



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

2019 Community Strategy  
Analysis

**April, 2022**

Produced by ICLEI - Local Governments for Sustainability USA



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

The City of Golden first developed a Greenhouse Gas (GHG) Inventory in 2010 for the 2007 activity year (Figure 1). The 2007 GHG inventory was conducted using methods developed by Dr. Anu Ramaswami. 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 quantifying and reporting GHG emissions for communities.

Figure 1 The City of Golden first developed a Greenhouse Gas Inventory in 2010 for the 2007 activity year.

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 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 use Direct and Indirect to classify emissions. This memo will use the terms Scope 1, 2, and 3.

## 2019 Annual GHG Emissions

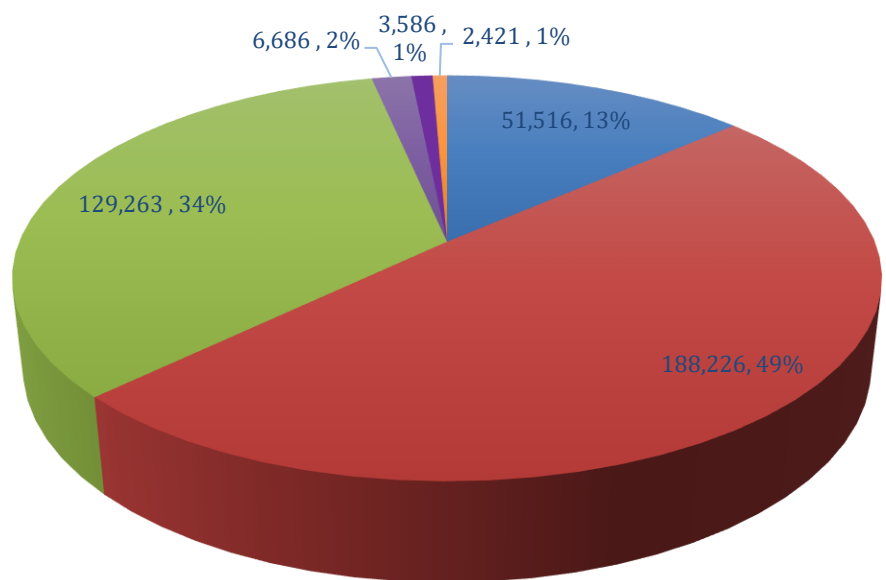
Using the US Community Protocol, 2019 data on sources and activities for Golden were collected and entered into ICLEI's ClearPath online Climate Action Planning Tool. Below is the breakdown of emissions by the sector and the fuel or source (Table 1 and Figure 2). This 2019 version of Golden's GHG Inventory 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 1 Breakdown of Emissions by Scope and Sector as defined by the US Community Protocol and GPC.

Scope	Sector	Emissions (MT-CO <sub>2</sub> e)
Scope 1	Transportation & Mobile Sources	129,262
	Commercial Energy	69,855
	Residential Energy	25,342
	Process & Fugitive Emissions	2,420
	<b>Total</b>	<b>226,879</b>
Scope 2	Commercial Energy	118,369
	Residential Energy	26,172
	<b>Total</b>	<b>144,541</b>
Scope 3	Solid Waste	6,686
	Water & Wastewater	3,587
	<b>Total</b>	<b>10,273</b>

### Golden 2019 GHG Emissions (mtCO<sub>2</sub>e)



- Residential Energy Total
- Commercial Energy Total
- Transportation & Mobile Sources Total
- Solid Waste Total
- Water & Wastewater Total
- Process & Fugitive Emissions Total

Figure 2 Additional breakdown of emissions based on Sector Only.



Table 2 A breakdown of emissions by Sector and fuel source.

Sector	Fuel or Source	Usage	Units	Emissions (CO <sub>2</sub> e)
Residential Energy	Electricity	50,572,914	kWh	26,173
	LPG*	3726	MMBtu	237
	Natural Gas	4,699,255	Therms	24,994
	Kerosene*	1480	MMBtu	112
<b>Residential Energy Total</b>				<b>51,516</b>
Commercial Energy	Electricity†	228,720,987	kWh	118,370
	Natural Gas	13,134,090	Therms	69,856
<b>Commercial Energy Total</b>				<b>188,226</b>
Transportation & Mobile Sources	Diesel	14143189	VMT	22,093
	Gasoline	210742287	VMT	98,142
	Other			9,028
<b>Transportation &amp; Mobile Sources Total</b>				<b>129,263</b>
Solid Waste	Waste Sent to Landfill	19078	Tons	6,600
	Other			86
<b>Solid Waste Total</b>				<b>6,686</b>
Water & Wastewater	Wastewater Energy			3,314
	Fugitive Emissions			274
<b>Water &amp; Wastewater Total</b>				<b>3,586</b>
<b>Process &amp; Fugitive Emissions Total</b>				<b>2,421</b>

\*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

**Total Emissions 381,698**

## Stationary Energy

The majority of Golden's emissions come from stationary commercial/industrial energy (49.3%) and residential (13.5 %) 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 Report<sup>1</sup>. Xcel Energy provides communities in its service territory with annual updates, providing consumption of electricity and 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 CO<sub>2</sub>/MWh. Xcel does not provide an emissions factor for CH<sub>4</sub> and N<sub>2</sub>O, therefore EPA's eGRID data set for the Rocky Mountain West (WECC Rockies RMPA)<sup>2</sup>

<sup>1</sup> Xcel Energy Community Energy Reports Updated September 15, 2021

<sup>2</sup> [EPA Egrid 2019](#) Accessed August 1, 2021.





Table 3 2019 Energy Consumption Data provided by Xcel Energy.

Electricity	Number of Customers [5]	Energy Consumption (kWh)	Carbon Emissions (metric tons CO2) [6]
Business <sup>3</sup>	1,653	228,257,166	117,324
Residential	8,317	50,572,914	25,994
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
<b>Total:</b>	9,970	279,293,901	143,557
Natural Gas	Number of Customers [5]	Energy Consumption (therms)	Carbon Emissions (metric tons CO2) [9]
Business <sup>3</sup>	1,202	13,134,090	69,611
Residential	6,071	4,699,255	24,906
<b>Total:</b>	7,273	17,833,345	94,517

Subsequent to the completion and analysis of Golden's 2019 GHG Inventory, an updated Community Energy Report was provided by Xcel Energy. In an effort to provide a more complete inventory and analysis, 1 entity that was excluded from the original dataset provided permission to have their data included in the updated Community Energy Report. However, there are still 2 Natural Gas accounts 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. As a result, these data are not included in the inventory, nor the BAU forecast and emissions reduction analysis. It should also be noted that Xcel's update Community Energy Report also include changes to total customers and residential consumption. These data were also updated subsequent to the initial analysis.

Data for this sector comes from Xcel Energy's Community Energy Report<sup>4</sup>. Xcel Energy provides communities in its service territory with annual updates, providing consumption of electricity and 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 CH<sub>4</sub> and N<sub>2</sub>O, therefore EPA's eGRID data set for the Rocky Mountain West (WECC Rockies RMPA)<sup>5</sup>

<sup>3</sup> 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.

<sup>4</sup> [Xcel Energy Community Energy Reports](#) Updated March 2022

<sup>5</sup> [EPA Egrid 2019](#) Accessed August 1, 2021.



## Transportation

The second-largest contributor to community-wide emissions is transportation (33.8%). Utilizing the Denver Regional Council of Governments<sup>6</sup> (DRCOG) modeled VMT for Golden (Table 5) and the Colorado Department of Public Health & Environment estimate of on-road vehicle mix (Table 6) for Golden, the estimated emissions from on road vehicles are 120,235 mt-CO<sub>2</sub>e. There were smaller transportation emissions from off-road sources<sup>7</sup> (EPA 2017 National Emissions Inventory) and the railroad<sup>8</sup> within Golden of 9,028 mt-CO<sub>2</sub>e.

Table 5 VMT Breakdown.

	677,913	652,784	665,348
	229,134,543	220,640,894	224,887,725

Table 6 Fleet Mix.

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

## Solid Waste

Emissions from waste generated within Golden used waste generation/household counts<sup>9</sup>/ census average persons per household<sup>10</sup> 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 counts<sup>11</sup>, EPA's average waste generation per person per day<sup>12</sup> and average workdays to develop an estimate.

## Water & Wastewater

Activity data for the Wastewater Sector was provided by Metro Wastewater Reclamation District<sup>13</sup> and the Molson Coors Wastewater Treatment Plant<sup>14</sup>. Fugitive emissions were calculated based on the

<sup>6</sup> DRCOG uses an Origin-Destination model to calculate DVMT for each jurisdiction within the region

<sup>7</sup> [EPA NEI](#)- Off-road emissions were downscaled from Jefferson County data using on a population-based allocation

<sup>8</sup> Emissions are specific to Golden and calculated using an Eastern Regional Technical Advisory Committee (ERTAC) confidential dataset.

<sup>9</sup> [Census Demographic And Housing Estimates](#)

<sup>10</sup> [Colorado Census QuickFacts](#)- Colorado persons per household was used because it more closely aligned with provided data.

<sup>11</sup> [Census OnTheMap Job Counts](#) - 2018 job counts were used because 2019 data was not available at the time of inventory development

<sup>12</sup> [EPA Waste National Overview](#)

<sup>13</sup> Wastewater treatment and energy was downscaled from a MWRD territory dataset using a population-based allocation. MWRD service population includes accounts from West Pleasant View, as separate data would be negligible.

<sup>14</sup> Treatment service population was estimated using customer accounts and average persons per household





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.



## Data Gaps

Table 7 Inventory Data Gaps

Stationary Energy Sectors	2 Large Natural Gas Commercial Customers (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).

# 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 modeled 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 by 80% from 2005 levels by 2030. This carbon intensity of the electricity sector was also modeled as part of the BAU forecast as there was a formal approval of the plan by the Public Utilities Commission.

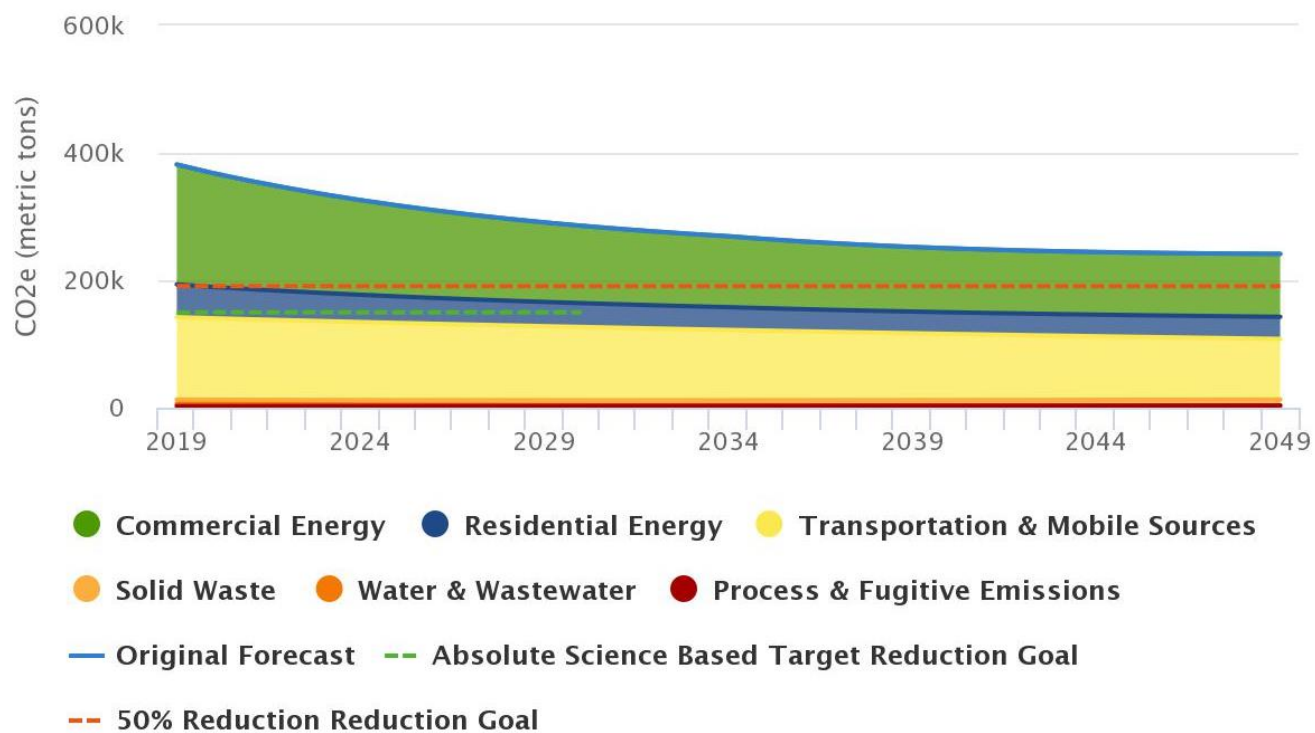


Figure 3 Timescale graph of emissions along with a 50% emissions reduction goal (Red dotted line) and a Science Base Target (Green dotted line) that is in line with the IPCC recommended reductions to stay below 1.5 degrees Celsius.



To better analyze emissions reductions, detailed outputs of each sector by 2030 are presented below. Table 8 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 9 is the same BAU projection along with additional modeling of a 100% renewable electricity achievement by the City of Golden.

*Table 8 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 (CO <sub>2</sub> e [MT])	121,450	37,506	114,981	7,383	1,524	2,701

*Table 9 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 (CO <sub>2</sub> e [MT])	77,937	27,885	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 CO<sub>2</sub> 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 Emissions 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 strategies<sup>15</sup> are modeled below and presented by sector. ICLEI ran two separate scenarios of renewable electricity. The first scenario modeled 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 plans<sup>16</sup>, 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, its residents, or commercial building owners. Therefore, a 15 MW solar expansion project is modeled 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.

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<sup>15</sup> 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.

<sup>16</sup> During the drafting of this report, Xcel Energy announced it would likely reach an 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)

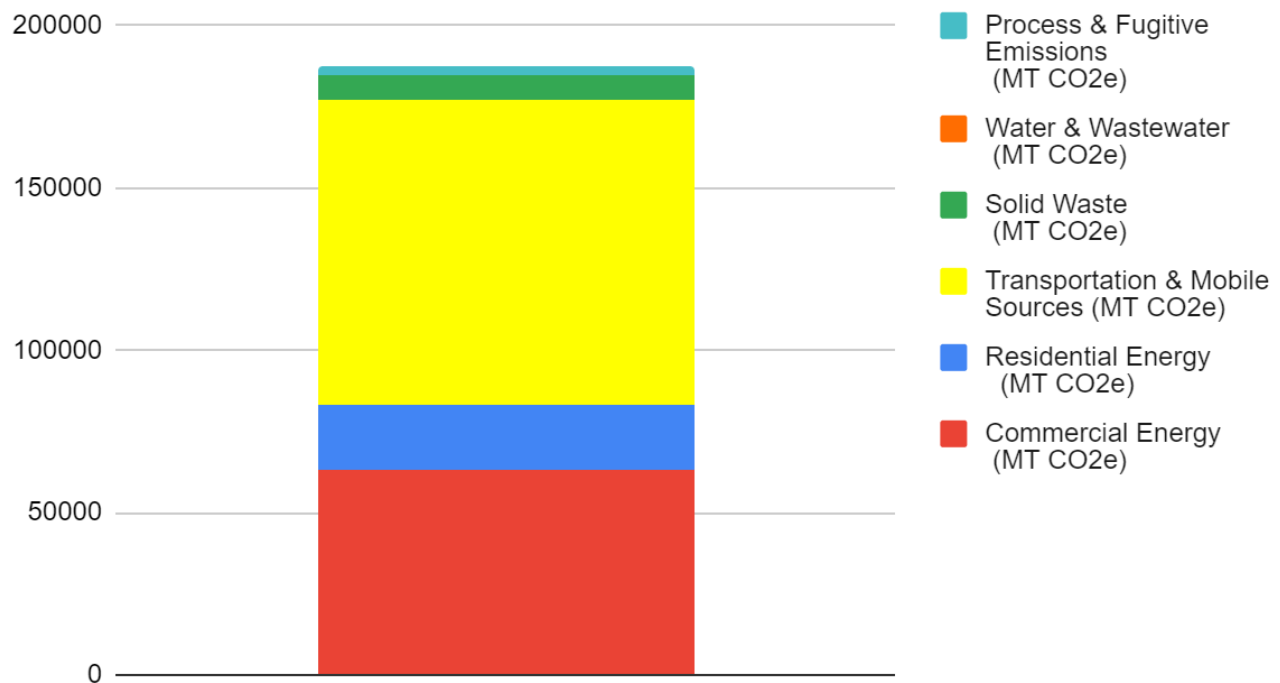


Figure 4 Projected 2030 emissions by sector (Scenario 1).

Table 10 Projected 2030 emissions by sector (Scenario 1).

2030 Emissions by Sector (Scenario 1)					
Commercial Energy (MT CO <sub>2</sub> e)	Residential Energy (MT CO <sub>2</sub> e)	Transportation & Mobile Sources (MT CO <sub>2</sub> e)	Solid Waste (MT CO <sub>2</sub> e)	Water & Wastewater (MT CO <sub>2</sub> e)	Process & Fugitive Emissions (MT CO <sub>2</sub> e)
62,970	20,215	93,909	7,383	306	2,701





## 2030 Emissions By Sector (Scenario 2)

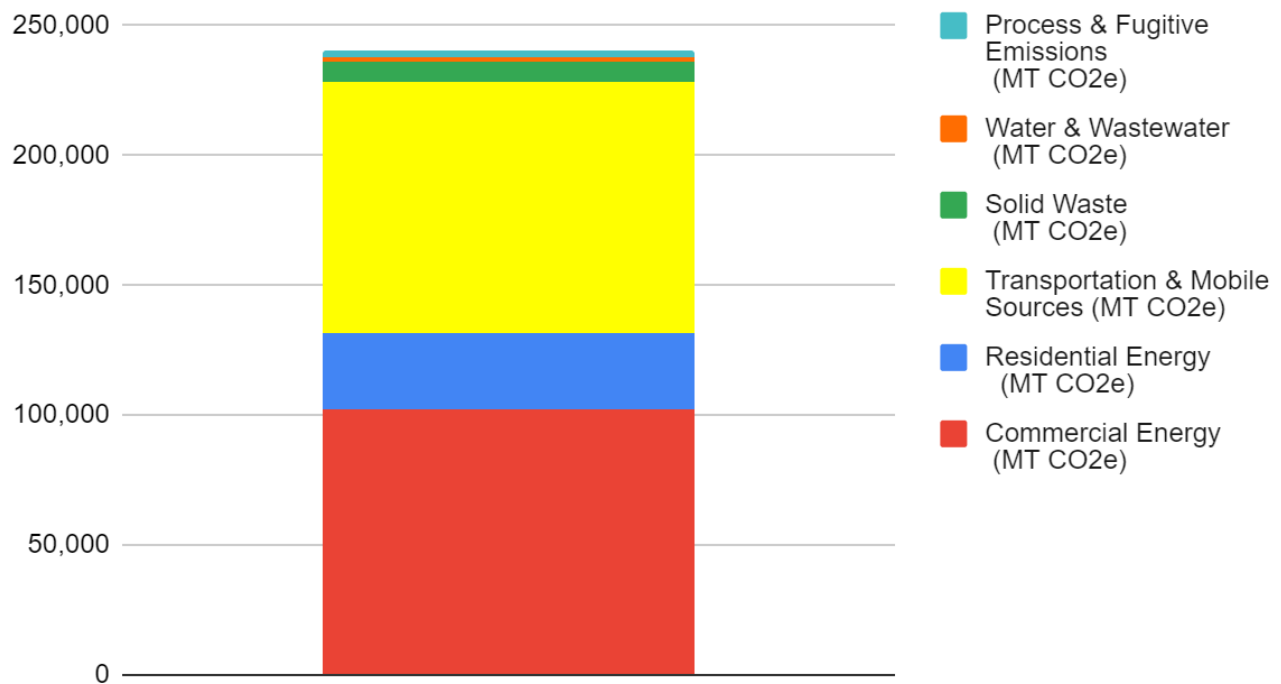


Figure 5 Projected 2030 emissions by sector (Scenario 2).

Table 11 Projected 2030 emissions by sector (Scenario 2).

2030 Emissions by Sector (Scenario 2)					
Commercial Energy (MT CO <sub>2</sub> e)	Residential Energy (MT CO <sub>2</sub> e)	Transportation & Mobile Sources (MT CO <sub>2</sub> e)	Solid Waste (MT CO <sub>2</sub> e)	Water & Wastewater (MT CO <sub>2</sub> e)	Process & Fugitive Emissions (MT CO <sub>2</sub> e)
102,189	29,532	96,892	7,383	1,524	2,701



(In Production)

Figure 6 Wedge depiction of emissions reductions with all strategies, Xcel's known decarbonization, and an additional 15 MW of Solar.

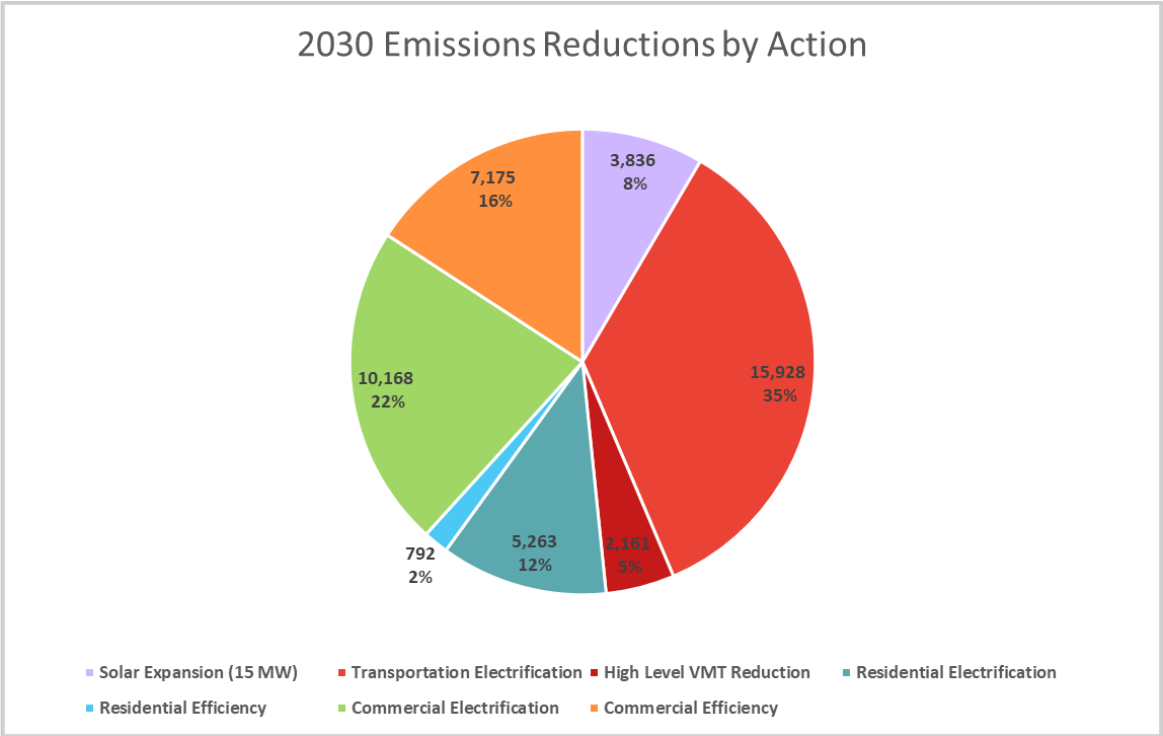


Figure 7 Depiction of emissions reductions in the year 2030 by action (Scenario 2).

## Modeling Results

Table 12 Scenario Modeling Results.

Scenario Results			
	2030 Business-As-Usual Emissions	2030 Emissions (After actions)	Percent Reduction
Scenario 1	231,698	187,477	50.9%
Scenario 2	285,544	240,219	37.1%