Community Climate Action Plan

CITY OF BEND

BEND COMMUNITY ENERGY EFFICIENCY IN BUILDINGS

BACKGROUND REPORT

City Manager's Office

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Energy Use in Buildings

The City of Bend conducted a Community Greenhouse Gas (GHG) Inventory to better understand local sources of GHG emissions and inform development of a Community Climate Action Plan (C-CAP).[1] It was determined that Bend's largest sources of local sector-based emissions include residential and commercial energy use by buildings (57% of total). Electricity is the largest source of buildings emissions (58%) followed by natural gas (40%) and other fuels (2%). This action area is particularly important since building stock tends to turn over only every 30 to 50 years – optimizing energy efficiency in buildings will reduce energy costs as well as provide more resilient, comfortable spaces to live, work and play.

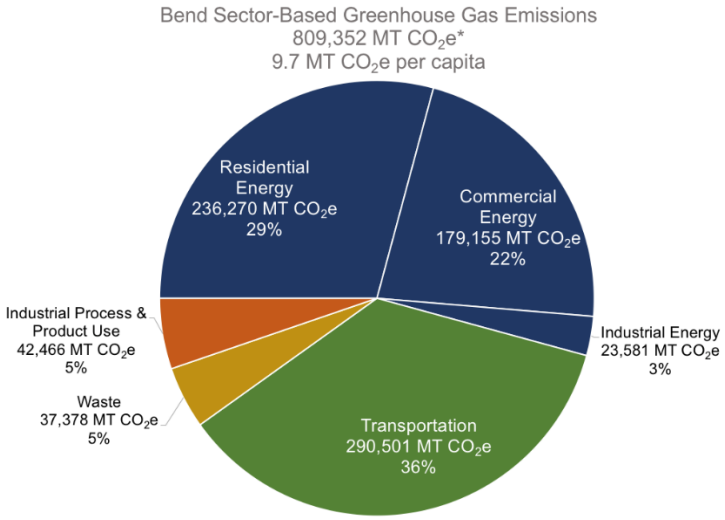


Figure 1. Summary of sector based greenhouse gas emissions from Bend's 2016 Community Greenhouse Gas Inventory

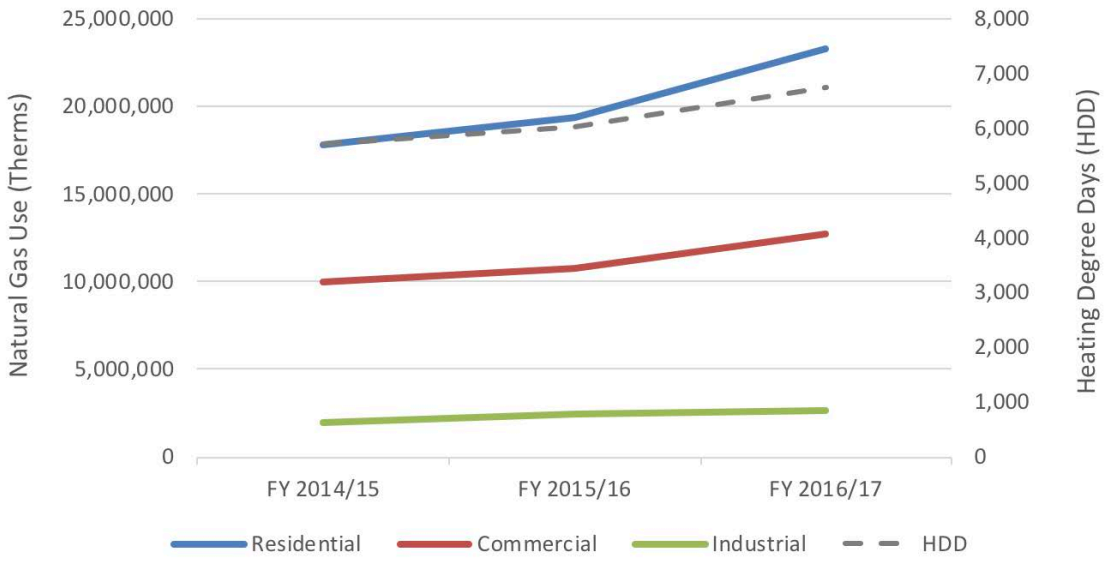
Total community electricity use increased by 5% between FY15 and FY17, with residential sector use increasing by 7.9% during the period and commercial sector use increasing by 3.7% (see Figure 2). Industrial electricity use decreased by 6.8% between FY15 and FY17.

[1] City of Bend, 2016 Community Greenhouse Gas Inventory, Prepared by Good Company, August 2018. https://www.bendoregon.gov/Home/ShowDocument?id=38856

Figure 2. Bend electricity use (in MWh), by sector. Percent (%) change, FY15-FY17

Total community natural gas use increased by 30% between FY15 and FY17, with residential sector use increasing by 31.1% during the period; commercial sector use increasing by 27.7%; and industrial use increasing by 36.8% between FY15 and FY17 (see Figure 9). There are two suspected drivers for the overall increase in stationary energy use: 1) the Bend community population is growing at a pace of 2.2% annually, and 2) the winter of FY17 was colder than the previous two years increasing the heating load. This is demonstrated by the increase in heating degree days (Figure 3) which is a measure of the energy needed for space heating.

Figure 3. Bend natural gas use (in therms), by sector. Percent (%) change, FY15-FY17



Focusing on energy efficiency in buildings provides the opportunity to curb Bend's community stationary emissions and control how much energy is needed to serve the built environment.

Policy Framework in Oregon

Zero Energy Ready Oregon

Building energy efficiency is one of the most cost effective ways to reduce greenhouse gas emissions. Oregon's Zero Energy Ready Oregon (ZERO) is a coalition of nonprofits focused on getting all buildings in Oregon on the path to zero energy by 2030.[2] The coalition's definition of a zero energy building is "A home or building in which energy efficiency is maximized, the capacity to meet the building's energy needs with renewable energy sources has been enabled, and site and community based renewables are prioritized."[3] The goal of zero energy buildings is to produce as much energy as it uses. "On November 6, 2017, Governor Kate Brown signed an executive order that mandates code amendments that require newly constructed residential buildings to achieve at least equivalent performance levels with the US DOE Zero Energy Ready Standard by October 1, 2023."[4]

Reach Code

Oregon's state energy code prevents any building from performing below a certain energy standard. No local government in Oregon can demand buildings to be built above the state requirements. However, Oregon adopted a voluntary "reach code" which sets guidelines and standards for increased energy efficiency. Some states allow cities to implement their own

[2] Earth Advantage, Zero Energy Ready Oregon Webpage, https://www.earthadvantage.org/zero-energy/
[3] Earth Advantage, Zero Energy Ready Oregon Webpage, https://www.earthadvantage.org/zero-energy/
[4] Earth Advantage, Zero Energy Ready Oregon Webpage, https://www.earthadvantage.org/zero-energy/

"reach codes," which require buildings to be more efficient than the state code mandates. Oregon cities can have voluntary reach codes which incentivize developers to construct energy efficient buildings.

Property Assessed Clean Energy Programs (PACE)

PACE programs are a way to finance energy efficiency, renewable energy, and water conservation upgrades to buildings. Buildings under construction and retrofits are able to be financed for upgrades. PACE programs pay for the full cost of the upgrade, whether it's a new heating and cooling system, solar panels, or water pumps. Owners can pay back the costs over 20 years. "Annual PACE repayment can be less than the amount being saved on annual utilities on the project."[5] Both commercial and residential programs are available.

Currently, there is one active PACE program for commercial customers in Oregon. Property Fit, which is a partnership between Prosper Portland, Multnomah County, and the Energy Trust of Oregon is an assessment tool for private property owners to finance building improvements that provide a public benefit.[6] Uniquely, owners do not have to pay up-front investments, which further incentivizes retrofits.

Cost Analysis of Energy Efficiency

Energy efficiency in buildings is the most cost effective method of reducing energy consumption and greenhouse gas production. The total costs of an energy efficient building, including maintenance and utilities, are lower over the building's lifespan. The first costs of energy efficiency materials may prevent builders and developers from constructing an efficient home. However, the cost of energy efficiency has decreased over time as the market adapts to customer preferences. "Cost Analysis of Potential Energy Code Improvements," a report by Earth Advantage detailed "When utility costs are considered alongside financed construction costs over the life of the building, the analysis shows that building with improved energy efficiency standards costs 1.5% to 6.5% less than building under the current energy code."[7]

[5] PACENation, PACE for Homeowners Webpage, http://pacenation.us/pace-for-homeowners/
[6] Property Fit Oregon, Home Webpage, https://www.propertyfitoregon.com/
[7] Earth Advantage, *Cost Analysis of Potential Energy Code Improvements*, December 2, 2016. https://www.earthadvantage.org/assets/documents/Publications/EnergyCodeCostAnalysis-20161202.pdf

The report compares the first costs and lifetime costs of homes which are built to code, 10% more efficient, and 20% more energy efficient. Data was gathered on single and multifamily buildings from Hillsboro and Bend.

Figure 4.Retrieved From Earth Advantage, Cost Analysis of Potential Energy Code Improvements, December 2016

	West side residential home		***East side residential home***	
Energy efficiency increase	*10%*	*20%*	*10%*	*20%*
Capital cost increase vs. current code	0.2%	1.7%	0.5%	1.7%
Cost recovery period	1 year	7 years	2 years	5 years
Decrease in total costs vs. current code (over life of building)	1.5%	2.2%	1.6%	3.0%

Figure 4 shows the energy efficiency cost increase for building a single family home in Bend. Initially, to build a home that is 20% more energy efficient, it would cost 1.7% more. However, in 5 years the homes have already recouped initial costs. The first costs of energy efficiency measures will decrease as contractors become more familiar with energy efficiency buildings, and as customers push the market towards efficient buildings.

Best Practices

Several opportunities based on widely available technologies offer the potential to significantly reduce emissions from buildings. These include raising building standards for new constructions, retrofitting building envelopes, upgrading HVAC and water heating technology, and implementing lighting, appliance and automation improvements. Progress will require city leaders to work closely with building owners, both residential and commercial, real estate developer, and building occupants. Best practices from other communities across the nation include:

- Encourage benchmarking and disclosure
- Set energy targets for efficiency and renewable energy
- Develop incentives and partnerships

Benchmarking and Disclosure

Building energy benchmarking is the process of comparing a measured performance against its peers, or established norms, with the intent to inform owners and motivate them for energy improvement. Energy Star's Portfolio Manager is one of the available tools. Benchmarking alone has been documented to save an average of 2.4% per year.[8]

Building energy benchmarking is often combined with disclosure for maximum energy reduction. Disclosure requires data transparency that aids current and future tenants and investors to compare buildings, predict energy costs, and invest in buildings where utility bills are lower. Studies have shown about 10% reduction in building energy use when benchmarked data is reported.[9] Transparency requirements often start with city buildings before requiring commercial buildings to benchmark and disclose energy consumption data. A few leading cities (Austin, Berkeley, and Portland) are requiring single-family energy performance disclosure at the time of sale, which requires home sellers to conduct a home energy audit that discloses how energy efficient the home is, triggering voluntary energy efficiency improvements.

Energy Targets

Leading cities are setting targets for energy and emissions reduction from existing building stock, carbon neutral operations, and net zero energy new construction.[10] Targets provide the foundation for benchmarking progress. Setting building energy targets in addition to requiring third-party rating systems can provide a specific goal for both existing and new buildings to make net zero and/or carbon neutrality achievable.

Building rating systems help set guidelines and educate developers on how to effectively build energy efficient buildings. As the market is pushing for green buildings and energy efficiency,

[8] Portfolio Manager DataTrends: https://www.energystar.gov/buildings/about-us/research-and-reports/portfolio-manager-datatrends

[9] New York Energy and Water Report: https//urbangreencouncil.org/content/reports/new-york-city-energy-water-use-2016-report

[10] New Buildings Institute Bend Energy Policy Gap Analysis, April 2, 2018.

rating systems can help customers articulate how they want their green building designed to developers. Certified buildings receive recognition and are more desirable on the market.

LEED

LEED, or Leadership in Energy and Environmental Design, is the most widely used green building rating system in the world.[11] LEED offers an outline for developers to follow in order to get points in categories including: energy, water, waste, transportation/location, innovation, etc. A building with high access to public transportation, good natural lighting, and low energy use will achieve high points in the respective categories. A higher score will grant the building titles: LEED Certified, Silver, Gold, and Platinum.

Earth Advantage

Earth Advantage is a nonprofit that certifies green buildings across the Northwest. "An Earth Advantage-certified house incorporates design elements, systems and materials that create superior indoor air quality, use natural resources responsibly, protect land, and lower water usage."[12] They also train and educate industry professionals about the green building market.

Bend's very own Northwest Crossing is an example of a real estate developer using a third party certification program to increase and legitimize a community's energy efficiency and sustainability. Each home was certified by Earth Advantage, which ensured that they were built from recycled and less toxic materials, have high indoor air quality, and were more energy efficient.

Green Globes

Green Globes is a nationally recognized green rating assessment, guidance, and certification program for new construction, existing buildings and interiors. It offers on-site, third parting building assessment throughout the certification process.

Partnerships and Incentives

There are strong examples of partnerships and incentives that are already available in Oregon and here locally in Bend.

In 1999, the Oregon State Legislature passed a law that requires the states' largest investor-owned electric utilities to collect a 3% public purpose charge and authorized the Oregon Public Utility Commission to direct a portion of those funds to residential, commercial and industrial electric energy efficiency, renewable energy and market transformation programs. Energy Trust of Oregon was formed in 2001 and began operations in 2002 to carry out this purpose.

[11] U.S. Green Building Council, LEED Webpage, https://new.usgbc.org/leed
[12] Earth Advantage, Earth Advantage Home Certification Webpage, https://www.earthadvantage.org/certifications/earth-advantage-home-certification.html

Living Future Challenges

The International Living Future Institute has prepared toolkits and guiding documents in support of their Living Building Challenge, Living Community Challenge and Living Product Challenge. They have a model incentive ordinance that provides a tool to accelerate the uptake of Living Buildings. These are fairly recent additions (May 2018) to the information available to Cities interested in reducing GHG emissions for the built environment.

Energy Trust of Oregon

The Energy Trust of Oregon (ETO) is a nonprofit organization which helps Oregon utility customers benefit from energy efficiency and renewable energy. ETO incentivizes customers by offering cash to support energy efficiency. For example, the residential windows incentive is $1.75-$4.00/sq. ft. To receive the incentive, you must select a qualified Energy Trust contractor, and then submit the incentive application within 60 days of installation. There are both residential and commercial customer incentives. The Energy Trust is funded by customers of Portland General Electric, Pacific Power, NW Natural and Cascade Natural Gas. A percentage of customer utility bills is dedicated to ETO, which supports its energy incentives.

Bend Energy Challenge

The Environmental Center organized and staffed the Bend Energy Challenge, the Bend community's team in a national competition to reduce energy use in the local community and win $5 million. While Bend's team did not win, 7,600 Bend community members signed up for the challenge and the value of total avoided energy use from actions taken during the Challenge amounted to $2.8 million. Bend ranked 17th among the 48 competing communities and was recognized as one of the "high-performing communities" that are leading the way for other cities and counties across the country. The Environmental Center is continuing to educate and advocate for energy efficiency under their program, which is now known as The Energy Challenge of Central Oregon. The Energy Challenge has a number of partners which offer cash incentives for customers wanting to modify their home. Incentives include: heat pump water heaters, ductless heat pumps, energy assessments, and low income energy upgrades.

South Hillsboro

In 2016, the Hillsboro City Council passed a high performance building resolution to improve building efficiency of new homes to be built in South Hillsboro. The City partnered with the Oregon Department of Energy, Energy Trust of Oregon, Earth Advantage, Portland General Electric, and SolarWorld. Each of the partners offers incentives to promote energy efficiency and building performance. The initial goal was to construct all the residential buildings 15% more efficient than the base code. This would save $2.5 million in homeowner utility costs, 735 million kWh, and thermal savings equivalent to 633 homes' gas usage.[13]

Hillsboro has a 2035 Community Plan that provides an outline for the future of the city. The Plan has an environmental sustainability section (page 24) outlining the long-range goals for reducing climate change and increasing environmental stewardship. The environmental sustainability section's goal statement envisions a "sustainability community that takes proactive steps to

[13] Hillsboro City Council, Resolution 2539, August 16th, 2016.

protect natural assets, minimize greenhouse gas emissions, and recover, recycle and renew resources. Residents, businesses and community institutions understand the link between economic prosperity and environmental health, and work collaboratively to maintain a thriving city for future generations."[14] The resolution to improve homes in South Hillsboro is a small part of the larger Community Plan.

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[14] City of Hillsboro, Hillsboro 2035 Community Plan, August 2016.

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TRANSFORMING BUILDING ENERGY EFFICIENCY SYSTEMS

A city's building energy efficiency system — energy consumption by residential, commercial, industrial, and public facilities, including streetscapes (outdoor lighting, for example) — produces an enormous portion of most cities' carbon emissions, especially in larger and densely developed cities. Most broadly, this system divides into two categories: new buildings for which increased energy efficiency standards can be put in place from the beginning, and existing buildings whose energy systems must be retrofitted.

Different cities' buildings profiles and situations may vary considerably:

- Type, age, uses, construction methods and materials, height, size (square meters/feet), age, energy-use intensity and type of energy use (electricity/thermal loads, hours of operation, plug loads) of building stock vary. Although cities haven't standardized a typology for building stock, a fairly typical version of building types includes:
  - Small Scale Residential
  - High Rise Residential
  - Residential/Commercial Mixed Use
  - Small to Mid-Scale Commercial
  - High-Rise Commercial
  - Industrial
  - School/Daycare/Church
  - Medical/Laboratory
  - Government
- In **BERLIN**, almost 90 percent of dwellings are in multifamily houses, while single- or two-family houses account for only 10 percent and 9.6 percent of the buildings are protected as listed monuments.60 Low household density can drive up the amount of energy needed for building heating citywide.
- The dynamics of the real estate market vary — both in terms of the amount of demand and supply ("strong" versus "weak" markets), as well as demand for "green performance" building space, and these drive both the pace of new development and the rate of demolition, ownership transfer, and renovations of existing buildings.
- City and other applicable building codes and real-estate development requirements (zoning requirements, development project requirements) vary in how stringent they are when it comes to efficiency and conservation.
- The presence of district-scale heating and cooling systems and building-by-building fossil-fuel heating systems varies — and this affects strategy choices.
- The concentration of building ownership is different, although there is not substantial cross-city data about this.

Cities' building energy efficiency profiles vary, as do their regulatory jurisdiction. However, the basic methods for building-level energy efficiency are broadly applicable.

60 City of Berlin, "Climate-Neutrality Berlin 2050: Results of a Feasibility Study," March 2014, p. 10.

- In **BOSTON**, for instance, commercial and industrial buildings produce about 50 percent of Greenhouse Gas emissions. In those sectors, the 50 biggest property owners control buildings that generate 30 percent of the city's building emissions.
- In **NEW YORK CITY**, the largest buildings (over 50,000 square feet or multiple buildings on a lot that total 100,000 square feet) make up just 2 percent of building stock, but account for almost half of built floor area and 45 percent of citywide energy use.
- In **WASHINGTON D.C.**, the capital of the U.S., a substantial portion of the buildings are owned by the federal government.

In spite of these differences, cities tend to share a set of general building energy efficiency conditions, a vision for what the redesigned system will look like, and common barriers to system change. They also share a strategic balancing act: how much to push for efficiency and resulting reductions in demand for energy, versus how much to push for reduction of the carbon content of energy supply to buildings. In addition, the basic methods for building-level energy conservation methods tend to be broadly applicable to power sources, heating and cooling, windows and lights, and the building envelope. Some examples include:

Typical Building-level Energy Conservation Methods

Building Power Sources	• On-site and remote renewables, including Power Purchasing Agreements • Combined heat and power • Clean energy grid procurement
Heating and Cooling	• High efficiency HVAC systems, including boilers and chillers • Demand controlled ventilation; displacement ventilation • Separation of thermal conditioning from ventilation • High efficiency fan and pump motors • Tighter and better insulated building envelopes
Building Management	• Development of standardized building operating manuals • Retro-commissioning of existing buildings on a regular basis • Annual building maintenance upgrades • Building energy management systems • Certification programs for facilities and building management
Lighting and Windows	• Reduced lighting power densities; LEDs • Day-lighting • Occupancy sensors • High performance windows and glazing
Other	• Occupant behavior change initiatives • Plug-load management • Data center management • Thermal energy storage • Demand response • Load shifting • Other

Building Energy Efficiency System Conditions

- **Blend of Markets and Regulations** — The system is made up of a complex blend of markets, private and public finance, professions (architects, engineers, building operators), and government regulations with highly distributed ownership/control of buildings
- **Economic Value** — The system contains an enormous amount of underlying private economic value, (property assets and income), and both new construction and existing buildings generate substantial business activity and job creation in cities. Even in cities with fast-growing populations, existing buildings make up the bulk of the economic value in real estate — and this puts a priority on retrofitting their energy efficiency.
- **LONDON:** "It is anticipated that 80 percent of London's buildings will still be standing in 2050. Retrofitting existing homes with energy efficiency and energy supply measures is therefore essential to reducing Londoners' energy bills and the associated CO2 emissions."[61]
- **Building Variation** — Variations in building stock mean that energy conservation methods have to be customized to a building's specific characteristics.
- **Building Ownership** — Across most cities there are single-owner "campuses" (e.g., universities, hospitals) as well as large commercial properties.
- **Real Estate Market Dynamics** — The "metabolics" of the real estate sector — including rate of new building development, transfer of ownership, remodeling, deconstruction, etc. — are complex and not well documented or analyzed. This makes planning for retrofitting particularly difficult since extensive "deep" retrofits typically disrupt a building's inhabitability, often for extended periods of time.
- **SEATTLE:** With a mild climate and inexpensive electricity, returns on investment for energy efficiency upgrades are often longer in Seattle than in other U.S. cities. In large commercial buildings, the challenge is magnified by the frequency in which buildings change hands. For companies that often hold properties for only three years, paybacks on energy efficiency investments are even more challenging to absorb.
- **Energy Efficiency Market Capacity** — The building energy retrofitting services sector usually operates at very small scales, with a large number of small enterprises, so capacity to expand to greater scales is uncertain.
- In addition to managing system reliability and demand response, **YOKOHAMA'S** Integrated Building Energy Management System (BEMS) controls 29 separate BEMS's at city-owned facilities, commercial buildings and large-scale office complexes with multiple energy generation, storage, water purification and wastewater treatment functions. The system has been able to demonstrate a 22.8% peak demand reduction.[62]
- **"Green Buildings" Economic Sector** — The emergence of new "green building" and "energy performance" skills, products, and services is helping to increase "green jobs" in cities.
- **Climate Change Effects** — In most cities, the buildings sector has already experienced some of the damage caused by effects of climate change — and long-term resilience has become a concern.
- **Demand for Green Buildings** — Some cities have strong demand for "green" commercial space, which provides market incentives for building owners/managers to invest in reduction of carbon-emissions/energy consumption.
- **Variation in City Control** — Cities' control over building systems varies considerably. Most importantly, some cities control local building and energy codes, but for others these are set at the state/province or national level.

Vision for Redesigned Building Energy Efficiency Systems

The vision for redesigned building energy efficiency systems typically has five elements:

High-Efficiency Existing Buildings — Older buildings will have been transformed into highly energy efficient structures, powered by renewable sources of energy, and using energy recovery systems. An important element of reducing consumption is demand management by building residents.

61 Greater London Authority, "The Mayor's Climate Change Mitigation and Energy Annual Report, 2013-2014," June 2015, p. 19.

62 City of Yokohama.

Vision for Redesigned Building Energy Efficiency Systems:

- High-Efficiency Existing Buildings
- Net Zero or Positive Renewable Energy New Buildings
- Building Energy Performance Information for the Market
- Performance-Driven Management of Building Energy
- Growing "Green Buildings" Economic Sector

- In the summer of 2013, for instance, YOKOHAMA tested home energy management systems in about 3,500 homes, the largest test of its kind in Japan, and found that peak demand for power dropped up to 15.2 percent.[63]
- **Net Zero or Renewable Energy Positive New Buildings** — All new buildings will meet the highest possible energy performance standards
- **Building Energy Performance Information for the Market** — The market for real estate will provide and be driven in part by energy-performance information.
- SEATTLE has envisioned several aspects of this development: "Individuals making decisions about whether to buy, lease, or finance a building expect to receive information about a building's energy performance. Building energy use information is just as available and understandable as a "miles per gallon" rating on a vehicle is today, and energy efficiency has a clear market value. Building owners, operators, and occupants have access to real-time feedback about the energy use in their building and options to improve energy performance."[64]
- **Performance-Driven Management of Building Energy** — Larger buildings in particular will be run by building operators trained in green, energy-performance management and systems.
- **Growing "Green Buildings" Economic Sector** — The growing market for technologies and services for green, energy-efficient buildings will spur business and job creation and expansion in the green buildings sector.

PORTLAND'S climate action plan noted that "several initiatives in the building industry support low- to no-energy use by maximizing energy-efficient construction techniques, incorporating on-site renewables and reducing occupants' energy use." These include:

- **Passive Buildings** — A design and construction approach used to attain super-insulated, virtually air tight buildings primarily heated by solar gain and minimal equipment.
- **Net-Zero/Zero-Energy and Energy Positive Buildings** — A net-zero or zero-energy building produces as much energy as it consumes, calculated on a net basis for one year. An energy positive building produces more energy than it consumes, sending excess back into the electricity grid.
- **Living Buildings** — To achieve Living Building status, buildings are required to meet a series of performance requirements, including net-zero energy, waste and water, over a minimum of 12 months of continuous occupancy.[65]

63 City of Yokohama, Community Development of FutureCity Yokohama," October 2015, p. 10.
64 City of Seattle, "Seattle Climate Action Plan," June 2013, p. 38.
65 City of Portland, "Climate Action Plan," June 2015, p. 67.

Major Barriers to Building Energy Efficiency System Change

The primary barriers to building energy efficiency system transformation include:

- **Cost-Benefit Analysis** — Return on investment in building energy efficiency, generated by savings in future costs, takes a number of years to achieve, and some technologies, such as certain heat pumps, biogas, and biomass fuels, are not yet cost-effective.
- **The "Split Incentive" Problem** — This occurs when a rental-building owner pays for energy efficiency retrofits to the building but cannot recover the savings from reduced energy use that tenants receive.
- MELBOURNE detailed some of the complications around the split incentive problem: "High-rise apartments have been shown to be the most energy intensive dwelling type, due in large part to the energy consumption of shared services and common property such as hallway and car park lighting, ventilation and pool and heating pumps. A key challenge is to achieve the largest reduction in emissions for the least cost by encouraging energy efficient retrofits in apartment building common areas as well as within the apartments themselves. Making change within an apartment building's owners corporation can be complex and each building is unique in its physical and human elements. Apartment residents, managers and owners need tailored assistance and long lead times to create change. High upfront costs and limited access to finance for retrofits can impede change, as well as overcoming a split incentive between property owners and tenants."[66]
- BOULDER is one of the few cities that has mandated residential rental property energy standards. In 2011 the city launched the nation's first residential rental property energy efficiency requirement in the U.S. Rental units represent approximately 50 percent of Boulder's housing stock. This city required that every licensed rental property meet basic efficiency standards by 2018.
- **Housing Affordability** — Even as they tackle energy performance of buildings, many cities find they also need to address concerns about affordability, equity, and gentrification of neighborhoods.
- SEATTLE'S plan includes actions to support growth near high capacity transit without displacement, allow a greater diversity of housing types, and provide for the retention and creation of affordable family-sized housing and commercial space in transit communities through strategies such as expanded density and height bonuses, tax exemptions, joint development projects, and inclusionary zoning.
- **Enforcement Capacity** — As standards for buildings increase, cities need to increase investment in monitoring and enforcement.
- **The Need for — and Resistance to — Mandates** — Leading-edge cities anticipate that residential and commercial real estate markets probably will not choose or be incentivized to invest in energy efficiency at sufficient scale to meet the cities' decarbonization goals. Thus, they expect that sooner or later more stringent policy mandates will be needed, but the local real estate/development sector naturally resists government mandates that will force investment and new behaviors.
- **Managing the Market's "Metabolics"** — Cities have recognized that as they substantially increase energy efficiency requirements for existing buildings they need to align the mandates with the natural times when it is least disruptive to implement deep retrofitting: when a building is being sold or undergoing significant renovation, for instance.
- An analysis of NEW YORK CITY'S metabolics estimated that the volume of annual sales and renovations of the city's residential and commercial buildings between 2015 and 2050, based on historic patterns, would be enough to ensure that "nearly all buildings" could be retrofitted under updated city energy conservation codes that would require high standards of energy performance.[67]

66 City of Melbourne, "Zero Net Emissions by 2020: 2014 Update," 2014, p. 21.

67 Ed Mazria, "Achieving 80x50: Reducing Energy Use, Creating Jobs, and Phasing Out Carbon Emissions in New York City's Buildings," July 2015.

Levers, Strategies and Actions for **Transforming Energy Supply Systems**

LEVERS	STRATEGIES	ACTIONS
Voluntary Action	Encourage Improved Energy Efficiency Performance of Existing Buildings	• Conduct building energy performance challenges • Promote building energy rating systems (commercial and residential) • Promote voluntary energy use benchmarking programs • Promote voluntary "stretch" building energy conservation codes and green-building principles by providing information, technical assistance • Promote "cool roofs" — coating of rooftops white to reduce building energy use — and other low-cost approaches • Support best practice information sharing among building owners
	Promote Energy Conservation Behaviors by Building Occupants/Tenants	• Work with utilities to improve customer access to energy-use data • Conduct public education programs and campaigns that promote energy-saving measures • Promote green leasing for commercial buildings, which enable a fair proportion of costs/benefits to be allocated to both tenants and landlords
Price Signals	Increase Access to Financing	• Improve access to specialized financing to pay for efficiency improvements
	Support/Provide Rewards for Performance	• Provide regulatory and zoning relief for projects meeting certifiable high standards (e.g., LEED) • Promote supportive market mechanisms such as building appraisal and mortgage underwriting that capture the value of investments in energy efficiency
	Subsidize Capacity Improvements for Building Management	• Support efforts to train building operators in energy efficiency best practices

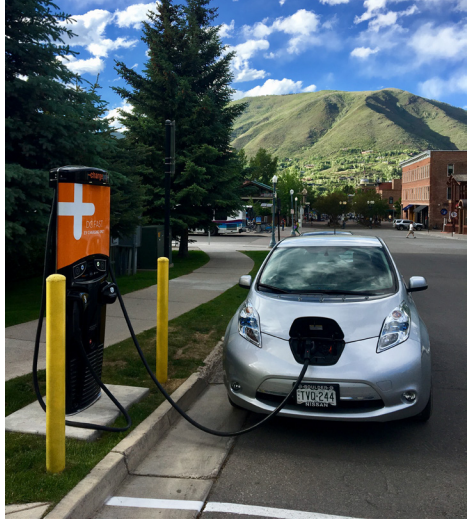
Public Investment	Expand capacity of efficient heating and cooling Invest in Technology Development and Deployment	• Develop and expand low- to no-carbon district heating and cooling systems • City piloting of new building technologies • Support Municipal Strategic Energy Management programs
	Model the Behavior-Invest in Energy Retrofitting of Government Buildings	• Conduct deep retrofitting combined with installation of on-site renewable energy supply • Improve building operations and preventative maintenance • Improve energy efficiency of public/government-owned housing • Require all rehabilitation projects financed by city to include “green” capital needs assessment
Mandates	Mandate Reporting	• Adopt Building Energy and Reporting Disclosure ordinances • Require energy audits and disclosure • Require sub-metering • Require building rating system
	Mandate No- to Low-Carbon Standards for New Construction	• Adopt/phase-in building and energy conservation codes based on carbon neutral, zero net energy, Passive House, Living Buildings, and other cost-effective high-efficiency approaches
	Mandate Performance Improvement of Existing Buildings	• Require targeted buildings (e.g., commercial above certain amount of floor area) to benchmark (measure and disclose) energy performance, and/or conduct energy audits, and/or install energy sub-meters for large tenants • Require “deep” retrofitting of buildings at designated intervention points: time of sale/purchase, financing, major renovation of building or space, and rebuilding • Require upgrades to commercial/industrial buildings’ lighting systems • Require higher standards for energy efficiency of appliances • Require certification of building operators

Resources

Climate Action Plan Building Energy TAG Preliminary Recommendations 2012	Seattle	Includes recommendations to reduce greenhouse gas emissions in the building sector.
A common definition of Net Zero Buildings	U.S. Department of Energy	Generally speaking, a zero energy building produces enough renewable energy to meet its own annual energy consumption requirements, thereby reducing the use of non-renewable energy in the building sector. This definition also applies to campuses, portfolios, and communities. In addition to providing clarity across the industry, this publication provides guidelines for measurement and implementation, specifically explaining how to utilize this definition for building projects.
Analysis of the Chinese Market for Building Energy Efficiency	Pacific Northwest National Laboratory (PNNL)	Assesses the impact of China's policies on building energy efficiency and on the market for energy efficiency in the future. By examining the existing literature and interviewing stakeholders from the public, academic, and private sectors, the report seeks to offer an in-depth insights of the opportunities and barriers for major market segments related to building energy efficiency.
Green Building City Market Brief	C40	Addresses a critical issue facing mayors in cities around the world: building energy use is a leading contributor to urban and global greenhouse gas (GHG) emissions.
State and Local Energy Policy	American Council for an Energy Efficient Economy (ACEEE)	ACEEE's State and Local Policy Database includes comprehensive information on energy efficiency policies currently implemented at the state and local level. The database tracks policy activity across multiple sectors, including government, utilities, transportation, buildings, combined heat and power, and appliance standards.
Urban Energy Efficiency Key to Mexico's Ambitious Goals for Energy and Low Carbon Growth	World Bank	SENER, Mexico's Ministry of Energy, is rolling out a national municipal energy efficiency program with the help of the World Bank. The program will work with city institutions to systematically integrate energy efficiency into policymaking, investment decisions, and procurement at the local level.

Applying Sustainable Building Strategies	National Resource Defense Council	Brief descriptions of a wide range of building strategies, grouped according to the five areas of sustainability: site, water, energy and atmosphere, materials and resources, and indoor environmental quality.
ACHIEVING 80x50, Reducing Energy Use, Creating Jobs, 50 and Phasing Out Carbon Emissions in New York City's Buildings	By Edward Mazria for Architecture 2030	Renovating New York City's buildings to high-performance standards when they change hands is crucial to the City reaching its ambitious goal of an 80% reduction in greenhouse gas emissions by 2050. New York City contains about one million buildings comprising 5.75 billion square feet of building stock. Its buildings are responsible for 71% of the city's greenhouse gas emissions (GHG) and 94% of its electricity consumption. While requiring new buildings to become more efficient and renovating city-owned buildings are both important, in order to meet the city's greenhouse gas emissions reduction target by the year 2050, most of the city's existing building stock must also be renovated to high-performance standards over the next 35 years.
Building With Nature	EcoShape	Where possible, strive to make use of natural processes, creating integrated building solutions that are flexible, safeguard our economy, boost our ecology, and are cost effective and sustainable.
Local Energy Efficiency Policy	American Council for an Energy Efficient Economy (ACEEE)	The responsibilities of local governments give them large influence over energy use in their communities through land use and zoning, building requirements, property taxes and transfers, transportation investment decisions, economic and workforce development, and, in many cases, the provision of services such as water and electricity
Transforming Cities: IMT Resources for Local Governments and Allies	Institute for Market Transformation (IMT)	Buildings account for more than 40% of the total energy consumption in the U.S., and addressing their energy use is key to reaching a city's carbon reduction targets. IMT helps cities engage their building owners, managers, tenants and finance stakeholders in all areas of building efficiency to reduce carbon emissions and bolster local development.
Achieving 50% Energy Savings in Office Buildings	U.S. Department of Energy: Energy Efficiency & Renewable Energy	Summarizes recommendations for designing new office buildings that result in 50% less energy use than conventional designs meeting minimum code requirements. This fact sheet provides key principles and a set of prescriptive design recommendations appropriate for smaller office buildings with insufficient budgets to fully implement best practices for integrated design and optimized performance.

ACUPCC Energy Performance Contracting (EPC) Best Practices Toolkit	American College & University Presidents' Climate Commitment (ACUPCC)	A best practices toolkit as a resource for signatories interested in learning about and conducting an EPC. This toolkit is intended to support a school's internal project team throughout the EPC process, from early stage opportunity assessment to contract negotiation, implementation, and beyond.
Deep Energy Retrofits: An Emerging Opportunity	American Institute of Architects and The Rocky Mountain Institute	Besides introducing architects to the retrofit market, the guide explains how energy efficiency–related skills such as energy modeling are integrated into the project delivery process of a deep energy retrofit, providing architects with the resources they will need to begin acquiring these specialized skills. Additionally, the guide acquaints architects with basic financial knowledge, including available incentives and financing methods that they can use to help clients access capital for retrofits.
United States Building Energy Efficiency Retrofits	The Rockefeller Foundation	Upgrading and replacing energy-consuming equipment in buildings offers an important capital investment opportunity, with the potential for significant economic, climate, and employment impacts. The potential employment and climate benefits presented by energy efficiency retrofits have led to the production of this research report.



GREENHOUSE GAS REDUCTION TOOLKIT

How to Take Action in Your Community

TABLE OF CONTENTS

INTRODUCTION TO THE GREENHOUSE GAS REDUCTION TOOLKIT

The Greenhouse Gas Reduction Toolkit (Toolkit) is designed to support cities, counties, and regions as they work to advance their emissions reduction programs. It identifies best-practices, strategies and actions that reduce greenhouse gas (GHG) emissions while enhancing quality of life and helping create thriving communities.

The menu of over 250 actions from six emission sectors reflect input from a diverse group of experts. The actions are adaptable to fit the unique needs of communities and vary in terms of carbon reduction potential, feasibility, cost, associated co-benefits and more.

HIGH-IMPACT SECTORS

The Toolkit provides readers with ideas to reduce emissions stemming from the six GHG sectors common to most Colorado communities[1]:

Full descriptions of these sectors are provided in their respective chapters.

ENERGY SUPPLY

How electricity powering the community is generated

RESIDENTIAL ENERGY

How energy is used in residential buildings

COMMERCIAL ENERGY

How energy is used in commercial buildings

VEHICLES & TRANSPORTATION

The on-road movement of people, goods and services in private, transit and fleet vehicles

WASTE & LANDFILL

The solid waste generated by the community and how it is transported to the landfill

AVIATION & AIRPORT

Aircraft operations as well as energy use and transportation directly attributable to airport operations and passengers

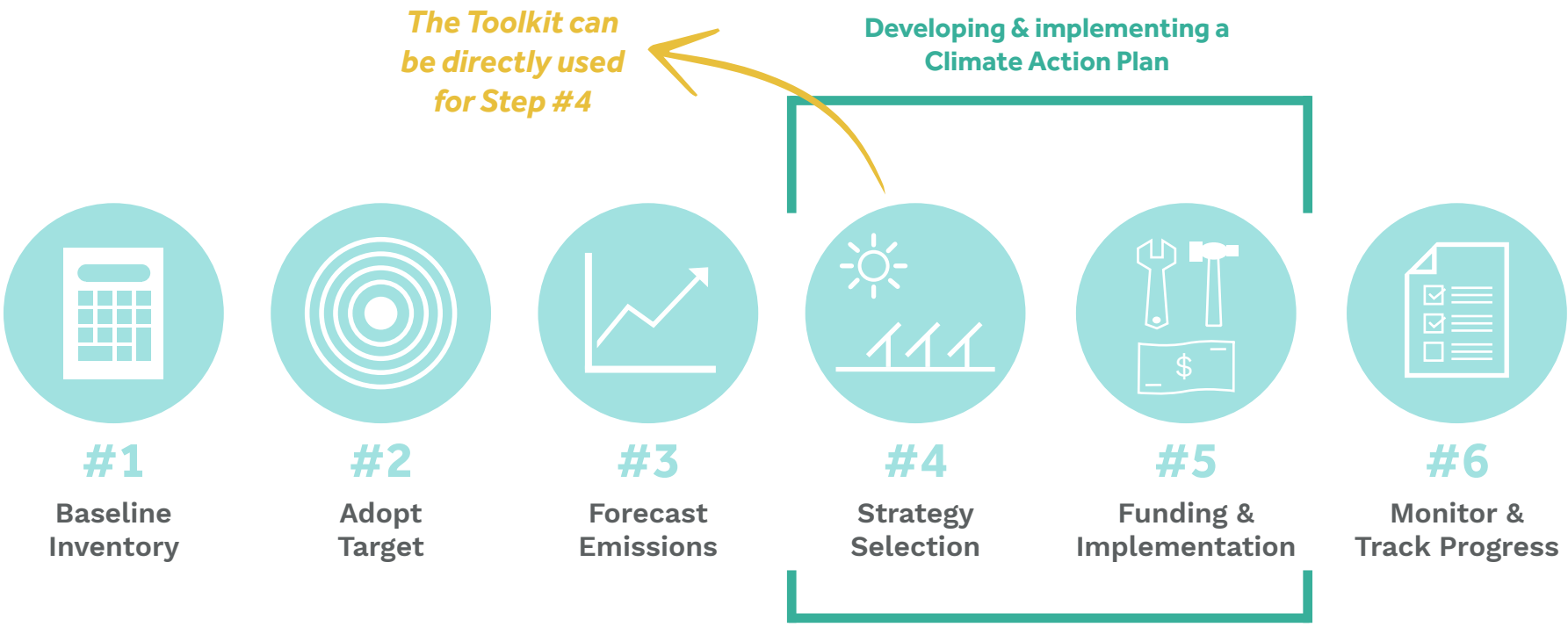
[1] These sectors also align with national and international best practices. Both the *US Community Protocol* and the *Global Protocol for Communities* suggest tracking and mitigating emissions associated with these activities.

HOW TO USE THE TOOLKIT

Fundamentally, the Toolkit is a shortcut and resource communities can use to develop climate action plans that fit their unique conditions. By listing potential actions in addition to defining the associated GHG reduction potential and co-benefits of each one, the priorities that are most important to a given community are identifiable.

The most effective way to use the Toolkit is to identify actions for implementation during the "strategy selection" phase of the climate action planning process[2]. Once actions have been selected, communities can get into the detailed deliberation necessary to move selected actions towards implementation. The Toolkit itself is a type of workbook and provides the user with space to take notes and brainstorm key considerations like implementation timeframe and partners. Since the actions detailed throughout the document are generalized, it is likely that communities will choose to modify, customize and specify Toolkit language into their own.

As actions are identified and moved towards implementation, a wide variety of considerations will likely be evaluated. Among these, it is especially beneficial to compare preferred climate actions with other strategic planning documents to identify complementary priorities. It is also especially helpful to consider opportunities for regional collaboration, given that efforts at the multijurisdictional scale can lead to efficiencies and greater impact.



[2] Detailed information and resources for completing each of these steps is available at http://www.coolcalifornia.org/local-government/toolkit and http://icleiusa.org/programs/emissions-management/5-milestones.
Page 4 figure is based on the Climate Action Resource Guide graphic on CoolCalifornia.org from the California Air Resources Board, http://www.coolcalifornia.org/local-government/toolkit.

TOOLKIT PROCESS

The Toolkit emerged as a by-product of the City of Aspen's most recent climate action planning (CAP) process. During 2016 and 2017, Aspen convened experts under the auspices of an official Advisory Committee (AC) to develop a robust strategy aimed at achieving its long-term GHG reduction goals (30% below 2004 levels by 2020 and 80% below 2004 levels by 2050). This AC is comprised mostly of leadership-level staff, specialists, and elected officials or board members[3].

The deliberative, yearlong process of GHG analysis, stakeholder meetings, and community surveys, led the leadership team to the realization that the refined yet comprehensive list of 250+ actions was far beyond the scope of a 3-5 year CAP. Further, the group realized that the list of actions could be relevant to other communities. Not wanting to limit the accessibility and impact of this impressive body of work, compiling the Toolkit became the solution to provide Aspen and others with an immediate-, mid- and long-term planning resource.

KEY RECOMMENDATIONS FOR COMMUNITY LEADERS

As community members convene to determine which actions to prioritize and refine for implementation, it is important that leaders create a supportive culture and provide resources for success. These recommendations for decision-makers will help ensure success of the overall climate planning and implementation process:

1. **Secure and prioritize the necessary organizational capacity.** This could involve assigning existing staff, hiring new staff, convening advisory commissions or otherwise.

2. Ensure that **stakeholders from all relevant sectors** are included in selecting Toolkit actions for the community's plan.

3. **Identify champions** to guide implementation when the plan is finalized.

4. **Identify and allocate funds** for plan development and implementation. This could include using existing funds, securing a new funding mechanism, or incremental multi-year budgeting. Funding is needed for projects, infrastructure, outreach, and staff capacity.

5. **Develop technical capacity** to do the work and an understanding of the linkages between climate and other local priorities. Joining the Compact of Colorado Communities[4] provides training for all levels of staff from specialists to senior leadership.

6. **Engage in state policy discussions.** Often, local priorities can be bolstered by enabling legislation at the state level. Groups such as Colorado Communities for Climate Action[5] enable municipalities to collectively represent their interests at the state capital.

7. **Collaborate across jurisdictional boundaries.** Regional collaboration in all sectors enhances efficiency and magnifies impact.

8. **Track performance, celebrate successes, and adjust course** when necessary. By measuring progress, building off what works, reevaluating when necessary, trying new things and maintaining a long-term commitment, communities are more likely to be successful in achieving their climate-related goals.

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[3] List of Advisory Committee members provided in the Acknowledgments section of this document.
[4] http://www.compactofcoloradocommunities.org/
[5] http://cc4ca.org/

GHG REDUCTION TOOLKIT: Key & Definitions

In addition to presenting a wide range of options for reducing GHG emissions in each sector, the Toolkit presents a 'GHG reduction potential' ranking and a list of potential co-benefits of each 'Objective' and 'Action'. The schematic below explains the elements of the tables throughout the rest of the document.

OBJECTIVE:

The broad and big picture things that need to happen to make significant progress in reducing community-wide and regional GHG emissions.

ACTION:

The programs, policies and steps that help achieve each Objective.

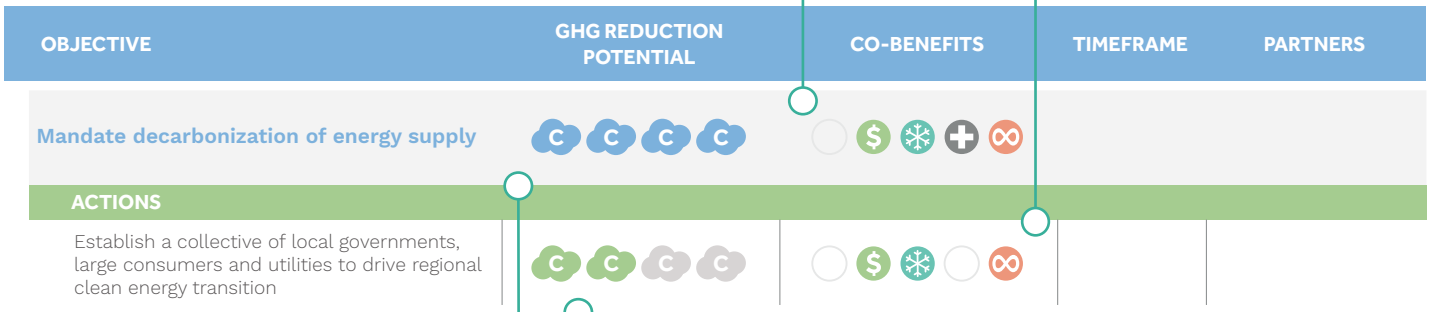
CO-BENEFITS:

Co-benefits are the additional positive benefits related to the reduction of greenhouse gases. Nearly all of the Objectives and Actions in this toolkit have co-benefits that achieve at least one of these measures:

Objective co-benefits:
The primary co-benefits of accomplishing the Objective.

Action co-benefits:
The specific co-benefits of implementing the Action.

- Promotes Equity
- Fosters Economic Sustainability
- Improves Local Environmental Quality
- Enhances Public Health & Safety
- Builds Resilience



GHG REDUCTION POTENTIAL (BLUE):

GHG reduction potential for each **Objective** represents how much it could reduce GHG emissions in the context of the sector it is a part of if fully and successfully implemented. Reduction potential was quantified using a proprietary model and simplified to a scale of 1 to 4 for presentation in the Toolkit:

Marginal

Small

Medium

Large

GHG REDUCTION POTENTIAL (GREEN):

GHG reduction potential for each **Action** represents how much it could reduce GHG emissions in the context of the Objective it is a part of. Reduction potential was approximated and is presented using a 1 to 4 scale:

Marginal

Small

Medium

Large

TIMEFRAME:

Defines whether the action is happening now or whether it should happen in the near, mid- or long-term future.

PARTNERS:

Describes which individuals, groups or organizations are leading and collaborating on implementation.

These columns have been left blank and are to be filled out by Toolkit users to help choose Actions for prioritization and implementation.

GHG REDUCTION TOOLKIT:

Energy Supply

GHG emissions in the **Energy Supply** sector are associated with purchased electricity and the use of natural gas and propane in residential and commercial buildings. The carbon intensity of a given electricity supply is the result of the resources used to generate the power; fossil resources are significantly more carbon intensive than renewable energy sources. Opportunities to reduce emissions in this sector range from fuel switching to decentralizing production. The co-benefits of successfully reducing Energy Supply sector GHGs include widespread improvements to environmental quality and the unleashing of wealth creation and employment opportunities.

GHG REDUCTION TOOLKIT: Energy Supply

OBJECTIVE	GHG REDUCTION POTENTIAL	CO-BENEFITS	TIMEFRAME	PARTNERS
Mandate decarbonization of energy supply	C C C C	Primary Co-Benefits: $ ❄ ✚ ∞		
ACTIONS				
Participate in regional collaborative of governments, businesses, and utilities to drive clean energy transition	C C C C	$ ❄ ∞		
Establish regional market-based mechanism favoring low-carbon energy (e.g., a price on carbon or a carbon tax and fee)	C C C C	= $		
Pursue retirement, conversion or sale of fossil-fuel plants serving area	C C C C	❄ ∞		
Remove barriers to local renewable energy generation	C C C C	∞		
Establish a local renewable energy generation target	C C C C	$ ❄ ∞		
Communicate to utilities the importance of reducing the carbon content of electricity	C C C C	$ ❄ ∞		
Enable consumers to purchase and produce renewable energy	C C C C	Primary Co-Benefits: = $ ❄ ✚ ∞		
ACTIONS				
Install renewable systems on municipal facilities	C C C C	$ ❄ ∞		

C Level of Potential GHG Reduction
= Promotes Equity
$ Fosters Economic Sustainability
❄ Improves Local Environmental Quality
✚ Enhances Public Health & Safety
∞ Builds Resilience

GHG REDUCTION TOOLKIT: Energy Supply

OBJECTIVE	GHG REDUCTION POTENTIAL	CO-BENEFITS	TIMEFRAME	PARTNERS
(Cont.) Enable consumers to purchase and produce renewable energy				
ACTIONS				
Expand municipal renewable energy power purchasing when on-site renewables are unsuitable	C C C C	$ ❄		
Pilot microgrid infrastructure to create districts that produce the same amount of energy they consume	C C C C	$ ∞		
Enable consumers to participate in wholesale clean power market (e.g., feed-in tariffs, net metering)	C C C C	= $ ∞		
Promote access to rooftop solar for homes and businesses through code and utility policy	C C C C	= $ ∞		
Assist large entities in implementing clean energy purchasing (e.g., virtual PPAs)	C C C C	$		
Use Property Assessed Clean Energy (PACE) and other financing mechanisms to fund renewable installations	C C C C	= $ ❄ ∞		
Address the soft costs of solar energy installations such as permitting and interconnection fees	C C C C	= $ ∞		
Change land use codes to encourage regional solar development	C C C C	$ ❄ ∞		

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GHG REDUCTION TOOLKIT: Energy Supply

OBJECTIVE	GHG REDUCTION POTENTIAL	CO-BENEFITS	TIMEFRAME	PARTNERS
Reduce the cost of renewable energy	C C C C	Primary Co-Benefits: = $ ∞		
ACTIONS				
Expand Advanced Metering Infrastructure (AMI)	C C C C	= $		
Facilitate solar PV and/or solar thermal bulk purchase program	C C C C	= $ ❄ ∞		
Provide funding and incentives for residential and commercial solar projects	C C C C	= $ ❄ ∞		
Expand solar programs for low-income households (e.g., GRID Alternatives)	C C C C	= $ ❄ ∞		
Streamline and incentivize rooftop solar installation process (e.g., sales tax legislation)	C C C C	= $ ❄ ∞		
Incentivize local utility owned and operated renewable capacity	C C C C	$ ❄ ∞		
Incentivize community solar	C C C C	= $ ❄ ∞		

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GHG REDUCTION TOOLKIT: Energy Supply

OBJECTIVE	GHG REDUCTION POTENTIAL	CO-BENEFITS	TIMEFRAME	PARTNERS
Invest in renewable generation at the community and utility scales	C C C C	Primary Co-Benefits: $ ∞		
ACTIONS				
Develop goal to self-generate a given percentage of government, public, and nonprofit buildings' energy needs and install corresponding renewable capacity	C C C C	$ ∞		
Develop geothermal energy	C C C C	$ ∞		
Develop local hydropower capacity (ideally micro, pico-hydro or run of the river)	C C C C	$ ∞		
Site and develop utility-operated renewable capacity in local service area	C C C C	$ ∞		
Advance regional grid flexibility to enable a predominantly renewable electricity supply	C C C C	= $ + ∞		
Invest in energy storage to address the intermittency of wind and solar	C C C C	= $ + ∞		
Install methane digesters	C C C C	$		
Encourage customers of electric cooperatives to vote in board elections	C C C C	=		

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GHG REDUCTION TOOLKIT: Energy Supply

OBJECTIVE	GHG REDUCTION POTENTIAL	CO-BENEFITS	TIMEFRAME	PARTNERS
Support relevant federal and state policies through active legislative and regulatory engagement	C C C C	Primary Co-Benefits: = $ ❄ + ∞		
ACTIONS				
Promote and share success of local climate initiatives as local narrative for broader climate action	C C C C			
Cultivate elected officials as local champions for state and federal climate and energy policy	C C C C	$ ❄ + ∞		
Track state and federal climate and energy policy and engage when appropriate	C C C C	= $ ❄ + ∞		
Advocate for grid modernization and flexibility policies	C C C C	$ ❄ ∞		
Support continuation and strengthening of Colorado's Renewable Energy Standard	C C C C	$ ❄ ∞		
Support State Energy Office	C C C C	= $ ❄ + ∞		
Become a member of Colorado Communities for Climate Action to support state climate/ energy policies	C C C C	=		

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GHG REDUCTION TOOLKIT: Energy Supply

OBJECTIVE	GHG REDUCTION POTENTIAL	CO-BENEFITS	TIMEFRAME	PARTNERS
(Cont.) Support relevant federal and state policies through active legislative and regulatory engagement				
ACTIONS				
Join coalition of communities advocating for federal climate/energy policies (e.g., Mountain Pact)	C C C C	= $ ❄ + ∞		
Support state or national price on carbon	C C C C	= $ ❄ + ∞		
Help defend the Clean Air Act and continued EPA regulation of CO_2 as a pollutant	C C C C	= $ ❄ + ∞		

Notes:

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GHG emissions in the **Residential Energy** sector are associated with the use of electricity, natural gas and propane in ownership and rental units. These units vary widely in age, quality, size and occupancy, and include single-family homes, multifamily properties, mobile homes and residences in mixed use buildings. Residential units are typically served by both electric and natural gas utilities, and opportunities to reduce GHG emissions are tied to decarbonizing the supply of energy flowing to the unit and consuming less of it. The co-benefits of successfully reducing Residential Energy sector GHGs include direct consumer savings and improved dwelling comfort and safety.

GHG REDUCTION TOOLKIT:

Residential Energy

GHG REDUCTION TOOLKIT: Residential Energy

OBJECTIVE	GHG REDUCTION POTENTIAL	CO-BENEFITS	TIMEFRAME	PARTNERS
Increase the efficiency of natural gas space and water heating, and convert to electric	C C C C	Primary Co-Benefits: ○ ○ ❄ ✚ ∞		
ACTIONS				
Convert natural gas heating system to electric or renewable energy	C C C C	○ $ ❄ ✚ ∞		
Convert natural gas water heating systems to electric or renewable energy	C C C C	○ $ ❄ ✚ ∞		
Heat buildings with geothermal heat pumps, air source heat pumps, or other heat exchange technology	C C C C	○ $ ❄ ○ ∞		
Integrate space and water heating equipment standards into building codes	C C C C	○ ○ ❄ ○ ∞		
Promote energy efficiency improvements such as adding insulation and pipe wrap to water heaters	C C C C	= $ ○ ✚ ○		
Offer technical assistance to determine natural gas heating alternatives	C C C C	= ○ ○ ○ ∞		
Encourage integration with air conditioning systems if future AC need is anticipated (e.g., dual ground/air-source heat pumps)	C C C C	○ ○ ○ ✚ ∞		

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GHG REDUCTION TOOLKIT: Residential Energy

OBJECTIVE	GHG REDUCTION POTENTIAL	CO-BENEFITS	TIMEFRAME	PARTNERS
Mandate no- to low-carbon standards for new construction and major remodels	C C C C	Primary Co-Benefits: = $ ❄ + ∞		
ACTIONS				
Incentivize above-code buildings	C C C C	$ ∞		
Adopt the latest energy codes with specific local requirements to exceed minimum standards	C C C C	$ ❄ + ∞		
Adopt net zero (or similar) building and energy conservation codes	C C C C	= $ ❄ + ∞		
Require net zero (or near net zero) for all new development	C C C C	= $ ❄ + ∞		
Require net zero (or near net zero) for houses over a certain square footage	C C C C	$ ❄ ∞		
Strengthen building codes and standards to move toward net zero energy	C C C C	$ ❄ ∞		
Conduct community trainings on updated code requirements	C C C C	= +		

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GHG REDUCTION TOOLKIT: Residential Energy

OBJECTIVE	GHG REDUCTION POTENTIAL	CO-BENEFITS	TIMEFRAME	PARTNERS
Improve the energy efficiency performance of existing buildings	C C C C	Primary Co-Benefits: = $ ❄ + ∞		
ACTIONS				
Retrofit buildings to meet current building codes	C C C C	= $ ❄ + ∞		
Provide incentives for energy efficiency retrofits (e.g., tax abatement, rebates, etc.)	C C C C	= $ ❄ + ∞		
Enact ordinances to drive and support deep energy retrofits and align regionally	C C C C	$ ❄ ∞		
Facilitate education and accreditation for contractors, architects and property managers	C C C C	= ∞		
Require and incentivize measurement and verification (to gauge efficacy of energy efficiency programs)	C C C C	= $ ❄ + ∞		
Mandate sleep mode technology for second homes when unoccupied	C C C C	❄ ∞		
Encourage adoption of building automation systems	C C C C	❄ +		
Conduct energy efficiency challenges and provide incentives to drive energy retrofits	C C C C	$ ∞		
Expand number of cool roofs (white coating on rooftops) to reduce cooling needs	C C C C	= $ ❄ ∞		
Expand number of green roofs (covered in soil and vegetation) to reduce heating and cooling needs	C C C C	$ ❄ ∞		

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GHG REDUCTION TOOLKIT: Residential Energy

OBJECTIVE	GHG REDUCTION POTENTIAL	CO-BENEFITS	TIMEFRAME	PARTNERS
(Cont.) Improve the energy efficiency performance of existing buildings				
ACTIONS				
Facilitate peer-to-peer information sharing among building owners	C	= ∞		
Improve access to Property Assessed Clean Energy (PACE) and other specialized financing mechanisms	C C	= ❄ ∞		
Provide regulatory and zoning relief for projects that meet verifiable high energy standards (e.g., LEED, Net Zero Energy Building, etc.)	C C	= $ ∞		
Provide energy consulting services	C	= $		
Support low-income households with energy upgrades and onsite renewable energy (e.g., Colorado's Affordable Residential Energy program, GRID Alternatives)	C C	= $ ❄ + ∞		
Reduce energy consumption in rentals, apartments and multifamily buildings	C C C	Primary Co-Benefits: = $ ❄ + ∞		
ACTIONS				
Encourage and incentivize energy efficiency retrofits in rental housing	C C	= $ ❄ + ∞		
Partner with seasonal housing providers to deploy large-scale energy efficiency retrofits	C C	= $ ❄ + ∞		

C Level of Potential GHG Reduction | = Promotes Equity | $ Fosters Economic Sustainability | ❄ Improves Local Environmental Quality | + Enhances Public Health & Safety | ∞ Builds Resilience

GHG REDUCTION TOOLKIT: Residential Energy

OBJECTIVE	GHG REDUCTION POTENTIAL	CO-BENEFITS	TIMEFRAME	PARTNERS
(Cont.) Reduce energy consumption in rentals, apartments and multifamily buildings				
ACTIONS				
Partner with utilities to improve tenants' access to energy-usage data	C C C C	○ ○ ○ + ∞		
Implement mandatory, phased energy efficiency upgrades for rental units (e.g., SmartRegs in Boulder)	C C C C	= ○ ❄ ○ ∞		
Support building automation to optimize efficiency and effectiveness	C C C C	○ $ ○ ○ ○		
Deploy a targeted outreach strategy to engage renters	C C C C	= ○ ○ + ∞		
Adopt building energy reporting and disclosure ordinances	C C C C	○ ○ ○ ○ ○		
Require energy performance disclosure at point of lease or sale	C C C C	= $ ❄ ○ ○		
Implement sub-metering for multifamily buildings for more granular building energy data	C C C C	= ○ ○ ○ ∞		
Promote energy efficiency opportunities through outreach, workshops, and neighborhood challenges	C C C C	= ○ ○ ○ ∞		
Pilot green leasing strategies to address the landlord and tenant split incentive	C C C C	= $ ❄ + ∞		

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GHG REDUCTION TOOLKIT: Residential Energy

OBJECTIVE	GHG REDUCTION POTENTIAL	CO-BENEFITS	TIMEFRAME	PARTNERS
Anticipate and mitigate likely expansion of air conditioning use	C C C C	Primary Co-Benefits: ∞		
ACTIONS				
Avoid or delay the need for air conditioning through building design and management	C C C C	$ ∞		
Require high efficiency air conditioning systems as AC use becomes more prevalent	C C C C	$		
Coordinate with efforts to adopt high efficiency electric heating systems (e.g., dual ground/air-source heat pumps)	C C C C	+ ∞		

Notes:

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Improves Local Environmental Quality

\+ Enhances Public Health & Safety

∞ Builds Resilience

GHG emissions in the **Commercial Energy** sector are associated with the use of electricity, natural gas and propane in owner-occupied and tenant-occupied businesses in single occupancy and mixed-use buildings. These properties vary widely in age, quality, size, occupancy and use. All are typically served by both electric and natural gas utilities. Opportunities to reduce GHG emissions are tied to decarbonizing the supply of energy flowing to commercial properties and consuming less energy in them. The co-benefits of successfully reducing Commercial Energy sector GHGs include direct financial savings for businesses and enhancing the health, safety and comfort of the built environment.

GHG REDUCTION TOOLKIT:

Commercial Energy

GHG REDUCTION TOOLKIT: Commercial Energy

OBJECTIVE	GHG REDUCTION POTENTIAL	CO-BENEFITS	TIMEFRAME	PARTNERS
Promote building energy benchmarking and reporting	C C C C	Primary Co-Benefits: $ ❄ + ∞		
ACTIONS				
Create commercial energy benchmarking and disclosure ordinance	C C C C	$ ❄ +		
Leverage the business license renewal process as a way to increase benchmarking participation and performance	C C C C	= + ∞		
Facilitate submetering for more granular building energy data and improve building owners' access to utility data	C C C C	$ ∞		
Provide technical support to help building owners begin benchmarking	C C C C	=		
Increase the efficiency of natural gas heating systems and appliances	C C C C	Primary Co-Benefits: $ ❄ + ∞		
ACTIONS				
Expand participation in voluntary incentive programs for upgrading old or inefficient equipment	C C C C	$ ❄ + ∞		
Identify opportunities for and implement district heating projects	C C C C	$ ❄ + ∞		

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GHG REDUCTION TOOLKIT: Commercial Energy

OBJECTIVE	GHG REDUCTION POTENTIAL	CO-BENEFITS	TIMEFRAME	PARTNERS
Replace NG heating and appliances with electric and/or renewable systems	C C C C	Primary Co-Benefits: ❄ ➕ ∞		
ACTIONS				
Eliminate natural gas connections for all new commercial developments	C C C C	➕		
Integrate geothermal heat or ground heat to offset natural gas use	C C C C	$ ❄ ➕ ∞		
Promote solar thermal for water heating	C C C C	$ ➕ ∞		
Provide rebates and incentives to replace old or inefficient boilers with electric	C C C C	= ➕		
Encourage integration with air conditioning systems if future AC need is anticipated (e.g., dual ground/air-source heat pumps)	C C C C	➕ ∞		
Enhance energy and resource efficiency in new commercial developments	C C C C	Primary Co-Benefits: = $ ❄ ➕ ∞		
ACTIONS				
Strengthen building codes to promote energy and resource efficiency in new commercial developments	C C C C	❄ ➕ ∞		
Provide above-code incentives for new commercial developments	C C C C	❄ ➕		

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GHG REDUCTION TOOLKIT: Commercial Energy

OBJECTIVE	GHG REDUCTION POTENTIAL	CO-BENEFITS	TIMEFRAME	PARTNERS
(Cont.) Enhance energy and resource efficiency in new commercial developments				
ACTIONS				
Require new buildings achieve LEED standards, mandating that criteria focus on energy efficiency	C C C C	○ ○ ❄ ✚ ∞		
Require new buildings meet net zero energy building (NZEB) standards	C C C C	○ ○ ❄ ✚ ∞		
Use land use planning to encourage density in development	C C C C	○ ○ ❄ ✚ ○		
Allow an outcome-based compliance path (target) to promote build/design flexibility	C C C C	○ ○ ❄ ✚ ∞		
Coordinate regional alignment of building energy codes and beyond code preferences	C C C C	= $ ○ ○ ○		
Bring all buildings up to current building codes or retrofit a majority of existing buildings	C C C C	**Primary Co-Benefits:** ○ $ ❄ ✚ ∞		
ACTIONS				
Require or incentivize remodels to meet current energy code	C C C C	○ ○ ❄ ✚ ∞		
Require commercial lighting retrofits in existing buildings	C C C C	○ $ ❄ ○ ∞		

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GHG REDUCTION TOOLKIT: Commercial Energy

OBJECTIVE	GHG REDUCTION POTENTIAL	CO-BENEFITS	TIMEFRAME	PARTNERS
(Cont.) Bring all buildings up to current building codes or retrofit a majority of existing buildings				
ACTIONS				
Require or incentivize refrigeration upgrades	C C C C	$ ❄ ∞		
Ban or disincentivize open doors while heating or cooling is happening	C C C C	❄ ✚		
Conduct energy assessments	C C C C	= $ ✚ ∞		
Provide energy efficiency and renewable energy incentives for large consumers	C C C C	$ ❄ ✚ ∞		
Develop programs targeting specific commercial users (e.g., small lodges, restaurants, etc.)	C C C C	$ ❄		
Require deep energy retrofits at designated points, such as time of sale or major renovation	C C C C	= $ ❄ ✚ ∞		
Establish incremental timeline to require that all commercial buildings meet current building energy codes	C C C C	❄ ✚ ∞		
Develop and implement program for energy efficiency and renewable energy in historical buildings	C C C C	$ ❄ ✚ ∞		

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GHG REDUCTION TOOLKIT: Commercial Energy

OBJECTIVE	GHG REDUCTION POTENTIAL	CO-BENEFITS	TIMEFRAME	PARTNERS
Model best practices through energy retrofitting of government buildings and properties	C C C C	Primary Co-Benefits: $ ❄ + ∞		
ACTIONS				
Implement energy efficiency measures on government buildings, offices and facilities	C C C C	$ ❄ + ∞		
Improve energy efficiency in affordable housing units and complexes	C C C C	= $ ❄ + ∞		
Require green capital needs assessment for renovation projects financed by local government	C C C C	$ ❄ + ∞		
Train building operators and facility managers in energy efficiency best practices	C C C C	$ +		
Ensure new government buildings achieve high performance green building standards (e.g., NEZB, LEED, etc.)	C C C C	$ ❄ + ∞		
Identify opportunities for and implement district heating in new construction, remodels and campuses	C C C C	$ ❄ + ∞		
Improve education and infrastructure; optimize utility rates	C C C C	Primary Co-Benefits: = $ ∞		
ACTIONS				
Integrate carbon sequestration practices and infrastructure into built environment	C C C C	❄ + ∞		

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GHG REDUCTION TOOLKIT: Commercial Energy

OBJECTIVE	GHG REDUCTION POTENTIAL	CO-BENEFITS	TIMEFRAME	PARTNERS
(Cont.) Improve education and infrastructure; optimize utility rates				
ACTIONS				
Provide contractor education programs on green building and energy efficiency upgrades	C C C C	$ + ∞		
Require certification of building operators	C C C C	$ ❄ + ∞		
Redesign utility rates to incentivize and balance current and future priorities (e.g., electric vehicles, fuel switching, time of use, peak shaving, energy efficiency, demand side management)	C C C C	= $ ❄ + ∞		
Establish a green business certification program to recognize buildings that achieve energy efficiency and sustainability thresholds	C C C C	$ ❄		
Create green business corridors	C C C C	$ ❄		
Require higher energy efficiency standards for major appliances	C C C C	❄ + ∞		
Optimize water distribution system to make it as efficient as possible	C C C C	$ + ∞		
Increase public works oversight in construction to prevent continual reconstruction due to poor initial construction quality	C C C C	= $ ∞		

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GHG REDUCTION TOOLKIT: Commercial Energy

OBJECTIVE	GHG REDUCTION POTENTIAL	CO-BENEFITS	TIMEFRAME	PARTNERS
(Cont.) Improve education and infrastructure; optimize utility rates				
ACTIONS				
Promote optimal thermostat settings to couple comfort with efficiency	C C C C	=		
Expand messaging and communication on energy programs	C C C C	= $		
Anticipate and mitigate likely expansion of air conditioning use in buildings	C C C C	**Primary Co-Benefits:** $ + ∞		
ACTIONS				
Avoid or delay the need for air conditioning through building design and management	C C C C	$ ∞		
Require high efficiency air conditioning systems as AC use becomes more prevalent	C C C C	$		
Coordinate with efforts to adopt high efficiency electric heating systems (e.g., dual ground/air-source heat pumps)	C C C C	+ ∞		

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GHG REDUCTION TOOLKIT: Commercial Energy

Notes:

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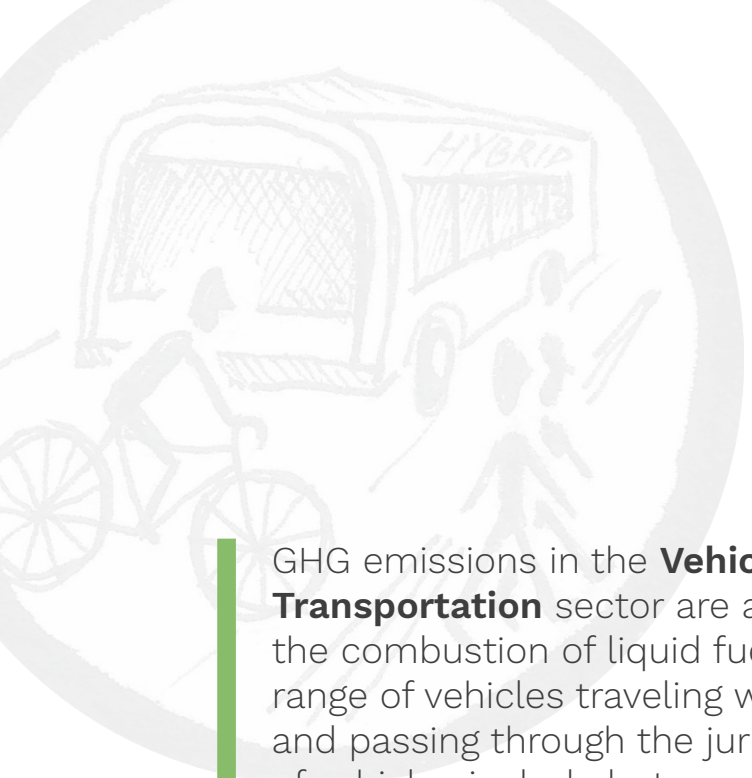

GHG emissions in the **Vehicles and Transportation** sector are associated with the combustion of liquid fuels in the wide range of vehicles traveling within, to, from, and passing through the jurisdiction. Types of vehicles include but are not limited to personal vehicles, light trucks, transit buses, commercial transport vehicles, heavy duty vehicles, and motorcycles. Opportunities to reduce emissions in this sector are diverse, and include shifting transportation modes away from single occupancy vehicle use and transitioning personal and commercial vehicle fleets to low or zero-emission options like electric vehicles. The co-benefits of successfully reducing Transportation sector GHGs include reduced congestion and improved air quality.

GHG REDUCTION TOOLKIT:

Vehicles & Transportation

GHG REDUCTION TOOLKIT: Vehicles & Transportation

OBJECTIVE	GHG REDUCTION POTENTIAL	CO-BENEFITS	TIMEFRAME	PARTNERS
Reduce VMT by promoting alternatives to single-occupancy vehicles	C C C C	Primary Co-Benefits: = $ ❄ + ∞		
ACTIONS				
Encourage employers to subsidize bus passes for employees	C C C C	= ❄ +		
Create funding mechanism for free regional bus ridership	C C C C	= $ ❄ +		
Promote and incentivize carpooling	C C C C	= $ ❄ + ∞		
Strengthen enforcement of high occupancy vehicle (HOV) and transit lanes	C C C C	❄ +		
Boost public transit reliability	C C C C	=		
Promote teleworking as an alternative to commuting	C C C C	$ ❄		
Make transit more convenient, affordable and fun than driving (e.g., optimized schedules, dedicated bus lanes, comfortable seats, free wi-fi, etc.)	C C C C	= $ ❄ + ∞		
Increase the number and quality of safe routes and transit options to schools	C C C C	= ❄ + ∞		

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GHG REDUCTION TOOLKIT: Vehicles & Transportation

OBJECTIVE	GHG REDUCTION POTENTIAL	CO-BENEFITS	TIMEFRAME	PARTNERS
(Cont.) Reduce VMT by promoting alternatives to single-occupancy vehicles				
ACTIONS				
Evaluate high-speed rail to optimize transit coverage and efficiency	C C C C	= $ ❄ + ∞		
Enable growth of on-demand mobility services (i.e., ride-sharing, e-hailing, bike-sharing, car-sharing etc.)	C C C C	$ ❄ +		
Place 'air pollution disclosure' labels on gas pumps (similar to Surgeon General's warning on cigarettes)	C C C C			
Enhance first and last mile connectivity to transit	C C C C	**Primary Co-Benefits:** = $ ❄ + ∞		
ACTIONS				
Expand feeder transit network to primary bus stops (e.g., circulators, 'mobility as a service')	C C C C	= $ ❄ + ∞		
Expand bike share network to better connect neighborhoods and work centers to public transit	C C C C	= $ ❄ + ∞		
Expand rideshare network to better connect people traveling to similar destinations	C C C C	= $ ❄ + ∞		

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GHG REDUCTION TOOLKIT: Vehicles & Transportation

OBJECTIVE	GHG REDUCTION POTENTIAL	CO-BENEFITS	TIMEFRAME	PARTNERS
(Cont.) Enhance first and last mile connectivity to transit				
ACTIONS				
Promote zero-emission and driverless technologies for expanded mobility services	C C C C	$ +		
Expand bicycle network to better connect neighborhoods and work centers to public transit	C C C C	= $ ❄ + ∞		
Expand pedestrian infrastructure to better connect neighborhoods and work centers to public transit	C C C C	= $ ❄ + ∞		
Promote adoption of alternate fuel vehicles for individuals and fleets	C C C C	Primary Co-Benefits: $ ❄ + ∞		
ACTIONS				
Provide free parking for zero-emissions vehicles in areas that typically charge parking fees	C C C C	❄ +		
Increase the proportion of EVs in fleets (e.g., car share, municipal, rental cars, hotel shuttles, etc.)	C C C C	= ❄ +		
Create EV charging hubs for taxis or other fleets	C C C C	❄ + ∞		
Increase EV charging stations in visible, accessible locations	C C C C	= $ ❄ + ∞		

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GHG REDUCTION TOOLKIT: Vehicles & Transportation

OBJECTIVE	GHG REDUCTION POTENTIAL	CO-BENEFITS	TIMEFRAME	PARTNERS
(Cont.) Promote adoption of alternate fuel vehicles for individuals and fleets				
ACTIONS				
Encourage off-peak EV charging through electricity rate structure	C C C C	$ ❄ + ∞		
Require EV charging stations (or EV readiness) in all new commercial developments	C C C C	$ ❄ + ∞		
Require EV charging stations (or EV readiness) in all new multifamily developments	C C C C	= $ ❄ + ∞		
Require all new single-family construction to be EV ready	C C C C	$ ❄ + ∞		
Provide incentives to tie PV (and storage battery) installation to EV purchases	C C C C	$ ❄ + ∞		
Provide free public EV charging stations	C C C C	= $ ❄ + ∞		
Support the full spectrum of low emission vehicle technologies, in addition to EVs	C C C C	= $ ❄ +		
Convert transit and government fleets to low-carbon fuel vehicles (e.g., electric buses)	C C C C	❄ + ∞		
Provide financial incentives to convert fleets to low-carbon fuel vehicles	C C C C	= $ ❄ +		
Make transportation fuels at landfill using methane capture	C C C C	$ ❄ ∞		

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GHG REDUCTION TOOLKIT: Vehicles & Transportation

OBJECTIVE	GHG REDUCTION POTENTIAL	CO-BENEFITS	TIMEFRAME	PARTNERS
(Cont.) Promote the adoption of alternate fuel vehicles for individuals and fleets				
ACTIONS				
Deploy public outreach campaign and give the public opportunities to drive an EV	C C C C	=		
Facilitate EV bulk purchase program	C C C C	$ ❄ + ∞		
Redesign urban form and population density to reduce vehicle use	C C C C	**Primary Co-Benefits:** ❄ + ∞		
ACTIONS				
Use zoning and transit-oriented development to site new development near jobs and transit	C C C C	= $ ❄ + ∞		
Enable a greater percentage of the workforce to live near work and transit	C C C C	= $ ❄ + ∞		
Improve winter bike and pedestrian options	C C C C	= $ ❄ + ∞		
Improve and expand pedestrian infrastructure (e.g., pedestrian malls, fast walk signals, sidewalks)	C C C C	= $ ❄ + ∞		
Create or expand no car zones	C C C C	$ ❄ + ∞		

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GHG REDUCTION TOOLKIT: Vehicles & Transportation

OBJECTIVE	GHG REDUCTION POTENTIAL	CO-BENEFITS	TIMEFRAME	PARTNERS
(Cont.) Redesign urban form and population density to reduce vehicle use				
ACTIONS				
Improve and expand bicycle infrastructure (e.g., well-placed bike lanes, find solutions for conflict/hazard areas, etc.)	C C C C	= $ ❄ + ∞		
Build bike racks in strategic locations; consider covered or winter bike racks	C C C C	= $ ❄ + ∞		
Support local food production and sale at scale	C C C C	$ ❄ + ∞		
Change codes to include EV service equipment installations as acceptable transportation demand management (TDM) option	C C C C	❄ ∞		
Limit parking and drop-off permits at schools	C C C C	❄ +		
Eliminate minimum parking requirements for development; instead, require transit and mobility services	C C C C	= + ∞		
Support relevant federal, state and local policy through active legislative and regulatory engagement	C C C C	**Primary Co-Benefits:** = $ ❄ + ∞		
ACTIONS				
Support local, state and federal incentives, policies and programs to grow EV adoption and infrastructure	C C C C	= ❄ +		

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GHG REDUCTION TOOLKIT: Vehicles & Transportation

OBJECTIVE	GHG REDUCTION POTENTIAL	CO-BENEFITS	TIMEFRAME	PARTNERS
(Cont.) Support relevant federal, state and local policy through active legislative and regulatory engagement				
ACTIONS				
Actively support Colorado transit grants	C C C C	= $ ❄ + ∞		
Support EPA greenhouse gas emissions standards and fuel efficiency standards for medium- and heavy-duty engines and vehicles	C C C C	❄ +		
Promote state fuel economy standards, such as California's standards	C C C C	❄ +		
Advocate for a strengthening of the CAFE standards (the national fuel economy targets)	C C C C	= ❄ +		
Promote new mobility technologies and business models	C C C C	Primary Co-Benefits: $		
ACTIONS				
Integrate a multi-modal mobility system at the regional or state scale	C C C C	= $ ❄ + ∞		
Pilot on-demand bus and/or van share	C C C C	= $ ❄ +		
Implement peak demand service for strategic transit routes	C C C C	= $ ❄ + ∞		

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GHG REDUCTION TOOLKIT: Vehicles & Transportation

OBJECTIVE	GHG REDUCTION POTENTIAL	CO-BENEFITS	TIMEFRAME	PARTNERS
(Cont.) Promote new mobility technologies and business models				
ACTIONS				
Address regulatory barriers to shared-use mobility and driverless vehicles	C C C C	= $ ❄ + ∞		
Support on-demand parking apps to reduce vehicle circulation and congestion	C C C C	$ ❄		
Deploy real-time public transit data to provide up-to-the-minute information (e.g., bus arrival information, parking availability, etc.)	C C C C	❄ +		
Increase the cost of using fossil-fuel vehicles	C C C C	**Primary Co-Benefits:** ❄ +		
ACTIONS				
Establish CO_2 fees on fossil-fuel vehicles at purchase or registration	C C C C	❄ +		
Establish congestion fees on fossil-fuel vehicles in designated areas or for driving during high-use times	C C C C	❄ +		
Tax gasoline sales locally or regionally	C C C C	$ ❄ +		

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GHG REDUCTION TOOLKIT: Vehicles & Transportation

OBJECTIVE	GHG REDUCTION POTENTIAL	CO-BENEFITS	TIMEFRAME	PARTNERS
Increase the cost of driving in certain places	C C C C	Primary Co-Benefits: ○ ○ ❄ ✚ ○		
ACTIONS				
Institute new parking pricing models (e.g., performance-based parking, off-street parking tax, dynamic pricing, etc.)	C C C C	○ ○ ❄ ○ ○		
Establish regional road pricing (e.g., toll roads, dynamic pricing)	C C C C	○ ○ ❄ ○ ○		

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GHG emissions in the **Waste and Landfill** sector come from waste generated within the jurisdiction, then transported to, and processed at the landfill. Organic components within the waste stream generate methane as they decompose. Organic components vary but predominantly include food waste and construction and demolition (C&D) waste. Heavy duty vehicles hauling waste to the landfill and processing it on site consume liquid fuels. Opportunities to reduce emissions in this sector include diverting or salvaging organic components of the waste stream and increasing the efficiency of hauling and processing. The co-benefits of successfully reducing Landfill sector GHGs include extending the life of local landfills and improving local environmental quality.

GHG REDUCTION TOOLKIT:

Waste & Landfill

GHG REDUCTION TOOLKIT: Waste & Landfill

OBJECTIVE	GHG REDUCTION POTENTIAL	CO-BENEFITS	TIMEFRAME	PARTNERS
Increase rates of and participation in composting and recycling	C C C C	Primary Co-Benefits: $ ❄ ∞		
ACTIONS				
Require composting through codes or regulations	C C C C	= $ ❄ + ∞		
Create convenient, accessible neighborhood compost drop-off locations	C C C C	= ❄ ∞		
Equip an entity like the landfill with resources to turn organic waste into a safe and usable compost product	C C C C	$ ❄ + ∞		
Make finished compost product accessible to gardeners and landscapers	C C C C	$ ❄ ∞		
Require waste haulers to offer compost pickup	C C C C	$ ❄ + ∞		
Require waste haulers to offer recycling pickup	C C C C	= ❄		
Run ongoing public education campaigns to promote composting	C C C C	=		
Ensure buildings have adequate space for composting and recycling collection and storage (e.g., equal space ordinance)	C C C C	❄ +		
Create (or strengthen, if existing) yard waste composting ordinances	C C C C	❄ +		

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GHG REDUCTION TOOLKIT: Waste & Landfill

OBJECTIVE	GHG REDUCTION POTENTIAL	CO-BENEFITS	TIMEFRAME	PARTNERS
(Cont.) Increase rates of and participation in composting and recycling				
ACTIONS				
Create (or enforce, if existing) ban on burying yard waste in landfill	C C C C	○ ○ ❄ ✚ ○		
Create composting program and infrastructure for multifamily complexes	C C C C	= $ ❄ ✚ ○		
Supply local food waste to agricultural operations (e.g., animal feed)	C C C C	○ $ ❄ ○ ∞		
Provide resources and support for property managers to increase recycling and composting	C C C C	= $ ❄ ✚ ○		
Charge more for trash service and reduce trash pickup days	C C C C	○ $ ❄ ○ ○		
Implement a single-stream recycling policy	C C C C	○ ○ ❄ ○ ○		
Expand public recycling and composting infrastructure	C C C C	= ○ ❄ ✚ ○		
Expand businesses' participation in compost collection services	C C C C	○ ○ ❄ ○ ○		

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GHG REDUCTION TOOLKIT: Waste & Landfill

OBJECTIVE	GHG REDUCTION POTENTIAL	CO-BENEFITS	TIMEFRAME	PARTNERS
Maximize diversion of construction and demolition (C&D) waste	C C C C	Primary Co-Benefits: $ ❄ ∞		
ACTIONS				
Create a system for moving C&D waste to markets	C C C C	$ ∞		
Make demolition more expensive than deconstruction	C C C C	$ ❄ ✚ ∞		
Mandate deconstruction	C C C C	$ ❄ ✚ ∞		
Update building codes to ensure deconstruction of buildings is prioritized over demolition	C C C C	$ ❄ ✚ ∞		
Charge a lot more for C&D loads	C C C C	$ ❄ ✚ ∞		
Adopt and enforce C&D waste ordinance	C C C C	$ ❄ ✚ ∞		
Create a salvage yard for deconstructed building materials	C C C C	= $ ❄ ✚ ∞		
Establish reuse center for building materials	C C C C	= $ ❄ ✚ ∞		
Facilitate markets for resale businesses to pre-resell materials	C C C C	$ ❄ ∞		

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GHG REDUCTION TOOLKIT: Waste & Landfill

OBJECTIVE	GHG REDUCTION POTENTIAL	CO-BENEFITS	TIMEFRAME	PARTNERS
(Cont.) Maximize diversion of construction and demolition (C&D) waste				
ACTIONS				
Offer incentives to encourage reuse of existing structures	C C C C	❄ ✚		
Introduce onboard technology to sort C&D waste at landfill	C C C C	= $ ❄ ✚ ∞		
Provide technical support to contractors to reduce C&D waste	C C C C	= ✚		
Increase community compliance with waste diversion ordinances	C C C C	**Primary Co-Benefits:** = ❄ ✚		
ACTIONS				
Impose tickets and fines for not recycling or for contaminating recycling loads	C C C C			
Provide consistent education across relevant target audiences	C C C C	=		
Create and enforce zero-waste event requirements	C C C C	= ❄ ∞		
Require recycling and compost bins at public events	C C C C	= ❄ ✚ ∞		
Align city, county and regional waste policies and codes	C C C C	=		

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GHG REDUCTION TOOLKIT: Waste & Landfill

OBJECTIVE	GHG REDUCTION POTENTIAL	CO-BENEFITS	TIMEFRAME	PARTNERS
(Cont.) Increase community compliance with waste diversion ordinances				
ACTIONS				
Perform compliance spot-checks (similar to health code inspections at restaurants)	C C C C	=		
Host community-wide waste collection events to support proper disposal of hard-to-recycle items (e.g., electronics, tires, batteries, etc.)	C C C C	= $ ❄ + ∞		
Consume fewer products and resources	C C C C	Primary Co-Benefits: ❄ ∞		
ACTIONS				
Conduct “buy local” and “consume local” campaigns	C C C C	$ ∞		
Promote reusable mugs and water bottles	C C C C	$ ❄		
Develop and adopt local Styrofoam ban	C C C C	❄ +		
Tax or ban plastic water bottles	C C C C	❄ +		
Develop programs to reduce use of plastic foodservice packaging	C C C C	❄ +		
Incentivize the use of reusable containers over disposable	C C C C	❄ +		

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GHG REDUCTION TOOLKIT: Waste & Landfill

OBJECTIVE	GHG REDUCTION POTENTIAL	CO-BENEFITS	TIMEFRAME	PARTNERS
(Cont.) Consume fewer products and resources				
ACTIONS				
Promote government and corporate purchasing policies favoring low waste	C C C C	$ ❄ ∞		
Redesign organizational purchasing rules to favor sustainable consumption	C C C C	$ ❄ ∞		
Require improved materials management by businesses and government	C C C C	$ ❄ + ∞		
Increase oversight by public works departments to reduce the need to reconstruct poorly built projects	C C C C	❄ + ∞		
Support food waste reduction programs	C C C C	= $ ❄ + ∞		
Change state regulations to allow food rescue (e.g., food pantry)	C C C C	= $ ❄ + ∞		
Facilitate donation of excess or unused food (e.g., Uber-style app to connect restaurants and private chefs to organizations that feed the hungry)	C C C C	= $ ❄ + ∞		
Require use of recycled asphalt in streets	C C C C	❄ + ∞		
Ban plastic bags	C C C C	❄ +		

C Level of Potential GHG Reduction
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∞ Builds Resilience

GHG REDUCTION TOOLKIT: Waste & Landfill

OBJECTIVE	GHG REDUCTION POTENTIAL	CO-BENEFITS	TIMEFRAME	PARTNERS
(Cont.) Consume fewer products and resources				
ACTIONS				
Impose fees on paper bags	C C C C	= ❄		
Promote thrift stores, reuse programs, fix-it clinics and community share programs	C C C C	= $ ❄ ∞		
Increase the cost of waste disposal for MSW and C&D	C C C C	Primary Co-Benefits: ❄ ∞		
ACTIONS				
Implement tiered 'Pay As You Throw' rates to all jurisdictions served by a particular landfill	C C C C	= ❄ +		
Expand and improve existing waste hauling practices	C C C C	Primary Co-Benefits: $ ❄ +		
ACTIONS				
Combine yard waste and food waste for pickup service	C C C C	$ ❄ +		
Re-route haulers to increase operating efficiency	C C C C	$ ❄ +		
Require haulers use cleaner vehicles	C C C C	❄ +		

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GHG REDUCTION TOOLKIT: Waste & Landfill

OBJECTIVE	GHG REDUCTION POTENTIAL	CO-BENEFITS	TIMEFRAME	PARTNERS
Pilot new technologies	C C C C	Primary Co-Benefits: ∞		
ACTIONS				
Develop waste-to-energy technologies at regional landfills	C C C C	= $ ❄ + ∞		
Pilot small-scale anaerobic digestion facilities for organic waste	C C C C	$ ❄ + ∞		
Assess feasibility of FastOx Gasification (waste becomes energy via hydrogen, syngas)	C C C C	$ ❄ ∞		
Combine small-scale plasma gasification with district heating	C C C C	$ ❄ ∞		

Notes:

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GHG emissions in the **Aviation and Airport** sector are associated with aircraft operations, airport ground support equipment, on road vehicle use and energy consumed in airport buildings. Aircraft operations include landings and takeoffs. Opportunities to reduce emissions in this sector include increasing the operating efficiency of aircraft, electrifying ground support equipment and ground access vehicles and maximizing the energy efficiency and production of airport buildings. The co-benefits of successfully reducing Airport sector GHGs include improvements to both public health and environmental quality.

GHG REDUCTION TOOLKIT:

Aviation & Airport

GHG REDUCTION TOOLKIT: Aviation & Airport

OBJECTIVE	GHG REDUCTION POTENTIAL	CO-BENEFITS	TIMEFRAME	PARTNERS
Reduce airport-controlled GHGs	C C C C	Primary Co-Benefits: ❄ ✚		
ACTIONS				
Require EVs and/or cleaner fuels for ground support vehicles and ground support equipment (GSE)	C C C C	❄		
Build onsite PV or PV canopies to power EV service vehicles and EV GSE	C C C C	$ ❄ ∞		
Install alternative fueling sources (would need to be regionally based) at airports to enable airlines to convert ground support equipment to cleaner, lower emission vehicles	C C C C	❄ ✚ ∞		
Maximize the energy efficiency and energy performance of airport buildings	C C C C	$ ❄ ✚ ∞		
Integrate ground heat or geothermal heating into existing buildings and facilities	C C C C	$ ❄ ∞		
Replace airfield lighting with LED lighting	C C C C	$ ❄ ∞		
Increase the efficiency of the airport curbside to reduce vehicle trip lengths and idling	C C C C	❄ ✚		
Prohibit vehicle idling in pickup/drop-off and waiting zones	C C C C	❄ ✚		
Install ground power and preconditioned air systems at gates to reduce the use of the auxiliary power units on aircraft	C C C C	❄		

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GHG REDUCTION TOOLKIT: Aviation & Airport

OBJECTIVE	GHG REDUCTION POTENTIAL	CO-BENEFITS	TIMEFRAME	PARTNERS
(Cont.) Reduce airport-controlled GHGs				
ACTIONS				
Optimize waste diversion practices and rates at airport facilities and terminal	C C C C	❄ ✚ ∞		
Require taxi and airport shuttles to meet a clean-fuels or MPGe standard for onsite agreements	C C C C	❄		
Reduce aircraft- and aviation-related GHGs	C C C C	Primary Co-Benefits: ❄ ✚		
ACTIONS				
Modernize Air Traffic Control System (NextGen – FAA controlled)	C C C C	$ ❄ ✚ ∞		
Encourage continuous descent approaches (CDAs) if possible	C C C C	❄		
Financially incentivize the use of more efficient aircraft serving airport (e.g., through takeoff/ landing fees)	C C C C	❄ ✚		
Incentivize the use of aviation biofuels in aircraft servicing local airport (would require local supply, regional approach or partnership with DIA)	C C C C	$ ❄ ✚ ∞		

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GHG REDUCTION TOOLKIT: Aviation & Airport

OBJECTIVE	GHG REDUCTION POTENTIAL	CO-BENEFITS	TIMEFRAME	PARTNERS
(Cont.) Reduce aircraft- and aviation-related GHGs				
ACTIONS				
Offer targeted offsets through partnerships with industry leaders and airlines serving local airport	C			
Encourage and support Bustang to DIA	C C	❄		
Reduce the need for air travel via state/regional high-speed rail	C C	❄		
Pressure local airlines to implement their aspirational International GHG goals	C C C	Primary Co-Benefits: ❄ ✚ ∞		
ACTIONS				
Inform airlines of local GHG reduction targets, and provide operational incentives connected with facilitating attainment	C C	❄ ✚		
Educate passengers about 'greener' flying and becoming consumer advocates via airline promotional material	C	❄		
Encourage airlines to continue developing improved Engine and Airframe Technology	C	❄ ✚		

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GHG REDUCTION TOOLKIT: Aviation & Airport

OBJECTIVE	GHG REDUCTION POTENTIAL	CO-BENEFITS	TIMEFRAME	PARTNERS
If a new terminal is developed, ensure that it represents the pinnacle of energy efficiency and sustainability	C C C C	Primary Co-Benefits: $ ❄ + ∞		
ACTIONS				
Require any new terminal or airport building to be net-zero	C C C C	$ ❄ + ∞		
Mandate 'zero construction waste' and 'sustainable construction' plans for any new terminal or airport facilities	C C C C	❄ +		
Integrate ground heat or geothermal heating into new buildings and facilities	C C C C	$ ❄ ∞		
Plan for and install PV at airport and adjacent areas (e.g., PV parking canopies)	C C C C	$ ❄ ∞		
Ensure terminal encourages next-generation mobility by providing EV and 'mobility as a service' infrastructure	C C C C	= $ ❄		
Encourage passengers to use transit and mobility services to access airport	C C C C	Primary Co-Benefits: = $ ❄		
ACTIONS				
Deploy combined marketing outreach with chamber and lodges regarding transit and mobility options	C C C C			
Provide luggage delivery to hotels or residences so passengers can use the transit and mobility options of their choice	C C C C	= $ ❄		

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GHG REDUCTION TOOLKIT: Aviation & Airport

OBJECTIVE	GHG REDUCTION POTENTIAL	CO-BENEFITS	TIMEFRAME	PARTNERS
(Cont.) Encourage passengers to use transit and mobility services to access airport				
ACTIONS				
Require rental car companies to have EV options (and require that EVs are a certain percentage of rental fleet); also require an MPGe standard for rental car fleet	C C C C	= $ ❄		
Partner with airport rental car companies to include info card about local mobility options (including option of zero-emissions rental cars)	C C C C			
Provide a dedicated ground transit route with local service into terminal drop-off	C C C C	= ❄ +		
Establish an easy-to-use link from terminal to transit	C C C C	= ❄ +		
Create a luxury bus system to carry people and luggage to and from airport to their accommodations	C C C C	❄		
Install signage and wayfinding from terminal to existing transit	C C C C	+		
Install light rail from airport to city	C C C C	$ ❄ +		
Provide appropriate amount of remote airport parking (including at Park and Rides)	C C C C	= ❄		

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GHG REDUCTION TOOLKIT: Aviation & Airport

OBJECTIVE	GHG REDUCTION POTENTIAL	CO-BENEFITS	TIMEFRAME	PARTNERS
Support relevant federal and state policies through active legislative and regulatory engagement	C C C C	Primary Co-Benefits: $ ❄		
ACTIONS				
Push for federal air quality standards to reduce GHGs associated with jet fuel	C C C C	❄		
Establish an active local government voice in federal aviation policy	C C C C	$ ❄		
Encourage or facilitate the adoption of 'sustainable aviation fuels,' such as biofuels	C C C C	$ ❄ + ∞		
Support federal carbon tax that includes aircraft operations	C C C C	= $ ❄ + ∞		

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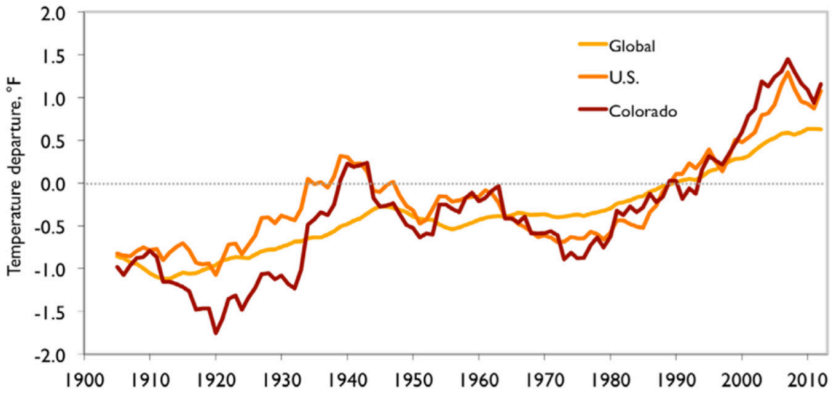
APPENDIX: Notable climate change info for your CAP

While questions remain about the exact specifics of future climate conditions, the basic facts of climate science and solutions are well understood, and more relevant and accessible to local communities than they ever have been. The following insights have been compiled to provide Toolkit users with accessible climate change information that can be drawn for use in their own climate action plans.

Our climate is changing, and more rapidly than at any point on record[i].

- "Every single year since 1977 has been warmer than the 20th century average, with 16 of the 17 warmest years on record occurring since 2001, and 2016 being the warmest year on recorded history."[ii]
- Global temperatures have risen by 1.5°F since 1880[iii] and national temperatures have increased 2°F since 1978[iv].
- In Colorado, average temperatures have risen by 2.5°F since the 1950s[v].
- In Western Colorado, there are 23 fewer frost free than there were before the 1980s and annual snowfall has declined by 10 inches[vi].

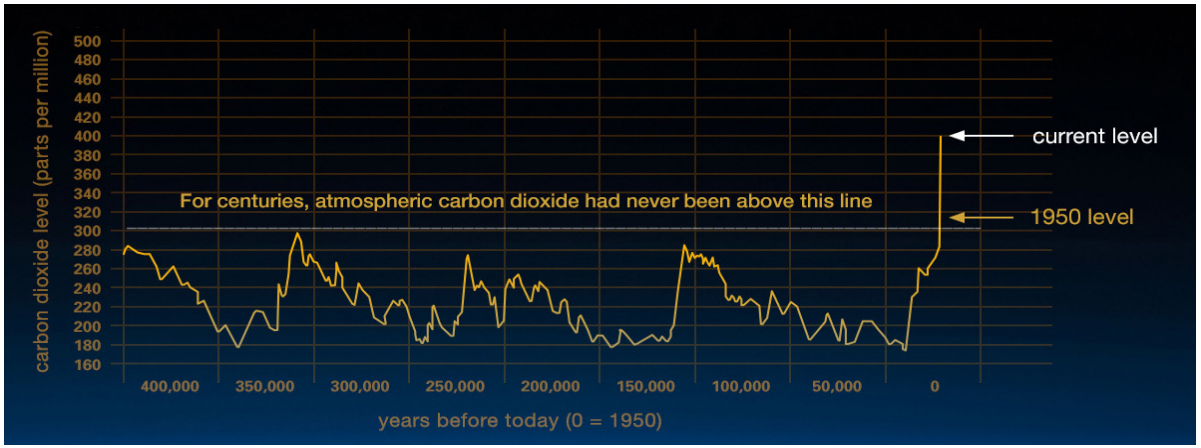
Figure 1. Observational record of annual mean temperature: Global, U.S. and Colorado (Aspen Global Change Institute[v])



Human activity is driving most of this change.

- 97% of climate scientists agree that the warming over the past century is due to human activity. Most leading scientific organizations worldwide have issued public statements affirming this[vii].
- Atmospheric concentrations of CO_2 have risen 40% since the industrial revolution[viii].

Figure 2. Evidence that atmospheric CO_2 has increased since the Industrial Revolution (NASA[vii])



APPENDIX: Notable climate change info for your CAP

The severity of future climate change is directly linked to GHG emissions.

- GHG emissions are the single most significant factor in determining the amount of future global temperature change[ix].
- Currently, the world is on a high emissions trajectory. Unless GHG emissions are mitigated, this could lead to a 9.7°F increase in Western Colorado by 2100[x].
- The best available science indicates that the world, Colorado and communities should reduce GHG emissions 45% below 2005 levels by 2030 and 90% below 2005 levels by 2050, to limit warming to 1.5 to 2°C above preindustrial levels[xi].

We know how to solve it.

- Robust and effective climate solutions are developed and ready for implementation at the international, national, state and local level[xii].

Acting now is less expensive than inaction and can create healthy, thriving communities.

- Dramatically reducing GHG emissions is much less expensive than the anticipated costs of dealing with the impacts of unchecked climate change[xiii] [xiv].
- Effectively addressing climate change at the scale necessary to solve the problem could be the largest wealth creation opportunity of our time[xv].
- In communities, climate action typically creates numerous co-benefits such as increased resilience and economic activity, healthier citizens and improved environmental quality. This Toolkit defines some of the co-benefits that are associated with various actions.
- Climate action is frequently complementary to existing priorities for communities and regions.

Local action matters.

- While future climate will be determined by global GHG emissions, the cumulative impact of local action is significant and meaningful.
- 78% of energy globally is consumed in cities[xvi]. Collectively, local action can significantly accelerate a transition away from fossil fuels.
- Local governments in the US currently have some of the most ambitious climate action commitments. More than 350 US mayors have signed a pledge to uphold the Paris Climate Agreement through local action and necessary policy at the state, federal and international levels[xvii].

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The City of Aspen strives to be an environmental leader and to promote environmental stewardship throughout the Roaring Fork Valley, across the state of Colorado, and around the globe. We recognize Aspen's dependence on climate and natural resources for a thriving economy, healthy ecosystems, and exceptional quality of life. In an effort to do our part to reduce the threat of climate change, Aspen's City Council adopted the Canary Action Plan in 2007, which commits to reducing community-wide emissions 30% by 2020 and 80% by 2050, below 2004 levels.

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The Community Office for Resource Efficiency (CORE) works cooperatively with businesses, individuals, utilities, and government entities to create measurable improvements in energy and water efficiency in order to benefit the environment and develop a more sustainable economy. The non-profit has been serving the Roaring Fork Valley since 1994.