# Rapid City

## Community Climate Resiliency Plan

A Priority Climate Action Plan for Reducing Greenhouse Gas Emissions and Improving Climate Resiliency

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## Authors

City of Rapid City

Sustainability Solutions Group

VIREO

## Designed by SSG

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# Executive Summary

## Context

Rapid City is joining jurisdictions across the United States that are using federal Inflation Reduction Act (IRA) funding (through the Environmental Protection Agency's Climate Pollution Reduction Grants (CPRG) program) to take local action to reduce climate pollution. The funding is for two stages of planning—Priority Climate Action Plans (PCAP) and Comprehensive Climate Action Plans (CCAP)—with the possibility of additional funding for implementing measures identified in the plans. The funding program is designed to help identify local measures that will reduce air pollution, reduce waste, generate clean energy, create resilience against extreme weather events like forest fires, bolster the local economy, and improve quality of life for residents. For this PCAP component of the process, 34 priority measures have been developed across seven action themes. Many priority measures focus on low-income and disadvantaged communities (LIDAC), as taking action in these communities typically provides benefits to all. The upcoming CCAP component of the process will involve a more systematic analysis and thorough engagement process leading to a long-term action plan.

This PCAP is for the Rapid City Metropolitan Statistical Area (MSA), which includes Pennington County and Meade County. The CCAP effort is intended to extend to the Micropolitan Statistical Area, which includes Lawrence County and the second-largest city in western South Dakota, the city of Spearfish. For this reason, references to initiatives happening in Lawrence County have been included in the context review. The PCAP includes a greenhouse gas (GHG) emissions inventory for the Rapid City area as well as a contextual analysis of trends and drivers of energy and emissions.

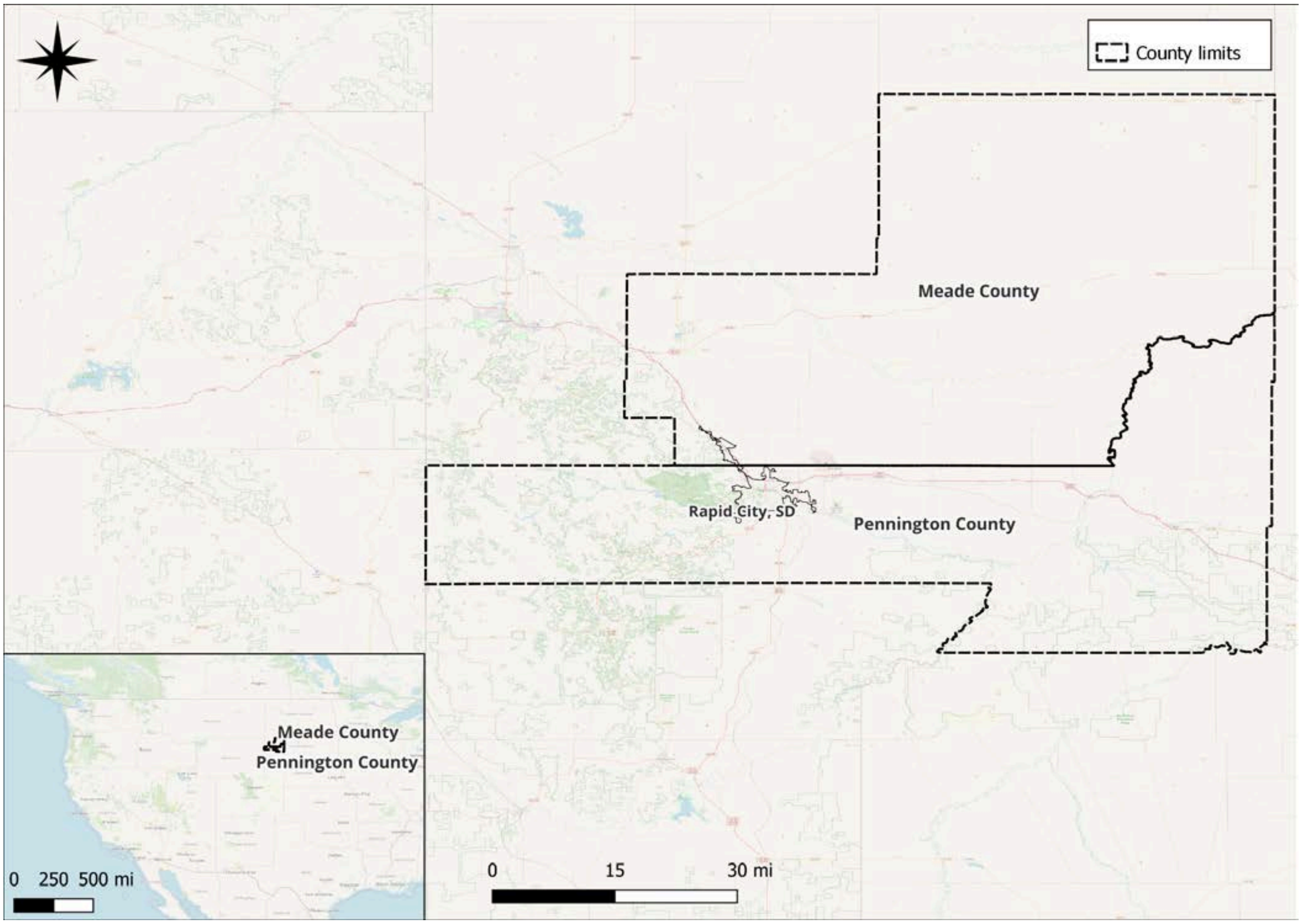

*Figure 1. Map of the Rapid City Metropolitan Statistical Area, which forms the geographic scope of the PCAP.*

## Challenges and Opportunities

Like many regions in the US, Rapid City faces the dual challenges of eliminating GHG emissions from heating, cooling, and transportation while transitioning the electricity grid from fossil fuels to cleaner generation sources. Both efforts require major investments. Reducing GHG emissions in heating, cooling, and transportation involves upgrading infrastructure and technologies that have incremental upfront costs but lower operating costs. These technologies are readily available. South Dakota is a national leader in solar photovoltaic (PV) and wind electricity generation, making inspiration near at hand for Rapid City's electricity grid transition.

The largest sources of GHG emissions in Rapid City are from the residential and industrial sectors. Supporting the reduction of GHG emissions in the residential sector will generate new employment opportunities, while improving the quality of housing through retrofitting older homes and building new energy-efficient homes. It will additionally help with housing affordability in the long term by reducing household energy costs. To reduce GHG emissions in the industrial sector, electricity generation will have to shift to renewable sources. This will aid in establishing a cleaner energy grid overall, while also facilitating the region's adoption of new and innovative energy technologies that are emerging worldwide.

This energy transition will additionally be supported by other measures such as building infrastructure to increase walkability and bikeability of the region, electrifying City equipment and fleets, retrofitting municipal and school buildings, and reducing organic waste while using more landfill methane emissions as energy. Maximizing efficiencies across all sectors minimizes the need for new electricity infrastructure, reducing overall energy transition costs in the long run.

As mitigating efforts are being made to reduce emissions in the building, transportation, and energy sectors, parallel adaptive efforts are required to protect people from extreme weather events like floods, droughts, wildfires, and extreme heat days. Key strategies, such as increasing tree canopy cover and greenspaces to cool urban areas while sequestering carbon and bolstering stormwater infiltration and flood mitigation, are also included in this PCAP.

## Community Building

With these measures in mind, careful consideration should be made in areas that have a high population of LIDAC, as climate risks and impacts disproportionately affect those with less access to resources. As identified using the Climate and Economic Justice Screening Tool (CEJST) methodology, the majority of LIDAC are located in the center of Rapid City. Noting this trend, an urban-to-rural prioritization will be considered in the priority measures included in this plan. As all measures come with community co-benefits, LIDAC will both directly and indirectly benefit from seeing these measures implemented. Examples of co-benefits include the reduction of air and noise pollution by incentivizing more residents to walk and bicycle, the creation of recreational community spaces, and the reduction of heat-related issues by increasing greenspace in the region.

# Priority Measures

An engagement process helped identify possible priority measures through preliminary interviews, questionnaires, and a workshop with representatives of interested parties and employees of the City of Rapid City. A CPRG Task Force consisting of a diverse group of representatives from local organizations, institutions, and businesses was formed to contribute to the development of this PCAP, and their input was integrated throughout this document. Broader community engagement will be included during the next phase of CPRG, which includes development of the more in-depth and longer-term CCAP.

The CPRG planning process is being facilitated by the City of Rapid City. This effort is being undertaken to create a “community” plan (not just a “city” plan) with input from a diverse group of stakeholders and the general public that is intended to embody the community at large. Entities have been identified as potential partners in planning and delivering certain measures in this plan, although their participation has not necessarily been confirmed and their inclusion here does not necessarily indicate their commitment.

Table 1 describes the seven GHG reduction measure themes that were identified as priorities for Rapid City.

*Table 1. PCAP priority GHG reduction measures for Rapid City.*

| Project Title | Description |
|---|---|
| **1. Low Emission City Facilities and Schools** | The City of Rapid City will lead by example in its efforts to reduce energy consumption and GHG emissions production. City-led projects like fleet electrification and municipal facilities upgrades will showcase the benefits of clean vehicles and building energy efficiency retrofits, while saving energy costs and producing fewer airborne particulates. Local schools will also conduct weatherization improvements to increase energy efficiency and create comfortable learning environments for students. |
| **2. Renewable Rapid City** | To encourage the clean energy transition that is occurring in the rest of the state, several solar photovoltaic energy projects will be developed: one community utility-scale project, one institutional project, and one city project. A geo-exchange system will be installed on the SD Mines campus. A renewable energy education and outreach program for institutions and the public will encourage solar energy uptake in these sectors. A solar energy training program at the local college will bolster the local trades market. Finally, the City will evaluate the feasibility of electricity micro-grids for energy and climate impact resilience. |

| Project Title | Description |
|---|---|
| **3. Low Waste Rapid City** | To reduce solid waste emissions and improve food distribution, a community food and yard waste diversion and composting program will be created with residential, business, grocery retail, restaurant, and school streams. The existing recycling program will also be expanded to include commercial, schools, and non-profits in order to divert more waste from the landfill. The Rapid City landfill will be further studied to map a path to removing its methane emissions and using them for energy production. |
| **4. Greenway Climate Resilience Enhancements** | The 10-mile central Rapid Creek Greenway will be enhanced with thousands of trees, stormwater infiltration measures, and dozens of paths and trails connecting adjacent neighborhoods. The measures will sequester carbon, reduce the urban-heat-island effect, create extreme weather resilience, and provide active transportation routes. |
| **5. Multi-modal Transportation Transformation** | Enhancements and extensions to the Greenway paths and trail systems, active transportation connections to major institutions, transit service improvements, and an e-bike incentive program will provide more and better options for residents to get around Rapid City while reducing the region's high transportation GHG emissions. |
| **6. Clean Vehicle Readiness** | Outfitting Rapid City with an EV charger network will encourage the transition to clean vehicles that is already happening in other jurisdictions. College EV maintenance programs and incentives for home EV charging systems will bolster the local workforce to support EV owners. |
| **7. Efficient, Affordable Home Energy** | The region's high buildings GHG emissions will be reduced by implementing coordinated programs of home energy efficiency retrofits (prioritizing LIDAC and pre-1990 homes), creating a property-assessed clean energy (PACE) program, and developing building codes for energy-efficient new buildings. A public education and awareness program about energy efficiency retrofits and renewable energy tax credits and a new mechanism for households to purchase renewable electricity will help increase retrofits and decrease home energy costs. |

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# Disclaimer

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## Consulting Team

### Sustainability Solutions Group (SSG) Workers Cooperative

- Camilla Melrose
- Chris Strashok
- Jeremy Murphy
- Erica Brook
- Francisca Cid
- Sophie Lévesque
- Soraya Sarshar

### VIREO

- Robin Fordyce
- Triveece Penelton

## CPRG Task Force

- City of Rapid City
  - Community Development
  - Community Relations
  - Commission
  - Finance Office
  - Parks & Recreation
  - Public Works
  - Standing Committee on Sustainability
  - The Monument
- Black Hills Energy
- Black Hills Environmental Coalition
- Citizens' Climate Lobby
- Dakota Rural Action - Black Hills Chapter
- Elevate Rapid City
- Monument Health
- Peter Lien & Sons, Inc.
- Rapid City Area Schools
- SD Mines
- West River Electric Association

# Acronyms

| **Abbreviation** | **Definition** |
|---|---|
| AFOLU | Agriculture, Forestry and Other Land Use |
| BAU | Business-as-Usual |
| CCAP | Comprehensive Climate Action Plan |
| CDBG | Community Development Block Grant |
| CEJST | Climate and Economic Justice Screening Tool |
| CPRG | Climate Pollution Reduction Grants |
| EAFB | Ellsworth Air Force Base |
| EJ | Environmental Justice |
| EJScreen | Environmental Justice Screening Tool |
| EPA | Environmental Protection Agency |
| EV | Electric Vehicle |
| GHG | Greenhouse Gas |
| GHG Inventory | Greenhouse Gas Inventory |
| GI | Green Infrastructure |
| GPC | Global Protocol for Community-Scale Greenhouse Gas Inventories |
| GWP | Global Warming Potential |
| IAP2 | International Association for Public Participation |
| IRA | Inflation Reduction Act |
| LFG | Landfill Gas |
| LID | Low-Impact Design |
| LIDAC | Low-income and Disadvantaged Communities |
| MSA | Metropolitan Statistical Area |
| NAAQS | National Ambient Air Quality Standards |
| NPL | National Priorities List |
| PACE | Property-assessed Clean Energy Program |
| PCAP | Priority Climate Action Plan |
| PV | Photovoltaic |
| RCAMPO | Rapid City Area Metropolitan Planning Organization |
| RCSC | Rapid City Sustainability Committee |
| RMP | Risk Management Plan |
| RSEI | Risk-Screening Environmental Indicators |
| SD | South Dakota |
| SD Mines | South Dakota School of Mines and Technology |

# Key Energy and Emissions Units

## GHG Emissions

1 kt$CO_2$e = 1,000 Mt$CO_2$ee

## Energy

1 MMBTU = 1.055 GJ
1 MJ = 0.0001 GJ
1 TJ = 1,000 GJ
1 PJ = 1,000,000 GJ
1 GJ = 278 kWh
1 MWh = 1,000 kWh
1 GWh =1,000,000 kWh

## GHG Global Warming Potential (GWP) Equivalents

| | |
|---|---|
| $CO_2$ to $CO_2$e | 1 |
| CH4 to $CO_2$e | 30 |
| N2O to $CO_2$e | 273 |

# Glossary

**British Thermal Units (BTU):** A measure of the heat content of fuels or energy sources. One BTU is the quantity of heat required to raise the temperature of one pound of liquid water by 1° Fahrenheit (F) at the temperature that water has its greatest density (approximately 39° F). One million BTUs is expressed as MMBTU.

**Carbon Dioxide ($CO_2$):** A common gas that is a potent heat trapping agent in the atmosphere if present in high concentrations. $CO_2$ is emitted from combustion, fermentation, and respiration activities.

**Carbon Dioxide Equivalents ($CO_2e$):** The heat trapping ability of a given gas expressed in terms of how much $CO_2$ is essential to produce a similar warming effect over the chosen time. It is calculated by multiplying the amount of gas by its accompanying global warming potential. Expressed in tons as $tCO_2e$ and kilotons ($ktCO_2e$). In the US, it is also expressed as metric tons ($MtCO_2e$).

**Carbon Neutral:** Making no net release of greenhouse gasses into the atmosphere, either by reducing emissions to zero or by offsetting emissions.

**Climate:** The long-term weather patterns of a given location averaged over a period of time, typically 30 years.

**Climate Action Planning:** The act of identifying actions to take across socio-economic and community sectors (e.g., buildings, transportation, waste, industry, etc.) to mitigate greenhouse gas emissions, remove harmful emissions from the atmosphere, and adapt to current and anticipated climate change impacts.

**Climate Adaptation:** The process by which built, natural, social, and human systems adjust to actual or expected climate change. Adaptation seeks to manage unavoidable harm.

**Climate Change:** Changes in long-term weather patterns caused by natural phenomena and exacerbated by human activities that alter the chemical composition of the atmosphere by the buildup of greenhouse gasses, which trap heat and reflect it back to Earth's surface.

**Climate Equity:** Ensuring the just distribution of the benefits of climate protection efforts and alleviating unequal burdens created by climate change.

**Climate Mitigation:** Any activities (e.g., policy, program, regulation, infrastructure, activity, or other project-based measures) that contribute to the reduction of greenhouse gas concentrations in the atmosphere.

**Global Warming Potential (GWP):** The measure of each greenhouse gas' ability to trap heat in the atmosphere compared to carbon dioxide ($CO_2$), measured over a specified time.

**Greenhouse Gas (GHG):** A variety of gasses whose presence in the atmosphere keeps the Earth's temperature stable. The increased presence of these gasses over the past 200 years is causing more heat to be trapped inside the atmosphere, which is generating changes to Earth's climate.

**Greenhouse Gas Intensity:** The amount of emissions associated with a certain metric. For example, per the energy use of a square meter of a building; per liter of gasoline burned; per kilowatt-hour of electricity used.

**Green Infrastructure:** The range of measures that use plant or soil systems, permeable pavement or other permeable surfaces or substrates, stormwater harvest and reuse, or landscaping to store, infiltrate or evapotranspirate stormwater and reduce flows to sewer systems or to surface waters. Certain green infrastructure, like engineered wetland systems, can contribute to carbon sequestration.

**Joules:** A joule is a basic unit of energy, equal to the kinetic energy of a kilogram mass moving at one meter per second or the work done on an object by a force of one newton. It is expressed as one thousand joules (kJ), megajoules (one million joules, MJ), gigajoules (one billion joules, GJ), and terajoules (one trillion joules, TJ), and petajoules (one quadrillion joules, PJ).

**Kilowatt Hour (kWh):** The energy delivered by one kilowatt of power for one hour, equal to 3.6 megajoules. Also expressed in megawatt hour (MWh) and gigawatt hour (GWh).

**Low-carbon Energy System:** Energy systems that provide heating, cooling, and sometimes hot water, with limited GHG emissions, typically regulated through a maximum annual emissions per square meter basis.

**Methane (CH4):** A colorless, odorless gas that occurs abundantly in nature and as a product of certain human activities. It is among the most potent of the greenhouse gasses—28 times more potent than carbon dioxide over the long term (100 years) and 83 times more potent over the short term (20 years).

**Net-zero Emissions:** As defined in the *Canadian Net-zero Emissions Accountability Act*: human caused or influenced (anthropogenic) emissions of greenhouse gasses into the atmosphere are balanced by anthropogenic removals of greenhouse gasses from the atmosphere over a specified period.

**Nitrous Oxide (N2O):** A colorless gas that is produced from fossil fuel combustion and many fertilizers. It is among the most potent greenhouse gasses—265 times more potent than carbon dioxide over 100 years.

**Renewable Natural Gas (RNG):** Biogas (the gaseous product of the decomposition of organic matter) that has been processed to purity standards and is interchangeable with conventional natural gas.

**Scope 1, 2, 3 Emissions:**

- **Scope 1:** Covers emissions from sources that a community owns or controls directly.
- **Scope 2:** Covers emissions that a community causes indirectly from the energy it uses that is imported from outside the community boundary.
- **Scope 3:** Encompasses emissions that are not produced in the community itself and that are not the result of activities from assets owned or controlled in the community, but those that it is indirectly responsible for across its supply chain.

**Sequestration:** The process of capturing and storing atmospheric carbon dioxide, either through geologic sequestration (e.g., carbon capture) or biologic sequestration (e.g., through trees, soils, aquatic environments, and vegetation).

# 1. Introduction

## 1.1 Climate Pollution Reduction Grants (CPRG) Overview

Section 60114 of the Inflation Reduction Act (IRA) appropriates $5 billion to the US Environmental Protection Agency (EPA) to develop and implement plans to reduce greenhouse gas (GHG) emissions. Through the CPRG program, EPA is seeking to achieve three broad objectives:

- Tackle damaging climate pollution while supporting the creation of good jobs and lowering energy costs for families;
- Accelerate work to address environmental injustice and empower community-driven solutions in overburdened neighborhoods; and
- Deliver cleaner air by reducing harmful air pollution in places where people live, work, play, and go to school.

The CPRG program includes two phases: Phase 1 provides grants to develop plans to reduce GHGs, while Phase 2 provides funding to implement measures from the Phase 1 GHG reduction plans. EPA's priorities for the Phase 1 planning grants are described in Table 2.

*Table 2. CPRG planning grant priorities.*

| **Theme** | **Description** |
|---|---|
| Analytics | Improve understanding of current and future GHG emissions in order to prioritize measures that reduce such emissions and harmful air pollution where citizens live, work, play, and go to school, particularly in non-attainment areas for the National Ambient Air Quality Standards (NAAQS) for criteria air pollutants. |
| Programs | Adopt and implement ambitious policies and programs to reduce GHG emissions and accelerate GHG emissions reductions across multiple important sectors (e.g., industry, electricity generation, transportation, commercial and residential buildings, agriculture/natural and working lands, and waste and materials management). |
| Partnerships | Collaborate closely with other entities in their state, region, municipality, and/or air district to develop coordinated plans based on best practices. |

| Theme | Description |
|---|---|
| Financing | Explore opportunities to leverage sources of funding and financing from the Inflation Reduction Act of 2022, the Bipartisan Infrastructure Law of 2021, the American Rescue Plan Act of 2021, and the Creating Helpful Incentives to Produce Semiconductors and Science Act of 2022. |
| Innovation | Stimulate innovative technologies and practices to reduce GHG emissions and associated co-pollutants in hard-to-abate sectors. |
| Transformation | Prioritize measures and policies that will be durable and replicable and that will provide certainty in pollution reductions. |
| Economic Development | Reduce climate pollution while building the clean energy economy in a way that benefits all Americans, provides new workforce training opportunities, and effectively addresses environmental injustices in disadvantaged communities. |
| Monitoring and Evaluation | Adopt robust metrics and reporting programs to track emission reductions and important benefits throughout the jurisdiction and in disadvantaged communities. |

## 1.2 The Priority Climate Action Plan (PCAP)

The first deliverable of the CPRG planning grant is the PCAP. The primary objective of the PCAP is to identify near-term, high-priority, implementation-ready measures to reduce GHG emissions, which can be submitted as measures under Phase 2 of CPRG for implementation funding. The PCAP includes a GHG Inventory, quantified GHG reduction measures, a low-income and disadvantaged communities (LIDAC) benefits analysis, and a review of authority to implement the GHG reduction measures.

A Comprehensive Climate Action Plan (CCAP) will be completed following the PCAP. The CCAP provides the scope for more detailed modeling, technical analysis, and community engagement and will represent a detailed roadmap for reducing GHG emissions in the Rapid City Metropolitan and Micropolitan Statistical Areas.

## 1.3 The Role of Local and Regional Governments

Local governments can have a considerable impact on reducing GHG emissions in the community. By developing a quantitative understanding of the community's GHG emissions (i.e., the GHG Inventory) and systematically identifying the measures for change (i.e., climate action planning), local and regional governments can influence the level of community GHG emissions now and many years into the future. Land-use planning decisions made today will have environmental and socio-economic impacts for hundreds of years into the future. These decisions can "lock-in" emissions, meaning past decisions limit options to transform the current situation and increase the costs of future decisions. In the context of climate change, planning decisions regarding longer-term investments are among the most urgent.

In addition to planning policy, local and regional governments have multiple roles that can support and enable GHG emissions reductions, including acting as:

- **A mobilizer:** Local governments can engage people, municipalities, and other organizations around a vision, goals, objectives, and targets. For example, local governments can lead community engagement programs or bulk purchasing of renewable energy on behalf of citizens;
- **An innovator**: Local governments can directly or indirectly support innovation through targeted investments, partnerships, and/or policies that support low-carbon projects or enterprises, reducing risk for investors, partners, and community members. For example, local governments can develop new infrastructure to support electric vehicle (EV) adoption;
- **A collaborator:** There are multiple opportunities for collaboration in the energy transition, including with other levels of government, transit authorities, utilities, businesses, non-profit organizations, neighborhoods, and governments in other parts of the region, state, and world. Collaboration can take the form of shared targets, policies, joint projects, and investments;
- **An investor**: Local governments can use access to low-interest capital to make investments directly in building retrofits and renewable energy technologies. Alternatively, or in tandem, local governments can enable investments by third parties. For example, local governments can levy local improvement charges as a way to finance building retrofits;
- **An implementer**: Through policies and incentives, local governments can support businesses and households in making the clean energy transition. For example, local governments can amend building code requirements to mandate or incentivize more energy-efficient construction; and

- **An incubator:** Local governments can cultivate the development of new technologies or applications that enable the low-carbon economy by supporting and attracting new and existing businesses and creating a hub or ecosystem in which the businesses and organizations support each other. Examples include a low-carbon business park or incentives for different levels of building performance that stimulate innovation by builders.

## 1.4 A Framework for Climate Action Planning

“Reduce-Switch-Produce-Offset and Sequester” is a simple mantra to follow in energy and emissions planning (Figure 2). Adapted from similar approaches, such as “Reduce-Reuse-Recycle” from the waste sector and “Avoid-Shift-Improve” from the transportation sector, this framework provides guidance on an overall approach to community energy and emissions planning.

To start, prioritizing reductions in energy consumption will reduce the level of needed investment in renewable energy and result in energy cost savings. Reducing energy consumption and maximizing energy efficiency opportunities reduces total energy costs and per-unit energy costs by reducing the overall build-out of the electricity system, which is logistically complex and capital intensive.

The second and third steps are to switch to locally-produced renewable electricity, which will maximize local economic benefits and the resilience of the electricity system. The final step is to offset and sequester any remaining GHG emissions.

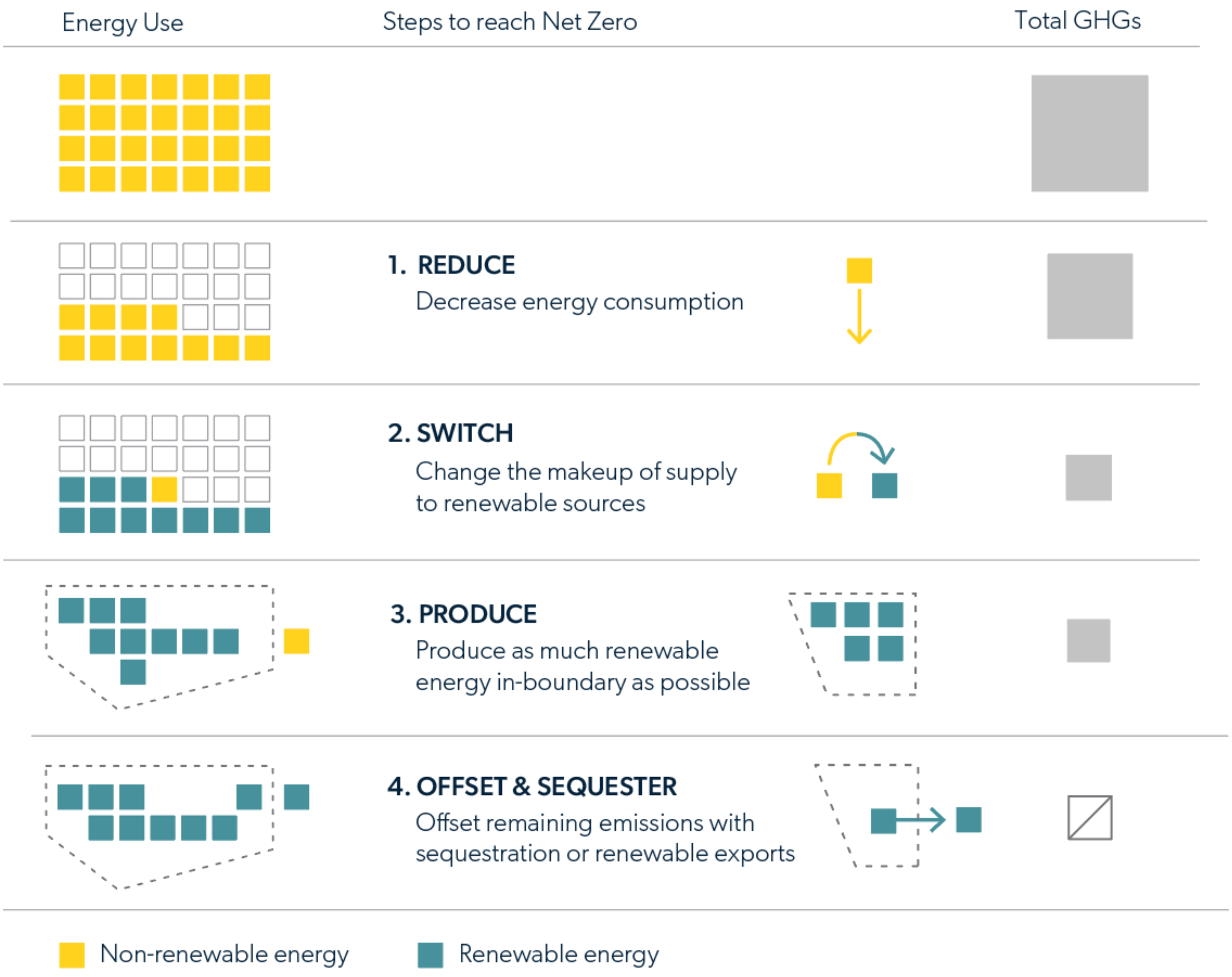

*Figure 2. A systematic approach to reducing GHG emissions. Source: SSG elaboration.*

Other key considerations are to identify measures and investments that will improve durability and avoid lock-in patterns of behavior and capital. From this perspective, the first priorities are land-use planning and infrastructure planning, including development density or intensity, mix of land uses, energy supply infrastructure, and transportation infrastructure. The second priorities are major manufacturing or production processes, including industrial processes; choice of transportation modes; and building and site design. The final priority is energy-using equipment, including transit vehicles, motors, appliances, and HVAC systems.

The approach of “Reduce-Switch-Produce-Offset and Sequester” guided the development of Rapid City’s GHG reduction measures included in this PCAP.

## 1.5 Climate Action Is Economic Development

Reducing Rapid City's transportation, buildings, waste management, and energy supply GHG emissions requires new investments. Many of these investments can save local residents, businesses, and governments money, primarily as a result of efficiency gains, while stimulating innovation and new business opportunities. The investments also require work—and workers—to install heat pumps, retrofit homes, and build infrastructure, for example. The scale of the investment and work required means that a climate action plan can also act as a major economic development strategy for a region.

## 1.6 PCAP Process

Rapid City's PCAP development included four activity streams: coordination, technical analysis, engagement, and outcomes. Priority GHG reduction measures were identified based on findings from a context review, GHG inventorying, and engagement with various interested and affected parties, as well as with input from Rapid City staff and the consulting team. The GHG reduction measures were prioritized based on criteria developed to reflect both local priorities and EPA's evaluation criteria for CPRG Phase 2. Rapid City's CPRG Task Force also provided input over the course of the PCAP development.

# 2. Project Background

## 2.1 Climate Change Context

### National and Regional Context

Climate change presents a particularly complex challenge. It operates over a relatively long timescale and affects all of Earth's natural systems. Given the variation in impacts across locations and time, addressing climate change necessitates comprehensive solutions that span all aspects of human activity across both short and long time frames.

Below are several excerpts from the US Global Change Research Program's Fifth National Climate Assessment, which is the US government's preeminent report on climate change impacts, risks, and responses that supports informed decision-making across the United States.[1] This is followed by what the Rapid City region can expect as impacts and risks associated with climate change in the coming years.

**The Impacts of Climate Change for the US and Northern Great Plains**

*Selected excerpts from the Fifth National Climate Assessment USGCRP, "Fifth National Climate Assessment."*

**United States**

- One of the most direct ways that people experience climate change is through changes in extreme events. Harmful impacts from more frequent and severe extremes are increasing across the country—including increases in heat-related illnesses and death, costlier storm damages, longer droughts that reduce agricultural productivity and strain water systems, and larger, more severe wildfires that threaten homes and degrade air quality.

- Each additional increment of warming is expected to lead to more damage and greater economic losses compared to previous increments of warming, while the risk of catastrophic or unforeseen consequences also increases.

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[1] U. S. Global Change Research Program Program. "Fifth National Climate Assessment." *Fifth National Climate Assessment*. U.S. Global Change Research Program, Washington, DC, 2023. https://nca2023.globalchange.gov/.

- In the 1980s, the country experienced, on average, one (inflation-adjusted) billion-dollar disaster every four months. Now, there is one every three weeks, on average. Between 2018 and 2022, the US experienced 89 billion-dollar events. Extreme events cost the US close to $150 billion each year—a conservative estimate that does not account for loss of life, healthcare-related costs, or damages to ecosystem services.
- The impacts and risks of climate change unfold across interacting sectors and regions. For example, wildfires in one region can affect air quality and human health in other regions, depending on where winds transport smoke. Further, climate change impacts interact with other stressors, such as the COVID-19 pandemic, environmental degradation, or socio-economic stressors like poverty and lack of adequate housing that disproportionately impact overburdened communities. These interactions and interdependencies can lead to cascading impacts and sudden failures. For example, climate-related shocks to the food supply chain have led to local and global impacts on food security and human migration patterns that affect US economic and national security interests.
- Some communities are at higher risk of negative impacts from climate change due to social and economic inequities caused by ongoing systemic discrimination, exclusion, and under- or disinvestment. Many such communities are also already overburdened by the cumulative effects of adverse environmental, health, economic, or social conditions. Climate change worsens these long-standing inequities, contributing to persistent disparities in the resources needed to prepare for, respond to, and recover from climate impacts.

**Northern Great Plains**

- The Northern Great Plains is experiencing unprecedented climate-driven extremes, including severe drought, floods, and wildfires. These changes threaten economic sectors, such as agriculture and recreation, and affect the health, well-being, and livelihood of the region’s residents. While adaptation efforts are underway, climate change creates complex tradeoffs and tests the resilience of the region’s residents, especially rural, Indigenous, and low-income immigrant populations.
- This region is largely rural, and its intact natural areas, farms, and wildlands serve as habitat for resident and migrating species, which are threatened by changing water scarcity. The region is an energy and food exporter and is vulnerable to policy decisions and markets outside the region. Historical processes may lead to unequal distribution of harms, with Indigenous communities, service and energy workers, and rural residents more sensitive to impacts.

- The Northern Great Plains region is heavily reliant on agriculture and resource-based economies, placing livelihoods at risk from the impacts of climate change and related policy. Agriculture and recreation will see some positive effects but primarily negative effects related to changing temperature and precipitation regimes. Energy-sector livelihoods will be affected as emissions-reductions policies drive shifts away from fossil fuel sources.

### Local Context

At a more local level, climate impacts and risks were analyzed in the Rapid City Metropolitan Statistical Area (MSA) using the Climate and Economic Justice Screening Tool (CEJST). The main impacts identified for this area are wildfires, flooding, drought, extreme heat, and urban-heat-island effects, as well as extreme weather events, including increased precipitation events and tornadoes.

The main climate impacts or risk of impacts in the Rapid City region are wildfires. All three counties of Pennington, Meade, and Lawrence are subject to wildfire risk and rank over the 90th percentile (nationally) for the share of properties at risk of wildfire in the next 30 years (Figure 3). Figure 3 presents the 80th to 90th percentile and the more than 90th percentile census tracts at risk of flooding in the next 30 years. Wildfires pose a hazard to the community due to their potential to cause extensive property damage, threaten lives, and disrupt ecosystems. Wildfires also have the primary consequence of degrading air quality through the emission of pollutants and smoke particles into the surrounding atmosphere.

As a consequence of these natural hazards, many census tracts in Pennington and Lawrence Counties are listed in the top 90th percentile nationwide for the expected population loss rate. The population loss rate is defined by: *"Expected fatalities and injuries due to fourteen types of natural hazards each year. These hazards have some link to climate change. They are: avalanche, coastal flooding, cold wave, drought, hail, heat wave, hurricane, ice storm, landslide, riverine flooding, strong wind, tornado, wildfire, and winter weather."*[2]

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[2] Council on Environmental Quality. "Climate and Economic Justice Screening Tool." Data and Tools, 2022. https://screeningtool.geoplatform.gov.

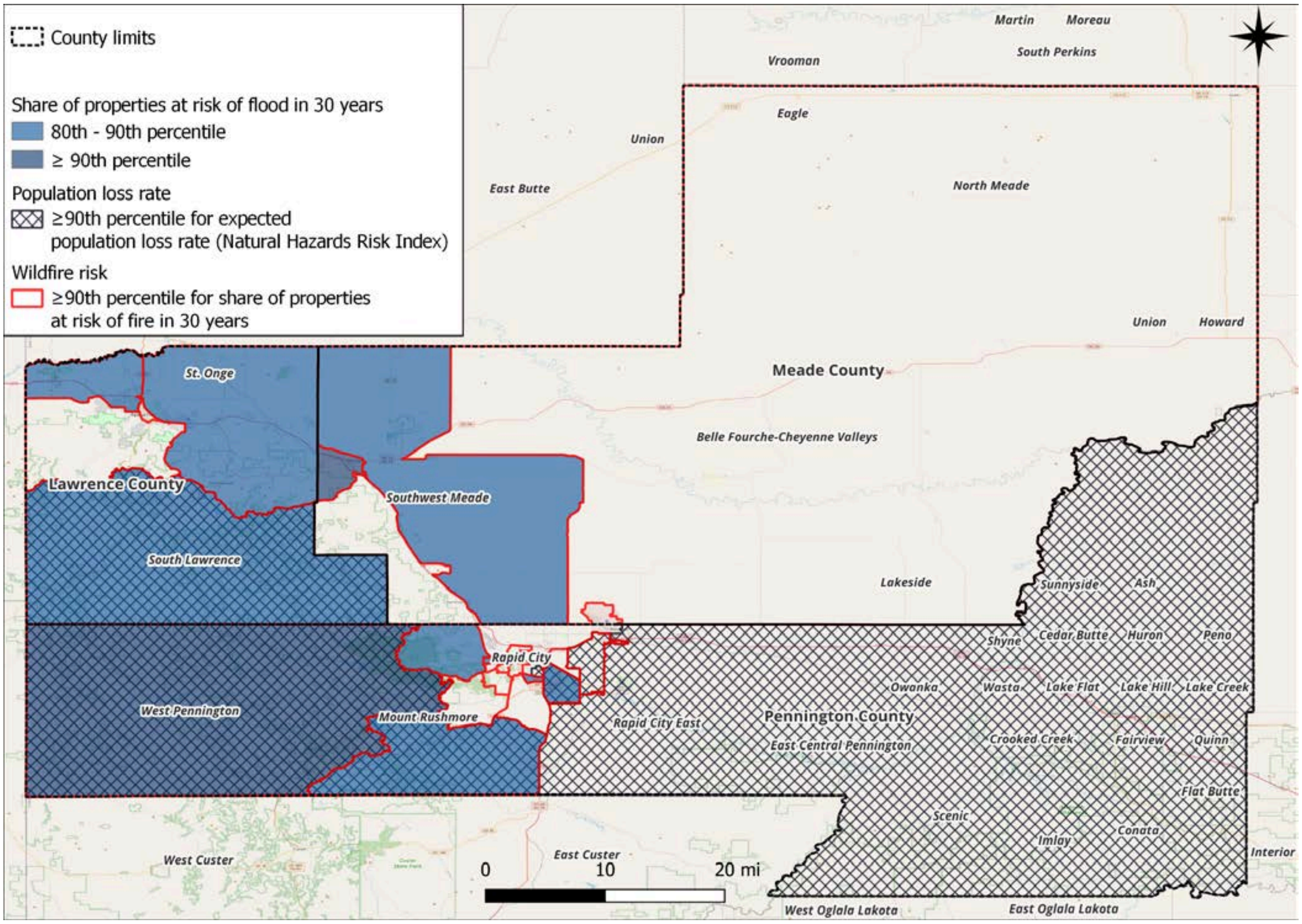

*Figure 3: Map of the census tracts that are most affected by wildfires, flooding, and expected population loss rate, as a consequence of climate change.*[3]

According to the National Oceanic and Atmospheric Administration, another significant climate-related risk for the Rapid City region is flooding. Flooding typically occurs when there are prolonged and consecutive precipitation events or intense rainfall over a short period of time. This is in part due to rising temperatures that, in turn, increase the frequency of storms (e.g., tornadoes), making them more intense and increasing overall annual rainfall.[4] The Black Hills are particularly vulnerable to flash floods, where steep slopes and narrow canyons can channel large amounts of precipitation, damaging infrastructure and putting human safety at risk.[5] The region experienced a relatively recent significant flood event in 1972, resulting in the loss of 238 lives, displacement of residents, and extensive property damage.[6]

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[3] Ibid.

[4] Environmental Protection Agency (EPA). "What Climate Change Means for South Dakota," August 2016. https://19january2017snapshot.epa.gov/sites/production/files/2016-09/documents/climate-change-sd.pdf.

[5] National Oceanic and Atmospheric Administration. "Severe Weather Preparedness: Flooding." NOAA's National Weather Service. Accessed February 22, 2024. https://www.weather.gov/unr/FloodSafety.

[6] Rapid City Historic Preservation Commission. "1972 Flood History." Accessed February 8, 2024. https://www.rapidcityhpc.com/projects/1972-flood-history.html.

# 2.2 Rapid City Background

## Population and Demographics

The Rapid City MSA is one of the United States' most remote urban areas and the largest population center in western South Dakota, with a population of approximately 149,000.[7] According to the US Census Bureau, the Rapid City MSA is the fastest-growing metro area in the Midwest.[8] The Rapid City MSA comprises Pennington and Meade Counties, alongside several urban centers, including Rapid City, Box Elder, and Sturgis.

In 2022, the area's populations by county were:[9]

- Pennington County: 114,416 and
- Meade County: 30,698.

The most populated area in this region is Rapid City, found in Pennington County, with an approximate population of 79,000.[10] Rapid City's demographics include a predominantly white population of 89%, alongside a notable American Indian and Alaska Native population of 11% (Figure 4).[11] Rapid City is home to many Lakota and Dakota people of the Sioux, or Oceti Sakowin, Tribe and other Tribal groups. Due to Rapid City's proximity to nearby reservations, Indigenous residents often frequent the city to shop, recreate, visit family, conduct business, and engage in a wide array of other activities. For this reason, the Indigenous population can account for as much as a quarter of the people in the city on any given day. Indigenous presence in the region extends back at least 12,000 years. Contemporary presence of the urban Indigenous community is reflected in outdoor spaces and community gathering places such as the Mother Butler Center and the planned He Sapa Otipi Center.[12]

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[7] Elevate Rapid City. "Why Rapid City." Accessed February 5, 2024. https://www.elevaterapidcity.com/economic-development/why-rapid-city/.

[8] Elevate Rapid City. "Rapid City Region: Fastest-Growing Metro Area in the Midwest." Rapid City Government Website. Accessed February 5, 2024. https://www.rcgov.org/rapid-city-news-room/rapid-city-region-fastest-growing-metro-area-in-the-midwest-elevate-rapid-city-10585.html

[9] US Census Bureau. "QuickFacts: Lawrence County, South Dakota; Pennington County, South Dakota; Meade County, South Dakota." Census Data, 2022. https://www.census.gov/quickfacts/fact/table/lawrencecountysouthdakota,penningtoncountysouthdakota,meadecountysouthdakota/RHI125222#RHI125222.

[10] US Census Bureau. "QuickFacts: Rapid City, South Dakota." Census Data, 2022. https://www.census.gov/quickfacts/fact/table/rapidcitycitysouthdakota/PST045222.

[11] US Census Bureau. "Table DP05: ACS DEMOGRAPHIC AND HOUSING ESTIMATES." Census Data. https://data.census.gov/table/ACSDP5Y2021.DP05?g=310XX00US39660.

[12] Rapid City Historic Preservation Commission. "Diverse Rapid City: Indigenous Presence Deep History to 2020," November 11, 2020. https://www.rapidcityhpc.com/images/Indigenous_Rapid_City_11.20.2020X_2.pdf.

Rapid City's population is projected to grow to between 85,000 and 97,000 by the year 2035.[13] This trend will only be amplified by the continuing growth in neighboring counties and municipalities, which largely depend on Rapid City for its numerous services. Effectively managing this growth and preserving the region's distinct identity, while striving to pave the way forward toward a sustainable future, are the primary motivations behind Rapid City's decision to participate in the CPRG program.

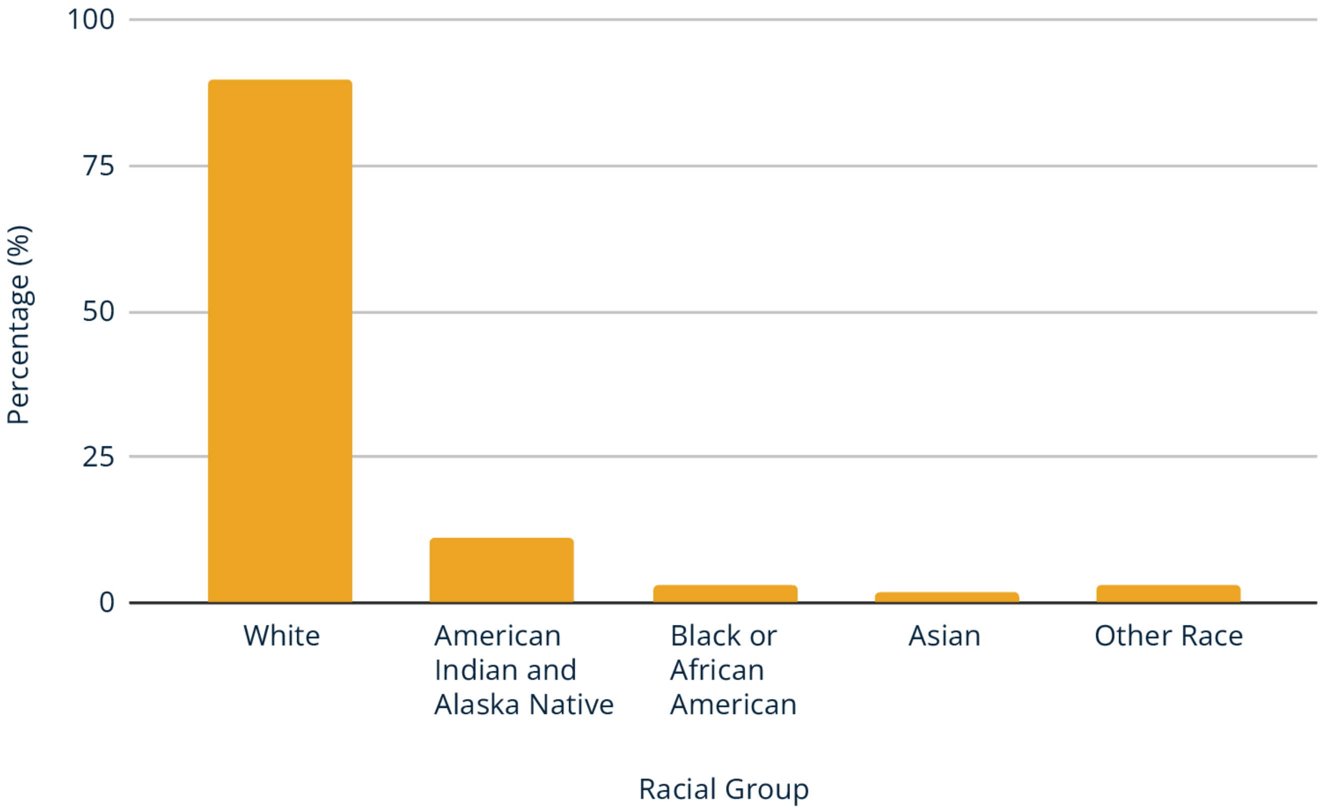

*Figure 4. Racial composition of population. Area: Rapid City MSA. Source: US Census Bureau, 2022.*

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[13] City of Rapid City. "Rapid City Comprehensive Plan," April 2014. https://www.rcgov.org/index.php?option=com_docman&view=download&alias=23936-rapid-city-comprehensive-plan-adopted-april-2014-with-maps-no-appendices&category_slug=transportation-planning&Itemid=149

Incomes in the Rapid City MSA are lower than the national average, with a median household income of $68,000 in 2022, which is less than the national average of $75,000.[14] More than 50% of the population has household incomes less than $75,000 and more than one-third of the population has household incomes less than $50,000 (Figure 5).[15] Overall, 61.5% of the population from the municipality are employed, leading to an employment rate on par with the 2022 national average of 60.3%.[16,17]

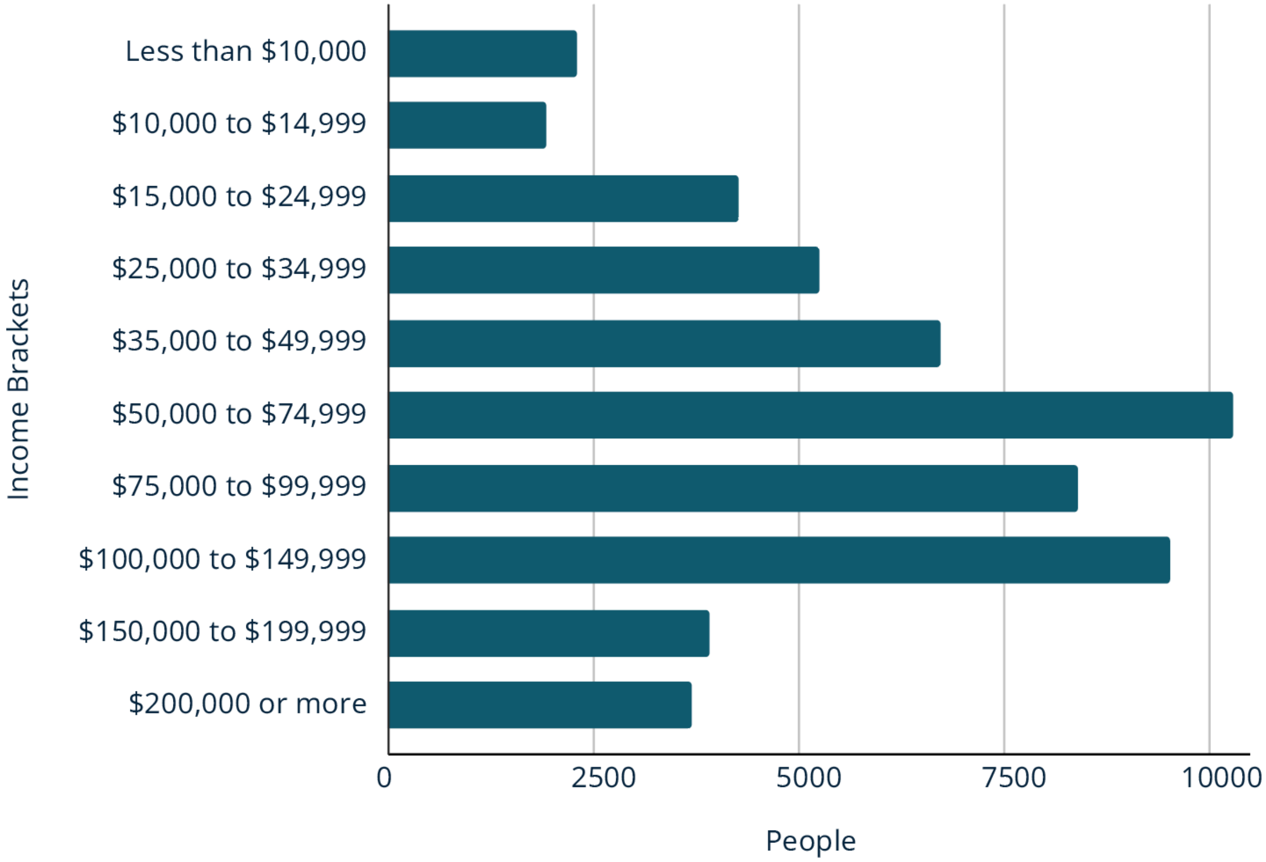

*Figure 5. Household income. Area: Rapid City MSA. Source: US Census Bureau, 2022.*

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[14] US Census Bureau. "Income in the United States: 2022." Census Data, September 12, 2023. https://www.census.gov/library/publications/2023/demo/p60-279.html.

[15] US Census Bureau. "DP03: ACS Selected Economic Characteristics." Census Data. Accessed February 6, 2024. https://data.census.gov/table/ACSDP5Y2022.DP03?g=310XX00US39660&d=ACS%205-Year%20Estimates%20Data%20Profiles&moe=false.

[16] US Census Bureau. "DP03: ACS Selected Economic Characteristics." Census Data. Accessed February 6, 2024. https://data.census.gov/table/ACSDP5Y2022.DP03?g=310XX00US39660&d=ACS%205-Year%20Estimates%20Data%20Profiles&moe=false.

[17] US Census Bureau. "United States Employment." Census Data, 2022. https://data.census.gov/all?q=United+States+Employment.

## History and Geography

The Rapid City area sits at the foothills of the Black Hills, nestled within a diverse landscape of mountain peaks, hills, canyons, caves, and bluffs. The area is known for its stunning natural beauty and its proximity to many sites of historical, cultural, and spiritual significance, including Black Hills National Forest, Bear Butte State Park, Black Elk Wilderness, Custer State Park, Mount Rushmore National Memorial, Badlands National Park, Wind Cave National Park, and Jewel Cave National Monument. The place is known by outdoor enthusiasts for its myriad of opportunities for hiking, biking, fishing, hunting, and camping, as well as a community that greatly values these amenities and the natural resources on which they depend. The areas to the north and east of Rapid City are largely rural, with significant swaths of land dedicated to the agricultural sector where wheat, soybean, and beef are produced.

The region's colonial history is rooted in stories from the 1870s Black Hills gold rush and "Wild West" legends, as Rapid City incorporated in 1882.[18,19] The city's small downtown is centrally located not far from nearby Rapid Creek, a waterway that runs west to east through the entire community and which experienced a monumental flood in 1972. This flood led to Rapid City no longer allowing development by the waterway for public safety measures and instead creating a recreational greenspace that includes a 10-mile-long bike path named after Leonard "Swanny" Swanson, a former Public Works Director, as well as many parks, including the 28-acre Memorial Park in the heart of downtown.[20]

## Economy

Rapid City has a robust and business-friendly local economy that attracts a diverse group of industries due to the lack of corporate and individual income taxes in South Dakota. The Rapid City MSA worker distribution is approximately 65% white collar.[21] The largest sectors of employment include government services, engineering firms, business services, and financial services. The area is home to many federal government institutions, including Ellsworth Air Force Base, the South Dakota Army National Guard, Indian Health Services, Fort Meade VA Medical Center, and both the US Forest Service and National Park Service. Local businesses are relatively small with 71% composed of just one to four employees. Cultural and scenic attractions in the area, including those mentioned above, along with Spearfish Canyon, Devils Tower National Monument, Deadwood, and the Sturgis Motorcycle Rally, create a significant tourism industry.

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[18] City of Rapid City. "Rapid City Comprehensive Plan," April 2014. https://www.rcgov.org/index.php?option=com_docman&view=download&alias=23936-rapid-city-comprehensive-plan-adopted-april-2014-with-maps-no-appendices&category_slug=transportation-planning&Itemid=149.

[19] Visit Rapid City. "About the Region." Accessed February 8, 2024. https://www.visitrapidcity.com/.

[20] Rapid City Historic Preservation Commission. "1972 Flood History." Accessed February 8, 2024. https://www.rapidcityhpc.com/projects/1972-flood-history.html.

[21] Elevate Rapid City. "Why Rapid City." Accessed February 5, 2024. https://www.elevaterapidcity.com/economic-development/why-rapid-city/.

Other notable employers include Black Hills Energy, a diversified electric and gas utility company, which is headquartered in Rapid City, and Monument Health, an integrated healthcare system with six hospitals in the area that employ over 8,000 people.[22]

Rapid City is located about five miles southwest of Ellsworth Air Force Base (EAFB), near Box Elder. EAFB employs approximately 3,300 service members and serves a population of approximately 15,840 when accounting for all active military members, their families, retirees, and civilian workers.[23] The base is one of two Air Force bases in the United States to house B-1B Lancer bombers. In the next few years, Ellsworth will see the arrival of the B-21 Raider bomber and will become the B-21's main operating base and formal training unit. A report completed by the South Dakota Legislative Research Council states that the total workforce at Ellsworth is expected to grow 30% as a result of the B-21's arrival, equating to approximately 4,860 active military personnel and 13,743 personnel when including all civilians, contractors, and dependents. Workforce impacts are forecasted to include the creation of 2,246 new jobs and the need for 1,011 additional housing units.[24]

The South Dakota School of Mines and Technology (SD Mines) is an important local university—one of six accredited universities in the state of South Dakota. It is among the top STEM universities in the state and nation, specializing in engineering research and innovation. In 2023, the university created a Center for Sustainable Solutions, which focuses on sustainability studies involving water quality, infrastructure, carbon capture, environmental stewardship, and more.

## 2.3 Climate Goals, Partners, and Programs in Rapid City

To ensure this plan's priority GHG reduction measures align with the community's values, several plans in the Rapid City area were reviewed, and their diverse sustainability objectives were outlined.

### Comprehensive Plan

Rapid City's Comprehensive Plan, adopted in 2014 and set to be updated in 2024, shapes a long-term vision for the community. The plan is divided into seven core values: A Balanced Pattern of Growth; A Vibrant, Livable Community; A Safe, Healthy, Inclusive, and Skilled

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[22] Ibid.

[23] Military One Source. "Ellsworth Air Force Base." Accessed February 22, 2024. https://installations.militaryonesource.mil/in-depth-overview/ellsworth-air-force-base.

[24] South Dakota Legislative Research Council. "Ellsworth Air Force Base Expansion," 2020. https://mylrc.sdlegislature.gov/api/Documents/Attachment/207171.pdf?Year=2020.

Community; Efficient Transportation and Infrastructure Systems; Economic Stability and Growth; Outstanding Recreational and Cultural Opportunities; and Responsive, Accessible, and Effective Governance.[25] Below is a condensed list of notable principles, goals, and policies that reflect the outcomes of this plan:

- **Goal GOV-4.2B: Energy Efficiency** Explore cost-effective ways to improve the energy efficiency of City facilities.
- **GPD-MU6: Sustainable Development Practices** Encourage the use of energy-efficient construction techniques, materials, designs, and other strategies where feasible.
- **Principle BPG - 1.1D: Sustainable Development** Permit and encourage the use of sustainable development practices (e.g., renewable energy systems, water-conserving fixtures and landscaping, and storm-water management techniques in all public and private development projects).
- **Principle TI-2: Providing a Safe and Efficient Multi-Modal Transportation System** Rapid City will maintain a safe transportation system that provides for efficient travel within and through the community for all motorized and non-motorized modes. This will include linking the city’s many neighborhoods, employment areas, parks, schools, and recreational facilities with a comprehensive system of roadways, multi-use pathways, bicycle facilities, and sidewalks. Additionally, the City will seek opportunities to expand existing transit services to increase travel choices for the community.
- **Goal LC-6.2A: Air Quality** Protect air quality by encouraging the development of land-use patterns that reduce vehicle trips, supporting transportation alternatives that decrease dependence on single-occupancy vehicles, establishing targets for and monitoring greenhouse gas emissions, and promoting energy efficiency in existing and new buildings.

## Sustainability Coordinator

The Rapid City Comprehensive Plan also recommended establishing a full-time sustainability coordinator position, a goal which was primarily accomplished in 2023 with the hiring of a Sustainability and Stewardship Program Development Manager in the Public Works Department (Goal Gov-1.3F: Sustainability Initiatives). Five priority areas were identified by city leadership for this position to focus on: Sustainable Growth and Development, Water, Waste, Transportation, and Sustainability Education and Outreach. These themes will be developed into a larger sustainability program for Rapid City over the next few years.

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[25] City of Rapid City. “Rapid City Comprehensive Plan,” April 2014. https://www.rcgov.org/index.php?option=com_docman&view=download&alias=23936-rapid-city-comprehensive-plan-adopted-april-2014-with-maps-no-appendices&category_slug=transportation-planning&Itemid=149.

## City Sustainability Committee

The City of Rapid City has a Standing Committee on Sustainability (or Rapid City Sustainability Committee, or RCSC, for short), whose members have also participated in the engagement activities informing this report. The RCSC was formed in 2012, and its purpose is to encourage education, stewardship, and policy leadership that will make the community a leader in economic, social, and environmental sustainability. The committee works with and assists City departments, including Public Works, Community Development, and Parks and Recreation, while also serving as a resource on sustainability-related matters for the Rapid City Common Council and Mayor.

As outlined in RCSC's 2022–2023 Work Plan, several pertinent goals and action items were stated under the City Facilities and Sustainable Development subcommittees. In addressing city facilities, the committee emphasized the importance of promoting energy efficiency in all new constructions and renovations, supporting the transition to electric vehicles, and showcasing city-wide support for renewable energy. When discussing sustainable development, the committee underscored the need to expand alternative transportation infrastructure and integrate both Low-Impact Design (LID) and Green Infrastructure (GI) principles into the City's stormwater practices.[26] Moreover, the committee oversees a #STARTNOW website, which serves as an educational platform for residents to adopt more sustainable lifestyles.[27] The website provides resources on five key topics: energy, water, waste, landscaping, and food, directing users to information such as energy-efficient upgrades and tax credits available for both residents and business owners.

## Transportation Plans

The Rapid City Area Metropolitan Planning Organization (RCAMPO), the region's transportation planning board, released two transportation plans in August 2020, one entitled Rapid City Metropolitan Transportation Plan and the other entitled Rapid City Metropolitan Area Bike and Pedestrian Master Plan Update. These plans identified various goals, including meeting the diverse needs of multi-modal transportation and ensuring environmental sustainability and resilience in future transportation projects. Some interest in the electrification of vehicles was identified, with concern around challenges like providing a charging network that adequately meets future demands, an increasing demand for electricity, and obtaining transportation funding. Overall, the RCAMPO aims to enhance transportation choices by developing a network of safe and comfortable on-street and off-street bicycle and pedestrian facilities that provide

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[26] "Rapid City Sustainability Committee 2022-2023 Work Plan," November 28, 2022. https://static1.squarespace.com/static/5e66bce716532e7300994a3e/t/638d35e33eeef110fa38bcb3/1670198756183/RCSC_2022_2023_WorkPlan_Final.pdf.

[27] Rapid City Sustainability Committee. "#STARTNow." Rapid City Sustainability Committee. Accessed February 8, 2024. https://www.rapidcitysustainability.com/startnow.

connections to destinations throughout the city.[28] The document envisioned a 20-year plan for completing the system of walkways, bikeways, and shared-use paths, including fulfilling the following recommendations: 5.25 miles of city sidewalk projects, 6.22 miles of shoulder bikeways, 11.52 miles of bike lanes on future roadways, and 8.37 miles of extensions to the Leonard "Swanny" Swanson Memorial Pathway, also known as the Rapid City bike path.[29]

## Climate Plans

In February 2020, Black Hills State University, in collaboration with the City of Spearfish, adopted the region's first climate plan. This Climate Resiliency Plan holds a 2040 vision of a thriving and resilient Spearfish. Priority areas of the plan include: Prepare for Extreme Weather Events; Nurture Economic Health; Strategically Invest in Our Educational Resources; Increase Environmental Coordination and Monitoring; Improve Access to Basic Human Needs; Build Community Cohesion; and Conserve Our Natural Resources.[30] A notable goal in this plan is to "Conserve Energy and Increase Renewable Sources," which includes the following short- and long-term strategies:

- Three- to Five-Year Strategies:
  - Pilot a low-income support program for energy conservation (includes home insulation, water heater insulation, double-paned windows, thermostats, window coverings, etc.)
  - Increase the amount of electricity from renewable sources provided to the City of Spearfish by 5% per year to reach a goal of 80% by 2040.

- Six- to 10-Year Strategies:
  - Benchmark, disclose, and reduce energy use in city-owned buildings.
  - Encourage local businesses to benchmark, disclose, and reduce energy use in their buildings. Consider creating a city-sponsored recognition program for businesses who conserve energy.
  - Educate the public on energy conservation strategies.

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[28] Rapid City Area Metropolitan Planning and Organization. "Rapid City Metropolitan Transportation Plan," August 2020. https://www.rcgov.org/index.php?option=com_docman&view=download&alias=18406-20tp028-metropolitan-transportation-plan-final-report&category_slug=08-august-tp-4&Itemid=149.

[29] Rapid City Area Metropolitan Planning and Organization. "Rapid City Metropolitan Area Bike and Pedestrian Master Plan Update," August 2020. https://www.rcgov.org/index.php?option=com_docman&view=download&alias=18407-20tp028-bicycle-and-pedestrian-master-plan-final-report&category_slug=08-august-tp-4&Itemid=149.

[30] City of Spearfish, and Black Hills State Univeristy. "Climate Resiliency Plan," February 2020. https://www.bhsu.edu/Faculty-Staff/Campus-Services/Facilities-Services/Sustainability/_docs/climate-resiliency-plan-2020.pdf.

## Higher Education

Moreover, Black Hills State University has a Facilities Department with personnel dedicated to sustainability. Launched in November 2017 (revised in June 2021), the Sustainability Master Plan makes a carbon commitment[31] that focuses on reducing greenhouse gas emissions and achieving carbon neutrality by 2050. Notably, the Sustainability Coordinator at Black Hills State University recently started serving in the same capacity at South Dakota School of Mines and Technology (SD Mines), one of Rapid City's two large higher-educational institutions, alongside Western Dakota Technical College.

Rapid City has expressed interest in cultivating partnerships with educational institutions to collaborate on campus planning and meeting energy needs. This interest extends to initiatives aimed at establishing training programs to enhance proficiency in energy-efficient technologies for both buildings and transportation. Such efforts could involve collaborating with the Civil and Environmental Engineering programs at SD Mines, as well as with programs in electrical trades, automotive technology, and environmental engineering technology at Western Dakota Technical College.

## Energy and Emissions Planning in Other Organizations

A variety of Rapid City organizations, institutions, and businesses have sustainability plans and initiatives underway. Black Hills Energy provides the region's electricity using a mixture of coal-fired, natural-gas-fired, and renewable generation technologies. Black Hills Energy's Sustainability Strategy commits the corporation to reducing its natural gas emissions to net zero by 2035 and reducing its electricity generation emissions intensity by 40% by 2030 and 70% by 2040. This will be achieved through the addition of renewable energy generation, improved transmission, new renewable energy storage facilities, and the retirement of fossil fuel generation facilities.[32]

As shown in these findings, many organizations in the Rapid City area are eager to start implementing meaningful sustainability initiatives, laying a strong groundwork for potentially leveraging upcoming CPRG funding and other financial opportunities provided by the Inflation Reduction Act and the Bipartisan Infrastructure Law to achieve their climate goals.

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[31] Black Hills State Univeristy. "Sustainability Master Plan," November 2017. https://www.bhsu.edu/Faculty-Staff/Campus-Services/Facilities-Services/Sustainability/_docs/VER_BHSU_sustainability_master_plan_final2.pdf.

[32] Black Hills Energy Sustainability Report 2022. https://www.blackhillsenergy.com/sites/blackhillsenergy.com/files/2022-sustainability-report.pdf

# 3. Greenhouse Gas Inventory

## 3.1 Emissions by Sector

In 2021, GHG emissions for the Rapid City area totaled 1.49 million $MtCO_2e$, or 20 $MtCO_2e$ per person. These emissions were produced in the residential (35%), commercial/institutional (29%), and industrial (35%) sectors (Figure 6). The emissions are associated with the energy-using activities in each sector, such as the energy used by each sector's buildings, processes, and transportation. Emissions also include those from waste generated in each sector.

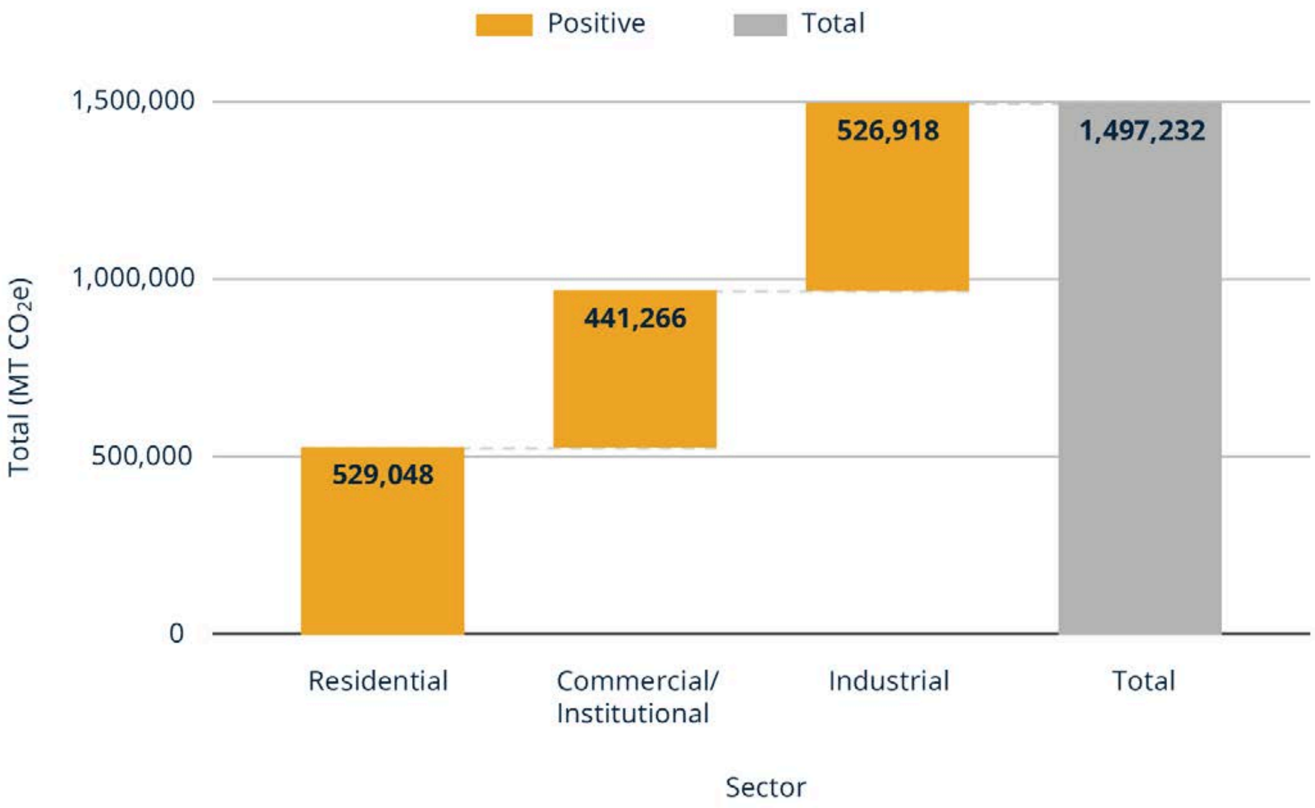

*Figure 6. GHG emissions by sector, 2021, excluding agriculture and forestry. Source: SSG analysis.*

Figure 7 summarizes GHG emissions by sector. Emissions in the residential sector are dominated by mobile combustion (transportation) emissions (52%). The commercial/institutional and industrial sectors are dominated by emissions from electricity (59% and 47%, respectively).

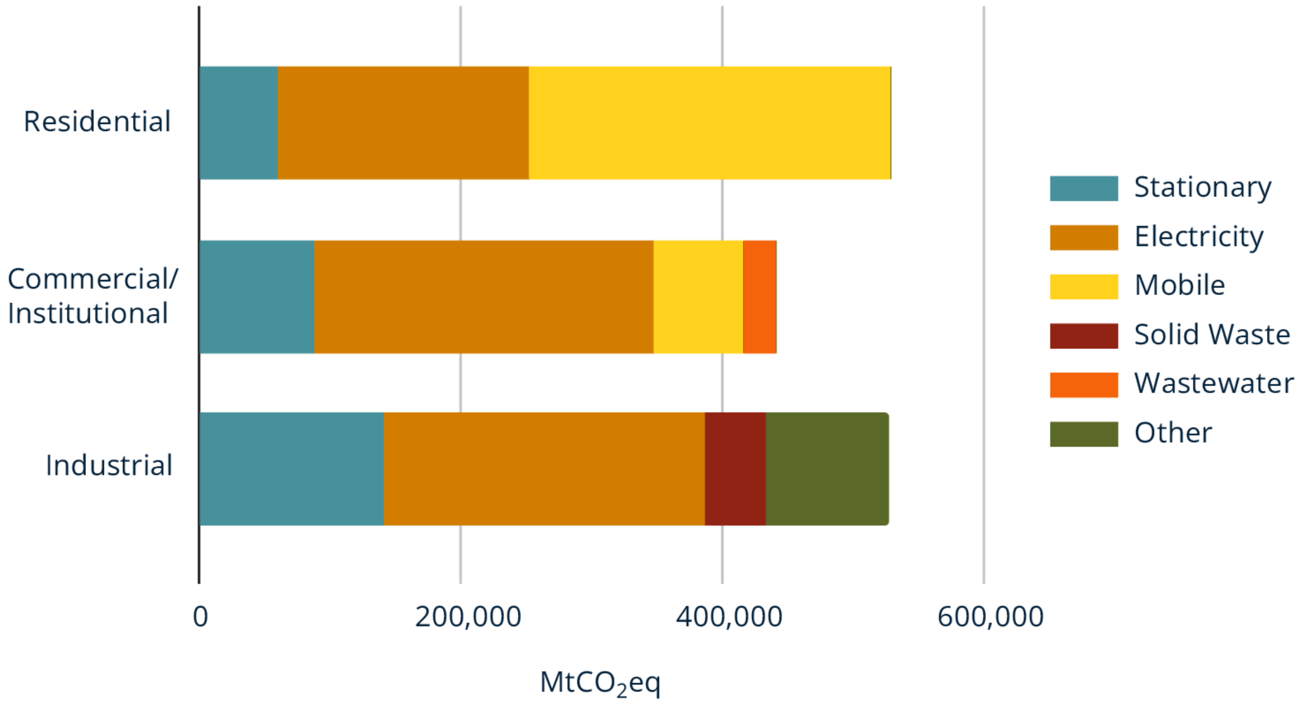

*Figure 7. GHG emissions with sectoral components, 2021. Source: SSG analysis.*

## 3.2 Emissions by Sub-sector

Electricity is the major source of GHG emissions overall (47% of the total), followed by transportation emissions (23%) and stationary emissions (natural gas) (19%) (Figure 8). Reducing GHG emissions from electricity would cut the region's GHG emissions by almost 700,000 $MtCO_2e$ annually, nearly half of the region's total annual emissions. Solid waste and wastewater treatment represent less than 5% of the total emissions (<0.08 $MtCO_2e$).

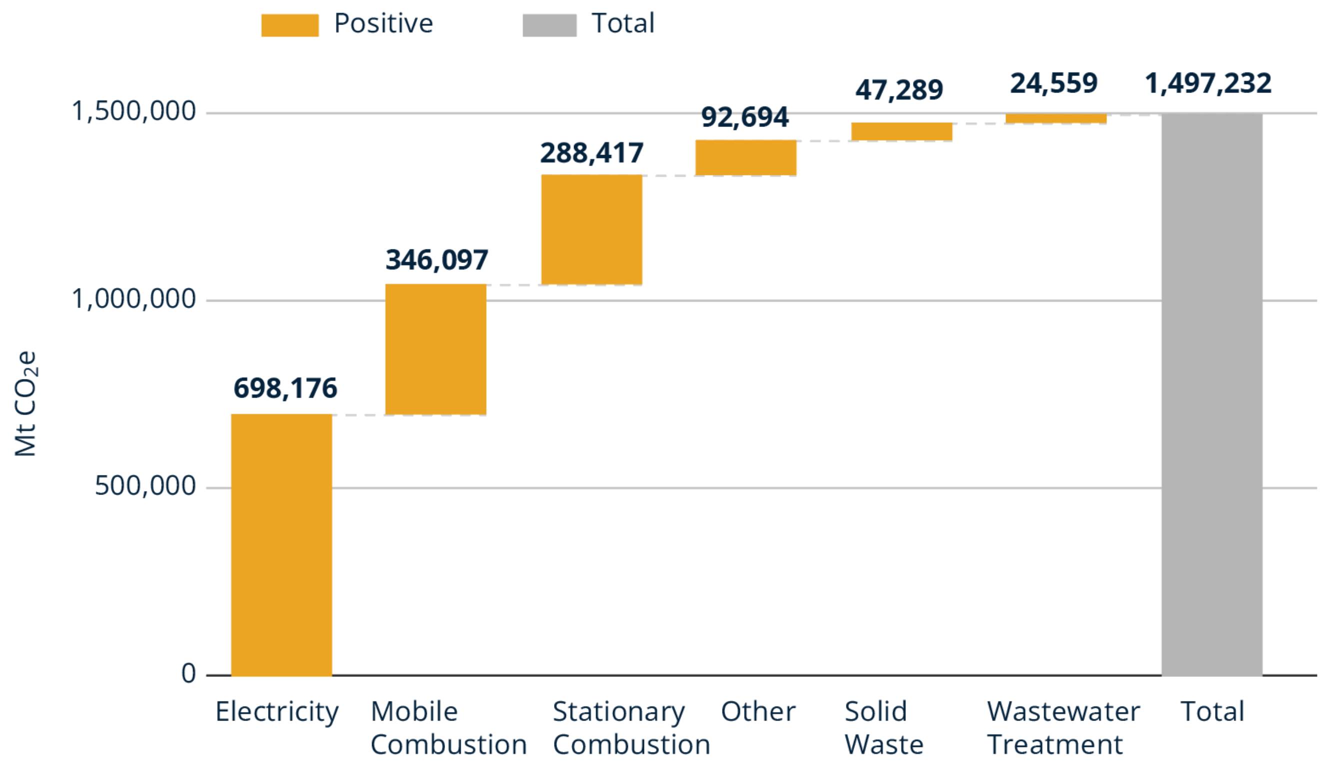

*Figure 8. GHG emissions by sub-sector, 2021. Source: SSG analysis.*

## 3.3 Emissions by Scope

For base year 2021, Scope 1 GHG emissions totaled 799,056 $MtCO_2e$. Scope 2 GHG emissions were 698,176 $MtCO_2e$, which primarily result from electricity generation outside of Rapid City's boundaries. No GHG emissions from Scope 3 were tracked. GHG emission scopes are defined in Table 3 and Figure 9. Figure 10 graphs the region's GHG emissions by scope.

*Table 3. Reporting scopes of GHG emissions.*

| Scope | Definition |
|---|---|
| Scope 1 | GHG emissions from sources located within the city boundary. |
| Scope 2 | GHG emissions that occur as a consequence of grid-supplied electricity, heat, steam, and/or cooling use within the city boundary. |
| Scope 3 | All other GHG emissions that occur outside the city boundary as a result of activities taking place within the city boundary. |

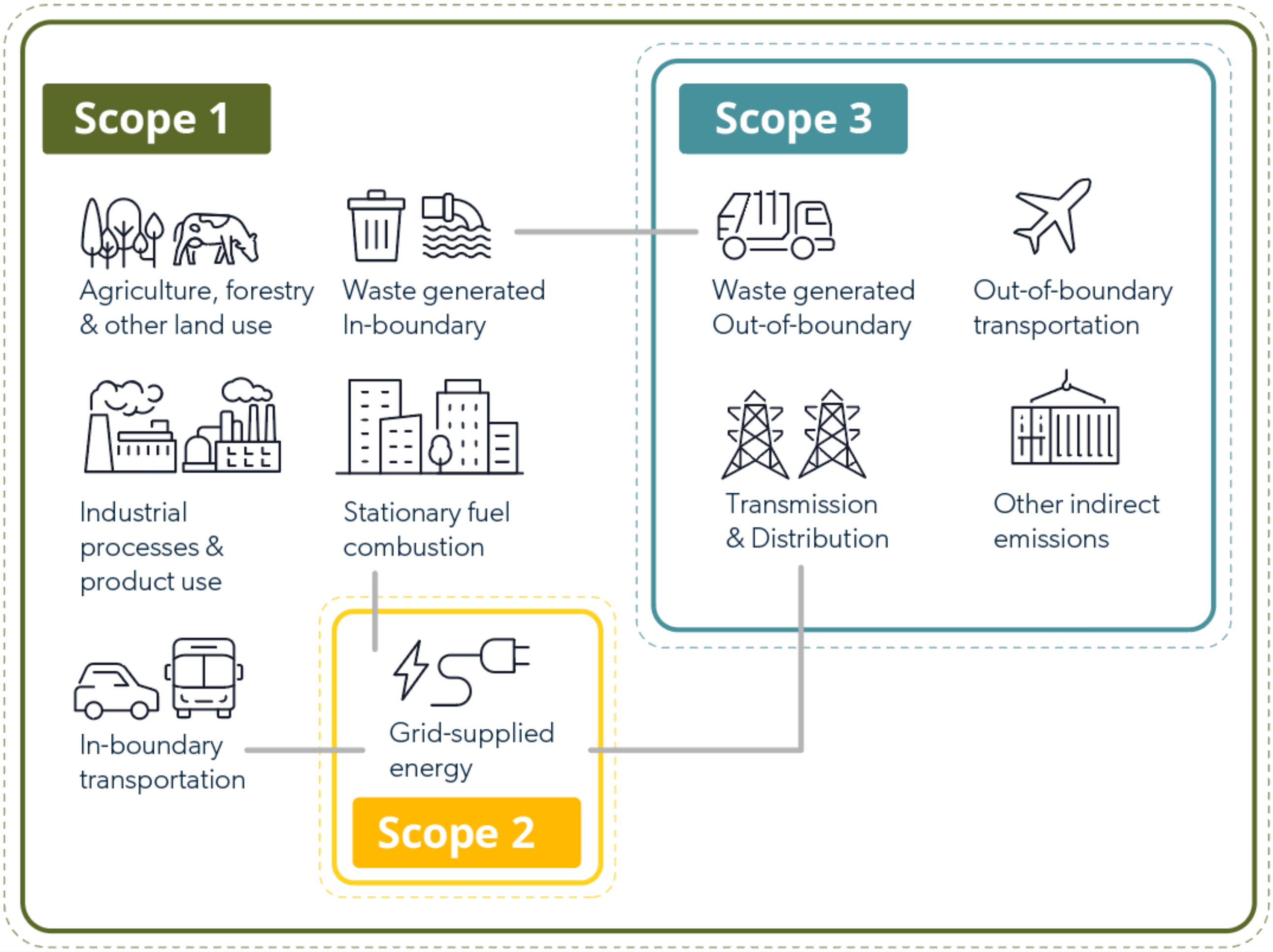

*Figure 9. Illustration of GHG emission scopes. Source: SSG elaboration.*

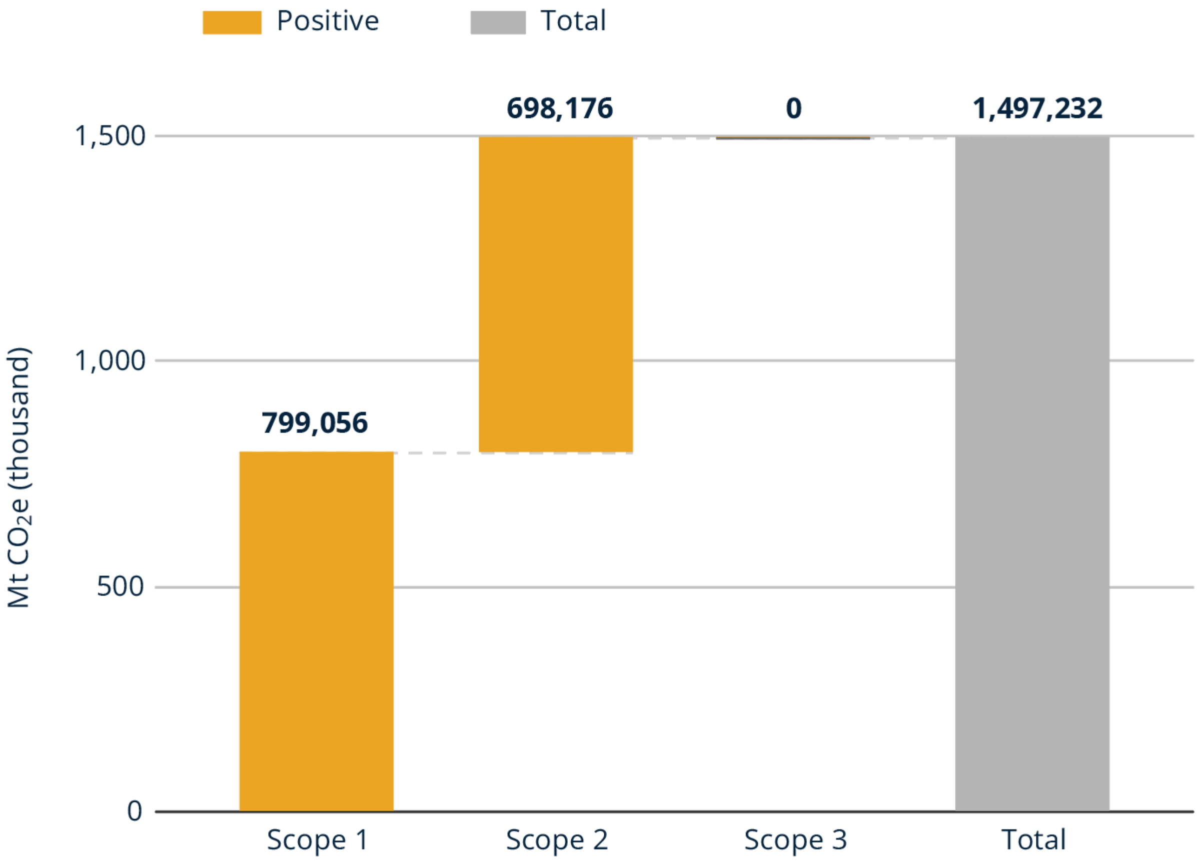

*Figure 10. GHG emissions by scope, 2021. Source: SSG analysis.*

## 3.4 Emissions by GHG Type

When all the GHG emissions have been normalized to carbon dioxide equivalents (how potent each gas is compared to the global warming potency of carbon dioxide), carbon dioxide ($CO_2$) is the dominant source of emissions (Figure 11).

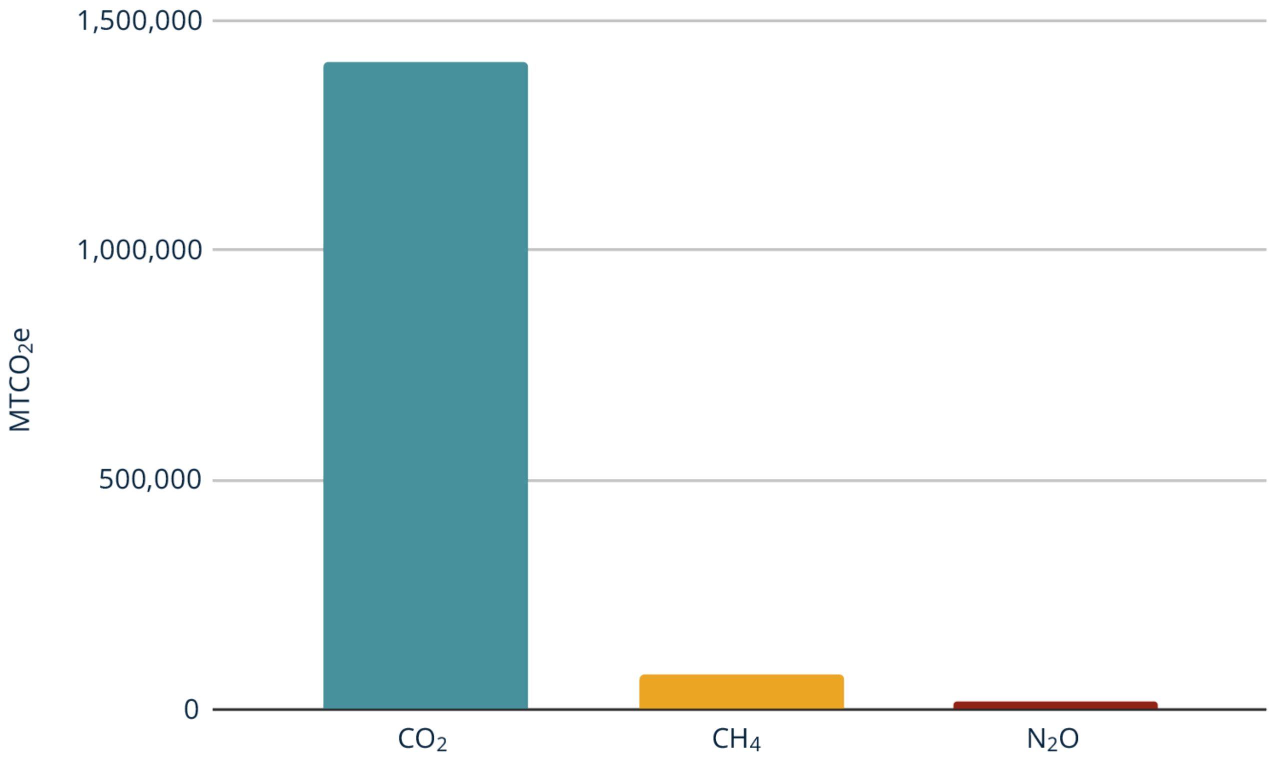

*Figure 11. GHG emissions by type, 2021. Source: SSG analysis.*

$CO_2$ emissions are directly correlated to the combustion of fossil fuels, such as coal, oil, and natural gas, as illustrated in Figure 12.

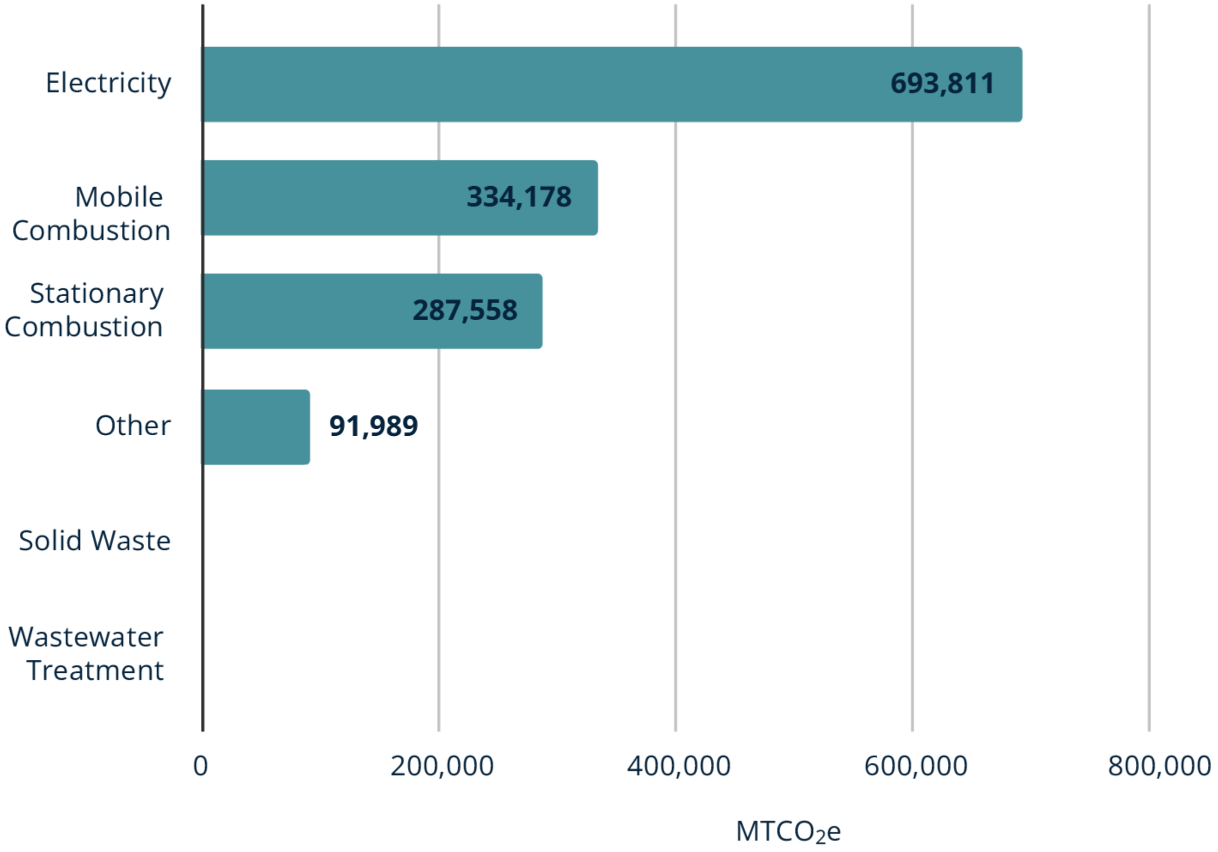

*Figure 12. GHG emissions, carbon dioxide ($CO_2$), 2021. Source: SSG analysis. Note that the region's electricity is primarily generated by coal-fired power plants.*

The largest source of methane ($CH_4$) emissions is solid waste, followed by wastewater treatment (Figure 13). Note that methane's long-term global warming potential (GWP) is used here, shown as $MtCO_2e$. GWP is the relative ability of a gas to trap heat, and each gas has a different GWP. If methane's short-term (20-year) GWP were used instead, methane emissions would nearly triple. A 20-year GWP reflects the importance of reducing methane emissions in the near term, but it is not standard in GHG emissions reporting protocols.

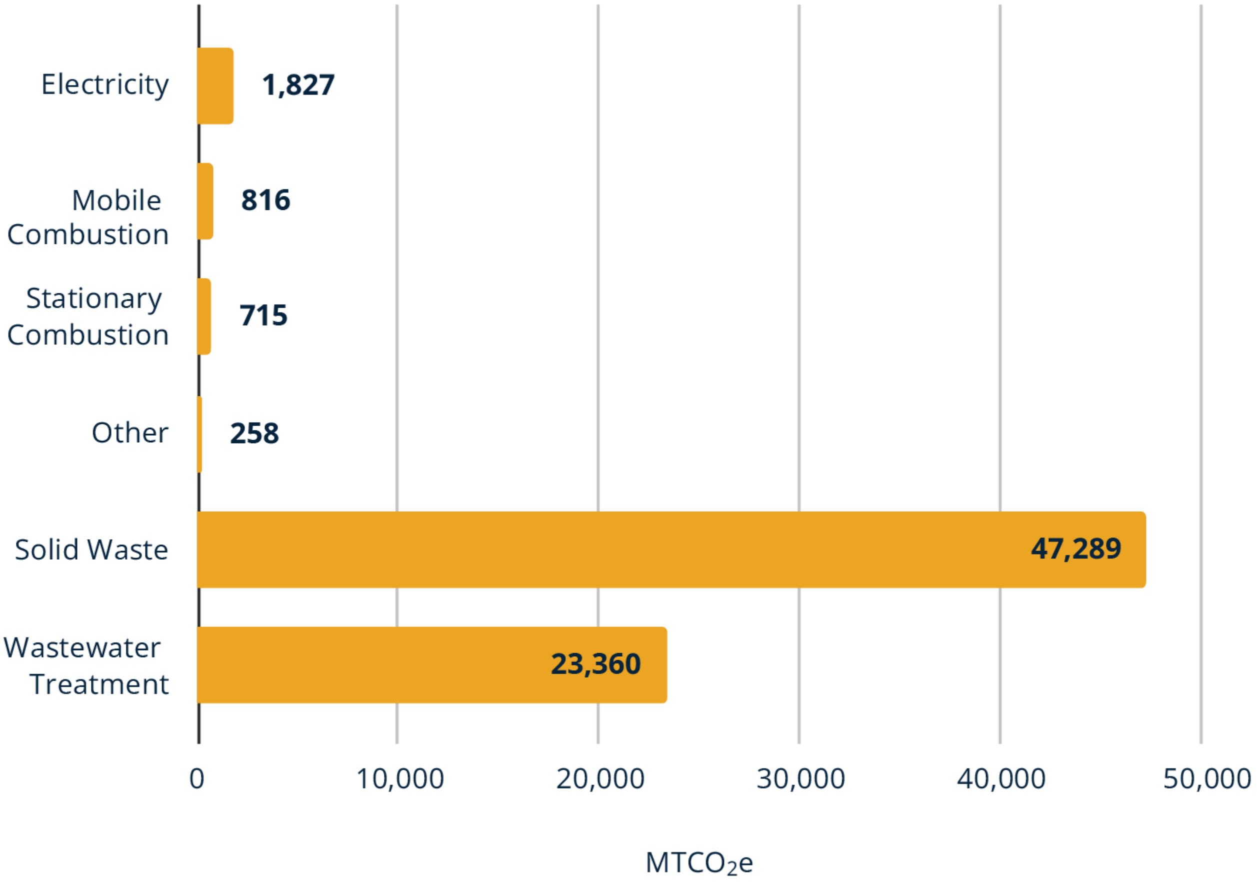

*Figure 13. GHG emissions, methane ($CH_4$), 2021. Source: SSG analysis.*

Nitrous oxide ($N_2O$) emissions are primarily from mobile combustion (transportation) sources (Figure 14).

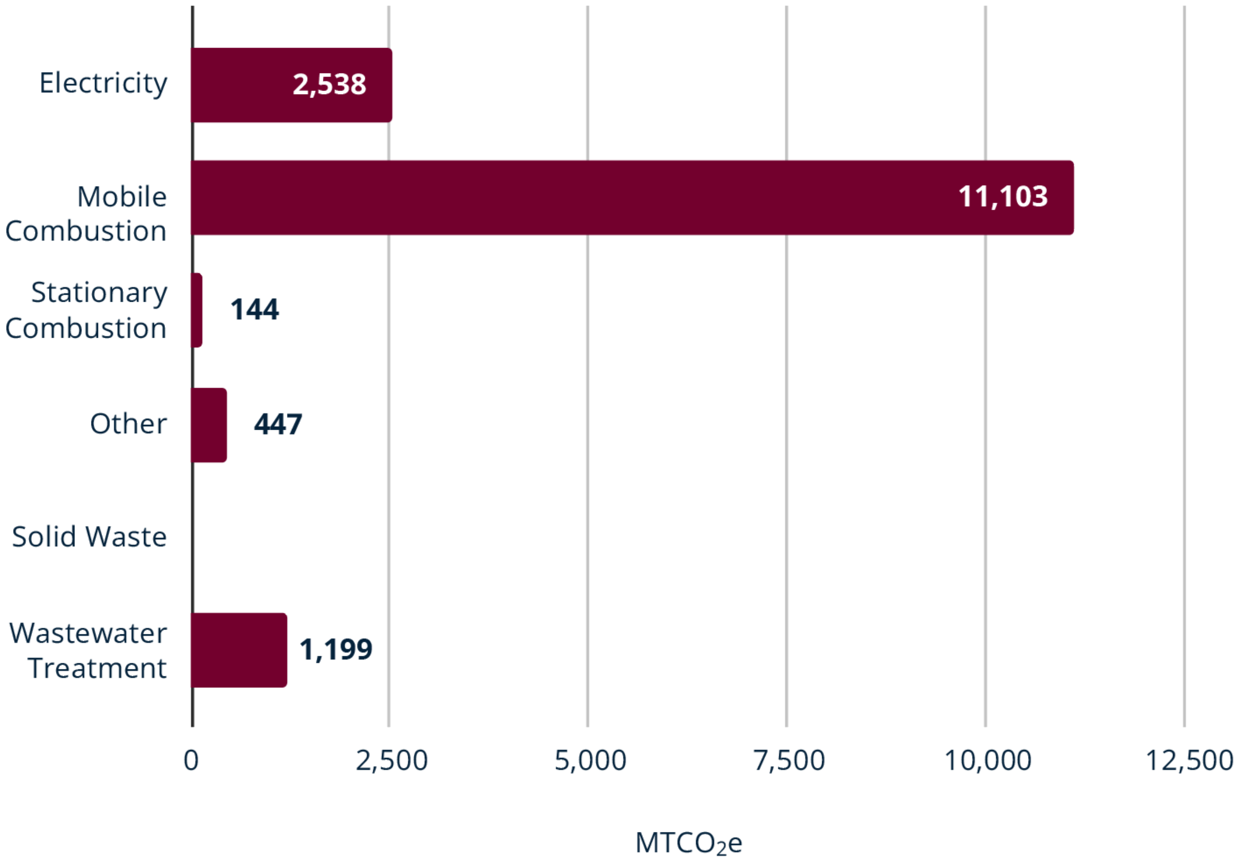

*Figure 14. GHG emissions, nitrous oxide ($N_2O$), 2021. Source: SSG analysis.*

## 3.5 Energy Use and Emission Shares

Electricity accounts for 31% of total energy supply but 52% of the total emissions, illustrating the potential for GHG emissions reductions from this sub-sector. Although electricity is mainly generated with fossil fuels, the fossil fuel segments illustrated in Figure 15 account for direct use of fossil fuels (i.e., combustion for heat, transportation, and industrial energy), not electricity generation.

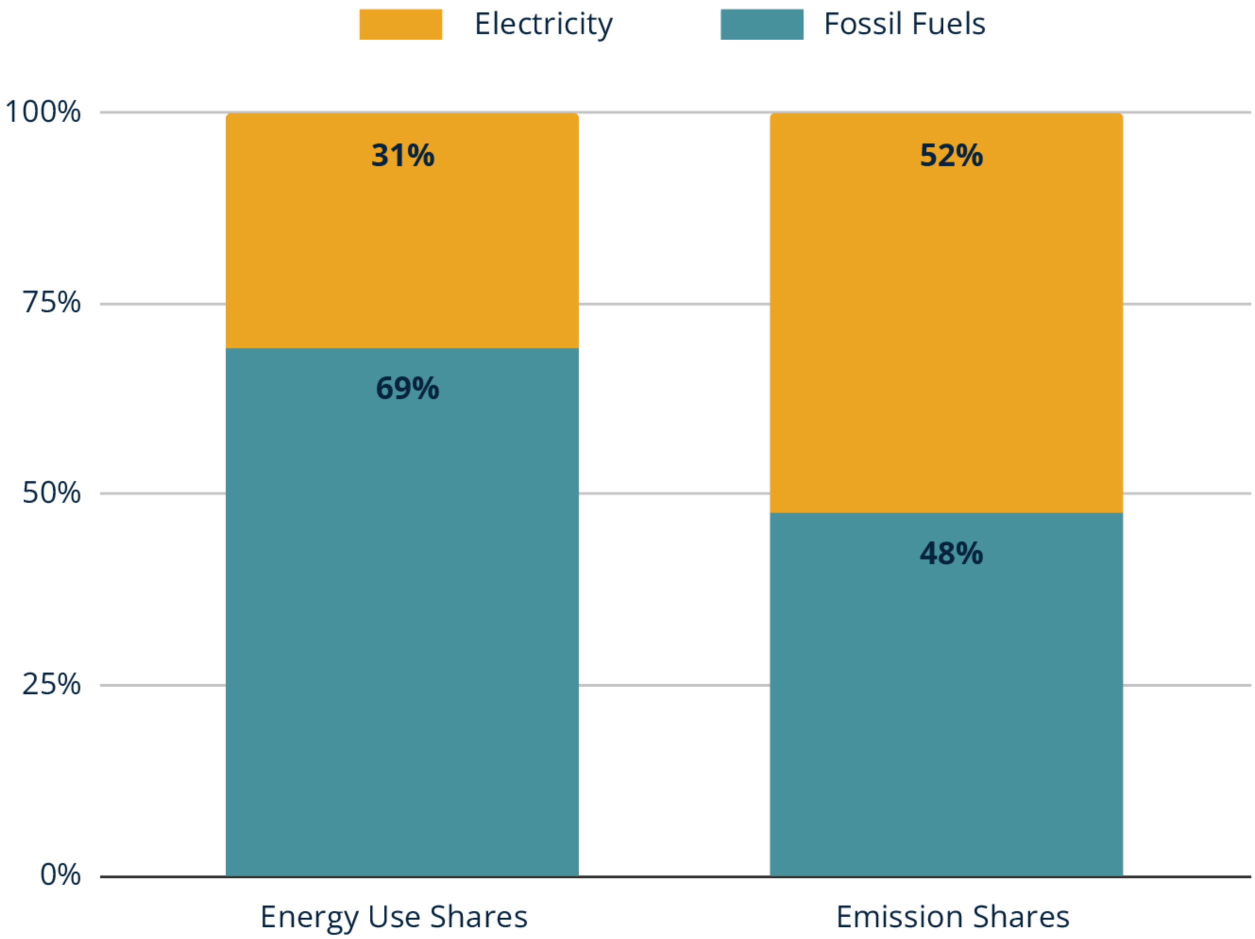

*Figure 15. Electricity vs. fossil fuels percentage of energy use and emission shares, 2021. Source: SSG analysis.*

# 3.6 Total Energy Use

As expected, the residential sector uses the most energy. Total energy consumption across all sectors is 14.6 million MMBTU (Figure 16).

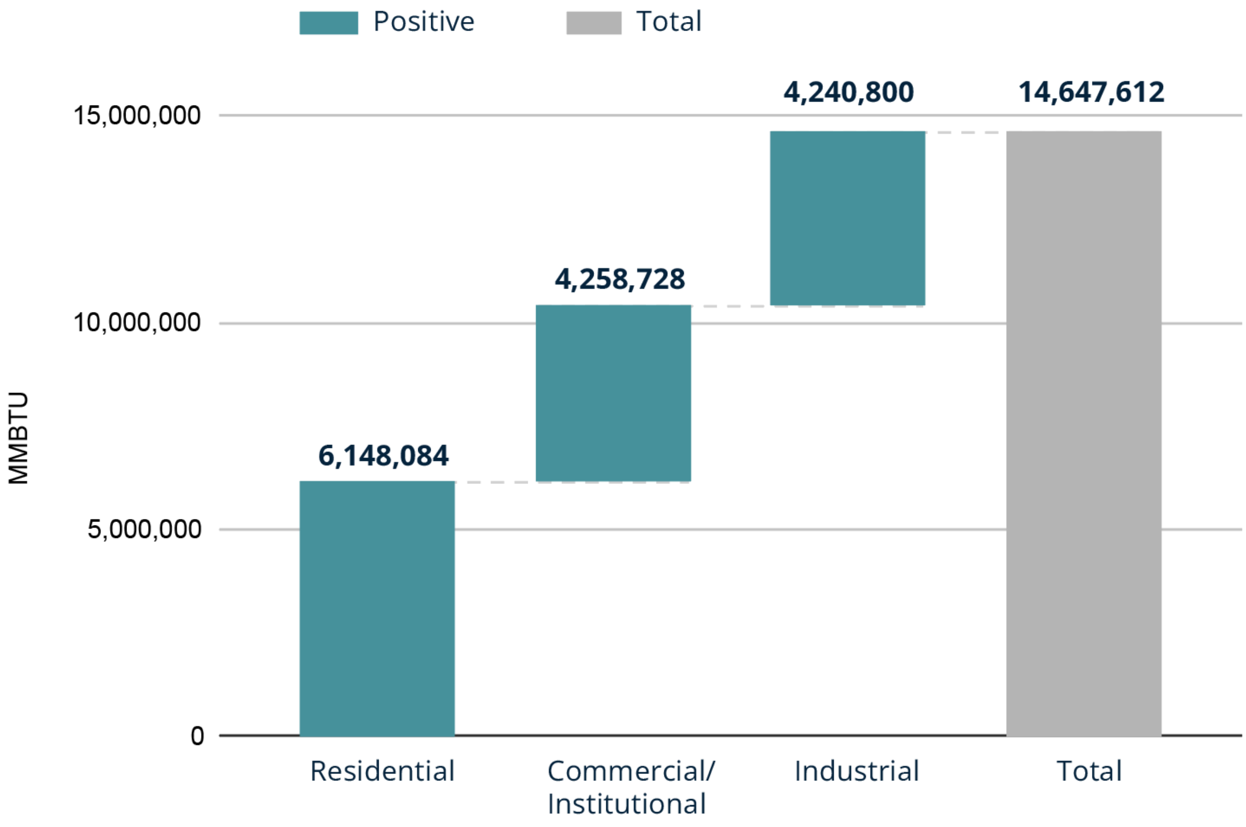

*Figure 16. Energy consumption by sector, 2021. Source: SSG analysis.*

## 3.7 Electricity Consumption

Electricity's share of stationary energy for the residential, commercial/institutional, and industrial sectors is 27%, 37%, and 35%, respectively (Figure 17).

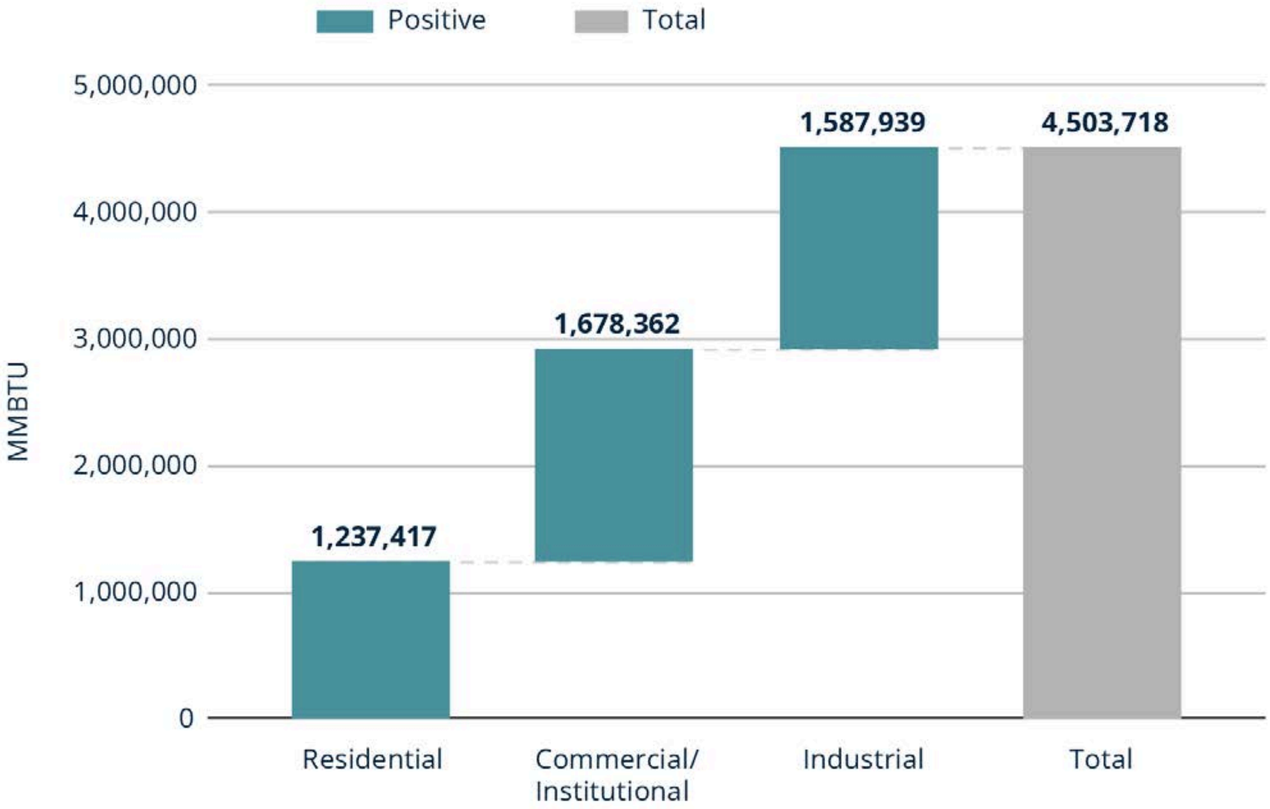

*Figure 17. Electricity consumption by sector, 2021. Source: SSG analysis.*

## 3.8 Business-as-Usual Projection

Based on current trends and projections in population, housing, employment, and vehicle growth, as well as energy generation, Rapid City's GHG emissions are projected to decrease over time by almost half (Figure 18), even though total energy consumption is projected to increase.[33] This projection to the year 2050 can be used as a business-as-usual (BAU) reference case.

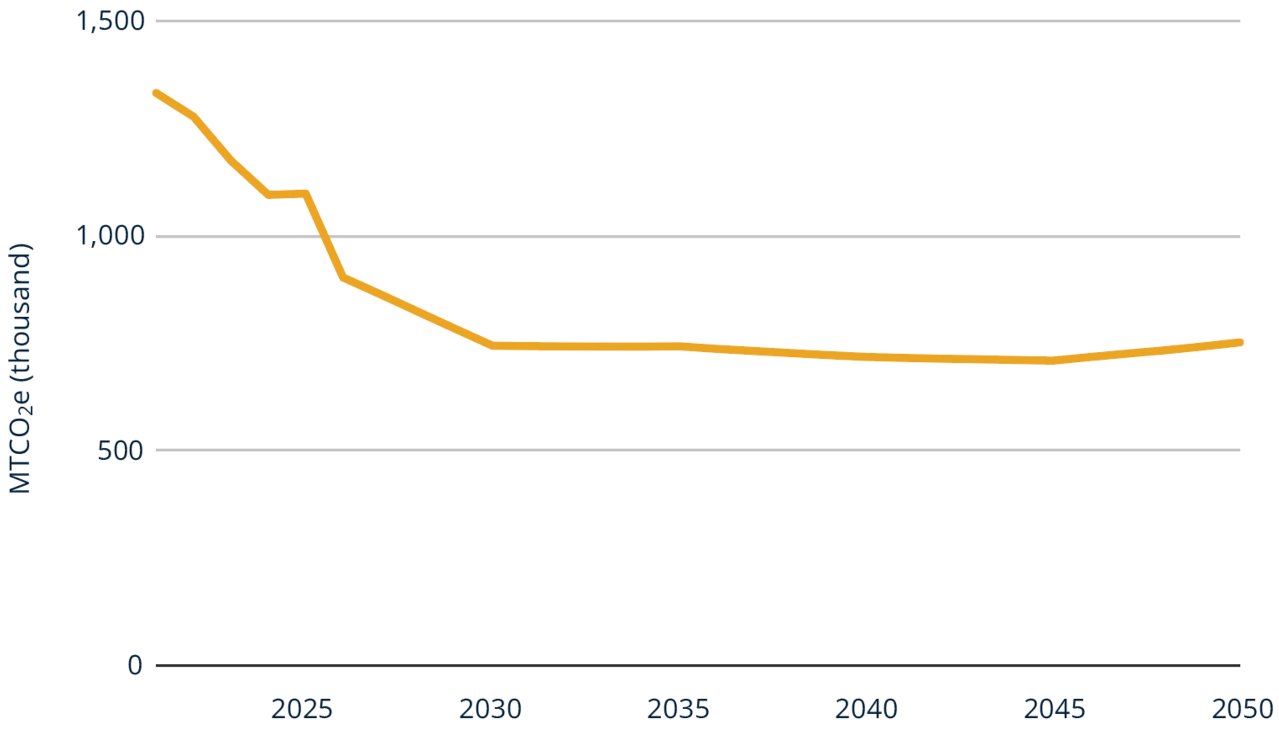

*Figure 18. Total GHG emissions, 2021–2050. Source: SSG analysis.*

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[33] Population projections come from the EPA State Inventory Projection Tool. https://www.epa.gov/statelocalenergy/state-inventory-and-projection-tool

The decrease in emissions is the result of increasingly clean electricity driven by the phasing out of coal-fired electricity generation and the decreasing costs for wind and solar. Figure 19 summarizes the BAU emission trajectories of each fuel used in the region.

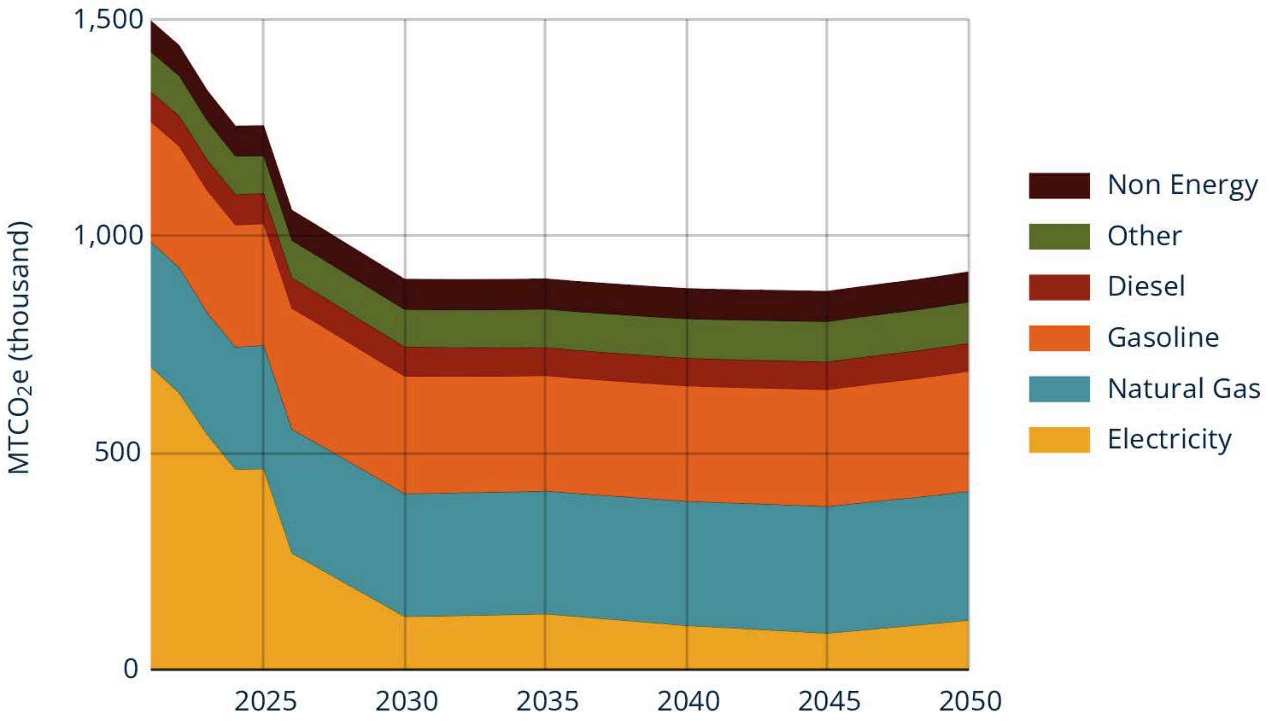

*Figure 19. GHG emissions by fuel and non-fuel sources, 2021–2050. Source: SSG analysis.*

The residential, commercial, and industrial sectors are all impacted by the BAU change in emissions associated with generating electricity. The industrial and commercial sectors see the largest reductions (Figure 20).

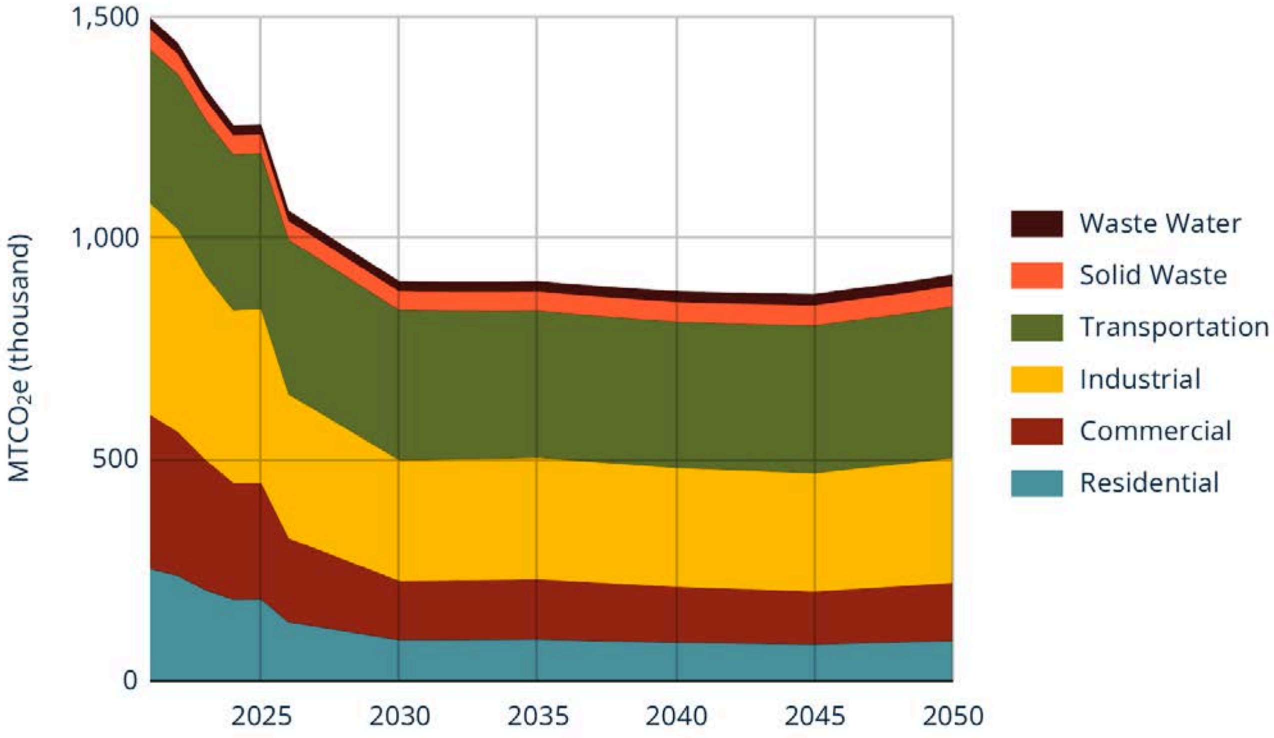

*Figure 20. GHG emissions by sector, 2021–2050. Source: SSG analysis.*

## 3.9 Observations

At 20 $MtCO_2e$, Rapid City's current per capita emissions are higher than the national average of 15 $MtCO_2e$. This is largely due to the coal- and natural gas-produced electricity consumed in the region by residential, commercial/institutional and industrial buildings. The region is also highly dependent on personal vehicles for getting to and from destinations, which generates substantial emissions from gasoline and diesel use. Over time, emissions will decrease in the building sector due to some coal- and natural gas-fired electricity generation phase out. However, there is little change in the emissions levels expected in the transportation (gas, diesel use), industry (electricity, natural gas, diesel use), waste, and wastewater sectors over the next 30 years.

Like many regions, Rapid City has the twin challenges of electrifying heating and transportation and cleaning the electricity system in parallel, both of which will require major investments. Reducing GHG emissions in transportation and heating involves technologies that may have bigger upfront costs but are lower cost to operate. These technologies are readily available.

As discussed above, removing coal from the electricity system will cut total GHG emissions by one third, and the technologies required to enable this transition are already cost effective.

The residential (buildings and transportation) and industrial sectors are the largest sources of GHG emissions. Priority measures for these sectors (identified later in this plan) will generate new employment opportunities while improving the quality and affordability of housing across the region and decreasing industrial operating costs.

This transition will be aided by opportunities to improve energy efficiency, including measures such as implementing building retrofits; increasing trips made by walking, cycling, and transit; and electrifying equipment (electric vehicles and heat pumps are more efficient than existing technologies). Maximizing energy efficiency minimizes the need for additional electricity generation and transmission capacity, which will reduce the cost of transitioning to cleaner energy systems. Increased efficiency also reduces energy costs for households and businesses.

# 4. Benefits Analysis for LIDAC

The CPRG program will advance the goals of the Justice40 Initiative set forth in Executive Order 14008, which aims to deliver 40% of the overall benefits of relevant federal investments to disadvantaged communities.

## 4.1 Methodology

The US Council on Environmental Quality's Climate and Economic Justice Screening Tool (CEJST) was used in combination with EPA's Environmental Justice Screening and Mapping (EJScreen) tool for an initial identification of low-income and disadvantaged communities and climate change impact risks.

### 4.1.1 The Climate and Economic Justice Screening Tool

The CEJST tool was used to identify disadvantaged communities at the census tract-level. Census tracts are considered disadvantaged in the CEJST tool if they are at or above the 65th percentile for the number of low-income households[34] and at or above the 90th percentile for one of the data indicators in the areas of climate change, energy, health, housing, legacy pollution, transportation, waste and wastewater, and workforce development, and/or if they are federally recognized Tribes. Table 4 presents the burdens included in each of these categories. In other words, disadvantaged communities are generally those with disproportionately high numbers of low-income households and exceptionally high exposure to one or more environmental burden(s).

*Table 4. Categories and types of burden in the CEJST and their corresponding descriptions.*

| Categories | Type of Burden | Description |
|---|---|---|
| Climate Change | Expected agriculture loss rate | Expected agricultural value at risk from losses due to the following natural hazards: avalanche, coastal flooding, cold wave, drought, hail, heat wave, hurricane, ice storm, landslide, riverine flooding, strong wind, tornado, wildfire, and winter weather. |
| | Expected building loss rate | Expected building value at risk from losses due to the following natural hazards: avalanche, coastal flooding, cold wave, drought, hail, heat wave, hurricane, ice storm, landslide, riverine flooding, strong wind, tornado, wildfire, and winter weather. |

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[34] In the CEJST tool, low income households are defined as households where household income is at or below 200% of the Federal poverty level, not including students enrolled in higher education. This is based on US Census Bureau American Community Survey data from 2015-2019. In 2023, the Federal poverty level (100%) for a household of 4 is $30,000.

| Categories | Type of Burden | Description |
|---|---|---|
| Climate Change | Expected population loss rate | Expected fatalities and injuries due to the following natural hazards: avalanche, coastal flooding, cold wave, drought, hail, heat wave, hurricane, ice storm, landslide, riverine flooding, strong wind, tornado, wildfire, and winter weather. |
| | Projected flood risk | Number of properties at risk of floods occurring in the next 30 years (projected from a high-precision climate model) from tides, rain, and riverine and storm surges, or a 26% risk total over the 30-year time horizon. |
| | Projected wildfire risk | A model projecting the wildfire exposure for any specific location in the contiguous US today and with future climate change. The risk of wildfire is calculated from inputs associated with fire fuels, weather, human influence, and fire movement. |
| Energy | Energy cost | Average household annual energy cost in dollars, divided by the average household income. |
| | PM2.5 in the air | Fine inhalable particles with 2.5 or smaller micrometer diameters. The percentile is the weight of the particles per cubic meter. |
| Health | Asthma | Share of people who answer “yes” to both of these questions: “Have you ever been told by a health professional that you have asthma?” and “Do you still have asthma?” |
| | Diabetes | Share of people ages 18 years and older who have been told by a health professional that they have diabetes other than diabetes during pregnancy. |
| | Heart disease | Share of people ages 18 years and older who have been told by a health professional that they have angina or coronary heart disease. |
| | Low life expectancy | Average number of years people have left in their lives. |
| Housing | Historic underinvestment | Census tracts that experienced historic underinvestment based on redlining maps between 1935 and 1940. |
| | Housing cost | Share of households that are both earning less than 80% of Housing and Urban Development’s Area Median Family Income and are spending more than 30% of their income on housing costs (here onwards, also mentioned as housing burden). |
| | Lack of green space | Share of land with developed surfaces covered with artificial materials like concrete or pavement, excluding crop land used for agricultural purposes. |
| | Lack of indoor plumbing | Housing without indoor kitchen facilities or complete plumbing facilities. |

| **Categories** | **Type of Burden** | **Description** |
|---|---|---|
| Housing | Lead paint | Share of homes built before 1960, which indicates potential lead paint exposure. |
| Legacy Pollution | Abandoned mine land | Presence of an abandoned mine left by legacy coal mining operations. |
| | Formerly Used Defense Sites | Properties that were owned, leased, or possessed by the United States, under the jurisdiction of the Secretary of Defense prior to October 1986. |
| | Proximity to hazardous waste facilities | Number of hazardous waste facilities (Treatment, Storage, and Disposal Facilities and Large Quantity Generators) within 3 miles. |
| | Proximity to Superfund sites | Number of proposed or listed Superfund or National Priorities List (NPL) sites within 3 miles. |
| | Proximity to Risk Management Plan facilities | Count of Risk Management Plan (RMP) facilities within 3 miles.[35] |
| Transportation | Diesel particulate matter exposure | Mixture of diesel exhaust particles in the air, measured as micrograms per cubic meter. |
| | Transportation barriers | Average relative cost and time spent on transportation relative to all other tracts. |
| | Traffic proximity and volume | Number of vehicles (average annual daily traffic) at major roads within 1650 ft. |
| Water and Wastewater | Underground storage tanks and releases | Weighted formula of the density of leaking underground storage tanks and the number of all active underground storage tanks within 1,500 ft of the census tract boundaries. |
| | Wastewater discharge | Risk-Screening Environmental Indicators (RSEI) modeled toxic concentrations at stream segments within 1650 ft. |
| Workforce Development | Linguistic isolation | Share of households where no one over age 14 speaks English very well. |
| | Low median income | Low median income calculated as a share of the area's median income. |
| | Poverty | Share of people living at or below 200% of the federal poverty level. |
| | Unemployment | Number of unemployed people as a share of the labor force. |

*Source: US Council on Environmental Quality, "Climate and Economic Justice Screening Tool."*

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[35] These facilities are mandated by the Clean Air Act to file RMPs because they handle substances with significant environmental and public health risks.

To supplement tract-level information, census tracts with a disproportionately high number of burdens were investigated via the Environmental Justice (EJ) and Supplemental Indexes from the EJScreen Tool to learn more descriptive information about these areas.

### 4.1.2 Environmental Justice Screening and Mapping

In addition to the CEJST, the EPA's Environmental Justice Screening and Mapping Tool (EJScreen)[36] was used to complement the LIDAC analysis. The EJScreen contains environmental and demographic indicators. There are similarities to those described above in the CEJST (Table 4). A summary of the EJScreen's indicators is presented in Table 5.

*Table 5. Summary of the EPA's EJScreen indicators.*

| Environmental Indicators | Socioeconomic Indicators |
|---|---|
| • Particulate matter 2.5<br>• Ozone<br>• Diesel particulate matter<br>• Air toxics cancer risk<br>• Air toxics respiratory hazard index<br>• Toxic releases to air<br>• Traffic proximity and volume<br>• Lead paint<br>• Superfund proximity<br>• Risk Management Plan facility proximity<br>• Hazardous waste proximity<br>• Underground storage tanks and releases<br>• Wastewater discharge | • People of color<br>• Low income<br>• Unemployment rate<br>• Limited English speaking<br>• Less than high school education<br>• Under age five<br>• Over age 64 |

The EJScreen is a computer mapping technology that provides a single, nationally consistent tool used by the EPA, the government, partners, and the public for environmental and demographic characteristics of locations across the US. It includes two demographic indexes: 1) the Demographic Index based on the average of the two demographic indicators: percent low-income households and percent people of color; and 2) the Supplemental Demographic Index based on the average of five indicators: percent of low-income, unemployed, limited English speaking, less than high school education, and low life expectancy. The EJScreen uses the demographic indexes for two sets of overall indexes: 13 EJ indexes and 13 supplemental indexes. These indexes are a combination of the environmental indicators and the Demographic Index or the Supplemental Demographic Index.

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[36] Environmental Protection Agency (EPA). "Environmental Justice Screening and Mapping Tool." Data and Tools, 2023. https://www.epa.gov/ejscreen.

In order to categorize communities as disadvantaged according to the EJScreen tool, the EPA defines them according to:

- Any census tract that is included as disadvantaged in the CEJST;
- Any census block group at or above the 90th percentile for any of EJScreen's Supplemental Indexes when compared to the nation or state; and/or
- Any geographic area within Tribal lands, as included in EJScreen, including:
    - Alaska Native Allotments
    - Alaska Native Villages
    - American Indian Reservations
    - American Indian Off-reservation Trust Lands
    - Oklahoma Tribal Statistical Areas

Using the CEJST and EJScreen to identify disadvantaged communities, the following section describes communities in the Rapid City MSA, according to the categories shown above, in general terms, and it identifies communities affected by the GHG reduction measures. For some measures, Section 6: Priority GHG Reduction Measures presents a map with identified locations and identification of potential benefits resulting from the implementation of each proposed GHG reduction measure.

## 4.2 Low-Income and Disadvantaged Communities

This section presents the low-income and disadvantaged communities within the three counties of Pennington, Meade, and Lawrence and the number of burden categories they are facing, following the CEJST methodology (Figure 21).

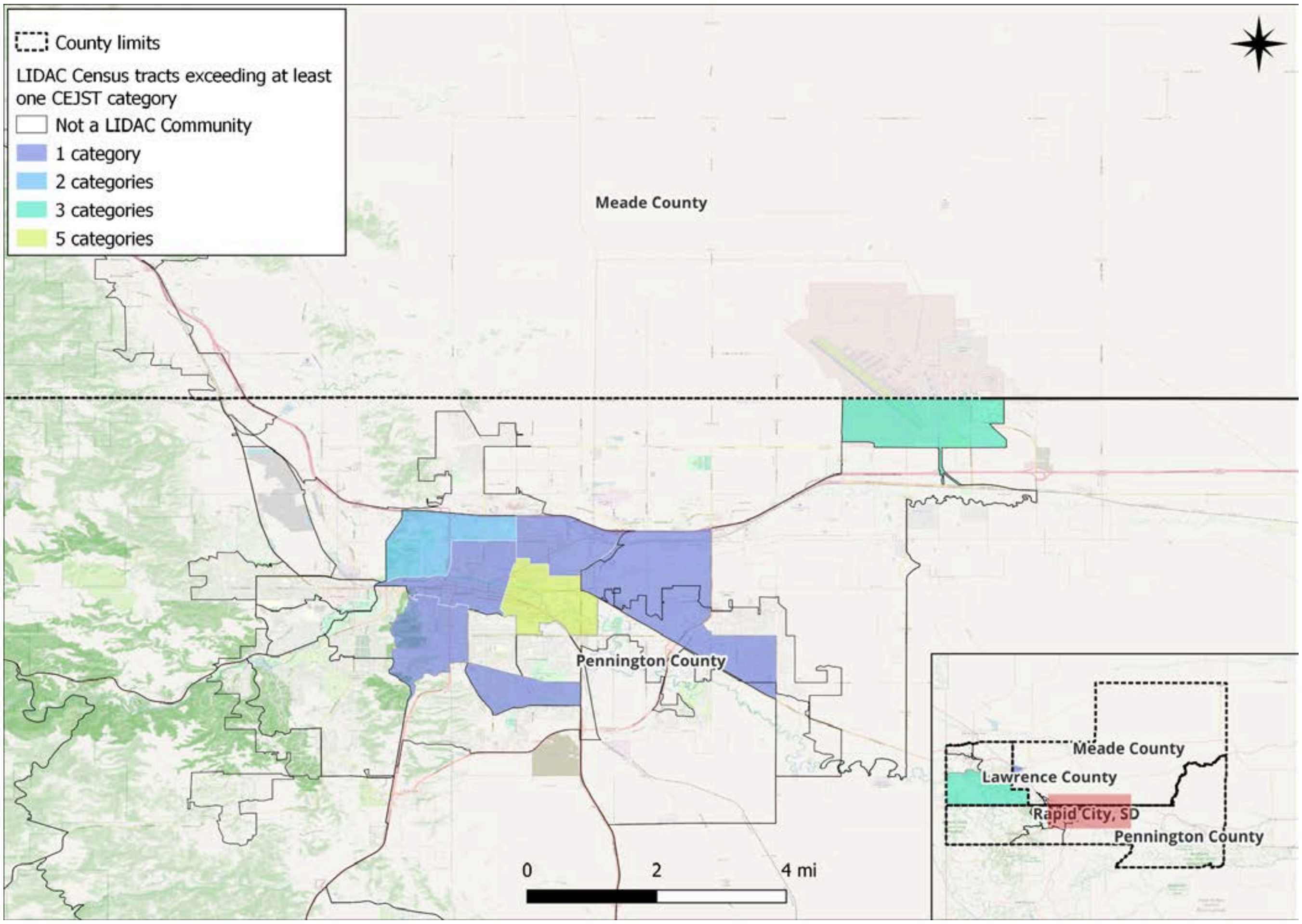

*Figure 21. Low-income and disadvantaged communities in Rapid City by census tracts. The color of the tracts indicates the number of categories where the CEJST thresholds are exceeded.*[37]

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[37] Census tracts are considered disadvantaged in the CEJST tool if they are at or above the 65th percentile for the number of low-income households and at or above 90th percentile for one of the data indicators in the areas of climate change, energy, health, housing, legacy pollution, transportation, waste and wastewater, workforce development, and/or are Federally Recognized Tribes.

Most LIDAC are located in the center of Rapid City, except one tract in southern Lawrence County, one in Sturgis, and one in Box Elder, as shown in Figure 21. These tracts rank in the 90th percentile of the CEJST categories and they rank at least at the 65th percentile for low income, which makes them more vulnerable to the different burdens described in Table 4. A list of these census tracts can be found in Appendix C.

The EPA criteria to define a disadvantaged communities area is broader. Figures 22 and 23 present these communities. Most of the urbanized areas in and around Rapid City now fall under the definition of disadvantaged community, as well as most of Lawrence County and some of Meade County census block groups.

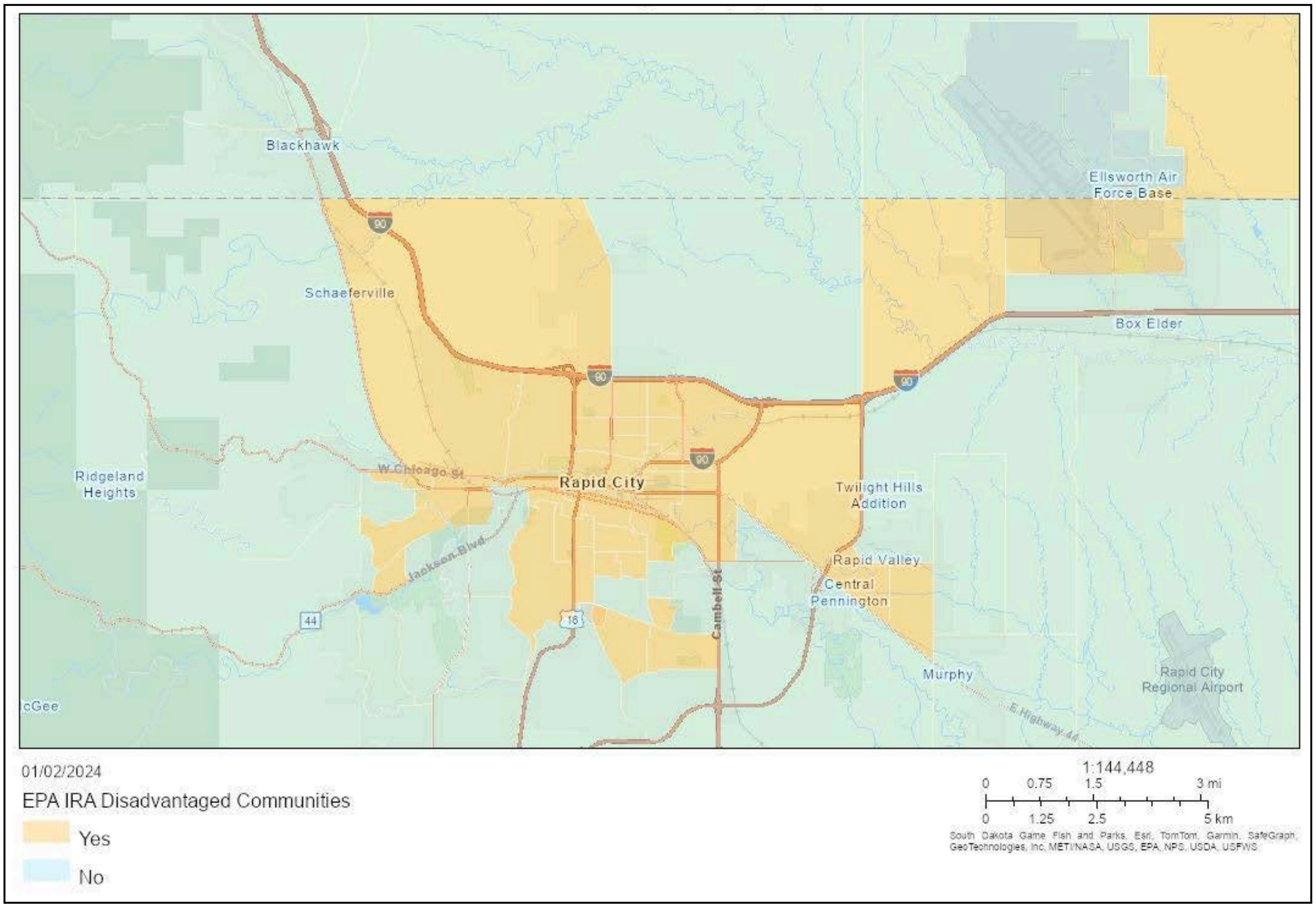

*Figure 22. Map presenting the EPA IRA Disadvantaged Communities around Rapid City and Box Elder. Source: EPA, 2023.*

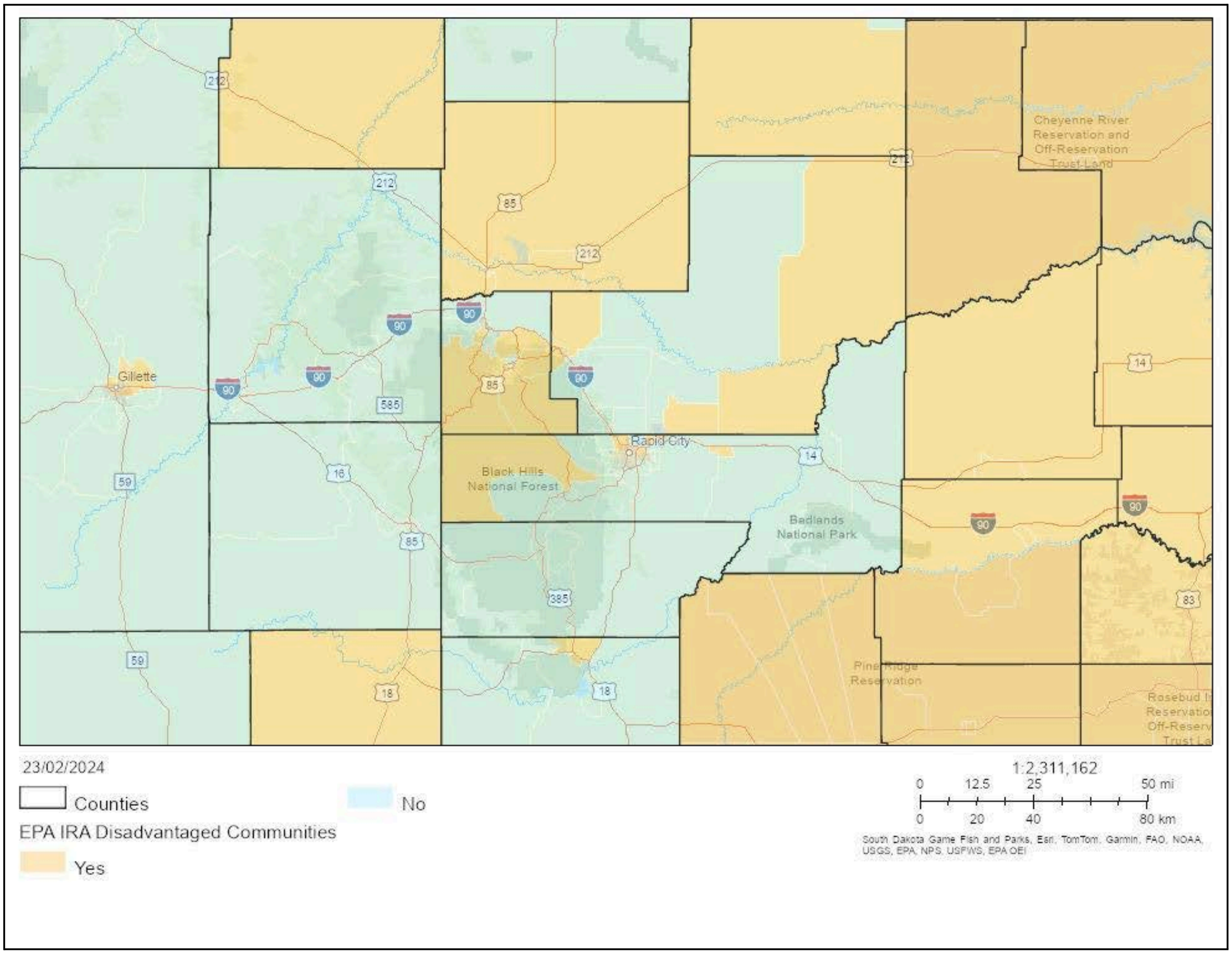

*Figure 23. Map presenting the EPA IRA Disadvantaged Communities in Pennington, Meade and Lawrence Counties. Source: EPA, 2023.*

This section details the composition of the population and describes the different kinds of burdens each of the three counties face.[38]

**Pennington County** has a population of 108,707. Major population centers include Rapid City and Box Elder. Of the total population, 28% are considered low-income and 22% are people of color (American Indian and Alaska Native People: 8%; Hispanic: 6%; Two or more races: 5%). The county has 69% owner-occupied housing. Within the county, there are two hazardous waste, treatment, storage, and disposal facilities; 243 water dischargers; 78 air pollution sites; four brownfields; and 23 sites on a toxic release inventory. While there are no Superfund sites reported, the county ranks high for proximity to Superfund sites (implying a nearby area has a Superfund site—in Meade and Lawrence Counties). Pennington County contains Justice40 CJEST

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[38] Environmental Protection Agency (EPA). "Environmental Justice Screening and Mapping Tool." Data and Tools, June 2023. https://www.epa.gov/ejscreen/overview-environmental-indicators-ejscreen

disadvantaged communities, EPA IRA disadvantaged communities, and American Indian Off-reservation Trust Lands (Shakopee Mdewakanton Sioux Community). Some census tracts, mostly in Rapid City and Box Elder, have critical service gaps, including broadband gaps, lack of health insurance, housing burdens, and food deserts. The county ranks high for flood risk (85th percentile in the state and 78th percentile in the country) and higher for wildfire risk (78th percentile in the state and 92nd percentile in the country).  Pennington County also has impaired waters, as designated by the Section 303(d) of the Clean Water Act.

Rapid City has a population of 78,824, with 79% identifying as White (alone) and 9% identifying as American Indian or Alaska Native (alone). The owner-occupied housing rate is 62%. An estimated 13% of people live in poverty.[39] Just to the east of Rapid City is a developed, unincorporated area known as Rapid Valley, with an additional population of 8,098.[40]

Box Elder has a population of 12,581, with 78% identifying as White (alone), 10% identifying as American Indian or Alaska Native (alone), and 6% identifying as Hispanic or Latino. The owner-occupied housing rate is 51%. An estimated 6% of people live in poverty.[41] Box Elder, specifically, is close to a Superfund site (Ellsworth Air Force Base), has a significant number of children less than five years of age, and has food desert census tracts constituting a critical service gap.

**Meade County** has a population of 29,561. Major population centers include Sturgis, Piedmont, and Summerset. Of the total population, 26% are considered low-income and 13% are people of color (American Indian and Alaska Native People: 3%; Hispanic: 4%; Two or more races: 4%). The county has 75% owner-occupied housing. Within the county, there is one Superfund site; one hazardous waste, treatment, storage, and disposal facility; 91 water dischargers; one air pollution site; six brownfields; and one site on a toxic release inventory. Meade County contains Justice40 CJEST disadvantaged communities, EPA IRA disadvantaged communities, and American Indian Off-reservation Trust Lands (near Bear Butte). The county has broadband service gaps in Sturgis. The county ranks high for flood risk (91st percentile in the state and 84th percentile in the country) and also high for wildfire risk (82nd percentile in the state and 93rd percentile in the country). The county also contains Clean Water Act impaired waters.[42]

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[39] US Census Bureau. “QuickFacts: Rapid City, South Dakota.” Census Data. Accessed January 31, 2024. https://www.census.gov/quickfacts/fact/table/rapidcitycitysouthdakota/PST045222.

[40] US Census Bureau. “QuickFacts: Rapid Valley CDP, South Dakota,” 2022. https://www.census.gov/quickfacts/fact/table/rapidvalleycdpsouthdakota/PST045222.

[41] US Census Bureau. “QuickFacts: Box Elder, South Dakota.” Census Data, 2022. https://www.census.gov/quickfacts/fact/table/boxeldercitysouthdakota/PST045222.

[42] Environmental Protection Agency (EPA). “Environmental Justice Screening and Mapping Tool.” Data and Tools, June 2023. https://www.epa.gov/ejscreen.

Sturgis has a population of 7,170, with 94% identifying as White (alone) and 2% identifying as Black (alone). The owner-occupied housing rate is roughly 67%. An estimated 7% of people live in poverty.[43] Only one census tract in the middle of Sturgis is struggling with many burdens (more than 90th percentile): broadband gap, lack of insurance, low income, and underemployment. Sturgis is also where the biggest flood risk occurs in Meade County.[44]

**Lawrence County** has a population of 25,687. Major population centers include Spearfish, Lead, and Deadwood. Of the total population, 30% are considered low-income and 10% are people of color (American Indian and Alaska Native People: 2%; Hispanic: 4%; Two or more races: 3%). The county has 64% owner-occupied housing. Within the county, there is one Superfund site; one hazardous waste, treatment, storage, and disposal facility; 83 water dischargers; 12 air pollution sites; two brownfields; and eight sites on a toxic release inventory. Lawrence County contains Justice40 CJEST disadvantaged communities and EPA IRA disadvantaged communities. The county has critical service gaps, including transportation access and food deserts. The county ranks high for flood risk (91st percentile in the state and 83rd percentile in the country) and for wildfire risk (67th percentile in the state and 89th percentile in the US). The county also has impaired waters.[45]

Spearfish has a population of 12,914, with 91% identifying as White (alone) and 3% identifying as American Indian or Alaska Native (alone). The owner-occupied housing rate is 51%. An estimated 15% of people live in poverty.[46] Additionally, Spearfish has a high cancer rate (96th percentile) and a high number of people with disabilities (97th percentile), and one tract in Spearfish has a high percentage of people over 64 years old (ranking 99th percentile).

Lead has a population of 2,989 with specific burdens of wastewater discharge (ranking 96th percentile nationwide) and lead paint (88th–93rd percentile).[47]

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[43] US Census Bureau. “QuickFacts: Sturgis City, South Dakota.” Accessed February 21, 2024. https://www.census.gov/quickfacts/fact/table/sturgiscitysouthdakota/PST045223.

[44] Environmental Protection Agency (EPA). “Environmental Justice Screening and Mapping Tool.” Data and Tools, June 2023. https://www.epa.gov/ejscreen.

[45] Environmental Protection Agency (EPA). “Environmental Justice Screening and Mapping Tool.” Data and Tools, June 2023. https://www.epa.gov/ejscreen.

[46] US Census Bureau. “QuickFacts: Rapid City, South Dakota.” Census Data. Accessed January 31, 2024. https://www.census.gov/quickfacts/fact/table/rapidcitycitysouthdakota/PST045222.

[47] Environmental Protection Agency (EPA). “Environmental Justice Screening and Mapping Tool.” Data and Tools, June 2023. https://www.epa.gov/ejscreen.

# 5. Engagement

## 5.1 Overview of Engagement

PCAP development requires the integration of community input and technical analyses. Engagement began in November 2023 and concluded in February 2024. The effort involved planning, facilitating meetings and discussions, and summarizing outcomes.

The work began with the development of a pre-engagement plan. It outlined the approach for pre-engagement in anticipation of Rapid City's climate planning process. The pre-engagement plan focused on understanding how to effectively engage interested and affected parties, as well as the overall community, for development of the PCAP and CCAP.

The following PCAP and the CCAP objectives informed pre-engagement efforts:

- **PCAP:** Engagement will inform and consult on the identification of priority measures and the criteria used to evaluate them. It will also involve key parties in assessing PCAP measures. The PCAP process has a tight schedule and offers fewer possibilities for community engagement.
- **CCAP:** Engagement will involve diverse affected parties in open-ended measure planning with a wider scope of time and possibility for participation and influence. Possibilities for collaboration may emerge.

For the development of this PCAP, specific tools and activities included:

- An inventory of interested and affected parties;
- Pre-engagement interviews;
- A Community Climate Awareness questionnaire;
- A CPRG Task Force workshop;
- A Project Ideas Submission questionnaire; and
- A presentation to the Rapid City Standing Committee on Sustainability.

## 5.2 Interested and Affected Parties

Recognizing the importance of centering the perspectives of those likely to be most interested and affected by the implementation of climate measures, Rapid City and the consultant team developed an inventory of more than 190 community contacts, including eight organizations serving or representing LIDAC. These contacts were categorized as follows, and an interest and influence analysis was undertaken to understand the ecosystem of interested and affected parties in climate action:

- Cities and counties within the study area
- Project partners
- Utility providers
- Environmental organizations
- State agencies
- Schools
- Indigenous American Tribes and organizations
- Potentially affected businesses
- Local businesses
- Developers and business leaders
- Healthcare
- Agriculture
- Social service organizations
- Community groups
- Faith-based organizations
- Public officials
- Political groups
- Local media
- Others

## 5.3 Pre-Engagement Interviews

Pre-engagement is a best practice in engagement planning and design. It is embedded in the International Association for Public Participation (IAP2) planning protocol, which is the recognized global standard for public engagement design. One-on-one interviews were conducted to understand how to effectively engage interested and affected parties and populations in Rapid City. Pre-engagement interviews helped identify baseline knowledge about climate action, preferences for engagement, community groups that might otherwise be missed, and other potential issues and opportunities for the engagement process.

Interviews were conducted with 12 interested and affected parties selected randomly from a larger pool of 19. Rapid City first reached out to these parties via an introductory email, and the consultant team then sent follow-up emails seeking specific meeting dates and times for interviews that would be held during December 2023 and January 2024. The interviews were conducted in confidence on Zoom by staff from the consulting team. They also provided invitees with a copy of the interview questions and an information sheet for the PCAP and CCAP. Representatives from the following sectors were interviewed:

- Health and Wellness
- Academic Institutions
- First Responders
- Community Benefit Organizations
- Business and Economic Development
- Utilities
- Rapid City Staff

Interview questions included the following:

- What is most important to you, for Rapid City to consider, as we begin this project?
- What concerns, if any, do you have about this project?
- Tell me how you think stakeholders will be engaged best? What, if anything, has not worked in other engagements you have seen?
- What communications approaches do you think could be most successful in reaching people interested in this project?
- Who is essential for us to speak with, during this pre-engagement phase of the planning process?
- Do you have any last thoughts or suggestions for us at this time?

These results will inform community engagement activities for the CCAP. Common themes expressed during the interviews revolved around the importance of:

- Facilitating relational forms of engagement (versus transactional) through trusted individuals and organizations.
- Avoiding large group discussions in favor of small-sized ones.
- Offering opportunities for early engagement.
- Using multiple tools to communicate.
- Remaining sensitive to local and cultural preferences, as well as the political climate.
- Coordinating with local partners to improve outreach and engagement success.

## 5.4 Community Awareness Questionnaire

This questionnaire, described below, was distributed among the CPRG Task Force. It gathered information about the current awareness of climate change impacts and local climate action in Rapid City. It received 14 responses, and submissions illustrated a range of perspectives among people representing local government, non-profit community benefit groups, non-profit environmental groups, academia, and healthcare. Extreme weather was the most frequently observed local impact of climate change among respondents. The second was energy and infrastructure strain, including increased demand for energy, especially cooling, and the need for significant investment in infrastructure to withstand extreme weather events. Most respondents agreed that current awareness and level of concern about climate change is moderate among the populations they work with. Most indicated they are currently somewhat involved in climate action and identified a need for more resources and planning to increase their involvement.

## 5.5 CPRG Task Force Workshop

A CPRG Task Force has been established for development of the PCAP and CCAP. The group consists of a combination of people from the inventory of interested and affected parties, plus members of the Rapid City Standing Committee on Sustainability. The first Task Force meeting was on January 17, 2024, via Zoom. The invitation list included 40 people, and 26 attended. During the meeting, the consultant team introduced participants to the concept of "climate action" and asked what it meant to them. The 22 participants who responded described it with similar words—future, future generations, responsibility, and sustainable. The full range of their responses appears in Figure 24.

*Figure 24. Word Map: What does climate action mean to you?*

At the Task Force meeting, the consultant team also described the planning process, reviewed data findings, and outlined potential PCAP measures by topic. Via break-out groups, participants self-selected the topics of interest to them. Then they discussed them with the Rapid City staff and consultant team facilitators and notetakers. Key themes from the discussion included:

- **Energy Generation:** Task Force members in the energy generation group commented that there are issues and challenges related to solar energy generation, such as the ability to secure tax incentives, a lack of compensation for contributing to the energy grid, and the time needed for construction that will yield utility-scale changes. They also noted the importance of including energy conservation, promoting energy efficiency for electricity and gas, and providing financial rebates or other compensation. Planning for how energy resources will operate going forward was also discussed and exploration of the topic during CCAP development is anticipated.

- **Buildings:** Task Force members in the buildings group discussed the connection between the need to make progress, the associated improvement costs, and access to available funding for projects. The group commented that community buildings, specifically schools, are aging and are not energy efficient. They said they would welcome grants for energy-efficient improvements, as making changes is both slow and expensive. One participant said that "half of students are in poverty," indicating that school improvements could directly benefit LIDAC. In addition, municipal facilities may offer opportunities for the beneficial use of methane gas, installation of charging stations that support electric vehicle conversions, carbon sequestration, and energy efficiency improvements for buildings, such as LED lighting improvements and the installation of heat pumps.

- **Transportation:** Task Force members in the transportation group discussed the importance of reducing GHG emissions, addressing gaps in the transit system by partnering with the Federal Transit Administration and other transit agencies, and Rapid City's upcoming Safe Streets for All action plan. They also commented on the community's size compared to its population, stating it "covers the same geographic size as San Francisco with one-tenth the population and is very isolated geographically." Further, participants expressed interest in upgrading the Transit and Parks and Recreation fleets to higher-efficiency vehicles. They also noted the challenges of not having electric vehicle maintenance providers in the community or nearby. Others commented on the need to connect Rapid City's existing greenway to other greenway systems and communities, so that multi-modal transportation and recreational opportunities could be provided.

- **Waste, Green Lands, Carbon Sequestration, and Other:** Group participants expressed concerns about the difficulties associated with diverting waste and the distance recycled materials travel. They commented that information on recycling is hard to find, but there could be opportunities to target educational programs to LIDAC areas, using a joint educational and outreach initiative tied to waste—a potential multi-benefit project. The group also said the Rapid City greenway and parks system is working and could become a resource to the entire community. They shared that being connected to nature is important to the community, especially for its Indigenous members, so opportunities to replicate resources should be sought. In addition, participants commented that stormwater and flood management should receive more attention and native plant options should be used for sequestration. They said improvements should be available to the entire community and equal access provided to them.

Key takeaways from the break-out group discussions and large group discussion that followed them concerned the following:

- Energy conservation and efficiency.
- Incentives and funding for improvements.
- Parks and greenway system improvements.
- Rapid City's geographic size and isolated location.
- Opportunities available through the Safe Streets for All planning grant.
- Lack of a workforce to support electric vehicles.
- Energy-efficient improvements for municipal vehicle fleets.
- Energy efficiency improvements for aging schools and municipal buildings.
- An outreach and educational campaign for recycling and diverting waste.
- Improvements that target LIDAC areas while also providing city-wide access to opportunities.
- Direct insight from Indigenous Peoples (and/or those with close relationships with them) about how to best engage their community.

Two Task Force members completed the post-meeting feedback form. Their responses indicate that they understood the process, felt the session was well facilitated, and felt enough information was shared during it. They also commented that they enjoyed the small group discussions. In addition, they asked that future discussions include leading questions for a virtual chat box and that a copy of the presentation be sent to all invitees.

## 5.6 Project Ideas Submission Questionnaire

This questionnaire asked for submission of GHG reduction measures and project ideas to include in the PCAP. It was sent to the 40 Task Force member invitees and the Rapid City Sustainability Committee. In total, 14 different respondents submitted 30 project ideas. Many project submissions fell into multiple sectors, most frequently measures related to the following sectors:

- Buildings (construction standards, school HVAC upgrades, residential energy retrofits)
- Electricity Generation (solar, geothermal)
- Transportation (fleet electrification, transit)
- Industry (factory emissions)

The primary co-benefits identified by respondents as being associated with their project idea submissions included air quality improvement and new jobs in the green economy, as well as specific benefits for LIDAC, including increased comfort and air quality for students, economic mobility to higher-paying employment sectors, and affordable/convenient public transportation. Many of the specific project ideas have been integrated into the GHG reduction measures identified in this PCAP.

## 5.7 Rapid City Standing Committee on Sustainability

To keep the full Rapid City Standing Committee on Sustainability up to speed on progress made during the PCAP planning process, Rapid City staff and the consultant team attended their regularly scheduled meeting on January 22, 2024, via Zoom. They gave a brief presentation consisting of a consolidated version of the information shared during the CPRG Task Force meeting. In response, committee member comments concerned:

- Questions about transportation and emissions-related data sets and the sources for GHG information;
- Positive feelings about the list of potential PCAP measures; and
- Announcements about upcoming events, such as the webinar about SSG’s GHG calculator.

In addition, the Rapid City Sustainability Committee was regularly given updates about the PCAP, as well as opportunities to provide their input at their regular bi-monthly meetings and via email by city staff.

# 6. Priority GHG Reduction Measures

Engagement with Rapid City staff and many interested and affected parties in the community identified seven major themes under which to take action to reduce GHG emissions. Each theme consists of multiple priority measures that have been evaluated for their GHG emissions reduction potentials and financial parameters, whenever possible. Rapid City leadership, staff, and community partners are considering these measures for implementation.

These measures provide ideas for how to achieve GHG reductions and are supported with data and analysis to aid decision-making. Ultimately, many other factors, such as funding, capacity, logistics, and circumstances, will all be considerations for the implementation of these measures and any others.

## 6.1 Low Emission City Facilities and Schools

### Description

The City of Rapid City will lead by example in its efforts to reduce energy consumption and GHG emissions production. Several City-led projects will showcase the benefits of clean vehicles and building energy efficiency retrofits while saving energy costs and producing fewer airborne particulates.

#### City Fleet Electrification

Rapid City Parks and Recreation Department's vehicle fleet will be electrified, with vehicles and equipment, like mowers, being transitioned before their end of life, based on a cost-benefit analysis. Transition will begin with the most available electric models (i.e., small- and medium-duty vehicles and equipment) and proceed with other models, as available (e.g., heavy-duty vehicles). The City will report on vehicle capital, operational, and maintenance costs to track the effectiveness of its fleet transition for energy use and cost reductions as well as emissions reductions.

#### Municipal Retrofits

Rapid City will create a municipal buildings retrofit plan that maps a pathway to perform retrofits on all City buildings and facilities. The plan will prioritize each building and facility for retrofitting. Energy assessments will be performed on priority buildings to identify envelope and HVAC system upgrades required, as well as renewable energy system installation potential. The retrofits will be performed according to municipal budget allocations (as available) and will consider the energy cost-savings payback periods. Energy cost savings from retrofitted buildings will help finance retrofits in other buildings.

Specific retrofit projects to be undertaken include:

- Updating the potable water treatment facility and related distribution infrastructure for improved energy efficiency;
- Retrofitting streetlights with LED models;
- Retrofitting outdoor lighting at public parks and sports fields with LED;
- Evaluating The Monument multi-purpose venue and performing energy efficiency upgrades;
- Prioritizing city facilities for retrofits and performing energy efficiency upgrades; and
- Evaluating the feasibility of replacing current space heating in several municipal buildings with geo-exchange heat pump systems and rooftop solar PV systems and implementing the study's recommendations.

### City Energy Dashboard

In the spirit of leading by example and establishing transparency, Rapid City will develop an energy-use reporting dashboard for its major buildings and facilities. The dashboard will describe the City's municipal retrofit plan and display the current, target, and actual energy use for each major building and facility. Upgrades will be described for all buildings and facilities that have been retrofitted. The dashboard will be updated weekly with current energy- use data.

### School Weatherization

Rapid City has over 25 elementary, middle, and high schools (Figure 25). These facilities were typically built without energy efficiency and resilience to future climate conditions in mind. All schools will benefit from energy efficiency and weatherization upgrades to decrease energy costs, GHG emissions, and air particulates, while increasing indoor comfort and extreme weather event resilience. A school weatherization plan will be created that prioritizes LIDAC schools and schools demonstrating the greatest need for energy efficiency and weatherization upgrades. The City will coordinate with Rapid City Area Schools to determine which schools to prioritize. Energy assessments will be performed and retrofit measures will be determined and prioritized. Lessons learned from the assessments and upgrades of each school will be passed on to the next through upgrade reports. One key focus of the upgrades will be HVAC systems controls, allowing school operators precise controls over indoor climates in each room of the school. Since school rooftops are prime candidates for solar PV systems and school grounds for geo-exchange systems, solar PV and geo-exchange feasibility studies will comprise part of the energy assessment. If determined appropriate, Rapid City Area Schools, the school being retrofitted, the City, and the new Rapid City Energy Cooperative will coordinate on the financing and installation of solar PV and/or geo-exchange systems. An additional educational component may include working with K–12 teachers to coordinate class projects and learning opportunities for students of all ages.

### Zero-Emissions Water System Pipeline

The region's population projections indicate additional water provision will be required in the area. A new water pipeline from the Missouri River will be built to bring water to Rapid City, following similar pipeline projects already in use in the area. The pumping required for water transportation will be powered by renewable energy. A zero-emissions renewable energy plan will be produced along with the pipeline plans.

### Non-Profit Organization Buildings Retrofits

Some non-profit organizations in Rapid City have high building energy-use costs. Partnerships between the City and these groups will create energy assessments for 10 non-profit buildings and retrofit plans to reduce energy use by at least 35% in each of the buildings.

**Low Emission City Facilities and Schools**

| | |
|---|---|
| *Sector(s)* | ● Transportation<br>● Energy Efficiency<br>● Renewable Energy |
| *Geographic Location* | Rapid City and surrounding area |
| *Priority Project Measures* | 1. Electrify the Rapid City fleet and equipment.<br>2. Retrofit municipal buildings and facilities for improved energy efficiency.<br>a. Retrofit the potable water treatment plant and distribution infrastructure for improved energy efficiency.<br>b. Convert street light fixtures to LED.<br>c. Convert outdoor lighting at parks and sports fields to LED.<br>d. Evaluate The Monument multi-purpose venue and perform energy efficiency upgrades.<br>e. Prioritizing and conducting energy efficiency upgrades at city facilities.<br>f. Evaluate feasibility for geothermal heat source and solar PV systems in municipal buildings.<br>3. Develop a dashboard for reporting on Rapid City's energy use.<br>4. Weatherize schools for energy efficiency and climate resilience.<br>5. Develop a net-zero-emissions transmission plan for Western Dakota Regional Water System's future pipeline project from the Missouri River.<br>6. Retrofit 10 non-profit organization buildings to reduce 35% of their energy use. |

| **Low Emission City Facilities and Schools** | |
|---|---|
| *Potential Project Partners* | • Black Hills Energy<br>• Local Non-for-Profit Organizations serving LIDAC<br>• Rapid City Area Schools<br>• Rapid City Energy Cooperative<br>• West River Electric Association |
| *Existing Programs and/or Funding Opportunities* | • Black Hills Energy Commercial Rebates<br>• Property and Sales Tax Revenues<br>• Rapid City Vision Funds<br>• School Bond |
| *LIDAC Benefit Analysis* | LIDAC members are primary users of civic facilities like libraries and recreation centers. Upgrading these facilities creates extreme weather event resilient spaces while creating interiors that are more comfortable and provide positive public health outcomes. The whole community benefits from public building energy efficiency and weatherization upgrades.<br>Lawn mowers, street maintenance vehicles, and landscaping equipment use highly polluting motors. Electrifying the City fleet and equipment lowers PM2.5 particulate matter and decreases noise across all communities, improving public health outcomes for all. Additionally, it initiates the process of electrifying fleets within the region. |
| *Authority to Implement* | • City of Rapid City<br>○ Parks and Recreation Department<br>○ Public Works Department<br>○ The Monument<br>• Rapid City Area Schools<br>• Non-Profit Entities<br>• Western Dakota Regional Water System |
| *Political and Community Support* | High |
| *Job Creation* | High<br>Similar to measure 6.7, public building upgrades create jobs in the contractor and building energy assessor trades. Retrofit material and energy technology retail jobs increase. Electrifying City fleets and equipment creates jobs in the EV sales and maintenance sector, as well as in the municipal equipment retail and maintenance sector. |

<table>
<tr><th colspan="2">Low Emission City Facilities and Schools</th></tr>
<tr><td><em>Technical Parameters</em></td><td>
<ul>
<li>Number of City fleet vehicles transitioned to electric models.</li>
<li>Number of City equipment transitioned to electric models.</li>
<li>Cost savings from reduced fuel use in City operations.</li>
<li>Number of civic facilities retrofitted.</li>
<li>Number of schools retrofitted.</li>
<li>Annual energy savings in each City facility.</li>
<li>Annual energy savings in each school.</li>
<li>Annual energy savings in each non-profit facility.</li>
<li>Projected energy savings and avoidance of GHG emissions for the future water transmission pipeline project from the Missouri River to Rapid City.</li>
</ul>
</td></tr>
<tr><td><em>Estimate of the Quantifiable GHG Emissions Reductions</em></td><td>2025–2030: 12,492 $MtCO_2e$<br>2025–2050: 110,254 $MtCO_2 e$</td></tr>
<tr><td><em>Estimate of the Quantifiable Criteria Air Pollutant Emissions Reductions (e.g., through 2030 and 2050)</em></td><td>
<table>
<tr><td>Type</td><td>2025–2030 (lb)</td><td>2025–2050 (lb)</td></tr>
<tr><td>VOC</td><td>4,595</td><td>32,784</td></tr>
<tr><td>CO</td><td>70,709</td><td>499,204</td></tr>
<tr><td>NOx</td><td>17,527</td><td>135,625</td></tr>
<tr><td>PM 2.5</td><td>172</td><td>1,319</td></tr>
<tr><td>SO2</td><td>98</td><td>778</td></tr>
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</td></tr>
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## Low Emission City Facilities and Schools

*Implementation Schedule and Milestones*

**City Fleet Electrification**

- 80% of light-duty vehicles transitioned to electric models by 2030.
- 80% of medium-duty vehicles transitioned to electric models by 2030.

**Municipal Retrofits**

- Major facilities are energy assessed with energy efficiency upgrades identified and prioritized by the end of 2025.
- 25% of priority retrofits are completed by the end of 2027.
- The remaining 75% of priority retrofits are completed by 2030.

**City Energy Dashboard**

- The public-facing city energy dashboard is completed by the end of 2026.

**School Weatherization**

- 100% of schools are energy assessed with energy efficiency and weatherization upgrades identified by the end of 2025.
- School retrofit financing mechanisms are determined in early 2026.
- 25% of priority retrofits are completed by the end of 2027.
- The remaining 75% of priority retrofits are completed by 2030.

**Net-Zero Emissions Water Pipeline Project**

- The renewable energy plan to power the water pipeline is completed by 2026.

**Non-Profit Organization Buildings Retrofits**

- 10 non-profit buildings at 50,000 sq ft each use 35% less energy by 2030.

*Quantitative Cost Estimates*

Capital Costs
2025–2030: \$21,397,686
2025–2050: \$38,471,055

Fixed O&M
2025–2030: -\$3,043,809 (savings)
2025–2050: -\$41,966,146 (savings)

Lifetime Costs or Savings/MT Emissions Avoided: -\$32/MT$\mathrm{CO_2}$e (savings)

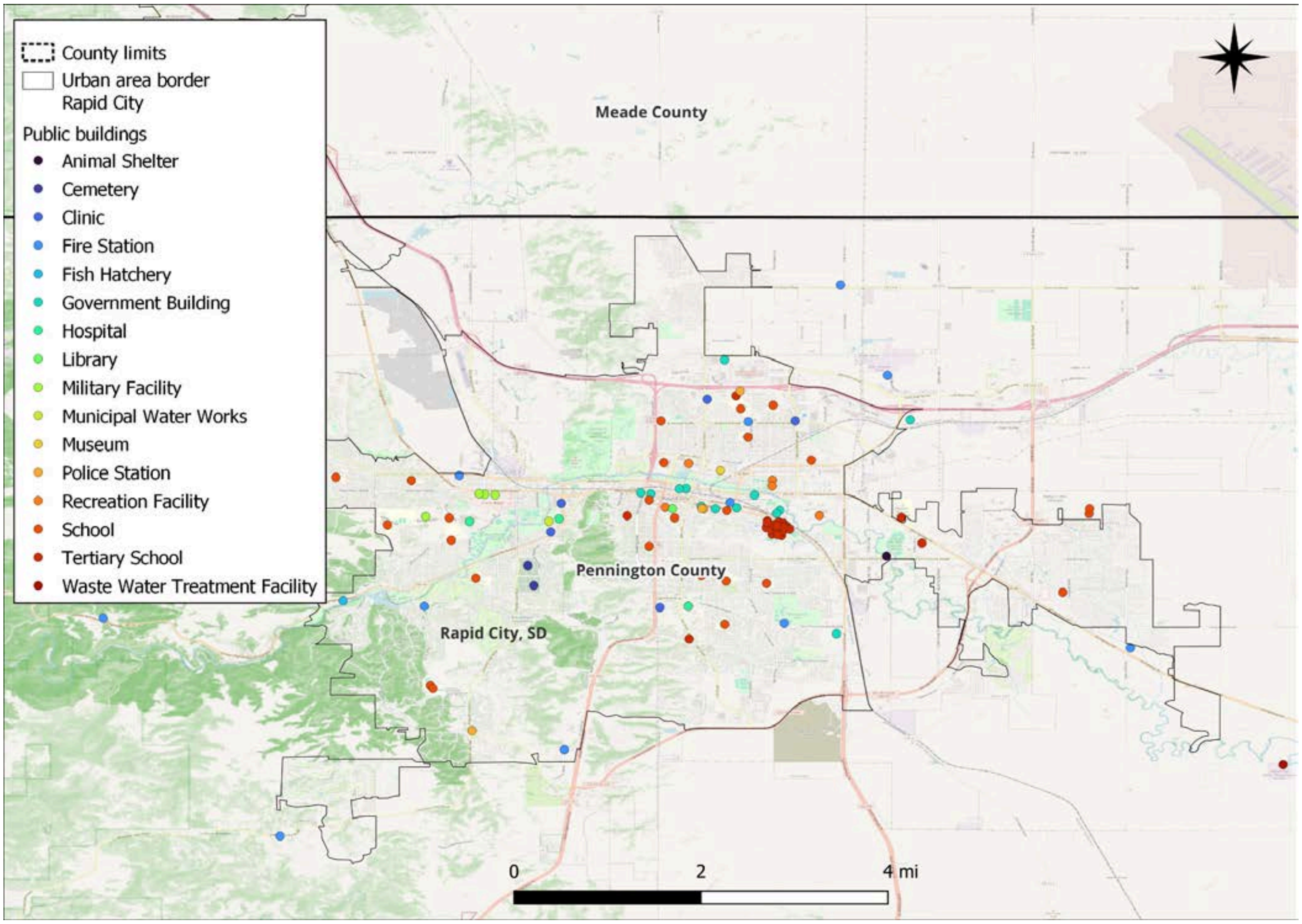

*Figure 25: Map of municipal buildings and schools (e.g., primary schools, high schools, library, city hall, police station, fire stations, city facilities, public works, water and wastewater treatment, etc.) eligible for energy efficiency retrofits.*

# 6.2 Renewable Rapid City

## Description

Solar photovoltaic electricity generation is common in many parts of South Dakota but has yet to be developed in the Rapid City area. New provision of this affordable, clean energy supply could power local homes and businesses while decreasing emissions from the coal-fired electricity grid.

### Solar PV Pilot Projects

This measure aims to kick-start solar PV installations in the area. Three solar PV installation pilot projects are proposed: one community project, one institutional project, and one City project.

A 20 MW community solar PV farm project will be established in the northwest part of Rapid City where post-industrial mining sites require rehabilitation. A renewable energy cooperative will be formed to plan, coordinate construction, and operate the facility. It will be based on successful renewable energy cooperatives in other jurisdictions and initiated with the help of the Rapid City Sustainability Committee. The co-op will coordinate with Black Hills Energy for grid integration and customer coordination.

A rooftop 750 kW solar PV system will be installed at the SD Mines campus. The system will be owned and operated by the college. It will offset the college's electricity use through bi-directional metering with the local electricity grid. EV charging stations will be installed here as well, as part of the evolving EV charging station network (measure 6.6).

A 2 MW solar PV system will be installed at the Rapid City Water Reclamation Facility. Owned and operated by the City, the system will offset the facility's electricity use and sell excess generation to the local energy grid.

### SD Mines Geo-exchange System

A 1,254 kW vertical well geo-exchange system will be installed on the SD Mines campus to provide heat to a 111,000 sq ft building. This system will replace the current use of natural gas space heating with ambient ground heat exchange space heating.

### Renewable Energy Institution and Public Education Program

A renewable energy institution and public education program will be developed as part of an energy efficiency education and awareness program (measure 6.7). The program will target building owners and public and private institutions to increase their interest in solar PV system installations. With increased visibility from the pilot projects, residential and business solar PV installations are likely to increase. These installations could qualify for assistance under the home energy retrofit program and PACE program (measure 6.7).

### College Renewable Energy Training Program

Building on the success of college renewable energy training programs elsewhere in the state, Western Dakota Technical College or another school could develop a similar course.

The program would focus on:

- Renewable energy technologies;
- Small-, medium-, and large-scale implementation of renewable energy systems;
- Technical requirements for planning, construction, and installation of renewable energy projects;
- Renewable energy system operation and maintenance; and
- Energy utility operations.

The program could target LIDAC enrollment, offering scholarships and bursaries sponsored by energy systems companies and local energy utilities.

### Micro-grid Evaluation

With extreme weather hazards expected to become more frequent and more severe, Rapid City is interested in exploring energy resilience. Wildfires and floods have threatened the area’s energy stability in the past and are expected to again. Electricity micro-grids can provide electricity delivery resilience by localizing electricity distribution in small districts and by providing redundancy in the greater electric grid system. Rapid City will undertake a study to determine the usefulness and viability of micro-grids in the area.

**Renewable Rapid City**

| | |
|---|---|
| *Sector(s)* | ● Energy |
| *Geographic Location* | Rapid City<br>Pennington, Meade, and Lawrence Counties<br>SD Mines Campus |
| *Priority Project Measures* | 1. Develop a 20 MW community energy pilot project (e.g., solar garden) and renewable energy cooperative.<br>2. Install a 750 kW rooftop solar panel system at SD Mines.<br>3. Install a vertical well geo-exchange system to serve a peak heating and cooling load of 1,254 kW and 111,000 sq ft of floor space at SD Mines.<br>4. Install a 2 MW solar panel system at Rapid City's Water Reclamation Facility.<br>5. Create a renewable energy institutional and public education program.<br>6. Create a college program for solar PV planning, installation, operation and maintenance instruction that prioritizes LIDAC enrollment.<br>7. Evaluate feasibility of micro-grid projects. |

| **Renewable Rapid City** | |
|---|---|
| *Potential Project Partners* | ● Black Hills Energy<br>● Local Developers<br>● SD Mines<br>● West River Electric Association<br>● Western Dakota Technical College |
| *Existing Programs and/or Funding Opportunities* | ● Black Hills Energy Solar Program<br>● Rapid City Vision Funds<br>● South Dakota Board of Regents |
| *LIDAC Benefit Analysis* | These measures provide three key benefits to LIDAC:<br>● Agency in energy provision and use via the new Rapid City Renewable Energy Cooperative. Cooperatives are community-oriented businesses that ensure equitable ownership and operations for its member consumers.<br>● Energy cost stability through local, community-led energy projects. Renewable energy cooperatives have proven resilient in keeping energy costs low for consumers in other US jurisdictions.<br>● Accessibility to the energy trades market through college programs. Training programs will provide job opportunities in the burgeoning solar PV industry. |
| *Authority to Implement* | ● City of Rapid City<br>○ Community Development Department<br>○ Public Works Department<br>○ Public Works—Water Reclamation Facility<br>● Rapid City Renewable Energy Cooperative (new entity)<br>● SD Mines<br>● South Dakota Public Utilities Commission<br>● Western Dakota Technical College |
| *Political and Community Support* | High |

**Renewable Rapid City**

*Job Creation*

Medium

Jobs will be created in the solar PV installation, operation, and maintenance sectors. The new Rapid City Renewable Energy Cooperative will create administrative and technical jobs. Communications jobs will be created for the renewable energy education program. Teaching positions will be created for the college renewable energy program.

*Technical Parameters*

- Completion of the three solar PV installation pilot projects.
- Annual kWh of generation for each project.
- College program enrollment.

*Estimate of the Quantifiable GHG Emissions Reductions*

**Solar Projects**
2025–2030: 21,594 MtCO$_2$e
2025–2050: 67,723 MtCO$_2$e

**Geo-exchange Project**
2025–2030: 4,770 MtCO$_2$e
2025–2050: 36,568 MtCO$_2$e

*Estimate of the Quantifiable Criteria Air Pollutant Emissions Reductions (e.g., through 2030 and 2050)*

**Geo-exchange Project**

| Type | 2025–2030 (lb) | 2025–2050 (lb) |
|---|---:|---:|
| VOC | 476 | 3,649 |
| CO | 3,461 | 26,535 |
| NOx | 8,134 | 62,357 |
| PM 2.5 | 37 | 285 |
| SO2 | 52 | 398 |

| **Renewable Rapid City** | |
|---|---|
| *Implementation Schedule and Milestones* | **Solar PV Pilot Projects**<br>● Rapid City Renewable Energy Cooperative established by the end of 2026.<br>● 20 MW community installation<br>○ Sited and planned by the end of 2027.<br>○ Installed and operational by mid-2028.<br>● 750 kW institutional installation<br>○ Sited and planned by the end of 2025.<br>○ Installed and operational by mid-2026.<br>● 2 MW City installation<br>○ Sited and planned by the end of 2025.<br>○ Installed and operational by mid-2026.<br>**Geo-exchange Project**<br>System installed and operating at full capacity by 2028.<br>**Renewable Energy Institution and Public Education Program**<br>Program developed by mid-2025, as part of the home energy retrofit education and awareness program (measure 6.7).<br>**College Renewable Energy Training Program**<br>Program studied and scoped by end of 2025. Program staffed and accepting enrollment in the fall of 2026. The program targets 25 graduates per year.<br>**Micro-grid Evaluation**<br>The micro-grid evaluation study is complete by early 2026. |

| **Renewable Rapid City** | |
|---|---|
| *Quantitative Cost Estimates* | **Solar PV Projects**<br>*Capital Costs*<br>2025–2030: \$23,996,750<br>2025–2050: \$23,996,750<br>*Fixed O&M*<br>2025–2030: -\$18,682,203 (savings)<br>2025–2050: -\$94,024,380 (savings)<br>Lifetime Costs or Savings/MT Emissions Avoided: -\$1,034/$MTCO_2e$ (savings)<br>**Geoexchange Project**<br>*Capital Costs*<br>2025–2030: \$2,874,900<br>2025–2050: \$2,874,900<br>*Fixed O&M*<br>2025–2030: -\$732,930 (savings)<br>2025–2050: -\$5,619,127 (savings)<br>Lifetime Costs or Savings/MT Emissions Avoided: -\$75/$MTCO_2e$ (savings) |

# 6.3 Low Waste Rapid City

## Description

Although the Rapid City Solid Waste Division operates a composting facility at the Rapid City landfill, many organic materials still end up buried in the landfill. Buried organics decompose anaerobically, producing methane emissions. Methane has approximately 25 times more global warming potential than carbon dioxide, particularly in the first 20 years of its release. Currently, some landfill gas (LFG) is captured at the landfill and used to generate heat within the landfill facility buildings, but most is flared. These measures will greatly amplify organic waste diversion across the region while increasing the LFG capture area and improving the captured gas end use.

**Community Food and Yard Waste Diversion and Composting Program**
To improve the separation of food and yard waste from the solid waste stream, Rapid City will launch an education and outreach program and enhanced curbside collection. The education and outreach program will have five central streams:

1. Residential
2. Business
3. Grocery retailers
4. Restaurants
5. Schools

Specific programming for each stream will be developed based on existing relationships and successes locally and drawing from best practices in other jurisdictions (some of which have been identified in the draft Rapid City Solid Waste Master Plan, 2021). The residential and business streams will inform residents about City diversion practices and the use of diversion services. The grocery retailers, restaurants, and schools streams will connect the City Public Works Department directly with retailers, restaurants, Elevate Rapid City, Rapid City Area Schools, and other schools to establish coordinated organic waste diversion programs. The grocery retailer and restaurant streams will feature a food reclamation and redistribution element, providing food to community programs and local food banks. The program will focus first on LIDAC areas, where the pilot programs will begin. Each of these five program streams will target 90% organic waste diversion once fully implemented. The City will bolster its curbside food and yard waste collection system for residents and businesses and put measures in place to encourage solid waste separation (e.g., incentives, fines).

These efforts will streamline the organic waste treatment that currently occurs at the Rapid City landfill, where much effort is currently spent in separating organics from the solid waste stream (with only partial success). With fewer contaminants and pre-separated organic waste, the facility can focus on improving its composting facilities and practices to process greater organic waste volumes. The current practice of selling compost soil additives and bark mulch will continue and will be expanded to engage the agricultural community. These efforts will inform residents on the relationship between greenhouse gas emissions and waste, the importance of composting, and the life cycle of food.

These measures will avoid substantial methane production from organic material decomposition in the local landfill while extending the life of the landfill.

### Expanded Recycling Program

Rapid City's current recycling program will be expanded to include commercial, educational, and non-profit sector buildings. These sectors require additional considerations to the current recycling collection and diversion program which will be addressed through program expansion planning. The program will expand to include dozens of schools, dozens of non-profit buildings, and hundreds of commercial operations throughout the city, diverting far more recyclables than current volumes.

### Landfill Gas Capture

The Rapid City landfill captures the methane off-gassing from the capped areas of the facility, as required by federal and state law, given its size and its rate of gas production. A 2012 study provided recommendations for captured gas use, but alternative gas uses have not been pursued since the study. A 2019 landfill study recommends updating the study, as the size and composition of the landfill have changed, as have market conditions for alternative uses for the captured gas (e.g., refining for use in natural gas pipelines as renewable natural gas, using on-site for heat and electricity generation). Rapid City aims to engage contractors to perform an updated study and proceed with the study's most advantageous recommendations.

This measure is likely to substantially increase the methane capture from the landfill, replace flaring with a more sustainable and useful captured gas end use, and remove thousands of tons of methane from being released from landfill operations each year.

| **Low Waste Rapid City** | |
|---|---|
| *Sector(s)* | ● Waste<br>● Energy |
| *Geographic Location* | Rapid City and surrounding area |
| *Priority Project Measures* | 1. Develop a community food and yard waste diversion and composting program.<br>2. Expand the recycling program to include commercial, schools, and non-profit operations.<br>3. Update landfill gas capture to energy studies to map a path to captured gas energy production for the Rapid City landfill. |

| **Low Waste Rapid City** | |
|---|---|
| *Potential Project Partners* | • Elevate Rapid City<br>• Local grocery stores, restaurants, and businesses<br>• Montana-Dakota Utilities Co.<br>• Monument Health<br>• Rapid City Area Schools<br>• SD Mines<br>• Western Dakota Technical College |
| *Existing Programs and/or Funding Opportunities* | • Rapid City Solid Waste Fees<br>• Rapid City Sustainability Committee—#STARTNow Program<br>• Rapid City Vision Funds<br>• SD Department of Agriculture and Natural Resources—Solid Waste Management Program |
| *LIDAC Benefit Analysis* | The five low-waste program streams will focus first in LIDAC areas, benefitting LIDAC households first. Low-income families will benefit from the food waste diversion programs, as food will be redistributed to community programs and food banks. Job opportunities will also be available across all of the measures. Cost savings or revenues from methane energy capture and conversion at the Rapid City landfill will help to offset operation costs, keeping services more affordable for everyone in the community. |
| *Authority to Implement* | City of Rapid City<br>• Public Works Department<br>• Public Works—Solid Waste Division |
| *Political and Community Support* | Medium |
| *Job Creation* | Medium<br>These measures will create City jobs and community jobs in the waste and energy sectors, including curbside pickup vehicle operators; community, business, school, and restaurant liaisons; landfill operators; composting facility operators; landfill gas capture system operators; and energy retail and/or facility staff. |

| **Low Waste Rapid City** | |
|---|---|
| *Technical Parameters* | ● Annual tons of organic waste diverted from landfills.<br>● Annual tons of organic waste collected from each stream: residential, business, grocery retailers, restaurants, and schools.<br>● Additional tons of recyclables collected and waste diverted from landfills.<br>● Annual tons of landfill gas captured.<br>● Annual kWh of energy generated and/or volume of renewable natural gas produced. |
| *Estimate of the Quantifiable GHG Emissions Reductions* | 2025–2030: 78,065 $MtCO_2e$<br>2025–2050: 344,693 $MtCO_2e$ |

*Implementation Schedule and Milestones*

**Community Food and Yard Waste Diversion and Composting Program**

- Residential program stream created and implemented by the beginning of 2026.
    - Year 1: 10% of residences participating in pilot program.
    - Year 2: 25% of residences participating.
    - Year 3: 50% of residences participating.
    - Year 4: 75% of residences participating.
    - Year 5: 100% of residences participating.
    - 90% organics diversion achieved across all residences by year 5.
- Business program stream created and implemented by mid-2025.
    - Year 1: 10% of businesses participating in pilot program.
    - Year 2: 50% of businesses participating.
    - Year 3: 100% of businesses participating.
    - 90% organics diversion achieved across all businesses by year 3.
- Grocery retailer program stream created and implemented by mid-2025.
    - Year 1: 10% of retailers participating in pilot program.
    - Year 2: 50% of retailers participating.
    - Year 3: 100% of retailers participating.
    - 90% organics diversion achieved across all retailers by year 3.
- Restaurant program stream created and implemented by mid-2025.
    - Year 1: 10% of restaurants participating in pilot program.
    - Year 2: 50% of restaurants participating.
    - Year 3: 100% of restaurants participating.
    - 90% organics diversion achieved across all restaurants by year 3.
- School program stream created and implemented by fall 2025.
    - Year 1: 10% of schools participating in pilot program.
    - Year 2: 50% of schools participating.
    - Year 3: 100% of restaurants participating.
    - 90% organics diversion achieved across all schools by year 3.

**Expanded Recycling Program**

- School recycling program implemented by 2026.
- Non-profit recycling program implemented by 2027.

| **Low Waste Rapid City** | |
|---|---|
| | - Commercial and business recycling program implemented by 2028.<br>**Landfill Gas Capture**<br>- Study performed by mid-2026.<br>- Recommended gas capture and alternative captured gas use projects initiated by the end of 2026.<br>- Full implementation of gas capture and alternative-gas-use projects by the end of 2027. |
| *Quantitative Cost Estimates* | Capital Costs<br>2025–2030: $34,505,000<br>2025–2050: $34,505,000<br>Fixed O&M<br>2025–2030: -$411,000 (savings)<br>2025–2050: -$1,781,000 (savings)<br>Lifetime Costs or Savings/MT Emissions Avoided: $95/MTCO$_2$e |

# 6.4 Greenway Climate Resilience Enhancements

## Description

The Rapid Creek Greenway is a treasured east–west central green space connecting many neighborhoods along its more than 10 miles. In addition to providing park space and walking and biking paths, it acts as a floodway and stormwater catchment and infiltration area. Enhancing the Greenway's natural features has the following five major benefits:

1. Increasing the carbon sequestration of the area.
2. Decreasing the urban-heat-island effect in the area through tree canopy cover and planting.
3. Improving the stormwater infiltration capacity of the area.
4. Improving the flood management of the area.
5. Connecting various neighborhoods and destinations through new active transportation networks (measure 6.52).

**Greenway Climate Resilience Enhancements**

| | |
|---|---|
| *Sector(s)* | ● Carbon sequestration<br>● Climate resilience |
| *Geographic Location* | Rapid City and surrounding areas |
| *Priority Project Measures* | 1. Afforest the greenway with 2,000 trees by 2030.<br>2. Create a hub-and-spoke green space program (a central greenspace "hub" with greenery path "spokes" projecting into neighborhoods) to plant 5,000 trees and bushes along new and existing active transportation routes, prioritizing LIDAC and coordinating with the Multi-modal Transportation Transformation (measure 6.5).<br>3. Assess the greenway for stormwater infiltration and flood management upgrades for improved community resilience.<br>4. Update Rapid City's landscaping ordinance to enable increased urban tree canopy coverage. |
| *Potential Project Partners* | ● Friends of Rapid City Parks<br>● Rapid City Beautification Committee<br>● Rapid City Parks and Recreation Advisory Board<br>● Rapid City Urban Forestry Board<br>● Rapid City Sustainability Committee<br>● Visit Rapid City<br>● West Dakota Water Development District |

| | |
|---|---|
| *Existing Programs and/or Funding Opportunities* | ● Black Hills Energy<br>● Gwendolyn L. Stearns Foundation<br>● Pennington Conservation District<br>● Rapid City Parks and Recreation—Urban Forestry Program<br>● Rapid City Vision Funds<br>● SD Department of Agriculture and Natural Resources—Community Forestry Grant<br>● West Dakota Water Development District |
| *LIDAC Benefit Analysis* | The Greenway is a park and active transportation axis along Rapid Creek, connecting residences and local shops between various neighborhoods, many of which are home to low-income and disadvantaged communities. Rapid Creek is subject to seasonal flooding, which is occasionally severe. Greenway enhancement will directly benefit LIDAC by providing improved stormwater infiltration and flood maintenance capacity, thus helping to safeguard homes, energy systems, and transportation infrastructure from extreme rainfall and freshet flooding events.<br>Tree canopy cover has a positive impact on neighborhoods, especially in areas that are at high risk from climate impacts such as extreme heat and extreme temperature increases. In addition, tree cover and green spaces enhance mental and physical health, as well as quality of life for communities by providing access to recreational activities, sports, and enjoyment of nature.<br>Enhancing the Greenway with greenery and trees will provide a safer and cooler outdoor public space in the middle of the city. This will decrease the urban heat island effect in the summer, helping to prevent extreme heat days and decreasing risk of heat stroke, heat-exacerbated health conditions, and hospitalizations. It will also decrease the need for City-provided cooling centers.<br>The communities that will directly benefit from this measure are presented in Figure 26. |
| *Authority to Implement* | City of Rapid City<br>● Community Development Department<br>● Parks and Recreation Department<br>● Public Works Department |
| *Political and Community Support* | High |

| | |
|---|---|
| *Job Creation* | Low<br>Some jobs will be created for tree planters, landscapers, and floodway infrastructure construction. Others will be created in producing studies and updating ordinances. |
| *Technical Parameters and Metrics for Tracking Progress* | ● Acres of greenspace restored with native plants.<br>● Number of trees planted per year in LIDAC areas.<br>● Number of trees planted per year along trails.<br>● Survival rate of trees by age class.<br>● Stormwater infiltration capacity.<br>● Flood management capacity. |
| *Estimate of the Quantifiable GHG Emission Reductions* | 2025–2030: 6 MtCO$_2$e<br>2025–2050: 678 MtCO$_2$e |
| *Implementation Schedule and Milestones* | **Greenway and Greenspace Afforestation**<br>● 2025: Plant 750 trees.<br>● 2026: Plant 750 trees.<br>● 2027: Plant 1,000 trees.<br>● 2028: Plant 1,000 trees.<br>● 2029: Plant 1,500 trees.<br>● 2030: Plant 2,000 trees.<br>**Stormwater Infiltration and Flood Management Upgrades**<br>Complete study by mid-2025.<br>**Landscape Ordinance**<br>Complete ordinance update by mid-2026. |
| *Quantitative Cost Estimates* | $50,000 for afforestation and landscaping updates.<br>$150,000 for stormwater and flood study. |

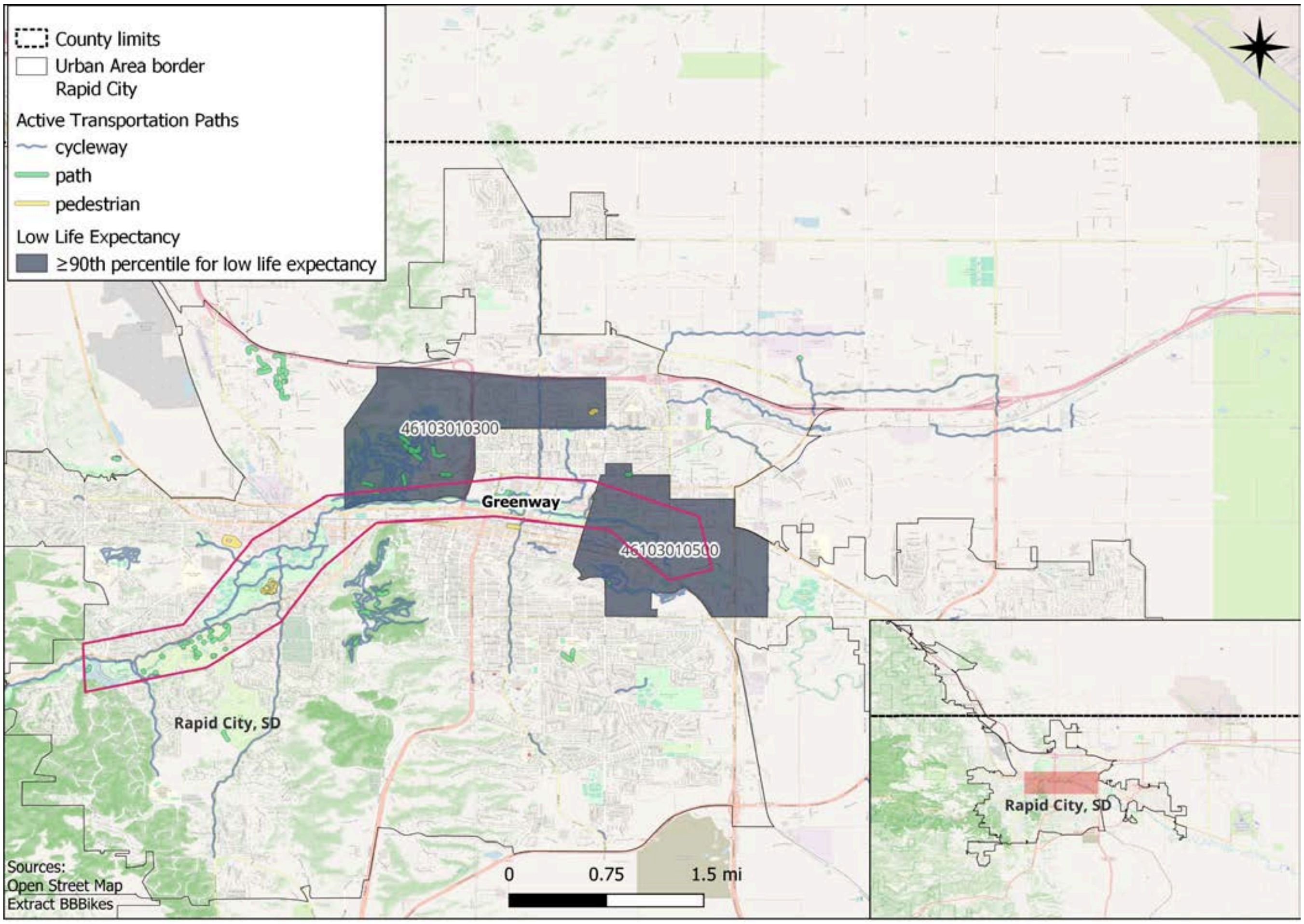

*Figure 26: Map of the Greenway and Rapid City's LIDAC areas.*

# 6.5 Multi-modal Transportation Transformation

## Description

This measure aims to provide Rapid City residents with low emission, affordable, healthy, and pleasant transportation options. Rapid City has very high personal vehicle use across all trip distances and purposes. Transit service is insufficient. Active transportation options are limited and the active transportation infrastructure network is disjointed. Providing improved active transportation and transit trip options will increase personal mobility, decrease traffic, reduce air and noise pollution, decrease road maintenance needs, and improve public health outcomes. Almost 10% of trips in the region are currently made by walking. This precedent is encouraging for the uptake of improved active transportation and transit systems.

| **Multi-modal Transportation Transformation** | |
|---|---|
| *Sector(s)* | ● Transportation<br>● Climate Resilience |
| *Geographic Location* | Rapid City and surrounding areas |
| *Priority Project Measures* | 1. Enhance the region's active transportation network, focusing on widening the Rapid Creek Greenway (up to 10–12 feet) and expanding it to neighboring communities beyond city limits. Create 30 miles of Greenway hub-and-spoke-style active transportation routes that connect neighborhoods and destinations by 2040. Coordinate this effort with the Greenway Climate Resilience Enhancement (measure 6.4).<br>2. Prioritize active transportation networks for students (LIDAC) to and from SD Mines campus.<br>3. Evaluate the feasibility of an e-bike incentive program, prioritizing availability in LIDAC.<br>4. Expand and reform public transit service with improved routes and increased service hours to achieve 30% increased ridership by 2030.<br>5. Develop a net-zero transit plan and do a micro-mobility study. |
| *Potential Project Partners* | ● Downtown Rapid City<br>● Elevate Rapid City<br>● Rapid City Area Metropolitan Planning Organization<br>● SD Mines<br>● Visit Rapid City |

| **Multi-modal Transportation Transformation** | |
|---|---|
| *Existing Programs and/or Funding Opportunities* | ● Rapid City Area Bicycle and Pedestrian Master Plan<br>● Rapid City Metropolitan Transportation Plan<br>● Rapid City Transit Development Plan<br>● Rapid City Vision Funds<br>● SD Department of Transportation—Transportation Alternatives Program<br>● SD Game, Fish and Parks—Recreational Trails Program |
| *LIDAC Benefit Analysis* | Bolstering the active transportation and transit networks will increase transportation options for everyone, particularly LIDAC neighborhoods (Figure 27).<br>Ten percent of trips are already made by walking, which indicates the need for quality active transportation infrastructure and sets a good precedent for shifting more vehicle trips to active transportation modes. It may also suggest limited access to alternative modes of transportation for individuals who do not own a personal vehicle. The region is highly car-dependent for its transportation needs. Connecting neighborhoods throughout the region with active transportation infrastructure, like paths and trails, improved transit routes and service hours, and micro-transit systems will provide more affordable and healthy options for making trips to stores, schools, and places of work and play. This can be especially helpful to LIDAC in order to save on transportation costs.<br>This measure also promotes a higher share of active transportation modes (e.g., biking and walking) and supports reductions in car trips that will reduce PM 2.5 emissions, reduce traffic congestion in high-concentration areas, and improve health and life expectancy (e.g., lower air pollution, increase in physical activities).<br>The Rapid Creek Greenway hub-and-spoke-model active transportation network will connect over 60% of residences and destinations across the Rapid City area. |
| *Authority to Implement* | ● City of Rapid City<br>○ Community Development Department<br>○ Parks and Recreation Department<br>○ Public Works Department<br>○ Rapid City Public Works—Rapid Transit Division<br>● Rapid City Area Metropolitan Planning Organization<br>● SD Mines |

### Multi-modal Transportation Transformation

<table>
<tr><td><em>Political and Community Support</em></td><td>High</td></tr>
<tr><td><em>Job Creation</em></td><td>Medium<br>Jobs will be created for active transportation path and trail construction, consultants for the e-bike incentive program study, and transit drivers and maintenance workers.</td></tr>
<tr><td><em>Technical Parameters</em></td><td><ul><li>Miles of paths and trails built annually.</li><li>Percentage of trips by mode.</li><li>Number of communities and major destinations served by the active transportation network.</li></ul></td></tr>
<tr><td><em>Estimate of the Quantifiable GHG Emissions Reductions</em></td><td>2025–2030: 6,762 $MtCO_2e$<br>2025–2050: 30,223 $MtCO_2e$</td></tr>
<tr><td><em>Estimate of the Quantifiable Criteria Air Pollutant Emissions Reductions (e.g., through 2030 and 2050)</em></td><td>
<table>
<tr><th>Type</th><th>2025–2030 (lb)</th><th>2025–2050 (lb)</th></tr>
<tr><td>VOC</td><td>8,569</td><td>33,827</td></tr>
<tr><td>CO</td><td>120,582</td><td>466,656</td></tr>
<tr><td>NOx</td><td>3,995</td><td>13,399</td></tr>
<tr><td>PM 2.5</td><td>176</td><td>750</td></tr>
</table>
</td></tr>
</table>

| **Multi-modal Transportation Transformation** | |
|---|---|
| *Implementation Schedule and Milestones* | **Active Transportation Network**<br>• 2025: 2 miles of new and upgraded paths.<br>• 2026: 4 miles of new and upgraded paths.<br>• 2027: 6 miles of new and upgraded paths.<br>• 2028: 6 miles of new and upgraded paths.<br>• 2029: 6 miles of new and upgraded paths.<br>• 2030: 6 miles of new and upgraded paths.<br>**E-bike Incentive Program**<br>Evaluation study completed by mid-2026.<br>**Transit Service**<br>• All recommendations of the 2022 Transit Development Plan are implemented to enhance routes and service hours by mid-2026.<br>• The Transit Development Plan is updated by 2028 to evaluate plan implementation effectiveness, identify service gaps, and recommend service expansion options.<br>• All recommendations of the updated 2028 Transit Development Plan are implemented by 2030. |
| *Quantitative Cost Estimates* | Capital Costs<br>2025–2030: \$31,500,000<br>2025–2050: \$31,500,000<br>Lifetime Costs or Savings/MT Emissions Avoided: \$1,042/MTCO$_2$e |

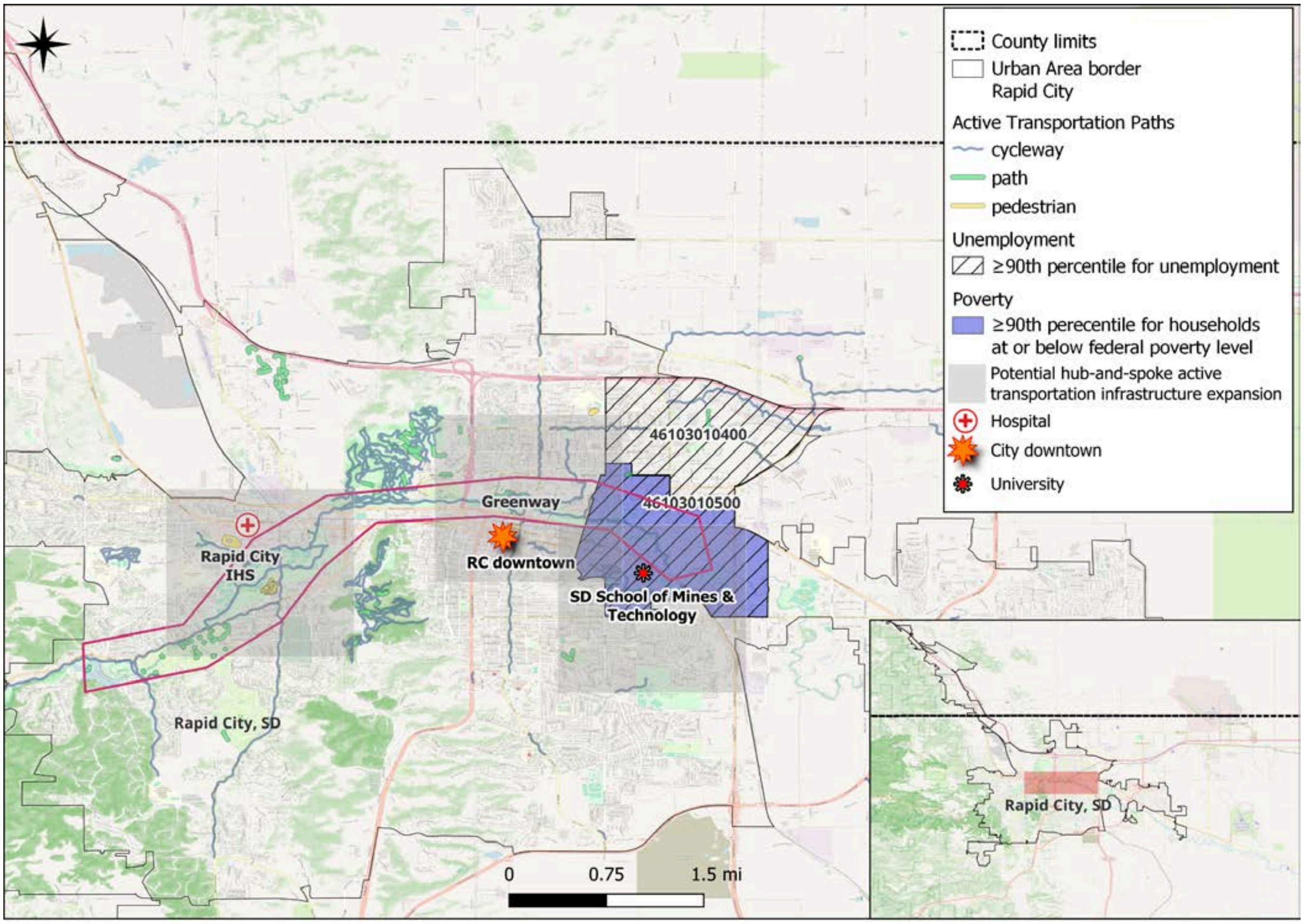

*Figure 27: Multi-modal transportation measures are localized around Rapid City's downtown, SD Mines campus, Oyate Health Center (Indian Health Services hospital), and the Greenway.*

# 6.6 Clean Vehicle Readiness

## Description

The Rapid City region trails behind most areas of comparable size in terms of electric vehicle readiness and market adoption. The region requires transportation infrastructure support upgrades as EV models become more prominent. Improving access to electric vehicle models and their required charging infrastructure will ensure residents and businesses have access to reliable personal and professional transportation. Replacing gas- and diesel-powered vehicles with electric models has positive public health outcomes via reduced noise and air pollution.

Transitioning to cleaner vehicles requires coordinated efforts. This measure identifies beneficial EV charging station locations throughout the region to develop an EV charger network. Initiating this network is a priority first step to encouraging the development of the local EV market. Providing chargers reduces negative perceptions around the viability of EV ownership. Charger network implementation prioritizes public civic facility locations and LIDAC neighborhoods.

Parallel to the charger network effort, an EV maintenance course at a local college or training school will provide job opportunities in this market while supporting EV owners. Residents can get support for installing a charger in their home through a home retrofits program. Performing a traffic light timing study to see how vehicles can spend less time idling at intersections will lead to reduced emissions and improved air quality.

**Clean Vehicle Readiness**

| | |
|---|---|
| *Sector(s)* | ● Transportation |
| *Geographic Location* | Rapid City and surrounding areas |
| *Priority Project Measures* | 1. Develop an EV charging station network, prioritizing public civic facilities and LIDAC areas.<br>2. Develop an EV maintenance education program at Western Dakota Technical College or other school.<br>3. Perform a traffic light timing study.<br>4. Include home EV charging systems in the home retrofit program—Efficient, Affordable Home Energy (measure 6.7). |
| *Potential Project Partners* | ● Western Dakota Technical College—Automotive Technologies Program |
| *Existing Programs and/or Funding Opportunities* | ● Additional funding is available from IRA tax incentives, including the Clean Vehicle Tax Credit and Previously Owned Clean Vehicle Tax Credit. |

| **Clean Vehicle Readiness** | |
|---|---|
| *LIDAC Benefit Analysis* | EV charging network development can begin by installing chargers in public spaces and at civic facilities, which benefit LIDAC areas (Figure 28). This enables residents to own EVs without having to pay for a personal EV charger at their home.<br>EV ownership creates long-term transportation cost stability. Electricity rates are typically stable, increasing only slightly over long periods of time, while gasoline prices fluctuate from week to week, sometimes wildly. EV fuel costs are also a small fraction of gas- and diesel-powered vehicle fuel costs. EV maintenance costs are typically 40% lower than those of gas- and diesel-powered vehicles.[48] All of these factors contribute to lower medium- and long-term overall costs of vehicle ownership and use.<br>Co-benefits from the implementation of these measures and reducing idling times at traffic lights include reducing air and noise pollution and community exposure to PM 2.5, especially in census tracts with a high traffic proximity index, because fewer internal combustion engine vehicles will be on the streets. |
| *Authority to Implement* | ● City of Rapid City<br>○ Community Development Department<br>○ Public Works Department<br>○ Public Works—Traffic Operations Division<br>● Western Dakota Technical College |
| *Political and Community Support* | Medium |
| *Job Creation* | Medium<br>Jobs will be created to install EV chargers, in EV sales and maintenance trades, in college teaching positions, and for consultants for the traffic light timing study. |
| *Technical Parameters* | ● Annual public EV chargers installed.<br>● Annual private EV chargers installed.<br>● Number of college program graduates.<br>● Reduction of average idling times at traffic lights. |

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[48] US Department of Energy Office of Energy Efficiency & Renewable Energy. "FOTW #11901: Battery-Electric Vehicles Have Lower Scheduled Maintenance Costs than Other Light-Duty Vehicles." Energy.gov, June 14, 2021. https://www.energy.gov/eere/vehicles/articles/fotw-1190-june-14-2021-battery-electric-vehicles-have-lower-scheduled.

| **Clean Vehicle Readiness** | |
|---|---|
| *Estimate of the Quantifiable GHG Emissions Reductions* | 2025–2030: 42,663 $MtCO_2e$<br>2025–2050: 296,881 $MtCO_2e$ |
| *Estimate of the Quantifiable Criteria Air Pollutant Emissions Reductions (e.g., through 2030 and 2050)* | See table below |

| Type | 2025–2030 (lb) | 2025–2050 (lb) |
|---|---|---|
| VOC | 48,430 | 292,283 |
| CO | 791,609 | 4,727,567 |
| NOx | 25,022 | 129,426 |
| PM 2.5 | 1,203 | 7,774 |

*Implementation Schedule and Milestones*

**EV Charger Network**

- Study identifying priority public EV charger locations complete by September 2025.
- 50 public EV charging stations installed by December 2026.

**EV Maintenance Training Program**

- Program needs study complete by December 2025.
- Program implementation in fall 2026.

**Traffic Light Timing Study**

- Study parameters defined by early 2025.
- Study complete by the end of 2025.

*Quantitative Cost Estimates*

Capital Costs
2025–2030: -$12,398,532 (savings)
2025–2050: -$12,398,532 (savings)

Fixed O&M
2025–2030: -$12,264,178 (savings)
2025–2050: -$87,965,287 (savings)

Lifetime Costs or Savings/MT Emissions Avoided: -$338/$MTCO_2e$ (savings)

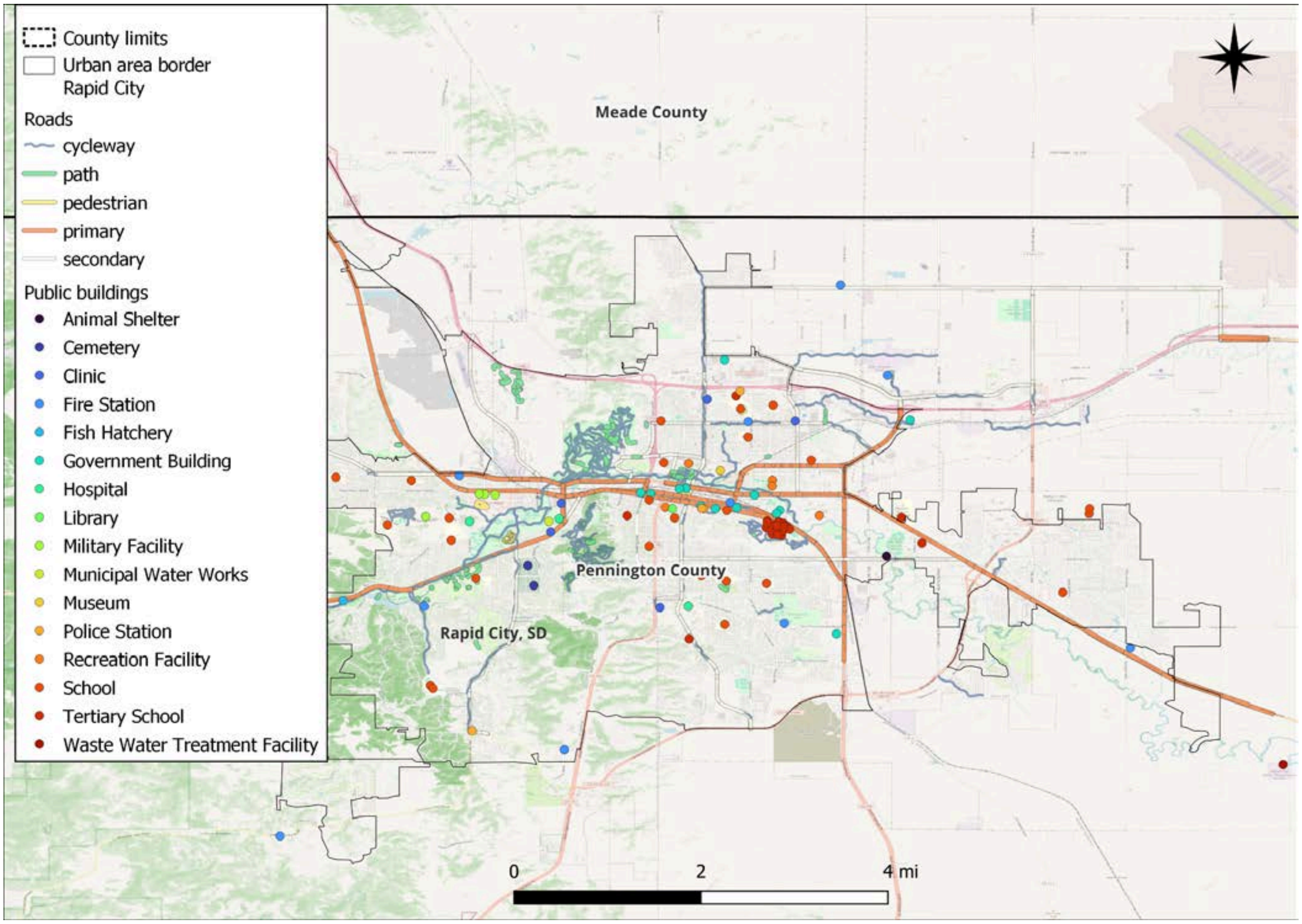

*Figure 28: Map of potential priority public EV charging stations.*

# 6.7 Efficient, Affordable Home Energy

## Description

Homes in the Rapid City area are big energy users and emitters. They typically feature poor insulation and drafty doors and windows, resulting in high energy bills and GHG emissions. These measures enable and support residents to upgrade their homes in order to decrease energy costs, improve indoor comfort, and reduce emissions.

The measures include updating local building codes, creating a home energy efficiency educational program, and developing an incentive program for home energy efficiency retrofits, along with a municipal financing program to fund homeowners' efforts. The City of Rapid City will champion these programs with support from local partners.

### Home Energy Retrofit Program

The home energy retrofit program will prioritize LIDAC areas and pre-1990 built homes. It will coordinate the following for homeowners and landlords:

- Program customer service to guide homeowners in their retrofit process.
- Home energy bill evaluation.
- Home energy audits from certified energy assessors.
- Identification of potential home energy efficiency upgrades.
- Selection of home energy efficiency upgrades to implement.
- Selection of retrofit contractors to engage.
- Identification of materials and energy technologies to use in the retrofits.
- Selection of and application to retrofit grant, incentive, and financing programs.

The home energy retrofit program will be marketed through various local media. The program operators will be proactive in contacting homeowners to offer services. It will focus on building envelope upgrades (e.g., windows, doors, roof, and insulation) and home energy systems (e.g., space heating and cooling, water heating, electrical, appliances, and energy generation and storage).

### Property Assessed Clean Energy (PACE) Program

The City of Rapid City will initiate a PACE program to support homeowners in financing their home upgrades. The program will use best practices from other jurisdictions in its design and implementation. The program will enable homeowners to perform energy efficiency retrofits and energy generation and storage system installations through a low or no-interest loan financing mechanism that allows payback through an annual fee on property taxes. The loan repayment is made by the homeowner, even if homeowners change over the timeline of the payback period. This arrangement encourages retrofits and energy generation and storage installations, even if homeowners are uncertain about the longevity of their tenure. The Rapid City PACE program could be simultaneously or incrementally implemented across Pennington, Meade, and Lawrence Counties and operated at the county level.

### Building Code Update

The City will update its building codes so that new buildings achieve net-zero GHG emissions by 2030. The City will follow best practices from other jurisdictions. The code update will follow the usual requirements of the city and state legislation.

### Energy Efficiency Education and Awareness Program

Working with local utilities and non-profit groups, the City and Counties will coordinate a home energy efficiency education and awareness program that is enhanced from those currently available in the region. The primary goals of the program will be to promote the home energy retrofit program and PACE program. Secondary goals will include promoting energy efficiency practices and awareness of renewable energy tax credits. The program will set a number of household engagement goals as well as goals for converting engagements to home retrofit and PACE program uptake.

### Renewable Ready Program for Residences

Black Hills Energy currently has a Renewable Ready Program for commercial businesses, offering renewable electricity purchases (currently fully subscribed). Rapid City, local partners, and Black Hills Energy can form a working group to create a similar opt-in program for homes, allowing homeowners and renters to purchase renewable electricity for up to 100% of their demand. This program may lead to the creation of new solar PV and wind farm development, as needed.

### Efficient, Affordable Home Energy

| | |
|---|---|
| *Sector(s)* | • Buildings<br>• Energy Efficiency |
| *Geographic Location* | Rapid City and Pennington, Meade, and Lawrence Counties |
| *Priority Project Measures* | 1. Create a home energy efficiency retrofit program, prioritizing LIDAC and pre-1990 built homes.<br>2. Create a property-assessed clean energy program.<br>3. Develop building codes for energy-efficient new buildings.<br>4. Create an education and awareness program about energy efficiency retrofits and renewable energy tax credits.<br>5. Develop a Renewable Ready Program for residential properties. |
| *Potential Project Partners* | • Elevate Rapid City<br>• Financial Institutions<br>• Local Developers<br>• Media<br>• Rapid City Sustainability Committee<br>• Social Purpose Groups (e.g., Western South Dakota Community Action) |

### Efficient, Affordable Home Energy

| | |
|---|---|
| *Existing Programs and/or Funding Opportunities* | ● Black Hills Energy—Residential Rebates<br>● South Dakota Public Utilities Commission<br>● Western South Dakota Community Action<br>● Community Development Block Grant (CDBG) Program |
| *LIDAC Benefit Analysis* | Housing and energy costs are prevalent burdens in Rapid City's LIDAC neighborhoods. Figure 29 displays LIDAC areas that could most benefit from home energy efficiency upgrades. These measures provide relief for these communities by lowering their energy costs and providing consistent, stable energy bills. The home upgrades also enhance resilience to extreme temperatures, lowering health risks such as heat stroke and other health conditions exacerbated by heat exposure. The PACE program ensures a fair, owner-specific payback regime for retrofits, ensuring LIDAC members have stable financial expectations. |
| *Authority to Implement* | ● Black Hills Energy<br>○ Renewable Ready Program<br>● City of Rapid City<br>○ Community Development Department<br>○ Finance Department—Community Enrichment Division<br>○ Finance Department—Grants Division<br>○ Public Works Department |
| *Political and Community Support* | High |
| *Job Creation* | High<br><br>These measures will provide many jobs in the construction industry, HVAC component sales, energy sales, renewable energy system installation and maintenance, and education sectors. |
| *Technical Parameters* | ● Number of homes retrofitted.<br>● Number of PACE program subscriptions.<br>● Household energy bill reduction.<br>● Number of Renewable Ready Program subscribers.<br>● Number of engagement conversions. |

| **Efficient, Affordable Home Energy** | |
|---|---|
| *Estimate of the Quantifiable GHG Emissions Reductions* | 2025–2030: 37,762 $MtCO_2e$<br>2025–2050: 301,138 $MtCO_2e$ |
| *Estimate of the Quantifiable Criteria Air Pollutant Emissions Reductions (e.g., through 2030 and 2050)* | |

| Type | 2025–2030 (lb) | 2025–2050 (lb) |
|---|---|---|
| VOC | 2,873 | 24,213 |
| CO | 20,897 | 176,097 |
| NOx | 49,107 | 413,827 |
| PM 2.5 | 225 | 1,892 |
| SO2 | 313 | 2,641 |

**Efficient, Affordable Home Energy**

*Implementation Schedule and Milestones*

**Home Energy Retrofit Program**

- Program developed by mid-2025.
- First 20 homes retrofitted by the end of 2025.
- 100 homes retrofitted in 2026.
- 200 homes retrofitted in 2027.
- 300 homes retrofitted in 2028.
- 350 homes retrofitted in 2029.
- 450 homes retrofitted in 2030.

**PACE Program**

- Program implemented by mid-2025.
- 20 subscribers by the end of 2025.
- 50 subscribers in 2026.
- 100 subscribers in 2027.
- Program refinancing determined in 2027.
- 250 subscribers in 2028.
- 400 subscribers in 2029.
- 600 subscribers in 2030.
- Program refinancing determined in 2030.

**Building Code Update**

Building code updates completed and in-force by the end of 2026.

**Energy Efficiency Education and Awareness Program**

Program developed by mid-2025, in coordination with the home retrofit and PACE programs.

- 2025: 1,000 engagements, 10% conversion.
- 2026: 2,000 engagements, 15% conversion.
- 2027: 3,000 engagements, 20% conversion.
- 2028: 4,000 engagements, 20% conversion.
- 2029: 5,000 engagements, 20% conversion.
- 2030: 5,000 engagements, 25% conversion.

**Renewable Ready Program for Residences**

Program developed by the end of 2025.

- 2026: 200 total subscribers.
- 2027: 500 total subscribers.
- 2028: 1,000 total subscribers.
- 2029: 1,500 total subscribers.
- 2030: 2,000 total subscribers.

| **Efficient, Affordable Home Energy** | |
|---|---|
| *Quantitative Cost Estimates* | Capital Costs<br>2025–2030: \$123,703,909<br>2025–2050: \$123,703,909<br><br>Fixed O&M<br>2025–2030: -\$14,458,499 (savings)<br>2025–2050: -\$152,141,091 (savings)<br><br>Lifetime Costs or Savings/MT Emissions Avoided: -\$94/MTCO$_2$e (savings) |

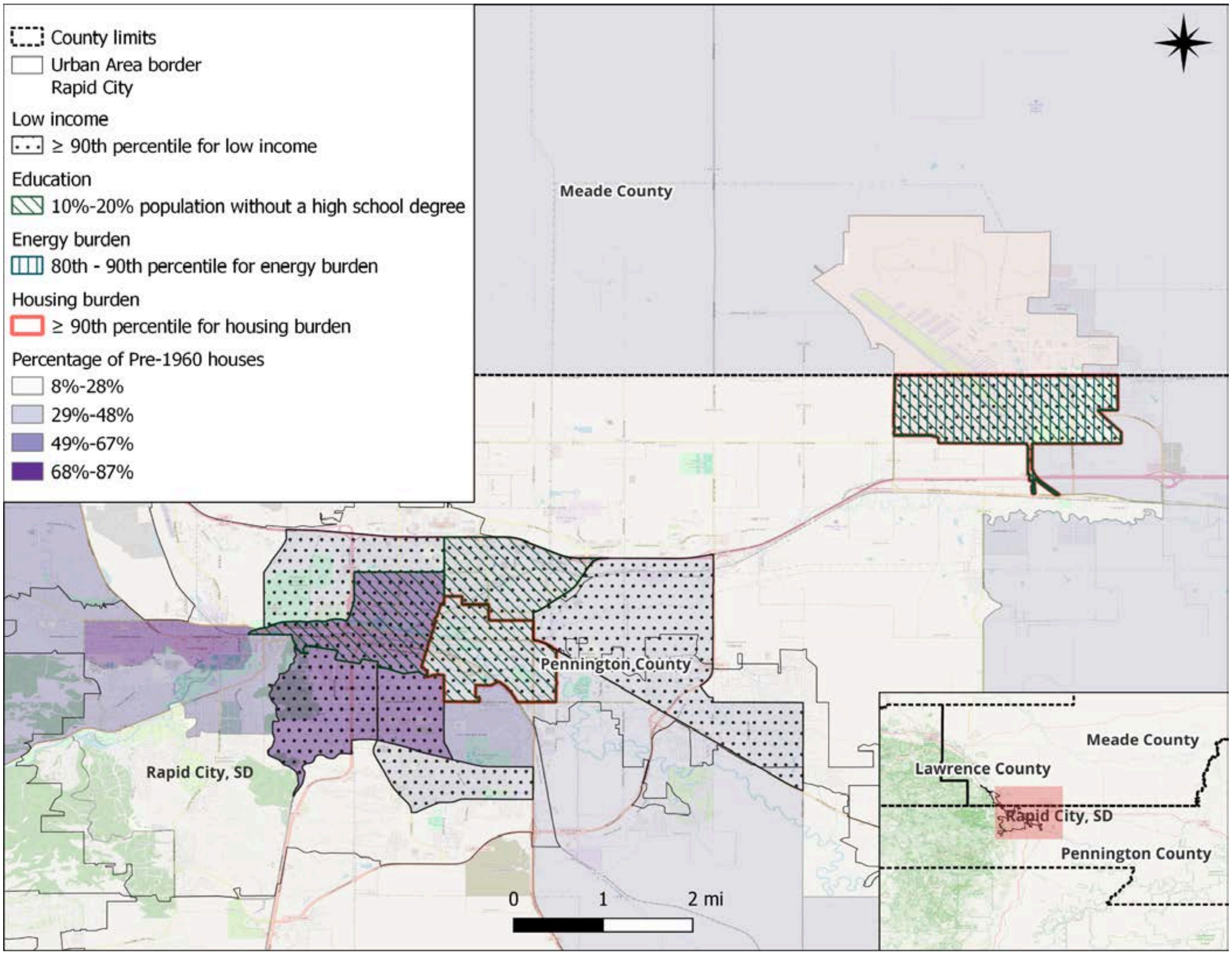

*Figure 29. Map representing the percentage of pre-1960 houses (purple), low-income, highest housing cost burden, and energy burdened communities and tracts with more than a 10% share of people without a high school degree.*

# 7. Comprehensive Climate Action Plan Recommendations and Next Steps

In short order—but using many inputs and considerations—this PCAP identifies important measures for short-term implementation to respond to Rapid City's major climate change and GHG emissions challenges. The measures have significant emissions reduction potential, economic development direction, and demonstrated benefits for LIDAC neighborhoods. The PCAP also lays the groundwork for more in-depth analysis that will be conducted during the CCAP process.

## 7.1 Technical Analysis

While the PCAP evaluated the impact of specific measures, the CCAP will construct a more comprehensive model for the Rapid City MSA to systematically evaluate measures and policies for their GHG emissions and financial impacts. Implementation mechanisms will also be explored in detail.

Based on the technical analysis in the PCAP, recommendations for the CCAP include:

1. Evaluating the compounding and integrated benefit of electrification with clean energy generation on GHG reductions for key measures;
2. Investigating energy supply mix options and their economic implications in more detail;
3. Identifying mechanisms to target LIDAC neighborhoods in a meaningful and equitable manner, namely through policies, incentives, and investments;
4. Directly involving LIDAC representatives in designing policies and mechanisms;
5. Identifying transportation options for rural areas, given the high reliance on personal vehicle trips; and
6. Evaluating mechanisms to scale building weatherization and energy efficiency retrofits across the region.

## 7.2 Engagement Recommendations

The results of the pre-engagement and PCAP engagement activities will inform the plan for outreach and communications used during the CCAP. The following key considerations should be included in the engagement process:

- Using small group meetings, rather than larger ones, to ensure participants have occasions where they can be heard and feel comfortable expressing their thoughts to one another, the City, and the consultant team.
- Providing community members early opportunities to share their thoughts and ideas at the beginning of meetings and gatherings instead of providing time to do so much later during an event.
- Recognizing the close-knit nature of the community, the value of existing relationships, and the power of word-of-mouth communication to spread information about the planning process, key measures, and other information.
- Honoring cultural customs and practices, such as prayer and smudging with sage, which are important to the Indigenous American community and others in LIDAC areas.
- Proactively engaging Indigenous American and other LIDAC groups via existing relationships, connections, methods of communication, etc.
- Making use of multiple communication channels, including print, television, radio, social media, and online sources, to share project information with the community at large.
- Recognizing the political environment present within the community and its relationship to national happenings.
- Being mindful of the wording used to describe the project and its outcomes.
- Collaborating with community partners to expand the reach of communication and engagement efforts associated with the CCAP.
- Recognizing that people's level of knowledge regarding climate change and the importance of reducing GHG emissions varies widely throughout the community, as does their readiness for change, indicating the importance of including education and ensuring all opinions are valued as part of the engagement effort.

## 7.3 In Closing

Rapid City staff and the CPRG Task Force members have moved quickly to advance the local conversation around climate change impacts and to identify meaningful measures that can be taken to reduce GHG emissions while creating socio-economic benefits for residents. Such efforts are relatively new to Rapid City, but the PCAP process has generated interest, momentum, and ambition around climate planning and related measures. The CPRG program is a unique opportunity to foster this direction, creating a sustained effort to continuously improve the lives and livelihoods of Rapid City residents, while simultaneously joining 46 other states and many MSAs to broadly address climate change impacts in the US.

# 8. Appendices

## 8.1 Appendix A: GHG Inventory Method

### 8.1.1 Accounting Protocol

The accounting protocol for this GHG Inventory is the Global Protocol for Community-Scale Greenhouse Gas Inventories (GPC).[49]

### 8.1.2 Background Information

*Table A1. Background information.*

| | |
|---|---|
| Name of jurisdiction | Rapid City, MSA |
| State | South Dakota |
| Inventory year | 2021 |
| Geographic boundary | Rapid City |
| Land area (sq miles) | 55.13[50] |
| Resident population | 76,173[51] |
| GDP | $7.76 million (2021)[52] |
| Composition of economy | 98,000 jobs: Healthcare, 13%; Government, 31%; Retail, 12%; Manufacturing, 3%; Professional, scientific, and technical services, 5%; Accommodation and food services, 9%; Other, 26%.[53] |
| Climate | Rapid City's climate features warm, dry, and sunny summers and cold (with occasional Chinook winds), dry winters.[54] |

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[49] World Resources Institute et al. (2021). Global Protocol for Community-Scale Greenhouse Gas Inventories. Retrieved from: https://ghgprotocol.org/ghg-protocol-cities

[50] U.S. Census Bureau. 2020 U.S. Gazetteer Files". https://www2.census.gov/geo/docs/maps-data/data/gazetteer/2020_Gazetteer/2020_gaz_place_46.txt

[51] U.S. Census Bureau, "ACS Demographic and Housing Estimates," 2022. American Community Survey, ACS 1-Year Estimates Data Profiles, Table DP05, 2022, https://data.census.gov/table/ACSDP1Y2022.DP05?q=rapid city.

[52] U.S. Bureau of Economic Analysis (2023). CAGDP1 County and MSA gross domestic product (GDP) summary. Retrieved from: https://apps.bea.gov/iTable/?reqid=70&step=1&isuri=1&acrdn=5#eyJhcHBpZCI6NzAsInN0ZXBzIjpbMSwyOSwyNSwzMSwyNiwyNywzMCwzMF0sImRhdGEiOltbIlRhYmxlSWQiLCI1MzMiXSxbIk1ham9yX0FyZWEiLCI1Il0sWyJTdGF0ZSIsWyI1Il1dLFsiQXJlYSIsWyIzOTY2MCJdXSxbIlN0YXRpc3RpYyIsIjMiXSxbIlVuaXRfb2ZfbWVhc3VyZSIsIkxldmVscyJdLFsiWWVhciIsWyIyMDIxIl1dLFsiWWVhckJlZ2luIiwiLTEiXSxbIllYXJfRW5kIiwiLTEiXV19

[53] U.S. Bureau of Economic Analysis (2023). CAEMP25N Total full-time and part-time employment by NAICS industry 1. Retrieved from: https://apps.bea.gov/iTable/?reqid=70&step=1&isuri=1&acrdn=5#eyJhcHBpZCI6NzAsInN0ZXBzIjpbMSwyOSwyNSwzMSwyNiwyNywzMCwzMF0sImRhdGEiOltbIlRhYmxlSWQiLCIzMyJdLFsiTWFqb3JfQXJlYSIsIjUiXSxbIlN0YXRlIixbIjUiXV0sWyJBcmVhIixbIjM5NjYwIl1dLFsiU3RhdGlzdGljIiwiLTEiXSxbIlVuaXRfb2ZfbWVhc3VyZSIsIkxldmVscyJdLFsiWWVhciIsWyIyMDIxIl1dLFsiWWVhckJlZ2luIiwiLTEiXSxbIllYXJfRW5kIiwiLTEiXV19

[54] National Weather Service. Retrieved from: Black Hills Climate Overview (weather.gov)

### 8.1.3 Reporting Sectors

Table A2 describes the sectors included and the rationale for exclusions according to the requirements of the GPC.

*Table A2. Reporting sectors.*

| Sector | Inclusion | Rationale |
|---|---|---|
| Stationary Energy | | |
| Residential buildings | Yes | |
| Commercial and institutional buildings and facilities | Yes | |
| Manufacturing industries and construction | Yes | |
| Energy industries | No | NO |
| Agriculture, forestry, and fishing activities | No | NO |
| Non-specified sources | No | NO |
| Fugitive emissions from mining, processing, storage, and transportation of coal | No | NO |
| Fugitive emissions from oil and natural gas systems | No | NE |
| Transportation | | |
| On-road | Yes | |
| Railways | No | NO |
| Waterborne navigation | No | NO |
| Aviation | No | NE |
| Off-road | No | NE |
| Waste | | |
| Solid waste disposal | Yes | |
| Biological treatment of waste | No | NO |
| Incineration and open burning | No | NO |
| Wastewater treatment and discharge | Yes | |

| **Sector** | **Inclusion** | **Rationale** |
|---|---|---|
| Industrial Processes and Product Use | | |
| Industrial processes | Yes | |
| Product use | No | NO |
| Agriculture, Forestry, and Other Land Use (AFOLU) | | |
| Livestock | No | NE |
| Land | No | NE |
| Aggregate sources and non-$CO_2$ emission sources on land | No | NE |

*Table A3. Exclusion rationale notations.*

| **Notation** | **Definition** | **Description** |
|---|---|---|
| IE | Included Elsewhere | GHG emissions for this activity are estimated and presented in another category of the inventory. |
| NE | Not Estimated | Emissions occur but have not been estimated or reported; justification for exclusion shall be noted in the explanation. |
| NO | Not Occurring | An activity or process does not occur or exist within the city. |
| C | Confidential | GHG emissions, which could lead to the disclosure of confidential information and can therefore not be reported. |

### 8.1.4 Inventory Tool

EPA's Local Greenhouse Gas Inventory Tool ("Inventory Tool") was used to develop the GHG Inventory. The Inventory Tool is attached as Appendix B.

### 8.1.5 Data Sources

*Table A4. GHG Inventory data sources.*

| Inventory Tool Sector | Data Source |
|---|---|
| Stationary | US Energy Information Administration<br>Natural Gas Consumption by End Use<br>Form EIA-176: Annual Report of Natural and Supplemental Gas Supply and Disposition, 2021 |
| Electricity | US Energy Information Administration<br>Electricity Sales to Ultimate Customers<br>Form EIA-861: Annual Electric Power Industry Report, 2021 |
| Mobile | US Federal Highway Administration<br>Highway Statistics, 2021<br>Table VM-2 Vehicle-miles of travel, by functional system |
| Mobile | US Federal Highway Administration<br>Highway Statistics, 2021<br>Table VM-4 Distribution of Annual Vehicle Distance Traveled |
| Stationary, Electricity, Mobile | National Renewable Energy Laboratory<br>Net Electricity and Natural Gas Consumption, Reference Case[55]<br>State and Local Planning for Energy |
| Additional Emissions Sources | US Environmental Protection Agency, Office of Atmospheric Protection<br>Greenhouse Gas Reporting Program, 2021<br>Emissions by Unit and Fuel Type |
| Additional Emissions Sources | US Environmental Protection Agency, Office of Atmospheric Protection<br>Greenhouse Gas Reporting Program, 2021<br>Facility Level Information on GHGs Tool |
| Additional Emissions Sources | US Environmental Protection Agency, Office of Atmospheric Protection<br>Greenhouse Gas Reporting Program, 2021<br>Facility Report: Minerals - GP-Kilns |
| Solid Waste | City of Rapid City<br>Rapid City Solid Waste Master Plan, 2021 |
| Wastewater | City of Rapid City<br>Facility Plan: Water Reclamation Facility, 2016 |

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[55] Data used to allocate South Dakota energy consumption to Rapid City.

### 8.1.6 Global Warming Potential

*Table A5. Global warming potentials (100 yr).*[56]

| | |
|---|---|
| $CO_2$ to $CO_2e$ | 1 |
| $CH_4$ to $CO_2e$ | 30 |
| $N_2O$ to $CO_2e$ | 273 |

### 8.1.7 Fuel Emissions Factors

*Table A6. Fuel emissions factors.*[57]

| Fuel | kg $CO_2$ | kg $CH_4$ | kg $N_2O$ | Heat Content (MMBTU/ Unit) | Unit |
|---|---|---|---|---|---|
| Natural Gas | 54.863 | 0.0049 | 0.0001 | 1.0370 | mcf |
| Digester Gas | 34.106 | 0.0021 | 0.0004 | 0.6550 | mcf |
| Diesel | 10.21 | 0.0004 | 0.00008 | 0.1381 | gal |
| LPG | 6.02 | 0.0003 | 0.00006 | 0.0920 | gal |
| Gasoline | 8.50 | 0.0004 | 0.00007 | 0.1202 | gal |
| Residual Fuel Oil No. 5 | 10.21 | 0.0004 | 0.00008 | 0.1400 | gal |
| Residual Fuel Oil No. 6 | 11.27 | 0.0005 | 0.00009 | 0.1500 | gal |
| Propane | 5.72 | 0.0003 | 0.00005 | 0.0910 | gal |
| Butane | 6.67 | 0.0003 | 0.00006 | 0.1030 | gal |
| Jet Fuel | 9.75 | 0.0004 | 0.00008 | 0.1350 | gal |
| Residential Coal | 2390.90 | 0.2742 | 0.03989 | 24.9300 | short tons |
| Commercial Coal | 2051.40 | 0.2353 | 0.03422 | 21.3900 | short tons |
| Industrial Coal | 2138.58 | 0.2459 | 0.03576 | 22.3500 | short tons |
| Electric Power Coal | 1890.52 | 0.2170 | 0.03157 | 19.7300 | short tons |
| Distillate Fuel Oil | 10.281 | 0.0004 | 0.00008 | 0.1387 | gal |
| Kerosene | 10.150 | 0.0004 | 0.00008 | 0.1350 | gal |

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[56] Arias, P.A., N. et al. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 33−144. doi: 10.1017/9781009157896.002.

[57] The Climate Registry. (2021). Default Emission Factors and Emissions Factors for Greenhouse Gas Inventories, U.S EPA April 2022

*Table A7. Emission factors per MMBTU.*[58]

| Fuel | kg $CO_2$ | kg $CH_4$ | kg $N_2O$ | MMBTU/Unit | Unit |
|---|---|---|---|---|---|
| Natural Gas | 52.91 | 0.0047 | 0.0001 | 0.001037 | MMBTU/scf |
| Digester Gas | 52.07 | 0.0032 | 0.00063 | 0.000655 | MMBTU/scf |
| Jet Fuel | 72.22 | 0.003 | 0.0006 | 0.135 | MMBTU/gal |
| Residential Coal | 95.90 | 0.011 | 0.0016 | 24.93 | MMBTU/short ton |
| Commercial Coal | 95.90 | 0.011 | 0.0016 | 21.39 | MMBTU/short ton |
| Industrial Coal | 95.69 | 0.011 | 0.0016 | 22.35 | MMBTU/short ton |
| Electric Power Coal | 95.82 | 0.011 | 0.0016 | 19.73 | MMBTU/short ton |

*Table A8. eGRID electricity emission factors for RMPA West Subregion.*[59]

| Fuel | lbs $CO_2$/MWh | lbs $CH_4$/MWh | lbs $N_2O$/MWh |
|---|---|---|---|
| Electricity | 1,158.86 | 0.109 | 0.016 |

### 8.1.8 Business-as-Usual (BAU) Projection

The BAU projection is an extrapolation of GHG emissions from 2022 to 2050 using EPA's State Inventory and Projection Tool.[60] The primary input into this tool is a population projection, which is derived from state projections from the US Census Bureau[61] through 2030 and national projections[62] through 2050, apportioned to states based on the 2030 population. The tool uses the population projection to calculate future fuel use by sector and fuel type.

The projected fuel consumption is divided by the state population to derive a per-capita fuel consumption rate by sector and fuel type through 2050. This per-capita consumption is multiplied by city population projections to estimate future fuel use by sector and fuel type.

Emissions factors are applied to the fuel use to determine emissions. The emissions factors for non-electricity fuels are shown in Table A7, above. The projected emissions factor for grid electricity is the National Renewable Energy Laboratory's (NREL) Cambium 2022 mid-case projection.[63]

Solid waste and wastewater emissions are scaled based on projected population. Industrial process emissions are held constant from 2021 through 2050.

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[58] Ibid.

[59] Emissions & Generation Resource Integrated Database (eGRID). https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid

[60] Environmental Protection Agency. State Inventory and Projection Tool. 2023 https://www.epa.gov/statelocalenergy/state-inventory-and-projection-tool

[61] US Census Bureau. "Current Population Reports, 1995-2030"

[62] US Census Bureau. "The Baby Boom Cohort in the United States: 2012 to 2060"

[63] NREL Cambium 2022 https://scenarioviewer.nrel.gov/?project=82460f06-548c-4954-b2d9-b84ba92d63e2&mode=download&layout=Default

# 8.2 Appendix B: GHG Inventory Tool

(External document)

# 8.3 Appendix C: List of LIDAC in the Project Area According to the CESJTool

*Table C1. LIDAC census tracts.*

| GEOID10 (Census Tract #ID) | State | County |
|---|---|---|
| 46103010200 | South Dakota | Pennington County |
| 46103011500 | South Dakota | Pennington County |
| 46103010300 | South Dakota | Pennington County |
| 46103010400 | South Dakota | Pennington County |
| 46081966600 | South Dakota | Lawrence County |
| 46103010904 | South Dakota | Pennington County |
| 46103010906 | South Dakota | Pennington County |
| 46093020400 | South Dakota | Meade County |
| 46103010800 | South Dakota | Pennington County |
| 46103010500 | South Dakota | Pennington County |

## Contact Info:

City of Rapid City

Lysann Zeller, Sustainability & Stewardship
Program Development Manager

(605) 394-4165

Lysann.Zeller@rcgov.org

# Data, Methods, and Assumption Manual

This appendix describes the data, methodologies and assumptions used to calculate emissions reductions for all measures/projects, as well as potential uncertainty factors present in the methodology used.

# Buildings

To quantify emissions reductions from residential and non-residential building energy improvements, the methodology compares a building's total energy use and resulting emissions before and after improvements are made.

Note that these improvements include both energy efficiency improvements and switching from systems using fossil fuel energy to heat pumps that can use zero-emissions electricity. The formulas provided here estimate changes in energy consumption and emissions from these two energy sources to either air or ground source heat pumps.

## 1. Changes in Total Energy Use

In the formulas below, for the purposes of building retrofit measures:

- The 'Energy Reduction %' was set to 50% to reflect a desired reduction in non-space conditioning energy consumption in these buildings by 50%.
- The 'Thermal Energy Reduction %' was set to 50% to reflect a reduction in space conditioning energy consumption by 50%; and,
- The COP (coefficient of performance) reflects the increase in efficiency of heat pumps relative to natural gas or electric systems.

## For Electricity

To determine the impact of improved performance on buildings' **non-space conditioning electricity consumption** (i.e., energy used for appliances, lighting, plug load, etc.) the following formula is used:

$$New\ NonSpace\ Conditioning\ Electricity\ Use\ (MMBTU)\ =\ (1\ -\ Energy\ Reduction\ \%)\times$$
$$Baseline\ NonSpace\ Conditioning\ Electricity\ Use\ (MMBTU)$$

To determine the impact of improved performance on buildings' **space-conditioning electricity consumption** (i.e., space heating and cooling and water heating) the following formula is used:

$$New\ Space\ Conditioning\ Electricity\ Use\ (MMBTU)\ =\ (1\ -\ Thermal\ Energy\ Reduction\ \%)\times$$
$$Baseline\ Space\ Conditioning\ Natural\ Gas\ Use\ (MMBTU)/COP\ \ +$$
$$(1\ -\ Energy\ Reduction\ \%)\times\ Electricity\ of\ Baseline\ Buildings\ (MMBTU)$$

The final, total electricity consumption after retrofits are complete is calculated as:

$$New\ Electricity\ Use\ (MMBTU)\ =\ New\ Space\ Conditioning\ Electricity\ Use\ (MMBTU)\ \ +$$
$$New\ NonSpace\ Conditioning\ Electricity\ Use\ (MMBTU)$$

## For Natural Gas

To determine the impact of improved performance on buildings' **non-space conditioning natural gas consumption** (e.g., natural gas use for stoves) the following formula is used:

$$New\ NonSpace\ Conditioning\ Natural\ Gas\ Use\ (MMBTU)\ =$$
$$(1\ -\ Energy\ Reduction\ \%)\times\ Baseline\ NonSpace\ Conditioning\ Natural\ Gas\ Use\ (MMBTU)$$

To determine the impact of improved performance on buildings' **space conditioning natural gas consumption** (e.g., space heating and hot water heating) the following formula is generally used to show, for example, a *reduction* in natural gas use due to increased insulation:

$$New\ Space\ Conditioning\ Natural\ Gas\ Use\ (MMBTU)\ =\ (1\ -\ Thermal\ Energy\ Reduction\ \%)\times$$
$$Baseline\ Space\ Conditioning\ Natural\ Gas\ Use\ (MMBTU)$$

However, in order to achieve significant emissions reductions, the projects for this PCAP will include completely removing natural gas systems for space conditioning, and replacing them with heat pumps. In this case the following formula is used:

$$New\ Space\ Conditioning\ Natural\ Gas\ Use\ (MMBTU) = 0$$

The final, total natural gas consumption after retrofits are complete is calculated as:

$$New\ Natural\ Gas\ Use\ (MMBTU)\ =\ New\ Space\ Conditioning\ Natural\ Gas\ Use\ (MMBTU)\ +\ New\ NonSpace\ Conditioning\ Natural\ Gas\ Use\ (MMBTU)$$

## 2. Changes in Total Emissions

The resulting changes in emissions are calculated by applying the appropriate emissions factors to the change in energy consumption (both electricity and natural gas) calculated above:

$$Net\ Electricity\ Emissions\ (MT\ CO2e)\ = Baseline\ Electricity\ Use\ (MMBTU)\ -\ New\ Electricity\ Use\ (MMBTU) \times Emission\ Factor\ of\ the\ Grid\ (MT\ CO2e/MMBTU)$$

$$Net\ Natural\ Gas\ Emissions\ (MT\ CO2e)\ = Baseline\ Natural\ Gas\ Use\ (MMBTU)\ -\ New\ Natural\ Gas\ Use\ (MMBTU) \times Natural\ Gas\ Emission\ Factor\ (MT\ CO2e/MMBTU)$$

The final, total emissions reductions (MT CO2e) are the sum of electricity and natural gas emissions.

$$Net\ Emission\ Reduction\ (MT\ CO2e)\ = Net\ Electricity\ Emissions\ (MT\ CO2e)\ +\ Net\ Natural\ Gas\ Emissions\ (MT\ CO2e)$$

## 3. Calculating Capital Costs

The capital costs of retrofitting buildings for the projects in this PCAP were assumed to consist of two elements. The first addresses the thermal envelope of the building, affecting the heating/cooling required to keep the building comfortable. The extent or ‘depth’ of the thermal retrofit dictates the cost of this action, such that the more the thermal envelope is improved, the greater the cost. The formulas for calculating retrofit capital costs for residential and non-residential buildings is as follows:

$$Residential\ Thermal\ Envelope\ Capital\ Cost\ (USD)\ =$$

$$number\ of\ dwelling\ units \times Costs\ for\ Percent\ Energy\ Reduction\ (USD/unit)$$

$$NonResidential\ \ Thermal\ Envelope\ \ Capital\ Cost\ (USD)\ =$$

$$floorspace\ retrofit\ \ \times Costs\ for\ Percent\ Energy\ Reduction\ (USD/sqft)$$

The second element addresses the equipment used to heat/cool the building. For these projects, it was assumed that natural gas furnaces or electric radiator heating would be replaced by either electric air source heat pumps or ground source heat pumps. Capital costs to make these replacements are calculated by multiplying the number of units being replaced by the cost per unit, as follows:

$$Space\ Conditioning\ Capital\ Cost\ (USD)\ =$$

$$number\ of\ installed\ units \times unit\ cost\ (USD/unit)$$

## 4. Calculating Energy Costs/ Savings

Changing the fuel used to heat and cool buildings also results in a difference in ongoing energy costs when operating the buildings. Actions such as retrofitting the thermal envelope of the building will reduce energy consumption, reducing energy costs. The formula for calculating annual energy costs  or savings that was used is shown here:

$$Annual\ Energy\ Cost\ (USD)\ =$$

$$Change\ in\ energy\ consumption\ by\ fuel\ (MMBTU)\ \ *\ \ Cost\ by\ fuel\ (USD/MMBTU)$$

## 5. Calculating Costs/ Savings per Ton of Emissions Avoided

The final cost / savings per metric ton of emissions avoided was calculated using the following formula:

*Cost/ Savings per MT of Emissions Avoided =*

*Capital Costs + (Annual Energy Cost/ Savings X Total Time) / Net Emission Reduction*

Calculating a cost/ savings per MT of emissions avoided allows SEMCOG to compare the cost-effectiveness of different actions to reduce emissions over a period of time (or the Total Time). For the purposes of this PCAP, the Total Time for each measure began when emissions reductions would first be realized and continue until 2050.

## Co-pollutants Reduction Calculations for Natural Gas

Eliminating natural gas combustion in buildings also reduces the presence of pollutants including carbon monoxide (CO), nitrogen oxides (NOx), sulfur dioxide (SO2), particulate matter (PM2.5), and volatile organic compounds (VOCs). Quantifying the reductions of these pollutants was done using emissions data from the EPA National Emissions Inventory (NEI). For each pollutant, its emission rate per MMBtu of natural gas consumed is calculated by dividing the total emissions of each co-pollutant by the total natural gas consumption, as shown in the formula:

$$Pollutant's\ Emission\ Rate\ by\ Type\ (metric\ tons/MMBtu) = \frac{Total\ Emissions\ of\ Pollutant\ (metric\ tons)}{Total\ Natural\ Gas\ Consumption\ (MMBtu)}$$

Subsequently, the reduction of the pollutant can be calculated by applying the reduction in natural gas consumption to the pollutants emission rate by type using this formula:

$$Reduction\ of\ Pollutant\ (metric\ tons) = Natural\ Gas\ Consumption\ Reduction\ (MMBtu) \times Pollutant's\ Emission\ Rate\ by\ Type\ (metric\ tons/MMBtu)$$

In this formula Natural Gas Consumption Reduction represents the amount of the reduction in natural gas use due to the retrofit (in million British thermal units, or MMBtu).

Each Pollutant’s Emission Rate by Type (metric tons/MMBtu) specifies the amount of pollutant emitted per unit of natural gas consumed. This rate varies by pollutant type and reflects the average emissions associated with the combustion of natural gas.

# Transportation

## Electric Vehicle Adoption Emissions Reduction

The calculation for Electric Vehicle (EV) adoption and its impact on emissions reduction involves several steps, each leveraging specific data points to quantify the net emissions reduction achieved by transitioning from conventional vehicles to EVs. Here is a detailed explanation of the process, and relevant equations.

### 1. Calculating Total Distance (VMT) that will Shift to EVs

This step calculates the total miles that will be transitioned by type of vehicle from gasoline or diesel to electric vehicles:

$$VMT\ to\ shift\ (miles) = Number\ of\ Vehicles\ to\ shift \times Annual\ VMT\ per\ vehicle\ (miles)$$

This equation multiplies the number of vehicles by type being transitioned to EVs by the annual vehicle miles traveled (VMT) per vehicle, giving the total miles that will now be covered by EVs instead of conventional vehicles.

## 2. Calculating Gross Emissions Reductions

This step calculates the gross emissions reduction, which is the total potential reduction in emissions *if* the shifted VMT were no longer contributing to greenhouse gas (GHG) emissions from conventional vehicle tailpipes.

$$Gross\ Emissions\ Reduction\ (MT\ CO2e)\ =$$

$$VMT\ to\ shift\ (miles) \times Emission\ Factor\ (MT\ CO2e/miles)$$

The emission factor (MT CO2e/mile) represents the amount of CO2e emissions produced per mile by conventional vehicles. Multiplying this factor by the VMT to shift gives the total emissions that could be avoided by switching to EVs.

## 3. Calculating Emissions from EVs

This step calculates the emissions from the electricity consumed by EVs for the shifted VMT. It considers the average electricity consumption by type of EV and the emission factor for electricity generation.

$$Emissions\ EVs\ (MT\ CO2e)\ =\ VMT\ to\ shift\ by\ type\ of\ EV\ (miles) \times$$

$$Average\ Electricity\ consumption\ by\ Type\ of\ EV\ (GWh/miles) \times$$

$$Emission\ Factor\ Electricity\ (MT\ CO2e/GWh)$$

This equation takes into account the average electricity consumption (GWh/mile) by the type of EV for the shifted VMT and multiplies it by the emission factor for electricity (MT CO2e/GWh). If the vehicles are being charged using grid electricity, the emission factor used is that of the grid. If the vehicles are charged using renewable power, then the emissions factor used will reflect that no emissions are generated from charging these vehicles.

## 4. Calculating Net Emissions Reduction

The net emissions reduction is the difference between the gross emissions reduction (potential emissions savings from not using conventional vehicles) and the emissions attributable to the electricity used by EVs.

$$Net\ Emission\ Reduction\ (MT\ CO2e)\ =$$

$$Gross\ Emissions\ Reduction\ (MT\ CO2e)\ -\ Emissions\ EVs\ (MT\ CO2e)$$

This final step provides the overall emissions reduction benefit of transitioning to EVs, taking into account the emissions from electricity generation for EV charging.

## Electric Vehicle Adoption Costs and Savings

The net costs/ savings associated with switching to an electric vehicle is calculated by adding the purchase cost to the operations (or fuel) costs/ savings and maintenance costs/ savings for the lifetime of the vehicle. This is shown in the two steps below.

### 1. Calculating Capital Costs

The capital cost reflects the investment needed to purchase a zero-emissions vehicle(s). It is calculated using the following formula:

$$Capital\ Cost\ (USD)\ =\ Number\ of\ Vehicles \times Cost\ \ (USD/vehicle)$$

In most cases in this PCAP, the capital costs presented are ‘incremental capital costs’. This means that they represent the difference between what would be paid for the traditional option (e.g. an ICE vehicle) and what will be paid for the new option (an EV). The column labels in the PCAP indicate when the costs provided are incremental versus total.

### 2. Calculating Operation and Maintenance Costs

Vehicle operation costs include the costs of fuel or charging. Maintenance costs include the costs of vehicle upkeep and servicing. These two values are calculated using the formulas below. If the calculation is being made for more than one vehicle, the Vehicle Miles Traveled and the Energy Consumed must be the total values for all the vehicles being considered:

$$Maintenance\ Cost\ (USD)\ =\ Vehicle\ Miles\ Traveled\ (miles) \times Cost\ \ (USD/mile)$$

$$Operation\ Cost\ (USD)\ =\ Energy\ Consumed\ (MMBTU) \times Cost\ \ (USD/MMBTU)$$

# Mode shift Emissions Reduction

The calculation for mode shift begins with estimating the reduction in vehicle miles traveled (VMT) as a result of shifting transportation modes from personal gasoline-powered vehicles to alternative modes such as public transit, biking, walking, or electric vehicles.

## 1. Calculating VMT Reductions

The formula provided here calculates the total reduction in distance driven that is attributable to the mode shift, and is expressed in millions of VMT:

$$VMT\ reduction\ (million\ VMT)\ =\ Total\ VMT\ with\ Gasoline\ (million\ VMT)\ -$$

$$(Total\ VMT\ with\ Gasoline\ (million\ VMT) \times \frac{Share\ of\ VMT\ by\ auto\ Baseline\ (\%)}{Share\ of\ VMT\ by\ auto\ After\ action\ (\%)}\ )$$

**Total VMT with Gasoline (Million VMT):** This represents the total miles traveled by gasoline-powered vehicles before any interventions to encourage a mode shift. It serves as the baseline against which the reduction in VMT is measured.

**Share of VMT by auto Baseline (%):** This is the baseline share of total VMT traveled by gasoline-powered vehicles before any interventions to encourage a mode shift.

**Share of VMT by auto After action (%):** This percentage reflects the projected share of total VMT that is traveled by gasoline-powered vehicles after interventions have been implemented to promote a mode shift.

The equation subtracts the adjusted VMT (considering the action-induced change in the share of VMT by auto) from the baseline total VMT with gasoline to calculate the reduction in VMT due to the mode shift, quantifying how much vehicle travel has been avoided by shifting away from gasoline-powered vehicles toward more sustainable modes of transportation.

## 2. Calculating Emission Reductions

The emission reductions from a transportation mode shift are calculated by multiplying the reduction in vehicle miles traveled (VMT) by the emission factor of the vehicle fuel being used (e.g. gasoline), yielding the total emissions avoided in metric tons of CO2 equivalent (MT CO2e). The formula is as follows:

$$Emission\ Reduction\ (MT\ CO2e)\ =$$

$$VMT\ reduction\ (Million\ VMT) \times Emission\ factor\ (MT\ CO2e\ /\ Million\ VMT)$$

This equation translates VMT reduction into greenhouse gas emissions savings, providing a clear measure of the environmental benefits of shifting away from internal combustion engine (ICE) vehicles towards more sustainable transportation modes.

### 3. Calculating Capital Costs

For this analysis, the capital costs to support the desired transportation mode shift are calculated by multiplying the miles of infrastructure required by the cost per mile. The formula is as follows:

$$Capital\ Cost\ (USD)\ =$$

$$Miles\ of\ infrastructure\ (mile) \times Costs\ per\ mile\ (USD/mile)$$

Note that other other costs such as education and safety programs, as well as savings such as avoided health care costs (e.g., from conditions arising from inactivity) could also be incorporated into a ‘total’ assessment of financial costs and benefits; however these values were not included in the calculations made for this PCAP.

## Co-pollutants Reduction Calculations

For the transportation sector, the calculation of emissions reductions for co-pollutants entails analyzing the decrease in vehicle miles traveled (VMT) and applying designated emissions rates for various vehicle types. The co-pollutants in focus—Total Hydrocarbons (HC), Carbon Monoxide (CO), Nitrogen Oxides (NOx), and Particulate Matter (PM2.5)—are evaluated for their emissions impact. The formula to calculate the emissions reductions for each co-pollutant is given by:

$$Emissions\ Reductions\ per\ co\ -\ pollutant\ (metric\ ton)\ =$$

$$VMT\ reduction\ (miles) \times Emissions\ Rates\ per\ Vehicle\ Type\ (metric\ ton/mile)$$

In this context:

VMT reduction (miles) denotes the decrease in vehicle miles traveled, achieved through increased adoption of electric vehicles (EVs), greater use of public transit, and encouragement of biking or walking.

Emissions Rates per Vehicle Type (metric ton/mile) specifies the rate at which each vehicle type emits HC, CO, NOx, and PM2.5 per mile. These rates vary by vehicle type and fuel used, reflecting the different contributions to air pollution.

# Energy Systems

To accurately assess the emissions reduction attributable to renewable installations, the methodology uses two key ‘factors’:

1. A ‘capacity factor’ for each type of technology, and for each State, as provided by NREL. These factors estimate the energy generation potential of solar and wind installations based on geographical and climatic variations that will affect wind patterns and solar irradiance and consequently also, energy production.
2. The ‘grid emissions factor’ from the EPA eGRID database. This factor represents the average emissions intensity of electricity generation and distribution on the region’s electricity grid. This provides a baseline against which the impact of renewable-generated electricity can be measured. Additionally, projections of emission factors based on Michigan’s Clean Energy targets are used to anticipate the grid's future carbon intensity.

## 1. Calculating Annual Generation

The annual electricity generation from installed renewable systems is calculated using the formula:

$$Annual\ Generation\ (GWh)\ =\ Installed\ Capacity\ (GWh) \times 8760 \times Capacity\ Factor$$

This equation multiplies the installed capacity (in gigawatt-hours, GWh) by the total number of hours in a year (8760) and the capacity factor, providing an estimate of the total energy produced by solar installations annually.

## 2. Calculating Emissions Reductions

The reduction in emissions resulting from the generated renewable electricity is quantified as follows:

$$Emissions\ Reduction\ (MT\ CO2e)\ =\ Emission\ Factor\ (MT\ CO2e/GWh) \times Annual\ Generation\ (GWh)$$

This calculation applies the emission factor (in metric tons of CO2 equivalent per gigawatt-hour, or MT CO2e/GWh) to the annual generation from renewable energy installations, estimating the total emissions avoided by displacing grid electricity with renewable energy.

## 3. Calculating Capital Costs

The capital costs of renewable energy depend on the installed capacity and the technology. The formulas for calculating renewable energy capital costs are as follows:

$$Renewable\ Energy\ Capital\ Cost\ (USD)\ =$$

$$Generation\ Capacity\ (kW) \times Costs\ (USD/kw)$$

## 4. Calculating Energy Costs

In cases such as rooftop solar, the amount of electricity a customer requires from the grid will be reduced by the amount they generate from their solar system. This translates into lower utility bills for the customer. The formula for calculating these energy savings is as follows:

$$Energy\ Cost\ (USD)\ =$$

$$Change\ in\ energy\ consumption\ by\ fuel\ (MMBTU)\ \ *\ \ Cost\ by\ fuel\ (USD/MMBTU)$$

# Restore Landscapes and Sequester Carbon

The methodology for calculating carbon sequestration from tree planting initiatives incorporates the EPA's State Inventory Tools for the Carbon Sequestration Factor and canopy cover planning tools from Oakville, California. Additionally, it assumes the planting of small-stature trees with a crown spread of 10-30 feet. This assumption is critical for estimating the potential canopy coverage and, consequently, the carbon sequestration capacity of the initiative. This approach enhances the carbon sequestration estimates by aligning with the physical characteristics of the trees being planted.

## Emissions Reduction

The emissions reduction is quantified by calculating the carbon sequestration potential of the vegetation at maturity. This calculation takes into account the area covered by the vegetation once the trees and plants have reached their full growth potential, as well as the carbon sequestration factor, which represents the amount of carbon dioxide (CO2) that can be absorbed per unit roof area or per tree. The formulas to estimate the emissions reduction in metric tons of CO2 equivalent (MT CO2e) are as follows:

## 1. Calculating Sequestration from Tree Planting

$$Emissions\ Reduction\ (MT\ CO2e)\ =$$

$$Canopy\ at\ Maturity\ (hectare) \times Carbon\ Sequestration\ Factor\ (MT\ CO2e/hectare)$$

In this formula:

Carbon Sequestration Factor (MT CO2e/tree) indicates the amount of CO2 that can be sequestered per tree per year, reflecting the capacity of the trees to absorb CO2 from the atmosphere.

# Data Sources

This table describes the data and assumptions used for the calculations outlined above, and their sources.

*Table 1: Data Sources.*

| Source | Data Set |
|---|---|
| Federal Highway Administration | Vehicle Miles Traveled (VMT) data by vehicle type[1] |
| NREL's BC Transit Fuel Cell Bus Project | Alternative fuel vehicle consumption metrics[2] |
| Replica | Detailed mode-specific transportation data, including trip numbers, lengths, and occupancy rates by county[3] |
| U.S. Department of Energy's resources, Alternatives Fuel Data Center and 2023 Fuel Economy Guide | Vehicle mileage and fuel consumption rates[4] |
| American Council for an Energy-Efficient Economy and average vehicle emissions rates from the U.S. Department of Transportation | Heavy-duty vehicle fuel consumption[5] |
| United States Department of Transportation, National Transportation Statistics | Estimated National Average Vehicle Emissions Rates per Vehicle by Vehicle Type using Gasoline and Diesel[6] |

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[1] Federal Highway Administration. "Vehicle Miles Traveled (VMT) data by vehicle type." Policy Information, Statistics 2020. https://www.fhwa.dot.gov/policyinformation/statistics/2020/

[2] National Renewable Energy Laboratory. "BC Transit Fuel Cell Bus Project: Evaluation Results." https://www.nrel.gov/docs/fy14osti/60603.pdf

[3] Replica. "Detailed Mode-Specific Transportation Data, Including Trip Numbers, Lengths, and Occupancy Rates by County." https://studio.replicahq.com

[4] U.S. Department of Energy. "2023 Fuel Economy Guide." Published January 2024. https://fueleconomy.gov/feg/pdfs/guides/FEG2023.pdf

[5] Nadel, Steven, and Eric Junga. "Electrifying Trucks: From Delivery Vans to Buses to 18-Wheelers." An ACEEE White Paper, January 2020. https://www.aceee.org/sites/default/files/pdfs/electric_trucks_1.pdf

[6] United States Department of Transportation. "Estimated National Average Vehicle Emissions Rates per Vehicle by Vehicle Type using Gasoline and Diesel." National Transportation Statistics. https://www.bts.gov/product/national-transportation-statistics

| Source | Data Set |
|---|---|
| U.S. Energy Information Administration Annual Energy Outlook 2023 | Residential, Commercial and Transportation Energy prices[7] |
| California HVIP | Bus and Heavy Duty Vehicle capital and O&M costs[8] |
| International Council on Clean Transportation, Argonne National Laboratory and American Automobile Association | Light Duty Vehicle capital and O&M costs[9,10,11] |
| Portland State University Cost Analysis of Bicycle Facilities | Capital Cost of active transportation infrastructure[12] |
| Energy Information Administration (EIA) forms 861 and 176 | Electricity and natural gas consumption data for both residential and non-residential buildings[13,14] |
| US Census Bureau | Dwelling units by building type[15] |
| Replica | Non-residential building floorspace |
| National Renewable Energy Laboratory's (NREL) ResStock and ComStock databases | Residential and commercial buildings' energy use by type and end-use |
| EPA National Emissions Inventory (NEI) | Co-pollutants emissions by Natural gas combustion in residential and commercial/ institutional buildings[16] |
| U.S. Energy Information Administration 2023 Building Sector Appliance and Equipment Costs and Efficiencies | Residential and commercial heat pump capital costs[17] |
| Environmental Protection Agency's (EPA) inventory tool | eGRID electricity and fossil fuel emission factors[18] |
| NREL Rooftop Solar Photovoltaic Technical Potential | Energy production potential of solar rooftop installations[19] |

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[7] U.S. Energy Information Administration. "Annual Energy Outlook 2023 - Table 3 Energy Prices by Sector and Source". https://www.eia.gov/outlooks/aeo/data/browser/#/?id=3-AEO2023&sourcekey=0

[8] California HVIP. "Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project". https://californiahvip.org/

[9] The International Council on Clean Transportation. "Update on electric vehicle costs in the United States through 2030". https://theicct.org/wp-content/uploads/2021/06/EV_cost_2020_2030_20190401.pdf

[10] Argonne National Laboratory. "Assessment of Vehicle Sizing, Energy Consumption, and Cost Through Large-Scale Simulation of Advanced Vehicle Technologies". https://publications.anl.gov/anlpubs/2016/04/126422.pdf

[11] American Automobile Association. "Your Driving Costs: How Much Are You Really Paying to Drive?". https://exchange.aaa.com/wp-content/uploads/2019/09/AAA-Your-Driving-Costs-2019.pdf

[12] Portland State University. "Cost Analysis of Bicycle Facilities: Cases from cities in the Portland, OR region". https://activelivingresearch.org/sites/activelivingresearch.org/files/Dill_Bicycle_Facility_Cost_June2013.pdf

[13] U.S. Energy Information Administration. "Electricity Sales." https://www.eia.gov/electricity/data/eia861m/

[14] U.S. Energy Information Administration. "Natural Gas Consumption." https://www.eia.gov/naturalgas/data.php

[15] U.S. Census Bureau. "Population and Housing Unit Estimates Datasets." https://www.census.gov/programs-surveys/popest/data/data-sets.html

[16] Environmental Protection Agency. "2020 National Emissions Inventory (NEI) Data." https://www.epa.gov/air-emissions-inventories/2020-national-emissions-inventory-nei-data

[17] U.S. Energy Information Administration. "Building Sector Appliance and Equipment Costs and Efficiencies, 2023". https://www.eia.gov/analysis/studies/buildings/equipcosts/

[18] Environmental Protection Agency. "Emissions & Generation Resource Integrated Database (eGRID)." https://www.epa.gov/egrid

[19] National Renewable Energy Laboratory. "Rooftop Solar Photovoltaic Technical Potential in the United States: A Detailed Assessment - Table 6. Total Estimated Technical Potential (All Buildings) for Rooftop PV by State." https://www.nrel.gov/docs/fy16osti/65298.pdf

| Source | Data Set |
|---|---|
| NREL Cambium 2022 | Electricity Grid Emission Factor projections[20] |
| Pembina Institute | Residential and Non-residential Building Envelope Retrofit Incremental Costs[21] |
| NREL System Advisory Model (SAM) | Capacity Factor for Photovoltaic Plants and Wind Farms[22] |
| NREL 2021 Electricity Annual Technology Baseline | Solar and Wind Renewable Electricity Production Capacity Capital Costs[23] |
| Town of Oakville Development Application Guidelines: Canopy Cover Plan and Canopy Calculation Chart | Crown area spread estimation[24] |
| EPA's State Inventory Tools | Carbon Sequestration Factor[25] |
| Aerosol and Air Quality Research | Green roof carbon sequestration potential[26] |

# Uncertainty

The quantification of GHG emissions is largely the result of applying emissions factors, as measured in metric tons per unit of activity, to an estimated amount of activity, as measured in MMBTU, kWhs, vehicle miles traveled, etc. Different methodologies and assumptions used in determining these emissions factors can introduce uncertainty into the process. To mitigate this, emission factors derived from EPA tools and calculations have been used where possible, ensuring that calculations align with EPA data and methodologies.

The projected transformation of the modeled activity also introduces uncertainties to the calculations. An assumption that crosses all action is the rate of adoption of various technologies or behaviors. Uniform adoption rates are assumed for zero emission vehicles (ZEVs), building retrofits, renewable energy, etc, which may not align with real-world market dynamics, consumer behavior, or policy shifts. The projected actions also simplifies the logistical and technical challenges involved in its deployment, such as spatial planning, required workforce, materials and electrical grid impacts. Furthermore, the methodology might not accurately capture the dynamic effects on emissions one action has on another action, for example, overlooking how increased use of one mode (e.g., biking) affects others

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[20] Gagnon, Pieter; Cowiestoll, Brady; Schwarz, Marty (2023): Cambium 2022 Data. National Renewable Energy Laboratory. https://scenarioviewer.nrel.gov

[21] Pembina Institute. "Building Energy Retrofit Potential in B.C.". https://www.pembina.org/docs/event/netzeroforum-backgrounder-2016.pdf

[22] National Renewable Energy Laboratory. "System Advisory Model (SAM) 2023.12.17, SSC 288." https://sam.nrel.gov.

[23] National Renewable Energy Laboratory. " 2021 Electricity Annual Technology Baseline". https://atb.nrel.gov/electricity/2021/data

[24] Town of Oakville. "Development Application Guidelines: Canopy Cover Plan and Canopy Calculation Chart." https://www.oakville.ca/getmedia/91ca5835-f9e5-46d5-88f8-d6c57359b1ee/planning-dag-ud-canopy-cover-plan.pdf.

[25] Environmental Protection Agency. "State Inventory and Projection Tool." https://www.epa.gov/statelocalenergy/state-inventory-and-projection-tool.

[26] Cai, L. "Reduction in Carbon Dioxide Emission and Energy Savings Obtained by Using a Green Roof." 2019. https://aaqr.org/articles/aaqr-19-09-oa-0455

(e.g., public transit). These technical limitations underscore the need for cautious interpretation of projected emissions reductions, highlighting the complexity of decarbonization.

Additionally, aggregating or averaging, such as the application of uniform capacity factors across counties, can create uncertainty. In reality local variations in rooftop orientations would allow for different levels of energy generation.

Finally when dealing with natural working lands and green infrastructure, the methodologies may not fully account for the variability in tree species' survival rates and carbon sequestration capacities or the long-term maintenance and potential risks to planted trees. Additionally, assumptions of linear growth and sequestration rates do not accurately reflect the dynamic growth patterns of trees. The potential indirect effects on local ecosystems and the lack of a robust framework for verification and ongoing monitoring of sequestration outcomes also pose challenges.