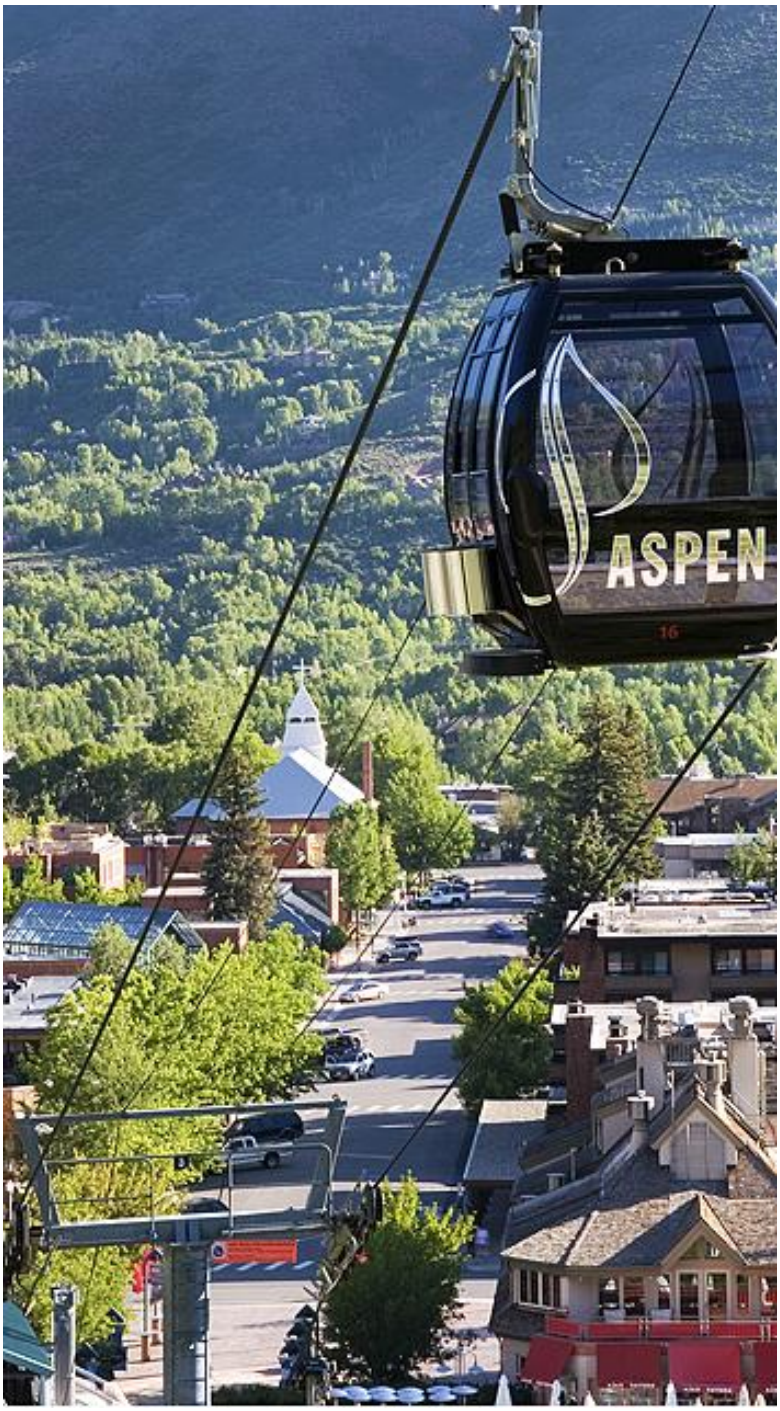

THE CITY OF ASPEN

2014 ASPEN COMMUNITY-WIDE GREENHOUSE GAS (GHG) INVENTORY

Since 2004, Aspen has tracked community-wide greenhouse gas (GHG) emissions to measure progress towards meeting climate mitigation goals. In 2014, the Aspen community had reduced emissions 7.4% below 2004 levels despite growth in both population and economic activity. Emissions from six sectors (residential energy, commercial energy, vehicles, airport, landfill and wastewater) are quantified and presented.

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CITY OF ASPEN
CANARY INITIATIVE

City of Aspen Canary Initiative

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Executive Summary

Background: Since 2004, the City of Aspen has tracked community-wide greenhouse gas (GHG) emissions as part of a commitment to mitigating Aspen's contributions to climate change. The production of a base-year GHG inventory in 2004 facilitated establishing long-term reduction targets of 30% below 2004 levels by the year 2020 and 80% below those levels by 2050. Subsequent community-wide GHG inventories, published for calendar years 2007, 2011 and now 2014 provide the opportunity to track progress in working towards the 2020 and 2050 reduction targets.

Approach and Scope: Aspen's 2014 *Community-wide Greenhouse Gas Inventory* was conducted in accordance with the US Community Protocol for Accounting and Reporting of GHG Emissions (USCP), and presents results in metric tons (MT) of Carbon Dioxide Equivalents (CO_2e). Ensuring consistent inter-annual comparisons is a top priority and required recalculating historic emissions for 2004, 2007 and 2011 by applying updated practices, categorizations and carbon intensities to the original data from those years, as is the best practice associated with GHG accounting. Community-wide emissions are totaled but also reported by sector to provide deeper insight into where the most progress has been made and to indicate where ongoing mitigation efforts might focus.

The *2014 Inventory* represents a sector–based approach to GHG accounting, quantifying and allocating GHG emissions to six sectors, and consistently referring to them as:

1. "**Residential energy**" (CO_2e from the use of electricity, natural gas and propane in residential buildings)

2. "**Commercial energy**" (CO_2e from the use of electricity, natural gas and propane in commercial buildings)

3. "**Vehicles**" (CO_2e from all on-road vehicle transportation within Aspen and a portion of trips originating from or destined to Aspen)

4. "**Airport**" (CO_2e from aircraft fuel dispensed at the Aspen Pitkin County Airport and from gasoline and diesel dispensed for ground support equipment)

5. "**Landfill**" (CO_2e from solid waste and Aspen's portion of on-site energy use): and

6. "**Wastewater**" (CO_2e from the treatment of Aspen's wastewater).

Photo 1. Aspen's skyline consists of residential and commercial buildings; the largest local sources of GHG emissions. Photo: C Menges

Results: Since 2004, the Aspen community has reduced total CO_2e emissions by 7.4% (Figure 1). After initially climbing between 2004 and 2007, net community-wide CO_2e dropped 7% below base-year levels in 2011. Between 2011 and 2014, emissions only declined by an additional 0.44%. Moving forward, meeting Aspen's long-term targets will require substantial additional emissions reductions from 2014 levels on the order of 23% by 2020 and 73% by 2050.

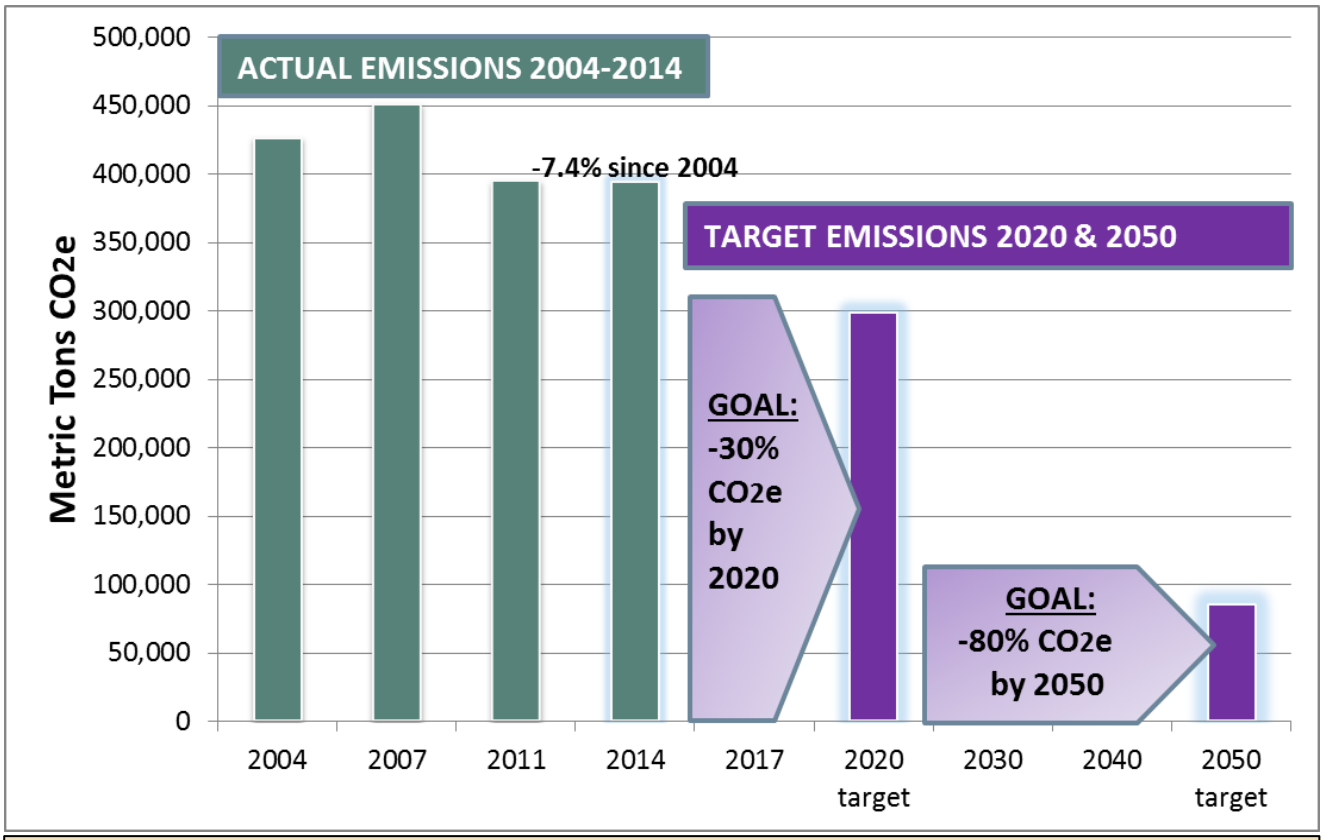

Figure 1. Aspen's CO_2e emissions 2004-2014 (teal bars) and future targets (purple bars)

2014 Aspen Community-wide Greenhouse Gas Inventory

In 2014, the Aspen community generated 394,341 metric tons of CO_2e: about the same amount as the energy used in 36,000 average American homes for one year or the emissions associated with driving an average passenger vehicle 934 million miles (EPA, 2014).

Residential energy use accounted for 31% of Aspen's 2014 emissions (Figure 2), making this sector the community's largest single source of GHGs. Between 2004 and 2014, residential energy emissions increased by 5%.

In terms of scale, residential energy was followed somewhat closely by commercial energy, which comprised 25% of Aspen's 2014 emissions. Since the base year, commercial energy emissions have decreased by 26%. Taken together, more than half of Aspen's 2014 GHGs (56%) came from the use of electricity, natural gas and propane in residential and commercial buildings, and collectively fell 11% between 2004 and 2014.

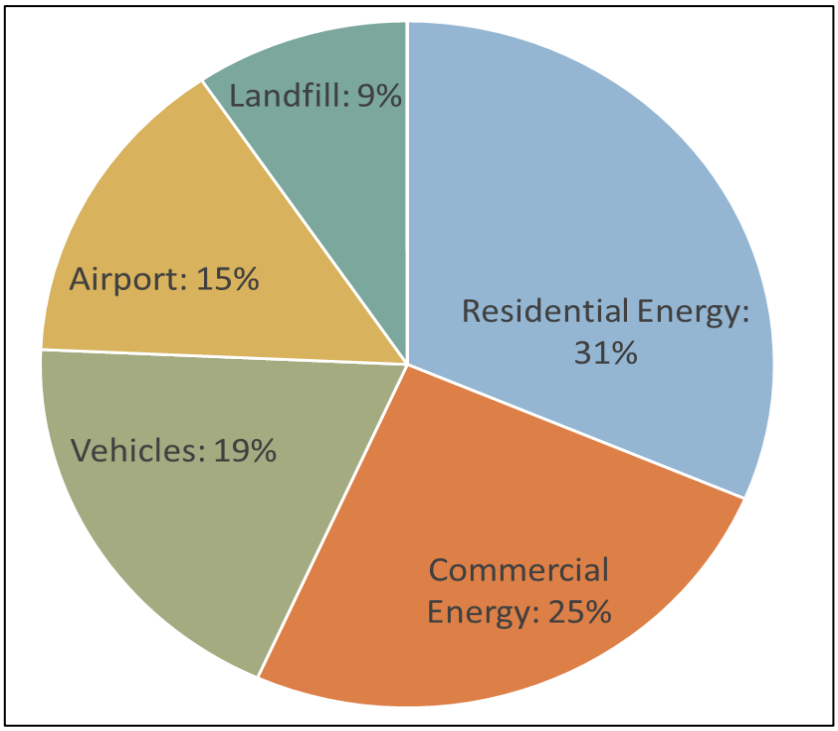

Figure 2. Sources of Aspen's GHG emissions in 2014

Vehicles traveling within and to or from Aspen comprise the third largest source of the community's emissions at 19% of the total, and have declined 13% since the base year. Emissions related to the Aspen/Pitkin County Airport comprise a significant percentage of the community-wide total (15%) and have increased 15% over 2004 levels as a result of serving more passengers traveling farther, and despite a decrease in aircraft operations (the number of landings and takeoffs). Aspen-attributable Pitkin County Landfill emissions represent 9% of the community's total 2014 GHG impact and have increased 2% since 2004.

Emissions related to wastewater at the Aspen Consolidated Sanitation District represent less than 1% of the community-wide total (only 0.01%) and are therefore considered "de-miminis", and not represented in the graphs and figures throughout the *Inventory*. Wastewater emissions fell 12% between 2004 and 2014. Results pertaining to each one of the six sectors are discussed in detail in the main body of the *Inventory* report.

Context: While a 7.4% decrease in net emissions from 2004 levels appears modest, it is important to contextualize these results by comparing them with changes in other community metrics that typically influence community-wide GHG emissions. Two of these are economic activity and population, both of which have grown since 2004. Inflation-adjusted total retail sales occurring within the City of Aspen

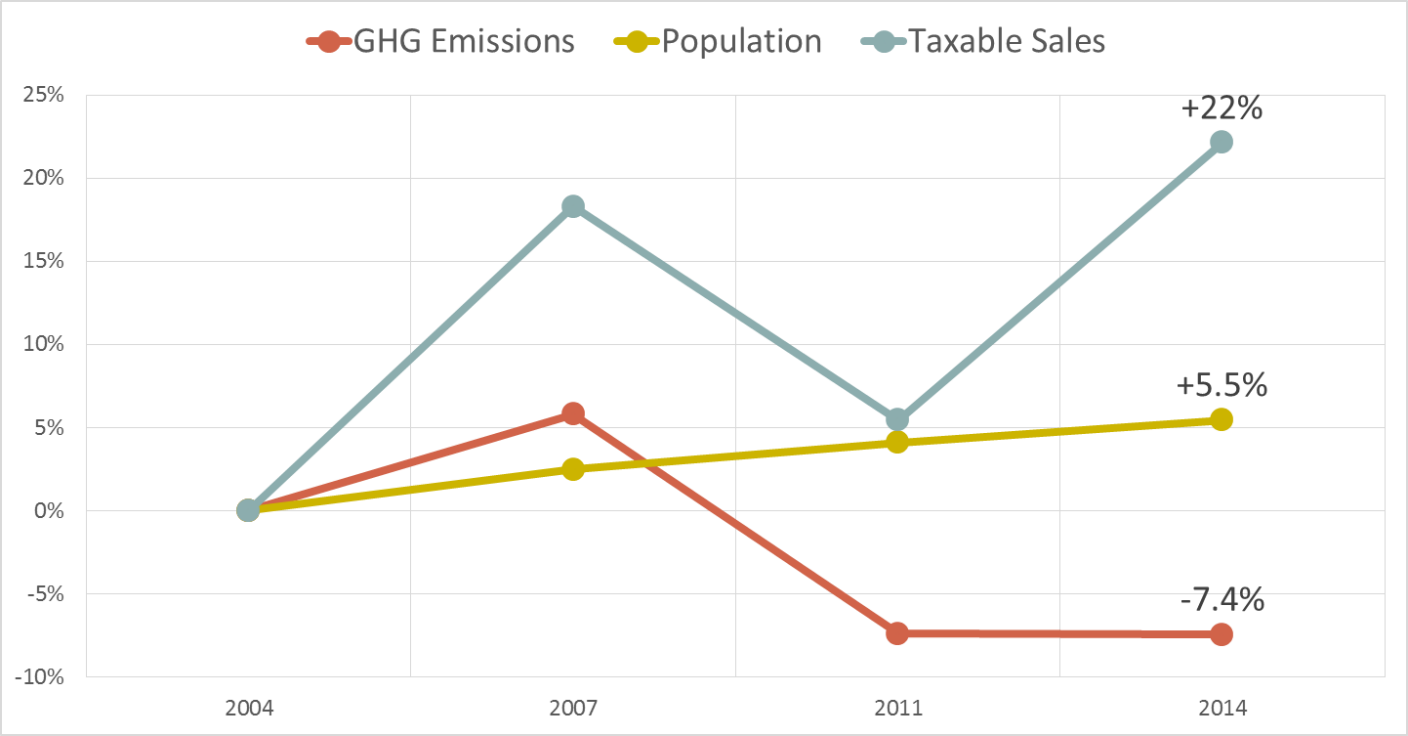

Figure 3. Change in Emissions, Population and Taxable Sales (inflation-adjusted), 2004-2014

have grown 22% since 2004 after a decline between 2007 and 2011 during the recession (City of Aspen Finance Department, 2014). Population within City limits has grown by 5.5% over the same time period from 6,365 people in 2004 to 6,712 in 2014 (Colorado Department of Local Affairs, 2014).

The fact that the Aspen community appears to have decoupled growth in emissions, at least somewhat, from both population and retail sales, is a testament to the success of its many GHG reduction programs such as public transit and growth in the amount of renewable electricity sold by local utilities. Without these programs, community-wide emissions would have likely followed the upward trend of these other community indicators.

Photo 2. Recently completed employee housing at Burlingame is energy efficient and features on-site renewables, which has helped limit emissions despite growing local population. Photo: C Menges

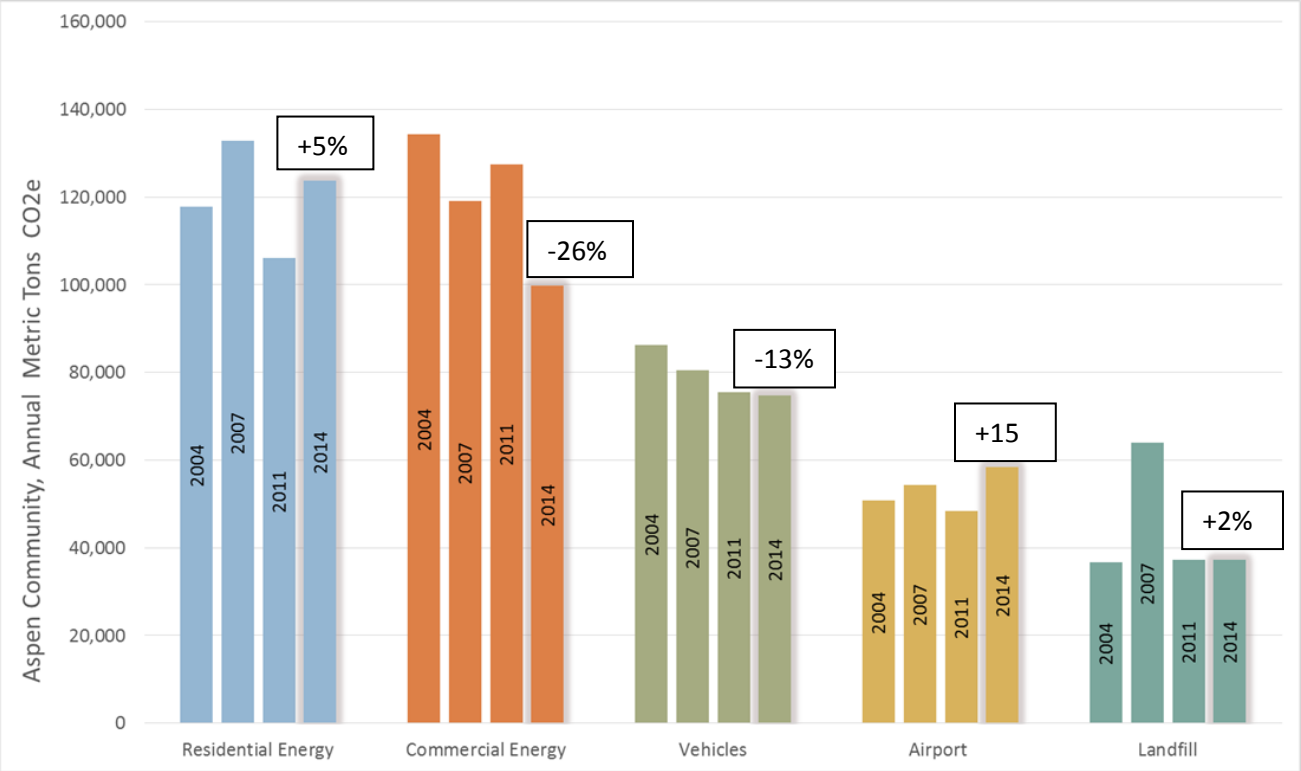

Figure 4. Changes in Aspen's Community-wide GHG emissions by sector, 2004-2014

Conclusion: Aspen's overall 7.4% drop in community-wide GHG emissions results from a combination of increases in some sectors and decreases in others (Figure 4). Despite growth in both population and economic activity since 2004, the Aspen community has successfully reduced its overall GHG emissions since that time. While this rate of decrease will not facilitate the successful fulfillment of Aspen's 2020 GHG reduction goals, it does demonstrate that it is possible to grow the economy and serve more residents while simultaneously reducing emissions.

Photo 3. Bike and pedestrian friendly infrastructure has helped improve quality of life for community residents while helping limit vehicle trips and reducing emissions. Photo: C Menges

Whether or not quality of life has improved for most residents of and visitors to Aspen over this same time period is subjective. However, several initiatives responsible for facilitating a part of the achieved GHG reduction likely have enhanced the overall well-being of the community. One of these, the growth in transit access and ridership, has mitigated the severity of traffic congestion, saved commuters time and money and improved Aspen's air quality

while also reducing GHG emissions. The efforts of City owned and operated Aspen Electric (a municipal electric utility) to dramatically bolster the percentage of its sales coming from renewable energy has saved consumers money, earned publicity for the community, fostered citizen engagement and demonstrated that high renewable penetration and low electricity rates can coincide, while dramatically cutting emissions. Similarly, active energy efficiency programs such as those administered by the Community Office for Resource Efficiency (CORE) have reduced energy use in the residential and commercial sectors, saving residents and business owners money and greatly improving the comfort of interior spaces, all while reducing associated GHG emissions.

These examples indicate that programs aimed at reducing emissions can often enhance a community and its quality of life by generating a myriad of co-benefits. In moving towards 2020, it is clear that accomplishing the community-wide goal of reducing GHG emissions by 30% is a challenge that will require ongoing planning, dedication and stakeholder engagement. If residents, visitors, planners and the private sector are able to collectively envision and plan for a low-carbon Aspen, doing so could provide an opportunity to continue enhancing quality of life in Aspen, while also furthering its status as a leader in the sustainability realm, and creating a conceptual framework that other municipalities could adapt in their own communities.

Photo 4. Downtown Aspen during the late autumn off-season. Traffic levels are almost unimaginably low compared with current summer and winter peak times. Photo: City of Aspen

Introduction

Welcome to the ***2014 Aspen Community-wide GHG Emissions Inventory*** (*2014 Inventory*) report. Since 2004, the City of Aspen has tracked community-wide greenhouse gas (GHG) emissions as part of an ongoing commitment to help mitigate Aspen's contributions to climate change. The production of a base-year GHG inventory in 2004 facilitated establishing long-term reduction targets of 30% below 2004 levels by the year 2020 and 80% below those levels by 2050. Subsequent community-wide GHG inventories, published for calendar years 2007, 2011 and now 2014 provide the opportunity to track progress in working towards the community's emissions reduction goals.

This report outlines the methodologies, boundaries and guidance used to prepare the*2014 Inventory* while also presenting and discussing the results. Complete, sector specific data sets can be found in the Appendices, but have been summarized in the report narrative to preserve readability. City of Aspen staff has attempted to present this GHG study in a way that is relevant for policymakers and community members, and based on the principles of accuracy, completeness, measurability, consistency and comparability across all inventory years.

In an evolution from past years, the *2014 Inventory* was prepared in accordance with the US Community Protocol for Accounting and Reporting of GHG Emissions (USCP), (ICLEI, 2012). Further, the *Inventory* was prepared in-house by City of Aspen staff, as opposed to by a consultant, as has been the case in past years. Finally, the *2014 Inventory* used ICLEI-Local Governments for Sustainability's (ICLEI) ClearPath emissions management platform to streamline calculations and store input and consumption data, emissions factors and methodology notes. The rationale for shifting the inventory approach to the USCP and using ClearPath fundamentally revolved around ensuring future comparability and replicability, employing best practices and leveraging the latest guidance available for quantifying emissions in each sector. It

The U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions is the first national standard to guide local governments on how to measure and report the GHG emissions associated with their communities.

should be noted that in order to compare 2014 results with those from past years, all of the City of Aspen's past community-wide GHG inventories – the 2004, 2007 and 2011 – have been recalculated using the same tools and USCP calculation methodologies that were used to create the *2014 Inventory*. Summary sheets of these recalculations can be found in Appendices B, C and D.

Purpose & Background

Climate Change and Aspen

The Intergovernmental Panel on Climate Change (IPCC) compiles international research showing that "scientific evidence for warming of the climate system is unequivocal" (IPCC, 2014) and the National Aeronautics and Space Administration (NASA) has stated that "ninety-seven percent of climate scientists agree that climate-warming trends over the past century are very likely due to human activities, and most of the leading scientific organizations worldwide have issued public statements endorsing this position" (NASA, 2015). Because Aspen's natural environment and economic model rely on stable climate conditions (AGCI, 2014), mitigating the community's contribution to climate-warming emissions has become a scientific and symbolic imperative. Mitigating climate change generally involves reductions in human emissions of GHGs, which can be achieved through a broad variety of activities such as transitioning to low-carbon energy sources, deploying energy efficiency measures and reforestation. Observed changes in regional conditions, such as the fact that Aspen is experiencing 23 more frost free days per year than it was in 1980, provide evidence that climate change is already manifesting itself locally (AGCI, 2014). Sophisticated climate models indicate that the degree to which Aspen will be affected by climate change over the medium and long-term is directly tied to current and future emissions trajectories (AGCI, 2014). Accordingly, proactive planning to reduce GHG emissions is in Aspen's economic and environmental self-interest. In order to meaningfully tackle climate change, emissions must be slashed on a global scale. Therefore, Aspen aspires to lead by example, ideally affecting national and international planning efforts and inspiring visitors to do their part in supporting climate-friendly practices.

CITY OF ASPEN
CANARY INITIATIVE

The City of Aspen Canary Initiative

In March of 2005, Aspen's City Council passed a resolution creating the Canary Initiative, which identifies the City and region as a "canary in the coal mine" in regards to its sensitivity to the effects of climate change. The resolution also directed the City Manager to 'establish an inventory for the City that quantifies GHG emissions and is capable of quantitatively tracking progress or lack thereof in reducing emissions from all sectors of the Aspen economy.' Since its

inception, the Canary Initiative has worked to measure and reduce emissions, and adapt to the impacts of climate change through research, programs, policy and community engagement. A community-wide GHG emissions inventory – which has been published every 3 to 4 years since 2004 – informs policymakers, City staff and the larger community about progress being made towards the 2020 and 2050 emissions reduction goals, while providing insights as to whether or not deployed mitigation measures have proven effective.

Aspen's Greenhouse Gas Reduction Goals

In 2007, Aspen's City Council created the *Canary Action Plan*, a roadmap to begin working towards Aspen's formal commitment to reduce community-wide GHG emissions 30% below 2004 levels by 2020 and 80% below 2004 levels by 2050. The 2*004 Aspen Community GHG Emissions Inventory* (Heede, 2005) conducted by Rick Heede of Climate Mitigation Services provides the baseline against which the reduction targets are measured. Follow-up inventories were conducted in 2007 (also by Climate Mitigation Services), and in 2011 by Cameron–Cole, LLC with assistance from City of Aspen staff. The *2014 Community-wide GHG Emissions Inventory* is the latest quantitative analysis in assessing progress towards the 2020 and 2050 GHG targets. Because the *2014 Inventory* was calculated using USCP-compliant methodologies, the 2004, 2007 and 2011 inventories have been recalculated to ensure consistent comparability across years. Future inventories will follow this best practice.

Inventory Benefits and Objectives

Conducting GHG inventories is both a best and common practice among cities with climate and sustainability commitments. The City of Aspen's *2014 Community-wide GHG Emissions Inventory* is a tool designed to:

- Inform climate action planning;
- Demonstrate accountability and leadership;
- Track GHG emissions performance over time;
- Motivate community action; and
- Contrast related metrics like population, energy consumption and collected revenue to GHG emissions.

Perhaps most importantly, the consistent and comparable measurement of community-wide GHG emissions provides local governments like the City of Aspen with quantitative and qualitative insights about where and how to pursue emission reduction opportunities.

Scope and Boundaries

Aspen's *2014 Community-wide GHG Emissions Inventory* represents a sector–based approach to GHG accounting. This method allocates carbon emissions among the residential, commercial, transportation, and aviation sectors according to energy use and the carbon intensity of that energy. It

also calculates emissions from solid waste based on the tonnage of materials disposed at the Pitkin County Landfill that can be attributed to Aspen, as well as corresponding onsite electricity and diesel use. Additionally, the *Inventory* includes fugitive emissions from wastewater treatment at the Aspen Consolidated Sanitation District. The *2014 Inventory* quantifies emissions from these six sectors, consistently reporting on and referring to them as:

- "**Residential energy**" (CO_2e from the use of electricity, natural gas and propane in residential buildings);
- "**Commercial energy**" (CO_2e from the use of electricity, natural gas and propane in commercial buildings);
- "**Vehicles**" (CO_2e from all on-road vehicle transportation within Aspen and a portion of trips originating from or destined to Aspen);
- "**Airport**" (CO_2e from aircraft fuel dispensed at the Aspen/Pitkin County Airport and from gasoline and diesel dispensed for ground support equipment);
- "**Landfill**" (CO_2e from solid waste and Aspen's portion of on-site energy use); and
- "**Wastewater**" (CO_2e from the treatment of Aspen's wastewater).

Sector-based emissions inventories are widely used by local, state and national governments. Aspen's sector-based inventory was designed to focus on emissions attributable to community-wide sources and activities as well as those that planners and community members have some ability to influence. In doing so, the *Inventory* strives to describe the community's full range of sector-based emissions while providing the necessary information to motivate action on both the individual and community scales.

Chemical Boundary (Reported Emissions)

Six GHGs are internationally recognized as those that contribute to anthropogenic (human-forced) climate change: Carbon dioxide (CO_2); Methane (CH_4); Nitrous oxide (N_20); Hydrofluorocarbons (HFCs); Perfluorocarbons (PFCs); and Sulfur hexafluoride (SF_6).

As has been the case since Aspen's base year inventory, the *2014 Inventory* quantifies emissions of CO_2, CH_4 and N_2O while excluding emissions of HFCs, PFCs and SF6, none of which are prevalent within the Aspen community (Heede, 2005). Emission totals for each sector throughout the *Inventory* (aside from the Airport, which only reports CO_2) are reported as carbon dioxide equivalents (CO_2e), which in this case represents the total 100-year climate warming impact of the CO_2, CH_4 and N_2O emissions collectively. CO_2e for CH_4 and N_2O are calculated by multiplying the global warming potential (GWP) of each gas by its emissions. GWP represents the amount of heat that a molecule of the given gas traps in the atmosphere as related to CO_2. CH_4 traps 21 times as much and N_2O traps 310 times as much heat as CO_2. Accordingly, CO_2e is herein calculated as follows: CO_2 (×1) + CH_4 (×21) + N_2O (×310) = CO_2e (ICLEI, 2012).

Aspen's Community-wide GHG Reduction Goals: 30% below 2004 levels by 2020 and 80% below 2004 levels by 2050.

Sources and Activities

The Aspen community contributes to GHG emissions in many ways, and two central categorizations of emissions are used in this report: 1) GHG emissions that are produced by community based "*sources*" located within Aspen's boundary and 2) GHG emissions produced as a consequence of community "*activities*". Under this categorization, *emissions sources* include any physical process inside the jurisdictional boundary that directly releases emissions (such as combustion of gasoline in transportation, and the stationary combustion of natural gas and propane in boilers).

Activities resulting in GHG emissions include the use of energy materials and services by members of the community that result in the creation of emissions either directly or indirectly. For example, the purchase of electricity by members inside the community is an *emissions activity* since the coal-fired generation associated with those purchases occurs outside of the Aspen community. Using a 'sources and activities framework' in this *Inventory* both enables compliance with the USCP and also alleviates the need to utilize the "scopes" concept, which is common for entity-specific inventories. Expert guidance indicates that the "scopes" concept does not translate to the community scale in a manner that is clear and consistently applicable (ICLEI, 2012). Distinguishing between sources and activities, which is done in the 2004, 2007, 2011 and 2014 Sector Rollup Tables (Appendices A-D), can help promote a deeper understanding of the GHG emissions associated with the Aspen community, by highlighting which ones are occurring within the geographic boundary, and which are occurring outside of the community but directly linked to in-boundary activities.

Geographic Scope and Emissions Boundary

The *2014 Inventory* captures both the direct and indirect emissions corresponding to *sources* and *activities* occurring within the Aspen community, which is delineated as the Emissions Inventory Boundary (EIB) (Figure 5). In doing so, the *Inventory* quantifies emissions that occur due to the energy consumption, activities, and people of Aspen.

The EIB, is nearly identical to the City of Aspen's Urban Growth Boundary (UGB), but also includes 1) the Starwood and the White Horse Springs section of the McLain Flats residential areas; 2) the residential areas within and contiguous to the Aspen city limits such as Red Mountain, Mountain Valley (on the southeastern edge of town), Highlands, Buttermilk West, the Aspen-Pitkin County Airport, the Aspen Airport Business Center, and North Forty; and 3) the electricity and natural gas used to run lifts and facilities on Aspen Mountain, Aspen Highlands, and Buttermilk ski areas (because the base facilities and many lifts are within the EIB).

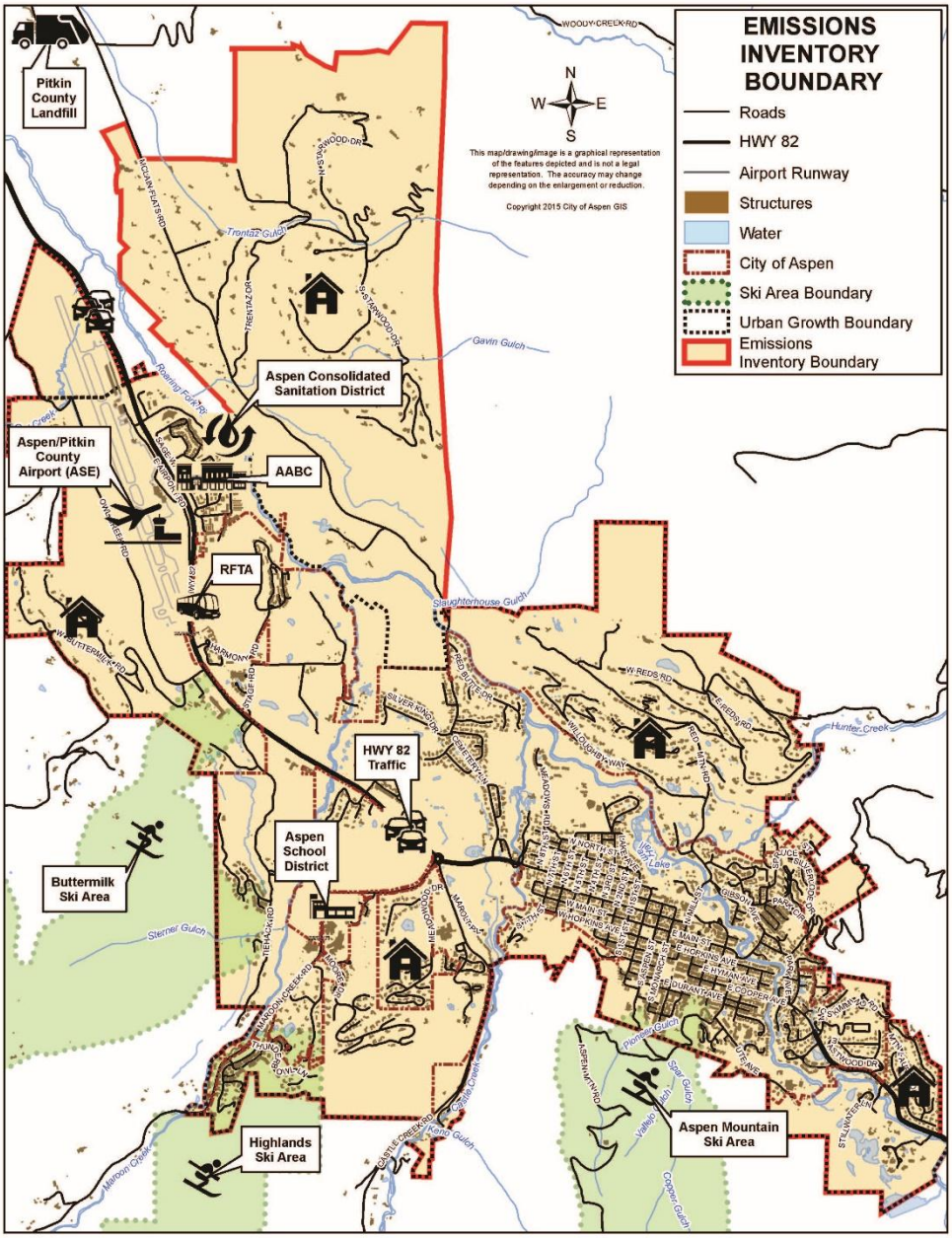

Figure 5. Emissions Inventory Boundary (Heede, 2005). Full page map in Appendix G.

The EIB has been used since 2004 under the rationale that this geographic area represents Aspen's core functionality, and assumes that the

contiguous outlying areas included in the EIB would likely not exist in the same capacity were it not for the existence of the Aspen community.

Inventory Protocol & Tracked Sectors

The 2014 Community-wide Inventory is compliant with the US Community Protocol for Accounting and Reporting of GHG Emissions (USCP). In consultation with various experts, City of Aspen staff decided to adopt this protocol as it is the best equipped to convey information about emissions associated with geopolitically defined communities such as Aspen's EIB.

A community-wide inventory is neither exclusive of emissions separately reported by organizations in the community, nor simply the sum of emissions reported by individual organizations or households. Rather, by aligning with USCP guidance, this *Community-wide Inventory* provides an opportunity to understand the collective GHG emissions associated with the Aspen community as calculated from community-wide data sets. While the *2014 Inventory* is not fully comprehensive (some emissions cannot be estimated due to lack of valid methods or emissions data) the USCP assembles as complete a picture of GHG emissions associated with the Aspen community as is reasonably possible.

At least five basic emissions generating activities must be included in a Community-wide GHG inventory in order for it to be USCP compliant and Aspen's includes six. Accordingly, the *2014 Inventory* reports emissions associated with the following sources and activities: 1) "**Residential energy**"; 2) "**Commercial energy**"; 3) "**Vehicles**"; 4) "**Airport**"; 5) "**Landfill;** and 6) "**Wastewater**". The following sections of the report present results for these sectors individually and in aggregate as "net emissions".

Photo 5. A Roaring Fork Transit Authority (RFTA) bus in downtown aspen. Photo: City of Aspen

Detailed Results: Net Emissions

For calendar year 2014, the Aspen community's largest single source of greenhouse gas emissions was the use of electricity, natural gas and propane in residential buildings (Figure 6). With residential energy accounting for 31% of CO_2e emissions, followed by commercial energy at 25%, the community's consumption of energy in buildings altogether accounted for 56% of GHG emissions resulting from both *sources* and *activities* in the EIB. Following the building sector, on-road vehicles including cars, trucks, buses and motorcycles accounted for 19% of the GHGs attributable to the Aspen community in 2014. Community-attributable emissions from the Aspen/Pitkin Country Airport made up 15% of 2014 community-wide GHG emissions, while those originating from *sources* and *activities* at the Pitkin County Landfill were responsible for 9% of the total. Emissions related to wastewater treatment at the Aspen Consolidated Sanitation District represented less than 1% of the community-wide total (only 0.01%) and are therefore considered "de-miminis", and not represented in many of the *Inventory* charts and graphs (when included, their scale is too insignificant to appear).

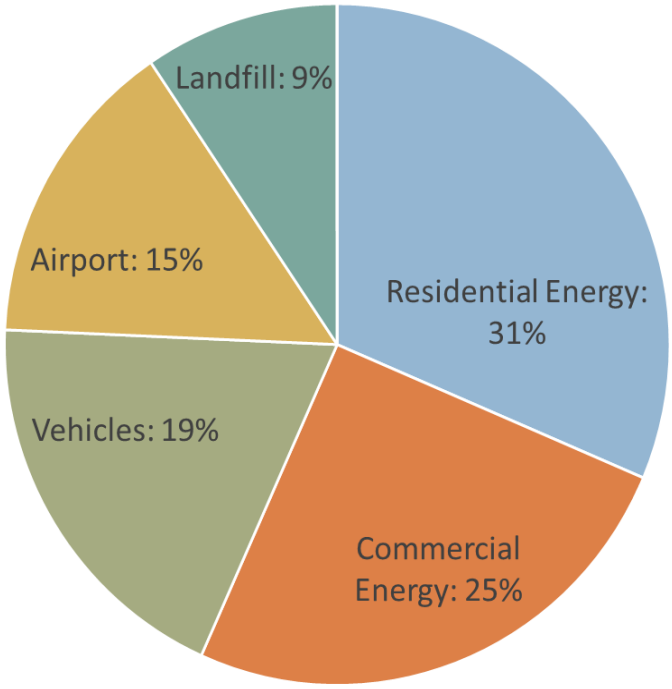

Figure 6. Percent of Aspen's GHG emissions by sector, 2014

Photo 6. Residential energy was the largest single source of Aspen's 2014 GHG emissions. Photo: C. Menges

Between 2004 and 2014 total emissions of CO_2e from all EIB-related *sources* and *activities* attributable to Aspen decreased by 7.4%. This net decline in emissions represents the combination of increases in some sectors with decreases in others. For example, while CO_2e emissions have gone up 5% in the residential energy sector, they have dropped 26% in the commercial energy sector. Similarly, emissions associated with aircraft operations at the Aspen Pitkin County Airport have risen 15% since 2004 while emissions associated with on-road transportation have decreased by 13% (Figure 7 & 8, Table 1).

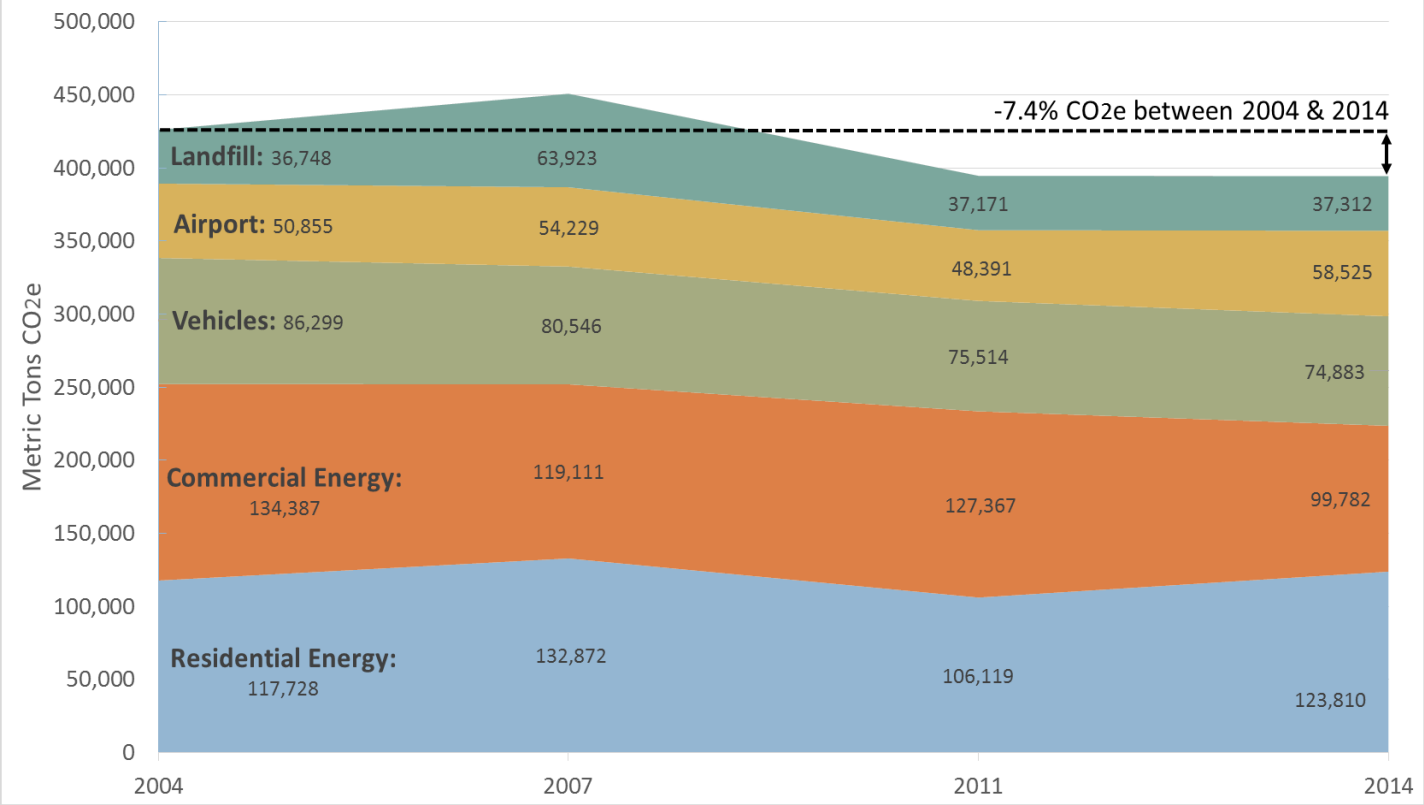

Figure 7. Changes in Aspen's total GHG emissions by sector from 2004 - 2014

Photo 7. Emissions from commercial energy have declined substantially (26%) since 2004 and remain the second largest slice of Aspen's GHG pie. Photo: C Menges

Table 1 presents total emissions for each sector for all community-wide inventory years to date, and the percent increase or decrease that occurred between each year.

CO2e (MT) Emissions By Sector 2004 - 2014

	2004 CO2e (MT)	2007 CO2e (MT)	% Change ('04-'07)	2011 CO2e (MT)	% Change ('04-'11)	2014 CO2e (MT)	% Change ('04-'14)	Trend ('04-'14)
1. Residential Energy	117,728	132,872	13%	106,119	-10%	123,810	5%	
2. Commercial Energy	134,387	119,111	-11%	127,367	-5%	99,782	-26%	
Total Energy Consumption: Buildings	252,115	251,983	0%	233,486	-7%	223,592	-11%	
3. Vehicles	86,299	80,546	-7%	75,514	-12%	74,883	-13%	
4. Airport	50,855	54,229	7%	48,391	-5%	58,525	15%	
5. Landfill (Aspen's share)	36,748	63,923	74%	37,171	1%	37,312	2%	
6. Wastewater	33	31	-6%	31	-6%	29	-12%	
Total	678,165	702,695	6%	628,079	-7%	617,933	-7%	

Table 1. Sector & total CO_2e emissions & percent change, 2004-2014

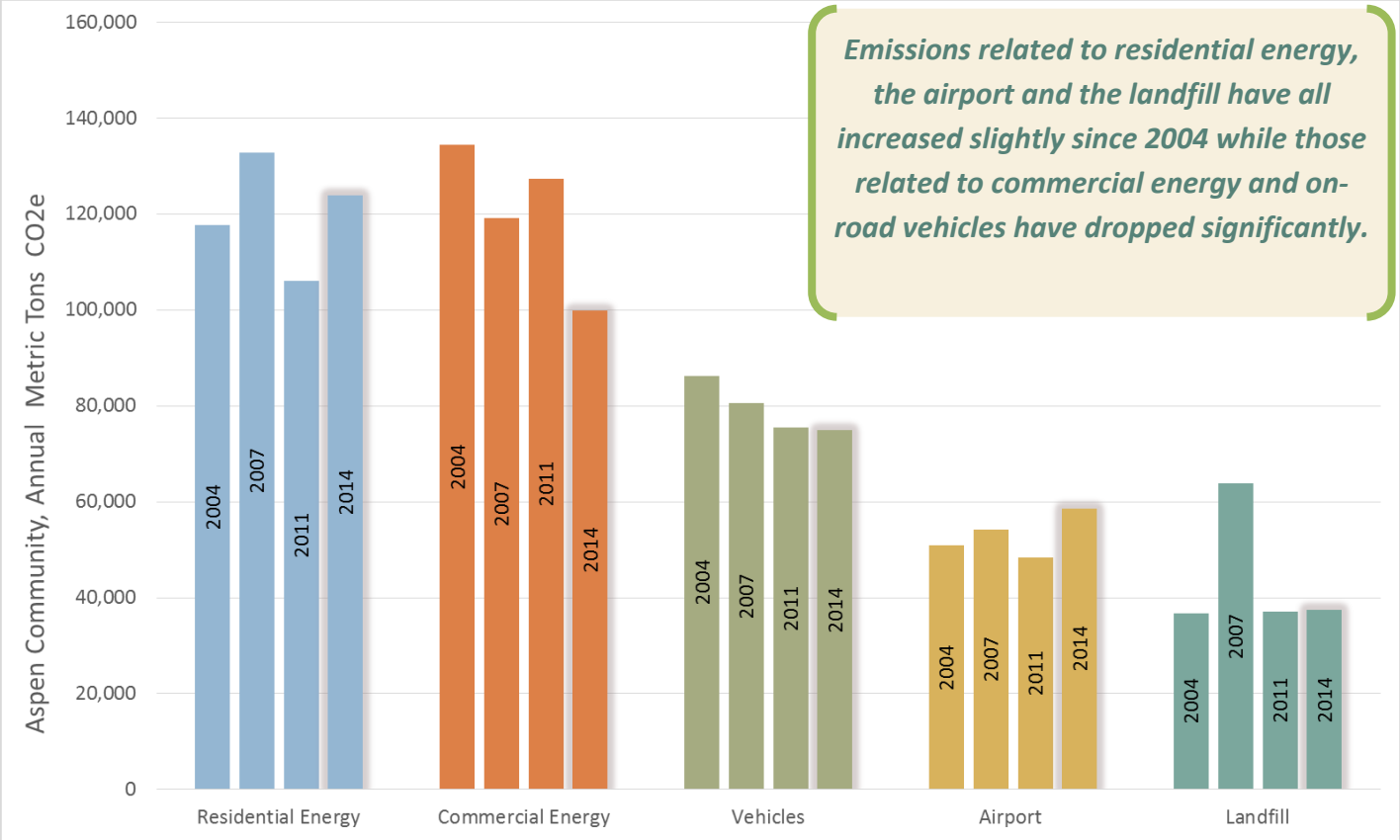

Figure 8. Annual CO_2e emissions and changes by sector, 2004-2014

Residential Energy Use

GHG emissions related to the residential energy sector result from the consumption of energy in all residential buildings within the EIB and totaled 123,810 MT CO_2e in 2014. Residential buildings can generally be categorized as single and multifamily homes and residences where energy bills are paid by an individual homeowner, tenant or landlord, and whereby the billing department of a given utility or fuel supplier has classified the account as 'residential'.

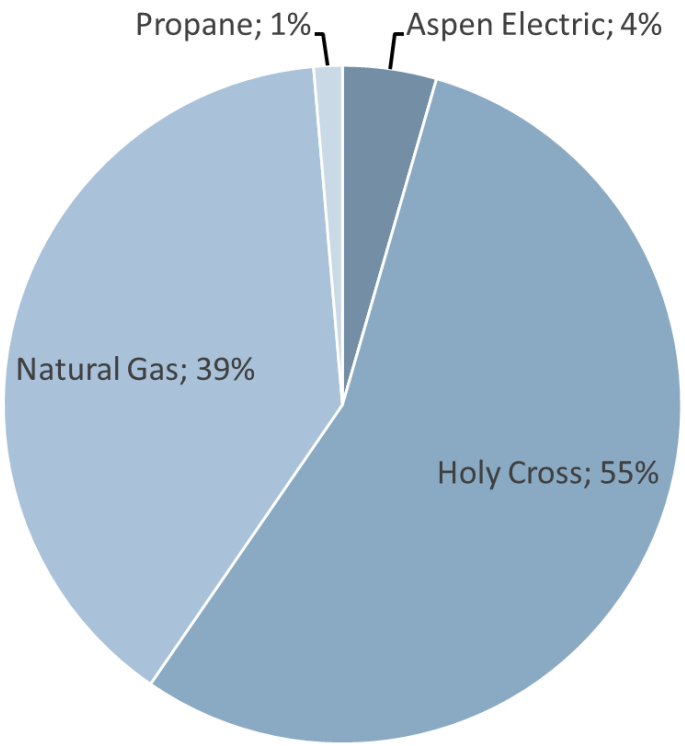

Figure 9. Residential energy emissions by vendor or fuel type, 2014

In Aspen, more than half of residential energy emissions are related to purchases of electricity (an *activity*), with a significant proportion being attributable to natural gas combustion and a small amount coming from propane combustion (both *sources*). Residential electricity is purchased from one of two local electric utilities, Aspen Electric or Holy Cross Energy. Taken together, purchases of electricity from Aspen Electric (4% of sector GHGs) and Holy Cross Energy (55% of sector GHGs) generate 59% of Community-wide residential energy emissions. The stationary combustion of natural gas, sold to area residents by SourceGas, is responsible for nearly 40% of residential energy emissions while the stationary combustion of propane, provided to customers by Cross Propane, Ferrellgas and AmeriGas accounts for the remaining 1% (Figure 9).

Total residential energy emissions initially grew 13% between the 2004 base year and 2007. In 2011, the community had achieved a 10% reduction in residential energy emissions from 2004 levels. Then in 2014, emissions from residential energy grew 5% from 2004 and 17% from 2011 levels (Figure 8 and Table 1, above). The growth in community-wide emissions related to residential energy is a result of increases in residential emissions from purchases of electricity from Holy Cross Energy and the stationary combustion of natural gas from SourceGas combined with decreases in emissions related to purchases of electricity from Aspen Electric and the stationary combustion of propane (Appendix F).

Purchased Electricity: Residential consumption of electricity – both on the Aspen Electric and Holy Cross Energy systems – has grown since 2004 (Figure 10).

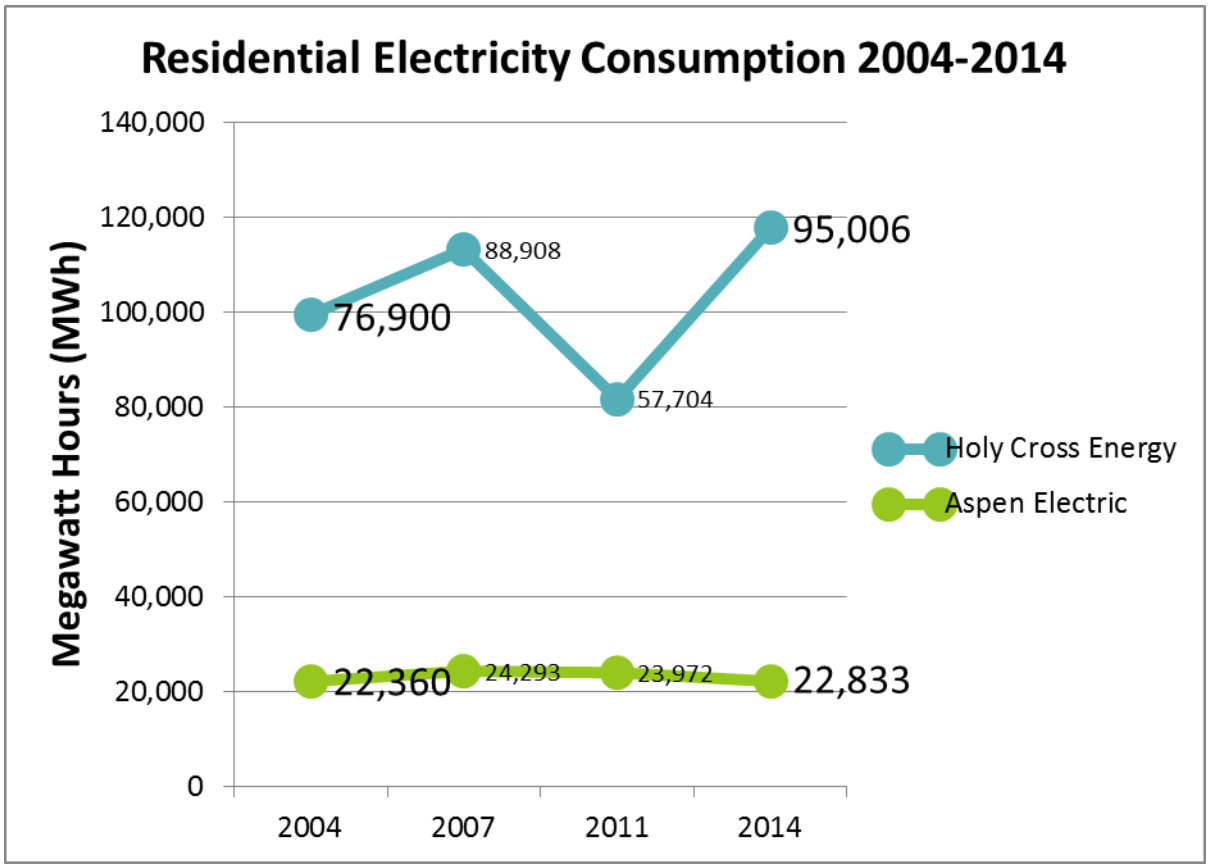

Figure 10. Residential Electricity Consumption, 2004-2014

At the same time, the carbon intensity of that electricity has declined, moderately for Holy Cross Energy and substantially for Aspen Electric (Figure 11). In 2004, Aspen Electric was about 35% renewable and Holy Cross Energy was approximately 6% renewable. Those numbers climbed to 74% and 20.3%, respectively, by 2014.

Photo 8. Consumption of electricity for residential consumers has grown since 2004. Photo: C Menges

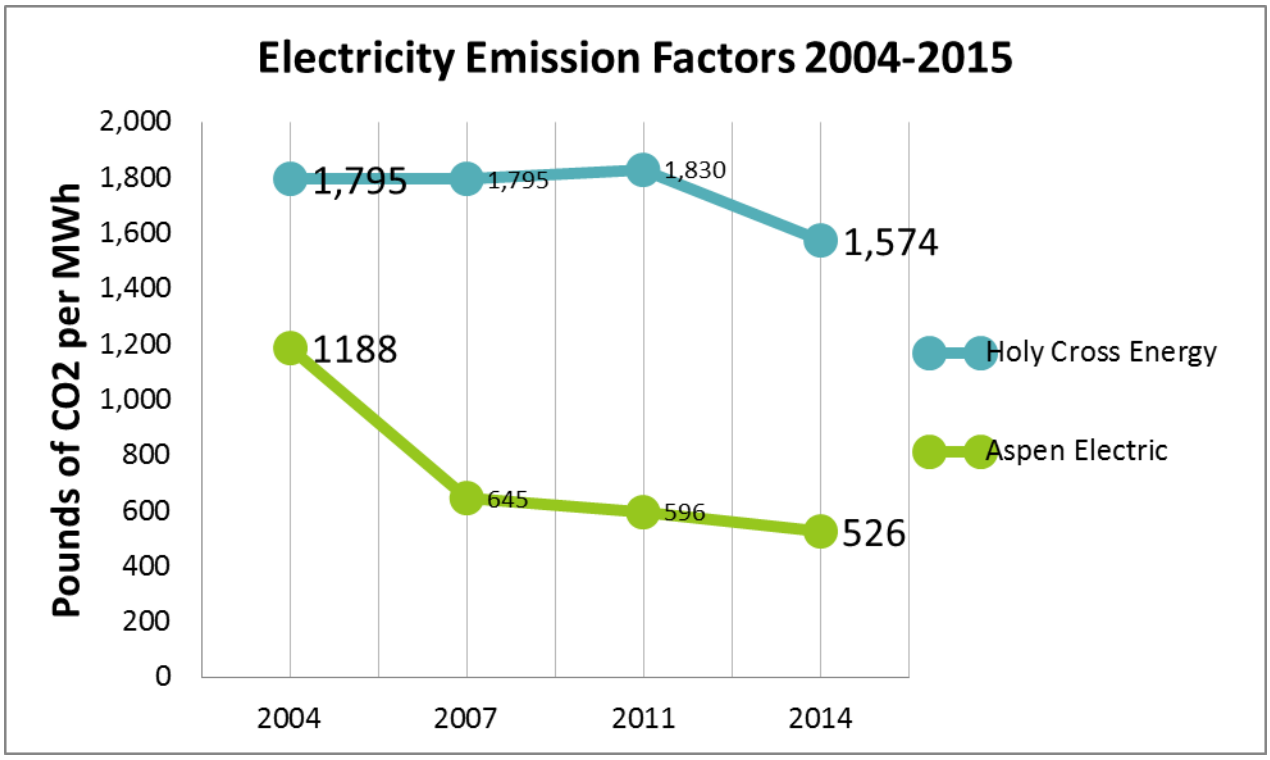

Figure 11. Carbon intensity of purchased electricity, 2004-2014

Correspondingly, the following changes were observed between 2004 and 2014:

- A 54% decrease in residential emissions related to Aspen Electric as a result of minor load growth coupled with a substantial increase in the amount of renewable energy underlying delivered electricity.
- An 8% increase in residential emissions related to Holy Cross Energy as a result of substantial load growth coupled with a more moderate increase in the amount of renewable energy underlying delivered electricity.

As such, it can be extrapolated with a relatively high level of certainty that GHG emissions related to residential electricity consumption would have grown significantly were it not for the decreases in the carbon intensity (aka: emissions factor) of purchased electricity that have been accomplished by bringing more renewables into the fuel mix of each utility.

An 'emissions factor' is the average GHG emissions rate for a given source, relative to units of activity. For purchased electricity, the *Inventory* describes the CO_2 emissions factor in pounds of CO_2 per Megawatt Hour. Multiplying the emissions factors times the amount of related activity generates a GHG emissions result.

Natural Gas & Propane: Emissions related to residential sources of natural gas combustion within the EIB have increased 21% since 2004 (Figure 12). Given that the emissions factor for natural gas is the same for all *Inventory* years, this increase is directly related to consumption, which climbed from close to 7.5 million therms per year in 2004 to approximately 9.1 million therms per year in 2014. Figure 12 provides a visualization of the direct relationship between natural gas consumption (therms) and emissions (MT CO_2e) from 2004 through 2014.

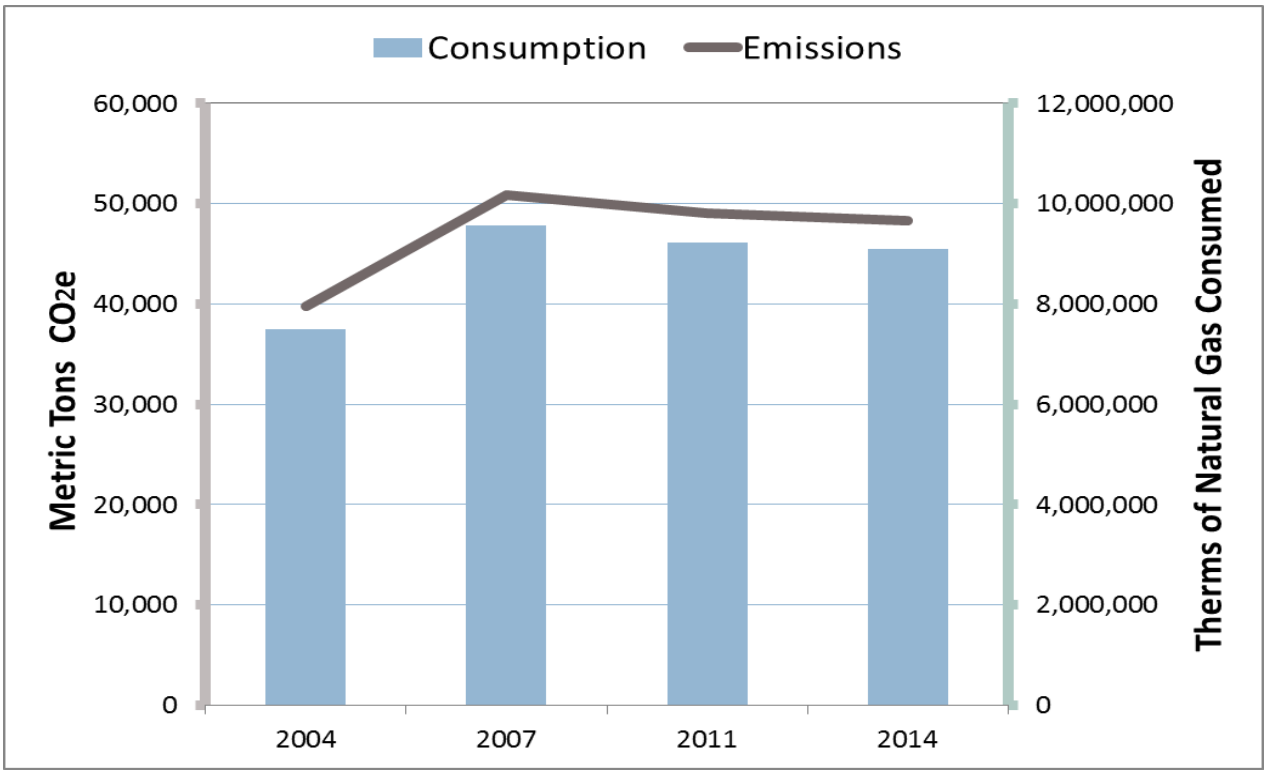

Figure 12. Natural gas consumption and emissions, 2004-2014.

Similarly, the emissions factor for propane has remained the same since the first community-wide inventory. Accordingly, changes in emissions related to residential sources of propane combustion directly follow consumption. Since 2004, emissions from residential propane combustion have decreased by 40%, corresponding to a significant drop in propane consumption within the EIB. While the propane purchased and combusted in the Aspen community comes from the three aforementioned vendors, consumption and emission results have been categorically consolidated as 'propane' throughout the report.

Residential Energy Summary: Net CO_2e emissions in the residential energy sector increased by 5% between 2004 and 2014, despite the active deployment of energy efficiency programs and significant increases in the percentage of renewable electricity powering homes within the EIB. This net increase

is a result of both increases and decreases in the components that comprise the sector. Specifically, between 2004 and 2014, emissions have increased in relation to purchases of electricity from Holy Cross Energy (+8%) and natural gas from SourceGas (+21%) while decreasing in relation to purchases electricity from Aspen Electric (-54%) and propane from all vendors (-40%).

Photo 9. Natural gas infrastructure delivers fuel for stationary combustion in a downtown Aspen building while meters monitor consumption. Photo: J Isenhart

It is possible that the significant increases in both residential electricity and natural gas consumption are related to growth in population and economic activity. Since 2004, Aspen's population has grown by 5.5% and inflation-adjusted taxable sales have grown by 22%. The population growth correlates closely with the 5% increase in emissions from residential energy between 2004 and 2014, while the jump in taxable sales indicates a possibility that residents may be purchasing more energy consuming goods and services.

It should also be noted that the original 2004, 2007 and 2011 community-wide GHG inventories combined data from the residential and commercial energy sectors and presented aggregate results as a "building energy" sector. The *2014 Inventory* is the first report where residential and commercial energy are clearly delineated as separate sectors, which provides more granular insights into building energy consumption and could help facilitate more targeted program planning and development for energy efficiency programs.

During the *2014 Inventory* process, the original 2004, 2007 and 2011 data was sorted into residential and commercial categories with the greatest accuracy that the original data allowed, to ensure as consistent as possible comparability with the *2014 Inventory* results. However, because there was less accurate delineation of residential versus commercial in past years (in some cases total building consumption of a given fuel was split down the middle), the sector specific changes (in residential and commercial energy) are subject to a margin of error and comparability. For this reason, a "combined building energy" section is provided in the report, following the commercial energy section. This section likely has little margin of error in terms of comparability because tracking consumption as a whole across all years without the delineation has remained a wholly consistent practice.

Overall, GHG emissions related to total community-wide energy consumption in buildings ("combined building energy" which equals both residential energy and commercial energy combined) decreased by

11%. This unofficial yet still reported "combined energy" metric corresponds identically with how building energy data was reported and compared in past inventory years. The slight increase in residential energy emissions with the substantial decrease in commercial energy emissions (discussed in the section below) may in part be related to the more accurate data collection methods available now than in past years. A majority of Aspen's utility providers have updated their data collection systems in recent years, and now have the ability to deliver higher-resolution data with a more accurate breakdown of residential versus commercial accounts. While the ability to delineate between residential and commercial building energy consumption across all inventory years may not be perfectly consistent going back to 2004, the *Inventory* authors have a high degree of confidence that the new delineation approach (i.e. separately reporting residential and commercial energy) is a necessary best practice for informing relevant and targeted energy efficiency programming.

Photo 10. Large homes dot Red Mountain on the Northeast flank of Aspen. While outside of City limits, Red Mountain is included in the Emissions Inventory Boundary. The residential energy sector represents emissions from all homes within the EIB.

Photo 11. A solar array at the Aspen Utilities. Emissions attributable to municipal facilities are included in the commercial energy sector, discussed below. Photo: C Menges

Commercial Energy Use

Totaling 223,486 MT CO_2e in 2014, GHG emissions related to the commercial energy sector result from the consumption of energy in all commercial and municipal buildings and to move water for treatment, delivery and irrigation within the EIB. The operation of these buildings and facilities involves the consumption of electricity, natural gas and propane, and the vendors of these fuels in the commercial energy sector are identical to the ones listed in the residential energy sector.

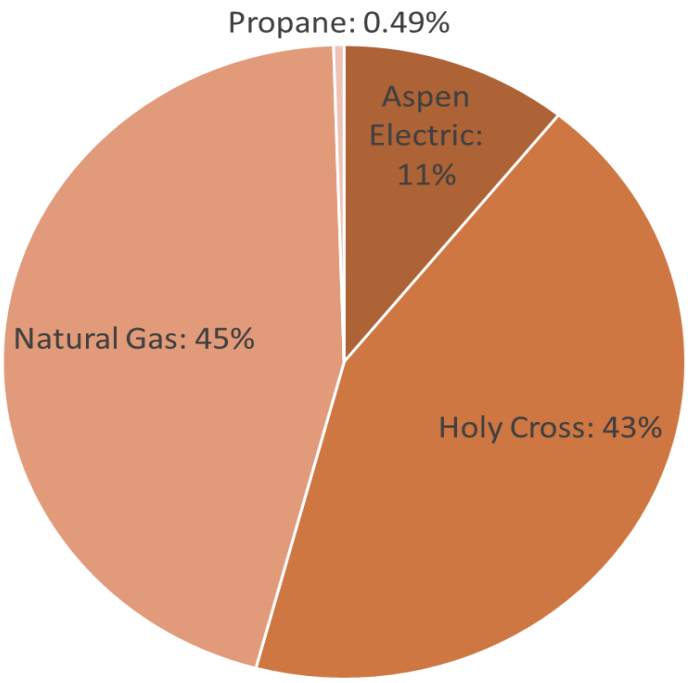

Figure 13. Commercial energy emissions by fuel type 2014

In Aspen, commercial energy emissions are predominantly related to purchases of electricity (an *activity*). Taken together, purchases of electricity from Aspen Electric (11% of commercial energy emissions) and Holy Cross Energy (43% of commercial energy emissions) are responsible for 54% of the sector's total GHGs . The stationary combustion of natural gas (a *source*) is responsible for 45% of commercial energy emissions while the stationary combustion of propane from all vendors accounts for less than 1%.

Photo 12. Commercial buildings in Aspen's downtown. Commercial energy is the second largest slice of the local GHG pie. Photos: C Menges

Between the 2004 base-year and 2007, commercial energy emissions decreased by 11%. In 2011, commercial energy emissions were 5% lower than they had been in 2004. In 2014, commercial energy emissions had declined 26% below 2004 levels and 22% below 2011 levels, as shown below.

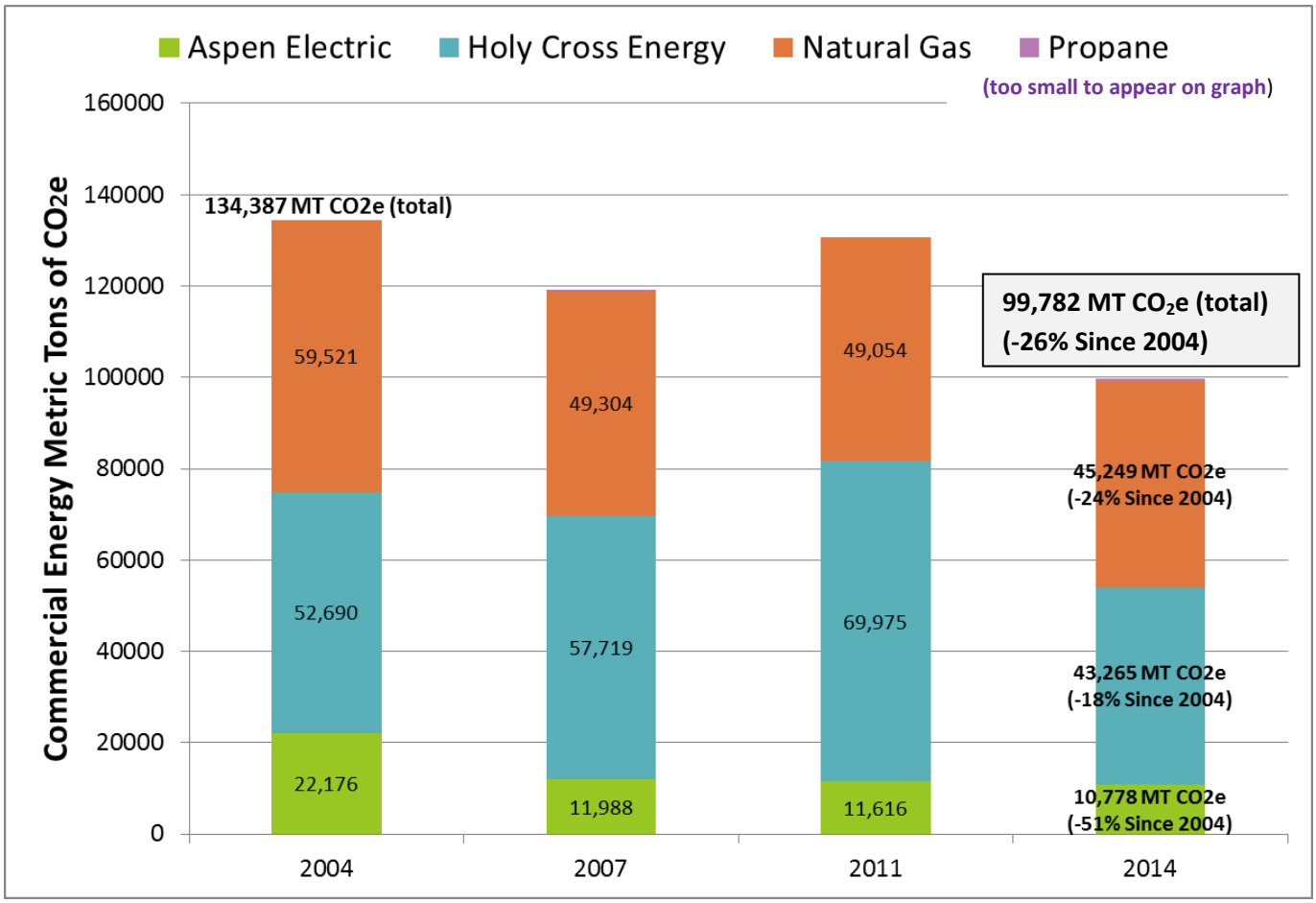

Figure 14. Commercial Energy CO_2e Emissions, 2004-2014

Purchased Electricity: The majority of the 2004-2014 emissions decrease in the commercial energy sector relates to purchased electricity where calculations reveal:

- A 51% decrease in emissions related to purchases of electricity from Aspen Electric (Figure 14 and Appendix F), resulting from minor increases in consumption coupled with a substantial increase in the percentage of renewable energy underlying delivered electricity; and
- An 18% decrease in emissions related to purchases of electricity from Holy Cross Energy (Figure 14 and Appendix F), as a result of a substantial reduction in consumption coupled with a smaller increase in the percentage of renewable energy underlying delivered electricity.

Figure 15 provides a visualization of the relationship between CO_2e emissions and commercial electricity consumption. On the Aspen Electric system, observe the significant decrease in emissions (green bars) despite the minor uptick in electricity consumption (green line). This decoupled relationship has occurred because of the large shift towards renewable energy on the Aspen Electric system.

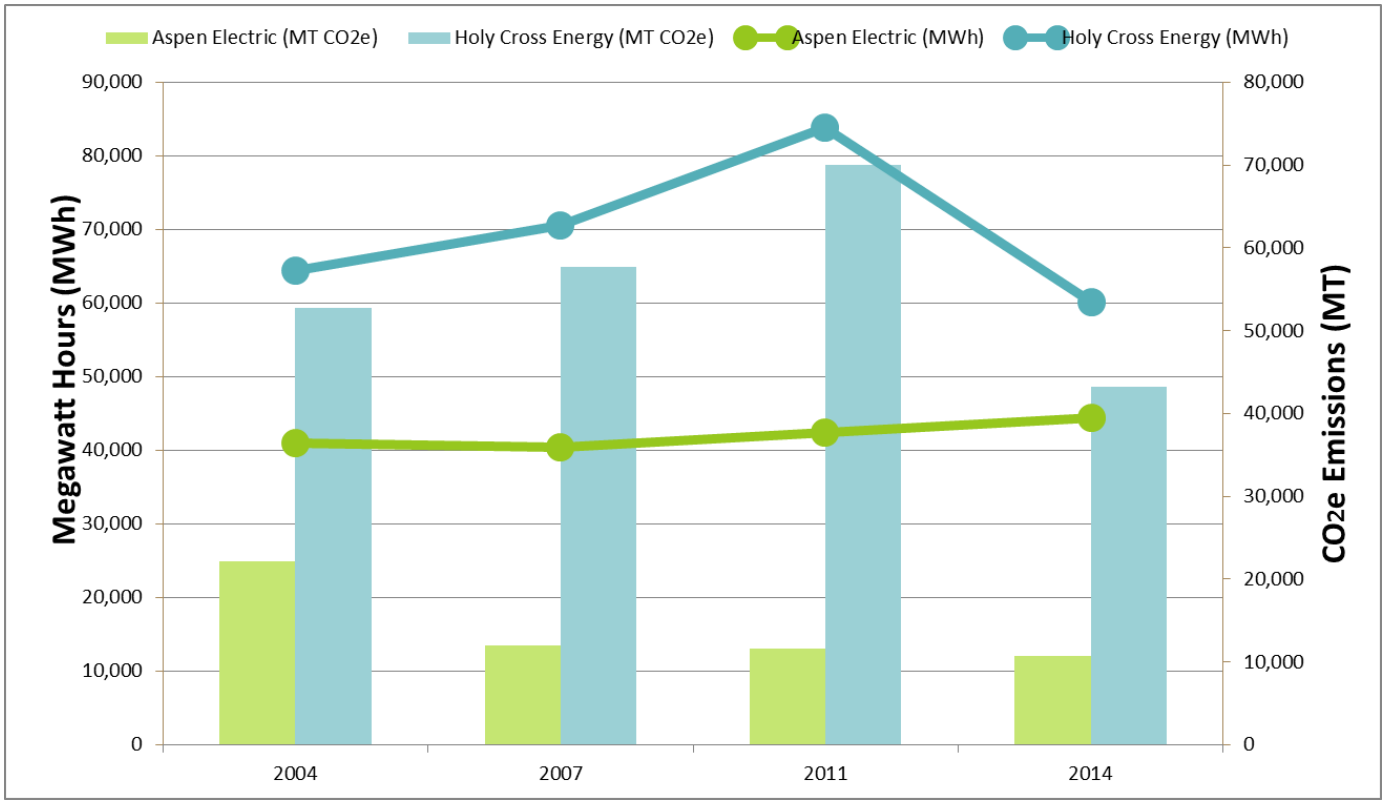

Figure 15. Commercial electricity consumption and emissions, 2004-2014

While Holy Cross Energy has also made strides in decarbonizing their electricity supply, this has not occurred to the same extent as at Aspen Electric, which can be observed in the more parallel relationship between the changes in electricity consumption (blue line) and CO_2e emissions (blue bars) attributable to commercial purchases of Holy Cross Energy between 2004 and 2014.

Photo 13 (both). Aspen's commercial energy emissions declined 26% between 2004 and 2014, in part thanks to major energy efficiency upgrades at large buildings and facilities within the EIB. Between 2015 and 2017 the Aspen Energy Challenge will enhance efficiency incentives and offerings to both the residential and public sector. Photos: C Menges

Natural Gas: Since 2004, GHG emissions related to the stationary combustion of natural gas in commercial and municipal buildings have declined by 24%. As described in the residential energy section above, the carbon intensity of natural gas has remained the same since 2004. Thus, the drop in emissions corresponds directly to a decline in consumption. A visualization of this relationship can be seen in Figure 12. Interestingly, consumption and emissions from natural gas increased by 21% in the residential energy sector yet declined by 24% in the commercial energy sector (Figure 16). When natural gas-related emissions from both residential and commercial are combined, the data reveals an overall decrease of 6% within the EIB.

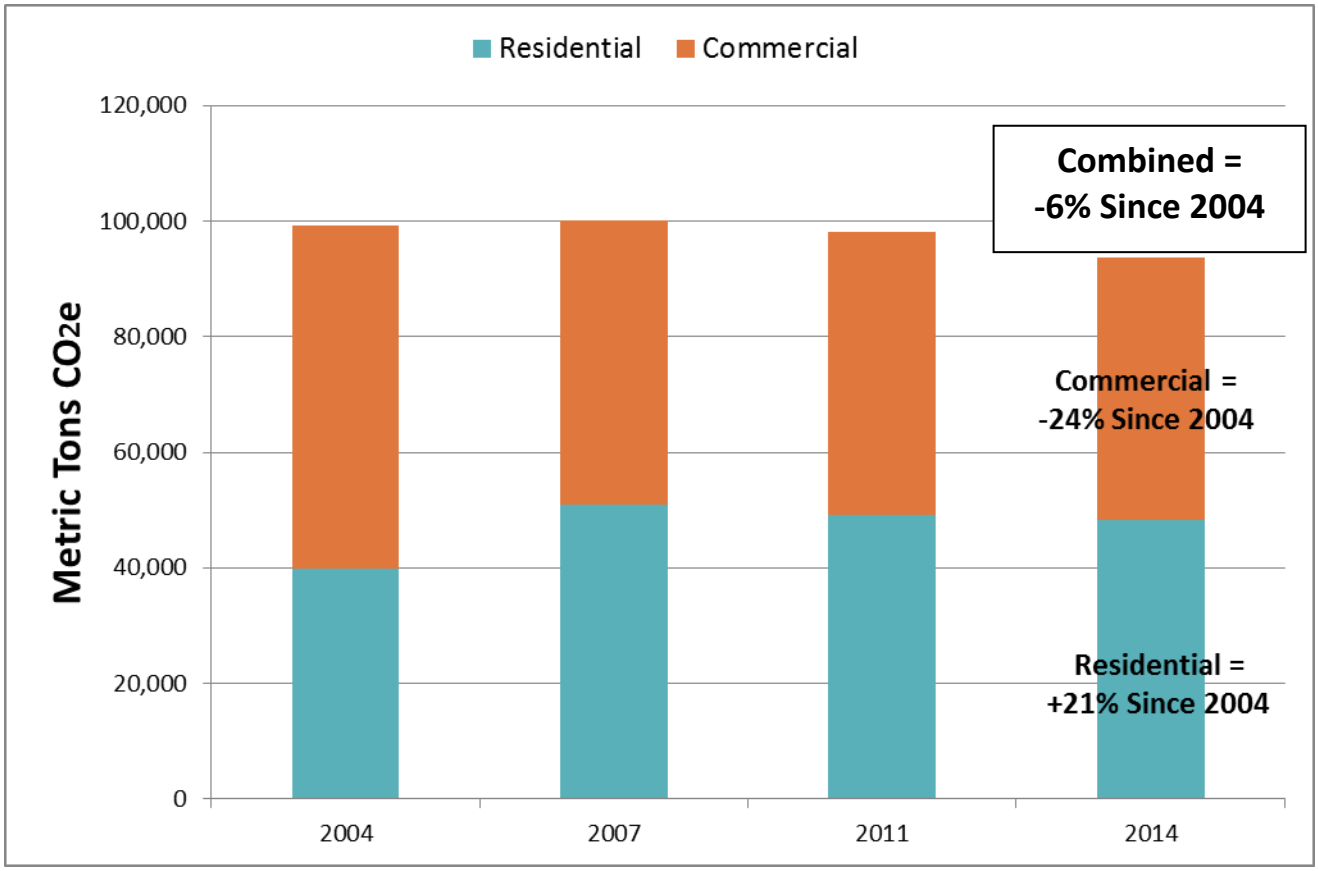

Figure 16. Combined natural gas emissions (residential and commercial), 2004-2014

One explanation for the varied change distribution between residential and commercial may lie in data collection methodologies. During the early community-wide GHG inventory years (2004 and 2007), Aspen's natural gas provider (at that time Kinder Morgan) had a less granular ability to aggregate consumption data and sort it between residential and commercial users than SourceGas (Aspen's current natural gas provider) does today. In 2010, SourceGas began using a new computer system which improved the accuracy of the data provided. As such, there is a much smaller variance in the difference between emission changes in both the residential and commercial energy sector from 2011 to 2014 (in each case a 1% decrease). Accordingly, paying attention to the combined (residential and

commercial) change in natural gas emissions between 2004 and 2014 is likely a more accurate way to assess whether or not general progress has occurred in this area. On the other hand, it is completely possible that the money and energy saving building upgrades deployed by a notable portion of commercial and municipal building operators over the last 10 years is responsible for the more pronounced emissions reductions achieved in the commercial energy sector.

Based on the overall 6% reduction in net residential and commercial emissions related to natural gas, combined with the increases in population and economic activity that have occurred within the EIB since 2004, it is safe to say that energy efficiency programs have likely been successful in mitigating what would have otherwise been substantial growth in associated GHG emissions. It should also be noted that moving forward, improved data collection capabilities (since 2011) will provide a more accurate portrayal of year to year changes in natural gas consumption as allocated between the residential and commercial energy sectors.

Combined Building Energy

As discussed in both the residential and commercial energy sections, delineating between the two sectors is important for identifying programmatic energy efficiency opportunities. At the same time, looking at total building energy is likely the most accurate way to assess overall GHG reduction progress in the built environment given uncertainties about delineation capabilities during the early inventory years. Though combined building energy is not an official *Inventory* sector, analysis on total building energy emissions for the Aspen community is presented below in order to provide the full context to readers.

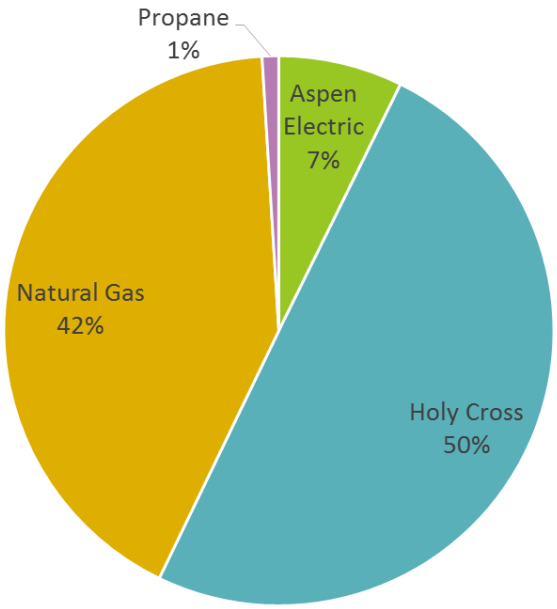

Figure 17. Sources of combined building energy emissions, 2014

In 2014, combined building energy emissions were predominantly attributable to purchases of electricity from Holy Cross Energy (50% of total). The stationary combustion of natural gas, purchased from SourceGas, comprised the second largest individual component of total 2014 building energy emissions, at 42%. Purchased electricity from Aspen Electric accounted for 7% of total building energy emissions in 2014, while the stationary combustion of propane from all vendors constituted 1% of the total.

The combined building energy analysis (residential and commercial) reveals that since 2004:

- Emissions related to all energy use in combined buildings have declined by 11%;
- Emissions related to purchased electricity from Aspen Electric have declined by 52%;
- Emissions related to purchased electricity from Holy Cross Energy have declined by 4%;
- Emissions related to the combustion of natural gas have declined by 6%; and
- Emissions related to combustion of propane have declined by 23% (Figure 18 – all bullets)

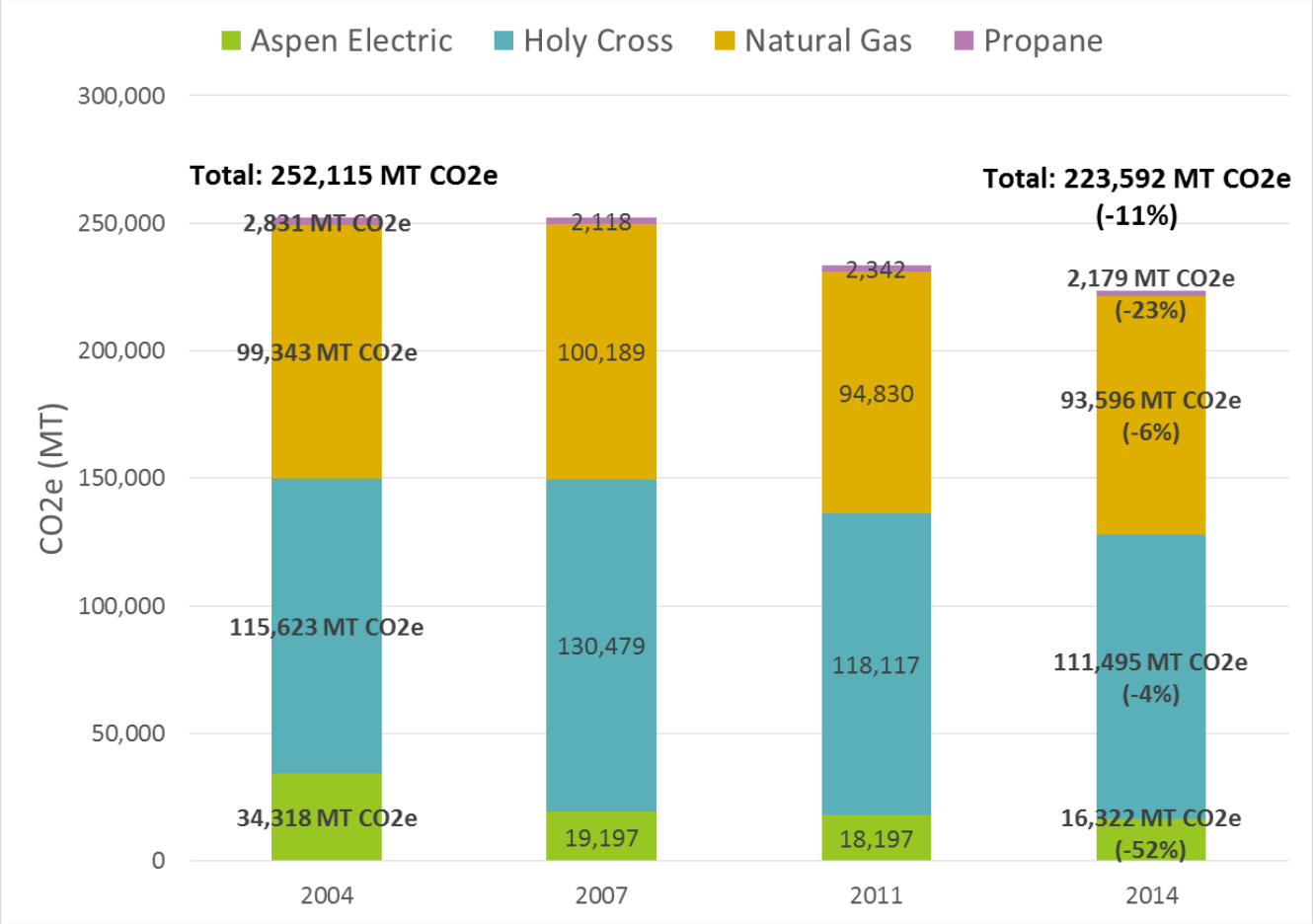

Figure 18. Combined building energy emissions, 2004 - 2014

These results suggest that programs to reduce per capita energy consumption in buildings and facilities have been successful. In particular, community-wide reduction in the combustion of propane has been significant. While the emissions reductions associated with purchases of electricity from Aspen Electric are very substantial, a majority of this drop can likely be attributed to large increases in the amount of renewable energy supplying those customers.

Given that the carbon intensity of natural gas has not changed over the years, the 6% decrease in combined building energy emissions from natural gas between 2004 and 2014 can be fully attributed to a drop in consumption, which is most likely related to an increase in efficiency. As with Aspen Electric, Holy Cross Energy's delivered electricity contained a higher percentage of renewables in 2014 than it did in 2004. As previously noted, in 2004, Aspen Electric was about 35% renewable and Holy Cross Energy was approximately 6% renewable. Those numbers climbed to 74% and 20.3%, respectively, by 2014.

Photo 14. A mixture of residential and commercial buildings. Combined building emissions are down 11% since 2004. Photo: C Menges

Photo 15. Vehicle emissions, discussed in the following section are down, thanks in part to infrastructure that incentivizes travel by foot and bicycle. Photo: C Menges

Vehicles Traveling Within and To/From Aspen

The vehicles sector comprises emissions associated with the movement of people and goods as well as service and transit vehicles on roads within the EIB and to Aspen-attributable trips originating from, or destined to, the EIB. The combustion of gasoline and diesel in vehicle engines produces CO_2, N_2O and CH_4 emissions, and electric vehicles (EVs) produce emissions associated with the generation of electricity needed to charge those vehicles.

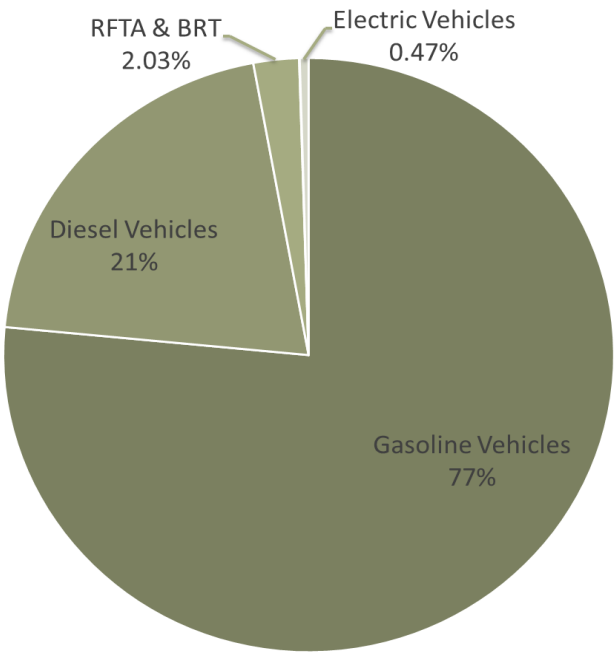

Figure 19. Percent of vehicle emissions by vehicle type, 2014

In 2014, emissions from vehicles traveling within and to/from Aspen totaled 74,883 MT of CO_2e.

A large portion of these emissions (77%) come from gasoline powered passenger vehicles (cars and light trucks/SUVs) with a significant portion coming from diesel powered passenger vehicles and heavy trucks (21%). A very small percentage (2%) were from Roaring Fork Transit Authority (RFTA) buses and less than 1% of vehicle emissions came from electric vehicles and RFTA's rapid transit (BRT) buses.

In the methodology that was used to quantify emissions from transportation, RFTA buses represent city bus routes traveling within the EIB (for example the Hunter Creek, Castle/Maroon and Burlingame routes), and the BRT buses represent commuter buses (for example Glenwood to Aspen) and assign emissions associated with their travel to Aspen based only on the portion of their trips occurring within the EIB, as is recommended by the USCP.

Photo 16. A majority of Aspen's vehicle emissions are from private vehicles, while less than 3% are from public transit. Photos: C Menges

CO_2e from on-road vehicles comprised 19% of community-wide emissions in 2014; a proportion that has barely fluctuated since the base year. Between 2004 and 2007, emissions from vehicles had dropped 7%. By 2011, vehicle emissions had been reduced by 12%. By 2014, emissions related to vehicles traveling within the EIB and to and from Aspen had decreased 13% since the base year (Figure 20).

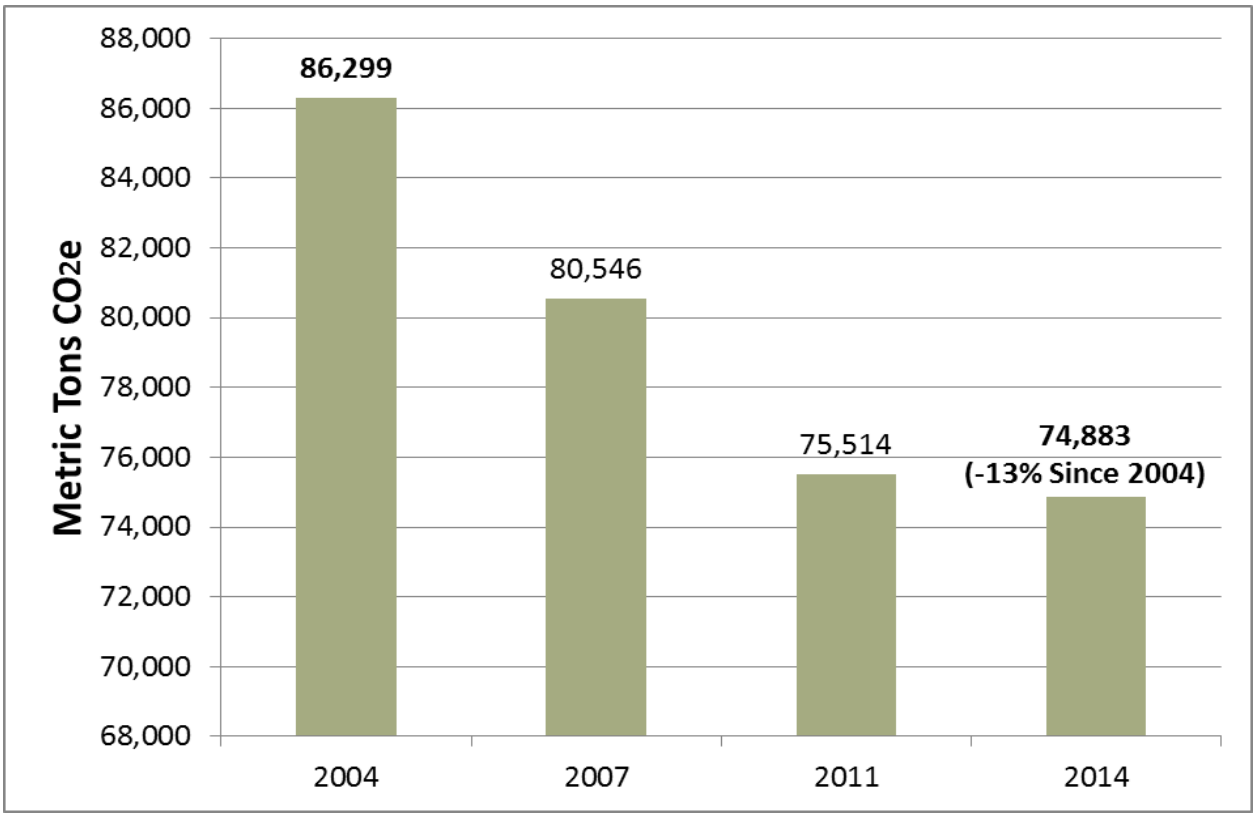

Figure 20. Vehicle emissions, 2004-2014

Photo 17. Vehicles enter and exit Aspen via the Castle Creek Bridge, where a counter tallies daily traffic.

The observed reduction in vehicle emissions relates to a decrease in annual vehicle miles traveled (VMT) and an increase in fleet-wide fuel economy. This dynamic can be seen by comparing the rate of decrease in both emissions and actual VMT. While emissions have decreased 13% since 2004, VMT has only decreased 5.93% (Figure 21). Because this decrease in VMT combines with an increase in the average miles per gallon (MPG) (22 MPG for the average gasoline vehicle in Aspen in 2004 versus 24.4 MPG in 2014), the associated decrease in emissions is magnified.

Vehicle miles travelled, or VMT, is calculated by multiplying the amount of daily traffic on the roadway segments within the area of interest (in this case the EIB) by the length of those segments, and then summing all of the segments' VMT together to generate an area-wide total. Using VMT to calculate emissions is the preferred USCP methodology.

On-road transportation emissions were calculated using output data from a detailed VMT model developed for the City of Aspen by Charlier Associates, a Boulder-based transportation consulting firm. Past VMT estimates for 2004 through 2011 were recalibrated with the 2014 model to ensure consistent comparisons across years. Several important methodological updates were applied to the 2014 VMT estimate. Noteworthy methodological changes applied in the 2014 model for estimating Aspen's VMT relate to how vehicle related emissions occurring throughout the "travelshed" (the road network area between Aspen, Parachute, and No Name) are attributed to Aspen. While in past years, emissions from round-trip travel to and from Aspen were fully attributed to the Aspen community, the USCP compliant methodology used for this *Inventory* ascribes 50% of the emissions from commuter trips to Aspen. The protocol compliant trip attribution methodology highlights the fact that each municipality within a *travelshed* shares responsibility for commuter trips, which possess both an origin and a destination. Ascribing a

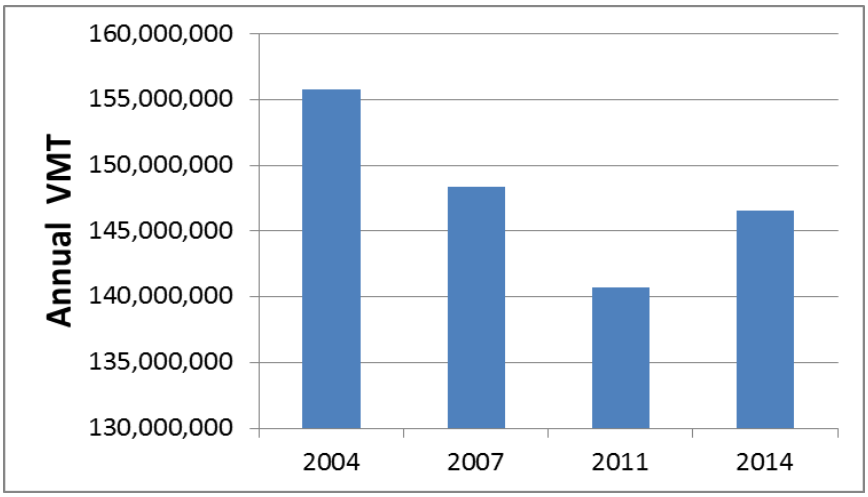

Figure 21. Annual Vehicle Miles Travelled in the EIB, 2004-2014

portion of each trip's emissions to both the origin and destination city reduces the likelihood of double counting transportation emissions while ideally facilitating multijurisdictional mitigation planning.

Given the commuter trip attribution and other methodological changes, the scale of Aspen's transportation emissions in relation to other sectors is presented as a smaller slice of the total emissions pie than in past years. Historically, under the original methodology, vehicle related emissions comprised around 40% of Aspen's total. With this updated approach, on-road transportation emissions now range between an18% and 20% slice of Aspen's total GHG pie for all inventory years.

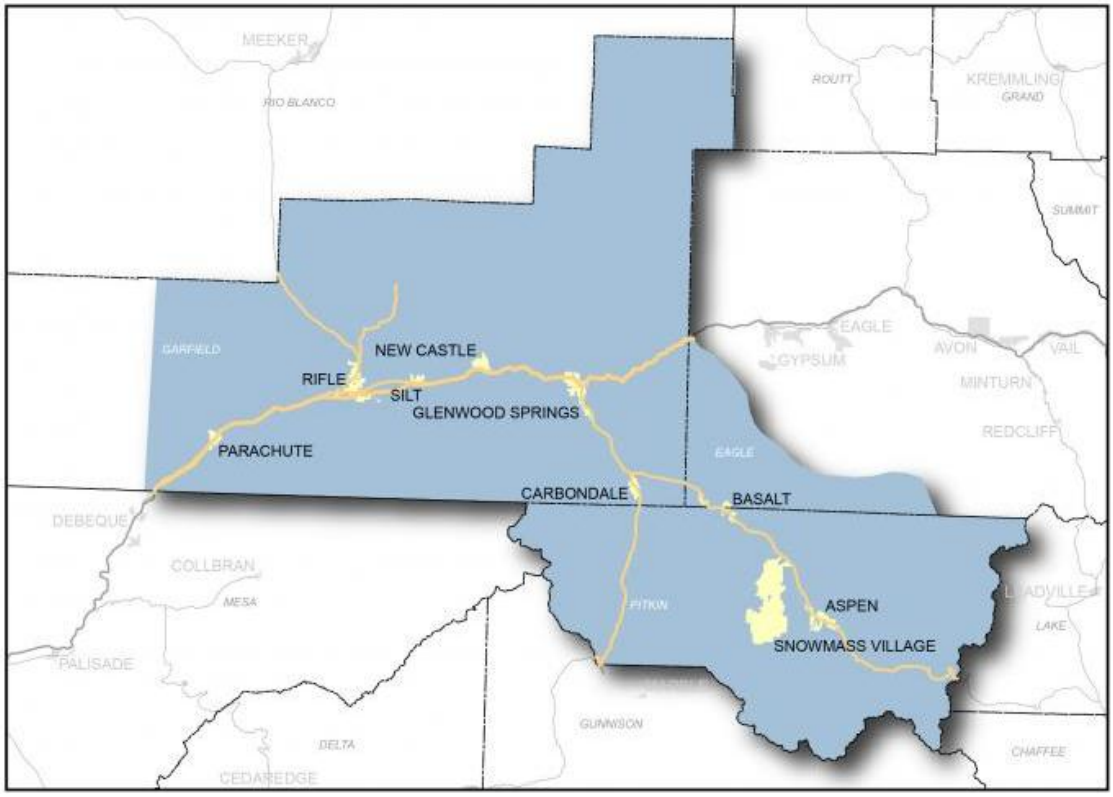

Figure 22. Roaring Fork Valley "Travelshed" (RFTA & Charlier Associates, 2014)

These methodological changes not only increase the accuracy of the VMT and transportation emissions estimates, but bring the *Community-wide Inventory* into compliance with the USCP by only attributing a prescribed/accurate portion of commuter trips to Aspen. This change is anticipated to facilitate more accurate travelshed-scale planning, which is necessary if communities in the region are to collaboratively impact this shared GHG sector and quality of life challenge.

Photo 18. At current peak-season VMT rates, Aspen often becomes congested with a mix of local, commuter and visitor traffic. An upcoming update to the 'Bike and Pedestrian Master Plan' seeks to provide travelers with safe routes to move throughout the City.

Photo 19 (both photos). The present provides a glimpse into various plausible futures in downtown Aspen. One remains dominated by vehicle traffic and the other balances all needs and encourages alternate transit. The community will decide which future is most desirable for Aspen.

Airport Emissions

Emissions related to the Aspen/Pitkin County Airport (ASE) comprise one of the five large source categories and represent 15% of the GHG emissions included in the *2014 Community-wide Inventory*. Emissions from fuel dispensed for aircraft and ground support equipment (GSE) at ASE totaled 58,525 MT in 2014. In calendar year 2014, aircraft and ground support equipment emissions had increased 15% since 2004 and 21% since 2011 (Figure 23). ASE officials attribute this increase to a greater number of passengers being served and flying longer distances directly to and from the Airport. While less aircraft operations (the number of takeoffs and landings) are occurring, more passengers are being served, resulting in an overall increase in the per passenger efficiency of the regional aircraft service.

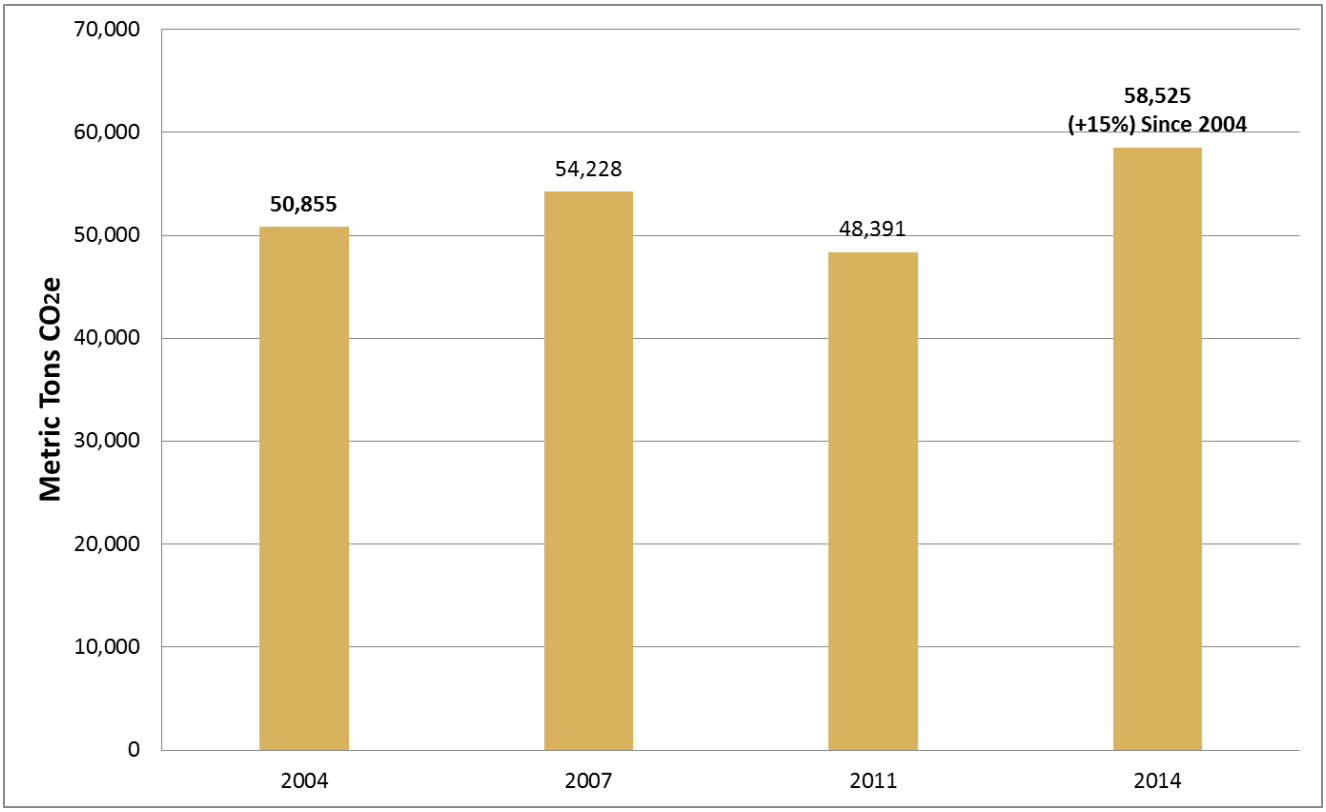

Figure 23. Aspen-attributable Airport emissions, 2004-2014

The Aspen/Pitkin County Airport has conducted entity-level GHG inventories since 2004, and provided the City of Aspen with an update for 2014 (Appendix L). Their quantification approach in 2014 was the same that has been applied in their past inventories, so the reported 2004, 2007, 2011 and 2014

emissions and data are fully comparable. Per the airport industry's standard approach to accounting for emissions, CO_2, not CO_2e are reported.

Pitkin County was one of the first airports in the United States to prepare an airport-wide GHG inventory. The approach that Pitkin County follows was established in the Transportation Research Board's Airport Cooperative Research Program Report 11 *Guidebook on Preparing Airport Greenhouse Gas Emissions* (ACRP, 2009). Following that guidebook, Pitkin County reports Airport-related GHG emissions according to the sources the County owns or controls, which are limited to purchased energy to power airport facilities, natural gas, and fuel to power airport fleet vehicles. The County also separately reports the emissions of its airport tenants which it does not have authority over, since aircraft are controlled by the federal government. A third category of ground vehicle emissions are also reported reflecting passenger travel to and from the Airport. ASE's complete entity-specific emissions are presented in Appendix L.

Photo 20. Aspen/Pitkin County Airport. Photo: Gloria Bouillon, ASE.

The *Community-wide Inventory* used the Airport numbers, extracting the aircraft-related GHG emissions from fuel dispensed for Airport and tenant aircraft and ground support equipment (GSE), which are not captured in other sectors (for example, Holy Cross Energy purchases for Airport facilities are captured in the commercial energy sector while vehicles traveling to and from the Airport are captured in the vehicles sector). The relevant portions of ASE's inventory results (those which cannot be assigned to another sector) have been directly integrated into the Airport section of this *Community-wide Inventory* and are presented in Appendix J.

It is important to reinforce, that because the ASE is within the EIB, a portion of the CO_2 emissions that Pitkin County includes in its entity-specific inventory (described above) are captured in other sections of the *Community-wide Inventory*. Specifically, the Airport's electricity and natural gas use is reported by ASE but captured in the *Inventory* in the commercial energy sector. This also applies to CO_2

emissions from passenger cars and trucks, hotel shuttles and other vehicles traveling to the Airport, all of which are captured in the vehicles section of the *Inventory*.

However, aircraft-related emissions cannot be assigned to any other *Inventory* sector. Accordingly, the *Community-wide Inventory's* Airport sector reports emissions from:

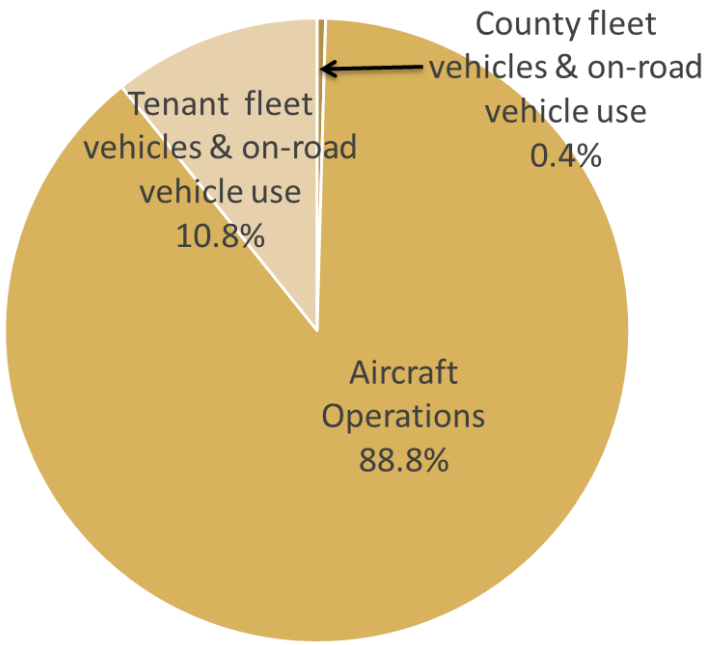

Figure 24. Sources of Airport CO_2 attributable to the Aspen Community.

- Pitkin County owned or controlled airport fleet vehicles/ ground support equipment (GSE, or fleet vehicles) and on-airport road ground access vehicles (0.4% of the total airport-related emissions)
- Aircraft approach, taxi/idle/delay, take off, climb out and residual/cruise/ Auxiliary Power Unit (APU), represented by dispensed aircraft fuel (88.8% of the total airport-related emissions); and
- Airline and tenant owned or controlled GSE and on-airport road ground access vehicles (10.8% of the total airport-related emissions).

Reported emissions for aircraft operations clearly represent the most significant component of Airport sector GHG emissions and are tied to the amount of Jet A Fuel and aviation gasoline (AV gas) that is dispensed (collectively referred to as aircraft fuel).

It is also important to note that the USCP recommends ascribing airport emissions to municipalities based on the proportion of passengers that are originating from or destined to that particular city. In this case, the USCP ideally would allocate ASE emissions to communities served (like Aspen, Basalt, Carbondale and Snowmass Village) based on the percentage of passengers traveling to or from them. The Protocol is designed this way to enable each community served by an airport to conduct its own community–wide GHG inventory while avoiding double counting (Aspen and Snowmass should not both count all ASE community-attributable emissions, but rather their own individual portions). Because ASE is within Aspen's EIB, and because the *Inventory* authors were unaware of commitments from other ASE- served communities to conduct community based inventories reflecting air travel at the time of writing the report, a decision was made to allocate all of ASE's aircraft related emissions to the Aspen community. It is plausible that the USCP preferred method (described above) will be applied to future community-wide inventories, if and when other communities being served by ASE are also conducting inventories and ascribing an appropriate portion of aircraft related emissions to their

communities. This change would also be reliant on ASE's ability to provide municipalities with that type of information.

Photo 21. A commercial aircraft landing at ASE. While the overall number of landings and takeoffs are down since 2004, larger planes are transporting more passengers into and out of Aspen. This trend requires dispensing more aircraft fuel but has increased the overall efficiency of the aircraft service. Photo: Gloria Bouillon, ASE.

Between 2004 and 2014, emissions associated with aircraft operations (defined as either a takeoff or a landing), and therefore tied to dispensed aviation fuels, increased 15%. Interestingly, and in contrast, total aircraft operations have declined over the same period. For example, between 2011 and 2014, total aircraft operations decreased 6% while the volume of aircraft fuel dispensed at ASE increased by 20%. Conversations with Airport staff indicate that one possible reason for this increase is that the proportion of larger aircraft using the facility has increased. Correspondingly, more passengers are able to be served by fewer aircraft, which is supported by the fact that the total number of passengers using ASE facilities increased by 14% between 2004 and 2014 (from 383,158 passengers per year in 2004 to 438,256 passengers per year in 2014). Another possible driver contributing to the increases in ASE's dispensed fuel and community-attributable GHG emissions is the recent runway extension. The runway extension has allowed airplanes to operate without weight restrictions; before the extension was undertaken, the airlines could not sell all seats on the aircraft on hot days. With the extension, the airlines can sell all available seats, which in turn requires more fuel.

Aspen's economy is closely tied to tourism, and ASE is an integral component of the tourist-based economy, and a valued community attribute. While directly addressing aircraft emissions may be beyond the City of Aspen's direct purview, ASE officials have shared that the aviation sector is working hard to reduce the carbon intensity of air travel. According to the Air Transportation Action Group, net aviation carbon emissions will be halved from 2005 levels by 2050. Further, airlines have a goal of increasing fleet fuel efficiency 1.5% per year through 2020, and holding emissions flat from there forward. The degree to which these changes might affect the GHG emissions that the Aspen community is responsible for remains to be seen.

Continued tracking of aircraft emissions at ASE, remains an important component of the *Community-wide Inventory* as doing so provides context for scaling efforts related to other emissions sectors. The City anticipates maintaining a productive working relationship with ASE and is encouraged by the Airport's willingness to help educate visitors about car-free vacations and the formalization of a long-term sustainability strategy (currently anticipated to be released late 2015 to mid-2016).

Photo 22. Commercial aircraft in Aspen. At present, all aircraft emissions are assigned to the Aspen community, regardless of a passenger's origin/destination. This accounting could change in the future as other communities served by ASE begin tracking community-wide emissions, and assign a representative portion of aircraft emissions to their community. Photo: Gloria Bouillon, ASE

Landfill Emissions

GHG emissions result from both the management and disposal of solid waste, and the *2014 Inventory* quantifies emissions arising from solid waste generated within the community and disposed outside of its boundaries. Aspen's municipal solid waste (MSW) is transported outside of the EIB to the Pitkin County Solid Waste Center (PCSWC, Landfill). Given that this facility is outside of the EIB, only the portions of Landfill-related emissions attributable to the Aspen Community are quantified in the *Inventory*. The 2014 GHG analysis revealed that 78% of the MSW received at the PCSWC originated within the EIB. Therefore, 78% of the following total Landfill-attributable emissions are included in the *Community-wide Inventory*:

- Fugitive emissions from landfilled MSW (from both private and commercial sources);
- Fugitive emissions from landfilled construction and demolition (C&D) waste;
- Electricity used in on-site PCSWC facilities (not captured in the commercial energy sector, rather allocated specifically to the landfill); and
- Diesel and gasoline used in on-site PCSWC facilities (not captured in the transportation sector, rather allocated specifically to the landfill).

Photo 23. A machine burying daily MSW deposition at the Pitkin County Solid Waste Center. Operating equipment combusts diesel, while organic MSW like food and paper emit CH_4 during decomposition. Photo: PCSWC

Fugitive GHG emissions come from facilities or equipment due to leaks and other unintended or irregular releases. GHG emissions from decomposing waste in landfills are considered fugitive because they are unintentional. Like direct emissions from power plants or tailpipes, fugitive emissions contribute to climate change. The decomposition of organic MSW in landfills emits CH_4, a GHG with climate warming impact 21 times as strong as CO_2. Because organic material such as food waste is the main source of fugitive CH_4 emissions from the Pitkin County Solid Waste Center, composting and programs like SCRAPS represent a significant opportunity to reduce Landfill-related emissions.

Overall, emissions related to landfilled waste originating within the EIB totaled 37,312 MT of CO_2e in 2014. A large majority of Aspen's emissions in this sector came from landfilled MSW. Residential MSW accounted for 16% and commercial MSW accounted for 58% of total landfill-related emissions. Construction and demolition waste (residential and commercial combined) accounted for 26% while the electricity and transportation fuels used on-site were responsible for less than 1% when combined.

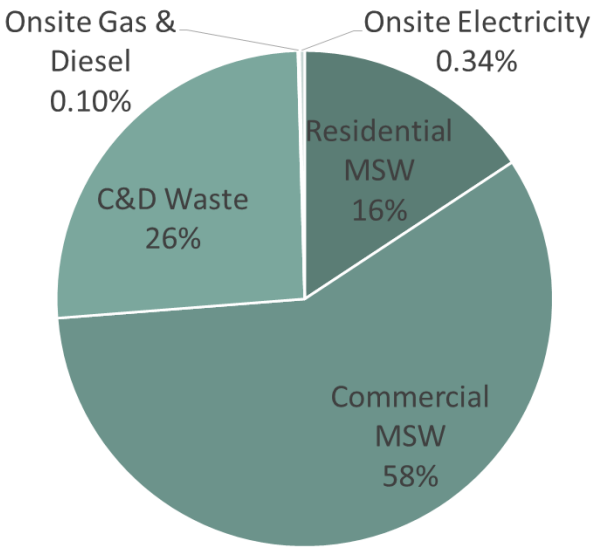

Figure 26. Sources of Landfill emissions, 2014

Since 2004, the Aspen community's total waste-related emissions have increased 2% (Figure 25). Breaking that total down into various components reveals that emissions related to fugitive methane from residential and commercial MSW have both declined (19% and 17%, respectively) while emissions attributable to C&D waste have pronouncedly increased. Though emissions related to on-site electricity use have increased, the largest drop within the landfill sector's emissions is tied to a drop in the use of on-site gasoline and diesel usage.

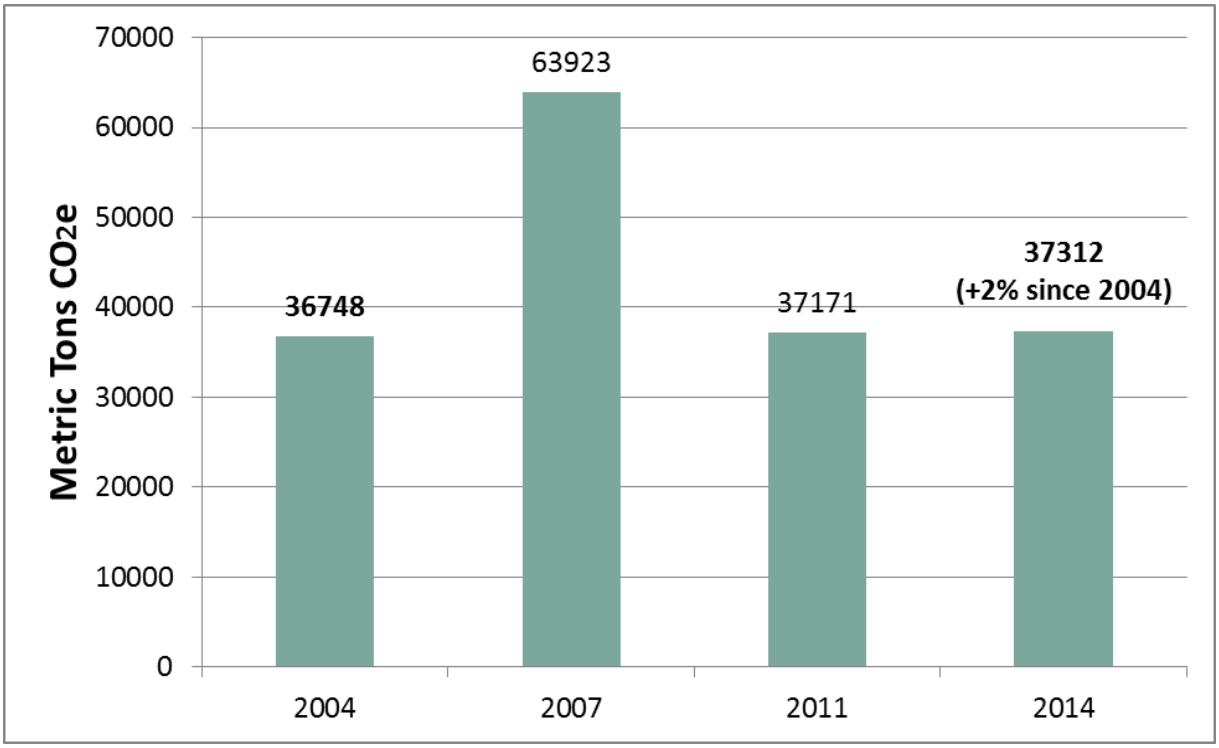

Figure 25. Landfill Emissions (Aspen's portion), 2004-2014

These results indicate that the City of Aspen's waste diversion programs to encourage more recycling and composting have been successful over the years. They also indicate that there has been resurgence in building activity, especially since 2011, and that the associated amount of C&D waste originating from Aspen and destined to the Landfill has increased dramatically. Correspondingly, this trend may indicate a strong need to address landfilled C&D waste.

Construction and demolition (C&D) waste is responsible for 26% of Aspen's Landfill -related emissions. Emissions from C&D waste have risen dramatically since 2004, reflecting a corresponding increase in building activity throughout the community. At left, two sources of C&D Waste: a new home being built in the West End and teardown at the site of the new Ruby Park Transit Center.

The USCP-compliant methodology for calculating waste-related emissions is to multiply the tons of solid waste originating within Aspen by a corresponding waste characterization emissions factor, which is itself based on the average composition of Aspen's MSW (the higher the composition of organics in the MSW stream, the more GHG intensive the factor). Accordingly, waste diversion programs that remove organics from the MSW stream provide an opportunity to achieve corresponding reductions in Landfill-related emissions.

As with some other sectors, one reason for the surprising changes we've seen in some Landfill emissions categories have to do with inconsistencies in available data. For one, each of the seven waste haulers operating in Aspen provides the City with annual "hauler reports" yet no consistent parameters for ensuring consistent or accurate reporting have been realized or implemented. Additionally, conversations with City and Landfill staff reveal a high level of confidence that data collection and reporting related to C&D waste and the on-site use of gasoline and diesel has varied widely since 2004. The *2014 Inventory* quantified emissions using the best available data, with assurances that high resolution consistency and comparability will be more achievable in future years. These data inconsistencies highlight a strong need to establish consistent metrics for tracking waste and Landfill-related activities moving forward.

Photo 24. Compactors unload organics - predominantly food waste - for composting at the PCSWC. The SCRAPS composting program helps avoid fugitive CH4 emissions and elongate the PCSWC's lifespan. Photos: J Isenhart

Offering Aspen citizens many options for waste services is a result of both State regulatory constraints and the consumer's demand for choice. Since the state regulations prevent Aspen from limiting commercial waste hauling, increasing voluntary participation in waste reduction must include residents, businesses and waste haulers to be successful.

Wastewater Treatment Emissions

CO_2e emissions related specifically to wastewater treatment totaled 29 metric tons in 2014, representing a 12% decrease since 2004 and a 6% decrease since 2011. Wastewater emissions represent less than 1% of the Aspen community's total GHG picture, making the sector "de-minimis" (too small to merit consideration). While wastewater emissions have been excluded from the community-wide graphics above due to their disproportionately small size, the sector remains in the inventory as required by the USCP. Given that Aspen's wastewater treatment plant is within the EIB, emissions related to the facility's building energy and ground transportation are captured in other sectors of the inventory. Sources of emissions specific to the Aspen Consolidated Sanitation District (ACSD) contained in the *Inventory* include:

- Process and N_2O emissions from the nitrification/denitrification process (down 12% since 2004)
- Process and N_2O emissions from effluent discharge to rivers and estuaries (down 14% since 2004)

Both of these represent biogenic sources of GHG emissions, meaning that they are produced or brought about by living organisms. In the case of the Sanitation District, N_2O, a powerful GHG, is an intermediary product of the specialized, biologically mediated process to remove excess nitrogen from wastewater before discharge. Additionally, a fraction of the nitrogen discharged into natural waters (the Roaring Fork River) may undergo a similar process and also produce N_2O, as is quantified in the *Inventory*. Generally, wastewater emissions are calculated based on the daily nitrogen load (in kilograms of nitrogen per day) of effluent discharge from ACSD in conjunction with the population that the facility serves. Population served was estimated using daily inflow. Both daily load and daily flow rates were obtained directly from ACSD, which were consistent cross all years.

Photo 25 (all). Wastewater treatment process and facilities at the Aspen Consolidated Sanitation District. Photos: C Menges

Conclusion

Despite growth in both population and economic activity since 2004, the Aspen community has successfully reduced its overall GHG emissions by 7.4% since that time. While this rate of decrease will not facilitate the successful fulfillment of Aspen's 2020 or 2050 GHG reduction goals, it does demonstrate that it is possible to grow the economy and serve more residents while simultaneously reducing emissions.

Whether or not quality of life has improved for most residents of and visitors to Aspen over this same time period is subjective. However, several initiatives responsible for facilitating a part of the 7.4% GHG reduction likely have enhanced the overall wellbeing of the community. One of these, the growth in RFTA ridership since 2004, has mitigated traffic congestion (as compared to lack of action), saved commuters time and money and improved Aspen's air quality, while also reducing GHG emissions. Similarly, Aspen Electric's efforts to dramatically bolster the percentage of its sales coming from renewable energy has saved consumers money, earned publicity for the community, and fostered citizen engagement while dramatically cutting emissions. Both of these examples indicate that programs aimed at reducing emissions can often enhance a community and quality of life by generating a myriad of co-benefits.

Photo 26. Affordable housing installations such as the 2nd phase of Burlingame can improve quality of life while also reducing GHGs. Residents save money in energy efficient dwellings bolstered by on-site renewables and enjoy alternate transit options such as the free RFTA bus and accessible bicycle and pedestrian corridors; all resulting in fewer per-capita building and vehicle emissions within the EIB. Photo: C Menges

In moving towards 2020 and 2050, it is clear that accomplishing the community-wide goal of reducing GHG emissions by 30% and 80%, respectively, is a challenge that will require ongoing planning and dedication. If Aspen's history over the past 10 years offers a good indicator, it is also apparent that doing so provides an opportunity to continue enhancing quality of life for the Aspen community while being part of the solution for helping to mitigate global climate change.

Photo 27. Achieving deep emissions reductions represents both the ultimate community-wide challenge and oportunity. Following this GHG inventory, the City of Aspen Canary Initiative plans to forecast emissions under various scenarios through 2020 and 2050 in order to facilitate community-wide conversations that might guide an update to Aspen's Canary (climate) Action Plan.

Acknowledgements

Completing a Community-wide GHG inventory – particularly when using new parameters and recalculating results from all past years – is a significant undertaking requiring the contributions of many individuals. The Canary Initiative would like to thank the following individuals for contributing their support, expertise and time to the production of Aspen's *2014 Community-wide GHG Inventory*.

Aspen's City Manager **Steve Barwick**, Mayor **Steve Skadron** and the 2014 and 2015 **Aspen City Council** continue to emphasize the need to de-carbonize Aspen's energy supply and transportation infrastructure. The production of the *2014 Inventory* would not have occurred without their underlying support.

Chris Menges is Canary's Data Research and Project Planner, and the chief inventorist and author of the *2014 Community-wide Inventory*. With support and review from **Ashley Perl**, Aspen's Climate Action Manager, **Chris** designed and executed the inventory process from scoping through publication.

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Jim Charlier and **Patrick Picard** of the Boulder-based transportation firm Charlier Associates conducted a cutting edge vehicle miles traveled (VMT) analysis for 2014 and recalculated estimates for past years. This allowed the quantification of transportation sector emissions much more accurately than ever before.

Brian Grefe of the Aspen/Pitkin County Airport and their inventory consultant **Mary Vigilante** provided Aspen with an updated emissions inventory for ASE, which allowed consistent comparisons with past years data and added confidence and credibility to the reported emissions in that sector.

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- **Appendix B: 2004 GHG Emissions Roll-up**
- **Appendix C: 2007 GHG Emissions Roll-up**
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- **Appendix H: Population and Households within the EIB**
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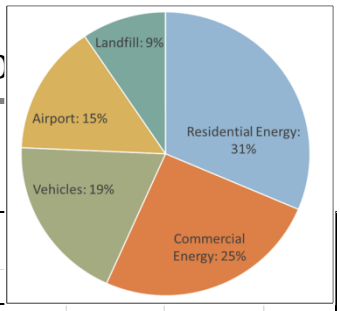
- **Appendix M: Inflation Adjusted Taxable Retail Sales and Percent Change, 2004 – 2014**



Appendix A: 2014 GHG Emissions Roll-up

City of Aspen Canary Initiative

Community Greenhouse Gas Emissions Inventory, 2014*

		Physical Units		MMBtu	CO_2 (MT)	CH_4 (MT)	N_2O (MT)	CO_2e (MT)	Percent of Total	Percent of Sector	Source/ Activity	Scope (GPC)
1. Residential Energy												
Electricity (Aspen Electric)		22,833,436	kWh	77,930	5,448	0.24	0.30	5,544	1.41%	4.48%	Activity	2
Electricity (Holy Cross)		95,006,050	kWh	324,253	67,830	0.98	1.00	68,230	17.30%	55.11%	Activity	2
Propane (Cross Propane)		55,531	Gallons	5,053	311	0.06	0.01	314	0.08%	0.25%	Source	1
Propane (Ferrellgas)		57,978	Gallons	5,276	324	0.06	0.01	327	0.08%	0.26%	Activity/Source	1
Propane (AmeriGas)		185,535	Gallons	16,884	1,048	0.19	0.02	1,048	0.27%	0.85%	Activity/Source	1
Natural Gas (Source Gas)		9,092,153	Therms	909,215	48,207	5.00	0.10	48,347	12.26%	39.05%	Activity/Source	1
Total Residential Energy				**1,338,611**	**123,168**	**6.53**	**1.44**	**123,810**	**31.40%**			
2. Commercial Energy												
Electricity (Aspen Electric)		44,393,228	kWh	151,513	10,591	0.46	0.59	10,778	2.73%	10.80%	Activity	2
Electricity (Holy Cross)		60,243,898	kWh	205,611	43,011	0.62	0.80	43,265	10.97%	43.36%	Activity	2
Propane (Cross Propane)		185	Gallons	17	1	0.00	0.00	1	0.00%	0.00%	Activity/Source	1
Natural Gas (SourceGas)		8,509,544	Therms	850,954	45,118	4.00	0.09	45,249	11.47%	45.35%	Activity/Source	1
Propane (AM Gas)		27,952	Gallons	2,544	156	0.03	0.01	158	0.04%	0.16%	Activity/Source	1
Propane (Ferrelgas)		58,603	Gallons	5,333	328	0.06	0.01	331	0.08%	0.33%	Activity/Source	1
Total Commercial Energy				**1,215,972**	**99,205**	**5.17**	**1.50**	**99,782**	**25.30%**			
Total Energy Consumption: Buildings				**2,554,583**	**222,373**	**11.70**	**2.94**	**223,592**	**56.70%**			
3. Vehicles	**MPG**											
Cars, gasoline (sedan, wagon, small SUV, crossover)	24.4	2,287,611	Gallons	812,024	57,037	2.00	0.70	57,303	14.53%	76.52%	Activity/Source	1
Truck, gasoline (med/large SUV, pickup, van, minivan)	17.9	4,082,787	Gallons								Activity/Source	1
Motorcycle, gasoline	43.5	34,650	Gallons								Activity/Source	1
Single-Unit Truck (and other bus), gasoline	7.3	88,783	Gallons								Activity/Source	1
Cars, diesel (sedan, wagon, small SUV, crossover)	25	20,593	Gallons	208,329	15,403	0.04	0.05	15,417	3.91%	20.59%	Activity/Source	1
Truck, diesel (med/large SUV, pickup, van, minivan)	17.6	370,400	Gallons								Activity/Source	1
Single-Unit Truck (and other bus), diesel	7.3	120,472	Gallons								Activity/Source	1
Combination Truck (semi, tractor-trailer), diesel	5.8	1,091,479	Gallons								Activity/Source	1
RFTA Bus (standard)	4.3	186,191	Gallons	25,619	1,806	0.00	0.00	1,807	0.46%	2.41%	Activity/Source	1
RFTA Bus (BRT)	5.8	34,199	Gallons	0	0	0.39	0.03	20	0.01%	0.03%	Activity/Source	1
Cars, electric (sedan, wagon, small SUV, crossover)	n/a	39,406	VMT	4,719	330	0.01	0.02	336	0.09%	0.45%	Activity/Source	1
Total Vehicles		**8,356,571**	Gallons	**1,050,691**	**74,576**	**2.44**	**0.81**	**74,883**	**18.99%**			
4. Airport												
Ground Support Equipment/Airport					256			256	0.06%	0.44%	Activity/Source	1
Approach					2,236			2,236	0.57%	3.82%	Activity/Source	1
Taxi/Idle/Delay					3,644			3,644	0.92%	6.23%	Activity/Source	1
Takeoff					4,110			4,110	1.04%	7.02%	Activity/Source	1
Climbout					1,069			1,069	0.27%	1.83%	Activity/Source	1
Residual/Cruise/APU					40,915			40,915	10.38%	69.91%	Activity/Source	1
Ground Support Equipment/Tenant					6,295			6,295	1.60%	10.76%	Activity/Source	1
Total Airport					**58,525**			**58,525**	**14.84%**			
Total Transportation		**8,356,571**		**1,050,691**	**133,101**	**2.44**	**0.81**	**133,408**	**33.83%**			
5. Landfill (Aspen's Share)												
Mixed Solid Waste: Residential		2,628	Tons	n/a	n/a	235.0000	n/a	5,866	1.49%	15.72%	Activity	3
Mixed Solid Waste: Commercial		11,520	Tons	n/a	n/a	866.0000	n/a	21,658	5.49%	58.05%	Activity	3
Construction and Demilition Waste: Res/Comm		23,700	Tons	n/a	n/a	385.0000	n/a	9,625	2.44%	25.80%	Activity	3
Landfill & Materials Recovery: diesel fuel		2,977	Gallons	411	30	0.0020	0.0010	31	0.01%	0.08%	Source	1
Landfill & Materials Recovery: gasoline		789	Gallons	99	7	0.0004	0.0002	7	0.00%	0.02%	Activity	3
Landfill & Materials Recovery: electricity (Holy Cross)		173,595	kWh	592	143	0.0020	0.0020	125	0.03%	0.34%	Activity	3
Total Landfill				**1,102**	**180**	**1486.0044**	**0.0032**	**37,312**	**9.46%**			
6. Wastewater												
Nitrification/Denitrification Process N2O Emissions from Wastewater Treatment		11,156	Pop. Served	n/a	n/a	n/a	0.08	23	0.01%	79.31%	Source	1
Process N2O from Effluent Discharge to Rivers and Estuaries		7	Daily N Load	n/a	n/a	n/a	0.02	6	0.00%	20.69%	Source	1
Total Wastewater				n/a	n/a	n/a	**0.10**	**29**	**0.01%**			
Total				**3,606,376**	**355,654**	**1500.1491**	**3.85**	**394,341**	**100.00%**			

Aspen Total Taxable Retail Sales, 2014:	$ 625.061.348
Aspen Population, 2014:	6,712

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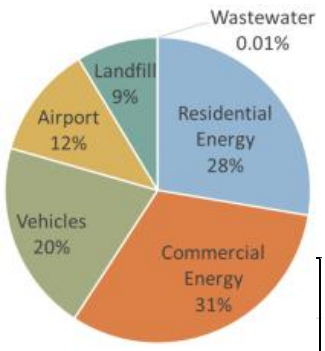

Appendix B: 2004 GHG Emissions Roll-up

City of Aspen Canary Initiative

Community Greenhouse Gas Emissions Inventory, 2004*

		Physical Units		MMBtu	CO_2 (MT)	CH_4 (MT)	N_2O (MT)	CO_{2e} (MT)	Percent of Total	Source/ Activity	Scope (GPC)
1. Residential Energy											
Electricity (Aspen Electric)		22,360,064	kWh	76,314	12,049	0.24	0.29	**12,142**	2.85%	Activity	2
Electricity (Holy Cross)		76,900,263	kWh	262,458	62,612	0.82	1.00	**62,933**	14.77%	Activity	2
Natural Gas (Kinder Morgan)		7,488,895	Therms	748,890	39,706	4.00	0.07	**39,822**	9.35%	Source	1
Propane (Ferrellgas)		251,037	Gallons	22,844	1,404	0.25	0.03	**1,418**	0.33%	Activity/Source	1
Propane (AmeriGas)		251,037	Gallons	22,762	1,399	0.25	0.03	**1,413**	0.33%	Activity/Source	1
Total Residential Energy				**1,133,268**	**117,170**	**5.57**	**1.42**	**117,728**	**27.63%**		
2. Commercial Energy											
Electricity (Aspen Electric)		40,836,545	kWh	139,374	22,006	0.44	0.56	**22,176**	5.21%	Activity	2
Electricity (Holy Cross)		64,383,596	kWh	219,739	52,421	0.69	1.66	**52,690**	12.37%	Activity	2
Natural Gas (Kinder Morgan)		7,488,895	Therms	748,890	39,706	4.00	0.07	**39,822**	9.35%	Activity/Source	1
Natural Gas (AM Gas)		3,704,498	Therms	370,450	19,641	2.00	0.04	**19,699**	4.62%	Activity/Source	1
Total Commercial Energy				**1,478,453**	**133,774**	**7.13**	**2.33**	**134,387**	**31.54%**		
Total Energy Consumption: Buildings				**2,611,721**	**250,944**	**12.69**	**3.75**	**252,115**	**59.17%**		
3. Vehicles	**MPG**										
Cars, gasoline (sedan, wagon, small SUV, crossover)	22.0	2,885,528	Gallons	971,509	68,239	2.00	2.00	**68,753**	16.14%	Activity/Source	1
Truck, gasoline (med/large SUV, pickup, van, minivan)	15.7	4,791,083	Gallons							Activity/Source	1
Motorcycle, gasoline	50.0	19,151	Gallons							Activity/Source	1
Single-Unit Truck (and other bus), gasoline	8.8	68,250	Gallons							Activity/Source	1
Cars, diesel (sedan, wagon, small SUV, crossover)	22.6	24,476	Gallons	198,406	14,669	0.04	0.05	**14,683**	3.45%	Activity/Source	1
Truck, diesel (med/large SUV, pickup, van, minivan)	15.4	450,443	Gallons							Activity/Source	1
Single-Unit Truck (and other bus), diesel	8.8	92,604	Gallons							Activity/Source	1
Combination Truck (semi, tractor-trailer), diesel	5.9	1,050,289	Gallons							Activity/Source	1
RFTA Bus (standard)	3.0	295,009	Gallons	40,592	2,861	**0.004**	0.004	**2,863**	0.67%	Activity/Source	1
RFTA Bus (BRT)	n/a	0	Gallons	0	0	**0.00**	0.00	**0**	0.00%	Activity/Source	1
Cars, electric (sedan, wagon, small SUV, crossover)	n/a	0	Gallons	0	0	**0.00**	0.00	**0**	0.00%	Activity/Source	1
Total Vehicles		**9,676,833**	Gallons	**1,210,507**	**85,769**	**2.04**	**2.05**	**86,299**	**20.26%**		
4. Airport											
Ground Support Equipment/Airport					81			**81**	0.02%	Activity/Source	1
Approach					1,958			**1,958**	0.46%	Activity/Source	1
Taxi/Idle/Delay					3,172			**3,172**	0.74%	Activity/Source	1
Takeoff					3,571			**3,571**	0.84%	Activity/Source	1
Climbout					938			**938**	0.22%	Activity/Source	1
Residual/Cruise/APU					35,673			**35,673**	8.37%	Activity/Source	1
Ground Support Equipment/Tenant					5,462			**5,462**	1.28%	Activity/Source	1
Total Airport					**50,855**			**50,855**	**11.94%**		
Total Transportation		**9,676,833**	Gallons	**1,210,507**	**136,624**			**137,154**	**32.19%**		
5. Landfill (Aspen's Share)											
Mixed Solid Waste: Residential		3,259	Tons	n/a	n/a	291.000	n/a	**7,275**	1.71%	Activity	3
Mixed Solid Waste: Commercial		13,896	Tons	n/a	n/a	1045.000	n/a	**26,125**	6.13%	Activity	3
Construction and Demilition Waste: Res/Comm		7,972	Tons	n/a	n/a	130.000	n/a	**3,238**	0.76%	Activity	3
Landfill & Materials Recovery: diesel fuel		3,782	Gallons	522	39	0.002	0.001	**39**	0.01%	Source	1
Landfill & Materials Recovery: electricity (Holy Cross)		86,171	kWh	294	70	0.001	0.001	**71**	0.02%	Activity	3
Total Landfill				**816**	**109**	**1466.003**	**0.002**	**36,748**	**8.63%**		
6. Wastewater											
Nitrification/Denitrification Process N2O Emissions from Wastewater Treatment		12,588	Pop. Served	n/a	n/a	n/a	0.09	**26**	0.01%	Source	1
Process N2O from Effluent Discharge to Rivers and Estuaries		8	Daily N Load	n/a	n/a	n/a	0.02	**7**	0.00%	Source	1
Total Wastewater				n/a	n/a	n/a	**0.11**	**33**	**0.01%**		
Total				**3,823,044**	**387,677**	**1,478.70**	**3.86**	**426,050**	**100.00%**		

Aspen Total Taxable Retail Sales, 2004:	$ 408,360,848
Aspen Population, 2004:	6,365

*Adjusted from orginal inventory to comply with U.S. Community Protocol

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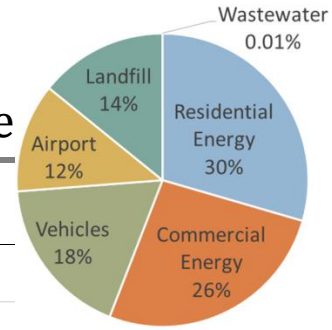

Appendix C: 2007 GHG Emissions Roll-up

City of Aspen Canary Initiative

Community Greenhouse Gas Emissions Inventory, 2007*

		Physical Units		MMBtu	CO_2 (MT)	CH_4 (MT)	N_2O (MT)	CO_2e (MT)	Percent of Total	Source/ Activity	Scope (GPC)
1. Residential Energy											
Electricity (Aspen Electric)		24,292,599	kWh	82,910	7,107	0.26	0.32	**7,209**	1.60%	Activity	2
Electricity (Holy Cross)		88,908,456	kWh	303,442	72,389	0.96	1.00	**72,760**	16.14%	Activity	2
Propane (Cross Propane)		51,226	Gallons	4,662	286	0.05	0.01	**289**	0.06%	Source	1
Propane (Ferrellgas)		36,233	Gallons	3,297	203	0.04	0.01	**205**	0.05%	Activity/Source	1
Propane (AmeriGas)		220,000	Gallons	20,020	1,230	0.22	0.02	**1,242**	0.28%	Activity/Source	1
Natural Gas (Source Gas)		9,569,334	Therms	956,933	50,737	5.00	0.10	**50,885**	11.29%	Activity/Source	1
Propane (Propane Services, Basalt)		50,000	Gallons	4,550	280	0.05	0.01	**282**	0.06%	Activity/Source	1
Total Residential Energy				**1,375,814**	**132,232**	**6.58**	**1.47**	**132,872**	**29.48%**		
2. Commercial Energy											
Electricity (Aspen Electric)		40,400,592	kWh	137,886	11,820	0.43	0.53	**11,988**	2.66%	Activity	2
Electricity (Holy Cross)		70,528,337	kWh	240,711	57,424	0.76	0.92	**57,719**	12.81%	Activity	2
Propane (Cross Propane)		17,732	Gallons	1,614	99	0.02	0.01	**100**	0.02%	Activity/Source	1
Natural Gas (SourceGas)		5,412,672	Therms	541,267	28,698	3.00	0.05	**28,782**	6.39%	Activity/Source	1
Natural Gas (AM Gas)		3,859,401	Therms	385,940	20,463	2.00	0.04	**20,522**	4.55%	Activity/Source	1
Total Commercial Energy				**1,307,418**	**118,504**	**6.21**	**1.55**	**119,111**	**26.43%**		
Total Energy Consumption: Buildings				**2,683,232**	**250,736**	**12.79**	**3.02**	**251,983**	**55.91%**		
3. Vehicles	**MPG**										
Cars, gasoline (sedan, wagon, small SUV, crossover)	22.0	2,619,150	Gallons	853,193	59,928	2.00	0.82	**60,229**	13.36%	Activity/Source	1
Truck, gasoline (med/large SUV, pickup, van, minivan)	17.5	4,074,576	Gallons							Activity/Source	1
Motorcycle, gasoline	42.7	37,984	Gallons							Activity/Source	1
Single-Unit Truck (and other bus), gasoline	7.3	107,122	Gallons							Activity/Source	1
Cars, diesel (sedan, wagon, small SUV, crossover)	22.6	22,444	Gallons	246,509	18,226	0.05	0.05	**18,243**	4.05%	Activity/Source	1
Truck, diesel (med/large SUV, pickup, van, minivan)	17.1	379,287	Gallons							Activity/Source	1
Single-Unit Truck (and other bus), diesel	7.3	145,347	Gallons							Activity/Source	1
Combination Truck (semi, tractor-trailer), diesel	6.0	1,367,312	Gallons							Activity/Source	1
RFTA Bus (standard)	4.3	213,706	Gallons	29,405	2,073	**0.01**	0.01	**2,074**	0.46%	Activity/Source	1
RFTA Bus (BRT)	n/a	0	Gallons	0	0	**0.00**	0.00	**0**	0.00%	Activity/Source	1
Cars, electric (sedan, wagon, small SUV, crossover)	n/a	0	Gallons	0	0	**0.00**	0.00	**0**	0.00%	Activity/Source	1
Total Vehicles		**8,966,926**	Gallons	**1,129,107**	**80,227**	**2.06**	**0.88**	**80,546**	**17.87%**		
4. Airport											
Ground Support Equipment/Airport					156			**156**	0.03%	Activity/Source	1
Approach					2,077			**2,077**	0.46%	Activity/Source	1
Taxi/Idle/Delay					3,381			**3,381**	0.75%	Activity/Source	1
Takeoff					3,812			**3,812**	0.85%	Activity/Source	1
Climbout					993			**993**	0.22%	Activity/Source	1
Residual/Cruise/APU					37,972			**37,971**	8.42%	Activity/Source	1
Ground Support Equipment/Tenant					5,838			**5,838**	1.30%	Activity/Source	1
Total Airport					**54,229**			**54,228**	**12.03%**		
Total Transportation		**8,966,926**	Gallons	**1,129,107**	**385,192**			**134,774**	**29.90%**		
5. Landfill (Aspen's Share)											
Mixed Solid Waste: Residential		3,631	Tons	n/a	n/a	324.0000	n/a	**8,105**	1.80%	Activity	3
Mixed Solid Waste: Commercial		15,479	Tons	n/a	n/a	1164.0000	n/a	**29,101**	6.46%	Activity	3
Construction and Demilition Waste: Res/Comm		65,412	Tons	n/a	n/a	1062.0000	n/a	**26,565**	5.89%	Activity	3
Landfill & Materials Recovery: diesel fuel		4,643	Gallons	641	47	0.0020	0.0010	**48**	0.01%	Source	1
Landfill & Materials Recovery: gasoline		681	Gallons	85	6	0.0003	0.0001	**6**	0.00%	Activity	3
Landfill & Materials Recovery: electricity (Holy Cross)		119,739	kWh	409	97	0.0010	0.0020	**98**	0.02%	Activity	3
Total Landfill				**1,135**	**150**	**2550.0033**	**0.0031**	**63,923**	**14.18%**		
6. Wastewater											
Nitrification/Denitrification Process N2O Emissions from Wastewater Treatment		11,637	Pop. Served	n/a	n/a	n/a	0.08	**24**	0.01%	Source	1
Process N2O from Effluent Discharge to Rivers and Estuaries		8	Daily N Load	n/a	n/a	n/a	0.02	**7**	0.00%	Source	1
Total Wastewater				n/a	n/a	n/a	**0.10**	**31**	**0.01%**		
Total				**3,813,474**	**385,342**	**2,562.79**	**3.12**	**450,711**	**100.00%**		

Aspen Total Taxable Retail Sales, 2007:	$ 516.899.691
Aspen Population, 2007:	6,523

*Adjusted from orginal inventory to comply with U.S. Community Protocol
Last Modifed by: Chris Menges, City of Aspen, Data Research and Project Planner
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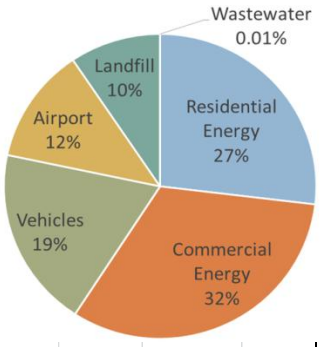

Appendix D: 2011 GHG Emissions Roll-up

City of Aspen Canary Initiative

Community Greenhouse Gas Emissions Inventory, 2011*

		Physical Units		MMBtu	CO_2 (MT)	CH_4 (MT)	N_2O (MT)	CO_2e (MT)	Percent of Total	Source/ Activity	Scope (GPC)
1. Residential Energy											
Electricity (Aspen Electric)		23,971,662	kWh	81,815	6,481	0.25	0.32	**6,581**	1.67%	Activity	2
Electricity (Holy Cross)		57,704,424	kWh	196,943	47,899	0.60	0.59	**48,142**	12.20%	Activity	2
Propane (Cross Propane)		26,817	Gallons	2,440	150	0.03	0.01	**151**	0.04%	Source	1
Propane (Ferrellgas)		48,062	Gallons	4,374	269	0.05	0.01	**271**	0.07%	Activity/Source	1
Propane (AmeriGas)		340,000	Gallons	30,940	1,902	0.34	0.03	**1,920**	0.49%	Activity/Source	1
Natural Gas (Source Gas)		9,225,104	Therms	922,510	48,912	5.00	0.10	**49,054**	12.43%	Activity/Source	1
Total Residential Energy				**1,239,022**	**105,613**	**6.27**	**1.06**	**106,119**	**26.89%**		
2. Commercial Energy											
Electricity (Aspen Electric)		42,310,815	kWh	144,406	11,428	0.43	0.56	**11,616**	2.94%	Activity	2
Electricity (Holy Cross)		83,874,350	kWh	286,261	69,622	0.86	1.00	**69,975**	17.73%	Activity	2
Natural Gas (SourceGas)		8,608,601	Therms	860,860	45,643	4.00	0.09	**45,776**	11.60%	Activity/Source	1
Total Commercial Energy				**1,291,527**	**126,693**	**5.29**	**1.65**	**127,367**	**32.28%**		
Total Energy Consumption: Buildings				**2,530,549**	**232,306**	**11.56**	**2.71**	**233,486**	**59.17%**		
3. Vehicles	**MPG**										
Cars, gasoline (sedan, wagon, small SUV, crossover)	23.9	2,116,155	Gallons	787,419	55,308	2.00	0.67	**55,562**	14.08%	Activity/Source	1
Truck, gasoline (med/large SUV, pickup, van, minivan)	17.9	4,072,651	Gallons							Activity/Source	1
Motorcycle, gasoline	43.5	27,932	Gallons							Activity/Source	1
Single-Unit Truck (and other bus), gasoline	7.3	103,509	Gallons							Activity/Source	1
Cars, diesel (sedan, wagon, small SUV, crossover)	24.5	18,312	Gallons	241,201	17,833	0.05	0.05	**17,850**	4.52%	Activity/Source	1
Truck, diesel (med/large SUV, pickup, van, minivan)	17.2	373,154	Gallons							Activity/Source	1
Single-Unit Truck (and other bus), diesel	7.3	140,444	Gallons							Activity/Source	1
Combination Truck (semi, tractor-trailer), diesel	5.8	1,345,850	Gallons							Activity/Source	1
RFTA Bus (standard)	4.2	216,515	Gallons	29,791	2,100	0.01	0.01	**2,102**	0.53%	Activity/Source	1
RFTA Bus (BRT)	n/a	0	Gallons	0	0	0.00	0.00	**0**	0.00%	Activity/Source	1
Cars, electric (sedan, wagon, small SUV, crossover)	n/a	0	Gallons	0	0	0.00	0.00	**0**	0.00%	Activity/Source	1
Total Vehicles		**8,414,521**	Gallons	**1,058,411**	**75,241**	**2.06**	**0.73**	**75,514**	**19.14%**		
4. Airport											
Ground Support Equipment/Airport					147			**147**	0.04%	Activity/Source	1
Approach					1,852			**1,852**	0.47%	Activity/Source	1
Taxi/Idle/Delay					3,017			**3,017**	0.76%	Activity/Source	1
Takeoff					3,402			**3,402**	0.86%	Activity/Source	1
Climbout					886			**886**	0.22%	Activity/Source	1
Residual/Cruise/APU					33,877			**33,877**	8.59%	Activity/Source	1
Ground Support Equipment/Tenant					5,210			**5,210**	1.32%	Activity/Source	1
Total Airport					**48,391**			**48,391**	**12.26%**		
Total Transportation		**8,414,521**	Gallons	**1,058,411**	**123,632**			**123,905**	**31.40%**		
5. Landfill (Aspen's Share)											
Mixed Solid Waste: Residential		3,068	Tons	n/a	n/a	274.00	n/a	**6,849**	1.74%	Activity	3
Mixed Solid Waste: Commercial		13,078	Tons	n/a	n/a	983.00	n/a	**24,587**	6.23%	Activity	3
Construction and Demilition Waste: Res/Comm		13,746	Tons	n/a	n/a	223.00	n/a	**5,583**	1.41%	Activity	3
Landfill & Materials Recovery: diesel fuel		4,643	Gallons	641	47	0.002	0.001	**48**	0.01%	Source	1
Landfill & Materials Recovery: gasoline		681	Gallons	85	4	0.0002	0.0001	**4**	0.00%	Activity	3
Landfill & Materials Recovery: electricity (Holy Cross)		119,739	kWh	409	99	0.001	0.002	**100**	0.03%	Activity	3
Total Landfill				**1,135**	**150**	**1,480.00**	**0.0031**	**37,171**	**9.42%**		
6. Wastewater											
Nitrification/Denitrification Process N2O Emissions from Wastewater Treatment		12,157	Pop. Served	n/a	n/a	n/a	0.09	**25**	0.01%	Source	1
Process N2O from Effluent Discharge to Rivers and Estuaries		7	Daily N Load	n/a	n/a	n/a	0.02	**6**	0.00%	Source	1
Total Wastewater				n/a	n/a	n/a	**0.11**	**31**	**0.01%**		
Total				**3,590,095**	**356,088**	**1,491.56**	**2.82**	**394,593**	**100.00%**		

Aspen Total Taxable Retail Sales, 2011:	$ 504,414,149
Aspen Population, 2011:	6,626

*Adjusted from orginal inventory to comply with U.S. Community Protocol

Last Modifed by: Chris Menges, City of Aspen, Data Research and Project Planner

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Appendix E: Sources of Aspen's GHG Emissions by percent of total for all *Community-wide Inventory* Years

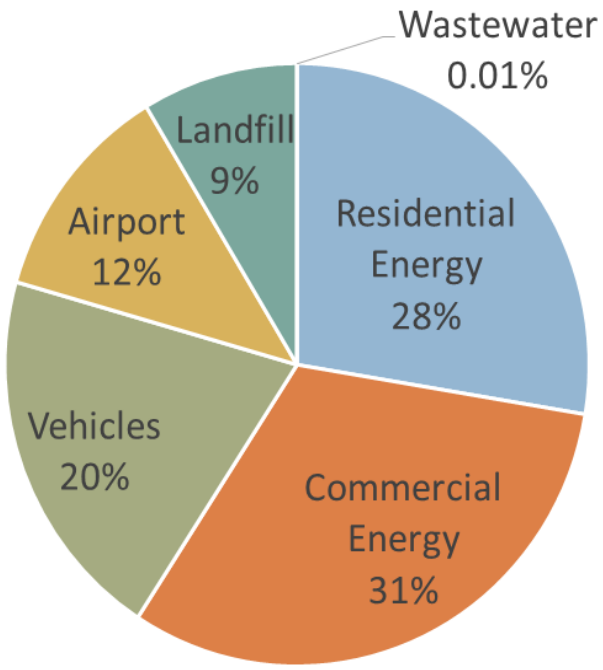

Figure 28. GHG Emissions by Sector 2004

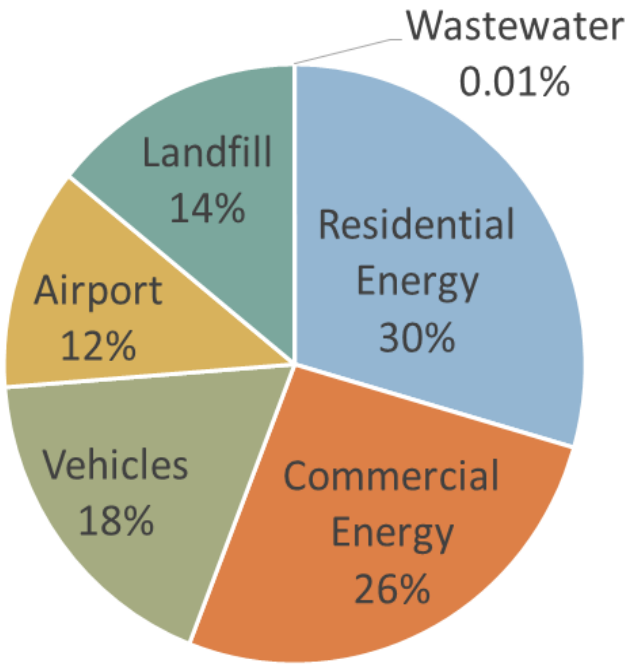

Figure 27. GHG Emissions by Sector 2007

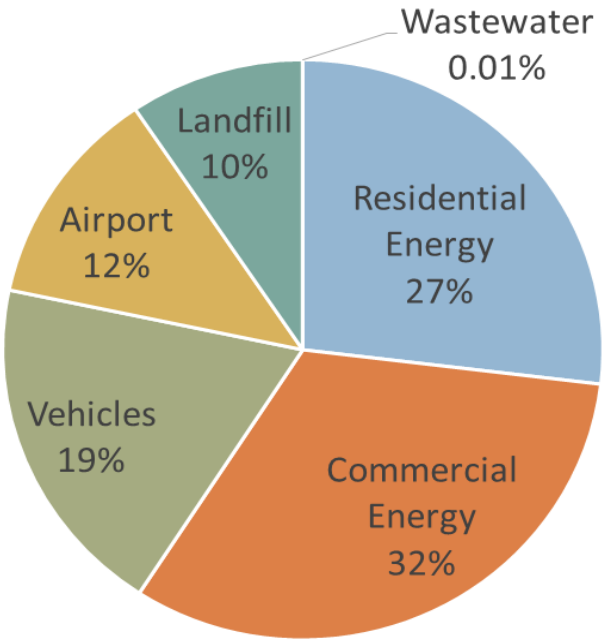

Figure 29. GHG Emissions by Sector 2011

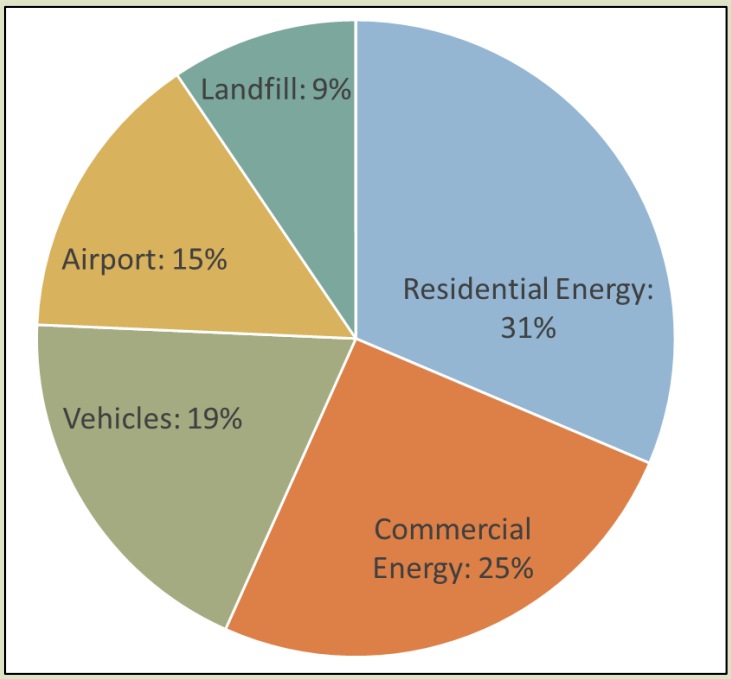

Figure 30. GHG Emissions by Sector 2014

Appendix F: CO_2e Emissions by Sector and Percent Change, 2004-2014

CO2e (MT) Emisions By Sector 2004 - 2014

	2004 CO2e (MT)	2007 CO2e (MT)	% Change ('04-'07)	2011 CO2e (MT)	% Change ('04-'11)	2014 CO2e (MT)	% Change ('11-'14)	% Change ('04-'14)	Trend ('04-'14)
1. Residential Energy									
Electricity (Aspen Electric)	12,142	7,209	-41%	6,581	-46%	5,544	-16%	-54%	
Electricity (Holy Cross)	62,933	72,760	16%	48,142	-24%	68,230	42%	8%	
Propane (All Vendors Consolidated)	2,831	2,018	-29%	2,342	-17%	1,689	-28%	-40%	
Natural Gas (All Vendors Consolidated)	39,822	50,885	28%	49,054	23%	48,347	-1%	21%	
Total Residential Energy	117,728	132,872	13%	106,119	-10%	123,810	17%	5%	
2. Commercial Energy									
Electricity (Aspen Electric)	22,176	11,988	-46%	11,616	-48%	10,778	-7%	-51%	
Electricity (Holy Cross)	52,690	57,719	10%	69,975	33%	43,265	-38%	-18%	
Propane (All Vendors Consolidated)	Not Reported	100	n/a	Not Reported	n/a	490	n/a	n/a	
Natural Gas (All Vendors Consolidated)	59,521	49,304	-17%	45,776	-23%	45,249	-1%	-24%	
Total Commercial Energy	134,387	119,111	-11%	127,367	-5%	99,782	-22%	-26%	
Total Energy Consumption: Buildings	252,115	251,983	0%	233,486	-7%	223,592	-4%	-11%	
3. Vehicles									
Cars, gasoline (sedan, wagon, small SUV, crossover)									
Truck, gasoline (med/large SUV, pickup, van, minivan)	68,753	60,229	-12%	55,562	-19%	57,303	3%	-17%	
Motorcycle, gasoline									
Single-Unit Truck (and other bus), gasoline									
Cars, diesel (sedan, wagon, small SUV, crossover)									
Truck, diesel (med/large SUV, pickup, van, minivan)	14,683	18,243	24%	17,850	22%	15,417	-14%	5%	
Single-Unit Truck (and other bus), diesel									
Combination Truck (semi, tractor-trailer), diesel									
RFTA Bus (standard)	2,863	2,074	-28%	2,102	-27%	1,807	-14%	-37%	
RFTA Bus (BRT)	0	0	0%	0	0%	20	100%	100%	
Cars, electric (sedan, wagon, small SUV, crossover)	0	0	0%	0	0%	352	100%	100%	
Total Vehicles	86,299	80,546	-7%	75,514	-12%	74,883	-1%	-13%	
4. Airport									
Ground Support Equipment/Airport	81	156	93%	147	81%	256	74%	216%	
Approach	1,958	2,077	6%	1,852	-5%	2,236	21%	14%	
Taxi/Idle/Delay	3,172	3,381	7%	3,017	-5%	3,644	21%	15%	
Takeoff	3,571	3,812	7%	3,402	-5%	4,110	21%	15%	
Climbout	938	993	6%	886	-6%	1,069	21%	14%	
Residual/Cruise/APU	35,673	37,972	6%	33,877	-5%	40,915	21%	15%	
Ground Support Equipment/Tenant	5,462	5,838	7%	5,210	-5%	6,295	21%	15%	
Total Airport	50,855	54,229	7%	48,391	-5%	58,525	21%	15%	
Total Transportation	137,154	134,775	-2%	123,905	-10%	133,408	8%	-3%	
5. Landfill (Aspen's Share)									
Mixed Solid Waste: Residential	7,275	8,105	11%	6,849	-6%	5,866	-14%	-19%	
Mixed Solid Waste: Commercial	26,125	29,101	11%	24,587	-6%	21,658	-12%	-17%	
Construction and Demilition Waste: Res/Comm	3,238	26,565	720%	5,583	72%	9,625	72%	197%	
Landfill & Materials Recovery: diesel fuel	39	48	23%	48	23%	31	-35%	-21%	
Landfill & Materials Recovery: gasoline	0	6	100%	4	-50%	7	75%	100%	
Landfill & Materials Recovery: electricity (Holy Cross)	71	98	38%	100	41%	125	25%	76%	
Total Landfill	36,748	63,923	74%	37,171	1%	37,312	0%	2%	
6. Wastewater									
Nitrification/Denitrification Process N2O Emissions from Wastewater Treatment	26	24	-8%	25	-4%	23	-8%	-12%	
Process N2O from Effluent Discharge to Rivers and Estuaries	7	7	0%	6	-14%	6	0%	-14%	
Total Wastewater	33	31	-6%	31	-6%	29	-6%	-12%	
Total	426,050	450,712	6%	394,593	-7%	394,341	0%	-7%	

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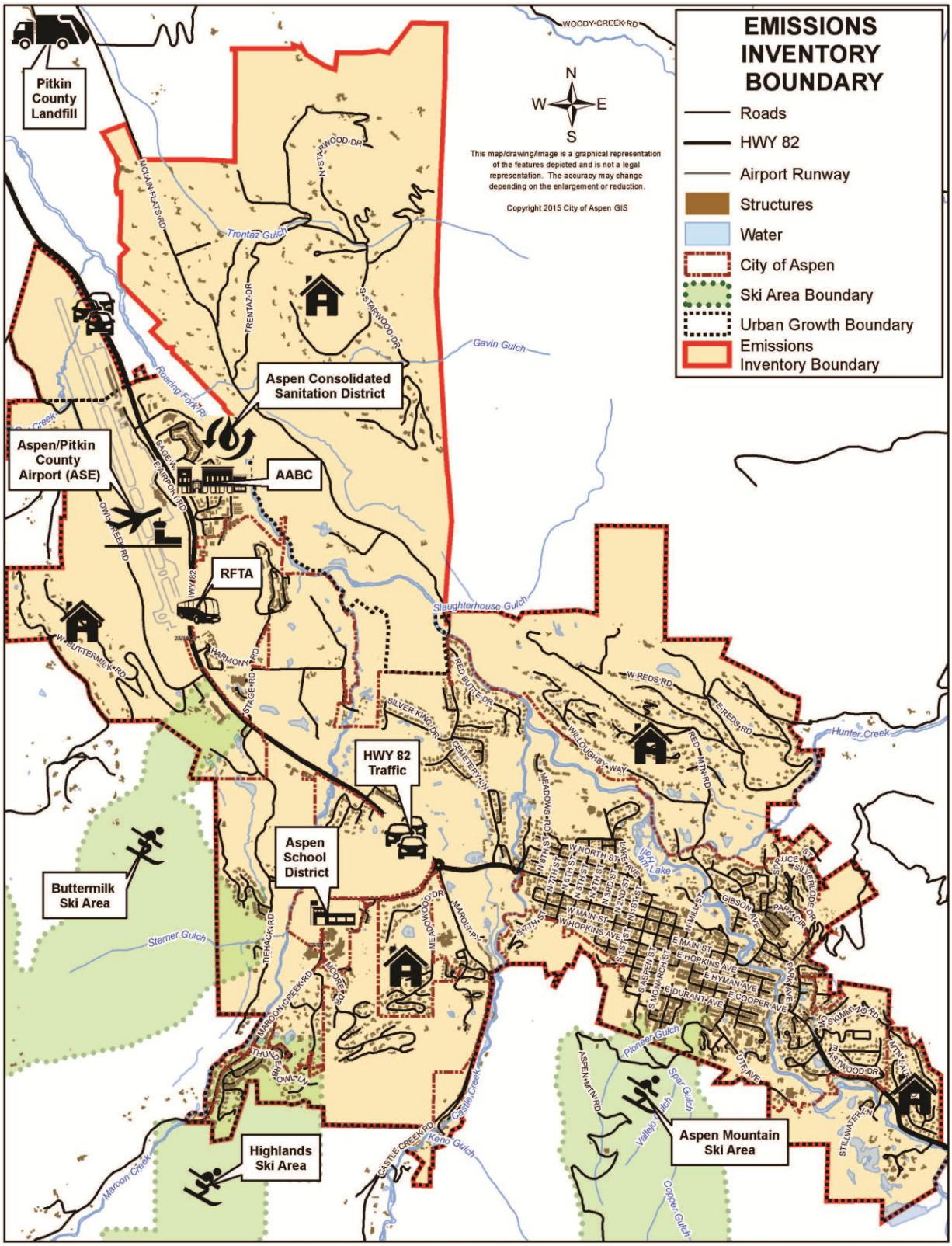
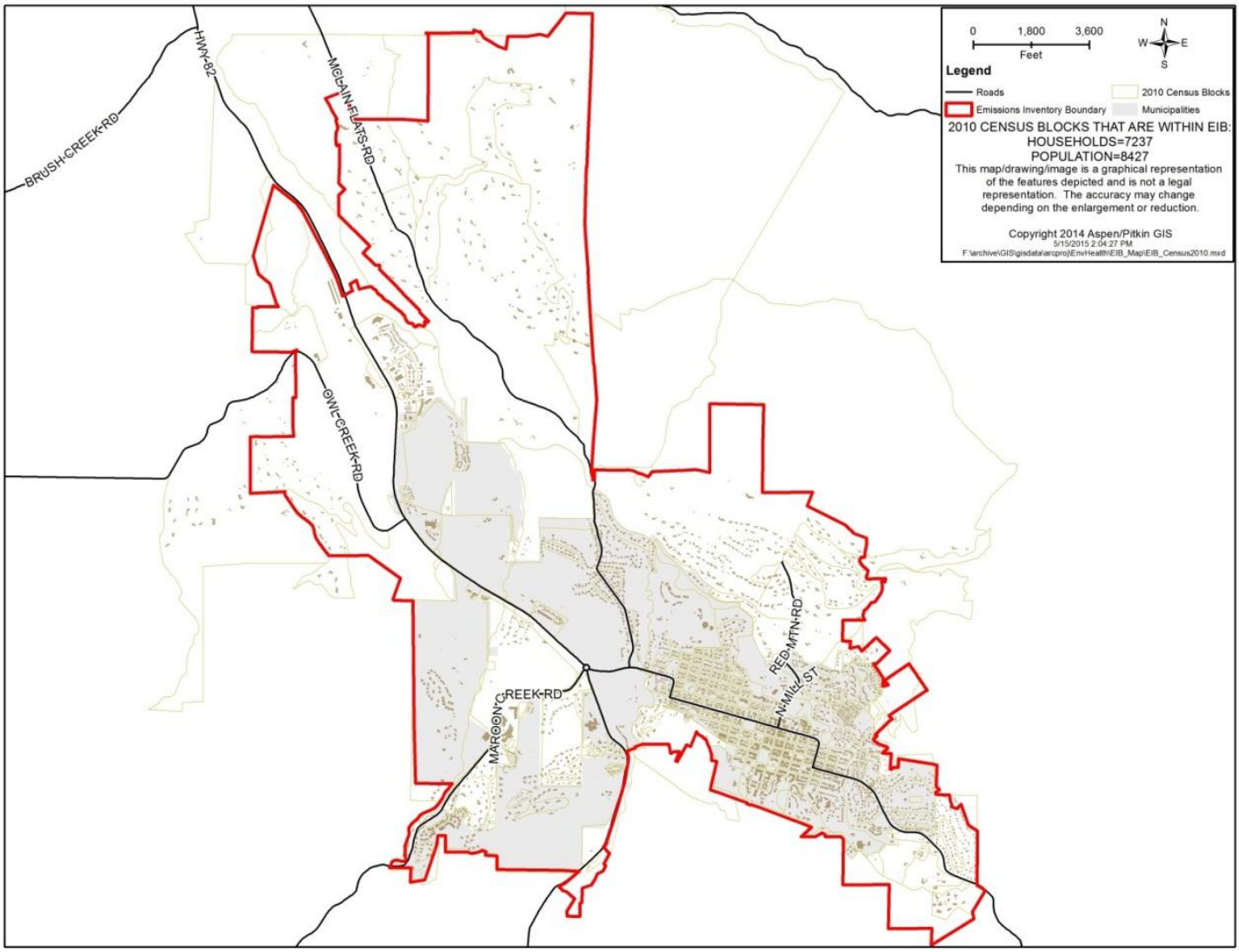
Table 2. CO2e emissions by sector and percent change, 2004 - 2014

Appendix G: Emissions Inventory Boundary (EIB)



Appendix H: Population and Households within the EIB



Appendix I: Emission Factors 2004, 2007, 2011 and 2014

2004 Emissions Factors and GWPs				
Emission Sources	**Emission Factors**	**Data Source**	**GWP**	**Data Source**
Purchased Electricity				
Aspen Electric				
CO_2	1188 lbs/MWh	Utility Company 2004	1	IPCC AR4
CH_4	23.63 lbs/GWh	eGRID 2007	21	IPCC AR4
N_2O	28.89 lbs/GWh	eGRID 2007	310	IPCC AR4
Holy Cross				
CO2	1795 lbs/MWh	Utility Company 2004	1	IPCC AR4
CH4	23.63 lbs/GWh	eGRID 2007	21	IPCC AR4
N2O	28.89 lbs/GWh	eGRID 2007	310	IPCC AR4
Stationary Combustion				
Natural Gas				
CO_2	53.02 kg/MMbtu	TCR Local Govenrment Operations Protocol (LGOP), default factor, Table G.1. p. 202	1	IPCC AR4
CH_4	.005 kg/MMBtu	LGOP, default factor, Table G.1. p. 205	21	IPCC AR4
N_2O	.0001 kg/MMBtu	LGOP, default factor, Table G.1. p. 205	310	IPCC AR4
Propane				
CO_2	61.46 kg/MMBtu	LGOP, default factor, Table G.1. p. 203	1	IPCC AR4
CH_4	0.0010 kg/gallon	LGOP, default factor, Table G.4. p. 206	21	IPCC AR4
N_2O	0.0010 kg/gallon	LGOP, default factor, Table G.4. p. 206	310	IPCC AR4
Mobile Sources				
Gasoline Passenger Vevicle (Avg MPG = 22)*				
CO_2	8.78 kg/gallon	2014 EPA Emission Factors, Table 2. p. 2	1	IPCC AR4
CH_4	0.0145 g/mile	2014 EPA Emission Factors, Table 3. p. 2	21	IPCC AR4
N_2O	0.0083 g/mile	2014 EPA Emission Factors, Table 3. p. 2	310	IPCC AR4
Diesel Passenger Vehicle (Avg MPG = 22.6)*				
CO_2	10.21 kg/gallon	2014 EPA Emission Factors, Table 2. p. 2	1	IPCC AR4
CH_4	0.0005 g/mile	2014 EPA Emission Factors, Table 4. p. 3	21	IPCC AR4
N_2O	0.0010 g/mile	2014 EPA Emission Factors, Table 4. p. 3	310	IPCC AR4

Table 3. 2004 emission factors

2007 Emissions Factors and GWP				
Emission Sources	**Emission Factors**	**Data Source**	**GWP**	**Data Source**
Purchased Electricity				
Aspen Electric				
CO_2	645 lbs/MWh	Utility Company 2007	1	IPCC AR4
CH_4	23.63 lbs/GWh	eGRID 2007	21	IPCC AR4
N_2O	28.89 lbs/GWh	eGRID 2007	310	IPCC AR4
Holy Cross				
CO2	1795 lbs/MWh	Utility Company 2007	1	IPCC AR4
CH4	23.63 lbs/GWh	eGRID 2007	21	IPCC AR4
N2O	28.89 lbs/GWh	eGRID 2007	310	IPCC AR4
Stationary Combustion				
Natural Gas				
CO_2	53.02 kg/MMbtu	TCR Local Govenrment Operations Protocol (LGOP), default factor, Table G.1. p. 202	1	IPCC AR4
CH_4	.005 kg/MMBtu	LGOP, default factor, Table G.1. p. 205	21	IPCC AR4
N_2O	.0001 kg/MMBtu	LGOP, default factor, Table G.1. p. 205	310	IPCC AR4
Propane				
CO_2	61.46 kg/MMBtu	LGOP, default factor, Table G.1. p. 203	1	IPCC AR4
CH_4	0.0010 kg/gallon	LGOP, default factor, Table G.4. p. 206	21	IPCC AR4
N_2O	0.0010 kg/gallon	LGOP, default factor, Table G.4. p. 206	310	IPCC AR4
Mobile Sources				
Gasoline Passenger Vevicle (Avg MPG = 22)*				
CO_2	8.78 kg/gallon	2014 EPA Emission Factors, Table 2. p. 2	1	IPCC AR4
CH_4	0.0170 g/mile	2014 EPA Emission Factors, Table 3. p. 2	21	IPCC AR4
N_2O	0.0041 g/mile	2014 EPA Emission Factors, Table 3. p. 2	310	IPCC AR4
Diesel Passenger Vehicle (Avg MPG = 22.6)*				
CO_2	10.21 kg/gallon	2014 EPA Emission Factors, Table 2. p. 2	1	IPCC AR4
CH_4	0.0005 g/mile	2014 EPA Emission Factors, Table 4. p. 3	21	IPCC AR4
N_2O	0.0010 g/mile	2014 EPA Emission Factors, Table 4. p. 3	310	IPCC AR4

Table 4. 2007 emission factors

2011 Emissions Factors and GWP				
Emission Sources	**Emission Factors**	**Data Source**	**GWP**	**Data Source**
Purchased Electricity				
Aspen Electric				
CO_2	596 lbs/MWh	Utility Company 2011	1	IPCC AR4
CH_4	22.66 lbs/GWh	eGRID 2010	21	IPCC AR4
N_2O	29.21 lbs/GWh	eGRID 2010	310	IPCC AR4
Holy Cross				
CO2	1830 lbs/MWh	Utility Company 2011	1	IPCC AR4
CH4	22.66 lbs/GWh	eGRID 2010	21	IPCC AR4
N2O	29.21 lbs/GWh	eGRID 2010	310	IPCC AR4
Stationary Combustion				
Natural Gas				
CO_2	53.02 kg/MMbtu	TCR Local Govenrment Operations Protocol (LGOP), default factor, Table G.1. p. 202	1	IPCC AR4
CH_4	.005 kg/MMBtu	LGOP, default factor, Table G.1. p. 205	21	IPCC AR4
N_2O	.0001 kg/MMBtu	LGOP, default factor, Table G.1. p. 205	310	IPCC AR4
Propane				
CO_2	61.46 kg/MMBtu	LGOP, default factor, Table G.1. p. 203	1	IPCC AR4
CH_4	0.0010 kg/gallon	LGOP, default factor, Table G.4. p. 206	21	IPCC AR4
N_2O	0.0010 kg/gallon	LGOP, default factor, Table G.4. p. 206	310	IPCC AR4
Mobile Sources				
Gasoline Passenger Vevicle (Avg MPG = 23.9)*				
CO_2	8.78 kg/gallon	2014 EPA Emission Factors, Table 2. p. 2	1	IPCC AR4
CH_4	0.0173 g/mile	2014 EPA Emission Factors, Table 3. p. 2	21	IPCC AR4
N_2O	0.0036 g/mile	2014 EPA Emission Factors, Table 3. p. 2	310	IPCC AR4
Diesel Passenger Vehicle (Avg MPG = 24.5)*				
CO_2	10.21 kg/gallon	2014 EPA Emission Factors, Table 2. p. 2	1	IPCC AR4
CH_4	0.0005 g/mile	2014 EPA Emission Factors, Table 4. p. 3	21	IPCC AR4
N_2O	0.0010 g/mile	2014 EPA Emission Factors, Table 4. p. 3	310	IPCC AR4

Table 5. 2011 emission factors

2014 Emissions Factors and GWP				
Emission Sources	**Emission Factors**	**Data Source**	**GWP**	**Data Source**
Purchased Electricity				
Aspen Electric				
CO_2	526 lbs/MWh	Utility Company 2014	1	IPCC AR4
CH_4	22.61 lbs/GWh	eGRID 2010	21	IPCC AR4
N_2O	29.21 lbs/GWh	eGRID 2010	310	IPCC AR4
Holy Cross				
CO2	1574 lbs/MWh	Utility Company 2014	1	IPCC AR4
CH4	22.61 lbs/GWh	eGRID 2010	21	IPCC AR4
N2O	29.21 lbs/GWh	eGRID 2010	310	IPCC AR4
Stationary Combustion				
Natural Gas				
CO_2	53.02 kg/MMbtu	TCR Local Govenrment Operations Protocol (LGOP), default factor, Table G.1. p. 202	1	IPCC AR4
CH_4	.005 kg/MMBtu	LGOP, default factor, Table G.1. p. 205	21	IPCC AR4
N_2O	.0001 kg/MMBtu	LGOP, default factor, Table G.1. p. 205	310	IPCC AR4
Propane				
CO_2	61.46 kg/MMBtu	LGOP, default factor, Table G.1. p. 203	1	IPCC AR4
CH_4	0.0010 kg/gallon	LGOP, default factor, Table G.4. p. 206	21	IPCC AR4
N_2O	0.0010 kg/gallon	LGOP, default factor, Table G.4. p. 206	310	IPCC AR4
Mobile Sources				
Gasoline Passenger Vevicle (Avg MPG = 24.4)*				
CO_2	8.78 kg/gallon	2014 EPA Emission Factors, Table 2. p. 2	1	IPCC AR4
CH_4	0.0173 g/mile	2014 EPA Emission Factors, Table 3. p. 2	21	IPCC AR4
N_2O	0.0036 g/mile	2014 EPA Emission Factors, Table 3. p. 2	310	IPCC AR4
Diesel Passenger Vehicle (Avg MPG = 25)*				
CO_2	10.21 kg/gallon	2014 EPA Emission Factors, Table 2. p. 2	1	IPCC AR4
CH_4	0.0005 g/mile	2014 EPA Emission Factors, Table 4. p. 3	21	IPCC AR4
N_2O	0.0010 g/mile	2014 EPA Emission Factors, Table 4. p. 3	310	IPCC AR4
Notes:				
*Emissions from numerous types of gasoline and diesel vehicles are quantified in the Inventory. Each vehicle type (i.e. gasoline passenger vehicles, gasoline light trucks, motorcycles, CNG buses, diesel heavy trucks) have different emission factors. These are fully documented in the Factor Sets section of ClearPath.				
Information Sources:				
The Climate Registry, Local Government Operations Protocol (2010)				
IPCC Fourth Assessment Report: Climate Change 2007. 2.10.2 Direct Global Warming Potentials				
EPA Factors for Greenhouse Gas Inventories (2014)				

Table 6. 2014 emission factors

Appendix J: Energy Emission Factors 2004-2014

Aspen's Building Energy Suppliers - Emission factors	GHG Inventory Year			
	2004	2007	2011	2014
Aspen Electric				
CO2 (lbs/MWh)	1188	645	596	526
CH4 (lbs/GWh)	23.63	23.63	22.66	22.66
N2O (lbs/GWh)	28.89	28.89	29.21	29.21
Holy Cross				
CO2 (lbs/MWh)	1,795	1,795	1,830	1,574
CH4 (lbs/GWh)	23.63	23.63	22.66	22.66
N2O (lbs/GWh)	28.89	28.89	29.21	29.21
Natural Gas				
CO2 (kg/MMBtu)	53.02	53.02	53.02	53.02
CH4 (kg/MMBtu)	0.005	0.005	0.005	0.005
N2O (kg/MMBtu)	0.0001	0.0001	0.0001	0.0001
Propane				
CO2 (kg/MMBtu)	61.46	61.46	61.46	61.46
CH4 (kg/gallon)	0.001	0.001	0.001	0.001
N2O (kg/gallon)	0.001	0.001	0.001	0.001

Table 7. Energy provider emission factors, 2004 - 2014

Appendix K: ASE CO_2 Emissions Included in the *Community-wide Inventory* (first table) & Units of Energy/Operations (second table), 2004-2014

Airport Sector CO2: City of Aspen Communitywide GHG Inventory 2014							
User/Source Category	**2014 CO2 (tons/year)**	**Percent of User**	**Percent of Total**		**2011 CO2 (tons/year)**	**2007 CO2 (tons/year)**	**2004 CO2 (tons/year)**
Airport-owned/controlled							
Facilities/Stationary Sources	*Numeric data witdrawn from COA airport rollup as it is captured in "commercial energy" sector.*						
Ground Support Equipment	256	100.0%	0.4%		147	156	81
Ground Access Vehicles*							
Passenger vehicles (on-airport roads) Hotel shuttles (on-airport roads) Rental Cars (on-airport roads) Airport Employee Commute (all roads)	*Numeric data witdrawn from COA airport rollup as it is captured in "vehicles" sector (VMT)*						
Subtotal	**256**	**100.0%**	**0.4%**		**147**	**156**	**81**
Airlines/Tenants/Aircraft Operator-owned/controlled							
Aircraft							
Approach	2,236	3.8%	3.8%		1,852	2,077	1,958
Taxi/Idle/Delay	3,644	6.3%	6.2%		3,017	3,381	3,172
Takeoff	4,110	7.1%	7.0%		3,402	3,812	3,571
Climbout	1,069	1.8%	1.8%		886	993	938
Residual/Cruise/APU	40,915	70.2%	69.9%		33,877	37,972	35,673
Sub-total	51,974	89.2%	88.8%		43,034	48,235	45,311
Ground Support Equipment	6,295	10.8%	10.8%		5,210	5,838	5,462
Ground Access Vehicles							
Tenant GAV	0	0.0%	0.0%		0	0	
Tenant Employee Commute (all roads)	0	0.0%	0.0%		0	0	
Stationary Sources	0	0.0%	0.0%		0	0	
Subtotal	**58,269**	**100.0%**	**99.6%**		**48,244**	**54,073**	**50,773**
Public-owned/controlled*							
Passenger Vehicles (off-airport roads) Rental Car Travel (all roads) Hotel Shuttles (off airport roads)	*Numeric data witdrawn from COA airport rollup as it is captured in "vehicles" sector (VMT)*						
Subtotal	**0**				**0**	**0**	0
Total	**58,525**		**100%**		**48,391**	**54,229**	**50,854**

Table 8. Aspen/Pitkin County Airport CO2 emissions, 2004-2014

User/Source Category	2004	2006	2007	2011	2014	
Airport-owned/controlled						
Facilities/Stationary Sources						
- Electricity	1,050,011	1,134,026	1,253,915	1,491,019	1,551,872	Kwhr
- Natural Gas	45,532	58,110	54,635	49,636	47,688	CCF
Terminal	34,389	39,350.0	39,350.0	33,613.0	30,435.0	CCF
Airport Main	3,409	4,139.0	3,967.0	824.0	305.0	CCF
AOC	7,734	14,621.0	11,318.0	15,199.0	16,948.0	CCF
Airport Fleet Vehicles						
- Fleet Vehicles Gas	2,732.80	3,316.70	3,695.20	4,820.60	5,371.20	Gallons
- Fleet Vehicles Diesel	5,635.73	12,401.47	12,133.80	10,242.50	20,471.30	Gallons
Subtotal						
Airlines/Tenants/Aircraft Operator-owned/controlled						
Aircraft	44,778	42,947	46,326	37,671	35,395	Operations
- Jet A	3,671,060.1	5,084,919	5,011,110.30	4,472,392	5,403,433	Gallons
- AvGas	53,949.0	39,229	34,360.20	28,797.00	32,559	Gallons
Subtotal						
Public-owned/controlled						
Passenger Vehicles (off-airport roads)	383,158	399,938	431,666	432,586	438,258	Tot Pax
Rental Car Travel (all roads)	14,517	17,410	20,139	18,527	18,398	days
Parking Lot	59,369	54,711	66,885	69,390	64,776	entry/exit
Total						

Table 9. Aspen/Pitkin County Airport energy use and operations, 2004-2014

Appendix L: ASE CO_2 Emissions (Aspen/Pitkin County Airport Entity-specific Inventory)

Aspen Pitkin County Airport CO2 Emissions 2014

User/Source Category	2014 CO2 (tons/year)	Percent of User	Percent of Total	2011 CO2 (tons/year)	2006 CO2 (tons/year)
Airport-owned/controlled					
Facilities/Stationary Sources	1,350	77.8%	2.2%	1,529	1,326
Ground Support Equipment	256	14.7%	0.4%	147	155
Ground Access Vehicles					
Passenger vehicles (on-airport roads)	15	0.9%	0.0%	16	15
Hotel shuttles (on-airport roads)	6	0.3%	0.0%	6	7
Rental Cars (on-airport roads)	5	0.3%	0.0%	3	1
Airport Employee Commute (all roads)	105	6.0%	0.2%	80	81
Subtotal	**1,736**	**100.0%**	**2.8%**	**1,781**	**1,584**
Airlines/Tenants/Aircraft Operator-					
Aircraft					
Approach	2,236	3.8%	3.6%	1,852	2,110
Taxi/Idle/Delay	3,644	6.3%	5.8%	3,017	3,433
Takeoff	4,110	7.1%	6.6%	3,402	3,869
Climbout	1,069	1.8%	1.7%	886	1,009
Residual/Cruise/APU	40,915	70.2%	65.6%	33,877	38,560
Sub-total	51,974	89.2%	83.4%	43,034	48,982
Ground Support Equipment	6,295	10.8%	10.1%	5,210	5,924
Ground Access Vehicles					
Tenant GAV	0	0.0%	0.0%	0	0
Tenant Employee Commute (all roads)	23	0.0%	0.0%	25	25
Stationary Sources	0	0.0%	0.0%	0	0
Subtotal	**58,292**	**100.0%**	**93.5%**	**48,270**	**54,931**
Public-owned/controlled					
Passenger Vehicles (off-airport roads)	561	24.4%	0.9%	603	557
Rental Car Travel (all roads)	1,731	75.3%	2.8%	1,929	589
Hotel Shuttles (off airport roads)	6	0.3%	0.0%	6	6
Subtotal	**2,298**	**100.0%**	**3.7%**	**2,537**	**1,152**
Total	**62,326**		**100%**	**52,588**	**57,667**

Appendix M: Inflation Adjusted Taxable Retail Sales and Percent Change, 2004 – 2014*

Inflation Adjusted Taxable Retail Sales and Percent Change, 2004 - 2014					
Years	Year	Inflation	2004 Infl. Adj.(FORWARD)	2014 Infl. Adj. (BACKWARD)	
0	2004		$408,360,848	$498,714,543	**22.1%**
1	2005	3.4%	$422,105,580	$510,104,429	
2	2006	3.2%	$435,706,199	$521,754,442	
3	2007	2.9%	$448,213,365	$533,670,524	
4	2008	3.8%	$465,312,496	$545,858,751	
5	2009	-0.3%	$463,825,795	$558,325,339	
6	2010	1.6%	$471,431,333	$571,076,645	
7	2011	3.2%	$486,312,198	$584,119,172	
8	2012	2.1%	$496,376,186	$597,459,570	
9	2013	1.5%	$503,646,903	$611,104,643	
10	2014	1.6%	$511,817,002	$625,061,348	**22.1%**
Average Change		2.3%			
Year	**Actual Dollars**	**2014 Adj. Dollars**	**Change**		
2004	$408,360,848	$511,817,002	0%		
2007	$516,899,691	$605,418,518	18.3%		
2011	$504,414,149	$539,769,628	5.5%		
2014	$625,061,348	$625,061,348	22.1%		

Table 10. Inflation adjusted taxable retail sales and percent change, 2004 - 2014

*Source: Pete Strecker, Assistant Finance Director, City of Aspen Finance Department