt" (column AA) and sum "FirstResSFLA" (residential square feet of heated living area) in column AI for the year or years in question. Repeat the sort for "FirstCommYearBuilt" and "FirstCommTotalArea" (columns AL and AM). The number of new properties added in 2009 or any later year will be easy to sum;

Step 8: Compute new Resl & Coml SF added;

Step 9: If desired, compute SF for property type categories in Table 2; if not needed, simply enter total residential and commercial SF built in year.

Air travel

The QuickTracker worksheet estimates air travel emissions on the basis or regularly-published data on passengers enplaning on air carrier's flights departing Aspen. While the full inventory accounts for both enplaning and deplaning (arriving) passengers at the Aspen Pitkin County Airport (ASE) as well as regional airports (in Eagle, Grand Junction, and Denver), CMS considers the readily available data on enplaning passengers a strong indicator of overall air travel fuel use and emissions. Note that 70 percent of fuel and emissions for air travelers using ASE is allocated to the Aspen inventory, and 30 percent to other communities in the Roaring Fork Valley (chiefly Snowmass Village).

Worksheet instructions:

Step 1: Methodology: download passenger enplanement and deplanement data from the Aspen Pitkin County Airport website (www.aspenairport.com/pdf/passenger_report.pdf);

Step 2: Enter passenger enplanement data in Table 1;

Step 3: Table 1 is linked to Tables 2 and 3, and automatically calculates estimated emissions in Table 3.

Step 4: These results are in turn linked to "QT trend analysis" summary worksheet.

Step 5: Analysts may assume that 2009 and later "tons CO_2 per enplaned passenger" in row 59 is equal to 2008, or else re-calculate; e.g., lower if air carrier load factors continue to increase.

QT trend analysis

Revise 2008 forecast with the completion of the 2010 inventory.

Wrapping it all up
Update charts.

Table 1. Summary of Aspen's greenhouse gas emissions 2004 and 2007

SOURCE	2004	2007
Electricity, Natural Gas, & Propane	273,324	262,475
Ground Transportation	211,175	203,471
Air Travel & General Aviation	332,247	276,907
Landfill	11,577	17,072
Nitrous oxide:	325	343
Total	828,648	760,268

2004 GA adjusted from **157,856 to 145,616, and total from 840,888 to 828,648 tons CO_2e.**

Table 1. Summary of Aspen's greenhouse gas emissions 2004 and 2007

SOURCE	2004	2007
Electricity (buildings)	166,557	156,392
Natural Gas & Propane (buildings)	106,754	106,070
Commuting on Hwy 82	125,714	117,242
Other Ground Transportation	85,461	86,229
Air Travel: Commercial	186,631	147,370
Air Travel: General Aviation	145,616	129,537
Landfill	11,577	17,072
Nitrous oxide:	325	343
Total	828,648	760,268

2004 GA adjusted from **157,856 to 145,616, and total from 840,888 to 828,648 tons CO_2e.**

Table 1. Summary of Aspen's greenhouse gas emissions 2004 and 2007

SOURCE	2004	2007	% 2007
Electricity, Natural Gas, & Propane	273,324	262,475	34.5%
Commuting on Hwy 82	125,714	117,242	15.4%
Air Travel via ASE	136,946	105,681	13.9%
Sources not in QuickTracker	292,664	274,870	36.2%
Total	828,648	760,268	

2004 GA adjusted from **157,856 to 145,616, and total from 840,888 to 828,648 tons CO_2e.**