C I T Y O F B O U L D E R
TRANSPORTATION ADVISORY BOARD
AGENDA ITEM

MEETING DATE: July 13th, 2015

Discussion of Upcoming Study Session with City Council re: Boulder's Climate Commitment

PRESENTERS:

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I. Purpose

There will be a study session with City Council on July 30th to discuss the draft Climate Commitment goal statement and strategy document. The purpose of the presentation is to discuss and obtain the Transportation Advisory Board's feedback on the transportation portion of this strategy document related to the greenhouse gas emissions (GHG) reduction goal, transportation emission reduction targets, and associated implementation strategies.

Please refer to **Attachment A**, which includes the recently completed staff report on the 2012 Community GHG Inventory. This information forms a basis for an ongoing assessment of community emissions reduction achievements. **Attachment B** provides a table showing the more detailed metrics and targets proposed for tracking progress towards the city's GHG reduction goal. **Attachment C** provides an overview of the communications strategy designed to launch community outreach and engagement around refinement and adoption of the Climate Commitment strategy.

II. Questions for the Transportation Advisory Board

1. Do you support adoption of an emissions reduction goal of 80 percent below 2005 levels by the year 2050?
2. Are there key emissions reduction actions not represented in the city's current programs and strategies that should also be considered?
3. How can the city most effectively engage the community in the refinement and implementation of the proposed Climate Commitment?

III. Updates

Two prior City Council Study Sessions have been held to discuss the development of Boulder's post-Kyoto[1] climate action goal. The July 29, 2013 Study Session presented analysis of a range of potential emissions reduction goals ranging from an 80 percent emissions reduction by 2030 to a 100 percent emissions reduction by 2050. Council provided staff direction at this meeting to conduct further analysis on the viability of implementing an 80 percent emissions reduction below 1990 levels by 2050. At the November 12, 2014 Study Session, staff presented council with a detailed assessment of the emissions reduction potentials of existing and anticipated city programs to determine the likelihood that these programs could achieve this 80 percent emissions reduction goal. This analysis indicated that a combination of full implementation of all existing building and transportation emissions-reduction programs coupled with an electricity utility providing 100 percent clean electricity could meet or achieve this emissions goal. Subsequent to these study sessions, staff has continued to refine the city's emissions analysis and projection tools as described below.

GHG Inventory

In early 2015, staff completed a new community greenhouse gas emissions inventory using a more comprehensive inventory protocol (ICLEI US Community Inventory Protocol) and an enhanced inventory system developed to align the city's inventory with both national and international standards. Given the ongoing challenges to acquire energy use information from Xcel, the city relied on energy data acquired through legal discovery. The most recent year for which the city could compile all of the necessary energy use information was 2012. A full review of the inventory process and results are included as **Attachment A** to this memo. The summary results of the inventory have also been compiled as an infographic intended to make the findings more comprehensible and useful to the community. Key findings of the inventory are summarized in the sidebar. As part of the inventory analysis, staff is recommending adopting a 2005 emissions baseline year (previously 1990). This will create better alignment between the city and community GHG inventories and uses the same baseline year as the State of Colorado and a growing group of both US and international cities.

Major Findings of the 2012 Community GHG Inventory

- Overall emissions declined slightly (↓~1%) between 2005-2012
- During the same period, overall employment increased (↑2.7%) and economic activity grew (↑23%)
- Emissions reductions did occur in several sectors including residential (↓4% per household), ground transportation (↓8%) and waste (↓8%)
- Emissions increases were most pronounced in commercial & industrial (C&I) which by ↑13% electricity, and increased by ↑27% natural gas.

C&I emissions growth was likely the result of both significant increases in business activity and the addition of both medical marijuana grow facilities, new data centers, and other industrial process growth.

Utility Emissions Reduction Potential

Staff conducted additional analysis of the projected emissions reduction potential of three possible utility configurations: the existing Xcel generation portfolio; a city operated electric utility with an 80 percent clean energy portfolio; and a city utility managing a 100 percent clean energy portfolio at 2050.

The Xcel Average (Current Configuration)– This analysis assumed Xcel would maintain its current accelerated growth in renewable energy generation (based on actual acquisition rates between 2008—2014) extended out to 2050. The municipal utility scenario used modeling previously conducted as part of the

[1] In 2002 Boulder's City Council adopted the Kyoto Protocol goal of reducing greenhouse gases by 7 percent below 1990 levels by 2012.

resource modeling for the municipalization analysis. Comparisons are shown below between the Xcel scenario (business as usual) and a municipal electric utility with a 100 percent renewable energy portfolio in combination with the anticipated emissions reductions achieved through both building and transportation related efficiency programs.

An 80% Renewable Energy Municipal Utility–This analysis assumed a municipal utility that acquired 80% of its electricity from sources utilizing renewable energy (wind, solar, hydro). It also included projected emissions reductions from more extensive energy service offerings that create additional energy efficiency and distributed generation incentives. This customized approach is more difficult to implement for a regional utility such as Xcel that is compelled by state regulations to offer similar services across its entire regional service territory. The city's municipal utility plan also calls for more extensive implementation of demand side-management programs that can generate additional energy use and cost savings for customers and reduced energy generation purchases (and thereby potentially lower rates).

A 100% Renewable Energy Municipal Utility – This scenario assumed the augmented level of energy services and demand side management programs modeled in the 80% municipal utility scenario with the remaining 20% of energy also provided by renewable sources. This configuration was the only one that enabled the city to achieve a full 80% reduction by 2050 and is shown in contrast with the Xcel business-as-usual case in Figure 1 below.

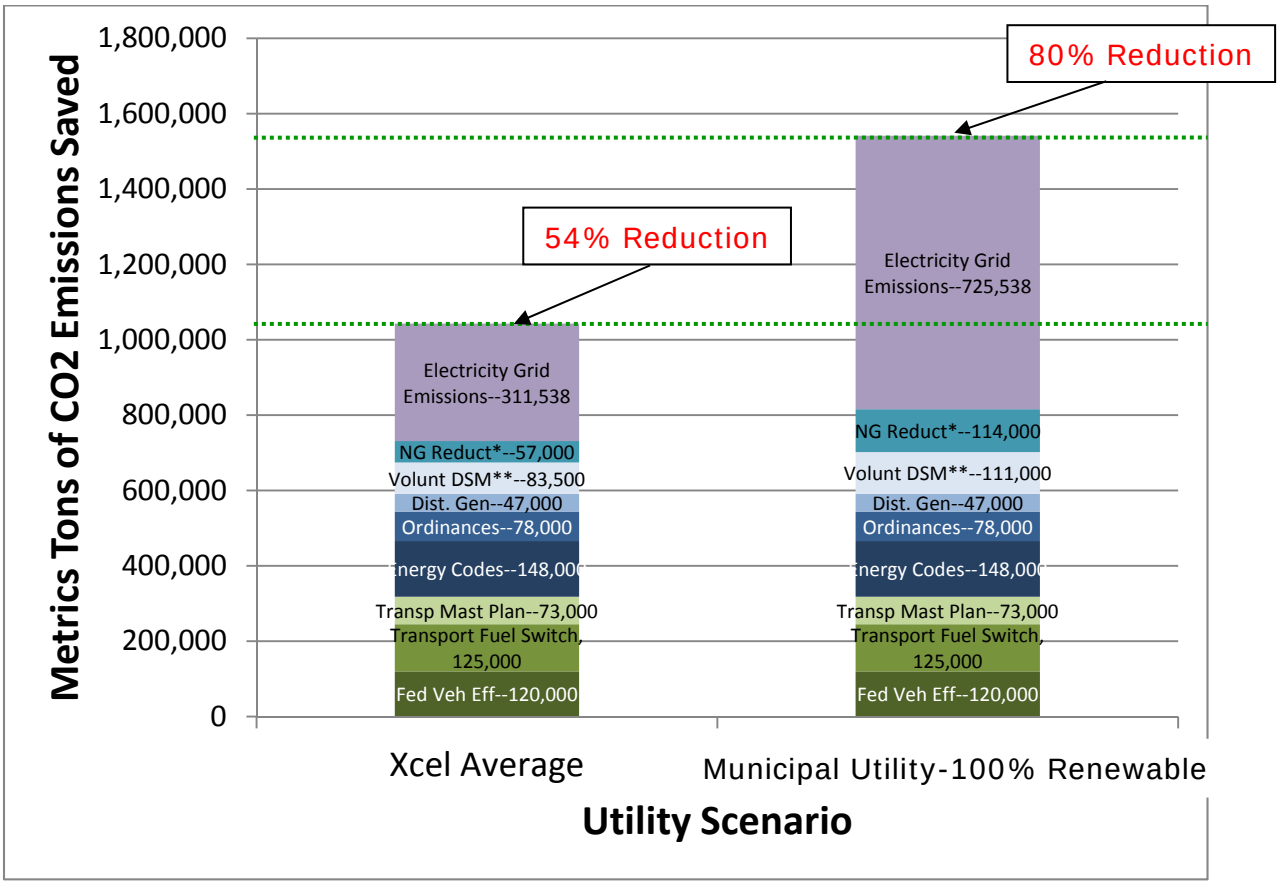
<u>Analysis of Emissions Reduction Potential of Existing Programs</u>

The preliminary assessment of the projected emissions reduction potential of the city's existing building and transportation related efficiency programs presented to council in November was updated based on the subsequent council direction on the characteristics of the new city commercial and industrial ordinance now referred to as the Boulder Building Performance Ordinance. This analysis was combined with the different utility energy portfolios described above to project the total emissions reduction potential the city could achieve under two scenarios:

1. ***Xcel average*** case projects Xcels current rate of renewable energy acquisition out to 2050.
2. ***100 percent Muni*** renewable electricity portfolio was selected for the municipal scenario because achieving the city's emissions reduction goal (80% reduction by 2050) was not projected as possible without this level of clean electricity. This is due in large part to the challenges associated with complete replacement of fossil fuel uses in several sectors such as transportation (air travel and heavy transport), and some natural gas uses (commercial/industrial scale thermal uses).

Figure 1 shows the emissions reduction potential of existing and planned city efficiency programs in both buildings and transportation under the two utility scenarios described above.

Figure 1 – 2050 Emissions Reduction Potential of City Programs Under Two Utility Scenarios



Glossary of Abbreviations

Electricity Grid Emissions—Reductions in emissions due to adding renewable energy generation sources
NG Reduct—Natural gas reduction programs
Volunt DSM—Voluntary demand side management programs coordinated by the city—Energy Smart or similar, with enhanced program capabilities under municipal utility
Dist Gen—Promotion of on-site distributed generation
Ordinances—SmartRegs rental energy efficiency ordinance and the Boulder Energy Ordinance for commercial and industrial properties
Energy Codes—Both residential and commercial Net-Zero Energy Ordinances
Trans Mast Plan—Transportation Master Plan efficiency related programs
Transport Fuel Switch—Electric Vehicle adoption and similar clean transport fuel programs
Fed Veh Efficiency—Federal vehicle efficiency standards (CAFE standards)

The projected reduction targets for each program area were established by combining emissions reductions projections from two sources. An extensive modeling tool was designed to project emissions reductions of existing programs. These estimates were combined with additional reductions projected to occur from the ongoing improvement of energy systems and technology in natural gas uses and transportation. These 2050 targets by program area are shown with the total associated emissions reduction projected at 2050 (percent below 2005 baseline year) in Table 1.

Table 1: Total Projected Emissions Reduction Under Two Utility Configurations

Programs	Metrics Tons Saved (2050) - STRETCH	
	100% Muni	Xcel Average
Energy Codes	148,000	148,000
Ordinances	78,000	78,000
Voluntary Demand Side Management	111,000	83,500
Natural Gas Reduction Program*	114,000	57,000
Distributed Generation	47,000	47,000
Transportation Master Plan	73,000	73,000
Transportation Fuel Switching	125,000	125,000
Federal Vehicle Efficiency	120,000	120,000
Electricity Grid Emissions	725,538	311,538
Total Emissions Saved	**1,541,538**	**1,043,038**
Percent Reduction from 2005 Levels	**~80%**	**54%**

The value of conservation & efficiency

Several important factors are notable in this analysis. First, the projected contribution of building related efficiency measures varies significantly depending on the characteristics of the electricity provided by an electric utility. In scenarios such as the projected Xcel portfolio, the continued use of both coal and natural gas for a significant portion of generation capacity results in relatively "dirty" electricity, meaning that it has a higher carbon per kilowatt (called the "carbon intensity factor"). Consequently, every kilowatt hour saved creates a relatively high number of pounds of carbon emissions reduced. Conversely, as the electricity generation source becomes "cleaner" (more renewable energy that generates low-or-no carbon per kilowatt), the emissions reduction "value" of each kilowatt is reduced.

It should also be noted that a significant portion of the reductions taking place in the "Xcel Average" scenario are the result of programs initiated and managed by the city. Without these efforts, emissions reductions for this scenario would likely be closer to 30 percent rather than 54 percent.

IV. Factors Shaping Boulder's Next Stage Climate Commitment

The next generation of Boulder's climate action outlined in the attached documents represents an evolving strategy based on the extensive efforts and investments made by the city and the larger community over nearly two decades. A brief summary of these efforts illustrates how Boulder's strategy has evolved and how past experiences are informing the strategy now in development.

Stage 1: 2002-2009: Incentive-driven behavior change

The Boulder city government formally launched a climate action focus through its passage of Resolution 906 in 2002 formally adopting the Kyoto Protocol goal of a 7 percent reduction in greenhouse gas emissions by 2012. Similar to most early climate action initiatives, Boulder focused on energy use behavior change initiatives focusing primarily on individuals and households. A wide variety of different types of educational and technical assistance projects were initiated during this period. During this stage, the community recognized the need for a dedicated source of funding to support these efforts and passed one of the first partial carbon

taxes based on a surcharge on both residential and commercial/industrial electricity use. These funds were directed primarily towards providing incentives to encourage changes in energy use through both behavior change (turning down thermostats, driving less) and some energy device changes such as lighting retrofits and energy efficiency retrofitting.

Stage II: 2010—2015: Policy/regulation driven energy use standards and energy source change

By 2009, both city staff and highly engaged community members began to recognize that the substantial efforts taking place were not sufficient to create significant emission reduction impacts. Through the involvement of several community working groups made up of hundreds of committed volunteers, a more ambitious and expansive strategy was conceived that included five major initiatives:

1. ***Enhanced Technical Assistance*** -- creation of a more extensive foundation of technical assistance for both residential and commercial energy users (Energy Smart)
2. ***Municipalization*** -- the exploration of deep reductions in the carbon intensity of the community's electricity sources through establishment of a city owned electric utility.
3. ***Energy Codes*** -- Implementation of an accelerated energy code implementation path for both residential and commercial buildings that set a standard of net-zero emissions for all new construction and major renovations by 2031 (Net Zero Energy Codes)
4. ***Energy Ordinances*** -- development of a set of regulatory mechanisms that would raise the standards for energy efficiency in the rental housing and commercial/industrial energy use sectors (SmartRegs and Commercial/Industrial Energy Ordinance)
5. ***Transportation Efficiency*** – Continued implementation of transportation programs intended to reduce vehicle use and associated emissions (Transportation Master Plan).

During this period the city also initiated a major energy efficiency initiative for city facilities that achieved a more than 20 percent reduction in both energy use and overall GHG emissions. The project has also resulted in significant financial savings, demonstrating the economic benefits of efficiency measures capable of creating significant emissions reduction.

Stage III: 2015—: Whole Energy System Transformation

Since the launch of climate action programs in 2002, significant community effort has created a foundation of community technical assistance, responsible energy use standards, and a pathway to local renewable electricity. Together these efforts have the potential to significantly reduce emissions while creating substantive economic and social benefits. However, full achievement of deep emissions reduction will require both sustaining these significant initiatives in addition to facilitating the transition to a clean, local, renewable energy system.

Four major action areas will be integral to this energy transition:

1. ***Maximize productivity and energy efficiency of electricity-based energy system*** – As conversion of the community's energy uses into systems capable of using clean electricity sources proceeds, the most cost-effective way to minimize the need for new electricity generation (and thereby associated system expansion costs) is to maximize efficiency and system productivity. The substantial platform of energy

efficiency services the city and county have jointly developed, and the enhanced demand side management services a municipal utility could offer, provide the foundation for development and delivery of these enhanced productivity and efficiency services.

2. ***Rapid transition to 100 percent clean electricity***—Electricity represents the one energy form that can currently be produced at larger scale through renewable/non-fossil-fuel based systems. The rapid reduction in costs for both wind and solar have now made these sources cost competitive with conventional fossil fuel sources in a growing number of markets. Given the challenges of transitioning some existing forms of energy use away from fossil energy sources (air travel, heavy transport, some industrial uses), the transition to clean electricity is one of the areas that needs to achieve at or near 100 percent renewable energy adoption[2] (see Solutions Project….).
3. ***Natural gas systems retirement (80 percent or greater) and equipment conversion*** – Deep emissions reduction will require a rapid phase-out of existing equipment and systems that rely on natural gas, such as boilers, furnaces, water heaters, chillers and other natural gas process uses. This is a new area of focus for both technical and policy solutions. Boulder is taking a leading role in beginning to assess options in this area (see below).
4. ***Petroleum-based transportation fuel retirement (80 percent or greater)—***Transportation represents a total of 30 percent of Boulder's emissions, with more than 20 percent of this related to ground transportation. Of these ground transportation emissions, the majority are generated by light duty personal vehicles. The rapidly expanding electric vehicle market place already offers a growing range of options that are capable of replacing shorter range travel (less than 40 miles round trip)—more than 80 percent of the miles travelled in this vehicle class. Again, electricity is the only energy source currently commercial viable for large-scale petroleum systems replacement and retirement in the light duty vehicle fleet.

This transition will need to take place at all levels of the community—household, business and institution. Essential to this transition is the proactive anticipation of the natural replacement cycles of a significant portion of these energy assets—heating and cooling systems, vehicles—in ways that leverage these already anticipated investments to build a new clean energy system. An important emerging role for the public sector will be the development of both financial programs and financial standards that can support and enable this infrastructure transition. Boulder County's recent step to become the first Colorado county to implement commercial Property Assessed Clean Energy financing (PACE) is an example of this kind of public sector financing mechanism. On-bill financing provided through municipal utilities like Fort Collins Municipal Electric Utility is another increasingly popular mechanism to support private investment. There are also an increasing number of other public-private financing mechanisms designed to leverage private sector investment.

V. Boulder Climate Action 2015-2020

Boulder's five year climate action plan builds on the foundation of experience and programs established in prior stages of work and integrates additional pilot projects and initiatives that develop additional deep emissions reduction opportunities.

<u>Implementation of Existing Programs</u>

[2] Numerous technical assessments have been conducted documenting the technical feasibility of achieving this level of renewable resource-based energy production. Please see http://thesolutionsproject.org/.

As summarized in the chart below, there are five major city program areas focusing primarily on energy-related emissions reduction. These existing initiatives were the basis for the projected emissions reductions described in the Updates section above. The city's waste related emissions reductions represent a sixth program area that is discussed in the Responsible Resource Use section of the Climate Commitment Strategy Document.

Together, the five energy-related program areas represent a major investment of organizational resources across three Divisions and multiple programs. A number of these programs are either recently implemented (Building Codes), represent significant new investments (transportation), or are still in final development and have not yet reached implementation stage (Boulder Building Performance Ordinance, municipalization, 15 Minute Neighborhoods).

Climate Action At a Glance—Energy

	Existing Programs	Pilots & Initiatives
Buildings & Uses	**1. Building Codes** Residential Commercial **2. Building Ordinances** SmartRegs C&I Ordinance **3. Voluntary Programs** Energy Smart PACE	**1. Solar Grants** **2. Community Power Partnership** **3. EV/PV/EE Pilot -SNUGG Home (BEC)** **4. Boulder Housing Partners Pilot (BEC)** **5. Energy Transformation Roadmap** **6. Thermal Decarbonization Strategy** **7. Nanogrids Pilot Projects** **8. Superior Ecotech (BEC)**
Mobility	**4. Transport Master Plan** VMT Reduction SOV Reduction	**9. Lightning Hybrids (BEC)** **10. eGo Carshare Pilot (BEC)**
Energy Source	**5. Municipalization**	**11. Solar Capacity Analysis** **12. Local Carbon Offset Fund** **13. Solar + Storage Pilot (BEC)**

"BEC" refers to Boulder Energy Challenge

Full and effective implementation of this existing portfolio of emissions impacting programs will draw significantly on existing organizational resources and will likely require additional staffing as programs mature. In addition to these five major program areas, the city has initiated 13 related pilot projects or initiatives that are designed to explore and develop further emissions reduction opportunities. Together, these five program areas and 13 pilots and initiatives constitute the primary areas of action and resource investment by the city over the 2015 to2020 timeframe. A number of these initiatives are profiled below to illustrate emerging opportunity areas for additional climate action.

New Initiatives and Pilot Projects

In addition to the ongoing implementation of existing programs, the city and its partners are engaged in 13 different initiatives and pilot projects designed to identify and develop new opportunities for deep emissions reduction. Four of these action areas are described below to illustrate the type of work taking place.

Solar Capacity Assessment – As part of the planning for implementation of a municipal utility, a local energy generation analysis has been initiated with a first stage focus on evaluation of local solar potential. In a

collaborative assessment conducted with the National Renewable Energy Labs, the city integrated recently acquired high quality satellite imagery with NREL's solar capacity assessment capabilities to evaluate the solar energy potential for every roof surface in the city of Boulder. This analysis included consideration of orientation to the sun, elevation, shading and minimum solar area suitable for a viable solar installation. Based on this preliminary analysis, NREL projected a total potential solar generation capacity of over 600 MW of electricity during peak production. Given a variety of factors this total capacity is sometimes discounted by 80% to account for factors like shading or imperfect aspect. However, this still indicates that at peak production, Boulder's roof areas could produce over half of Boulder's baseload[3] electricity needs. A second phase of this analysis will conduct a more in-depth assessment of the technical and financial feasibility of high potential solar sites to identify the constraints and opportunities for stimulating implementation of high value solar sites.

Mapdwell Community Solar Map—A second solar capacity mapping project has also been initiated to provide all Boulder building owners with an initial solar capacity assessment. To conduct this project, the city has contracted with MIT spin-off Mapdwell to utilize its proprietary solar capacity assessment tools capable of generating site specific solar capacity information—including an initial financial viability assessment—for every building in Boulder.

Cambridge Solar Capacity Map

Individual Household Assessment

Whole Energy System Transition Analysis and Planning – Recognizing the need to achieve decarbonization of energy across all energy sectors, the city has leveraged its participation in several national and international collaborations to secure grant funding to evaluate renewable energy transition options across all energy sectors including the gradual replacement of both natural gas and petroleum. On July 22 and 23, the city will use grant funds received from the Urban Sustainability Directors Network to bring staff from five other leading US cities—Boston, Minneapolis, Seattle, Portland and San Francisco to work together on the development of a set of tools cities can use to take a more active and influential role in creating low carbon energy systems. This gathering will also include technical specialists and leaders in energy policy including a member of the German Parliament who has been an active participant in helping develop and guide Germany's world standard setting "energiewende" clean energy transition plan. This event will include a public presentation and discussion at E-Town hall Wednesday night July 22.

[3] "Baseload" refers to the amount of electricity that needs to be constantly available to meet the current needs of the community.

In two closely related projects, the city was recently awarded grants through the Carbon Neutral Cities Alliance[4] to lead teams of cities working on energy decarbonization projects. The first project will identify pathways to achieve whole energy system transition in different types of neighborhoods or districts within cities e.g. residential, mixed use, commercial/industrial. The second project will identify specific renewable energy replacement strategies for natural gas-based heating systems in both residential and commercial/light industrial settings. Both of these projects are expected to be complete by mid-2016.

Energy Resilience Capacity Building – In early 2015, the city convened a public private partnership with several leading energy firms and the Colorado Clean Energy Cluster to pursue DOE funding as part of the Resilient Electricity Delivery Infrastructure (REDI) grant program. This project will support design and implementation of renewable energy systems that improve the ability of critical facilities to maintain operations during power disruptions. The lead project for this initiative is the installation of renewable energy back-up power systems at the city's Boulder Reservoir water treatment facility. Two additional projects are also being planned, one with Boulder Community Hospital and another with Boulder Housing Partners, to implement similar systems at their facilities. These projects are also being designed to integrate new energy savings features that will create significant financial savings in addition to improving the ability to withstand energy disruptions. These projects will also provide valuable initial experience in support of a larger community-wide critical energy infrastructure resilience assessment being evaluated with technical assistance providers made available through the 100 Resilient Cities initiative.

VI. A Comprehensive Climate Commitment Framework

The preceding summary provides an overview of the energy –related initiatives that have been the primary focus of Boulder's climate action efforts during its first two major stages. This focus on a transition to a low carbon renewable energy system is consistent with action strategies modeled in the most recent Intergovernmental Panel on Climate Change (IPCC) reports and numerous supporting assessments. However, these reports and a growing body of research and analysis are now pointing to two other broad areas of factors that play a significant role in either the total production of emissions for which a community is responsible, or the ability of natural systems to stabilize community emission impacts. These two areas represent important focus areas as part of a comprehensive long-term community climate stabilization commitment.

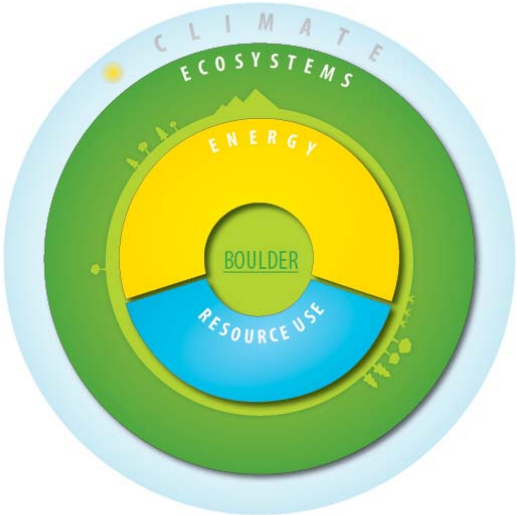
Resource Use – Currently the majority of internationally recognized community emission inventories measure only the emissions associated with energy use within its boundaries. However a community's full emissions impacts include its use and consumption of resources—from food, water and material goods, to the energy intensive streaming of digital media and the management of its wastes. Currently there is no standardized method for quantifying the impact of these resource based emissions beyond the landfill emissions allocated to organic waste streams--currently about 2% of Boulder's overall emissions inventory. These additional emission sources due to resource use are now increasingly recognized as integral considerations for a community's overall emissions impacts and long-term sustainability.

Ecosystems – While the majority of attention and climate action has been focused to-date on emissions generation, the eventual stabilization of the climate will also depend on effective management of

[4] The Carbon Neutral Cities Alliance is a consortium of 17 of the world's leading cities who have all made commitments to deep emissions reduction. Boulder was invited to be a founding member of the CNCA in 2014.

ecosystems. Ecosystems have two significant roles related to emissions. First, without effective management, large scale catastrophic events like wildfires can result in enormous carbon releases and degrade future capacities of ecosystems to maintain healthy carbon cycles. Second, there is a growing body of research indicating the potential to accelerate the capacity of natural systems to recapture (sequester) the excess amounts of carbon responsible for climate destabilization.

In recognition of these factors, the attached Climate Commitment Strategy document organizes and describes its next stage climate actions as three related broad goals: Clean Energy Future, Responsible Resource Use and Restorative Ecosystems. These are portrayed graphically in a way intended to both illustrate the relationships between these factors and simplify the often confusing complexity of the many factors implicated in climate change. Additional explanation of this approach is provided in the Climate Commitment Strategy Document.



Clean Energy Future

This focus areas encompasses the majority of efforts Boulder has identified as its primary climate action efforts. It is also basis of the city's proposed 80% emissions reduction goal. In the attached Climate Commitment Strategy document, these actions are discussed in three sectors of activity: high performance buildings; clean mobility, and clean energy sources. Given the central importance of energy as a driving factor in climate change, energy related action areas will continue to be the primary focus of the city's climate action efforts as describe in the prior sections.

Responsible Resource Use

In recognition of the importance of raising awareness about the connection between resource use and emissions, the city is focusing its resource related climate action efforts on three major resource use areas. These include:

Water—Boulder's long-standing water conservation efforts continue to explore the connection between water use, energy use and associated emissions.

Waste—The city's Zero Waste Master plan has both direct and indirect influences on the city's climate impacts. The city's current GHG inventory indicates that approximately 2% of city emissions are directly attributable to methane releases caused by community organic waste streams. More extensive diversion of both organic and recyclable materials could also further reduce indirect emissions for the city's waste stream.

Food—The growing interest and initiative around local foods and agriculture could also have emission consequences. The management of local agricultural lands in ways that either enhance or degrade ecosystem services such as sequestration is one example. A second potential effect is the displacement of energy and water intensive agricultural products by more low emission local products. It should be noted that this is an area in which only limited quantitative research has been completed.

Restorative Ecosystems

In addition to energy and resource use, ecosystems play a significant role in both maintaining and stabilizing climatic systems. Three areas of local ecosystem related action are described in more detail in the Climate Commitment document.

Urban Ecosystems – The primary focus of this area is the management of urban landscapes in ways that mitigate climatic extremes (heat and cold) to reduce energy needs and their associated emissions. Boulder' urban forest plays a critical role in this process. These landscapes currently face a number of significant disruptive influences that could significantly impact their ability to provide these services—increased temperature extremes, water stress, invasive species e.g. Emerald Ash Borer.

Natural Ecosystems – The city's extensive open space system also plays a significant role in maintaining stable ecosystem functions that provide substantial local ecosystem services (cooling, moisture retention, stormwater management) that could have serious negative energy and emissions impacts if not maintained.

Agro-ecosystems – A growing body of information and research suggest that deliberate strategies to enhance the sequestration capacities of managed lands could achieve measurable carbon capture and holding benefits. This is an area of emerging consideration, particularly in the context of agricultural and other highly managed landscapes e.g. parks.

Additional detail on both the Responsible Resource Use and Restorative Ecosystem focus areas will be included as part of the Climate Commitment Strategy document that will be completed by mid-July.

VII. Measuring Progress

The proposed 80% emissions reduction by 2050 goal is intended to provide the overall direction and long-term vision that guides all aspects of the city's operations and collaborations with the larger community. To measure interim progress towards achievement of this goal, each of the lead Divisions within the city have established shorter term metrics and targets that can be "rolled up" into cumulative emissions reduction objectives. These programmatic metrics and targets are summarized in Attachment B.

VIII. Community Engagement

Achieving an 80 percent emissions reduction by 2050 will require coordinated and sustained action across all sectors of the Boulder community. Mobilizing and coordinating this action will require extensive collaboration and in ways that leverage Boulder's innate creativity and innovation to develop a clean energy economy and lifestyle that grows economic vitality, social opportunity and environmental quality for the entire community.

The development of the attached Climate Commitment Strategy Document and the ratification of the emissions reduction goal are a starting point for the next steps in creating a community-wide discussion and development of an implementation strategy that honors a long-term commitment to maintaining a livable climate and acknowledges the more immediate and tangible concerns and considerations of daily community life. Attachment D provides an overview of the proposed Climate Commitment Communications Plan that will kick-off this next stage of community dialogue and collaborative implementation plan development. This engagement phase is intended to take place from August through the end of 2015 and culminate in Council's final approval of a Climate Commitment implementation strategy.

Attachment A: 2012 GHG Inventory Report

EXECUTIVE SUMMARY

The City of Boulder has completed an update to the communitywide greenhouse gas (GHG) inventory for the 2012 calendar year. This update was calculated in a new data reporting tool custom designed for the city by SWCA Environmental Consultants. The tool calculates emissions using ICLEI Local Governments for Sustainability U.S. Community Protocol, the new national standard for GHG emissions reporting. This protocol uses slightly different calculations and includes several new emissions sources as compared to previous inventories done by the city.[i] The data sources for this inventory are not consistent with past inventories as the city no longer receives franchise reports from its electric and natural gas utility, Xcel Energy. Using the new tool and omitting 2012 data sources for which data was not available in 2005, staff recreated Boulder's 2005 GHG baseline to create as accurate a comparison as possible between the baseline inventory and the current inventory.

Notwithstanding imperfect data, there are several key conclusions that can be drawn from the 2012 inventory. Since 2005, community emissions have remained fairly constant despite growth in population, jobs and economic activity. Boulder's biggest success in stabilizing emissions has been in the areas of waste, vehicle transportation and per capita residential energy use—all areas targeted by the city's climate programs and related initiatives between 2005 and 2012. The commercial and industrial sector (C&I)[ii] represents the greatest opportunity for reductions, thus reinforcing the city's targeted approach in designing policies and programs for this sector. Several new policies and programs for the C&I sector are in development and will be implemented in 2016.

Moving forward, the city hopes that improved data availability, either through action with the Public Utilities Commission (PUC) to introduce a standardized Community Energy Report from energy utilities, or through municipalization efforts, will support more accurate and detailed future inventories using the new ICLEI Protocol and the SWCA tool. In any inventory year, factors such as heating and cooling degree days, economic trends, and significant local developments impact emissions, requiring careful attention to and consideration of these factors in mapping overall emission trajectories to measure progress and inform next steps in policy and action.

BACKGROUND

Importance of a Greenhouse Gas Inventory

In 2002, the Boulder City Council passed Resolution 906, committing the community to reducing its GHG emissions to the target established by the Kyoto Protocol, a 1997 international agreement to combat global climate change. As a result, Boulder launched a series of climate action efforts in 2002 with the goal of reducing community emissions 7 percent by 2012. Boulder's first GHG inventory was conducted in 2006 and was updated again in 2010. In 2013, the city adopted the ICLEI Local Governments for Sustainability U.S. Community Protocol for communitywide emissions reporting and built an inventory tool to compile and report emissions congruent with this new national standard. This report provides the results of the completion of the first full inventory conducted using the tool, for emissions generated in the 2012 calendar year.

What are emissions and why do they matter?

A greenhouse gas is defined as any gas that traps heat in the atmosphere. These heat trapping gases, including carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), are essential to life on earth, maintaining the temperature of the planet and sustaining life. They are produced and released into the atmosphere through the everyday activities of the planet and its inhabitants: plants, animals and people. Since the Industrial Revolution, global GHG emissions have increased exponentially through the production and burning of fossil fuels and generated waste products. More than 70% of global emissions come from cities such as Boulder. The impacts of this exponential increase, referred to as "climate change," present significant current and projected, local and global issues.

In Colorado, the biggest concern is a shift in precipitation patterns, with more falling in the form of rain than snow. This results in smaller snow packs and thus increases the chance of drought, especially in late summer, as well as the likelihood of wildfires. More severe rain events could also increase the frequency of major flooding and landslides. On a global scale, it is predicted that areas subject to storms and flooding could see increases in intensity, frequency and duration of these events; that arid deserts could grow due to lack of available water; and that rising sea levels could inundate many coastal areas, including major population centers.

What can we learn from measuring emissions?

In 1992, the United Nations Framework Convention on Climate Change, an international environmental treaty, was negotiated with the objective to "stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.[iii] In order to stabilize GHG concentrations to a manageable level, it is helpful to create an emissions baseline against which to set reduction targets. Based on data quality and availability, as well as consistency with other Front Range communities, Boulder has adopted a 2005 baseline. This baseline will be used for the communitywide emissions inventory as well as for the city's municipal GHG inventory (i.e., emissions from city operations). By measuring emissions and monitoring trends such as economic activity, weather patterns and technology shifts, Boulder can track its progress toward emission reduction goals, determine impacts of certain programs, policies and community efforts, and identify areas of largest opportunity for reductions. This creates a valuable feedback loop for fine-tuning the estimated impact of existing policies and programs on emissions trends as well as the estimated impact of prospective climate action efforts. It is also a helpful reminder of the areas in which the city and Boulder community have direct control and the areas which rely upon more external factors. Such a reminder played a key role in the city's decision to seek to change its energy source and council's vote in 2010 not to renew a 20-year franchise with Xcel Energy. The emissions measurement process with the updated data continues to support the path of finding cleaner ways to supply customers with electricity.

Accountability and leadership

The City of Boulder continues to be a viewed as a sustainability thought leader, with its innovative climate programs and policies. These include the Climate Action Plan tax, approved by voters in 2006 and renewed in 2012; SmartRegs, a program to establish a minimum level of energy efficiency in the city's roughly 20,000 rental units; and new construction and building energy codes that are among the most aggressive in the country. Recently, the city has worked to define a path toward a new, ambitious climate goal: an 80 percent emissions reduction from 2005 levels by 2050. The city has also begun to embed emission reduction strategies in key areas of planning, such as the recently updated Transportation Master Plan. By measuring progress on emissions reductions, developing new approaches to climate action policies and programs, engaging with community partners, and sharing efforts and best practices with others, the city hopes to catalyze climate

action throughout Boulder and beyond. The city has a responsibility to lead by example and demonstrate innovation such as by piloting projects within city operations that may show promise for the community at large. To this end, in 2009 the city hired an energy service company (ESCo) to recommend energy efficiency improvements and calculate payback costs and time. Projects implemented between 2009 and 2012 have reduced emissions from city buildings and facilities by 34 percent.

History of inventories

The city established 2005 as the baseline year against which to measure emissions reduction progress. This was the year for which inventory data was available to calculate community emissions in 2006 when WSP Environment & Energy was hired to create the first community emissions inventory for the city. In 2010, an update to the inventory was performed and results were published in a comprehensive report titled "Community Guide to Boulder's Climate Action Plan, 2010/2011 Progress Report." With the end of franchise reporting from Xcel Energy in 2010 and the introduction of new data privacy rules, it has become much more difficult to obtain the data necessary to perform ongoing inventories, resulting in a significant lag in time to generate the updated inventory for 2012. A franchise report provides standardized data formatting and currently offers the most accurate energy data to a franchisee. A Community Energy Report docket currently filed with the PUC and sponsored by a regional working group of municipalities interested in data reporting may provide the necessary reporting structure and data access to support more timely future inventories. Updates are intended to continue on a three year cycle. Contingent upon receiving the necessary data, the next update to the inventory is expected to be conducted in 2016 for the 2015 reporting year. Should the PUC docket be delayed or not adopted, however, it may be necessary to postpone the 2015 inventory until accurate data is available.

METHODOLOGY

In October of 2012, ICLEI Local Governments for Sustainability released the U.S. Community Protocol, the first national standard for municipalities to report on community greenhouse gas emissions. This standard was the result of collaboration between ICLEI and a number of local governments, and focuses on the categories of emissions that local governments have the most likelihood of influencing through programs or policies. In addition to measuring progress against community goals, this standardized methodology allows cities to benchmark against one another and avoids double counting by clarifying jurisdictional boundaries for emissions accounting, particularly within the transportation category. The ICLEI protocol expands on the five emissions source categories that Boulder had previously measured under the Greenhouse Gas Protocol Initiative's GHG Protocol Corporate Standard: electricity, natural gas, vehicle transportation, landfill and offsets. See **Table 1** for a comparison of categories reported in the 2010 update to the inventory versus those reported in the 2012 inventory under the new protocol.

Table 1. Categorical Comparison of Protocols 2010 v. 2012

Category	2010	2012
Electricity	Included	Included
Natural Gas	Included	Included
Vehicle Transportation	Included	Included
Solid Waste	Included	Included
Offsets	Included	Not included
Air travel	Not included	Included
Refrigerant and Fire Suppression Equipment Leakages	Not included	Included
Recycling and Compost	Not included	Included

The protocol also calculates emissions for several sources that are duplicated in another category or informational only (not included in total emissions), with the express purpose of allowing a municipality to better identify emissions reduction opportunities in areas that may otherwise go unnoticed. These sources include regional travel, water treatment and transport, and recycling and compost. It is important to note that the ICLEI protocol also requires the calculation of emissions from electricity lost in transmission and distribution, which is then included in electricity totals. The protocol also separates emissions by sources and activities, rather than compiling all emissions into one comprehensive community summary. In order to compare the 2012 inventory and future inventories against pre-2012 inventories, a community summary report has been built into the city's greenhouse gas accounting software tool.

As a leader in the climate community, the city seeks to ensure that the Boulder community acknowledges and takes responsibility for the emissions it generates. Through this standardization of reported emissions data, Boulder can fully participate in several benchmarking efforts, including the Urban Sustainability Directors Network (USDN) and the Carbon Disclosure Project, the reporting platform of the Compact of Mayors and Carbon Neutral Cities Alliance.

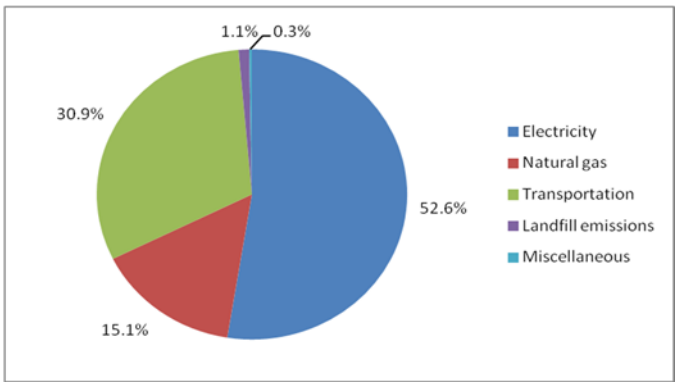
It is also important to note that with the change in methodology and the adoption of the new ICLEI protocol, the city has taken the opportunity to update some of its existing assumptions and conversion factors. For example, the city previously calculated CO_2 using the Environmental Protection Agency (EPA) eGrid carbon factor, a regional average of carbon emissions from power plants serving Colorado and portions of Wyoming, Nebraska and South Dakota. Due to the effort to calculate this carbon factor, the factor is updated every few years. By contrast, the city has now adopted Xcel Energy's Colorado emissions factor, which is calculated by Xcel every year and more accurately reflects the carbon intensity of electricity used in Boulder. Due to Colorado's Renewable Portfolio Standard, Xcel Energy's resource mix includes a higher percentage of renewables compared to the broader region, and thus is less carbon intensive. This is reflected in the results of the inventory and will be covered in more detail below.

EMISSIONS ANALYSIS

2012 Update to the Greenhouse Gas Inventory

The leading sources of emissions in Boulder's 2012 inventory remain consistent with previous inventories. These high-emissions sources include electricity and natural gas used in buildings and fuel used for transportation. Other sources worth noting include landfill emissions and emissions from the wastewater treatment process and from refrigerant and fire suppression system leakages.

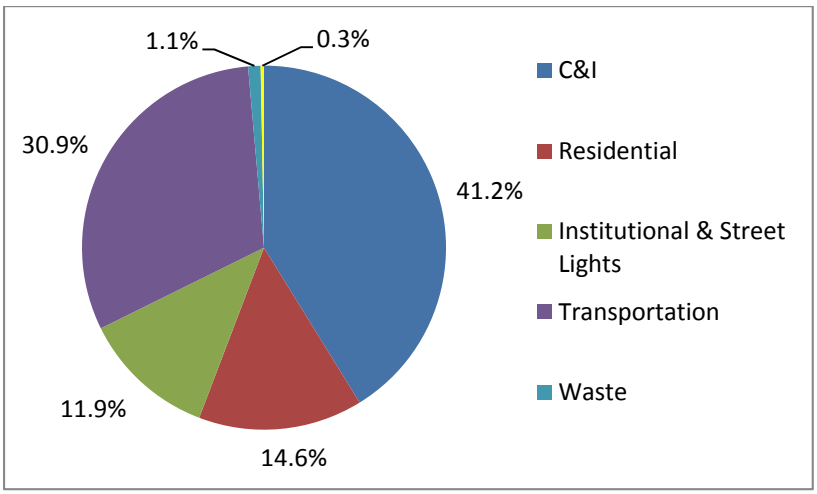
Chart 1. Emissions by Source



As shown in **Chart 1,** electricity and natural gas account for nearly 68 percent of all emissions, while transportation accounts for an additional 31 percent, bringing the total for these three sources to nearly 99 percent of Boulder's total emissions. Electricity and natural gas are the energy sources most commonly used to power and heat or cool buildings, while transportation includes gasoline and diesel used in vehicles and jet fuels used in air travel by Boulder residents at the Boulder Municipal Airport and Denver International Airport.

Another way to visualize the results of the 2012 inventory is to look at emissions broken out by sector. In **Chart 2,** electricity and natural gas are divided by residential, C&I and institutional uses. This represents the same roughly 68 percent of emissions attributed to buildings in Chart 1, with energy use in C&I buildings accounting for the largest portion of the inventory at 41.2 percent. It is worth noting that nearly 12 percent of community emissions come from institutional buildings, which include city and county operations within city limits (including street lighting and signals), the Boulder Valley School District and the University of Colorado, Boulder. The federal labs are represented in the C&I sector, rather than institutional, as breakout data was unavailable.

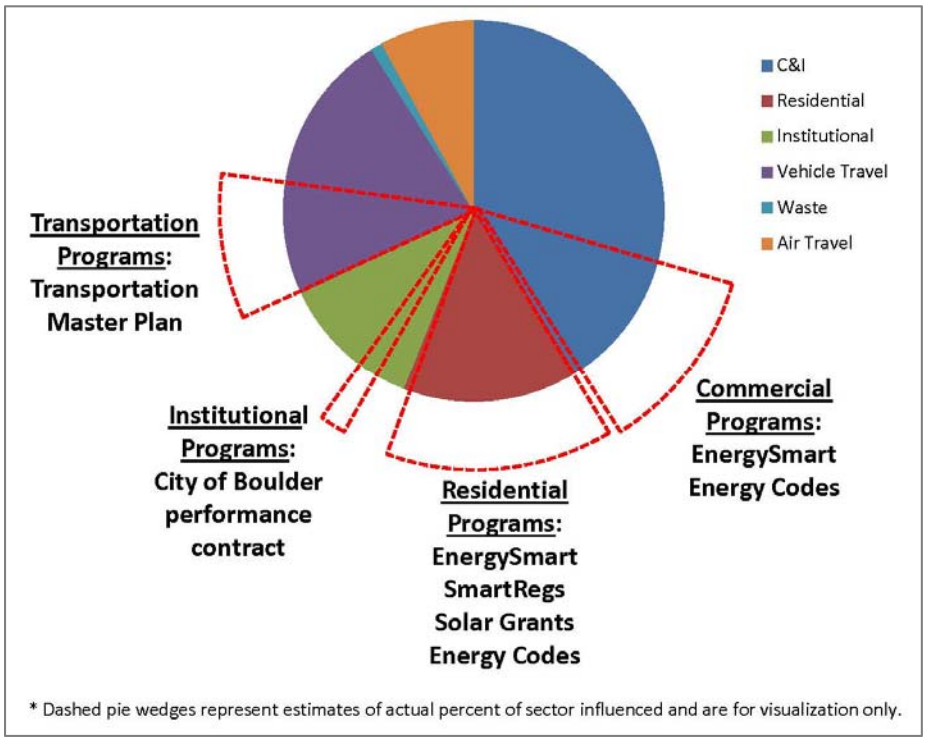
Chart 2. Emissions by Sector



In order to understand community emissions trends over time, the city recreated an estimate of the 2005 baseline using the new SWCA tool and ICLEI protocol and omitted data sources in 2012 for which data was not available in 2005. Every effort was made to create as accurate a comparison as possible; however, the data is imperfect. The inventory shows that emissions have remained fairly constant at a 0.5 percent increase from 2005 to 2012, despite significant growth in population, jobs and economic activity, which will be discussed further below.

Two areas targeted by the city's climate programs between 2005 and 2012 show some measure of success. These include a reduction in emissions associated with waste, which can be attributed to zero waste initiatives such as curbside compost and recycling programs, commercial incentives and rebates, and special events policies; per capita residential energy use, targeted by EnergySmart; and reduced vehicle miles traveled through prescribed efforts from the Transportation Master Plan. Because this inventory is for the 2012 calendar year, the impact of program activities since January 2013 is not reflected. As shown in **Chart 3**, city climate programs through 2012 impacted some but not all emissions inventory sectors. SmartRegs and the EnergySmart program have since facilitated upgrades in thousands of additional residential units. In 2016, new policies and programs for commercial and industrial buildings are expected to go into effect that will facilitate reductions in that sector while improving the quality of Boulder's building stock.

Chart 3. Emissions Sectors Influenced by Current City Programming



FACTORS INFLUENCING EMISSIONS

Quality of data dictates the quality of any emissions report. As previously stated, accurate energy data has become harder to attain without the aid of a franchise agreement with Boulder's utility provider, Xcel Energy, and due to the adoption of stricter customer data privacy rules by the PUC in 2012. Additionally, the change in methodology with the introduction of the new ICLEI protocol affects emissions inputs and calculations as well as the ability to compare this inventory to past inventories. To this effect, the most significant addition to this inventory is the source category of air travel, which had not previously been accounted for. Finally, changes in emissions factors, determined by the energy resource mix (coal, natural gas, wind, solar, hydropower, etc.) of the local electricity provider, have significant impacts on the outcome of an inventory.

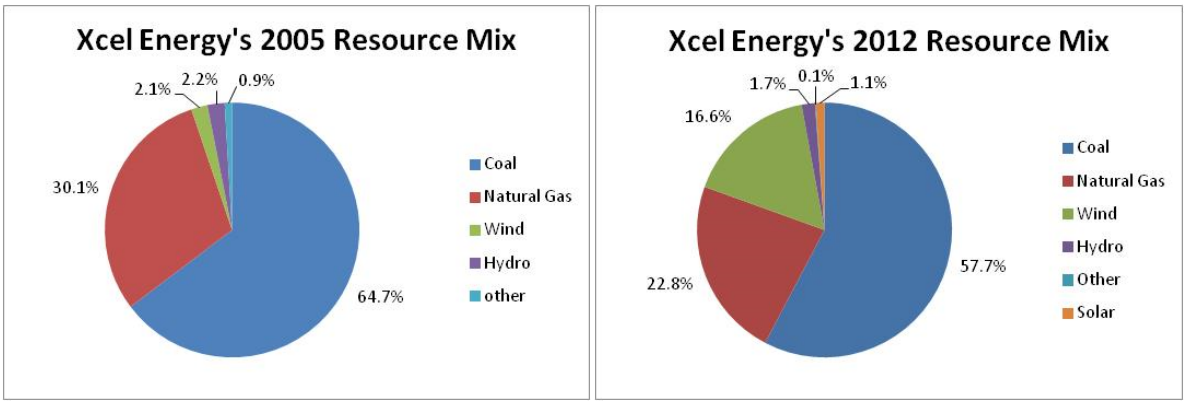
Air Travel

Air travel is an additional source category in the inventory under the new ICLEI protocol. The proxy measure for air travel of Boulder residents is the percent of total Denver International Airport travel represented by the population of Boulder as a percent of the greater metro-Denver area. This methodology does not provide an accurate accounting; however, absent better data, it provides a standard by which to account for this sector of emissions until better data becomes available. Based on the current methodology, air travel accounts for roughly one third of emissions produced by the transportation sector, or 8 percent of Boulder's total 2012 community inventory. This finding underscores the significance of air travel—a carbon-intensive activity—in terms of its contribution to Boulder's total emissions and climate impact. Total air travel has increased considerably since 2005, making this addition to the inventory quite substantive. To illustrate this point, the 2005 and 2012 inventories were compared with air travel removed as an emissions source. The result was a comparison calculation that showed Boulder's emissions had *decreased* by 3.4 percent rather than increased by 0.5 percent.

Emissions Factor for Xcel Energy's Electricity Mix

The Boulder community receives its electricity and natural gas from Xcel Energy. The types of energy Xcel incorporates into its electricity resource mix influence the carbon intensity of Boulder's electricity, and therefore the greenhouse gas emissions related to energy use in buildings. A comparison of Xcel's Colorado-wide electricity resource mix in 2005 and 2012 is illustrated in **Chart 4.**

Chart 4. Comparison of Xcel Energy's Colorado-wide Electricity Resource Mix 2005 to 2012



With the increase in renewable energy resources mandated by the Colorado Renewable Portfolio Standard, Xcel's emissions factor related to electricity generation has decreased from 1849 pounds (lbs.) CO_2e in 2005 to 1561 lbs. CO_2e in 2012. This underscores the great potential of renewable energy to reduce greenhouse gases. The decrease in Xcel's carbon factor impacts Boulder's net emissions; carbon intensity went down even while overall electricity use increased. Energy consumption—for both power and thermal uses—is the other side of this emissions analysis.

ENERGY ANALYSIS

Because total emissions are dependent upon the emissions factor of grid electricity, it is important to analyze and compare actual energy use as a metric in order to evaluate Boulder's climate progress.

Table 2. Total Energy Use Comparisons—2005 to 2012

	Units	*2005*	*2012*	*% Change*
Residential Electric	kWh	244,648,421	247,876,097	1.3%
Residential Natural Gas	dTh	1,870,490	1,869,965	0.0%
C&I Electric (excluding CU)	kWh	870,465,652	979,845,533	13%
C&I Natural Gas (excluding CU)	dTh	2,208,664	2,796,898	27%
CU Boulder Electric	kWh	75,778,347	143,680,272	90%
CU Boulder Natural Gas	dTh	1,324,306	900,173	-32%
Grid Loss	kWh	63,474,566	66,375,852	5%
Total Electric	kWh	1,254,366,986	1,437,777,754	15%
Total Nat Gas	dTh	5,403,460	5,567,036	3%
Total Electric (without CU)	kWh	1,178,588,639	1,294,097,482	10%
Total Nat Gas (without CU)	dTh	4,079,154	4,666,863	14%

To help understand the impact of a significant change in the University of Colorado, Boulder (CU Boulder) plant operation, the table above separates out the energy use of the campus (see following section for more

information). Excluding CU Boulder, total electricity and natural gas consumption for the Boulder community from 2005 to 2012 has increased 10 percent and 14 percent, respectively. To explore this data further, the table below summarizes various metrics for energy use "effectiveness"— energy use per household, per employee and per floor area.

Table 3. Energy Use Effectiveness Comparisons—2005 to 2012

	Units	*2005*	*2012*	*% Change*
Residential Electricity per Household	kWh/HH	6,263	6,035	-4%
Residential Natural Gas per Household	dTh/HH	47.9	45.5	-5%
C&I Energy Use Intensity*	kBtu/sf	161	188	16%
C&I Electricity per employee*	kWh/FTE	8,997	9,858	10%
C&I Natural Gas per employee*	dTh/FTE	23	28	23%

** Excludes CU Boulder*

The data in the above table indicate the following key findings:

- From 2005 to 2012, Boulder reduced residential energy use per household (per capita reductions are similar). This reflects, in part, the impact of climate programs on waste reduction and residential energy efficiency (zero waste programs and facilities, EnergySmart residential and SmartRegs).
- In the C&I sector, total energy use intensity (energy per square foot of floor area) and energy use per employee has increased. While more recent efficiency program investments have targeted commercial and industrial energy uses, and achieved an estimated 8,500 $mtCO_2e$ in savings, there is clear growth in this sector in the comparison of 2005 and 2012 inventory data.
- Despite a warmer winter (see following section), natural gas use in the C&I sector has increased even more than electricity. This indicates that the increase can likely be attributed to process loads in the industrial sector, which are not weather dependent. It is important to note that no existing city program addresses energy use in the industrial sector; however, a proposed C&I energy efficiency rating and reporting ordinance that would begin to address energy use in this sector may take effect as soon as 2016.

To fully understand what this data means, it is important to consider all of the factors that influence energy use and how they have changed from 2005 to 2012. Specifically with regard to C&I energy use, the economic recovery and expansion of economic activity could explain the increase in energy use intensity. This factor and additional factors are discussed in the following section.

FACTORS INFLUENCING ENERGY USE

The city and larger community have implemented a wide range of strategic and integrated efforts intended to address climate change by reducing energy use in residential and commercial buildings. As illustrated by the inventory, these efforts have had a positive overall impact. Distinct from these efforts, a range of other factors can significantly influence community energy use and emissions. This section provides an overview of some of the key factors that need to be considered and monitored as part of assessing both the overall trends in energy use over time and the impact of city programs.

Data Limitations
Due to the absence of franchise reports after 2010, which would have provided standardized reporting to the city, and stricter data privacy rules instituted in Colorado in 2012, the city used alternative sources to collect the source data for this inventory. These sources were not in the same format as previous reports received from Xcel when the city was still under a franchise agreement. As a result, there may be differences in the data that could influence Boulder's reported energy usage for both electricity and natural gas from year to year. The data sources used in the 2012 inventory differ from those used in 2010 and will differ from data used in the next inventory. Although the city has tried to correlate numerous sources to confirm data accuracy, the challenges in securing this data from Xcel could continue to create uncertainties in the inventory unless the PUC requires utilities to use an aggregation standard that does not compromise the quality of data in community energy reports provided to local governments. An open docket on this issue was being deliberated by the PUC at the time this report was written.

Weather
The intensity of both summer and winter weather can significantly impact the amount of energy a community uses to maintain comfort and livability in its buildings. Warmer summers lead to an increase in the use of air conditioning, water use (and associated pumping), and other heat mitigation actions. This typically results in an increase in electricity usage. Given the majority of heating systems in Boulder utilize natural gas, colder winters lead to an increase in natural gas usage.

One metric for tracking these weather variables is known as degree days. Warmer temperatures in the summer lead to more cooling degree days (CDD) and more cold weather in the winter leads to more heating degree days (HDD). **Table 4** shows the difference between cooling degree days and heating degree days between 2005 and 2012 in the 80302 zip code of Boulder.

Table 4. Annual Total Heating and Cooling Degree Day Comparison—2005 to 2012[iv]

2005		2012		Comparison Percentage	
HDD	CDD	HDD	CDD	HDD	CDD
5,227	745	4,664	1,126	-11%	51%

These results suggest that 2012 had a slightly warmer winter—and subsequent slight reduction in the need for natural gas for heating. This could partially explain the reduction of natural gas use per household (-5 percent) in the residential sector. As mentioned earlier, despite a warmer winter, natural gas use per employee in the C&I sector increased by 23 percent. This increase can likely be attributed to additional process loads in the industrial sector, which are not weather dependent.

Conversely, the significant increase in cooling degree days in 2012 suggests a hotter summer, which might have led to more electricity usage for cooling activities. This makes the 4 percent reduction in electricity use per household even more impressive, and could partially explain the increase in electricity use per employee in the C&I sector.

Population Growth and Economic Trends
The period between 2005 and 2012 encompasses the significant economic recession experienced by the U.S., and to a somewhat lesser extent, Boulder. By 2012, significant economic recovery had taken place and there was measurable growth in jobs and revenue compared to the 2005 baseline year – this must be considered when looking at the total energy usage.

Table 5. Economic Activity Comparisons—2005 to 2012

	2005	2012	% Change
Retail Sales	$1,750,987,683	$2,279,823,724	23.2%
Population	98,526	101,169	2.6%
Employment	96,755	99,400	2.7%

Not captured in this economic activity data is the development of new, highly energy-intensive facilities in Boulder, such as medical marijuana (MMJ) grow and processing facilities and International Business Machine's (IBM) large data center[v]. While MMJ was legalized in Boulder in 2000, there were only a few small grow operations until the announcement that the federal government would not interfere in states where MMJ was legal (2010). The city began licensing medical marijuana facilities in 2010 and saw a marked increase in operations, with 43 facilities licensed in 2012. Because data centers and MMJ grow and processing facilities are between 20 and 100 times more energy intensive than office buildings, the city can reasonably postulate that the addition of new MMJ facilities and the addition of new industrial activities such as the large IBM data center are partially responsible for the significant increase in C&I electricity use since 2005.

University of Colorado (CU) Boulder's Cogeneration Plant

Cogeneration, also known as combined heat and power, is the simultaneous production of electricity and heat from a single fuel source, such as natural gas. CU Boulder had been running a natural gas driven cogeneration system that produced electricity from a turbine, and recovered and reused free waste heat from the process. In 2004, CU Boulder began to phase out the operation of its cogeneration facility due to the increased cost of natural gas (the majority of the "phasing out" occurred between 2005 and 2012). Taking the cogeneration system offline resulted in a corresponding drop in natural gas consumption, a significant increase in the amount of grid electricity CU consumed and a marked increase in CU Boulder's overall emissions, which significantly impacted the 2012 GHG inventory and may impact the next inventory, as well.

Since shutting down its ageing cogeneration system, CU Boulder has been designing and building a new $91 million campus utility system that should be fully operational by the end of 2015. This new campus utility system includes:

- A new heating and cooling plant
- Renovation of the existing 103-year-old campus utility system, including expansion of cogeneration capabilities
- Interconnection of the two plants with new and upgraded distribution

While CU Boulder and the city expect that this new system, in addition to a number of other efforts at CU, will reduce total emissions for the campus, these reductions will not be evident for several inventories.

Technology and Usage Change

Another emerging factor affecting energy usage, particularly the electricity sector, is the rapid proliferation of electronic devices that are adding additional plug loads. Despite the documented increase in residential plug load, including energy use from plasma televisions and the charging of more and more mobile devices, 2012 still saw a reduction in electricity use per household.

In commercial buildings, plug loads are one of the fastest growing drivers of energy consumption and typically account for 30 to35 percent of the total electricity used in a given office building. Data from the Energy

Information Administration's Annual Energy Outlook shows that plug load electricity use increased almost 20 percent from 2005 to 2012.[vi]

Beyond plug load growth, there has been a trend in recent years to make more efficient use of space in commercial office buildings. New companies are adopting open office floor plans, which result in higher energy use intensities, but lower energy use per employee. Likewise, the typical workday has lengthened over time and commercial buildings are operating for more hours than ever before.

Though important anecdotal trends, the direct impacts of technology and plug load growth on energy use cannot be measured. Still, understanding these factors and trends helps the city design future programs that better address today's lifestyle.

Local Solar Growth

Local, or rooftop, solar electricity reduces the amount of electricity consumed and accounted for in the GHG inventory. Because the energy is consumed behind the main electric meter, local solar functions like reduced demand or energy efficiency in terms of accounting for electricity consumption. Boulder made important progress between 2005 and 2012 with regard to growth in local solar adding nearly 10 MW of permitted solar to the grid. Over three megawatts (MW) has been installed since 2012, and the city has plans to ramp up efforts to support the installation of more local solar on both residential and commercial buildings by providing residents better access to solar potential information.

Table 6. Rooftop Solar Permits – 2005 to 2012

	Solar Permits
2005	< 1.180 MW (prior to 2007)
2012	11.79 MW (through 2012)

CONCLUSIONS AND NEXT STEPS

The 2012 greenhouse gas inventory represents a new beginning in Boulder's inventory reporting, as Boulder increases accountability for its greenhouse gas emissions, adopts a new national reporting standard, takes ownership for additional emissions sources, and establishes new tools for measuring and projecting the impact of current and future community climate efforts.

As this is the first inventory performed according to the ICLEI U.S. Community Protocol using a more localized carbon factor and new data sources, it essentially represents a new baseline. This new baseline, however, will provide increased accountability for the emissions generated in Boulder and will enable the community to compare results to other communities in the U.S. and share best practices. Given better data availability and access, the inventory performed for 2015 will be a more accurate assessment of the overall trends in community emissions. The ability to conduct a 2015 inventory will be dependent upon the outcome of the PUC negotiation for a standardized Community Energy Report. In any inventory year, factors such as heating and cooling degree days, economic trends, and significant local developments (such as the CU Boulder cogeneration system and IBM data center) impact annual emissions, requiring careful attention to and consideration of these factors in mapping overall emission trajectories to measure progress and inform next steps in policy and action.

A number of factors make it difficult to do a direct comparison between the 2012 inventory and past inventories. These include the difficulty to obtain standardized energy usage data from Xcel, restrictions

imposed by data privacy rules and methodological changes in calculations and categories of information included with the introduction of a new protocol. Be that as it may, some general trends can be identified: although emissions appear to be holding constant, community energy use as a whole has increased. The energy results of 2012 compared to 2005 show reduced per capita residential energy use despite growing plug loads and a significantly warmer summer. This finding points to the success of residential energy efficiency programs such EnergySmart and SmartRegs, as well as zero waste and transportation efforts to reduce emissions. The majority of Boulder's increased energy use comes from the boost in energy use in the C&I sector. While the city has devoted significant resources to Commercial EnergySmart, this program does not target the highly energy intensive industrial businesses and manufacturers. To address the growth in electricity and natural gas use in the C&I sector, the city is proposing new requirements for rating and reporting for all C&I buildings greater than 20,000 square feet (sq ft.) These requirements will be brought to council in the form of an ordinance in Q3 of 2015. Still, there are limitations to how much the city can truly affect energy use in the industrial sector, which is responsible for the majority of the city's jobs and revenue. While many of the large industrial businesses have improved their energy productivity (the amount of energy related to their economic output), total energy use continues to rise with growth in business. The city will continue to strive to strike a balance between robust business activity and reducing GHG emissions.

Given the abstract nature of greenhouse gas emissions and the complex nuances of emissions data analysis, the city recognizes an inherent challenge in communicating the findings of the 2012 greenhouse gas inventory to the public in a way that is comprehensive, intelligible and engaging. To address this challenge, city staff has worked with a local design firm to develop an infographic that relies on visual components to convey the high-level takeaways from the this inventory. In addition to reporting the findings of the 2012 greenhouse gas inventory, the city intends to use this infographic to supplement climate education and engagement and to help the public connect existing and planned climate action efforts to the larger context of Boulder's climate footprint.

Attachment B: Summary Table of Emission Reduction Metrics and Targets[5]

		TARGETS BY DECADE		
	2015	2020	2030	2050
Overall CO2 Emissions				
Total CO2-MtCO2e		1,327,313	1,005,540	361,994
Per capita MtCO2e		11	8	3
Clean Energy Future				
Buildings & Related Uses				
Residential--kwh/HH/year		5,000		1,600
Residential Electricity Savings		10%		70%
Residential--therm/HH/year		38,000		28,000
Residential NG savings		5%		25%
Commercial EUI		70		65
Commercial Electricity Savings		-7.5%		30%
Commercial & Industrial NG Savings		7%		20%
Transportation/Mobility				
Total VMT--Anuual	883,000,000	846,000,000	757,000,000	579,000,000
VMT Per person				
Residents--miles per day	11	10	8	4
Non-residents--miles per day	14	14	12	9
Transit Mode Share				
Residents--% using transit	5%	6%	9%	14%
Non-residents--% using transit	9%	10%	11%	14%
Bike Mode Share				
Residents--% biking	19%	22%	27%	38%
Non-residents--% biking	1%	1.50%	2%	3%
Ped Mode Share-Residents--% walking	20%	21%	24%	29%
SOV Mode Share				
Residents--% driving alone	36%	32%	24%	8%
Non-residents--% driving alone	80%	75%	65%	45%
Neigbhorhood Accessibility--Residents	26%	40%	67%	100%
Light Duty Vehicle MPG equipvalent	23mpg	36 mpg	50 mpg	74 mpg
# of electric vehicles		2,000	10,000	30,000
# of other zero carbon fuel vehicles (e.g. hydrogen)		250	2,000	5,000
# of business with workplace charging		25	200	500
# of chargers/employees		1/1,000	1/500	1/50
# of public and workplace charging stations		50	500	2,500
Energy Source Change				
MW Clean Electricity		75	150	300
% Clean Energy		30%	50%	80%
MW Local Energy		30	60	150
% Local Energy		12%	22%	50%
Energy Cost/unit (all forms)				
Natural Gas replaced/reduced		5%	25%	80%
Petroleum replaced/reduced		5%	25%	80%
Community Infrastructure				
% undergrounded utilities	60%	70%	80%	90%
% of critical services faciliities with islanding capability		75%	85%	95%
# of community solar gardens		5	15	30

[5] 2050 targets for a variety of programs including Transportation were created by extrapolating trends from 2035 to 2050. Continued reductions between 2035 to 2050 will require additional investment. Targets will continue to be refined over time.

<u>Attachment C</u>: Climate Commitment Communications Plan

August through December 2015

Objective: To build momentum around, and a better understanding of, Boulder's next-generation climate goals and the strategies necessary to achieve them.

Goals:

1. To help target audiences understand the need for more aggressive and impactful climate action
2. To communicate the goal that City Council chooses to adopt, whether it is an 80 percent reduction in emissions by 2050; a fossil-fuel future; or some hybrid
3. To describe the three focus areas of the city's proposed Climate Commitment and facilitate community feedback on this approach. The three areas are:
    a. Creating a Clean Energy Future
    b. Using Resources Wisely
    c. Encouraging Restorative Ecosystems
4. To explain how existing initiatives, including municipalization, energy efficiency standards and programs; and innovative pilots and partnerships fit into this framework
5. To identify what the city can do, what community partners can do and what individuals can do to help reach Boulder's goals

Target Audiences:

- Residents, including students/youth
- Business and property owners
- Institutional and non-profit partners
- Environmental allies and other communities working on similar goals
- Legislators and regulators
- Potential investors and grantors

Key Messages:

- Boulder has long been a leader in confronting climate change, and meaningful action is more important than ever. Our community and others are already experiencing the negative effects of climate change and it is important that we focus both on minimizing these and adapting to them (or building resilience to them).
- The strategies the city and partners adopt to confront this challenge are good for the environment, and they have many other benefits for Boulder, including an improved quality of life; energy independence and enhanced reliability of service; economic vitality; and a continued commitment to innovation. These benefits may, in fact, be better motivators for encouraging communitywide action.
- The three focus areas stem from our greenhouse gas inventories and our knowledge, acquired through the actions we have taken in Boulder since voters created the carbon tax in 2006, about the areas where the biggest impacts are possible and where we, as a community, can have the most local control.
- The first – Creating a Clean Energy Future, which includes, but is not limited to municipalization – is the area in which the most city resources have been devoted in recent years. This is because energy (both

in terms of how we power our homes, businesses and other buildings and how we get around town) is the single largest source of Boulder's emissions.

- The city has valuable programs in the two other focus areas – Using Resources Wisely and Encouraging Restorative Ecosystems – and plans to continue these both because they play a part in climate action and because they are consistent with other important community priorities and values.
- The climate commitment is a long-term initiative, and the second and third focus areas, in particular, are ripe for development of policies and programs that would tackle the emerging areas of consumption and carbon sequestration.
- There are steps the city can – and is taking – to address climate change, but we have the greatest opportunity of being successful through partnerships and regional, national and international coalitions. In addition to this, individual action remains a high priority. Each one of us has a role to play.

Challenges:

- City Council has not yet adopted a Climate Commitment goal.
- The city has many different projects going on simultaneously, leading to community and organizational confusion about the city's overall approach and how the different pieces fit together
- Much of the focus has been on the highly politicized topic of municipalization. This has stolen the community's focus and threatens to undermine what had been community consensus around the importance of taking action.
- The city wants to support existing initiatives, which have led to meaningful success, but additional, significant and potentially costly work is required to effect real change.
- There are insufficient resources (both monetary and in staff capacity) to take on additional initiatives or efforts. It is anticipated that these staff teams will be seeking additional resources as part of the 2016 budget process, but these requests will have to be weighed against other city needs and priorities.

Opportunities:

- City Council's and Boulder's demonstrated commitment to this issue
- Recent events, like flooding, that have raised the community's interest in preparedness and resilience in the face of natural disasters
- More knowledge and data than we've ever had before about our energy use, supply and potential for improvements
- A recently adopted Transportation Master Plan that includes greenhouse gas emission reduction and infrastructure transformation as key goals
- Recent efforts to solidify and create new partnerships, coalitions and alliances within the city, in the county/region, across the country and internationally
- Success in pursuing grants to provide additional funding, especially for pilot and innovative programs
- Strong programs in the areas of resource conservation and restorative ecosystems upon which to build in the future

Strategies:

- Use this communication plan and the Climate Commitment framework as a way to unify messaging and communication efforts around <u>all</u> work being done by the city in this area (To be clear,

communication subplans will continue to exist and be updated for focus areas that fall within this broader context, such as Energy Future, the C&I Energy Efficiency Ordinance, Boulder Energy Challenge, Transportation Master Plan, etc. but their objectives/messaging/tone of messaging must roll up to those articulated by this effort)

- Shift tone of messaging away from gloom and doom/guilt-inducing moral imperative/avoiding peril to one that is both fact-based and positive, emphasizing the opportunity to leave a strong legacy for the next generation and co-benefits to our current way of living and economic security

- Leverage our existing relationship (and limited purchase order funds) with Vermilion for two phases of work

  - First phase from now until December 2015 – Creating clear and integrated informational materials, starting with a Climate Commitment executive summary report for the July 2015 Study Session and followed by a web framework that provides the overall presence and launching place for information on all efforts related to climate action

  - (Not built out in this plan, but just so you can see the bigger picture) Second phase – anticipated for 2016 – Building on the groundwork that has already been laid in creating a brand for an action-oriented campaign, i.e. Boulder Up that encourage individuals to support both collective action, including that taken by the city and institutions, and individual responsibility

- Maximize audience reach in a cost-effective way by utilizing existing communications platforms, including social media (specifically the city Facebook account and the City of Boulder LEAD Twitter account), Channel 8 programming, the Energy Future e-newsletter and LEAD e-newsletters (as appropriate), Inspire Boulder and strong media relationships to share information and seek feedback on the city's Climate Commitment direction

- Tap into existing and new partnerships (and the expertise and reach of individuals within these partnership organizations) for the purposes of cross-promoting consistent messages and meaningful climate action.

Tactics, in proposed chronological order (includes proposed timing and who's responsible for what):

- Build internal consensus around the three focus areas, messaging framework, key story components, overall tone and integration into GHG inventory work (Now until end of May 2015 – David, Brett, Jonathan, Susan and David – no budget needed)

- Develop visually compelling "Executive Summary" document that spells out the three focus areas, shows targets and where we are starting from and explains what roles the city, partners and individuals have; document will provide outline for content as it lives on web (Deadline July 17, 2015 for release as part of July 28, 2015 study session - David as lead writer; Brett as content generator; Sarah as editor and coordinator; and Vermilion as editor and designers - $10,000)

- Production and release of climate commitment motivational video that explains the need to act and outlines the three proposed focus areas; thinking of involving children and if they are willing, Boulder Dinner Theater directors who work with kids (Deadline July 28, 2015 – Sarah as coordinator; Brett as content generator; outside videography firm – not to exceed $4,000)

- Hiring of outreach fellow/intern (By July 1, 2015 – Brett as coordinator and manager - $5,000 contribution from CAP comm. budget; remainder of pay comes from elsewhere in CAP)

- Create or resurrect email listserv for people interested in receiving climate news or re-purpose/broaden EF email listserv (By July 22, 2015- Sarah, Colette and Lisa – minimal funding needed if we create new list; no funding needed if we add info to EF list)

- Coordination of media information for likely news articles both advance and coverage of July 28, 2015 study session (Week before and of July 28 study session – Sarah as lead coordinator; David and Brett as subject-matter expert spokespeople – no budget needed)

- Requests for inclusion in partner newsletters and communication platforms (post-study session through Oct. 15, 2015 - Sarah to forward content; Brett to make requests based on his relationships – no budget needed)

- Minimum of one business presentation and three community/neighborhood meetings to present video, proposed framework and solicit feedback (post-study session through Oct. 15, 2015 – Brett and outreach fellow with Sarah and Colette providing support in the way of inviting people to participate – room rental and refreshment costs anticipated to be about $1,000)

- Online feedback mechanism, such as a survey on Inspire Boulder and social media (post-study session through Oct. 15, 2015 – Sarah and Colette as coordinators; Brett and outreach fellow as content generators – no budget needed)

- Development of web landing page and framework for building out of additional pages (by Dec. 1, 2015 – Sarah as project coordinator; Colette and Lisa as web content coordinators; Brett, David and Jonathan as content generators; Vermilion as designers - $27,100)

- Channel 8 coverage of issue and milestones; social media blasts associated with feedback opportunities; e-newsletter articles (ongoing and as needed – Sarah, Colette and Lisa as coordinators; Brett and David as content generators and subject matter spokespeople – no budget needed)

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[i] Previous city inventories were calculated using the Greenhouse Gas Protocol Initiative's GHG Protocol Corporate Standard.

[ii] Two separate sectors that have been aggregated into one due to limited data availability.

[iii] "Status of Ratification of the Convention". United Nations Framework Convention on Climate Change. Retrieved 2015-04-25.

[iv] HDD and CDD calculated as deviations from a 65 degree balance point with a chosen geographic location of 80302 zip code. "A negative percentage means the Comparison Year was more mild than the Base Year. A positive percentage means the Comparison Year

was more severe than the Base Year. Annual Total comparison percentages include all heating and cooling degree days." http://www.weatherdatadepot.com/

[v] While IBM's new data center was constructed to be extremely energy efficient, data centers are energy intensive by nature and this still represents a large new electric load.

[vi] http://www.eia.gov/oiaf/archive.html

CLEAN MOBILITY

By 2050, people and goods will travel around Boulder in ways that generate little or no carbon emissions. This will include walking and biking as well as shared transportation like transit, car share, and van pools. The personal and work vehicles that remain will use clean energy sources such as renewably produced electricity and alternative fuels such as hydrogen or fuel cells.

How We Move Today:

Boulder has over 63,000 vehicles registered to residents. Tens of thousands of additional vehicles enter and depart from Boulder every day carrying employees, students, goods, and visitors. While Boulder has one of the highest per capita percentages of hybrid and EV ownership, we also have one of the highest per capita proportions of SUVs, bringing Boulder's average fuel efficiency to 21.4 MPG, a little higher than the state average. Together, this ground transportation accounts for 21% of the city's recorded emissions. An additional 11% is added for Boulder's share of the regional air travel out of Denver International Airport.

Targets & Timeframes:

SECTOR	METRIC	2014	2020	2035*	2050**
Passenger	miles/resident/day	11	10	7	4
SOV mode share	residents all trips	36%	32%	20%	8%
SOV mode share	non-resident work trips	80%	75%	60%	45%
Transit mode share	residents all trips	5%	6%	10%	14%
Bicycle mode share	residents all trips	19%	22%	30%	38%
Electric & Alternative Vehicles	Percent Owned	1%	15%	not calculated	75%

2012 Transportation Share of Emissions

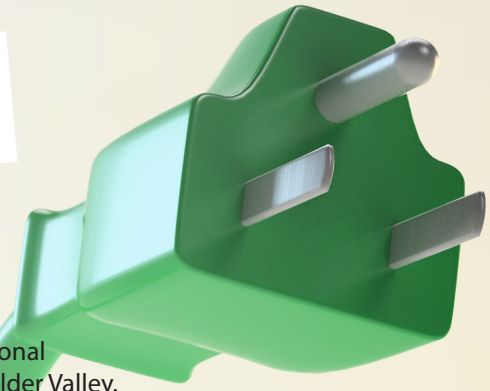
* Transportation Master Plan (TMP) Adopted Objectives.

** Projected levels based on simple linear extrapolation of TMP objectives out to 2050. Continued reductions between 2035-2050 will require additional investment, innovations and community changes beyond those in the TMP. Targets will continue to be refined over time.

A Boulder Success Story: Holding the Line on Vehicle Miles Traveled

In 1996, Boulder's Transportation Master Plan (TMP) established a goal of holding VMT steady to 1994 levels. Now 20 years later, while most other communities on the Front Range have seen vehicle miles traveled increase by 113%, Boulder has been able to keep its VMT from growing, despite growth in population and employment.

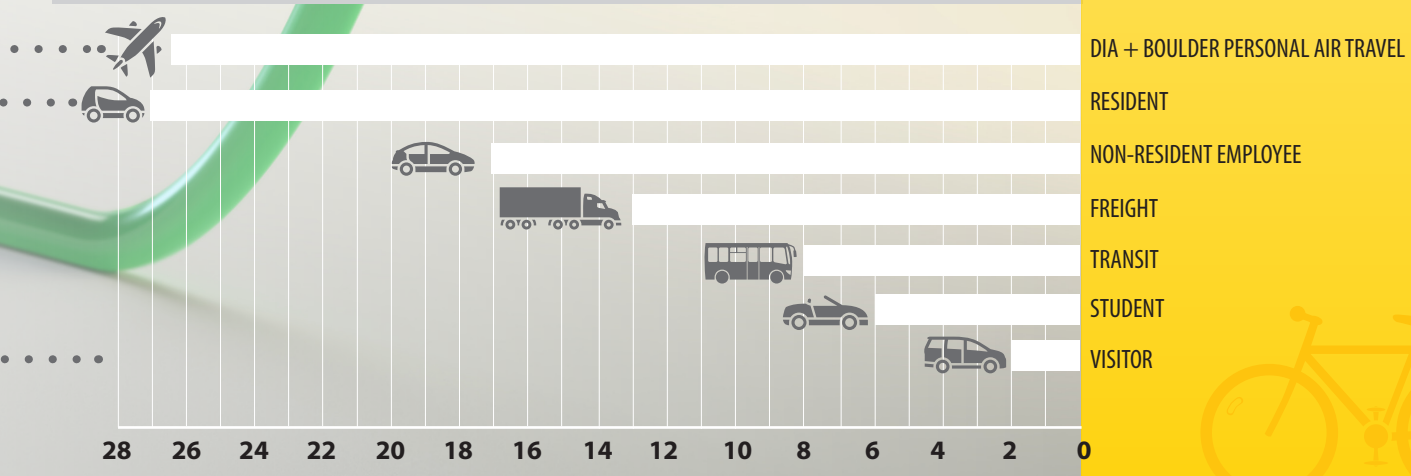
To help meet the new 2050 GHG reduction goals, the 2014 TMP Update established a goal to reduce vehicle miles traveled (VMT) by 20 percent by 2035. Together, the VMT reduction programs and strategies outlined in the TMP are projected to achieve close to a quarter of the transportation emissions reduction goal by 2050.



The Many Benefits of a Low Carbon Transportation System

A low emissions transportation system has many community benefits in addition to helping reduce climate change. Boulder's 20 year success in managing vehicles miles traveled has avoided an estimated 1.9 million additional daily vehicle miles of travel around Boulder Valley. This has kept a significant amount of pollutants out of the air, protecting the respiratory health in our community even as VMT and related emissions have nearly doubled in the Denver metro region. The city has also enhanced pedestrian, bike and transit systems providing transportation options to all members of the community, saving transportation costs and supporting forms of mobility that improves our health. The city's support of RTD's Eco Pass program has had significant impact on travel behavior and GHG emissions as residents with Eco Pass emitting 45 percent less GHG than residents without access to the annual unlimited use transit pass. The city also continues to integrate more diverse and connected neighborhoods. This, combined with the city's goal to make all areas accessible by walking and biking, minimizes the miles we have to travel by vehicle and the distance we have to travel when we do use our cars.

2012 Transportation Emissions By Travel Type



16%

TARGET REDUCTION IN EMISSIONS BY 2050

DID YOU KNOW?

The city's Eco Pass program provides no-fare transit for 70 thousand residents and employees every year.

CLEAN MOBILITY

2015-2020 City Action Priorities

Similar to the actions described for the building and related energy use sectors, there are three broad areas of action within which the city has initiated programs.

Reduce *carbon-based emissions by reducing the miles we need to travel, increase the efficiency of each trip (more riders/ mile); or substitute non-fossil fuel based modes such as biking or walking.*

- Expand access to transit: EcoPass, Bus Rapid Transit
- Expand ride share programs: carpool/vanpool
- Enhance bike and pedestrian travel options
- Pilot and promote telework and other no-travel work options
- Create enhanced mobility tools—mobile applications for trip planning
- Use parking management to encourage other travel options

Replace *petroleum-powered cars, buses and trucks with low/no carbon alternatives like electric or hydrogen fuel vehicles.*

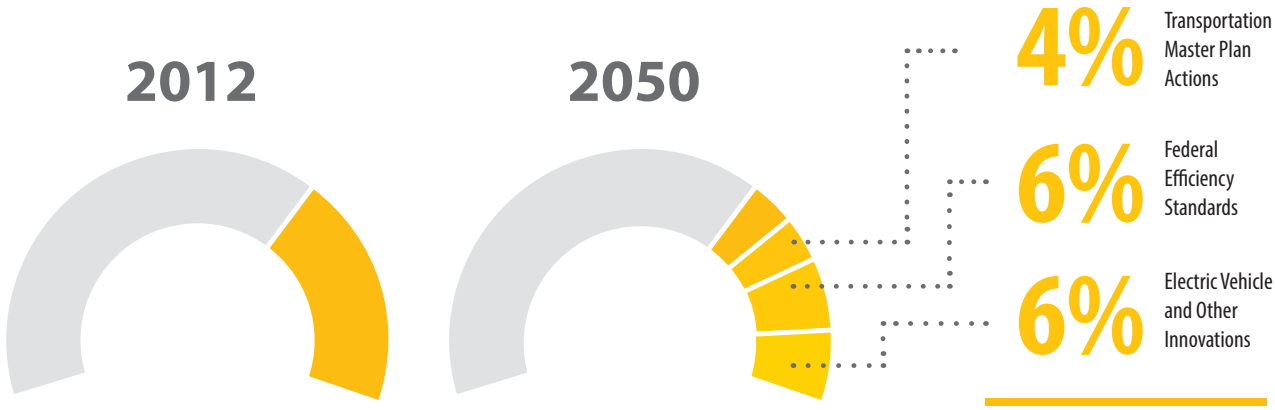
- Collaboratively expand regional electric vehicle (EV) charging infrastructure
- Promote electrification/clean fuel options for transit
- Pilot clean energy transit on select local routes
- Implement electrification of city vehicle fleet
- Co-organize Workplace Charging Challenge with other leading employers
- Develop employee EV commuting pilot project

Redesign *our neighborhoods so we don't have to drive as much to get the things we need*

- Encourage parking management systems using the city's "SUMP" (Shared, Unbundled, Managed, & Paid) principles
- Create parking districts with enhanced mobility options e.g. car share, bike share, transit hubs
- Continue complete streets planning to provide safe and convenient travel options
- Integrate mixed use development close to neighborhoods to provide walkable destinations for daily needs

Projected Impact of City Strategies

The combined efforts of local transportation strategies and federal fleet efficiency standard improvements can have a significant impact in reducing the emissions generated by the transportation sector.



Total 2050 Projected Emissions Reductions = 16%

Movers and Shakers

Creating a clean mobility system requires a collective effort. Boulder is fortunate to have many leaders and partners working together to achieve transformative change.

CU has an extensive program to significantly reduce the use of single occupancy vehicles and provide viable options in transit, biking and walking. The University provides full service bus passes to all 30,000 of its students through student fees along with over 13,000 bike parking spaces (more than cars!); has a state recognized vanpool service for employees; and is actively planning for the development of an EV charging infrastructure for both staff and students.

Boulder County has invested in low-emissions transportation alternatives throughout the county, and was lead sponsor, along with the City and CU, in a countywide electric vehicle adoption assessment. That assessment explored electric vehicle charging infrastructure needs as well as how building codes, transportation programs and employee commuting incentives could promote EV ownership. The County is currently helping to coordinate the Boulder County Electric Vehicle Workplace Charging Challenge to encourage other employers to actively support EV adoption by the over 50,000 daily in-commuters to Boulder and Boulder County.

BVSD has initiated a wide range of programs to reduce emissions from its bus and administrative fleet, including initiatives to increase walking, biking, transit and carpooling as well as efforts to lower emissions through hybrid buses, alternative fuels and efficient routing schedules. Through an internally developed "Trip Tracker," over 2,000 participating students in 17 schools cut an estimated 75,000 car trips in a single school year. The District is also exploring the expansion of its current EV fleet and charging infrastructure to provide more opportunities for both students and staff to use EVs.

UCAR sponsored federal labs provide van pool and ride sharing support for over XX,XXX employees, and free bicycle check outs, complementary Bike Share membership, and EcoPasses for all employees. Recently, the labs secured funding to install an electric vehicle charging network for its employees, and has been an active partner with the City, County, CU, and BVSD in developing a community-wide electric vehicle adoption plan.