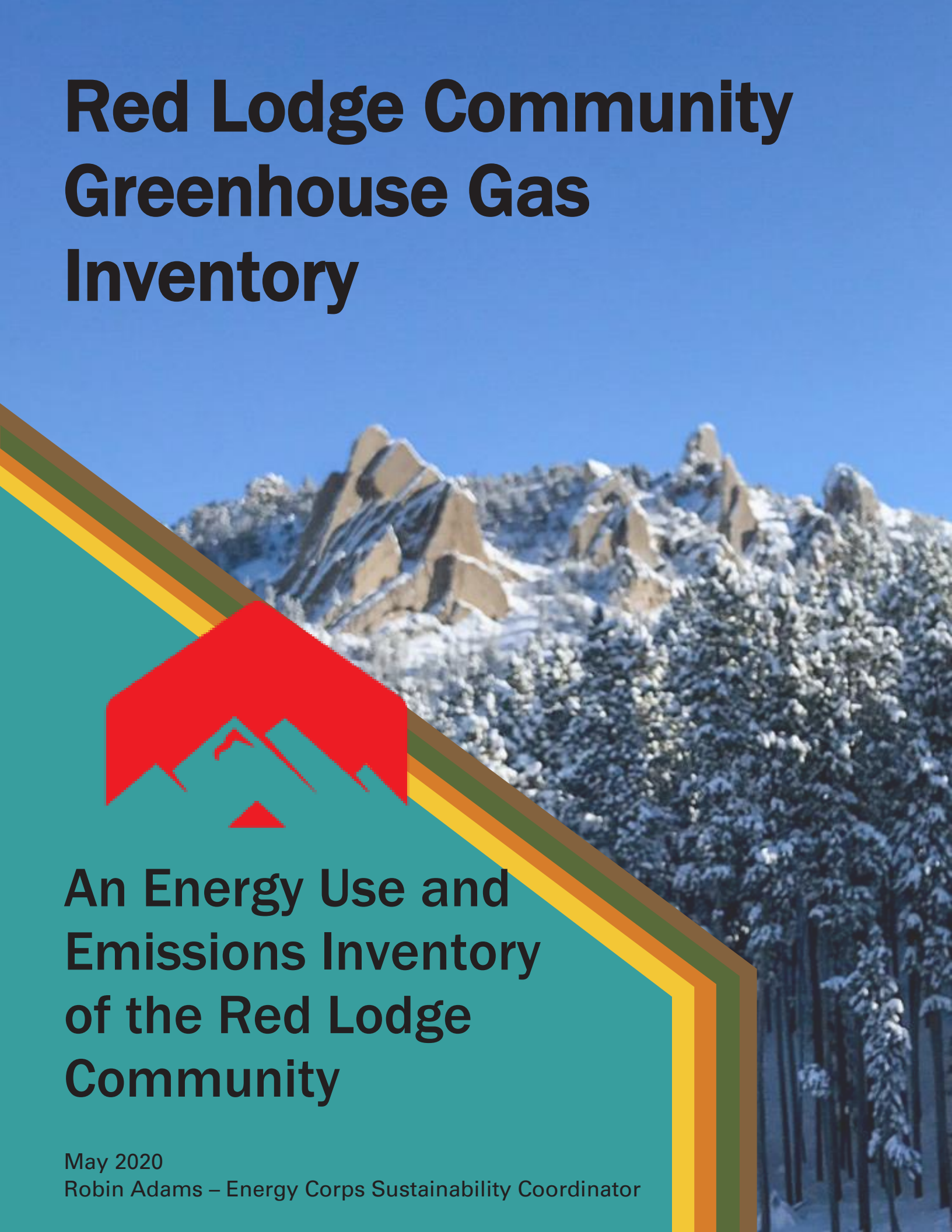
Red Lodge Community Greenhouse Gas Inventory



An Energy Use and Emissions Inventory of the Red Lodge Community

May 2020

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A bird's eye view of the Red Lodge Carnegie Library solar array installed in 2019.

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Introduction

Red Lodge, the Basecamp to the Beartooths, is nestled in a glacial valley near the base of the Beartooth Mountains in Carbon County, Montana. It is a place of scenic beauty, strong cultural heritage, and a thriving, tight-knit community. Our economy relies heavily on tourism and outdoor recreation, which are vulnerable to climate disruptions projected by the 2017 Montana Climate Assessment (MCA).

The City of Red Lodge is currently finalizing the 2020 Growth Policy, which acknowledges the consistent temperature increase recorded by the MCA over the last 65 years. These trends are expected to continue, which will likely result in longer growing seasons, more days with summer temperature extremes exceeding 90° F, and more variable mountain snowpack with earlier melting. These disruptions are driven largely by human activities releasing greenhouse gas (GHG) emissions into the atmosphere

The enclosed report is a baseline comprehensive assessment of energy use and GHG emissions for all activities within Red Lodge in the calendar year 2016. This is a valuable tool for identifying which aspects of the community hold the greatest potential for energy and emissions reduction. It also provides a benchmark upon which to evaluate the effectiveness of any mitigation goals the Red Lodge community may make in the future.

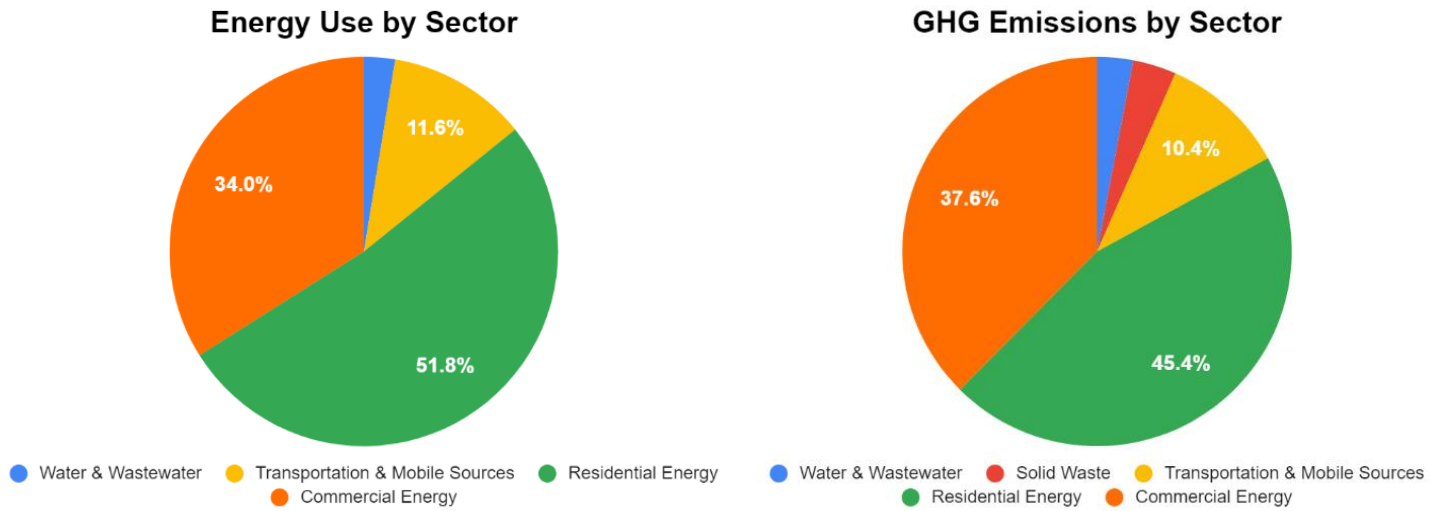
Executive Summary

As a community greenhouse gas inventory following GPC protocol, all energy use and emissions from Red Lodge residents, visitors, and employees within the City limits in the calendar year 2016 are accounted for. Reported emissions are broken down into five sectors: **Residential Energy**, **Commercial Energy**, **Transportation**, **Solid Waste**, and **Water & Wastewater**.

This inventory determines the following:

- In 2016, the Red Lodge community was responsible for:
  - **261,005** million British thermal units (MMBtu's) of energy.
  - **20,814** metric tons of carbon dioxide equivalents (mtCO2e) of GHG emissions. Our per capita emissions were 8.9 mtCO2e.
- Stationary energy from the residential and commercial sector made up over **80%** of both energy use and emissions in 2016 (see Figure 1).
- The Red Lodge community's waste diversion rate was only **4%** in 2016, compared to a national average of **35%** (according to the EPA).

Figure 1: 2016 Energy Use and Emissions by Sector



Methodology

The analysis follows the Greenhouse Gas Protocol's *Global Protocol for Community-Scale Greenhouse Gas Emission Inventories* for a BASIC reporting level. All seven Kyoto gases are accounted for, but only carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O) emissions were recorded. These are converted into metric tons of carbon dioxide equivalents (mtCO2e) by ICLEI software.

What is a mtCO2e?

A mtCO2e, or metric ton of carbon dioxide equivalent, is a more concise way of thinking about warming potential. There are seven Kyoto gases that contribute to climate change, and each of them has a different level of impact. For example, methane emissions have 21 times the warming potential of carbon dioxide. To present the impact of different gases in a uniform way, all emissions are converted into mtCO2e.

Table 1: Scope Definitions

Scope 1	GHG emissions from sources located within the city boundary.
Scope 2	GHG emissions occurring because of the use of grid-supplied electricity within the City's geographic boundary
Scope 3	All other GHG emissions that occur outside the city boundary as a result of activities taking places within the City's geographic boundary

Scope

Some activities within Red Lodge directly cause GHG emissions, such as exhaust from vehicles passing through. Other activities may indirectly cause GHG emissions but occur outside of the city. This range is classified into scopes, as can be seen in Table 1. Scope 1, 2, and 3 are all accounted for in this inventory. See Appendix A for the scope of each emission source included.

Data Sources

Data was collected from a variety of places. All energy, solid waste, and transportation data was gathered in 2018 by the previous Sustainability Coordinator, Kathryn Eklund. NorthWestern Energy provided data for residential and commercial electricity and natural gas usage in the calendar year 2016. There are no industrial accounts within City limits. Republic Services provided the data for the community's total waste sent to the landfill. Average vehicle miles travelled annually was collected using the Montana Department of Transportation's Automatic Traffic Recorders and includes miles travelled by both visitors and locals.

Software

All data was analyzed using ClearPath, a software system provided by ICLEI, or Local Governments for Sustainability, which tracks emissions of greenhouse gases and reports them in mtCO2e. The software's default calculations, values, and assumptions were used during analysis.

Figure 2: Geographic Boundary

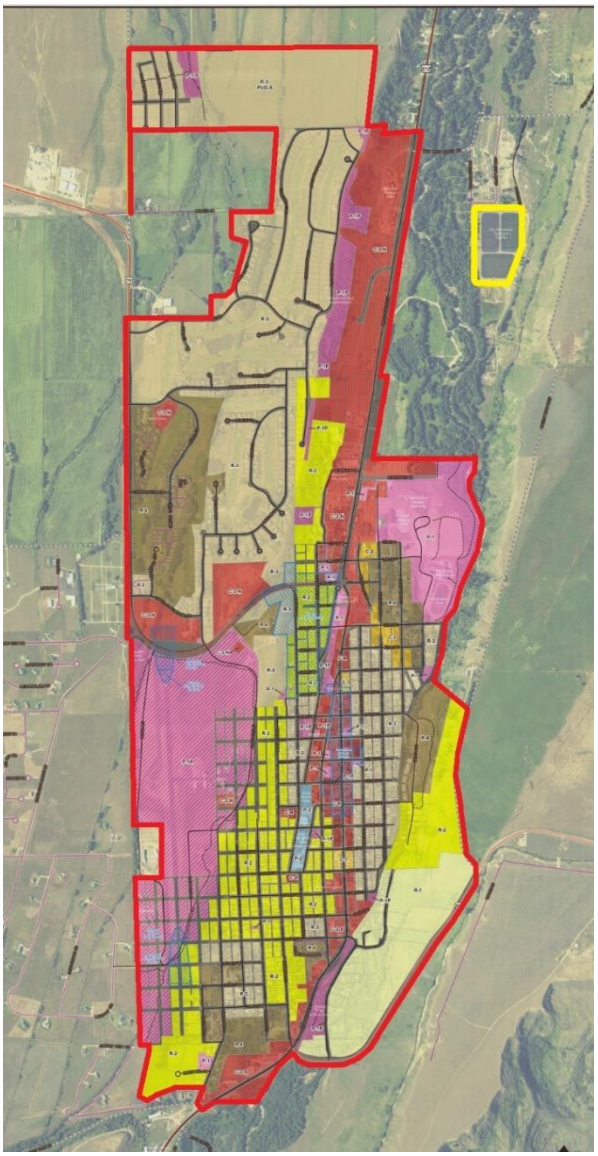


Table 2: Inventory Boundaries

Boundary	City Information
Name of City	Red Lodge
State	MT
Inventory Year	2016
Geographic boundary	City limits inc. WWTP
Land area	2.8 square miles
Resident population	2,328[1]
Number of households	1,390[2]
Number of businesses	214[3]
Composition of economy	agriculture, recreation, and tourism
Climate	continental

Baseline Year

All data collected is from the calendar year 2016. This shall serve as a baseline for any community greenhouse gas reduction methods in future years.

Geographic Boundary

Data was only collected from activities and residential, commercial, and municipal buildings within the City. The Wastewater Treatment Plant was also considered in boundary, despite being outside City limits. See Figure 2 for a map of areas included in the inventory. The Wastewater Treatment Plant is marked by the yellow line.

Other Boundaries See Table 2 for a summary.

[1] *2012 - 2016 American Community Survey (ACS) 5-Year Estimates*
[2] *2015 City of Red Lodge Growth Policy*
[3] *2016 - 2017 City of Red Lodge Business Licensing Records*

Inventory Results

In total, this inventory found that in 2016 the Red Lodge community used **261,005 MMBtu's** of energy and was responsible for **20,814 mtCO2e** emissions (see Table 3). That is equivalent to the amount of carbon dioxide sequestered each year by 27,182 acres of pine tree forest. The next sections detail emissions of Residential Energy, Commercial Energy, Transportation, Solid Waste, and Water & Wastewater (see Figure 3).

Commercial and residential energy combined (stationary energy) made up over 80% of both energy use and greenhouse gas emissions in 2016. Figure 4 shows exactly how many mtCO2e were released into the atmosphere by natural gas and electricity usage.

Figure 3: Emissions Summary

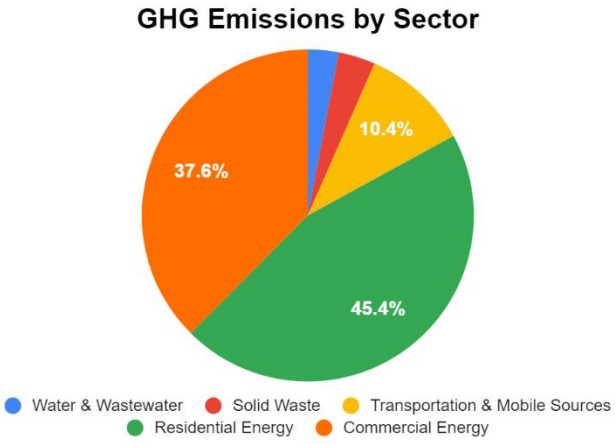


Figure 4: Stationary Energy

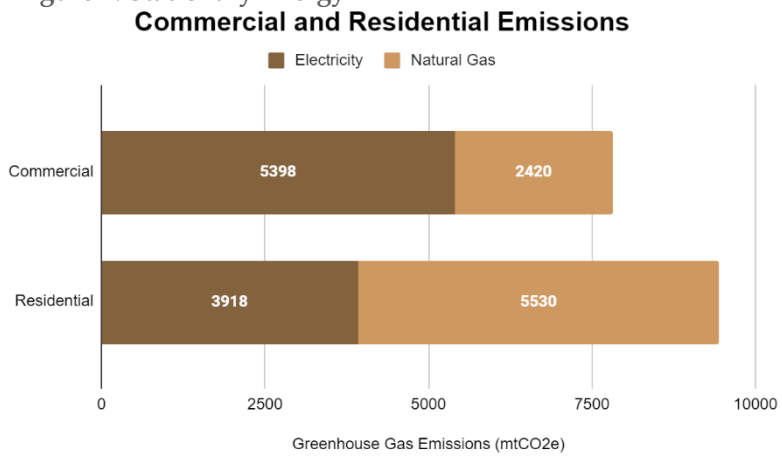


Table 3: Summary of Total Energy Use and Emissions by Sector

Sector	Energy (MMBtu)	Energy Usage (%)	GHG (mtCO2e)	GHG usage (%)
Water & Wastewater	6,745	2.58%	622	3.0%
Solid Waste	--	--%	751	3.6%
Transportation & Mobile Sources	30,366	11.63%	2,175	10.4%
Residential Energy	135,270	51.83%	9,448	45.4%
Commercial Energy	88,623	33.95%	7,818	38%
Totals	**261,005**	**100%**	**20,814**	**100.0%**

Residential Energy

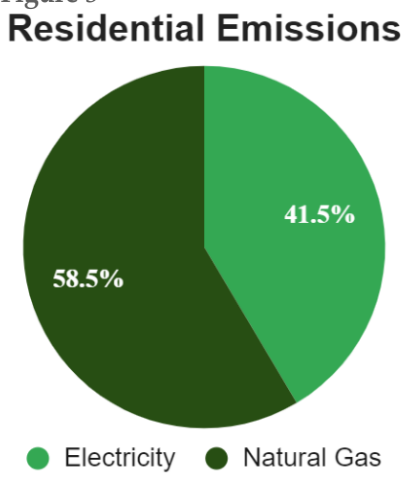
This sector has the largest share of energy use at **135,270 MMBtu**, or 52% of the Red Lodge community's recorded energy use. About 75% of this energy use is from natural gas. Residential energy is also responsible for the largest share of greenhouse gas emissions at **9,448 mtCO2e**, or 45% of the emissions within the Red Lodge community boundary.

Table 4: Residential Energy Summary

Source	Energy (MMBtu)	GHG (mtCO2e)
Residential Electricity	31,290	3,918
Residential natural gas	103,980	5,530
Total	**135,270**	**9,448**

On average, in 2016 each household's energy use was responsible for about 97 MMBtu's and 6.8 mtCO2e. **Red Lodge's residential energy use per household is 15% higher than the Mountain North average (84 MMBtu's) and almost 26% more than the national average (77 MMBtu's)[4].** One thing to keep in mind is the abnormally high prevalence of second homeowners in Red Lodge. Roughly 25% of dwellings within the City are not occupied year-round yet continue to use energy for heating[5]. Looking ahead, residential energy has great potential for both energy use and emissions reduction.

Figure 5



[4] *2015 U.S. Energy Information Administration RECS Survey*

[5] *Based on a comparison between American Community Survey estimates and number of dwellings connected to City water*

Commercial Energy

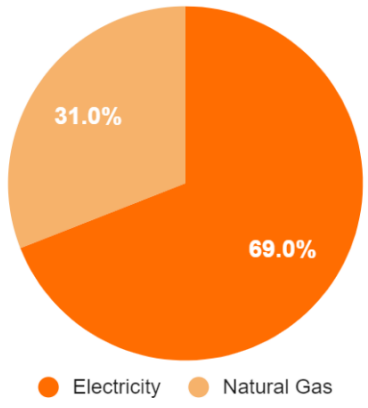
This sector has the second largest chunk of the emissions at **7,818 mtCO2e** released into the atmosphere, or 38% of the Red Lodge community's 2016 emissions. 69% of the emissions came from electricity. Energy usage was roughly split between natural gas and electricity and totaled **88,623 MMBtu's**, or 34% of Red Lodge's energy use. This sector includes all non-residential buildings such businesses, 501(c)(3) nonprofits, schools, a hospital, and municipal buildings.

Table 5: Commercial Energy Summary

Source	Energy (MMBtu)	GHG (mtCO2e)
Commercial Electricity	43,117	5,398
Commercial Natural Gas	45,506	2,420
Total	**88,623**	**7,818**

Even though commercial energy has less emissions and energy use overall than residential energy, the per capita emissions are much higher. With one outlier removed, each non-residential building was responsible for an average of 305 MMBtu's and 15 mtCO2e. This data demonstrates that **actions taken to decrease energy use even by one business could have a high impact** on the amount of mtCO2e released into the atmosphere by the Red Lodge community. Renewable energy installations and measures such as LED lighting retrofits, occupancy sensors, programmable thermostats, high efficiency windows, and increased insulation in non-residential buildings should be encouraged.

Figure 6
Commercial Emissions



Transportation

This sector was responsible for **30,366 MMBTu's** of energy, 11.5% of the community's energy usage, and **2,175 of mtCO2e**, about 10% of the community's GHG emissions. Most of these emissions were due to gasoline transportation. The average annual vehicle miles traveled was 4.8 million miles – this includes all local, employee, and visitor traffic[6].

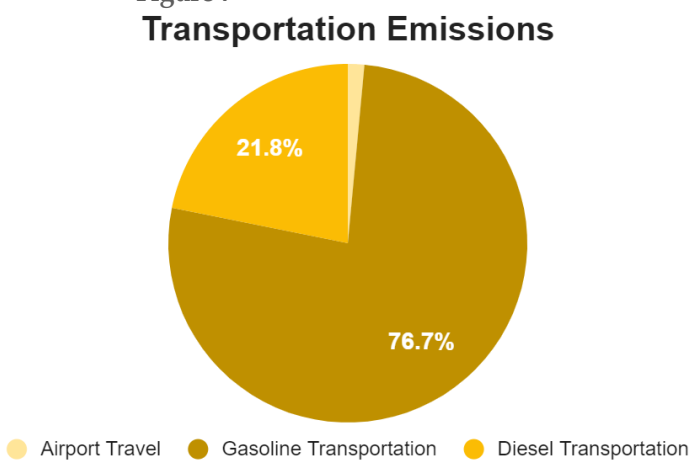
In June-December 2016, four public electric vehicle stations fueled about 1,100 miles for electric vehicles. This data was not included in this report, but it could be in future years. For example, in 2018 the stations fueled 20,600 clean miles and helped save over 180 mtCO2e.

To reduce transportation emissions, implementing the City's Active Transportation Plan and increasing electric vehicle infrastructure should be prioritized.

Table 6: Transportation Summary

Source	Energy (MMBtu)	GHG (mtCO2e)
Airport Travel	457	32
Gasoline Transportation	23,493	1668
Diesel Transportation	6,416	475
Total	**30,366**	**2,175**

Figure 7



[6] *Montana Department of Transportation*

Solid Waste

In 2016, the Red Lodge community generated about **3,151 tons** of waste. This resulted in **751 mtCO2e** emissions, or roughly 4% of the community's total emissions. Since the Billings Regional Landfill has a methane collection system, a significant amount of methane was captured before it would have been released into the atmosphere.

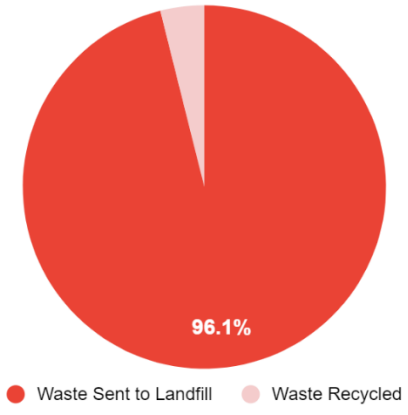
Another useful metric to analyze solid waste is the waste diversion rate, or the percentage of waste recycled instead of sent to the landfill. In 2016, 96% of the waste generated in Red Lodge was sent to the Billings Regional Landfill, while only 4% was recycled. This is compared to the national average waste diversion rate of 35%[7], and the Montana waste diversion rate of 17.1%[8].

Table 7: Solid Waste Summary

Source	Tons	(%)
Waste Sent to Landfill	3,028	96.1%
Waste Recycled	123.25	3.9%
Totals	**3,151.25**	**100.0%**

The landfill received approximately 341,467 tons in the inventory year. According to the City of Billings, **"If the landfill continues to receive the same amount of waste, it will be full in approximately 50 years. This can be greatly expanded if recyclables are diverted from the landfill."**

Figure 8
Total Waste Generated



[7] *EPA National Overview: Facts and Figures on Materials, Wastes and Recycling*
[8] *Montana DEQ 2016 Recycling and Waste Diversion Summary*

Water & Wastewater

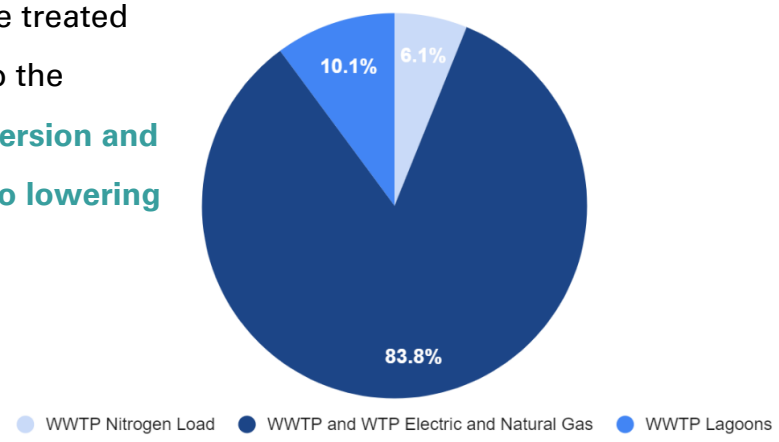
In 2016, the Water & Wastewater treatment used **6,745 MMBtu's** of energy. This resulted in **622 mtCO2e**[9] emissions, or roughly 4% of the community's total emissions in 2016. Most of the energy use and emissions are from WWTP and WTP Electric and Natural Gas.

45% of the water that enters our Wastewater Treatment Plant during the spring runoff months comes from snow melt and rain[10], leading to wasted energy and more emissions from unnecessary stormwater treatment. It is also estimated that 40% of the treated fresh water in Red Lodge is lost on its way to the intended home or business. **Stormwater diversion and addressing treated water loss are the keys to lowering emissions from Water & Wastewater.**

Table 8: Water & Wastewater Summary

Source	Energy (MMBtu)	GHG (mtCO2e)
WWTP Nitrogen Load	-	38
WWTP and WTP Electric and Natural Gas	6,745	521
WWTP Lagoons	-	63
Total	**6,745**	**622**

Figure 9
Water & Wastewater Emissions



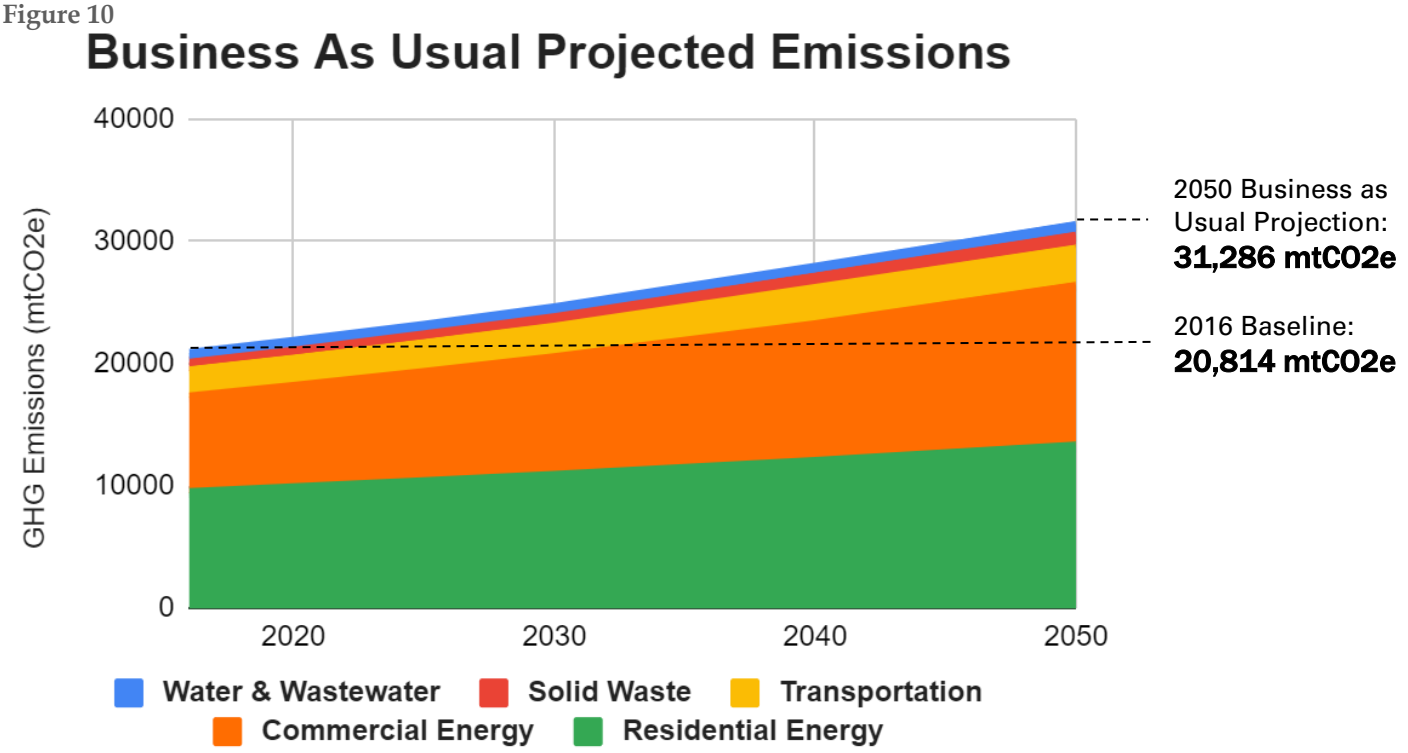
[9] *Based on 65% removal of BOD5 during primary treatment in WWTP Lagoons, corrected from 95% in the City Baseline Inventory.*
[10] *City of Red Lodge Energy Conservation Plan*

Next Steps

Most greenhouse gas inventories are unable to account for all the complex variables that contribute to the level of emissions released into the atmosphere by a single community. The Red Lodge Community GHG Inventory is no different. While not perfect, it offers a clearer picture of where the bulk of our emissions are coming from. It can also serve as a baseline to determine the efficacy of any future climate mitigation measures taken by the community.

The population of Red Lodge is growing. Figure 10 models a "Business as Usual" emissions scenario if our population grows at 1% annually, commercial accounts grow at 1.7% annually, and the sector per capita emissions remain constant. It is a rough model that assumes no actions are taken to reduce emissions. By 2050 our community emissions could be **31,286 mtCO2e, 50% higher than 2016.** See Appendix B for calculations used.

Figure 10



Within the state of Montana alone as of May 2020, twelve communities have used GHG emissions baseline data to form community resiliency plans to help mitigate the climate disruptions predicted in the Montana Climate Assessment[11]. This inventory brings our community one step closer to creating such a plan for the community of Red Lodge.

[11] *MSU Climate Smart Montana*

Appendix A

GPC protocol requires that we address all potential sources of emissions, even if they were not included in the inventory. This allows an easier comparison of GHG inventories across communities. Table 9 illustrates exactly which sources of emissions were included in this report as well as their scope (see Table 1 for a reminder of scope definitions).

Table 9: All Emissions by Sector and Scope

Sectors and Sub-Sectors	Included in Red Lodge Inventory	Scope 1	Scope 2	Scope 3
STATIONARY ENERGY				
Residential buildings	·	✓	✓	
Commercial buildings and facilities	·	✓	✓	
Manufacturing industries and construction	NO	✓	✓	
Energy industries	NO	✓	✓	
Agriculture, forestry, and fishing activities	NE	✓	✓	
Non-specified sources	NE	✓	✓	
Fugitive emissions from mining, processing, storage, and transportation of coal	NO	✓		
Fugitive emissions from oil and natural gas systems	NO	✓		
TRANSPORTATION				
On-road	·	✓	✓	
Railways	NO	✓	✓	
Waterborne navigation	NO	✓	✓	
Aviation	·	✓	✓	
Off-road	NE	✓	✓	
WASTE				
Disposal of solid waste generated in the City	·	✓		✓
Biological treatment of waste generated in the city	·	✓		✓
Incineration and open burning of waste generated in the city	NO	✓		✓
Wastewater generated in the city	·	✓		✓

Notation Key:

· marks an emissions source included in the Red Lodge inventory
NO is not occurring; an activity or process does not occur or exist within the city.
NE is not estimated; emissions may occur but have not been estimated due to insufficient data.

Appendix B

See Tables 10, 11, and 12 for the Business as Usual emissions projections by sector and sub-sector, GHG emissions per capita, and population and commercial account growth estimates. These tables can be used to create emissions projections for other years as well.

Table 10: Business As Usual (BAU) Emissions Projections in mtCO2e

Emission Sector	2016	2020	2025	2030	2040	2050
Energy total	17,266	18,118	19,251	20,468	23,179	26,309
Electricity Subtotal	9,317	9,768	10,370	11,019	12,473	14,165
Residential	*3,919*	*4,078*	*4,286*	*4,505*	*4,976*	*5,497*
Commercial	*5,398*	*5,690*	*6,084*	*6,515*	*7,497*	*8,668*
Natural Gas Subtotal	7,950	8,350	8,881	9,449	10,705	12,144
Residential	*5,530*	*5,755*	*6,048*	*6,357*	*7,022*	*7,756*
Commercial	*2,420*	*2,596*	*2,833*	*3,092*	*3,683*	*4,388*
Transportation	2,175	2,263	2,379	2,500	2,957	3,051
Solid Waste	751	781	821	863	954	1,053
Water & Wastewater	622	647	680	715	790	872
Total	**20,814**	**21,810**	**23,132**	**24,546**	**27,879**	**31,286**

Description: 2016 emissions are the baseline observed emissions (in gold), while 2020-2050 emissions are estimated based on population growth of 1% annually. Commercial growth is estimated at 1.7% annually. This includes any building within City limits with a NorthWestern Energy account that is not residential. GHG emissions per capita were assumed to remain constant.

Table 11: GHG Per Capita for BAU Estimations

GHG Emissions Per Capita	
Residential Electricity	1.683419244
Commercial Electricity[12]	14.94795539
Residential Natural Gas	2.375429553
Commercial Natural Gas	8.996282528
Transportation	0.9342783505
Solid Waste	0.3225945017
Water & Wastewater	0.2671821306

Description: These are observed GHG emissions per capita in 2016. Residential electricity produced 3,919 mtCO2e in 2016 and the population was 2,328. From there, we can say that 3,919 mtCO2e/2,328 people is 1.68 mtCO2e per person.

Table 12: Population and Commercial Account Estimates

Year	Population Estimates	Commercial Account Estimates
2016	2,328 (observed)	269 (observed)
2020	2,423	289
2025	2,546	315
2030	2,676	344
2040	2,956	409
2050	3,265	488

Description: Based on 1% annual population growth and 1.7% annual commercial account growth.

[12] *With one commercial account removed as an outlier with 1,377 mtCO2e released from electricity use in 2016.*

References and Further Reading

- 2012 - 2016 American Community Survey (ACS) 5-Year Estimates
- 2015 U.S. Energy Information Administration RECS Survey
- Montana Department of Transportation Automatic Traffic Recorders
- EPA National Overview: Facts and Figures on Materials, Wastes and Recycling
- Montana DEQ 2016 Recycling and Waste Diversion Summary
- 2016 City of Red Lodge Water PER
- City of Red Lodge Energy Conservation Plan
- MSU Climate Smart Montana
- 2015 Red Lodge Growth Policy
- 2017 Montana Climate Assessment
- Greenhouse Gas Protocol's *Global Protocol for Community-Scale Greenhouse Gas Emission Inventories*
- City of Red Lodge Active Transportation Plan
- City of Red Lodge Baseline Assessment