

GHG Emissions, Forecast, and Wedge Analysis for City of Golden, CO

Prepared by ICLEI USA
October 2021

City of Golden’s Greenhouse Gas Inventory

	Sector/use	Community-wide 2007 urban material/energy flows (MFA)		GHG emissions factors (EF)	Total GHG emitted = MFA x EF (thousand mt-CO ₂ e)	
Scopes 1 & 2 plus waste	Buildings Electricity Use	255 GWh (615 kWh/hh/mo)		0.75 kg CO ₂ e/kWh	192	
	Buildings Natural Gas	16 million therms (62 therms/hh/mo)		5.4 kg-CO ₂ e/therm		87
	Surface Vehicle Miles Traveled (VMT)	187	million VMT		9.1 kg-CO ₂ e/gal Gasoline PTW	95
		Average Fuel Economy = 20.1 mpg (gasoline), 6.3 mpg (diesel) (CDPHE)		10.2 kg-CO ₂ e/gal Diesel PTW		
	Water*	1,285	Million gallons		Varies	3
Municipal Solid Waste	29,027	short tons/yr		0.64 mt-CO ₂ e/short ton (landfill w/flaring)	19	
Scope 3	Airline Travel (PTW)	1,523	Jet Fuel (million gallons)		9.9 kg-CO ₂ e/gal Jet fuel PTW	15
	Fuel Production (WTP)	2	Jet Fuel (million gallons)		2.3 kg-CO ₂ e/gal Jet fuel WTP	27
		1.5	Diesel (million gallons)		2.3 kg-CO ₂ e/gal Diesel WTP	
		8.8	Gasoline (million gallons)		2.3 kg-CO ₂ e/gal Gasoline WTP	
	Cement Use	10.153	Mt-cement		1 mt-CO ₂ e per mt-cement	10
Food Purchases	\$21,207	Million (1997-\$)		1.5 kg-CO ₂ e/\$ (1997 \$)	32	
Total 2007 Community Wide Emissions:				480	thousand mt-CO₂e	
Community wide per-capita emissions:				27.1	mt-CO₂e per capita	

The City of Golden first developed a Greenhouse Gas Inventory in 2010 for the 2007 activity year (Figure 1). The 2007 GHG inventory was conducted using methods developed by Dr. Anu Ramaswami¹. The method used the standardized Local Governments Operations Protocol (LGOP) developed by ICLEI (ICLEI v.1 September 2008) to report GHG emissions from in-boundary (within jurisdictional boundary) activities. That protocol was later updated as the US Community Protocol and provides a protocol for the quantification and reporting of GHG emissions for communities.

Local governments estimate and report on community GHG fluxes using a tool known as a GHG inventory. A GHG inventory estimates the quantity of GHG

emissions and removals associated with community sources and activities taking place during a chosen analysis

¹ A Demand-Centered, Hybrid Life-Cycle Methodology for City-Scale Greenhouse Gas Inventories. VOL. 42, NO. 17, 2008 / ENVIRONMENTAL SCIENCE & TECHNOLOGY

year. By conducting additional inventories, and presenting data over time, local governments can use community GHG inventory reports to provide information on trends in GHG emissions associated with a given community. Local governments may choose to develop a community GHG inventory report for several reasons, including to:

- inform climate action planning
- demonstrate accountability and leadership
- track GHG emissions performance over time
- motivate community action
- recognize GHG emissions performance relative to similar communities
- enable aggregation of GHG emissions data across regions, and
- demonstrate compliance with regulations, voluntary agreements, and market standards (where applicable).

Community GHG inventory reports typically focus on selected GHG emissions occurring within the jurisdictional boundary of the community (e.g., emissions from combustion of natural gas in furnaces throughout the community), as well as certain trans-boundary emission sources associated with community activities (e.g., emissions from electricity generation at a power plant located outside the community associated with electricity use occurring in the community).

GHG emissions are typically categorized according to the related activity or source. While the US Community Protocol uses activity and source to distinguish emissions, the Global Protocol for Community GHG Inventories uses Scope, similar to a corporation or local government operations GHG inventory. Other reporting entities such as the Global Covenant of Mayor uses Direct and Indirect to classify emissions. This memo will use the terms Scop I, II, III.

2019 Annual GHG Emissions

Using the US Community Protocol, 2019 data on sources and activities for Golden were collected and entered into ICLEI's ClearPath online Climate Action Planning Tool. Below is the breakdown of emissions by the sector and the fuel or source. This 2019 version of Golden's GHG Inventory focuses on Scope 1 & 2 emissions as those emissions are most likely to be under the control or influence of Golden. Related to this inventory, Solid Waste and Water/Wastewater are both emissions that occur outside the boundary of Golden but are the result of activity taking place within Golden. The collection and understanding of Scope 3 emissions can be an important community consideration as they represent goods and services that are demanded by the community, but whose emissions are actually Scope 1 & 2 of another community. Tracking Scope 3 emissions in essence allows a community to have an understanding of those emissions without double counting. However, for the purposes of this Inventory and its use to build emissions reduction strategies, ICLEI has provided a 2019 Inventory that contains the primary emitting sectors related to community activities.

Table 2 Breakdown of Emissions by Scope and Sector as defined by the US Community Protocol and GPC.

Scope	Sector	Emissions (MT-CO ₂ e)
Scope 1	Transportation & Mobile Sources	129,263
	Commercial Energy	49,248
	Residential Energy	25,310
	Process & Fugitive Emissions	2,420
	Total	206,241
Scope 2	Commercial Energy	96,151
	Residential Energy	26,142
	Total	122,193
Scope 3	Solid Waste	6,686
	Water & Wastewater	3,587
	Total	10,273

Golden, CO 2019 GHG Emissions (mt-CO₂e)

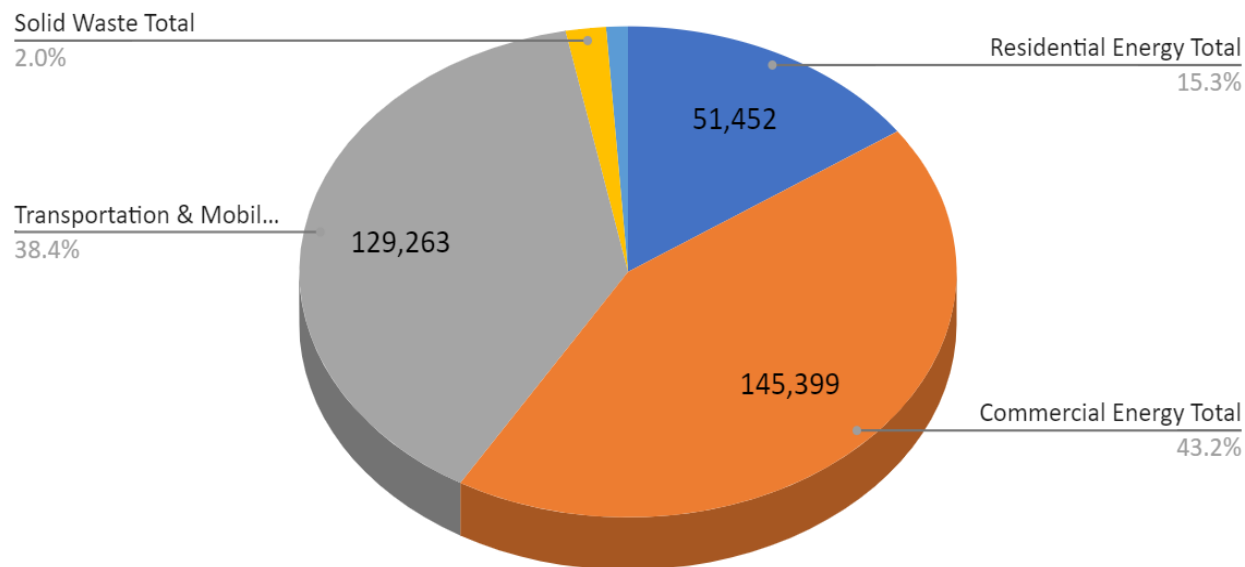


Figure 2 Additional breakdown of emissions based on Sector Only

Table 3 A breakdown of emissions by Sector and fuel source.

Sector	Fuel or Source	Usage	Units	Emissions (MT-CO ₂ e)
Residential Energy	Electricity	50,512,362	kWh	26,142
	LPG*	3,726	MMBtu	237
	Natural Gas	469,320	MMBtu	24,961
	Kerosene*	1,480	MMBtu	112
Residential Energy Total				51,452
Commercial Energy	Electricity†	185,788,054	kWh	96,151
	Natural Gas	925,947	MMBtu	49,248
Commercial Energy Total				145,399
Transportation & Mobile Sources	Diesel	14,143,189	VMT	22,093
	Gasoline	210,742,287	VMT	98,142
	Other (Rail, Off-Road)			9,028
Transportation & Mobile Sources Total				129,263
Solid Waste	Waste Sent to Landfill	19,078	Tons	6,600
	Other			86
Solid Waste Total				6,686
Water & Wastewater	Wastewater Energy			3,314
	Fugitive Emissions			274
Water & Wastewater Total				3,586
Process & Fugitive Emissions Total				2,421
			Total Emissions	338,807

*Estimated emissions based on Census estimates of homes using fuel source and the average MMBtu based on Natural Gas Consumption.

†Includes a small amount of Streetlight Energy Consumption

Stationary Energy

The majority of Golden’s emissions come from stationary commercial/industrial energy (43.2%) and residential (15.3%) energy sectors as evident from the emissions from stationary fuel (natural gas for heating and process energy) and electricity. Data for this sector comes from Xcel Energy’s Community Energy Report². Xcel Energy provides communities in its service territory with annual updates, providing consumption of electricity and

² [Xcel Energy Community Energy Reports](#) Updated September 15, 2021

natural gas by residential and commercial sectors. Xcel Energy also provides a utility specific emissions factor for its Colorado Service Territory. In 2019, the emissions factor reported by Xcel energy was 0.514 metric tons of CO₂/MWh. Xcel does not provide an emissions factor for CH₄ and N₂O, therefore EPA’s eGRID data set for the Rocky Mountain West (WECC Rockies RMPA)³

Table 4 2019 Energy Consumption Data provided by Xcel Energy

Electricity	Number of Customers [5]	Energy Consumption (kWh)	Carbon Emissions (metric tons CO ₂) [6]
Business ⁴	1,671	185,324,233	95,257
Residential	8,271	50,512,362	25,963
Street Lighting - Metered	n/a	9,731	5
Street Lighting - Non-Metered/Customer Owned	n/a	16,095	8
Street Lighting - Non-Metered/Xcel-Owned	n/a	437,995	225
Total:	9,942	236,300,416	121,458
Natural Gas	Number of Customers [5]	Energy Consumption (therms)	Carbon Emissions (metric tons CO ₂) [9]
Business ³	1,205	9,259,472	49,075
Residential	6,065	4,693,198	24,874
Total:	7,270	13,952,670	73,949

During the completion and analysis of Golden’s 2019 GHG Inventory, it was noted that the Community Energy Report provided by Xcel Energy had 1 electricity and 3 Natural Gas accounts were removed from the dataset to meet Regulatory Privacy Requirements. This regulatory requirement is referred to as the “15x15 Rule.” The 15x15 rule is applied to data that is provided by the utility and will remove an entire data set if there are not at least 15 individual records. The utility will also not include any individual data point if it represents more than 15% of the total data set. Attempts to identify commensurate data such as economic or wholesale data were not viable as those datasets also had redacted data due to confidentiality. While unable to confirm, this is likely one customer for all 4 of the removed data points. As a result, these data are not included in the inventory, nor the BAU forecast and emissions reduction analysis.

Transportation

The second-largest contributor to community-wide emissions is transportation (38.4%). Utilizing the Denver Regional Council of Governments⁵ (DRCOG) modelled VMT for Golden (Table 5) and the Colorado Department of Public Health & Environment’s estimate of on-road vehicle mix (Table 6) for Golden, the estimated emissions

³ [EPA Egrid 2019](#) Accessed August 1, 2021.

⁴ To protect individual customer confidentiality, Xcel Energy applies the "15/15 rule" as an aggregation standard to the energy consumption section of this report. So long as a given aggregated value contains 15 or more customers and no single customer makes up 15 percent or more of the aggregated value, the value can be publicized in this report. If these conditions are not met, customers will be removed. The number of customers removed is presented for informational purposes.

⁵ DRCOG uses an Origin-Destination model to calculate DVMT for each jurisdiction within the region

from on road vehicles is 120,235 mt-CO₂e. There were smaller transportation emissions from off-road sources⁶ (EPA 2017 National Emissions Inventory) and the railroad⁷ within Golden of 9,028 mt-CO₂e.

Table 5

	2015 Grand Total Est.	2018 Grand Total Est.	2019 Grand Total Est.
Golden DVMT	677,913	652,784	665,348
Golden VMT (annual)	229,134,543	220,640,894	224,887,725

Table 6

		Passenger	Light	Heavy	Motorcycles
	Gas	41.01%	49.80%	2.33%	0.57%
Percent of all VMT	Diesel	0.04%	0.18%	6.07%	0.00%

Solid Waste

Emissions from waste generated within Golden used waste generation/household counts⁸/ census average persons per household⁹ to develop a baseline of waste generation per person in order to calculate total residential waste generation. Non-residential waste was estimated using Golden Job counts¹⁰, EPA's average waste generation per person per day¹¹ and average workdays to develop an estimate.

Water & Wastewater

Activity data for the Wastewater Sector was provided by Metro Wastewater Reclamation District¹² and the Molson Coors Wastewater Treatment Plant¹³. Fugitive emissions were calculated based on the population served by each Treatment facility. Any combustion of digester gas at the facilities was allocated based on the population of Golden compared to the total population served by each facility.

Fugitive Emissions

Fugitive Emissions were calculated using an estimate of leakage occurring within the Natural Gas Distribution lines within the Boundary of Golden. A leakage rate of 0.3% was applied to the total Natural Gas Consumed. This does not include any leakage from the upstream extraction, and distribution of Natural Gas.

⁶ EPA NEI- Off-road emissions were downscaled from Jefferson County data using on a population-based allocation

⁷ Emissions are specific to Golden and calculated using an Eastern Regional Technical Advisory Committee (ERTAC) confidential dataset.

⁸ [Census Demographic And Housing Estimates](#)

⁹ [Colorado Census QuickFacts](#)- Colorado persons per household was used because it more closely aligned with provided data.

¹⁰ [Census OnTheMap Job Counts](#) - 2018 job counts were used because 2019 data was not available at the time of inventory development

¹¹ [EPA Waste National Overview](#)

¹² Wastewater treatment and energy was downscaled from a MWRD territory dataset using on a population-based allocation. MWRD service population includes accounts from West Pleasant View, as separate data would be negligible.

¹³ Treatment service population was estimated using customer accounts and average persons per household

Data Gaps

Stationary Energy Sectors	Molson Coors energy (due to the 15/15 rule and/or outside boundary of Golden)
Transportation	Attributable aviation emissions from Denver International Airport could not be determined because there were no current datasets
Solid Waste	Provided community-wide waste generation data represented roughly 65% of residential generation and no non-residential generation (estimates were made to represent missing data)

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City of Golden’s Greenhouse Gas Forecast & Planning Scenarios

Business as Usual Forecast

ICLEI utilized the ClearPath Climate Action Planning Tool to develop a Business as Usual (BAU) Forecast for Golden through 2030 and 2050. Using population growth as a driver for additional energy consumption, ICLEI modelled an annual 1% growth in the sectors of residential, commercial, and transportation sectors. This 1% growth was also used to determine growth in sectors that contribute to emissions such as Solid Waste, Water/Wastewater and Fugitive Emissions. In addition, Xcel Energy has received approval for its Colorado Energy Plan which would reduce emissions 80% from 2005 levels by 2030. This carbon intensity of the electricity sector was also modelled as part of the BAU forecast as there was a formal approval of the plan by the Public Utilities Commission.

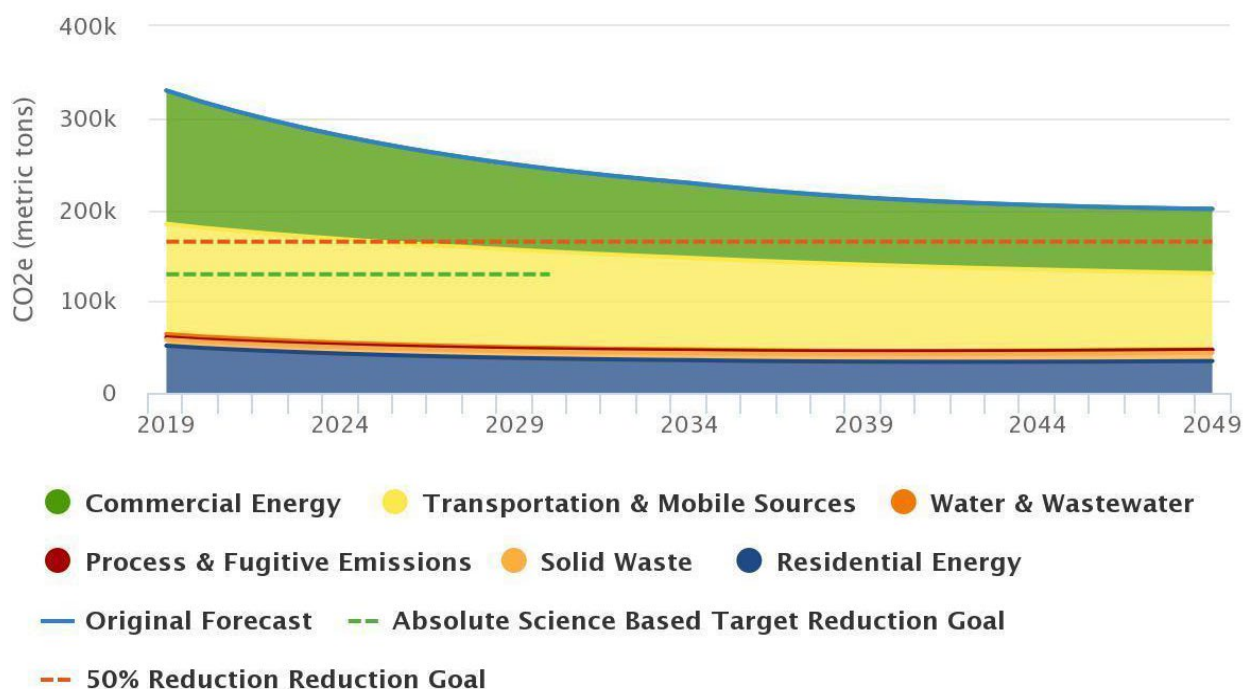


Figure 3 Timescale graph of emissions along with a 50% emissions reduction goal (Red dotted line) and a Science Base Target (Green dotted line) that is in line with the IPCC recommended reductions to stay below 1.5 degrees Celsius.

To better analyze emissions reductions, detailed outputs of each sector by 2030 are presented below. Table 7 shows a BAU forecast with Golden’s existing 2018 IECC Building Code, Xcel Energy’s approved decarbonization plan, on-road vehicle fuel efficiencies from the Federal CAFE standards, and projected BAU Electric Vehicle adoption. Table 8 is the same BAU projection along with an additional modelling of a 100% renewable electricity achievement by the City of Golden.

Table 7 Numerical outputs of a 2030 BAU projection with known electricity decarbonization, existing 2018 IECC building codes, projected on-road fuel efficiencies, flat VMT and BAU Electric Vehicle adoption

2030 Business as Usual						
Assumptions: 2018 IECC Building Code, Xcel Energy Emissions Factor 80% of 2005, No reduction in VMT and BAU EV adoption						
	Commercial Energy	Residential Energy	Transportation & Mobile Sources	Solid Waste	Water & Wastewater	Process & Fugitive Emissions
Emissions (CO₂e [MT])	90,290	37,459	114,981	7,383	1,524	2,701

Table 8 Numerical outputs of a 2030 BAU projection with 100% Renewable Electricity, existing 2018 IECC building codes, projected on-road fuel efficiencies, flat VMT and BAU Electric Vehicle adoption

2030 Business as Usual						
Assumptions: Same as above, plus additional Golden specific renewables to achieve 100%						
	Commercial Energy	Residential Energy	Transportation & Mobile Sources	Solid Waste	Water & Wastewater	Process & Fugitive Emissions
Emissions (CO₂e [MT])	54,945	27,849	114,981	7,383	306	2,701

Even with planned lower carbon electricity from Xcel Energy and realization of 100% Renewable Energy, stationary fuels will remain a large contributor to Golden’s overall emissions footprint. Natural Gas used in the thermal heating of water and spaces will continue to produce CO₂ emissions. Transportation emissions stay relatively flat as growth in VMT is somewhat blunted by fuel efficiency standards in new cars as well as Electric Vehicle sales growth in line with current projections.

Planning Scenarios for Emissions Reductions

In 2019, Golden City Council unanimously passed Resolution 2656 to formally revise Golden's existing sustainability goals and set new targets related to energy, water and waste. Related to this inventory and energy, Golden intends to meet the following Sustainability Goals:

- Renewables. To achieve 100% renewable energy for electricity by 2030 and 100% renewable for heating by 2050. To align Greenhouse Gas Emission reductions with the Paris Accord by 2050.
- Efficiency. To reduce consumption of electricity by 15% by 2030 and reduce consumption of natural gas by 15% by 2030.
- Transportation. To achieve 20% fossil fuel-free transportation sector by 2030 and 100% fossil fuel-free transportation sector by 2050.

This Planning analysis also considers the following strategies that were identified by the Community Sustainability Advisory Board and Golden Sustainability staff:

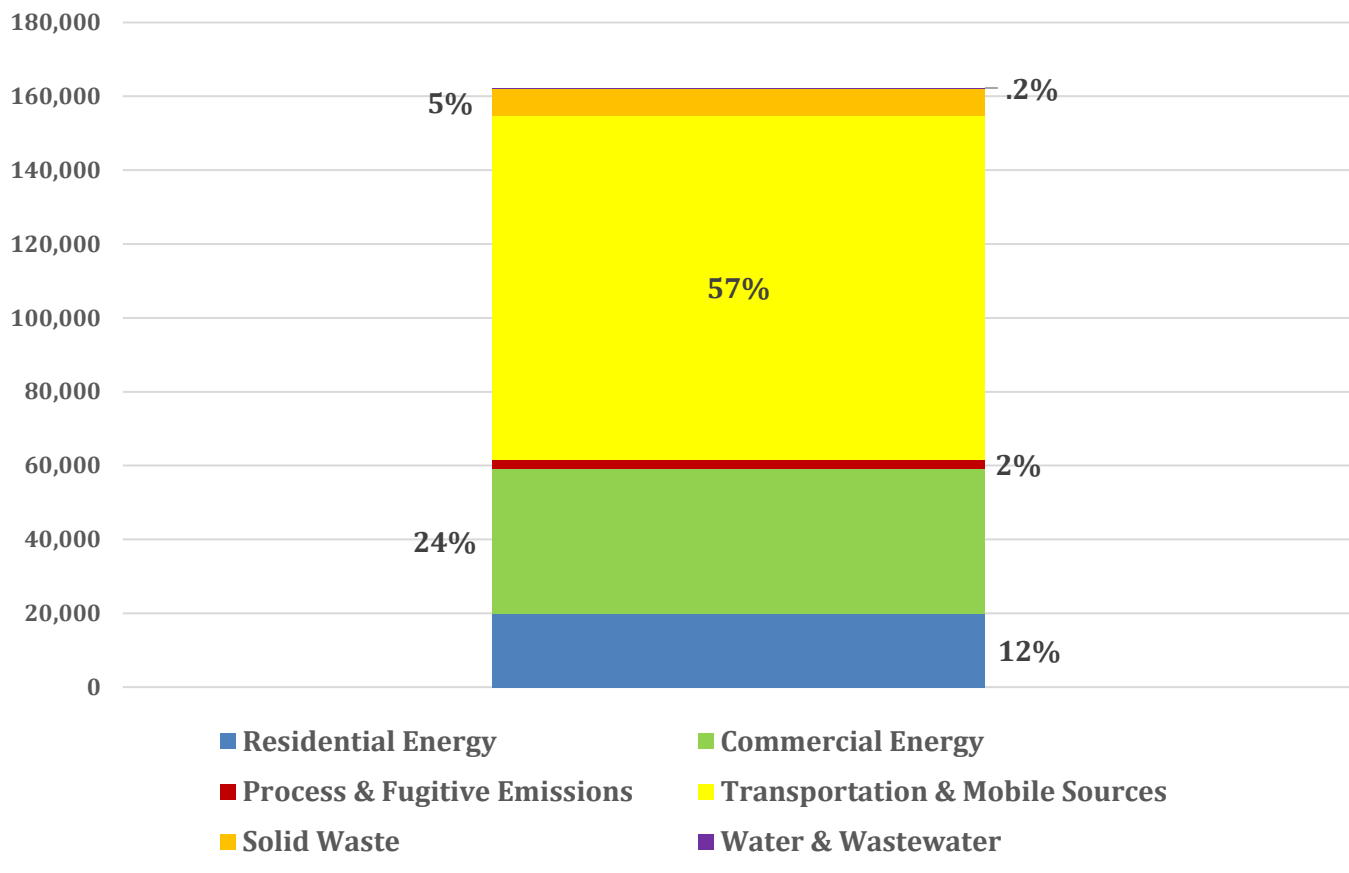
- Large scale community solar project and/or full buildout of distributed generation on existing buildings. (15 MW)
- Electrifying transportation through Electric Vehicle Adoption and expansion and enhancement of RTD's light rail line.
- Net zero buildings.
- Building Electrification
- Building Efficiency

The calculated emissions from the above high level strategies¹⁴ are modelled below and presented by sector. ICLEI ran two separate scenarios of renewable electricity. The first scenario modelled includes a 100% decarbonized grid with the remaining strategies. The second scenario attempts to model a middle ground where Golden continues to pursue renewable options. With Xcel's planned and approved decarbonization plans¹⁵, the remaining gap to achieve 100% Renewable Electricity would need to be met with interconnected solar where the RECs remain with the City of Golden, it's residents, or commercial building owners. Therefore, a 15 MW solar expansion project is modelled on top of Xcel's Colorado Energy Plan. This 15 MW is divided equally between residential and commercial solar. This 15 MW could likely be met with utility scale renewable projects where the RECs are retired on behalf of the subscriber.

¹⁴ During discussion with Golden City Staff and the Community Sustainability Advisory Board, it was determined to not model the 15% reduction in electricity consumption. As buildings and vehicles are increasingly electrified, the added consumption of cleaner electricity would make it virtually impossible to meet that goal.

¹⁵ During the drafting of this report, Xcel Energy announced it would likely reach 85% reduction in Carbon Intensity from its 2005 levels. This analysis still represents the approved plan and anticipated 80% reduction.

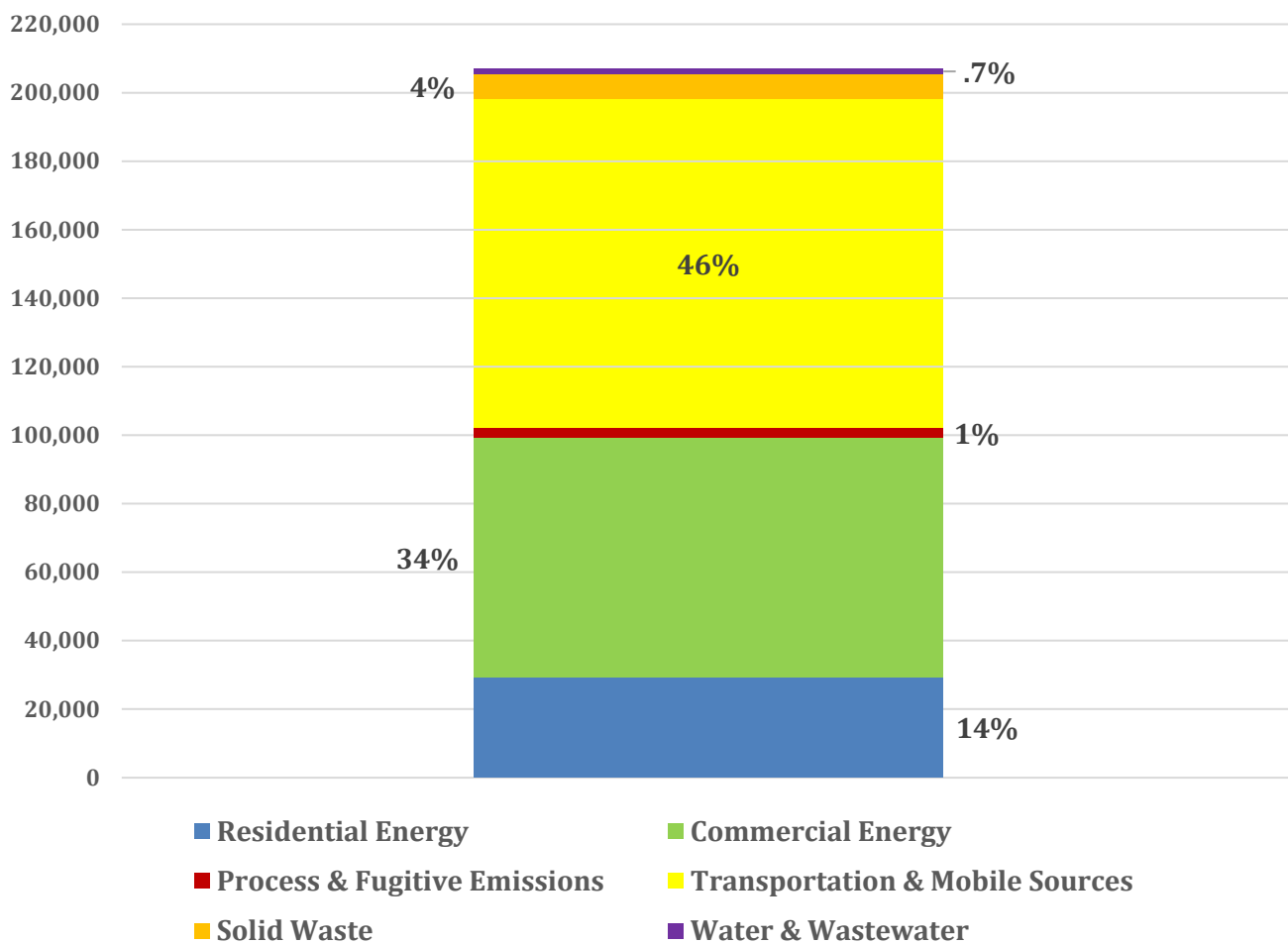
2030 Emissions by Sector (Scenario 1)



2030 Planning Analysis

Commercial Energy (MT CO _{2e})	Residential Energy (MT CO _{2e})	Transportation & Mobile Sources (MT CO _{2e})	Solid Waste (MT CO _{2e})	Water & Wastewater (MT CO _{2e})	Process & Fugitive Emissions (MT CO _{2e})
39,207	19,784	93,039	7,383	306	2,701

2030 Emissions by Sector (Scenario 2)



Commercial Energy (MT CO ₂ e)	Residential Energy (MT CO ₂ e)	Transportation & Mobile Sources (MT CO ₂ e)	Solid Waste (MT CO ₂ e)	Water & Wastewater (MT CO ₂ e)	Process & Fugitive Emissions (MT CO ₂ e)
70,067	29,160	96,151	7,383	1,524	2,701

Scenario 2 is also represented below as a “wedge diagram” where the reductions are depicted as wedges that demonstrate both the relative reduction to each other as well as to the remaining emissions.

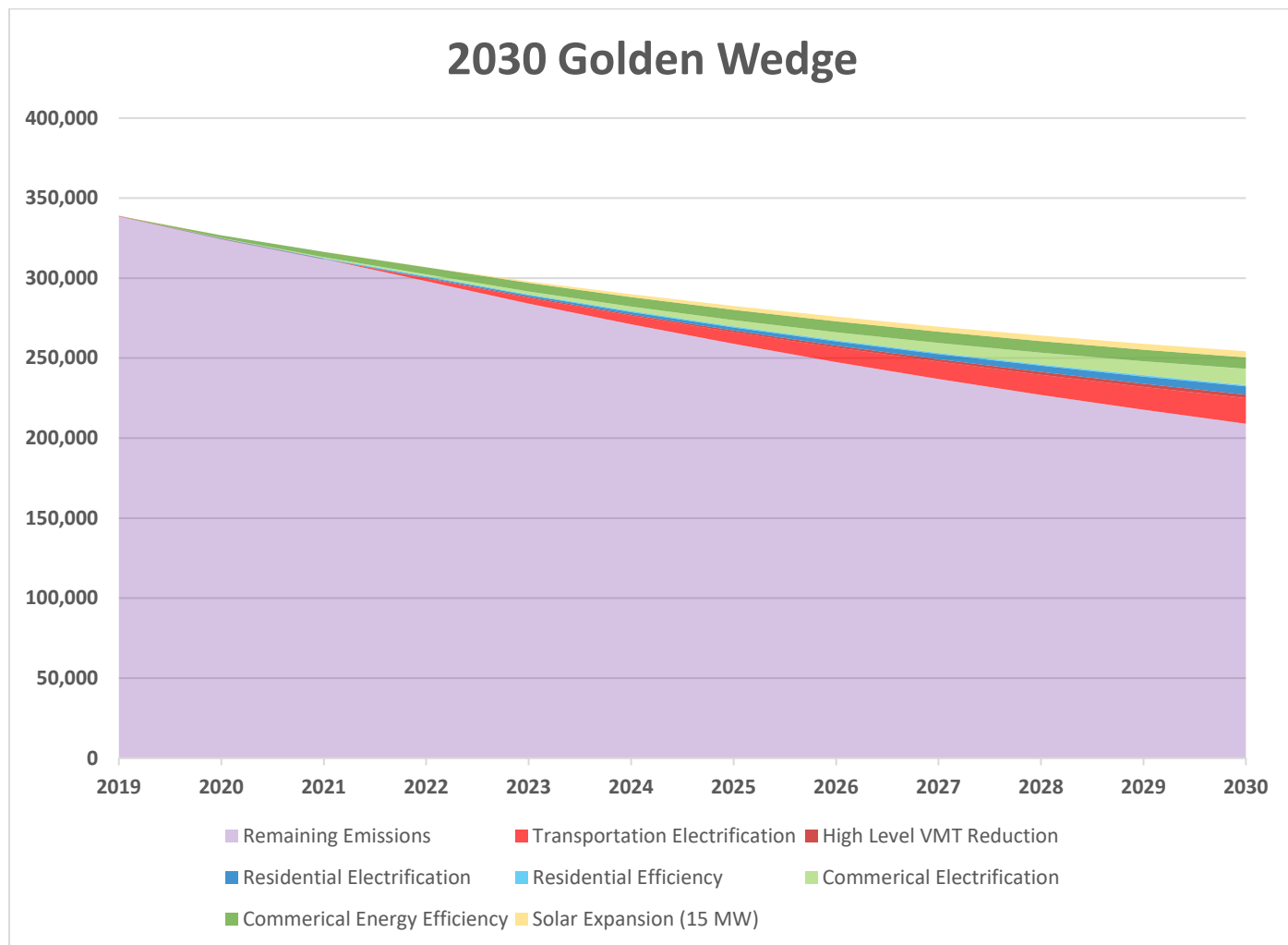
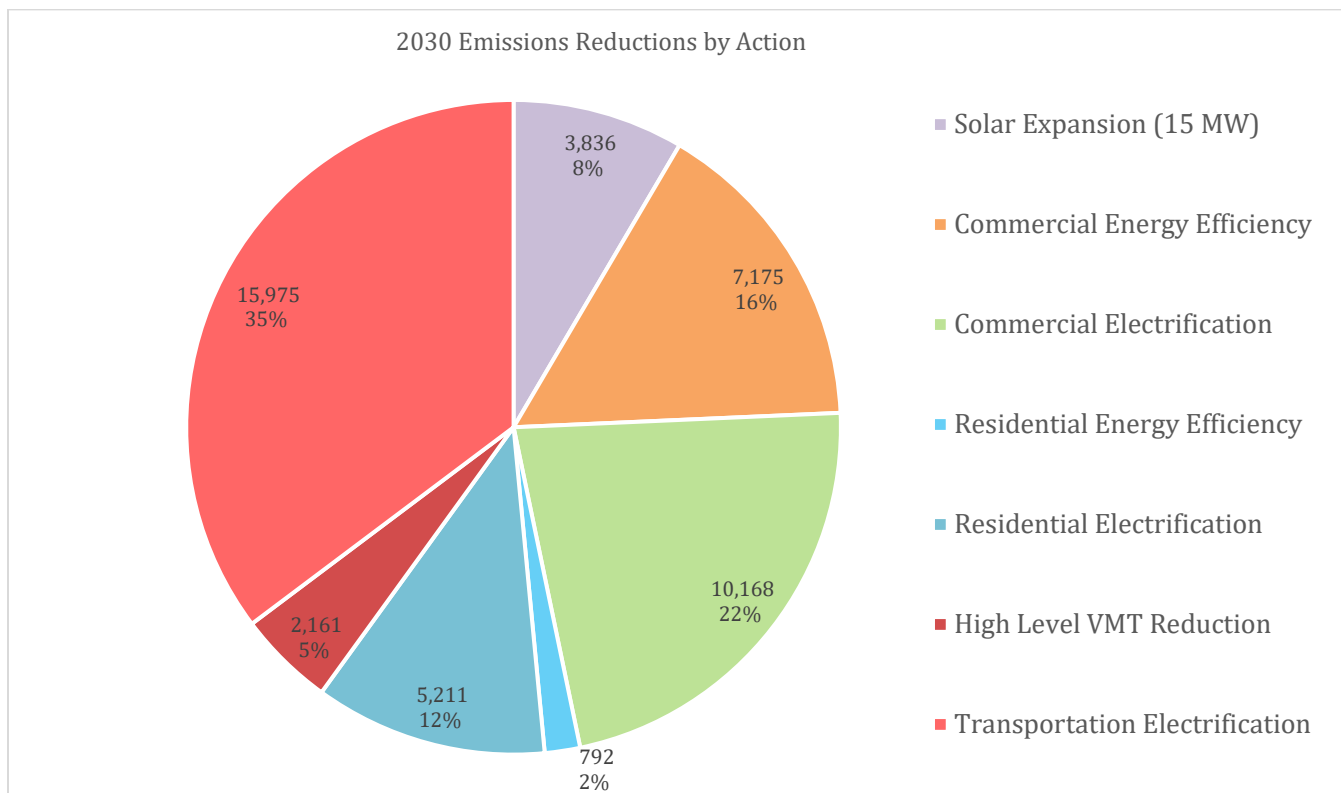


Figure 8 Wedge depiction of emissions reductions with all strategies, Xcel's known decarbonization, and an additional 15 MW of Solar.



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Figure 9 PieChart depiction of emissions reductions in the year 2030 by action, Xcel's known decarbonization, and an additional 15 MW of Solar.

Local Government	Golden, CO2019
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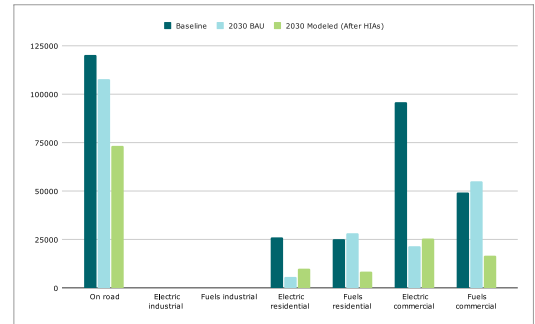
High Impact Action Analysis Summary: Golden, CO



	62.8%	58.5%	316,846	218,117

Growth Rates	Commercial Population Growth	Residential Population Growth	Industrial Population Growth	On-Road Population Growth	Grid Decarbonization Custom Scenario
	11.63%	11.63%	11.63%	11.63%	-80.00%

	Baseline		BAU 2030 Emissions		Modeled Emissions (After HIAs)		
	Baseline Activity	Baseline Emissions (MT CO2e)	2030 BAU Activity	2030 BAU Emissions (MT CO2e)	2030 Modeled Activity	2030 Modeled Emissions (MT CO2e)	Emissions Change
Fuels commercial	925,947	49,248	1,033,614	54,974	314,822	16,744	-66.00%
Electric commercial	185,324,233	95,911	206,873,377	21,413	245,641,105	25,425	-73.49%
Fuels residential	474,526	25,310	529,703	28,253	161,339	8,605	-66.00%
Electric residential	50,512,362	26,142	56,385,842	5,836	97,153,854	10,056	-61.53%
Fuels industrial			0	0	0	0	0.00%
Electric industrial			0	0	0	0	0.00%
On road	224,887,725	120,235	251,037,236	107,641	171,332,914	73,465	-38.90%
Sum of Primary Sectors	-	316,846	-	218,117	-	134,296	-
Inventory Total	-	-	-	-	-	-	-



HIA Overview					
Type	Name	Reduction (Activity)	Net Reduction (MT CO2e)	Description	Explanation/Source
Grid Decarbonization	Custom Scenario	-	108,996.07	80% reduction in grid electricity	Grid decarbonization scenario from user input
High Level Vehicle Miles Traveled Reduction	Custom Input	6,275,931	2,691.02	2.5% Reduction in total Vehicle Miles Traveled	Custom input
On-road Electric Vehicles Adoption	California-BAU (6% Annual Growth)	73,428,391.58	28,824.89	29.3% Reduction in total ICE Vehicle Miles Traveled	https://evadoption.com/ev-sales/ev-sales-forecasts/ This action influences an increase in Residential & Commercial buildings electricity emissions.
Commercial Building Efficiency	IECC New + 5% Existing	38,251,495	3,959	18.5% reduction in Commercial kWh	All new buildings and 1% of existing Square Feet (renovations and turnover) will meet IECC 2018 (36.95% reduction in building EUI) & 5% Existing Square Feet (renovations and turnover) EUI is reduced by 20%. https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-28125.pdf https://www.eia.gov/consumption/commercial/data/2012/c8e/pdf/e2.pdf
Residential Building Efficiency	IECC New + 10% Existing	16,628,350	1,721	29.5% reduction in Residential kWh	All new buildings and 1% of existing Square Feet (renovations and turnover) will meet IECC 2018 (36.95% reduction in building EUI) & 10% Existing Square Feet (renovations and turnover) EUI is reduced by 20%. https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-28125.pdf https://www.eia.gov/consumption/commercial/data/2012/c8e/pdf/e2.pdf
Commercial Building Electrification	New + 6% EB Electrified	718,792	30,790	69.5% reduction in Commercial MMBtu	All new buildings & 6% Existing Square Feet per year are electrified Based on a combination of other scenarios: 1. All new buildings & 1% Existing Square Feet per year are electrified- Based on % of building stock experiencing major retrofit or replacement each year. https://www.schroders.com/en/syglobalassets/digital/real-estate-de/publications/2--pages-from-property-chronicle-q6_online-2.pdf 2. 5% of existing Square Feet per year is electrified- "Because heating systems are replaced at a minimum of 10 years (assumption), this scenario represents half replacement with all electric heating systems." https://www.energystar.gov/campaign/heating_cooling/replace
Residential Building Electrification	New + 6% EB Electrified	368,364	15,835	69.5% reduction in Residential MMBtu	All new buildings & 6% Existing Square Feet per year are electrified Based on a combination of other scenarios: 1. All new buildings & 1% Existing Square Feet per year are electrified- Based on % of building stock experiencing major retrofit or replacement each year. https://www.schroders.com/en/syglobalassets/digital/real-estate-de/publications/2--pages-from-property-chronicle-q6_online-2.pdf

2030 Outlook	2030 HIA Modeled Emissions	Reduction Achieved (Absolute)	Percent To Go (Absolute)	2030 Modeled Emissions (Per Capita)	Reduction Achieved (Per Capita)	Percent To Go (Per Capita)
		134,296	57.6%	0.9%	5.81	62.0%



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Appendix A
Community Strategy Analysis & Recommendations
Golden, CO

Community-wide Analysis

Golden’s Science-Based Targets

Science-based targets (SBTs) are the GHG reductions needed to keep the earth below a 1.5 C increase in temperature, as outlined in the Paris Climate Accords. SBTs allow cities, towns and counties (as well businesses, universities and others) to account for their share of the amount of GHG reduction needed to limit that global temperature increase to 1.5 C. It requires both a long-term (2050) requirement to reach zero emissions, and an interim (2030) reduction target. ICLEI has adopted the SBT methodology for cities and local governments that was developed by World Wild Fund’s One Planet City Challenge in partnership with city networks. This methodology effectively requires an average of 50% per capita reduction from all entities by 2030 That 50% is then weighted by a country’s Human Development Index (HDI) so that each country can do it’s “fair share” based on their respective level of wealth and development. For the U.S., which has an HDI that is ranked 17th globally, this translates to a 2030 per capita reduction target of between 62.8% - 63.4%, depending on the inventory year that is used as a baseline. This will result in absolute reduction targets generally ranging from 45% - 64%, depending on a given region's anticipated growth between now and 2030. In the next 9 years, to achieve its fair share toward reducing global emissions by 50%,Golden would need to reduce its greenhouse gas (GHG) emissions by the below percentages.

Table A1 Golden’s Science Based Targets as calculated using the One Planet City Challenge methodology. This same methodology has been applied to other Front Range and Colorado communities that have committed to a Science Based Target.

	62.8%	58.5%

Emissions Forecast

Golden emissions were projected using the following variables:

- Golden population growth based on historic growth of the last decade¹
- On-road transportation fuel efficiency standards (CAFE Standards)

	2010 CAFE	Model Year 2025 Obama standard	Model Year 2025 Trump standard	Model Year 2025 Biden Standard
MPG	27.5	46.7	40.4	53.4
gallons/mile	0.0364	0.0214	0.0248	0.0187
% Decrease gallons/mile since 2010		-41.1%	-31.9%	-48.6%

¹ [Census Quick Facts](#)

Fuel efficiency standards are used to project the reduction of emissions intensity for each mile driven by on-road vehicles. Fuel efficiency standards decrease emissions due to federally mandated improvements in vehicle fuel economy. ICLEI developed variables from fuel efficiency projections provided by the Center for Climate and Energy Solutions² (C2ES). While there has been a flurry of litigation around the past 3 administrations’ standards, we have utilized the most recent administrations proposed changes. Colorado has also enacted a Clean Car Standard, with those not coming into effect until 2023 and 2025.

- *Electricity Sector Decarbonization*³

Xcel Energy has received PUC approval to move forward with a plan to reduce emissions 80% from 2005 levels by 2030, with additional reductions to reach carbon neutrality by 2050. While these reductions will come in large chunks at one time, we modelled a steady progression towards 2030 and 2050 goals. Based on Xcel's 2005 emissions intensity of 1,849 lbs/MWh and an 80% reduction by 2030 would equal 369.8 lbs/MWh.

Golden’s 2019 emissions were estimated at XXX Metric Tons Carbon Dioxide Equivalent (CO₂e). Based on the above growth rate and emissions intensity factors, 20XX emissions are projected to be XXX Metric Tons CO₂e. The following table displays 2019 baseline and 20XX projected activity and emissions.

	Baseline 2019		BAU 2030	
	Baseline Activity	Baseline Emissions (MT CO ₂ e)	2030 BAU Activity	2030 BAU Emissions (MT CO ₂ e)
Commercial Fuels	925947 MMBtu	49,248	1,033,050 MMBtu	54,944
Commercial Electric	185,788,054 kWh	96,151	207,277,869 kWh	35,346
Residential Fuels	474,526 MMBtu	25,310	523,605 MMBtu	27,849
Residential Electric	50,512,362 kWh	26,142	56,355,034 kWh	9,610
On Road	224,885,476 VMT	120,235	250897,607 VMT	105,025

Strategy Overview

ICLEI analyzed Golden’s GHG inventory and forecasted emissions through 2030. ICLEI also reviewed Golden City Council Resolution 2656 sustainability goals and targets related to energy, water and waste. Related to this inventory and energy, Golden intends to meet the following Sustainability Goals:

- Renewables. To achieve 100% renewable energy for electricity by 2030 and 100% renewable for heating by 2050. To align Greenhouse Gas Emission reductions with the Paris Accord by 2050.
- Efficiency. To reduce consumption of electricity by 15% by 2030 and reduce consumption of natural gas by 15% by 2030.

² [Center for Climate and Energy Solutions](#)

³ [Xcel Our Energy Future Colorado](#)

- Transportation. To achieve 20% fossil fuel-free transportation sector by 2030 and 100% fossil fuel-free transportation sector by 2050.

This Forecast and Planning analysis also considers the following strategies that were identified by the Community Sustainability Advisory Board and Golden Sustainability staff:

- Large scale community solar project and/or full buildout of distributed generation on existing buildings. (15 MW)
- Electrifying transportation through Electric Vehicle Adoption and expansion and enhancement of RTD's light rail line.
- Net zero buildings.
- Building Electrification
- Building Efficiency

Community-wide Impact Analysis

Stationary Energy

ICLEI suggests improving energy efficiency of all building types through a series of strategies. Energy Audits, specifically ASHRAE Level II mandatory audits for properties larger than 25,000 ft², help buildings identify EE opportunities and benchmark improvements. Buildings larger than 25,000 ft² can also benefit retro-commissioning and lighting upgrade requirements. For the residential sector, weatherization is beneficial in reducing emissions, especially in cold climates.

In conjunction with energy efficiency improvements, it is helpful to establish energy benchmarking and disclosure programs. Benchmarking programs at the local level are an affordable means to help measure and compare energy performance, provide transparency, and maintain accountability. Retrofit programs will help address residential and commercial energy efficiency.

Improving, requiring, and enforcing energy codes for new and existing buildings is the best way to ensure that building owners are taking sufficient steps toward reducing emissions. Understanding that Golden has adopted 2018 IECC building codes, ICLEI still suggests advocating for updated building codes to match the most recent IECC Codes, with the 2021 code providing additional efficiency improvements over the 2018 code. Process improvements to the review and adoption of energy codes may help promote incorporating the energy efficiency benefits of updated codes. This assumes that all new buildings are subject to the most recent IECC upgrades and buildings with substantial renovations trigger IECC upgrades. It is also necessary to provide education while enforcing code compliance.

To model potential impacts in the Stationary Energy Sector, ICLEI applied the following assumptions:

- 2018 IECC Building Code applied to 1% annual growth plus 1% annual turnover of residential building stock and 5% turnover of commercial building stock, with 20% residential energy savings, 20% commercial, compared to BAU

Related to Golden's specified goal of reducing electricity consumption 15% by 2030, we were not able to realistically achieve that goal with the shift of building/home heating and electric vehicles over to electricity.

Transportation

Implementing a city-wide EV strategy is a critical step in reducing emissions, as well as sparking EV adoption. An EV strategy often consists of providing EV incentives to promote adoption, expanding EV charging infrastructure to support adoption, converting transit fleets and municipal fleets, and establishing EV charging building ordinances.

While it's imperative to convert on-road vehicles to cleaner fuel sources such as electricity, it's equally important to reduce personal vehicle use. Personal vehicle discouragement takes many forms, but some strategies are more appropriate for a community like Golden. Adjusting parking minimums/establishing maximum parking standards for new construction reduces investment in parking, which encourages more efficient transportation.

Personal vehicle use is common for many cities, but as local economies struggle, deterring people from using their vehicles can produce inverse economic impacts. However, this issue can be resolved by providing robust transportation alternatives. Having abundant and efficient public transportation is essential and can be accomplished by working with RTD. It is also imperative to pursue transit-oriented redevelopment. TOD encourages the construction of transit hubs and housing development around transit hubs, which not only promotes public transit use but reduces personal vehicle emissions as residents have improved access to public transit.

Along with public transit, promoting alternative mode shifts by establishing pedestrian zones in high pedestrian-traffic areas, increasing bike-share programs, and improving cycling access is extremely valuable for small communities like Golden. When this alternative transportation is available, cycle and walk to work days are entertaining ways to promote further mode shifts.

To model the potential impacts in the Transportation Sector ICLEI utilized the following assumptions:

- 2.5% reduction in Internal Combustion Engine VMT (assumed to be replaced by RTD light rail)
- 20% reduction in fuel per mile in 2030 for light duty vehicles⁴
- 21.96% of new light duty vehicles electric in 2030

Electricity Generation

With Xcel Energy announcing its Colorado Energy Plan, the utility has developed a resource plan to reduce emissions 80%, based on Xcel's 2005 emissions intensity of 1,849 lbs/MWh - an 80% reduction by 2030 would equal 369.8 lbs/MWh. ICLEI utilized this projected emissions factor and a linear reduction from 2019 – 2030. In addition, a separate analysis was conducted that modelled additional distributed renewable and utility scale renewables that would in effect provide 100% renewable energy in line with the community & CSAB goals.

⁴ Based on Biden Administration's proposed CAFE updates

Summary and Conclusions

Electricity Sector

There are existing plans for Xcel Energy to vastly decarbonize its electricity generation by 2030 and beyond. The majority of these actions fall under what is considered “System Renewables.” These include energy and Renewable Energy Credits that are owned or retired by Xcel Energy. Other opportunities for RECs that are owned or retired on behalf of individual communities such as Xcel’s Renewable Connect and Distributed Solar programs would need to be where the remaining renewables are generated to achieve what would be considered a 100% renewable source of electricity, as far as a GHG inventory is concerned. This would be considered an extraordinary lift to achieve in less than 9 years and may in effect pull resources away from other sectors that still need to see significant mitigation efforts like building electrification and EV infrastructure. ICLEI’s model of an additional 15 MW of solar that is specific to Golden, i.e. the RECS remain or are retired with the subscriber in Golden.

Stationary Energy

With the known emissions reductions in the electricity generating sector, energy efficiency, while still a needed strategy to reduce consumption and save money for customers, will have a diminishing impact on GHG emissions. This is not to say that energy efficiency should become a lesser option, but rather it highlights the need to reduce emissions from the thermal heating sector of buildings. Building electrification of new buildings and a plan to electrify existing buildings would be critical to mitigating the remaining emissions from the Stationary Building Sector.

Transportation

Again, drawing on the decarbonization of the electrical grid, the transportation sector has the potential to greatly reduce emissions through the transfer of Internal Combustion Engines over to Electric Vehicles. This strategy will see increasing returns as the grid becomes cleaner past 2030. With US sales of Electric Vehicles projected to continue to grow and the State of Colorado’s Electric Vehicle Plans, Golden could reduce emissions from the on-road transportation sector with detailed plans for EV adoption and infrastructure support within the Community.

Overall Conclusions

Of the remaining emissions in Golden’s projected 2030 emissions and the reduction from the modelled scenarios, the majority of emissions are the result of natural gas combustion in buildings and fossil fuel Internal Combustion Engines. ICLEI has presented below a final model of the level of ambition that would be needed for Golden to meet a Science Based Target. This additional scenario is not meant to prescribe the exact methodology for achieving a Science Based Target, but rather presents the direction and speed of action needed to achieve a Science Based Target.

In order to best measure progress towards a Science Based Target or any target, Golden would benefit from a more regular update of its emissions inventory. With the 2019 Inventory, BAU projections and emissions reductions strategies now modelled in ClearPath, Golden can utilize readily available data in key sectors of Buildings and Transportation to maintain an updated inventory and monitoring program.

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