Aspen QuickTracker

Early detection of major drivers of greenhouse gas emissions

A manual for the City of Aspen's Canary Initiative

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27 April 2009

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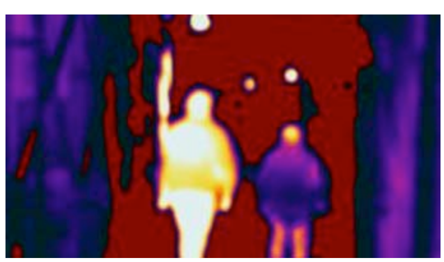
Note on units: common US units are used throughout. The spreadsheets present emissions results in US units. Emissions of methane and nitrous oxide are expressed in CO_2-equivalent terms (CO_2e).



Infrared image of people in the street of Aspen

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

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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 evolving emissions intensities and trends was needed. CMS proposed to develop a scheme that would establish an "early warning system" of emission trends by evaluating three main emission drivers. These three drivers are commuting & driving on Hwy 82, building energy, and air travel (via Aspen Pitkin Airport only), which comprise 64 percent of 2007 total emissions.

Most of the 36 percent excluded from the QuickTracker (QT) trends 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 of 2007), and non-commuting transportation fuel (such as driving around town, tourist driving, RFTA, etc: 11.3 percent of 2007). The linkage between QT and non-QT trends is not immutable; indeed, an effort to encourage residents, 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, discusses QT sources in the context of Aspen's overall emissions, interpolates QT emissions between the known quantities from the completed 2004 and 2007 inventories. CMS also 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 the City does not track information on net demolition and "scrape and build" to virgin construction, nor does the Tax Assessor database of properties contain this information (although an address-by-address comparison would reveal net new square feet). The assumption that new construction will consume as much energy per square foot of heated floor area per year as Aspen's existing building stock is only approximately accurate.[1] Nonetheless, CMS and the Canary staff 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.

[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 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.

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:

Commuting & Hwy82:	Vehicle counts at Castle Creek Bridge.
Building emissions:	Residential and commercial heated floor area added within City limits.
Air travel (ASE):	Passenger enplanements at Aspen Pitkin County Airport (ASE).

CMS has created a folio of worksheets as a template for data entry, entered the requisite data on floor area added, passenger departures 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. Table 1 summarizes the 2004 and 2007 inventory results, in which period emissions declined 8.25 percent. 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, or 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 General Aviation emissions were adjusted from 157,856 to 145,616 in Jan09 (after review of air carrier operations counted as air taxi operations in FAA data), 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_2e/kWh delivered in 2004 to 0.60 lb CO_2e/kWh-del in 2007. Holy Cross' emission factor declined 4 percent from 1.79 lb CO_2e/kWh-del in 2004 to 1.72 lb CO_2e/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 full 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 within city limits 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.

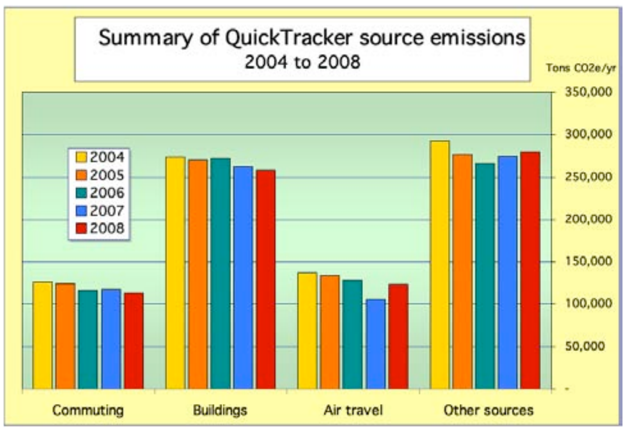
[4] Fuel and emissions from commercial air travel via the Aspen Pitkin County Airport are driven chiefly by the number of enplaning and deplaning passengers, although the fuel and carbon intensity is recomputed in each inventory. The U.S. aviation fleet load factor increased significantly from 2004 to 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, & forecast for 2008

Overview

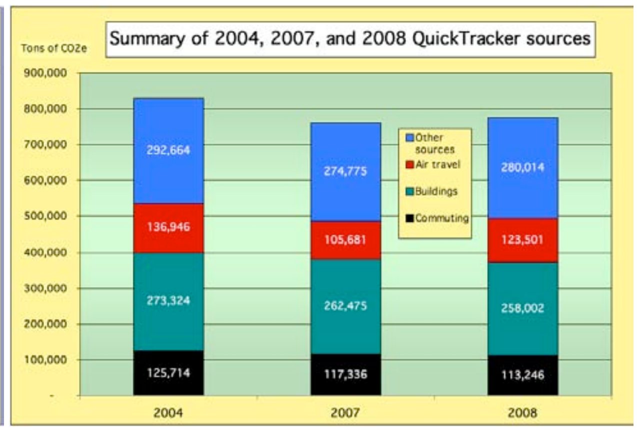
CMS has identified three critical drivers of energy use and emissions in the Aspen inventory and has ascertained that the requisite data is readily available from official sources. These drivers — Commuting, Building Energy, and Air Travel — comprise 15.4 percent, 34.5 percent, and 13.9 percent of total 2007 emissions, respectively. 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.

Fig. 1. QuickTracker emissions, 2004-2008



Actual emissions for 2004 and 2007, interpolation for 2005 & 2006, and QT projection for 2008.

Fig. 2. QuickTracker emissions, 2004, 2007, 2008



Actual 2004 and 2007 and projected 2008 emissions for QT and non-QT sources.

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 methodology assumes, for example, that traffic counts are a quick and reasonable indicator of commuting energy and emissions, and 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 and thus emissions. The rationale for developing the QuickTracker system is that the proxy data are readily available. 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. Energy intensity may be higher in new buildings (counter-intuitive, but likely, given new Aspen homes' plethora of energy-intensive heated driveways, spas, refrigerators, high ceilings, heated towel racks, and so forth) than in older homes. Also, while QT accounts for decreasing carbon intensity of Aspen's electricity sources in inventory years, QT does not reassess this rapidly changing factor; instead, a 2.1 percent emissions reduction factor is built into the QT model.[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, mUGB), although it's a fair assumption that there is a good correlation.[6] Lower traffic counts drive fuel consumption, but QT does not account for increasing (or decreasing) fuel economy of vehicles. The QT model also incorporates an emissions reduction rate of 4.1 percent for air travel, based on the trend from 2004 to 2007.

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.

Data acquisition

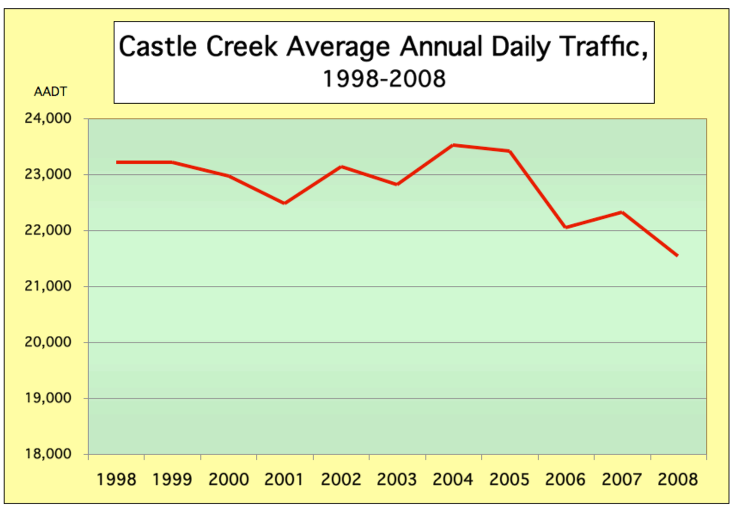
CMS has identified three critical drivers of energy use and emissions in the Aspen inventory and has ascertained that the requisite data is readily available from official sources. The following chapter as well as the QT worksheets identify the data sources, the contacts (or websites), and the process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

Data sources

For energy and emissions in 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 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.

Fig. 3: Castle Creek average annual daily traffic counts, 1998-2008



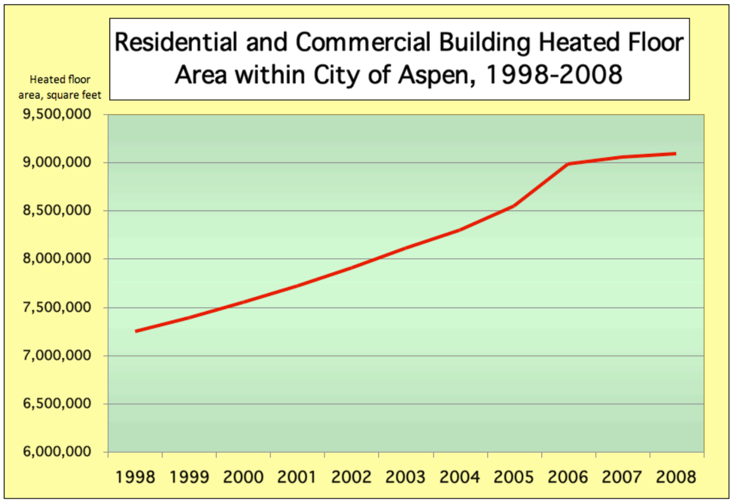
[5] To be specific, estimated emissions per square foot of heated floor area are accounted for in inventory years (2004 and 2007). Since the QuickTracker does not include the complicated calculation of both local utilities' carbon factor — or QT would be neither quick nor easy — CMS instead assumes continued reduction in 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 modUGB (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 9.0 million square feet, whereas the mUGB inventory heated floor area totaled 12.9 million SF, both as of year-end 2006 (Heede, 2007, *Anybody Home? Energy Consumption and Carbon Emissions from Second Homes in Aspen*, Sopris Foundation, 21 pp.).

FOR ENERGY AND EMISSIONS IN THE BUILDING SECTOR (ELECTRICITY, NATURAL GAS, & 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.

Fig. 4: Res'l & Com'l building floor area within Aspen City Limits, 1998-2008



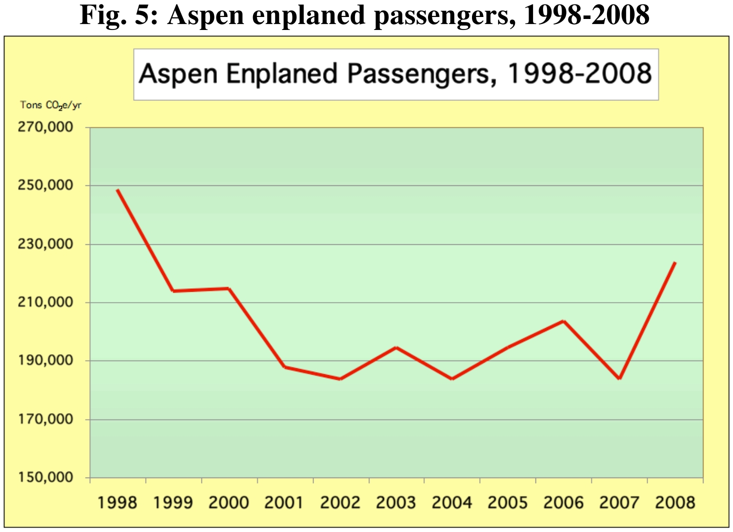
Total heated floor area of residential and commercial buildings within Aspen city limits, 2004-2008, and estimated for 1998-2003. Tax Assessors database, and CMS calculations.

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.

Fig. 5: Aspen enplaned passengers, 1998-2008

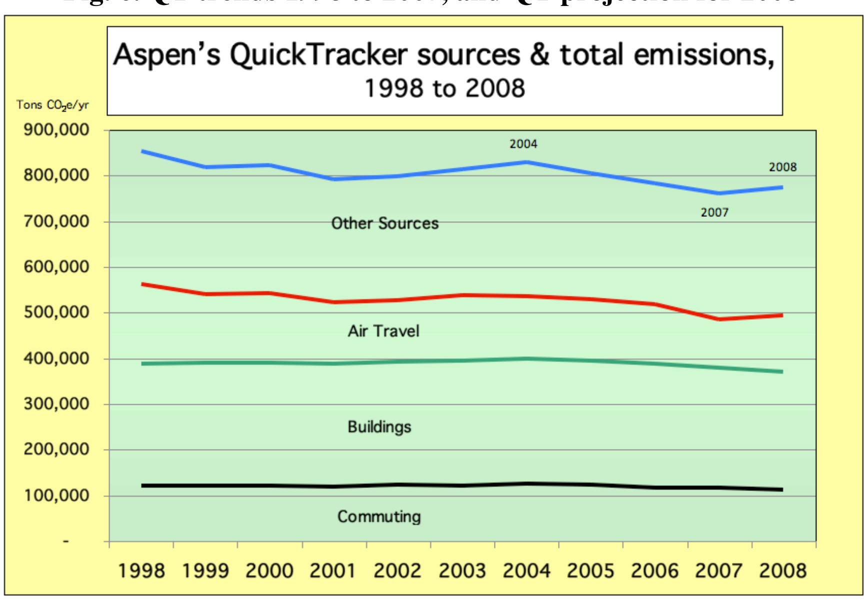


Data entry
QuickTracker data entry is designed to be easy using the template worksheets. Data on AADT traffic counts and passenger enplanements are entered directly into their respective worksheets. Data on new floor area added within city limits require some work with the Tax Assessor's property database, 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 linked to the "QT trend analysis" worksheet.

Data analysis
Inventory results for each QT source are entered for 2004 and 2007, and a "correlation" between emissions and 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 and 2008 forecast
The 2004 and 2007 actual emissions for each QT source are the basis for interpolating 2005 and 2006 emissions. Each QT emissions source is estimated using its own driver, and each source is forecast to 2008, since data for each driver — traffic counts, added floor area, and passenger enplanements — are already available. Estimated commuting emissions are down 3.5 percent from 2007, building emissions are down 1.7 percent, and air travel emissions are up 16.9 percent.

Fig. 6. QT trends 1998 to 2007, and QT projection for 2008



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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 trends of QT sources, emissions in 2008 are projected to total 774,763 tons CO_2e, an increase of 14,495 tons CO_2e. The average annual rate of emissions decrease was 2.83 percent from 2004 to 2007.

See Table 1 and the "QT trends analysis" worksheet for details.

Scenario to 2020

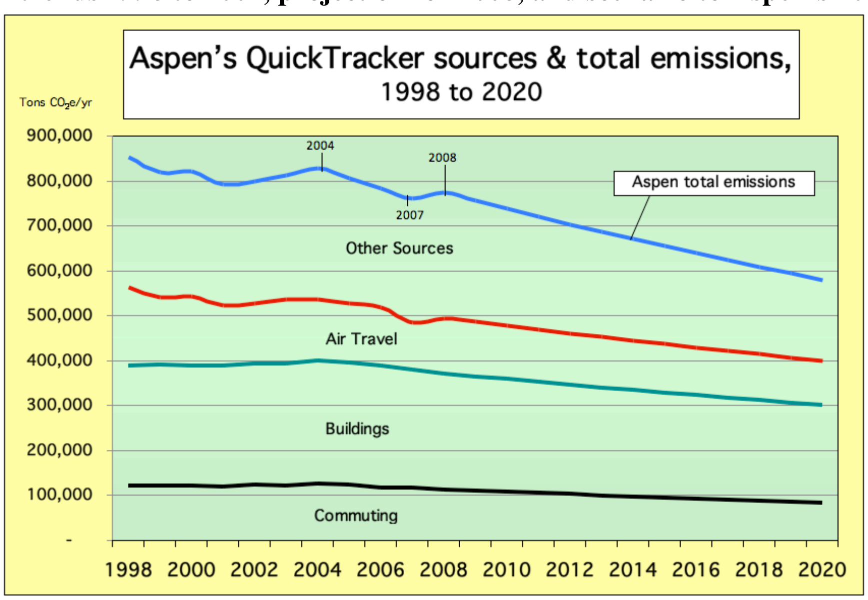
CMS developed a scenario for Aspen's total emissions out to 2020 based on trends from 1998 to 2007 and the forecasted emission for 2008.

City Council embraced the objective to reduce community-wide emissions by 30 percent from the 2004 baseline by 2020, i.e., from 828,648 tons CO_2e in 2004 to 580,054 tons CO_2e in 2020. CMS used the actual inventoried totals for 2004 and 2007, plus the emissions forecast for 2008, and applied the reduction rates from 2004 to 2008 for each QT source — minus 2.54 percent per annum in commuting emissions, minus 1.42 percent per annum in buildings,[7] and minus 1.78 percent per annum in air travel — to each QT source from 2009 to 2020.

Figure 7 shows the actual emissions in 2004 and 2007, backcasted emissions from 1998 to 2003, and the emissions forecast for 2008. *Also shown is the estimated emissions path to 2020 if the goal of reducing emissions by 30 percent below 2004 by 2020 is to be met*. Note: The scenario path is a smoothed approximation descending toward the 2020 objective. The QT sources shown are *not* forecasts of Aspen's emissions out to 2020, since internal variables will change too dramatically for forecasting purposes. The segment curves are merely illustrative.

The emission rate decrease for the 2020 scenario is 2.38 percent per year (2009 to 2020), or 0.45 percent per annum *less* than the reduction rate Aspen achieved from 2004 to 2007.

Fig. 7. QT trends 1998 to 2007, projection for 2008, and scenario to Aspen's 2020 target



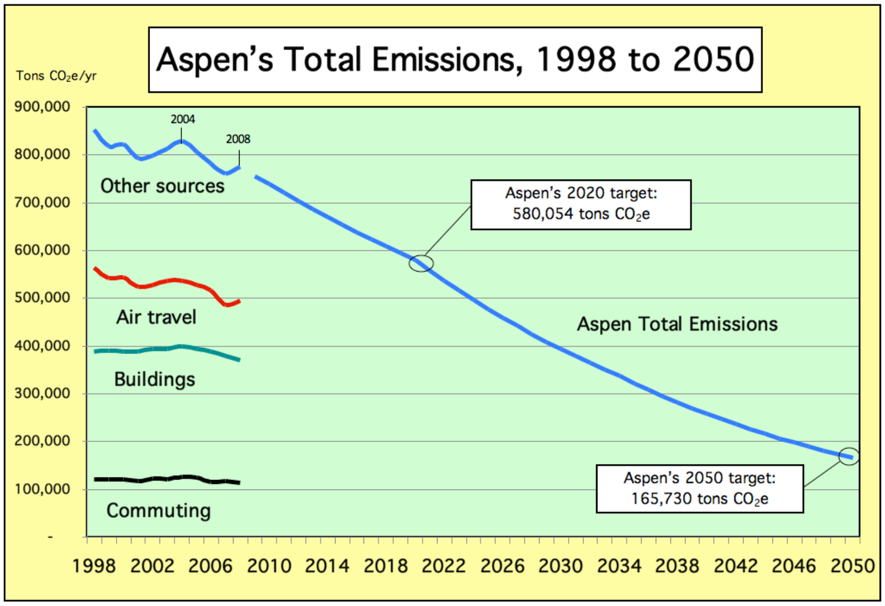
[7] While Aspen electric reduced its carbon factor by 53 percent from 2004 to 2007, electricity consumption rose (2.9 percent at Aspen Electric and 12.9 percent at Holy Cross). In addition, natural gas usage increased by 3.7 percent. Commuting emissions reductions were driven by slightly lower traffic counts and increased fuel economy per vehicle (based on vehicle type surveys in 2005 and 2008).

Scenario to 2050

CMS also developed a scenario of Aspen's total emissions out to 2050 based on trends from 1998 to 2007 and the forecasted emission for 2008. In Figure 8 we show Aspen's total emissions in 2004 and 2007, backcast for 1998-2003, the QT forecast for 2008, and a smoothed emissions reduction path that meets both the 2020 and 2050 emissions targets: 30 percent reduction below the 2004 baseline by 2020 and 80 percent reduction by 2050.

The same caveats and methodology for the 2020 scenario applies to this 2050 scenario.

Fig. 8. QT trends 1998 to 2007, projection for 2008, and scenario to Aspen's 2050 target



Cautionary notes

While it appears that Aspen is on a path to meet or even exceed its commitment at current rates of emissions reductions, a few cautionary notes are necessary. As measured, Aspen's emissions have decreased by an average annual rate of 2.83 percent, which compares favorable to the 2.38 percent per annum rate required to meet Aspen's target in 2020.

Yet some of the emissions decrease in 2007 is the result of technical improvements to the inventory methodology (e.g., disaggregating air travel into regional, domestic, and international flight distances, correcting the altitude adjustment for natural gas consumption, better data on landfill methane and propane consumption) and are "non-recurring" adjustments rather than substantive emissions reductions (such increased biodiesel use by RFTA, improved electricity carbon factors, higher load factors in commercial air travel, and less commuter traffic across Castle Creek Bridge).

What this means is that Aspen must not become sanguine and proclaim early success. On the contrary, the community must re-double its efforts to keep future gains in the pipeline.

Furthermore, Aspen faces population growth and continued pressure to build and renovate homes and commercial buildings, often with higher energy uses despite progressive energy building codes. Traffic and air travel are on a downward trend (despite the 2008 spike in air travel), but the economy will emerge from the doldrums and put more pressure on air travel, general aviation, commercial transportation, and driving by residents and visitors alike.

Finally, there are conflicting goals within the Aspen community that must be addressed and aligned. Tourism goals and hotel expansions increase pressure on driving, air travel, and energy use. Construction businesses and related service industries seek more work. Highway expansion proponents want to ease congestion with additional lanes into town. This is a resort town, and we market our amenities to draw business, culture, and people to our special enclave.

Aspen's commitment to reduce emissions of greenhouse gases is not in contradiction to new buildings, more visitors, and more access to our beautiful town. On the contrary, our success as a durable destination and a thriving community depends on deepening both our economic and environmental stewardship. These are not conflicting goals. Ignoring the pressures on future emissions is what undermines continued success.

Aspen possesses the leadership, skills, and resources to address the challenges of continuing to meaningfully reduce its emissions.

As Pogo said, "we are confronted by insurmountable opportunities."

Are we prepared to prove that, indeed, "yes, we can"?

Addendum: List of worksheets