Roaring Fork Transportation Authority

Climate Action Plan

May 2023

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LIST OF ACRONYMS

AMF	Aspen Maintenance Facility
APTA	American Public Transportation Association
BEB	Battery Electric Bus
BRT	Bus Rapid Transit
BTU	British Thermal Units
CAP	Climate Action Plan
CLEER	Clean Energy Economy For The Region
CNG	Compressed Natural Gas
CO2e	Carbon Dioxide Equivalent
Egrid	Emissions & Generation Resource Integrated Database
EPA	United States Environmental Protection Agency
EV	Electric Vehicle
FCEB	Fuel Cell Electric Bus
FHWA	Federal Highway Administration
GHG	Greenhouse Gas
GMF	Glenwood Springs Maintenance Facility
GREET	Greenhouse Gases, Regulated Emissions And Energy In Transportation
HOV	High-Occupancy Vehicle Lane
LDV	Light Duty Vehicles
MPG	Miles Per Gallon
PMT	Passenger Miles Travelled
PV	Photovoltaic
RFTA	Roaring Fork Transit Authority
TCRP	Transit Cooperative Research Program
TOD	Transit-Oriented Development
VMT	Vehicle Miles Traveled
WTW	Wheel To Well
ZEB	Zero Emission Bus

EXECUTIVE SUMMARY

The Roaring Fork Transportation Authority's (RFTA) mission is "Connecting the Region with Transit and Trails." RFTA is prepared to play an actionable and increasing role in climate leadership by taking ownership of direct emissions while working collaboratively with jurisdictional partners to reduce transportation-related greenhouse gas (GHG) emissions across the region. This plan outlines a framework and strategies to guide the agency in achieving future measurable GHG emissions reduction targets. RFTA member jurisdictions, regional partners, and transit customers will all play a role in helping to achieve shared climate action goals.

This phased planning framework is designed to provide RFTA and the region it serves with the vision, technical detail, and capabilities needed to plan and act concurrently with current and future climate initiatives. The Climate Action Plan (CAP) is a living document that can incorporate new data and creative solutions in the future and provide RFTA with the resiliency and flexibility it requires to continue meeting its core mission and climate goals. This CAP is a guiding document that will help RFTA identify climate action strategies that balance strategic goals of environmental and financial sustainability. The four-phased process used to develop the plan includes the following general steps:

- **Establishing a Vision for the Future:** collaboration between RFTA, stakeholders, and consultants to identify opportunities for GHG emissions reductions and development of goals.
- **Technical Discovery:** perform and analyze a baseline emissions inventory of RFTA's operations and facilities relative to regional transportation and land use trends.
- **Climate Action Plan Development:** careful evaluation of criteria, costs, and benefits of potential strategies and implementation of selected strategies.
- **Continuous Monitoring and Progress:** develop an implementation and monitoring plan for RFTA to continuously monitor and report progress towards stated goals.

The steps taken to develop this plan were designed to provide RFTA with a future-leaning vision, aggressive goal setting, consistent data monitoring, and a strong but flexible implementation strategy necessary to prepare for evolving and sustainable mobility solutions in the RFTA service region. The plan is underpinned and informed by an exhaustive review of regional, national, and international sustainability and climate action plans, along with a comprehensive dataset of RFTA facility utility bills and fleet performance metrics.

In 2019, RFTA's Scope 1 and 2 emissions, or agency-controlled emissions, totaled 17,315 metric tons of greenhouse gasses. Data from 2019 (the pre-pandemic baseline year) are being used to establish future emissions forecasts and to develop achievable GHG emissions' reduction strategies for the agency's operations and services. This Climate Action Plan prioritizes the

RFTA Climate Action Goals

1. Reduce scope 1 and 2 GHG emissions by 50% by 2030 and 90% by 2050.
2. Reduce transportation-related emissions throughout the region by increasing emissions offset compared to emissions produced in 2019 to 3x by 2030 and 5x by 2050.

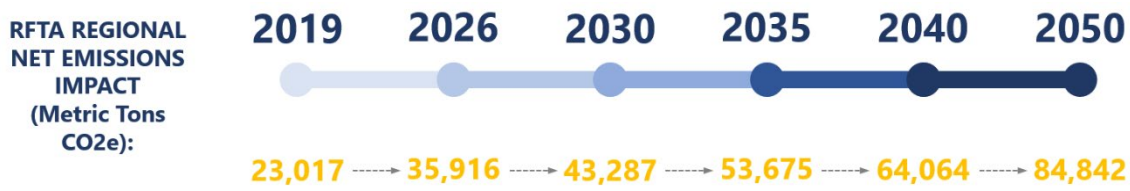
reduction of RFTA's scope 1 and 2 GHG emissions by 50% by 2030 and 90% by 2050. In addition to reducing GHG emissions, RFTA aims to help mitigate transportation-related emissions throughout the region by increasing the emissions offset compared to emissions produced in 2019 to 3x by 2030 and 5x by 2050.

Each strategy category, shown in Table 1 below, has been selected through a process of careful analysis and discussion with stakeholders to ensure effectiveness and efficiency in reducing RFTA's overall greenhouse gas emissions. These strategies represent tangible next steps pertaining to RFTA's commitment to a healthier environment and sustainable mobility future. Figure 1 additionally shows the regional net emissions impact due to the strategies and their forecasted impact.

Table 1: Climate Action Plan Strategy Categories

Climate Action Strategy Categories
Emissions from RFTA Fleet
Revenue Fleet
Non-Revenue Fleet
Emissions From RFTA Facilities
Electrification of Facility Operations
Development of On-site Renewable Energy Systems
Energy Efficiency Measures for Existing Facilities
Advanced Building Codes, Green Standards & Energy Benchmarking
Emissions Displaced by Transit
Expansion of Transit Priority Lanes
Expansion of BRT (& Mobility Hubs)
Expansion of Multi-Modal Services
Fare Reductions
Connected Housing, Jobs & Transit (TOD)

Figure 1: Forecasted Net Regional Emissions Displaced



RFTA will begin implementing strategies and actions within the above categories in 2023. Annual monitoring and periodic benchmark updates will allow RFTA staff to monitor and share cumulative progress toward bolder 2030 and 2050 goals. Implementation and monitoring will require coordination and consultation with regional partners to ensure alignment with one another's goals and efforts. RFTA, along with staff, riders, the Board of Directors, and partners, will help guide the region into a more sustainable and healthy future.

INTRODUCTION

The effects of climate change are wide-reaching and impact all organizations and individuals within RFTA's 70-mile service region. The challenges presented by climate change are equally extensive, including a greater risk of air pollution and illness, more extreme weather such as wildfires and reduced snowpack, and the potential adverse impact on local and regional ecosystems. A significant human-controlled element driving these changes is greenhouse gas emissions released each day from cars, buildings, electricity production, and more. According to the United States Environmental Protection Agency (EPA), the most significant percentage contributor of overall emissions nationally in 2019 was the transportation sector at 29%. RFTA is focused on doing their part to ensure that the Roaring Fork and Colorado River Valleys maintain a healthy and sustainable environment for current and future residents and visitors throughout the region.

This Climate Action Plan considers the direct impacts associated with RFTA's operations while highlighting the need to work collaboratively with other partners to displace regional transportation-related emissions. To accomplish this important task, key considerations of the plan include shifting users from less carbon-efficient modes to transit and other multimodal alternatives, reducing congestion and its associated emissions, and encouraging more transit-friendly development patterns to allow for shorter and fewer vehicular trips. The plan defines RFTA's aspired targets coupled with tactical recommendations to be implemented over a three- to seven-year timeframe that are both action- and customer-oriented and based on a collective understanding of the strategic context and future scenarios. The plan was developed through engagement with regional stakeholders, consultation with staff and riders, and resources from a variety of federal, state, and local agencies.

The plan was developed over an eight-month period from October 2022 to May 2023. As a first step, an extensive literature review was conducted, including a review of over 50 leading climate action and sustainability plans at the regional, state, national, and international levels. RFTA is fortunate to operate in a region that has shown exemplary climate planning, with nine cities and counties within the service territory having developed plans with emission reduction goals set between 2012 and 2050. Additionally, RFTA's climate action goals align with the State of Colorado and the multi-jurisdictional RFTA Board of Directors' Environmental Sustainability Strategic Plan Outcome.

Along with a review of existing literature, the CAP team conducted an evaluation of internal and external data pertaining to RFTA's operations. Using the baseline year of 2019, an emissions inventory was completed to determine the sources and amounts of emissions generated by each subcategory. These frequently updated data sources have informed, and will continue to inform, RFTA's climate strategies and planning. Leveraging this information and stakeholder input, RFTA has finalized the current version of the CAP and the stated GHG reduction goals and strategies.

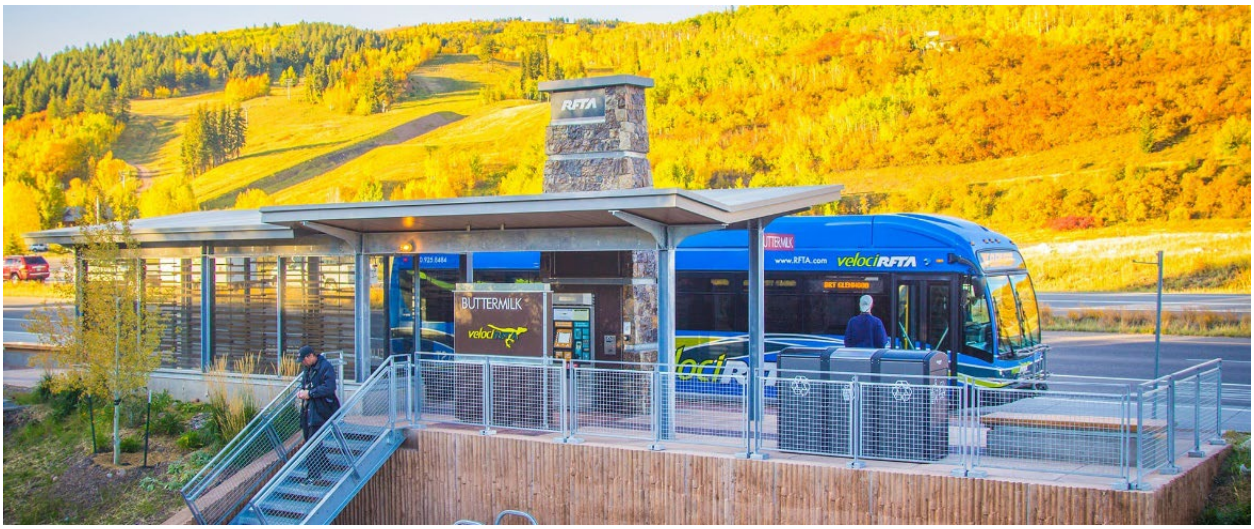
AGENCY OVERVIEW

RFTA provides millions of annual passenger trips along a roughly 70-mile corridor from Rifle to Glenwood Springs along I-70 and State Highway 6 & 24, and from Glenwood Springs to Aspen along State Highway 82. RFTA's service area spans portions of three counties in western Colorado, making it the second-largest transit agency in the state and the largest rural transit agency in the United States. Throughout RFTA's almost 23-year history, the agency has striven to attain an aspirational vision: ***RFTA pursues excellence and innovation in providing preferred transportation choices that connect and support vibrant communities***.

The RFTA Board of Directors has representation from eight jurisdictional members: Pitkin County, City of Aspen, Town of Snowmass Village, Eagle County, Town of Basalt, Town of Carbondale, City of Glenwood Springs, and Town of New Castle. Between 2016 and pre-pandemic 2019, RFTA ridership reached new heights, providing over 5 million passenger trips annually. RFTA owns 120 buses and operates 100 in revenue service. RFTA offers seamless connections to 9 Bus Rapid Transit (BRT) stations,160 bus stops and 14 Park & Ride locations. RFTA buses travel approximately 5.3 million miles per year, and 2019 pre-pandemic annual ridership was 5.47 million. In 2023, RFTA has an operating budget of approximately $60 million, and, following three years of reduced ridership due to the pandemic, it is on track to achieve ridership of approximately 5 million passengers. RFTA also owns and, with Pitkin County, co-manages 34 miles of the Rio Grande Railroad Corridor & Rio Grande Trail.

PAST AND CURRENT INITIATIVES

Since its initial inception in 1984, RFTA (and its predecessor organization, the Roaring Fork Transit Agency) has been in a constant state of growth leading up to the CAP's baseline year of 2019. During this time, RFTA has transported over 100 million passengers and has received numerous awards, including the "Best Mass Transit System of North America" by Mass Transit Magazine, the best "Large Transit Agency of the Year" award from the Colorado Association of Transit Agencies, and the White House Champions of Change Transportation Innovator award. This growth has enabled RFTA to become the largest rural transit agency in the United States, and a national leader in providing public transportation services.



In September 2013, with the assistance of a $25 million Very Small Starts grant, RFTA began operating VelociRFTA, the nation's first rural BRT system, on SH82 between Glenwood Springs and Aspen. The BRT system utilizes bus-only lanes, high-occupancy vehicle (HOV) lanes, and transit signal priority to provide expedited service, which generated over 800,000 annual passengers in 2014, the first full year of service.

At the national level, the United States has set a target for reducing GHG emissions by about 50% from 2005 by 2030 and reaching net zero emissions economy-wide by 2050. In support of these targets, the U.S. Congress has passed the Infrastructure Investment and Jobs Act and the Inflation Reduction Act, with each providing billions of dollars in funding toward clean energy and climate sustainability projects across infrastructure sectors, including transit.

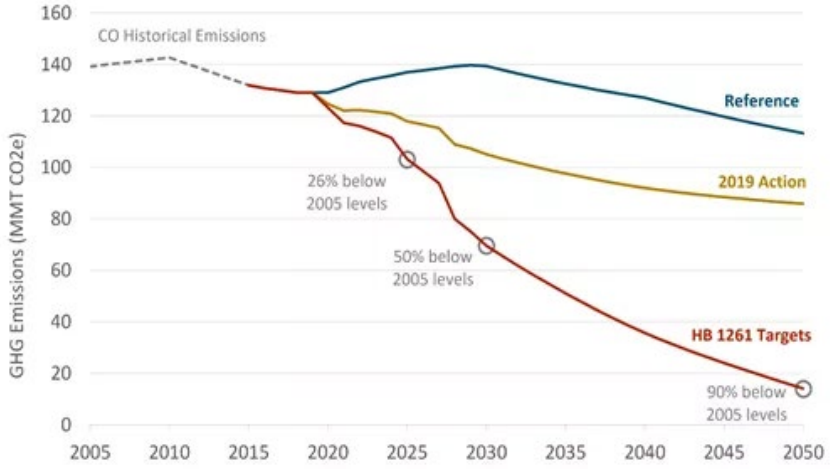
State of Colorado's Climate Action Goals

Reduce GHG emission by 26% by 2025, 50% by 2030, and 90% compared to the 2005 levels

In support of these federal emissions targets, the state of Colorado has also set a GHG emissions reduction target of 26% by 2025, 50% by 2030, and 90% by 2050 based on 2005 levels. According

to research conducted and documented within the Colorado Greenhouse Gas Pollution Reduction Roadmap in 2021, Colorado has not met the needed progress benchmarks for 2025 and will require additional steps to achieve these targets. [i] Figure 2 represent the outcomes of continued actions in accordance with the state's actions before the 2019 Climate Action Plan to Reduce Pollution, also known as HB-1261, when the targets were set. [ii] The 2019 Action Plan documents the outcomes of continued actions present in 2019 HB-1261. HB 1261 targets represent the projection of where GHG emissions should be per year to reach the stated objectives.

Figure 2: Colorado GHG Emissions Reduction Goals[iii]



Within the Roaring Fork Valley and RFTA's service area, most of the cities and counties have established their own GHG emissions' reduction goals, specifically supporting transit goals (*see* Table 2: Regional GHG Emissions' Reduction Goals*)*. Each of these jurisdictions' targets were taken into consideration to determine the goals and strategies for this plan.

Table 2: Regional GHG Emissions' Reduction Goals

City or County Plan	2050 GHG Reduction Goal
Aspen[iv]	80%
Carbondale[v]	Net-Zero
Eagle County[vi]	80%
Garfield County[vii]	100%*
Glenwood Springs[viii]	Target setting in progress
Pitkin County[ix]	80%
Town of Basalt[x]	80%
Town of New Castle[xi]	80%
Town of Snowmass Village[xii]	100%

*Reduction goal by 2030.

Together, RFTA and member communities will continue to monitor progress toward their shared GHG reduction goals and look for collaboration and coordination opportunities where possible.

ESTABLISHING A VISION FOR THE FUTURE

The development of this CAP required thoughtful planning and meaningful engagement with community leaders and stakeholders. RFTA and the CAP consultant, Gannett Fleming, engaged with local partners Clean Energy Economy for the Region (CLEER), and Project Resource Studio, to create a steering group for the plan. The intention was to collaborate with key stakeholders to refine the plan's goals, determine data collection methods, and develop planning outreach strategies. Beginning in October 2022, these partner organizations developed a variety of options to help determine the best course of action. RFTA and partners conducted reviews of relevant CAPs and strategies to create and track goals. During this process, RFTA also identified key stakeholders who could provide insights into the development of the CAP. Technical Discovery

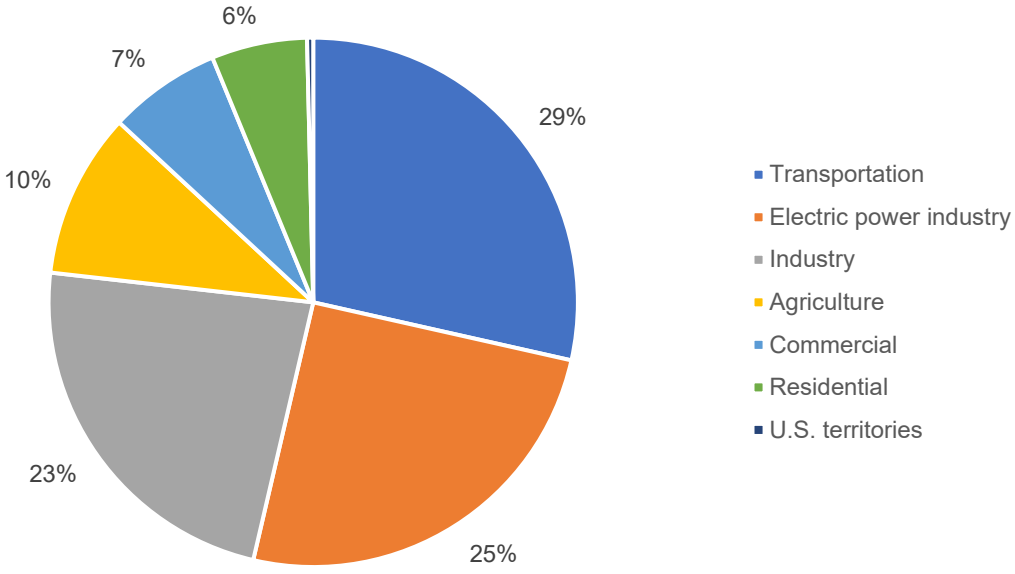
EMISSIONS BACKGROUND

Nationally, the United States has committed to achieving 100% clean electricity by 2035 and net zero emissions economy-wide by no later than 2050.[iii] Similarly, Colorado has set legislative goals to reduce greenhouse gas emissions by 50% from 2005 levels by 2030, while reducing all emissions from transportation by 12.1 million tons[xiii].

According to the Colorado Greenhouse Gas Pollution Reduction Roadmap, the decarbonization of vehicle fleets should be the primary goal of federal and state transit CAPs. More specifically, the goals for the transportation sector within the Roadmap are to:

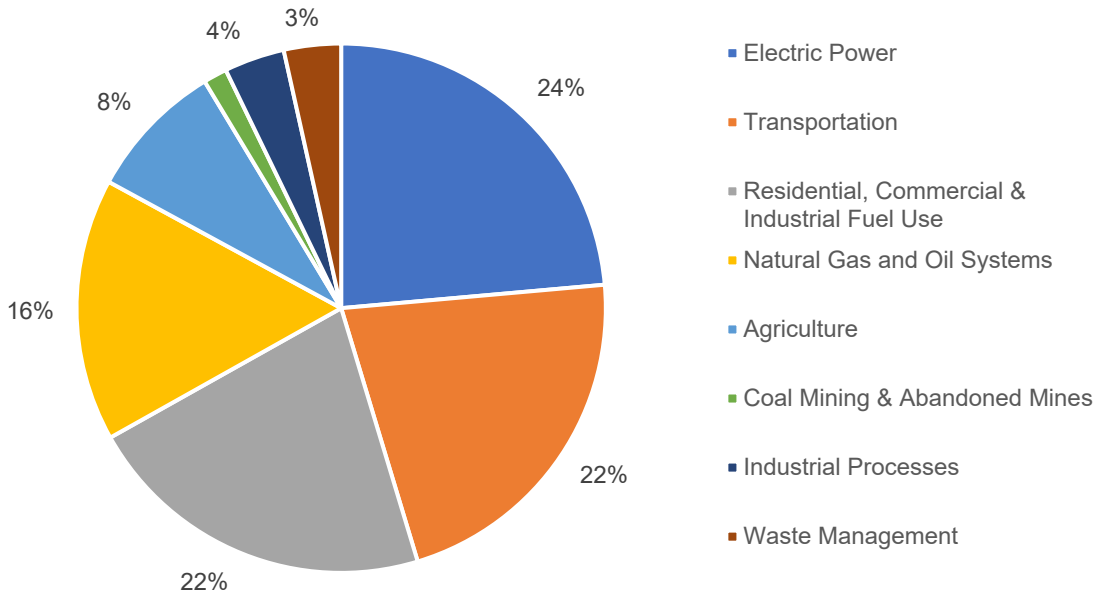
- Make cars, trucks, and buses cleaner
- Reduce the number of miles traveled by car
- Help local governments invest in infrastructure to reduce the need to drive

Figure 3: 2019 National GHG Emissions



Source: United States Environmental Protection Agency. (2020). EPA U.S. GHG Emissions Inventory. See Appendix A: Emissions Inventory Methodology for methodology

Figure 4: 2019 Colorado GHG Emissions



Source: Taylor, T. (2021, September). *2021 Greenhouse Gas Inventory Update*. Colorado Air Pollution Control Division. See Appendix A: *Emissions Inventory Methodology* for methodology

As shown in Figures 3 and 4, the transportation sector contributes a significant portion of annual GHG emissions at the national and state levels. RFTA has a service area consists of 270 directional route miles across three counties based on the National Transit Database reporting by RFTA. RFTA's services are accessible to an estimated 71,000 residents, or more when visitors are included. Furthermore, the segment of the I-70 corridor located in RFTA's service territory generates over 2 million vehicle miles traveled (VMT) each day. This ratio of VMT to local population within RFTA's corridor presents a unique opportunity to build a culture of sustainability across the region that not only affects the local population but Colorado and the nation.

RFTA's current transit and trails system is already making a significant impact on a regional scale through the inherent presence in the Roaring Fork Valley and the impact on regional decision-making pertaining to alternative transportation options. By encouraging more transit-oriented development in the region, RFTA can produce an estimated 9.5% reduction in regional VMT daily, amounting to nearly 90.5 million miles reduced annually.

Similarly, RFTA's public services directly influence rider decision-making pertaining to available and selected transportation modes. When people elect to ride buses or bikes, they directly reduce fuel consumption compared with the alternative to driving private vehicles. The decision to take public transit over personal vehicles is called "mode shift," otherwise referred to as the mode shift factor, and contributes an additional reduction in regional VMT by 6.9%, resulting in over 65 million vehicle miles avoided annually. See Appendix A: *Emissions Inventory Methodology* for more information on the quantification of emissions.

The emissions inventory and subsequent forecasting serve as a guiding light for informing the climate action strategies that RFTA has selected within this plan to further reduce the agency's environmental footprint.

EMISSIONS MEASUREMENTS AND METRICS

Three distinct categories, or "scopes," of emissions were used to classify RFTA's impact pertaining to greenhouse gas emissions, consistent with national standards for climate action planning for transit agencies. These scopes serve in part to establish a baseline for understanding the agency's emissions profile and for determining the most appropriate and effective climate action strategies for reducing emissions, while further promoting the positive climate benefits provided by transit ridership. These three scopes include:

Scope 1: Fossil fuels burned by RFTA for facilities and fleet

Scope 2: Electricity purchased by RFTA for facilities and fleet

Scope 3: Regional transportation-based emissions displaced by transit

Table 3 below includes the following emissions metrics for each scope category:

Table 3: Scope Emissions Metrics

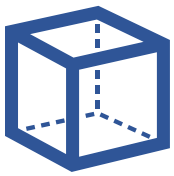
Inventory Categories	Emissions Source
Scope 1 - Fossil fuels burned by RFTA	
Revenue Fleet (Non-Electric)	Diesel and compressed natural gas (CNG)
Non-Revenue Fleet	Gasoline
Facilities – Stationary Combustion	Natural gas
Scope 2 - Electricity Purchased by RFTA	
Facilities – Purchased Electricity	Purchased electricity
Revenue Fleet (Electric)	Purchased electricity
Scope 3 – Regional Emissions Displaced by Transit	
Mode shift to transit	Directly reduced personal vehicle trips
Land use effect	Indirectly reduced personal vehicle trips

Collectively, these three scopes provide RFTA with unique and meaningful insights into the agency's overall operational emissions, while accounting for the positive impact that transit ridership and optimal service levels have on offsetting regional GHG emissions. It is important to note that this inventory is not comprehensive of all RFTA emissions. Fugitive emissions (Scope 1), and Scope 3 emissions not related to displaced emissions (capital works, construction, waste management, employee commuting, agency purchased goods, etc.), are not within the scope of this CAP's inventory.

For the emissions inventory, a **2019 baseline year** has been set for the analysis. The year 2019 was chosen because its operational patterns were similar to those of previous years, prior to the onset of COVID-19 restrictions. The baseline year is used for projecting emissions reduction goals in 2030 and 2050, as well as comparing emissions with both the Colorado and national baseline data.

CO2e, otherwise referred to as the carbon dioxide equivalent of greenhouse gas emissions, is a standard metric for tracking GHG emissions within this plan to standardize the agency's greenhouse gas emissions from the various sources under a single common unit. The carbon dioxide equivalent is used to compare the emissions from various greenhouse gases based on their global-warming potential, by converting amounts of other gases to the equivalent amount of carbon dioxide with the same global warming potential.

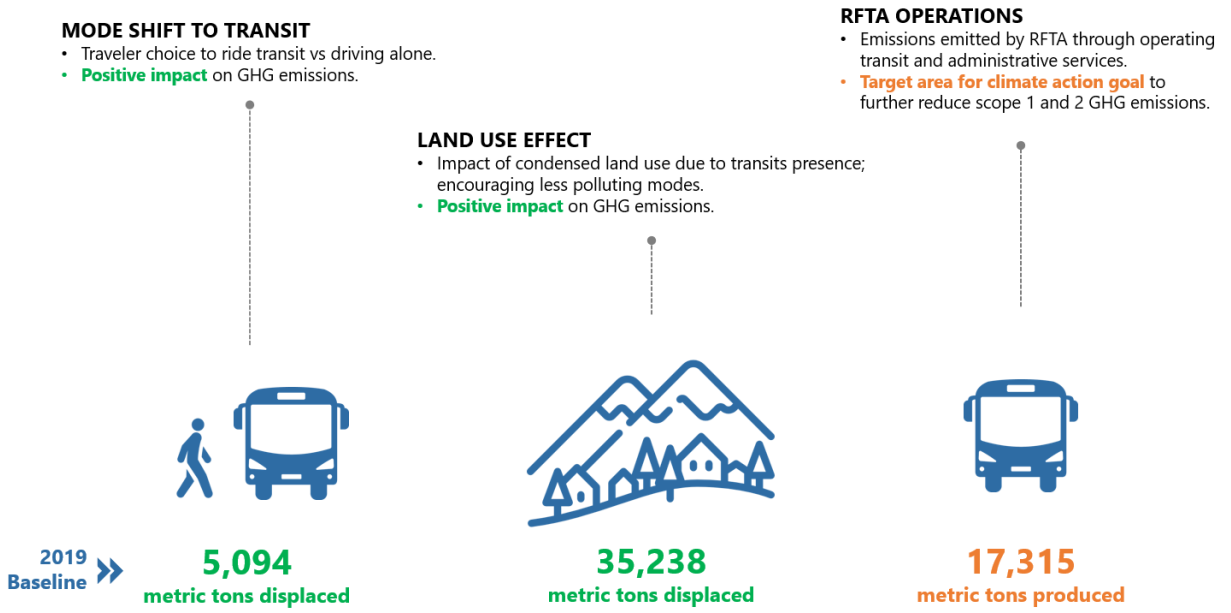
1 Metric Ton CO2e **0.462 Home's Annual Energy Use**



Metric tons of CO2e are a standard metric for measuring GHG emissions. The volume of one metric ton of CO2e is approximately equivalent to the GHG emissions generated by 0.462 homes annually or the consumption of 413 gallons of gasoline.[xiv]

RFTA'S EMISSIONS INVENTORY

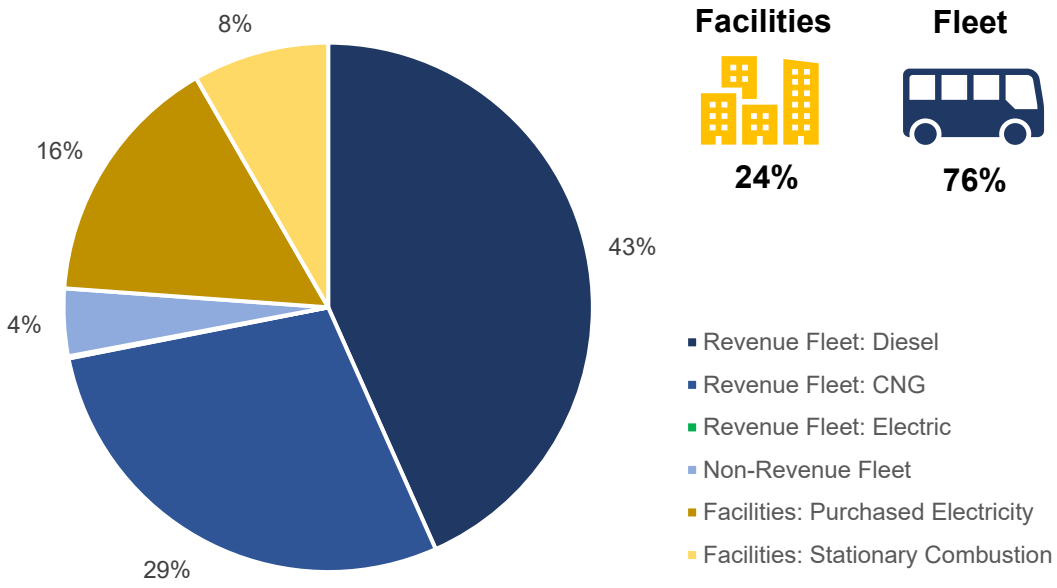
Measuring RFTA's overall emissions footprint requires quantifying the agency's emissions produced and displaced due to transit operations. This section will outline the process taken throughout the emissions inventory and set the stage for what actions can be taken to reduce RFTA's emissions moving forward. See Appendix A: *Emissions Inventory Methodology* for a comprehensive explanation of the emissions inventory.



EMISSIONS PRODUCED BY TRANSIT

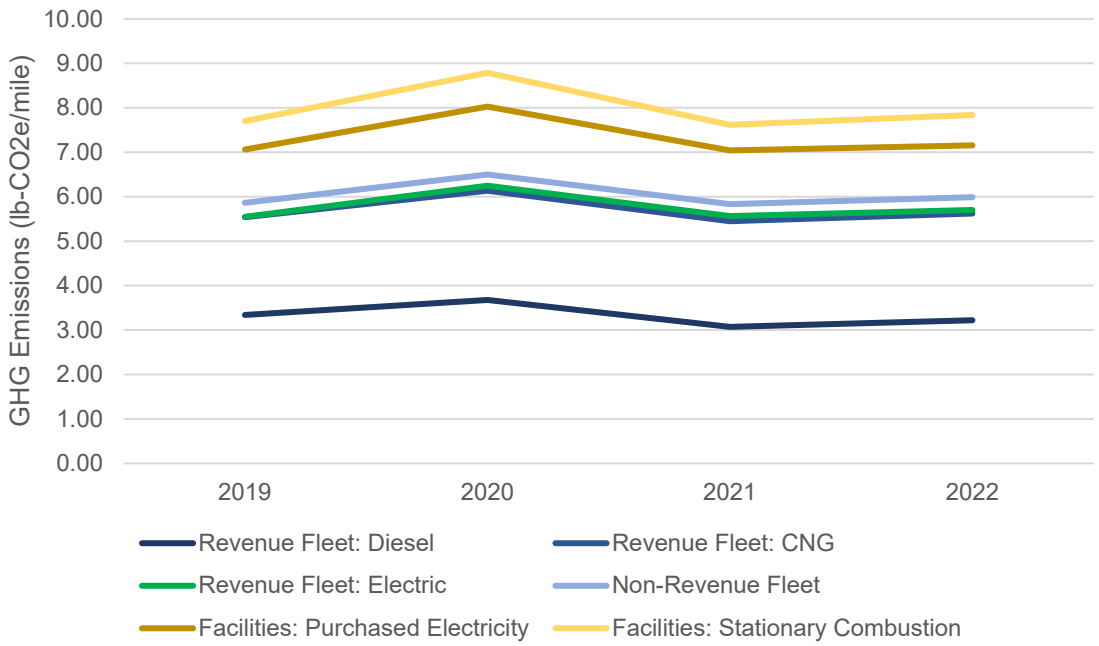
RFTA conducted a comprehensive assessment of the emissions produced by the agency's operations. The assessment includes emissions from mobile combustion, agency fleet, facility purchased electricity, electricity for traction power, and stationary facility combustion. In 2019, RFTA operations produced 17,315 metric tons of GHGs. This can be seen broken down by category in Figure 5. The breakdown results in approximately 76% of the agency's total emissions generated by fleet operations and the remaining 24% from facilities. This is an important distinction for determining the most effective climate action strategies for RFTA to implement, because a significant majority of emissions are derived from the bus fleet and operations.

Figure 5: Emissions Inventory by Category



Source: RFTA. (2022) 2019_Inventory Data. Internal data: unpublished. See Appendix A: *Emissions Inventory Methodology* for methodology

Figure 6: Historic Normalized GHG Emissions



Source: RFTA. (2022) 2019_Inventory Data. Internal data: unpublished. See Appendix A: *Emissions Inventory Methodology* for methodology

Within the emissions assessment, normalized emissions trends were also derived to support strategy evaluation as operational changes occur. Figure 6 shows the historical trend of GHG emissions with respect to revenue miles.

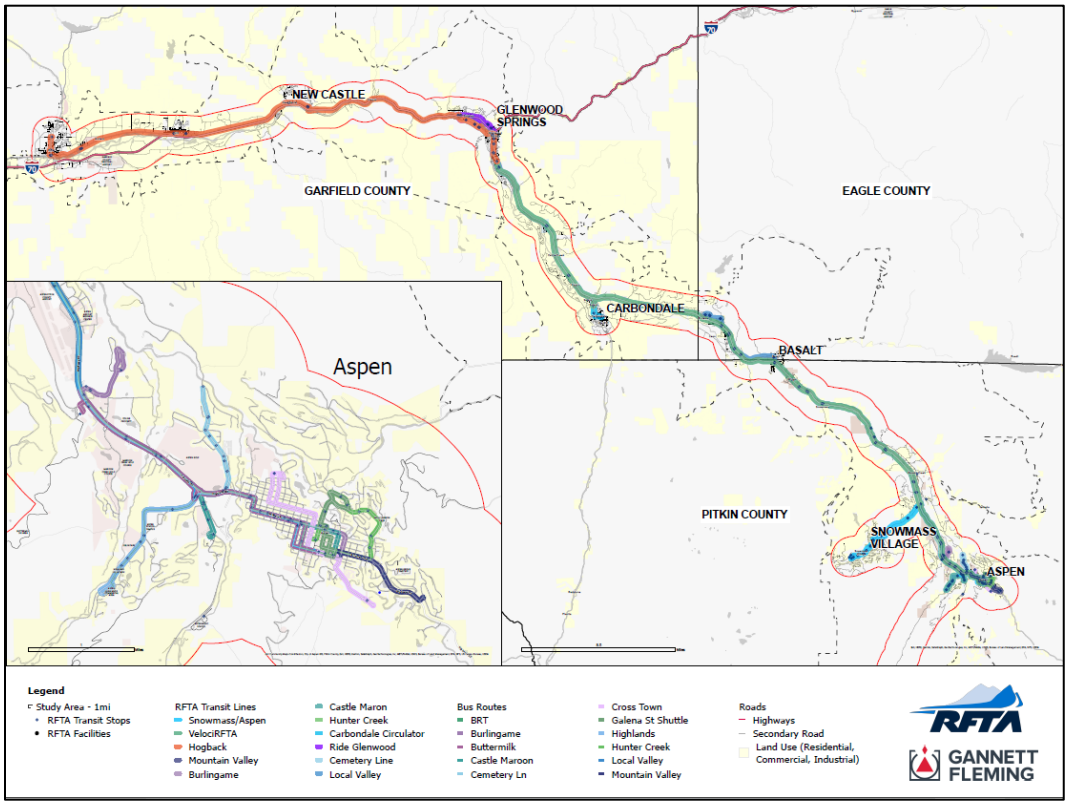
On average, RFTA emitted about eight pounds of CO2e for every revenue mile driven from 2019-2022. This will be an important tracking metric moving forward to determine if RFTA is decreases emissions, even if operations increase over time.

EMISSIONS DISPLACED BY TRANSIT

The amount of GHG emissions displaced in the region due to transit service is a key driver in attaining climate action success for RFTA. Higher utilization of public transit and shifts to less polluting modes of transportation results in less regional VMT, which results in fewer regional emissions.

Mode shift to transit signifies a traveler's choice to ride transit instead of driving alone. The cumulative passenger miles traveled (PMT) from multiple passengers riding on a bus at one time is one of the key beneficial metrics of transit in terms of reducing greenhouse gas emissions. By encouraging drivers to switch to less-polluting modes of transportation, such as public transit, RFTA reduces, or displaces, greenhouse gas emissions throughout the service area. **Mode shift** is the *direct* effect of RFTAs transit operations: people choosing to use RFTA services instead of driving their own vehicle. An estimated -5,094 metric tons of GHGs were displaced in 2019 due to travelers using RFTA buses instead of another polluting mode.

Figure 7: RFTA Land Use Effect Area of Analysis



Source: Gannett Fleming. (2022) *RFTA Land Use Effect Area of Analysis*. Internal data: unpublished.

In addition to the mode shift to transit, **the land-use effect** is another key factor in determining the emissions displaced by RFTA. According to the American Public Transportation Association (APTA), the land use effect "accounts for the indirect impacts of transit on reducing vehicle travel through changes in land use resulting from the provision of transit service." These land-use changes create more compact communities that may increase trips made by walking or biking modes of transportation that would otherwise be completed by more polluting modes, such as driving a personal automobile. Land-use effect can be considered the *indirect* effect of RFTA's transit operations: the inherent presence of transit in the region results in higher density, resulting in people choosing fewer polluting modes instead of driving their vehicles. A geospatial land-use analysis of the region was conducted, shown in Figure 7. The analysis determined that RFTA's impact on regional density displaced an estimated -35,238 metric tons of GHG emissions.

RFTA's region for the analysis was determined by utilizing all census tracts that intersect a one-mile buffer surrounding RFTA's services. The metrics identified through this analysis can be found below in Table 4:

Table 4: Land Use Effect Metrics

Metric	Quantity	Unit
RFTA service territory		
RFTA's transit directional route miles	270.4	Miles
RFTA's total annual revenue miles	4,946,740	Miles
Regional road network		
Freeway lane miles	133	Miles
Other roadway lane miles	1,163	Miles
Regional land use		
Total population	71,807	People
Total land area	683.83	Square miles
Gross population density	105	People / square mile
Regional travel characteristics		
Transit passenger miles travelled	2.08	PMT / capita / day
Vehicle miles traveled	30.4	VMT / capita / day

Source: RFTA. (2022) 2019_Inventory Data. Internal data: unpublished. See Appendix A: *Emissions Inventory Methodology* for methodology

Using the metrics above, RFTA can quantify the emissions impact the operations have through increased density. Estimates are based on a statistical model of transit, land use, and VMT for more than 300 U.S. urbanized areas created through research under the Transit Cooperative Research Program (TCRP) Project H-46 and published as TCRP Report 176. The model estimates the percent reduction in VMT due to compact, mixed-use neighborhoods that are anchored by RFTA transit stations. Using an estimated reduction in regional VMT, RFTA can then determine the displaced emissions in the region due to the land-use effect (see below, Table 5):

Table 5: Land Use Effect Impact

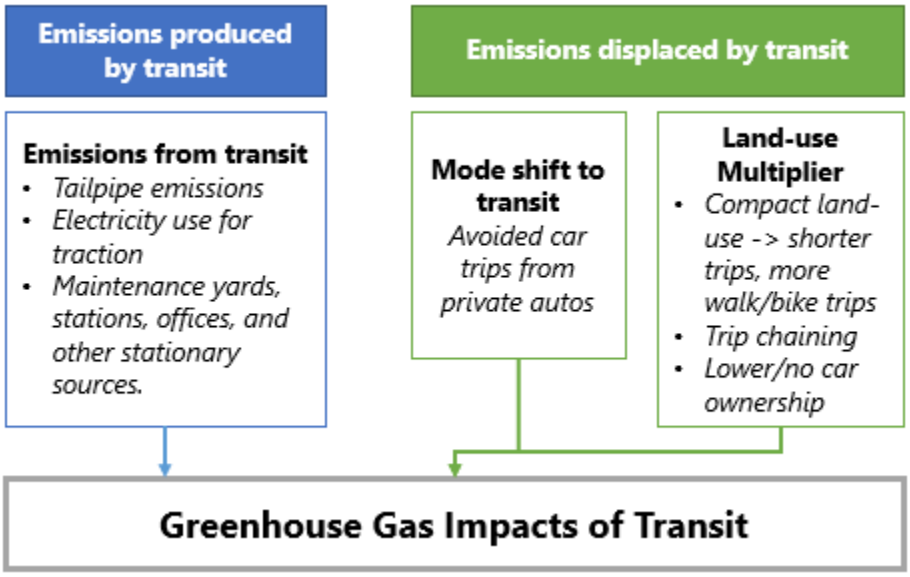
Metric	Quantity	Unit
Annual VMT reduction for region	9.5	%
Annual regional reduction in VMT	75,605,155	Miles
Annual reductions in gallons of gasoline	3,301,535	Gallons
Annual reduction in regional GHG emissions	-35,238	Metric tons CO2e

Source: RFTA. (2022) 2019_Inventory Data. Internal data: unpublished. See Appendix A: *Emissions Inventory Methodology* for methodology

RFTA, through mode shift and the land-use effect, has a unique opportunity to significantly reduce the state and regional VMT, and thus GHG emissions. As a region, the vehicle miles traveled per capita per day are much larger than the national and state averages due to the largely rural nature of RFTA's territory paired with the tourism and trucking that goes through the region on I-70.

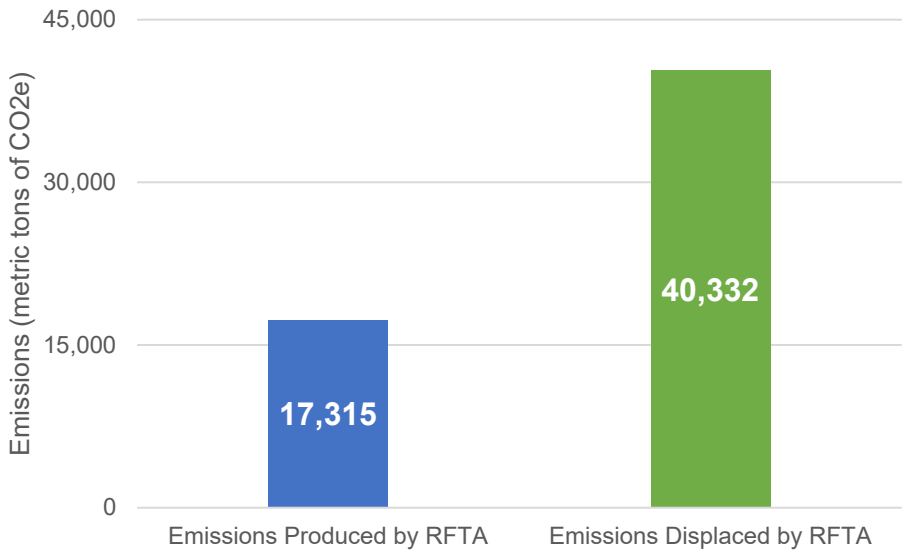
EMISSIONS IMPACT

Figure 8: Greenhouse Gas Impacts



RFTA's transit operations resulted in 17,315 metric tons of GHG emissions while displacing 40,332 through mode shift and the land-use effect (see). In combination, the agency's operations provided an overall net positive emissions impact of -23,017 metric tons of emissions displaced.[xv] This CAP seeks to provide aggressive and achievable strategies to further reduce RFTA's operational emissions while increasing displaced regional emissions by continuing to promote and enhance transit services.

Figure 9: 2019 GHG Impact



Source: RFTA. (2022) 2019_Inventory Data. Internal data: unpublished. See Appendix A: *Emissions Inventory Methodology* for methodology

Overall, RFTA's assessment of the emissions provides a thorough understanding of the environmental impact of RFTA's operations and allows for identifying opportunities for improvement. With the overall emissions impact equating to a net benefit of -23,017 metric tons of GHGs, the agency is already providing a positive emissions benefit to the region but can implement strategies to improve the benefit through reducing emissions produced and increasing emissions displaced (see Table 6 below).

By considering both emissions produced and displaced, RFTA can develop targeted strategies to reduce emissions and contribute to achieving a sustainable transportation system, along with developing a culture of sustainability across the region. The inventory also sets the stage for what actions can be taken to reduce RFTA's emissions moving forward; identifying emissions metrics that are understood by the agency and easily trackable as climate action strategies are implemented.

Table 6: RFTA Emissions Produced and Emissions Displaced

Emissions Produced by RFTA	
Metric	**Emissions (metric tons CO2e)**
Revenue Fleet (Non-Electric)	12,450
Non-Revenue Fleet	712
Electricity for Traction Power	23
Facilities – Purchased Electricity	2,690
Facilities – Stationary Combustion	1,440
Total	**17,315**

Emissions Displaced by RFTA	
Metric	**Emissions (metric tons CO2e)**
Mode Shift to Transit	-5,094
Land Use Effect	-35,238
Total	**-40,332**

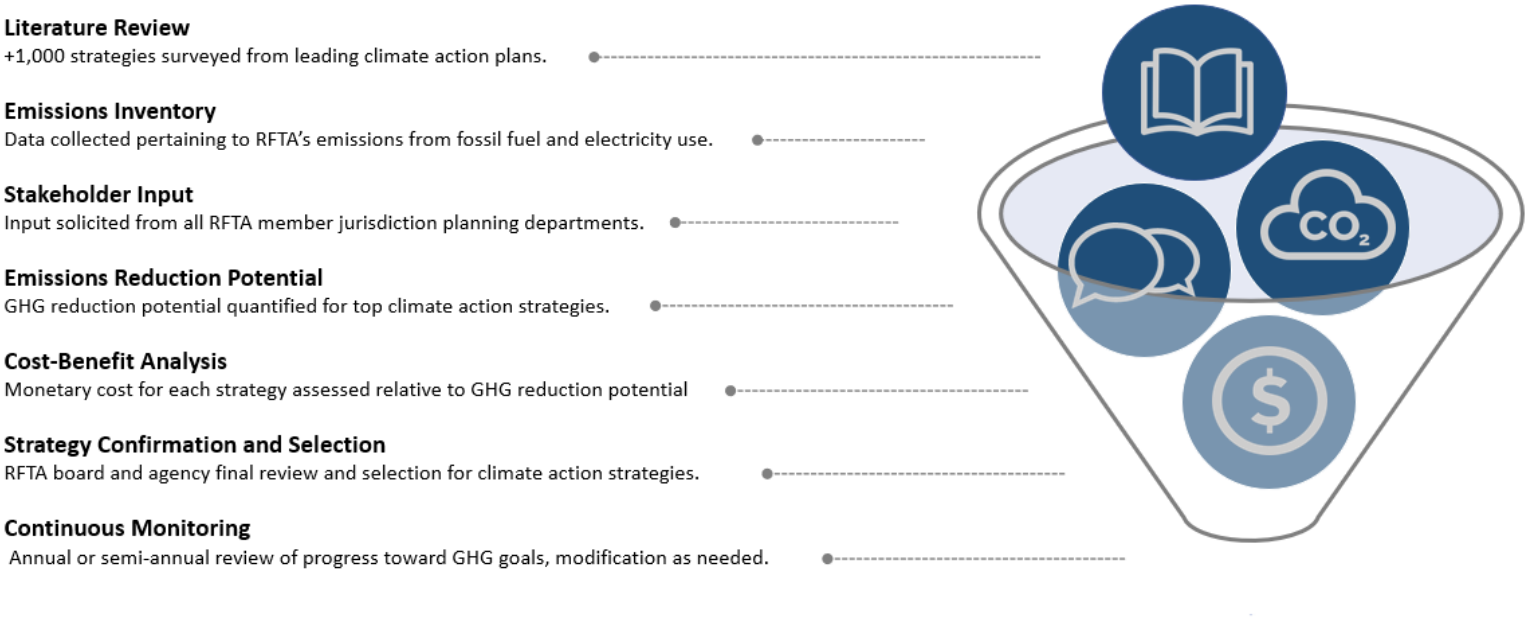
Greenhouse Gas Impacts of RFTA
-23,017 metric tons CO2e

Source: RFTA. (2022) 2019 Inventory Data. Internal data: unpublished. See Appendix A: *Emissions Inventory Methodology* for methodology

CLIMATE ACTION PLAN DEVELOPMENT PROCESS

Utilizing the information gained during the visioning and technical discovery phases of the project, RFTA began the process of identifying and evaluating climate action strategies. The approach throughout the process balanced RFTAs desired goals with considerations of the financial constraints associated with the effort. Figure 10 illustrates the steps taken in the development of this CAP.

Figure 10: CAP development process



LITERATURE REVIEW

As the development process for this plan began, it was critical to understand the strategies and targets outlined throughout the region, state, and country. An extensive literature review was conducted to fully comprehend the depth of climate solutions. In total, over 50 climate and sustainability plans were reviewed across 11 states and regions. The plans analyzed included transit agencies and municipal plans, as well as plans made possible by grant awards from the Federal Transit Administration. Over 1,000 strategies were assessed in this process informing RFTA's plan with the best current strategies and targets from around the country.

Regionally, nine plans were reviewed by RFTA's partners, see Table 7. Each of these partner plans outlined specific strategies aligned with transit, land use, and clean fuel solutions that better inform RFTA's priority strategies. Regional collaboration and partnerships will be more important than ever to make progress toward shared climate action strategies that move the needle in terms of a significant reduction in regional greenhouse gas emissions.

Table 7: Regional Transit Strategies

Strategy Categories	Plan & Year	Transit and Multimodal	Land Use and Connectivity	Fuels (alternative fuels and fuel efficiency)
City of Aspen	Climate Action Plan, 2017[xvi]		Enhance first and last connectivity, Redesign urban form and population density	Promote alternate fuel vehicles
Town of Carbondale	Climate and Energy Action Plan, 2017[xvii]	Increase percent mode share of travel by walking, biking, and public transit		All vehicles use low-carbon fuels
Eagle County	Climate Action Plan, 2016[xviii]	Fund rail transit opportunities, Incentivize multi-modal transportation (commuter rail, BRT, etc.)	Compact, mixed-use communities and land-use patterns + affordable housing	Expand network of electric vehicle (EV) charging stations, purchase EVs
Garfield County*	Energy Action Plan, 2017[xix]			Development and maintenance of EV charging stations and CNG stations
City of Glenwood Springs	Energy and Climate Action Plan, 2009[xx]	Improve public transportation for more frequent service, longer hours, and more served		Raise fuel efficiency standards, purchase low-emission, fuel-efficient, clean-burning vehicles
Pitkin County	Climate Action Plan, 2017[xxi]	Increase ridership of public transit		Require shuttles and rentals to meet mile per gallon (MPG) standards
Town of Basalt	Basalt Addendum and Eagle County Plan, 2017[xxii]	Fund rail transit opportunities, Incentivize multi-modal transportation (commuter rail, BRT, etc.)	Compact, mixed-use communities and land-use patterns + affordable housing	Expand network of electric vehicle charging stations, purchase EVs
Town of New Castle	Climate Action Plan, 2009[xxiii]	Promote alternative transportation methods including biking, public transit, and carpooling		
Town of Snowmass Village	Sustainability Plan, 2022[xxiv]	Increase bike presence for commuters and travelers with e-bikes and WE-cycle partnership		Expand EV Charging Station Network and Solar Power Network

*Garfield Clean Energy published a 2023 Energy Action Plan and is currently working on adopting the goals set out in the plan.[xxv]

EMISSIONS INVENTORY

The emissions inventory portion of the CAP process included an assessment of RFTA's internal emissions produced compared with the emissions displaced in the region from the agency's services. The emissions are broken down between scopes, with scope 1 and 2 emissions being direct effects of RFTA's actions and scope 3 being indirect effects from RFTA's existence in the region. Following a baseline year of 2019 as the most recent and accurate pre-COVID data, RFTA's emissions produced for scopes 1 and 2 emissions total 17,315 metric tons of GHGs.[xxvi] The majority of the emissions produced derive from the bus fleet, accounting for over 76% of the total. Due to a mode shift to transit and the land-use effect, the analysis determined that the agency displaced 40,332 metric tons of GHGs in 2019. This results in a net positive emissions impact of -23,017 metric tons of GHGs. While having a positive impact on the region is encouraging, RFTA will further improve the agency's emissions footprint through the strategies outlined in this plan. *See the Technical Discovery* section for more information.

STAKEHOLDER INPUT

Beginning in October 2022, RFTA and the Board of Directors met to identify the strategies needed to achieve their climate goals and meet the needs of stakeholders. RFTA hosted both an in-person and a virtual stakeholder engagement workshop. The workshops were attended by stakeholders, including RFTA employees, members of local government, climate leaders, and policy groups. Representatives from each of RFTA's stakeholder groups attended the workshop representing RFTA's region of operations. During these meetings, the group discussed potential strategies that RFTA could utilize to accomplish the goals. Strategies were broken into three primary categories: transit services, agency operations, and land use connections. A total of 45 different strategies were discussed in breakout groups and collectively. Table 8 outlines the strategies that the group identified as priorities during the workshop.

Table 8: Stakeholder workshop potential strategies

Agency Operations
Purchased renewable energy
Electric and alternative fuel vehicle procurement for agency fleet
Building energy efficiency measures
Energy efficiency conversions in facilities
Parking spaces used for power i.e., solar panel canopies over park-n-rides
Transit Services
Optimized and increased ridership
Optimized and increased transit routes
BRT optimization, extension, and expansion
Transit priority lanes
Transit preference over private vehicles i.e., gear storage, safe standing room, increased frequency during peak times, on-time all the time (storage, sports equipment, standing room), frequency, timeliness
Land Use Connection
Transit oriented development (TOD) to better integrate affordable housing, livable jobs, and high-quality transit
Connected Housing, Jobs, and Transit
Enhanced first-last mile solutions i.e., enhanced local circulator services, microtransit, public bike share, safe routes
Mobility Hubs and Parking: Incentivized park-and-ride locations
Improved native and drought-tolerant landscapes to save water
Additional contracts with microtransit providers for downtown solutions

EMISSIONS REDUCTION POTENTIAL

An essential aspect of determining the strength of each strategy option includes an assessment of the impact the strategy will have on emissions produced or displaced. By utilizing the emissions inventory GHG and service statistic trends, an overall impact on GHG emissions can be determined respectively for each potential strategy. This plan models each of these strategies to compare RFTA's current baseline against the impact each of the strategies would have to reach the stated emissions goal. As seen in Table 9, the following GHG impact ratings for RFTA's specific inventory and utilization were created:

- High reduction (>45,000 MT CO2e through 2050)
- Moderately high reduction (15,000 - 45,000 MT CO2e through 2050)
- Moderately low reduction (5,000-14,999 MT CO2e through 2050)
- Low reduction (<5,000 MT CO2e through 2050)

Table 9: Strategy Categories – GHG Impact

Climate Action Strategy Categories	GHG Impact Potential
Emissions from RFTA fleet	
Revenue Fleet	
Non-Revenue Fleet	
Emissions from RFTA facilities	
Electrification of Facility Operations	
Development of On-Site Renewable Energy Systems	
Energy Efficiency Measures for Existing Facilities	
Advanced Building Codes, Green Standards & Energy Benchmarking	
Emissions displaced by transit	
Expansion of Transit Priority Lanes	
Expansion of BRT (& Mobility Hubs)	
Expansion of Multi-Modal Services	
Fare Reductions	
Connected Housing, Jobs & Transit (TOD)	

COST-BENEFIT ANALYSIS

Through extensive stakeholder engagement and internal dialogue, it has been determined that reducing the emissions emitted by and increasing the regional emissions offset by RFTA operations should be the guiding principles for any strategy selection. However, another important consideration is the cost required for each strategy compared to its potential emissions benefit. To estimate these criteria, RFTA estimated the total costs of implementation for each potential strategy, this included upfront capital costs, implementation costs, and projected operations and maintenance costs. As seen in Table 10, the total cost benefit is estimated between three ranges:

$ - Less than $100 (or savings) per metric ton of CO2e reduced/displaced

$$ - Between $100 and $500 per metric ton of CO2e reduced/displaced

$$$ - Greater than $500 per metric ton of CO2e reduced/displaced

These cost-benefit calculations are evaluated using industry standard metrics for total cost of ownership and RFTA internal capital investment estimates.

Table 10: Strategy Categories – Cost

Climate Action Strategy Categories	Cost
Emissions from RFTA fleet	
Revenue Fleet	$$$
Non-Revenue Fleet	$
Emissions from RFTA facilities	
Electrification of Facility Operations	$$$
Development of On-Site Renewable Energy Systems	$$
Energy Efficiency Measures for Existing Facilities	$
Advanced Building Codes, Green Standards, & Energy Benchmarking	$
Emissions displaced by transit	
Expansion of Transit Priority Lanes	$$$
Expansion of BRT (& Mobility Hubs)	$$$
Expansion of Multi-Modal Services	$$$
Fare Reductions	$
Connected Housing, Jobs, & Transit (TOD)	$$$

STRATEGY CONFIRMATION AND SELECTION

RFTA's finalized strategy selection and confirmation combined the above metrics to determine explicit evaluation criteria that would be used to compare each strategy consistently. The main evaluation criteria metrics used to evaluate different strategies are:

- **Cost-Benefit** ($/MT CO2e reduced/displaced): The Total Cost of Implementation (capital costs, O&M, and fuel) divided by the emissions produced. This metric is designed to show the estimated cost per metric ton of CO2e of each strategy.
- **Emissions Displaced** (MT CO2e): The total sum of emissions displaced by each strategy over the analysis period.
- **Emissions Produced** (MT CO2e): The total sum of emissions produced/reduced by each strategy over the analysis period.
- **Emissions vs 2019 Baseline** (%)**:** The percent reduction of emissions by 2050 due to the selected strategies with respect to the 2019 baseline emissions.

To determine the outputs for each evaluation criteria, a cutting-edge cost-benefit climate calculator was created. The tool models the evaluation criteria outputs using RFTA historical emissions and service data, industry standard emissions metrics, and assumptions for each strategy relative to the impacts on specific "climate levers":

- Total Passenger Miles Traveled
- Total Bus Miles
- Revenue Fleet Fuel Composition
- Non-Revenue Fleet Fuel Composition
- Reduction in VMT due to the Land Use Effect

The tool allowed RFTA the ability to select different strategies and their corresponding implementation timelines to create a comprehensive "recipe" of strategies that will both achieve climate action goals *and* make sense economically. The Climate Action Strategies and Climate Action Strategies Forecasted Costs and Impacts section below provides further context of the selected strategies and their impacts.

CONTINUOUS MONITORING

This plan is designed to be a living document that can be updated and changed in the upcoming years as new information and potential climate solutions are discovered. RFTA will continue monitoring the progress of the targets in this plan with a dashboard and the modeling tool to ensure RFTA is continuing to provide a sustainable future for the region and services. The review process will include periodic updates for stakeholders, the RFTA Board of Directors, and RFTA's riders. RFTA will also routinely conduct audits and assessments of the agency's goals to ensure strong collaboration and credibility with regional partners. There will be recalibrations and adjustments to this plan throughout the future as RFTA remains flexible and utilizes the continued data monitoring, assessments, and discussions with stakeholders and partners to determine the best course of action for implementing climate solutions. More information regarding continuous monitoring is outlined in the *Monitoring and Implementation* section below.

CLIMATE ACTION STRATEGIES

Based on information gained during the climate action plan development process, RFTA has identified their target areas for GHG emission reduction:

- **Emissions from RFTA Fleet**: This category accounts for RFTA's scope 1 emissions that come from the use of diesel, gasoline, and natural gas in the bus fleet, and non-revenue fleet. By transitioning the fleet to Zero Emission Buses (ZEBs), RFTA can realize significant reductions in GHG emissions from the fleet.
- **Emissions from RFTA Facilities:** This category accounts primarily for RFTA's scope 2 emissions in the form of purchased non-renewable electricity and RFTA facility natural gas usage (scope 1). By reducing their electrical and natural gas needs and sourcing their electricity from renewable sources, RFTA can reduce emissions.
- **Emissions Displaced by Transit**: This category accounts for the emissions RFTA offsets in the region by providing their transit services. These strategies focus on increasing ridership on RFTA provided services and therefore reduce the number of individual drivers and vehicles on the road. More riders of public transit results in reduced regional emissions from cars.

In addition to GHG emission reductions and costs associated with each strategy, it is important to identify how these strategies align with RFTA's 2019 Strategic Plan.[xxvii] Similar to this CAP, the Strategic Plan is designed to guide RFTA's decision-making, budgeting, and daily operations. The strategic plan identifies seven outcome areas:

- Safe customers, workforce, and general public
- Accessibility and mobility
- Sustainable workforce
- Financial sustainability
- Satisfied customers
- Environmental sustainability
- High performing organization

For each strategy category listed below, the primary outcome areas have been identified to highlight their relationship with RFTA's planning and priority areas.

EMISSIONS FROM RFTA FLEET

The most direct way an agency can reduce its GHG emissions is by reducing fleet emissions. For RFTA, the fossil fuels burned by their buses and non-revenue fleet vehicles account for much of their scope 1 emissions. These fossil fuels come from the use of gasoline, diesel fuel, and natural gas. Utilizing the following strategies, RFTA can address over 76% of their 2019 baseline emissions. This group of strategies presents the most significant opportunity for RFTA to reduce GHG emissions and achieve their emissions goal.

REVENUE FLEET

Over the last decade, the transportation industry has seen growing demand and use of zero emission buses. A majority of ZEB options fall into two primary categories:

- **Battery electric buses (BEBs):** powered by electricity stored within onboard batteries

- **Fuel cell electric buses (FCEBs):** powered by fuel cells that convert hydrogen into electricity.

Each of these technologies offers various advantages over one another and comes with unique infrastructure requirements. BEBs require charging infrastructure by wired plug-in charging, overhead conductive charging, or wireless inductive charging. FCEBs require the production, or purchase and storage, of hydrogen fuel. Sources of hydrogen can be considered grey, blue, or green:

- **Grey** - produced using natural gas or methane but does not capture GHG made in the process. This is currently the most common form of hydrogen.
- **Blue** - produced from natural gas using a process called steam reforming. The steam reforming process produces hydrogen and carbon dioxide but utilizes a carbon capture and storage system for the carbon by-product.
- **Green**- produced using clean electricity to electrolyze water into hydrogen fuel. Currently, green hydrogen makes up a small percentage of the market but is expected to grow in the coming years. The US Department of Energy launched their Hydrogen Shot initiative in 2021 with the goal of reducing the cost of clean hydrogen by 80% to $1 per 1 kilogram in 1 decade.[xxviii]

Transitioning to a ZEB fleet requires consideration of existing infrastructure, utilities, charging strategies, and more. RFTA will provide a deeper analysis regarding their fleet conversion in the ZEB Transition Plan scheduled for release in 2024. Additional information on the conversion and deployment of ZEBs can be found in the Nation Academy of Science's *Guidebook for Deploying Zero-Emission Transmission Buses*[xxix] and several other sources.

Implementation: 100% Battery Electric Bus Fleet by 2050

RFTA's climate action strategy entails transitioning 100% of the revenue vehicles to battery electric by 2050. This target is set with the recognition of the challenges involved in converting the entire fleet along with respecting current transition plans and vehicle lifespans. As the development of their Zero Emission Bus Plan progresses, and ZEB technologies advance, adjustments will be made to the fleet composition. However, RFTA acknowledges the strategy's importance in achieving climate action goals and will prioritize ZEB fleet conversions throughout the implementation process.

The estimated cost of implementing this strategy from now until 2050 exceeds $40 million. Simultaneously, it is expected to result in a reduction of over 92,000 metric tons of GHGs over the same period. This equates to a cost of $438 per metric ton reduced.

Outcome Areas:

Sustainable Workforce

Satisfied Customers

Environmental Sustainability

High Performing Organization

NON-REVENUE FLEET

Municipalities and transportation authorities have also prioritized converting non-revenue fleets to electric vehicles (EVs). In addition to the vehicles cost, electrifying the non-revenue fleet would also require infrastructure investments including the installation of charging stations. The charging station locations and types would be identified through a prioritization based on vehicle travel fuel needs and the purpose of each vehicle's trips.

As discussed above in the *RFTA's Emissions Inventory* section, over 4% of RFTA's emissions (712 metric tons GHGs) are derived from the 250 non-revenue fleet vehicles.

Implementation: 100% Electric Non-Revenue Fleet by 2050

RFTA has set a goal to transition the entire non-revenue fleet to 100% electric vehicles by 2050. By converting the revenue and non-revenue fleet to electric, RFTA gains control over their largest emissions contributor and ensures the achievement of their climate action goals.

Implementing this strategy is projected to save RFTA over $900,000 from now until 2050, while also reducing emissions by over 11,000 metric tons over the same period. This equates to a cost savings of $82 for every metric ton of emissions reduced.

Outcome Areas:

Sustainable Workforce

Financial Sustainability

Environmental Sustainability

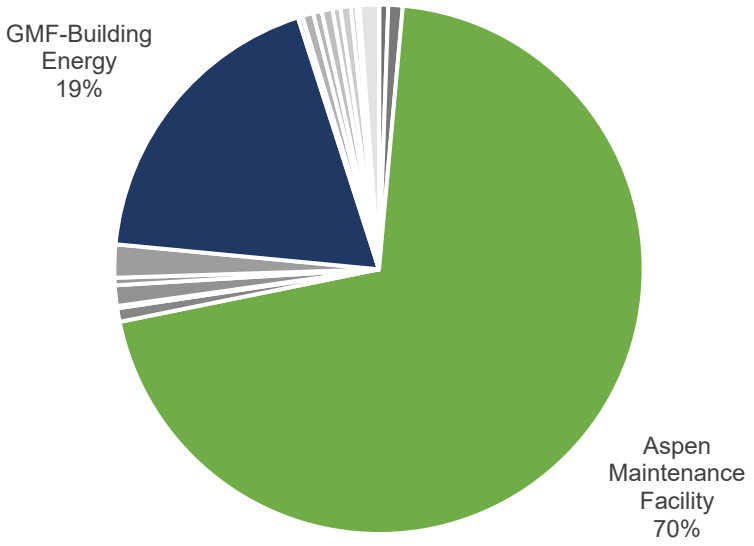
High Performing Organization

EMISSIONS FROM RFTA FACILITIES

As depicted in Figure 5, the electricity purchased and used by RFTA accounted for over 15% of their baseline emissions in 2019, while the use of natural gas in their facilities contributed to over 8%. Collectively, RFTA's electricity and natural gas consumption represents the second largest emission source. The strategies outlined in this section specifically target RFTA's facility emissions, aiming to achieve the goal of reducing emissions produced by RFTA's transit emissions by 50% by 2030 and 90% by 2050.

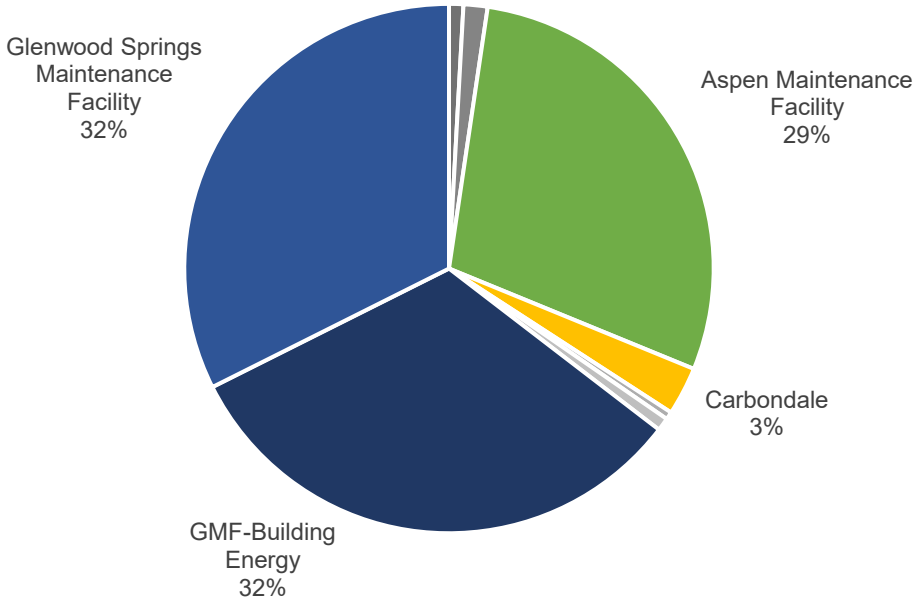
It is important to note that factors beyond RFTA's control influence the greenhouse gas intensity of these fuel sources and the effectiveness of the strategies discussed in this section, primarily concerning scope 2 emissions. For instance, one of RFTA's electric utility providers, Holy Cross Energy, is actively working towards providing 100% renewable energy by 2030 and offsetting their GHG emissions to net-zero by 2035. The successful attainment of this goal, and similar initiatives from RFTA's other utility providers, could significantly influence the outcomes of the strategies implemented in this section. Figures 11 and 12 display a breakdown of RFTA's 2019 purchased electricity and natural gas use by facility.

Figure 11: RFTA Facility Purchased Electricity



Source: RFTA. (2022) 2019 Inventory Data. Internal data: unpublished. See Appendix A: *Emissions Inventory Methodology* for methodology

Figure 12: RFTA Natural Gas Use by Facility



Source: RFTA. (2022) 2019 Inventory Data. Internal data: unpublished. See Appendix A: *Emissions Inventory Methodology* for methodology

ELECTRIFICATION OF FACILITY OPERATIONS

To electrify facility operations, RFTA aims to identify areas where natural gas is being used and transition those systems to electric-based energy consumption. Currently, RFTA's facilities rely on natural gas for heating and various other purposes. The electrification process may involve multiple options, such as upgrading space heating and water heating systems, among others.

In 2019, RFTA's facility stationary combustion of natural gas contributed to over 8% of the total emissions, producing approximately 1,440 metric tons of GHGs. Electrifying the operations of these facilities presents an opportunity for RFTA to reduce reliance on natural gas and subsequently lower GHG emissions.

The cost of implementing this strategy is relatively economical. In certain cases, electric heating systems offer more affordability and durability compared to gas systems. Depending on the relative costs of electricity and natural gas, RFTA may even realize cost savings by transitioning to electric systems in the facilities. Furthermore, as discussed above, RFTA has the potential to further minimize the environmental impact by exploring options to reduce the carbon footprint associated with the electricity purchased from energy providers.

Implementation: Electrification of Aspen Maintenance Facility (AMF) and Glenwood Springs Maintenance Facility (GMF) by 2043

By electrifying RFTA's Aspen Maintenance Facility (AMF) and Glenwood Maintenance Facility (GMF), the two largest consumers of natural gas, RFTA gains increased control over emissions associated with their facilities. The transition to electric power not only reduces the reliance on natural gas but also provides an opportunity for RFTA to benefit from cleaner sources of electricity. For example, by electrifying their facilities, RFTA can directly benefit from the cleaner electricity supplied by utilities like Holy Cross Energy. Additionally, the electrification of facilities allows RFTA to further leverage on-site renewable energy systems, enhancing their environmental impact.

The combined implementation and operation costs for these strategies are estimated to exceed $3 million from now until 2050. However, implementing these strategies also leads to a reduction of over 6,000 metric tons of GHG emissions during the same timeframe. This translates to an average cost of $518 per metric ton of emissions reduced.

Outcome Areas:

Sustainable Workforce

Financial Sustainability

Environmental Sustainability

High Performing Organization

DEVELOPMENT OF ON-SITE RENEWABLE ENERGY SYSTEMS

RFTA has various avenues to explore the development of on-site renewable energy. One of the more accessible forms of renewable energy is using solar photovoltaic (PV) panels. These solar installations can be utilized on existing RFTA facilities, at Park & Ride locations, or designed to provide canopy cover for transit users or fleet vehicles. Additionally, RFTA can consider other

options, such as small-scale wind turbines, hydroelectric systems, or a combination of renewable energy systems with battery energy storage.

Currently, RFTA's purchased electricity consumption contributes to approximately 2,690 metric tons of GHG emissions due to the carbon intensity of the source. By implementing on-site renewable energy systems, RFTA gains discrete control over the sources of electricity used in operations. This has the potential to reduce purchased electricity for facilities, facilitate the charging of BEBs, electrify the non-revenue fleet, or even support the production of green hydrogen fuel. Such measures ensure that the fuel sources utilized are clean and provide opportunities to reduce scope 1 and scope 2 emissions.

Implementation: AMF 300 kW Solar PV Installation by 2030

In December 2019, RFTA performed a solar feasibility assessment for the AMF. The feasibility assessment determined 300 kW of solar PV capacity potential on the facility's roof. RFTA has committed to installing this capacity at the AMF by 2030. Implementing solar PV will reduce the need for utility provided electricity and guarantee that approximately 400,000 kWh of electricity used by the AMF annually is 100% renewable.

The estimated cost of implementing and operating this strategy amounts to nearly $800,000. However, the adoption of solar PV at the AMF will result in savings of over $300,000 in electricity costs and a reduction of more than 1,500 metric tons of GHG emissions. This equates to a total cost of $282 per metric ton of emissions reduced.

Outcome Areas:

Sustainable Workforce

Financial Sustainability

Environmental Sustainability

High Performing Organization

EMISSIONS DISPLACED BY TRANSIT

RFTA provides a shared form of transit via buses, which helps reduce the number of individual drivers on the road and offsets emissions regionally. The strategies below are aimed at increasing RFTAs emissions offset in the region by increasing ridership, encouraging multi-modal transit, and reducing traffic on the roads. These strategies will impact RFTA's goal of increasing emissions displaced by their operations to 3x their 2019 emissions by 2030 and 5x by 2050.

EXPANSION OF TRANSIT PRIORITY LANES

This section refers to strategies designed to give transit buses priority within the traffic system, giving RFTA vehicles right-of-way and providing travel time savings, operating cost savings, and increased travel reliability.

When VelociRFTA, RFTA's BRT System, was introduced in September 2013, it employed a combination of bus-only lanes, BUS/HOV lanes, and transit signal priority. These strategies significantly improved bus travel efficiency, making bus travel time comparable to personal automobiles, especially during peak hours.

Over the past decade, traffic congestion has worsened in areas without transit priority measures. The most congested section is located on SH82 in Glenwood Springs, specifically between 32nd street and 8th street. During the Multimodal Options for a Vibrant Economy study, the railbanked Rio Grande Corridor ROW between 27th Street and 8th Street emerged as the most promising alignment. The study found that dedicated BRT lanes along the Rio Grande corridor are projected to increase ridership by 12% based on the expected baseline ridership in 2040. Additionally, an extra mile of dedicated BRT lanes along Rio Grande between 14th and 27th streets would further boost ridership due to reduced travel times.

Implementation: Rio Grande Exclusive Corridor by 2033

RFTA has committed to implementing and operating the Rio Grande Exclusive corridor by 2033. This endeavor is estimated to cost over $30 million. However, it will lead to the displacement of approximately 54,000 metric tons of GHGs in the region, attributable to land use and mode shift impacts. The resulting cost for each metric ton displaced is approximately $563.

Outcome Areas:

Safe Customers, Workforce, and General Public

Accessibility and Mobility

Financial Sustainability

Satisfied Customers

Environmental Sustainability

High Performing Organization

MOBILITY HUBS & EXPANSION OF BRT

Mobility hubs, such as RFTA's Park & Ride and Bike & Ride sites, are transportation terminals designed to integrate several transit modes in a single location, offering a range of benefits for both the environment and society. These hubs contribute to:

- Less GHG emissions
- Less road congestion
- Consumer savings on gas and other vehicle-related expenses
- Efficient land use
- Safer roads

Mobility hubs are designed to incentivize the use of alternative transit modes instead of personal vehicles. This has resulted in an increase in public transit ridership, along with increases in commuters walking, biking, and ridesharing.

The cost of implementing mobility hubs depends on the size and utilization of the hub. A larger, more robust hub will likely incur a cost in the millions, such as the proposed RFTA mobility hub on Wulfsohn Road in West Glenwood Springs, near I-70, which is estimated to cost approximately $6 million[xxx]. Smaller hubs may cost less and not require as significant an investment.

BRT systems have a dual impact: they enhance the transit service for existing users while stimulating ridership. As highlighted earlier, BRT implementation, and priority lanes, bring about

numerous infrastructure efficiencies that result in faster and more reliable travel times, potentially alleviating traffic congestion.

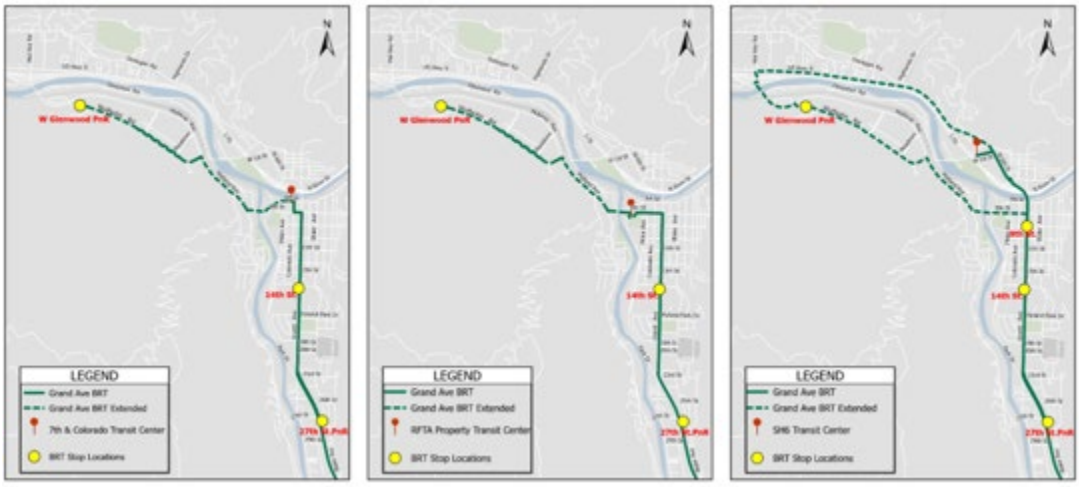
A comprehensive BRT system can achieve a 25% increase in ridership, with some systems experiencing even higher growth rates surpassing 80%[xxxi]. This ridership surge is particularly significant in areas with high congestion and without rail transit alternatives. These areas witness notable positive impacts, including increased total passenger miles, total bus miles, and reduced GHG emissions.

RFTA's utilization of BRTs will continue to play a pivotal role in enhancing transit options and curbing emissions in the coming years. BRT will prove invaluable in addressing congestion hotspots within RFTA's service area, providing regional commuters with a sustainable and time-saving choice for their daily commutes.

Implementation: West Glenwood Springs Transit Hub & BRT Extension to West Glenwood by 2030

To support service enhancements and expansions, RFTA has made a commitment to extend the BRT system to the Rio Grande Exclusive corridor. As part of this plan, the extension of BRT to the Hub has become even more crucial. Recognizing the importance of this development, RFTA has successfully secured a funding plan for the construction of the West Glenwood Transit Hub and will soon commence construction. Additionally, RFTA has been collaborating closely with the City of Glenwood Springs to establish a BRT alignment throughout the city (see Figure 13 for extension scenarios). These efforts demonstrate RFTA's dedication to satisfied customers.

Figure 13: West Glenwood BRT Extension Scenarios



Source: RFTA. (2022) *Destination 2040 Process*. Internal data: unpublished.

RFTA will complete the construction of the West Glenwood Springs Transit Hub and expand the BRT system to West Glenwood. The estimated cost for this project, including implementation, operation, and maintenance, is approximately $34.5 million. This significant investment is projected to have a substantial impact, displacing over 70,000 metric tons of GHGs in the region. When considering the overall cost, this amounts to an average of $487 per metric ton displaced, reflecting the value of the emissions reductions achieved through this expansion.

Outcome Areas:

Safe Customers, Workforce, and General Public | Accessibility and Mobility | Financial Sustainability | Satisfied Customers | Environmental Sustainability | High Performing Organization

EXPANSION OF MULTI-MODAL SERVICES

Expanding RFTA's transit services not only enhances regional transportation options but also plays a crucial role in reducing greenhouse gas emissions by promoting increased ridership and providing viable alternatives to private car usage. The expansion of multi-modal services encompasses geographic expansion into new areas and the augmentation of offerings within existing areas. Although the improved displaced emissions resulting from increased ridership or land-use effect may not directly impact RFTA's scope 1 and 2 emissions, they contribute significantly to emission reductions within the region. Some examples of expansion of multi-modal services could include:

- Establish public bikeshare systems
- Improved bike access to transit stations and stops
- Improved bike parking
- Development of multi-modal navigational tools such as guides, trip planning interfaces, and timetables
- Increase number of bike racks on buses
- Improved sidewalks and cross walks
- Addressing security and safety concerns
- Implement universal design to make stations more accessible to people with disabilities or other special needs

The costs associated with expanding transit and multimodal services for RFTA vary depending on the scale and nature of the expansion.

Outcome Areas:

Safe Customers, Workforce, and General Public | Accessibility and Mobility | Sustainable Workforce | Financial Sustainability | Satisfied Customers | Environmental Sustainability | High Performing Organization

FARE REDUCTIONS

Reducing transit fares or introducing discount or benefit programs for riders can lead to short and long-term increases in ridership. In general, a decrease of 1% in fare prices can result in a 0.5% increase in ridership[xxxii]. While a small increase in ridership may appear insignificant, even a modest reduction in fares can attract additional long-term riders and have a substantial impact. These few individuals choosing public transit over personal vehicles for their daily commutes can quickly add up to hundreds or thousands of trips each year. This shift not only contributes to a reduction in regional emissions but also helps alleviate congestion and improve overall transportation conditions. It highlights the importance of even incremental changes in pricing and their potential to drive significant positive outcomes.

In addition to the ridership and emissions impact of reducing fares, there is also a cost impact to RFTA. As of 2022, the agency received over $3.5 million in fare revenues[xxxiii]. Depending on the size of the decrease in fare and the size of the ridership increase, there could be a drastic change in revenue. Alternatively, RFTA may evaluate target fare reductions for off-peak travel times and travel directions or to lower-volume routes. This approach could potentially increase ridership, by utilizing available excess capacity, without compromising passenger comfort, fare revenues, and other RFTA resources.

Implementation: 20% Fare Reduction by 2026

RFTA will commit to reducing fares 20% by 2026. This reduction, when considered alongside the implementing other strategies outlined in the plan, is projected to have no adverse effect on fare revenues. On the contrary, with the anticipated increase in ridership from these strategies, RFTA is estimated to see a substantial increase in total fare revenues of over $45 million by 2050. Furthermore, the 20% fare reduction is expected to displace approximately 11,000 metric tons of GHG emissions in the region. When the factors are combined, it is estimated that RFTA will achieve savings of $4,308 for every metric ton of emissions reduced through the fare reduction initiative.

Outcome Areas: Outcome Areas:

Accessibility and Mobility

Satisfied Customers

Environmental Sustainability

High Performing Organization

CONNECTED HOUSING, JOBS, AND TRANSIT

Careful coordination and planning within the region can result in connected housing, job, and transit systems that work together to meet the needs of individuals and the region. By connecting these three categories and increasing their density, RFTA can increase their regional offset of GHG emissions. For instance, developing more compact residential, commercial, and transit areas encourages individuals to choose active modes of transportation, such as walking or biking for their daily commute. Additionally, individuals are more likely to opt for walking or biking to reach a nearby RFTA bus stop or transit station, facilitating their use of public transportation. RFTA recognizes the importance of addressing the first and last-mile challenge and is actively

developing strategies to improve accessibility to transit services. As previously discussed, implementing bikeshare programs can effectively address the first and last-mile needs. Collectively, by encouraging increased walking, biking, and public transit usage, emissions can be significantly reduced compared to individual vehicle usage for the same destination.

With RFTA's community-focus, the agency can lead the region in strengthening the regional economy, encouraging affordable housing and sustainable jobs. Studies find that, on average, for every 10 extra residential units per gross acre within acceptable walking distance (0.50 miles) of a transit station, transit commute mode split increases by 4%.[xxxiv] Additionally, connecting transit to housing and jobs can reduce the need to travel long distances, which leads to a reduction in vehicle miles traveled[xxxv].

Case Study: Carbondale BRT Development

In 2014, RFTA conducted the *RFTA Regional TOD Assessment,* which identified the potential for a Carbondale BRT Station paired with TOD. This development would have the capacity to add 50 to 450 residential units, along with retail and other applications, in the vicinity of the station. RFTA will continue prioritizing TOD through potential developments in Carbondale and other service areas.

The costs to RFTA to implement similar TOD strategies is difficult to estimate. Land development costs are likely borne by developers and jurisdictions. In Contrast, RFTA will likely bear the fleet's long-term capital and operating costs, facilities, and human resources required to accommodate the additional ridership. However, for example, it is estimated that a Carbondale BRT development would displace nearly 300,000 metric tons of GHG emissions in the region. This would have the greatest impact on displaced emissions of all the strategies evaluated by far.

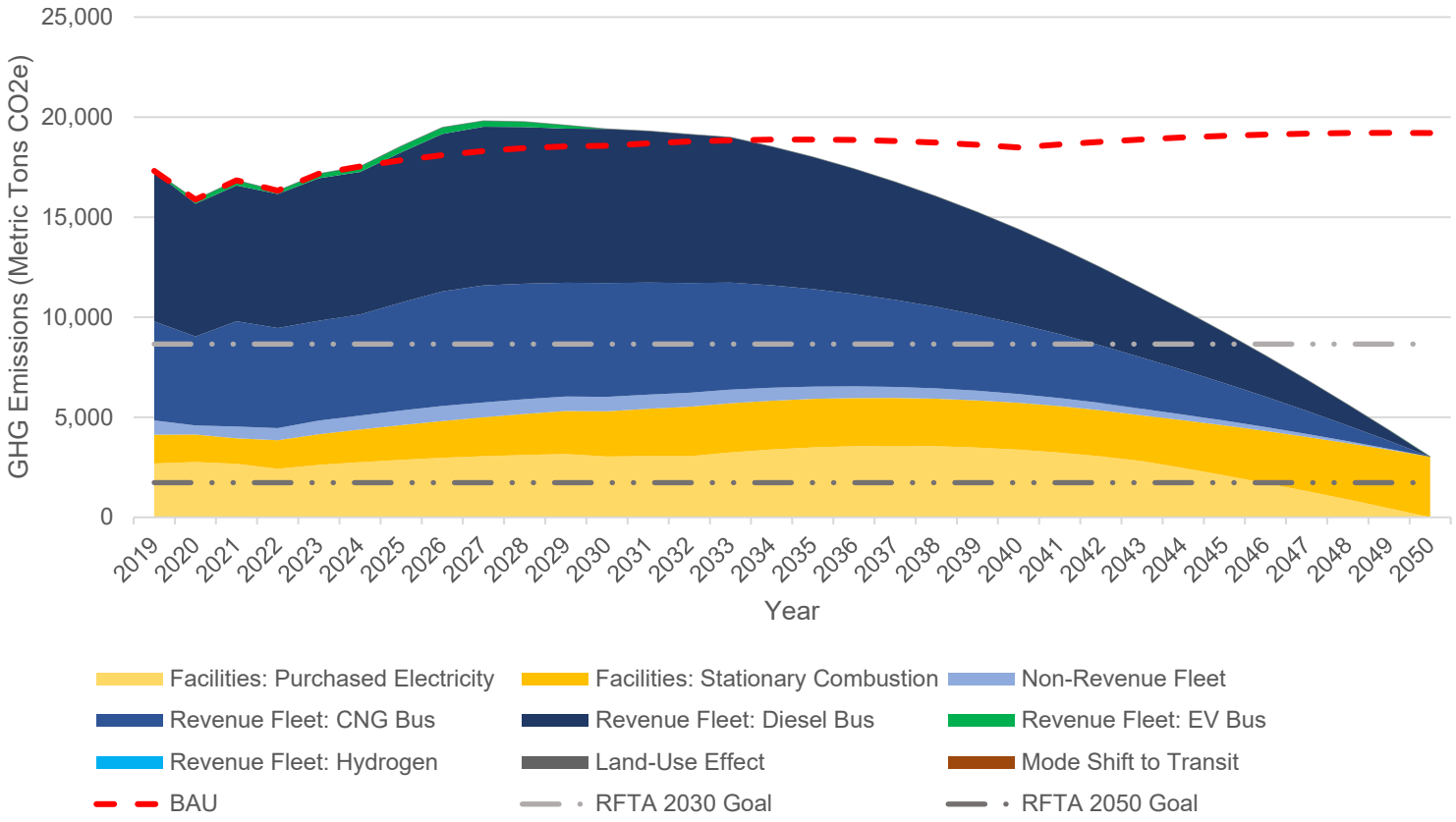
Outcome Areas:

Safe Customers, Workforce, and General Public | Accessibility and Mobility | Sustainable Workforce | Financial Sustainability | Satisfied Customers | Environmental Sustainability | High Performing Organization

CLIMATE ACTION STRATEGIES FORECASTED COSTS AND IMPACTS

Given the strategies outlined above, Figure 14 shows the estimated resulting impact on emissions, broken out by source:

Figure 14: Forecasted GHG Emissions by Category

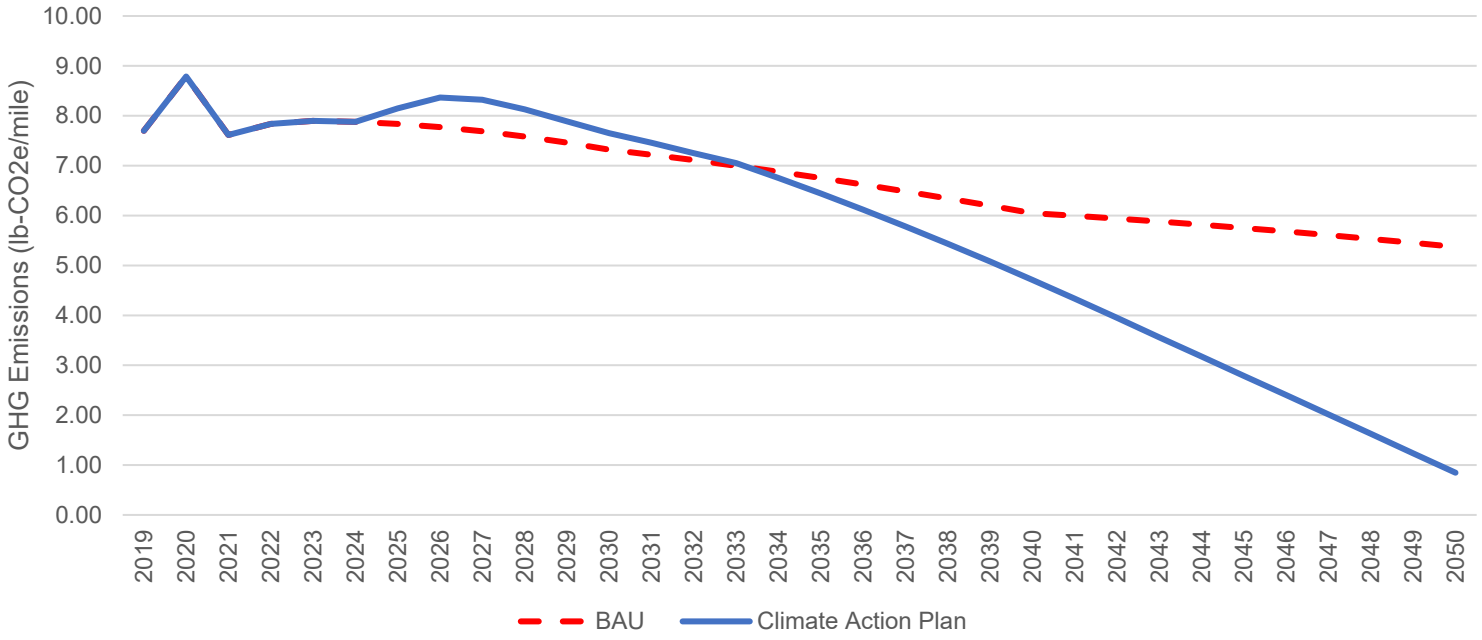


Source: RFTA. (2022) Cost-Benefit Climate Calculator. Internal data: unpublished. See Appendix A: *Emissions Inventory Methodology* for methodology

Emissions first increase over BAU; due to the initial focus on strategies that increase ridership and thus bus miles traveled. However, beginning in 2028, with the start of the revenue fleet transition, emissions start to drastically decrease, eventually resulting in an 83% total decrease in emissions compared to the 2019 baseline.

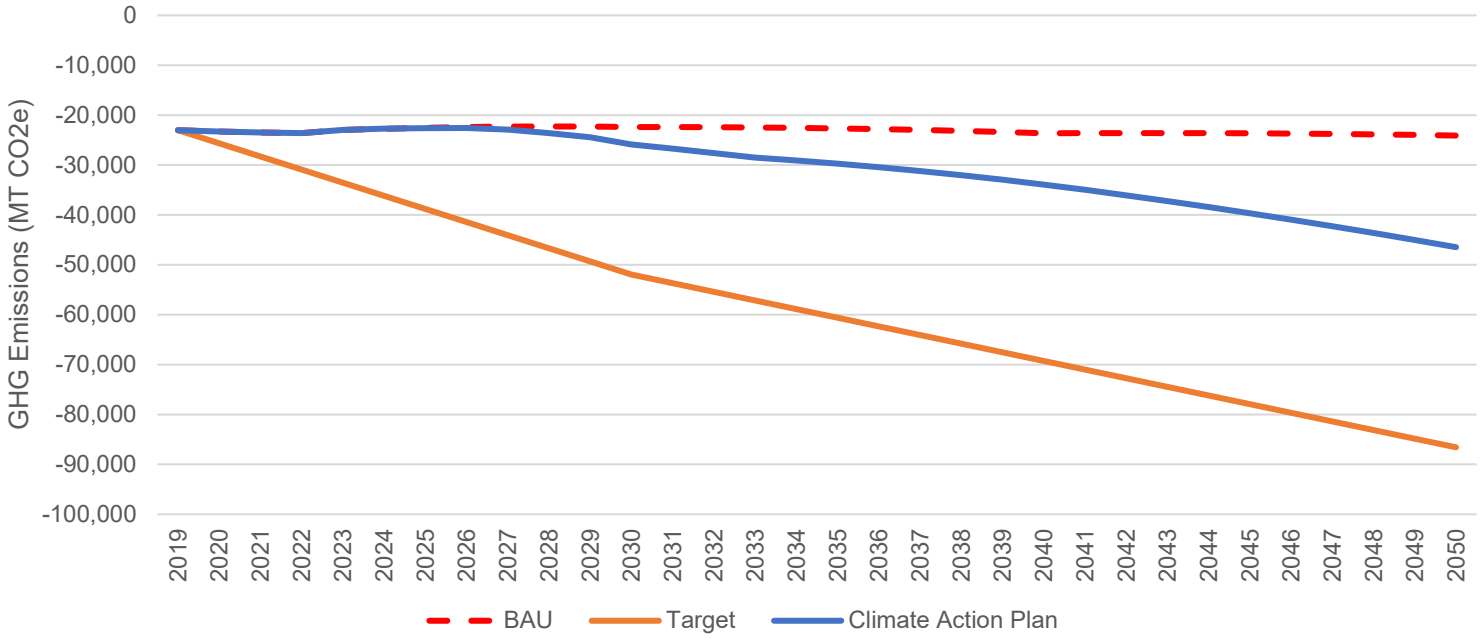
Figure 15 shows GHG emissions for revenue miles, displaying the difference between BAU forecasts and the results of the modeled climate action strategies.

Figure 15: Forecasted GHG Emissions Normalized by Revenue Miles



Source: RFTA. (2022) Cost-Benefit Calculator. Internal data: unpublished. See Appendix B: Cost-Benefit Climate Calculator and Strategy Evaluation Criteria for methodology

Figure 16: Forecasted Regional GHG Emissions Displacement



Source: RFTA. (2022) Cost-Benefit Calculator. Internal data: unpublished. See Appendix A: *Emissions Inventory Methodology* for methodology

Figure 16 shows the results of the modeled strategies on the emissions displacement goal. It can be observed that the climate action strategies being implemented have a drastic impact on RFTA's net emissions impact on the region. Table 11 summarizes each of the selected strategies, their modeled implementation timeline, and the resulting evaluation criteria outputs.

Overall, the climate action strategies prioritized by RFTA are estimated to reduce or displace over 500,000 metric tons of GHG emissions between 2023 and 2050, with the bulk of that coming from a displacement of regional emissions due to an increase in ridership and the land use effect of different strategies on the region. It is estimated to cost around $182 for every metric ton of displaced or reduced emissions. Despite the large amount of emissions being displaced or reduced through these selected strategies, Figures 15 and 16 show that RFTA is still estimated to fall short on their climate action goals.

Table 11: Priority Strategies and Implementation

Strategy Category	Level of Implementation	Start	End	Cost Benefit	Emissions Displaced	Emissions Produced
Revenue Fleet	100% Battery Electric	2028	2050	$438	-	-92,790
Non-Revenue Fleet	100% Battery Electric	2025	2050	$(82)	-	-11,474
Electrification of Facility Operations	GMF & AMF	2033	2043	$518	-	-6,328
Development of On-Site Renewable Energy Systems	AMF Solar PV Installation	2030	2030	$282	-	-1,558
Transit Priority Lanes	Rio Grande Exclusive Corridor	2030	2033	$563	-54,320	-
Mobility Hubs & Expansion of BRT	West Glenwood Springs Transit Hub & BRT Extension to West Glenwood	2025	2030	$487	-70,756	-
Fare Reductions	20% Reduction	2025	2026	$(3,079)	-11,537	-
Total				**$293**	**-136,612**	**-112,150**

Source: RFTA. (2022) Cost-Benefit Climate Calculator. Internal data: unpublished. See Appendix A: *Emissions Inventory Methodology* for methodology

However, the priority strategies are not comprehensive of all RFTA's efforts to meet their 2050 goals. Other strategies evaluated throughout the CAP development process will still be considered going forward. Moreover, the calculator tool used to estimate the impacts of different strategies will continue to be used throughout RFTA's planning processes to ensure that climate action is at the forefront of decision-making going forward.

As discussed in the *Monitoring and Implementation* section below, RFTA will continue to monitor and adapt their approach with newly available information and technology.

ADDITIONAL POTENTIAL STRATEGIES

In addition to the strategies selected and outlined above, RFTA has identified several other potential strategies it may implement to reach the climate action goals.

- Develop a BRT service to Parachute and increase transit in the I70 Corridor:
- Increases Multimodal/First and Last Mile Mobility Options, including microtransit
- Evaluate the potential for a downtowner-type service in Carbondale
- Energy Benchmarking existing facilities
- Implementing Green Standards for new facilities
- Utilizing advanced building codes for new facilities
- Identify and implement opportunities for additional TOD at other BRT stations

Together, these potential strategies and the priority strategies will help guide RFTA towards reaching their climate action goals of reducing their direct emissions and increasing their regional emission offsets.

MONITORING AND IMPLEMENTATION

This CAP is designed as a living, planning document to help guide RFTA's decision-making, capital project prioritization, and implementation of the climate action strategies. RFTA will continue to reference this plan to ensure future actions and investments will allow the agency to reach their goals. In addition to this CAP, RFTA will ensure future efforts align with the following planning documents:

- Aspen Climate Action Plan
- Basalt Climate Action Plan
- Carbondale Climate Action Plan
- Colorado Greenhouse Gas Pollution Reduction Roadmap
- Eagle County Climate Action Plan
- Garfield County Energy Action Plan
- Glenwood Springs Climate Action Plan
- New Castle Climate Action Plan
- Pitkin County Climate Action Plan
- Snowmass Village Sustainability Plan

This CAP provides the foundation for RFTA initiatives and efforts in the coming years. RFTA will create an implementation and monitoring program to capture the progress of the strategies discussed in this plan, emergency mitigation priorities, and funding efforts and timelines. The monitoring program developed by RFTA will utilize a multifaceted approach that includes engaging leadership and local communities, securing funding, and collaborating closely with staff and stakeholders.

Continuing data collection and monitoring will be important to ensure that RFTA's strategic goals are being accomplished in a timely manner. This monitoring strategy will include annual progress reviews towards the targets outlined in this plan to confirm that the plan is on track, and to make changes as new information or technology becomes available.

The collaboration and cooperation between RFTA leadership and local partners will remain critical to successfully implement the strategies discussed in this plan. RFTA will continue to work in close collaboration with key stakeholders in the region to attain shared emissions reduction goals and transit-related climate solutions. The agency has considered numerous local, state, and federal funding options to support the selected strategies and will pursue the appropriate programs and grants to attain adequate funding levels for achieving the objectives of this plan.

IMPLEMENTATION

This climate action plan will serve the RFTA organization, customers, and partner communities as a living document that leads the agency towards implementing climate solutions that help create a more sustainable region. This document and the strategies will require substantial coordination, planning, and funding from RFTA and stakeholders to fully execute. With this in mind, it will be imperative throughout the implementation of this plan, for RFTA to continually communicate with staff, stakeholders, and the public. This will be undertaken through regular updates at Board meetings and internal discussions.

The strategies in this plan will significantly reduce the agency's emissions produced and displaced through 2030 and 2050. RFTA will work to balance these actions with the Destination 2040 Project Roadmap and 2019 Strategic Plan, while ensuring future planning efforts align with the current strategies set within this Climate Action Plan. RFTA will also continue to pursue relevant funding opportunities and allocate the agency's budget accordingly over the coming years to reach these climate action goals.

The implementation plan presented in Table 12 below provides a framework for developing strategies through specific actions. Over the life of this plan, RFTA will conduct analyses on the strategies and reevaluate the value and timing of the action outlined below to ensure they will accomplish the agency's goals. RFTA will adjust the implementation plan accordingly as new information and technology become available.

Table 12: Strategy Implementation Framework

Key: ● Scope 1 emissions | ● Scope 2 emissions | ● Scope 3 emissions

EMISSIONS FROM RFTA FLEET	Scope	Timeframe
Revenue Fleet		
Develop ZEB Transition Plan.	●	2023 - 2024
Convert 33% of RFTA bus fleet to ZEB	●	2040
Convert 100% of RFTA bus fleet to ZEB	●	2050
Non-Revenue Fleet		
Conduct non-revenue fleet electrification feasibility study.	●	2023
Implement electrification into RFTA Non-revenue fleet conversion plan.	●	2024
Convert 30% of non-revenue fleet to ZEV	●	2040
Convert 100% of non-revenue fleet to ZEV	●	2050

Key: ● Scope 1 emissions | ● Scope 2 emissions | ● Scope 3 emissions

EMISSIONS FROM RFTA FACILITIES	Scope	Timeframe
Electrification of Facility Operations		
Conduct feasibility analysis of RFTA facilities for electrification. Aspen Maintenance Facility (AMF) Glenwood Spring Maintenance Facility/Regional Transit Center (GMF) Rodeway Inn Employee Housing Auxiliary RFTA facilities	●	2030
Electrify operations at the AMF and GMF	●	2043
Implement electrification efforts on other feasible facilities	●	*TBD*
Development of On-Site Renewable Energy Systems		
Participate in the AABC Microgrid Project	●	2024
Implement solar PV system at AMF	●	2030
Conduct renewable energy generation and storage site assessments at all RFTA facilities	●	*TBD*
Implement additional renewable energy projects at facilities where feasible	●	*TBD*
Energy Efficiency Measures for Existing Facilities		
Enter partnership agreements with energy efficiency organization such as CLEER and Garfield Clean Energy	●	*TBD*
Conduct energy assessments for all RFTA facilities to identify opportunities for improved efficiencies.	●	*TBD*
Implement energy efficiency measures across feasible RFTA facilities	●	*TBD*
Advanced Building Codes, Green Standards & Energy Benchmarking		
Ensure all buildings meet or exceed the 2021 International Building Codes.	●	*TBD*
Install energy benchmarking meters to evaluate RFTA facilities.	●	*TBD*
Develop Energy Action Plan to improve efficiencies based on benchmarking data.	●	*TBD*

Key: ● Scope 1 emissions | ● Scope 2 emissions | ● Scope 3 emissions

EMISSIONS DISPLACED BY TRANSIT	Scope	Timeframe
Expansion of BRT (& Mobility Hubs)		
Glenwood Springs 27th Street BRT Station Parking Expansion.	●	2025
Finalize construction of Glenwood Springs Maintenance Facility/Regional Transit Center.	●	2030
Complete development of West Glenwood Springs Transit Hub.	●●	2030
Implement expansion of BRT to West Glenwood Springs Transit Hub.	●●	2030
Implement BRT on the Rio Grande ROW in Glenwood Springs to streamline service in Glenwood Springs.	●●	2033
Complete improvements to Town of Snowmass Village Transit Center	●	2040
Identify opportunities for bus route efficiency measures based on changes in ridership and traffic patterns.	●●	2040 - 2050
Evaluate expansion of BRT on I-70 corridor as far as Parachute, CO	●●	*TBD*
Expansion of Multi-Modal Services		
Implement regional bike share plan.	●	2023 - 2028
Implement LOVA Trail Construction from Glenwood Springs to New Castle	●	2028
Construct Buttermilk Pedestrian Crossing in Pitkin County (by others)		2028
Evaluate opportunities for downtown focused transit in member jurisdictions (where appropriate)	●	*TBD*
Identify and implement additional opportunities for expanded transit service in high demand areas.	●	*TBD*
Fare Reductions		
Implement 20% reduction in fares	●	2026
Continue to evaluate options for fare reductions (such as off-peak, off-direction, lower demand routes, etc.)	●	Ongoing
Connected Housing, Jobs & Transit		
Identify opportunities to increase transit-oriented development.	●	Ongoing
Implement TOD at the Carbondale BRT station per scope defined in the Regional TOD Assessment (2014)	●	2035

MONITORING AND UPDATES TO THE CAP

RFTA will monitor progress toward the goals and milestones while continuing to identify ways to improve upon the performance of the CAP. RFTA will monitor and update the CAP on an annual basis through four main avenues:

Audits and assessments: RFTA will establish an annual committee to conduct routine and systematic audits ensuring the strategies effectively meet the goals and objectives discussed in this CAP.

Lessons learned: Utilizing the information gathered through audits and assessments, RFTA will meet internally to identify opportunities to improve on current initiatives and efforts to reduce emissions. Additionally, reviews may illustrate successful practices that can be further leveraged in the agency's efforts.

Reporting: RFTA will periodically take the information gained through audit and assessment process to create deliverable updates for the Board and stakeholders.

Recalibration: As necessary, RFTA can recalibrate and adjust strategies to account for unforeseen circumstances, inefficiencies, and costs. This plan has been developed to allow RFTA to remain flexible and adaptable as the agency strives towards the emission reduction goals.

RFTA's internal monitoring plan will include several tools. The first of these is a cutting-edge tool developed for RFTA's strategy selection and measurement that will allow the agency to continually monitor and update expectations based on real-time emissions data. The tool utilizes the RFTA emissions inventory and trend data from the baseline 2019 year to project emissions outcomes through 2050. This together with the emissions inventory and internal tracking data, will assist in informing RFTA about strategy selections and planning.

In addition to these efforts, RFTA will continue to improve the agency's ability to monitor and reduce greenhouse gas emissions. As technological and infrastructure improvements become available, RFTA will have the ability to further account for scope 3 emissions that are not currently captured in this CAP (see *Technical Discovery* section). This will help improve this plan's coverage and provide RFTA, regional communities, and regional partners with a more defined approach to reducing their emissions.

Utilizing the tool and data available to RFTA will be key to effectively monitoring and updating this plan and the strategies outlined. RFTA will create a committee of internal and external staff and stakeholders to meet annually. This annual committee will review the current strategies and plans being developed and implemented throughout RFTA and recommend updates and changes as needed to the Board of Directors, RFTA staff, and the public.

RFTA is committed to providing update reports on the strategies and targets detailed in this plan to the Board of Directors, stakeholders, and the public on a continual basis. As this document is designed with flexibility and accuracy in mind, stakeholder input will remain a crucial factor as RFTA plans for the future utilizing these implementation and monitoring tools.

CALL TO ACTION

This Climate Action Plan is a roadmap to a more sustainable future. RFTA's goal of reducing GHG emissions by 90% through 2050 aligns the agency with the state of Colorado's GHG Pollution Reduction Roadmap and regional plans within the Roaring Fork Valley. For RFTA to accomplish this plan, a significant effort from stakeholders, partners, staff, and riders will need to be made. Every person, from RFTA leadership to daily commuters, can make a difference in the fight against climate change through the act of riding public transit. This plan supports the community and RFTA riders through by focusing on improving operations and transit offerings.

Regional partners have clarified that finding climate solutions is a priority, with targets ranging from 80% reduction to completely net-zero emissions through the next three decades. With RFTA's aligned partners, combined with the fact that the highest emitting sector in the United States is transportation, the potential result is a significant impact that RFTA can have on the region and sustainability planning.

The emissions inventory has clearly defined areas of improvement, with the vast majority of emissions coming from the bus fleet. The inventory, along with the strategies to address potential improvements are divided between three scopes. The first scope relates directly to the emissions from RFTA's fleet and leads towards solutions including a zero-emission bus fleet conversion, bus route efficiency measures, and electrification of the non-revenue fleet. The second scope speaks to the emissions from the agency's facilities resulting in solutions such as developing on-site renewable energy systems, implementing green standards into building and construction codes, and overall being more energy efficient. The third scope links the impacts from RFTA's

operations to the region, quantifying the displaced emissions, and involves goals like expanding BRT priority lanes and options, reducing transit fares, and making transit-oriented development decisions relating to connected housing and jobs.

These scopes have led RFTA to outline several key strategies the agency will seek to implement in the upcoming years to reduce emissions and offer a more sustainable transit service. Each solution has been carefully evaluated against regional, state, and national standards and expectations to ensure the most effective strategies are selected. A dashboard and cutting-edge modeling tool have also been developed to communicate with the RFTA Board and staff, stakeholders, and the public, along with creating an annual committee to re-evaluate the strategies. Emission data will be continually updated to provide the region and riders with the best transit options possible.

This plan would not be possible without RFTA's regional partners, staff, and riders. As RFTA improves and expands services in the upcoming years, the community's support will be imperative. With more people using public transportation and alternative modes of transportation, while supporting RFTA and partners' efforts to reduce emissions and improve climate outcomes, the strategies and targets in this plan will be brought to life. Together, RFTA can make a significant regional difference in reducing emissions and providing real climate solutions.

APPENDIX A: EMISSIONS INVENTORY METHODOLOGY

RFTA's comprehensive emissions portfolio incorporates a wide range of internal data tracked and/or submitted to the National Transit Database. The calculation methodology employed in this emissions inventory is designed to account for the organization's baseline year of 2019 and provides a detailed breakdown of emissions across various operational categories. To achieve this, a master database was developed, which segregates emissions by utility account, isolating of different emissions categories by location, fuel type, and utility. This data-driven approach leverages account billing data, enabling RFTA to link emissions to energy costs, thereby, facilitating the implementation of an optimal CAP. The methodology outlined in this section is designed to enable continuous monitoring and updating of emissions metrics.

EMISSIONS DISPLACED BY TRANSIT

The calculation of emissions reductions from RFTA operations are split into two categories, Mode Shift to Transit and the Land Use Effect

MODE SHIFT TO TRANSIT

Quantifying the emissions impact of a mode shift towards transit is a crucial aspect of assessing the sustainability of transportation systems. To achieve this, two key metrics are leveraged: The Passenger Miles Traveled data for the transit agency, and a mode shift factor. The PMT data is obtained through internal tracking mechanisms, while the mode shift factor is calculated using a combination of data from passenger surveys and the APTA studies.[Error! Bookmark not defined., Error! Bookmark not defined.Error! Bookmark not defined.]

The mode shift factor is determined by calculating the ratio of transit passenger miles to the displaced private vehicle miles. This is accomplished by utilizing the passenger-indicated vehicle alternatives percentages, derived from APTA studies, which indicate that 14% of passengers would drive alone, 12% would use ride-hailing services, 10% would carpool, and 3% would use taxis. The percentage of passengers that would carpool is divided by 2.5 because that is the assumed average amount of passengers per carpool. These percentages are then incorporated into Equation 1, which allows for calculating a mode shift factor of .329.

Equation 1: Mode Shift Factor

$$\frac{\left[\%\ Drive\ Alone + \%\ Ridehail + \left(\frac{\%\ Carpool}{2.5\ passengers}\right) + \%\ Taxi\right]}{100}$$

Once the mode shift factor is calculated, it can be used in conjunction with the PMT data to determine the amount of vehicle miles traveled that are displaced by transit operations. This is achieved through the application of Equation 2, which accounts for the mode shift factor, the transit agency's vehicle fuel consumption and emissions data, and the relevant emissions conversion factors. The results of this process, along with the relevant inputs and sources, can be found in Table 13.

Equation 2: Mode Shift Factor Emissions Displacement

$$\left(\frac{PMT * Mode\ Shift\ Factor}{MPG}\right) * \frac{tonne\ CO2e}{Gallon}$$

Table 13: 2019 Mode Shift to Transit Variables

Mode Shift to Transit Emissions Displaced			
Term	Value	Units	References
PMT	33,221,951.07	Miles	RFTA Tracking
Mode Shift Factor	.329		APTA Studies
VMT Displaced	10,930,021.90	Miles	
Average Fuel Economy	22.90	MPG	FHWA Average for LDV
GHG Emissions	-5,094.26	metric tons-CO2e	

Source: RFTA. (2022) 2019_Inventory Data. Internal data: unpublished.

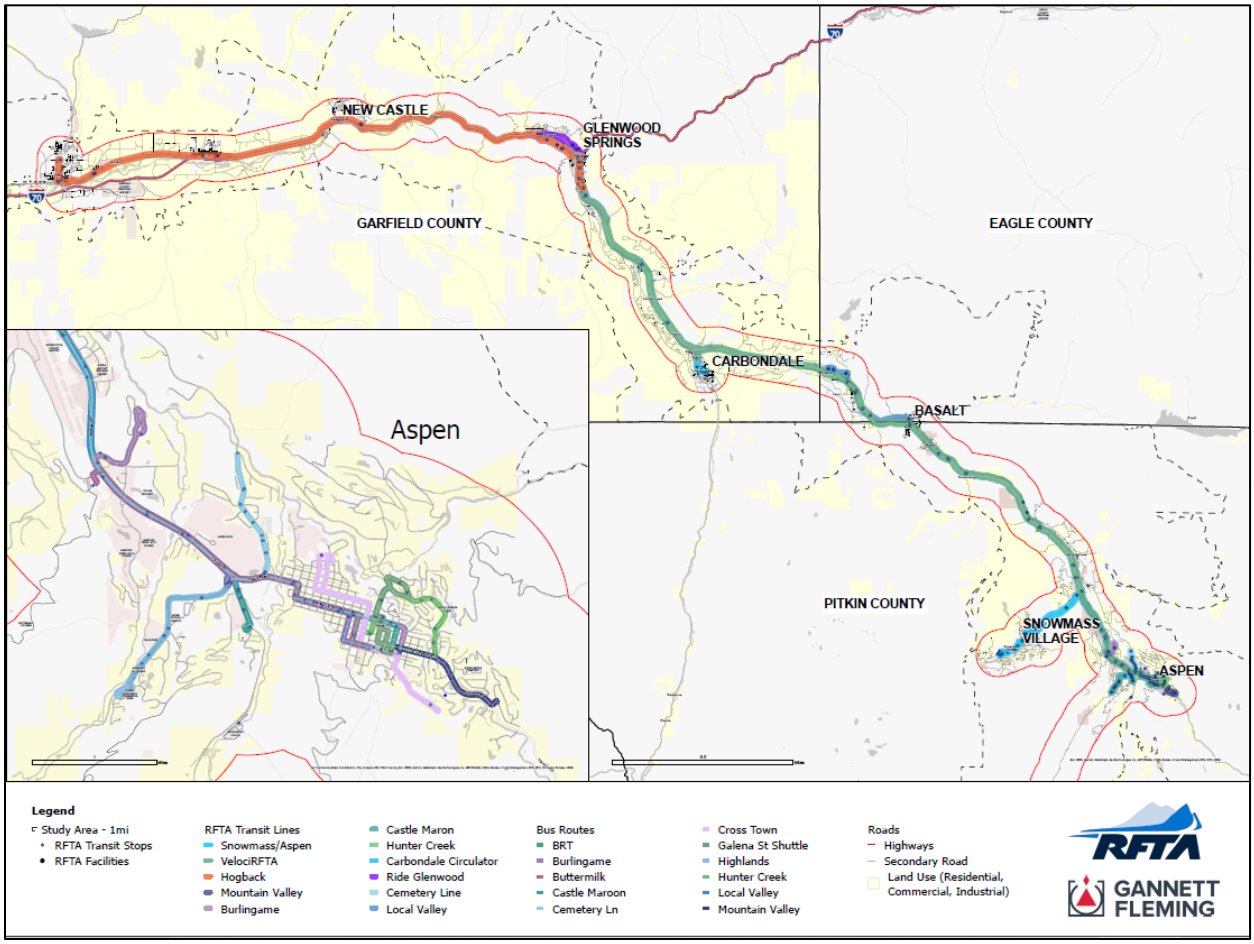
LAND USE EFFECT

The land-use effect is the measurable impact that a transit agency or other entity has on a region's usage of transit modes, population density, and employment density. Using two datasets that contain transit and regional data from over 300 urban areas and across nine national regions, a calculation can be made to determine the effect an organization has on the region. These effects relate to transit having a positive change on population density, a decrease in regional VMT, fuel use, and GHGs from transportation, and an overall increase in activity density (population and employment density combined).

The calculator tool, developed by the Transit Cooperative Research Program, is designed with the purpose of estimating VMT reduction, gasoline consumption reduction, and GHG emissions saved for regional transit systems, regional transit plans, new or improved transit services, routes, and stops. The inputs for the tool revolve around areas that have shown significant and positive effects towards land use densities and benefits. These inputs include transit directional route miles, transit revenue service miles, and job accessibility by transit. Other factors that have been researched and found to not have a measurable effect on land use are right-sizing vehicle capacity, providing rider amenities, and marketing campaigns. Although this calculator considers unique regional inputs, it does not consider local real estate market supply and demand factors and rather uses an aggregate from the two urban and national datasets. In addition, areas of high development that see large transit investments may see larger land use benefits than are estimated.

RFTA's use of the calculation begins with defining the agency's service territory. This region was determined using census tracts that intersect RFTA transit routes within one mile. With these census tracts, Figure 17 shows a detailed map of RFTA's territory relevant to their land-use effect on the region. The map highlights RFTA's transit routes, stops, and facilities along with showing the outline of the applied census tracts.

Figure 17: RFTA Land Use Effect Area of Analysis



Source: Gannett Fleming. (2022) *RFTA Land Use Effect Area of Analysis*. Internal data: unpublished.

Table 14: Land Use Effect Variables

Metric	Quantity	Unit
RFTA service territory		
RFTA's transit directional route miles[iv]	270.4	Miles
RFTA's total annual revenue miles[v]	4,946,740	Miles
Regional road network[vi]		
Freeway lane miles	133	Miles
Other roadway lane miles	1,163	Miles
Regional land use[vii]		
Total population	71,807	People
Total land area	683.83	Square miles
Gross population density	105	People / square mile
Regional travel characteristics		
Transit passenger miles travelled	2.08	PMT / capita / day
Vehicle miles traveled	30.4	VMT / capita / day

Source: RFTA. (2022) 2019_Inventory Data. Internal data: unpublished.

The metrics related to the map and the census tracts can be found in the above Table 14. Utilizing these metrics with the land-use effect calculator results in the specific land use effect impacts for RFTA, seen below in Table 15.

Table 15: Land Use Effect Emissions Displaced

Metric	Quantity	Unit
Annual VMT reduction for region	9.5	%
Annual regional reduction in VMT	75,605,155	Miles
Annual reductions in gallons of gasoline	3,301,535	Gallons
Annual regional GHG emissions displaced	35,238	Metric tons CO2e

Source: RFTA. (2022) 2019_Inventory Data. Internal data: unpublished.

These land use effects show that RFTA is producing a positive emissions displacement on the region with over 35,000 metric tons CO2e being reduced and over 75 million VMT annually. The impacts are sizeable due to the nature of the region being rural and the average commute distance in a personal vehicle being longer compared to urban areas. This results in RFTA having a larger impact than other transit agencies on the land use effect and the agency's ability to reduce VMT, gasoline usage, and GHG emissions.

EMISSIONS PRODUCED BY TRANSIT

RFTA has implemented the methodology below for calculating emissions from transit operations. By utilizing internal tracking of fuel and electricity use, RFTA can accurately

compute emissions across various categories, including revenue fleet (non-electric), non-revenue fleet, revenue fleet (electric) and facilities.

Table 16: 2019 Revenue Fleet (Non-Electric) Emissions Produced Variables

Revenue Fleet (Non-Electric) Emissions Produced			
Term	Value	Units	References
Diesel Bus Gallons	606,704.15	Diesel Gallons	RFTA Tracking
Diesel Bus GGE	700,743.29	gge	
CNG Bus mmBTU	63,566.06	mmBTU	RFTA Tracking
Diesel GHG Intensity	0.0107	MT CO2e/gge	GREET WTW Calculator
CNG GHG Intensity	0.0778	MT CO2e/mmBTU	GREET WTW Calculator
GHG Emissions	12,450.00	metric tons-CO2e	

Source: RFTA. (2022) 2019_Inventory Data. Internal data: unpublished.

The Revenue Fleet (Non-Electric) category, seen above in Table 16, specifically covers emissions sources associated with the combustion of fuels for transit vehicles, including diesel and CNG buses. The emissions calculation for this category is based on the fuel consumption of each vehicle type, along with their corresponding greenhouse gas intensity factors as determined by the Well-to-Wheel (WTW) calculator.

Equation 3: Revenue Fleet (Non-Electric) Emissions Produced

$$Diesel\ Bus\ GGE * Diesel\ GHG\ Intensity + CNG\ Bus\ mmBTU * CNG\ GHG\ Intensity$$

Table 17: 2019 Non-Revenue Fleet Emissions Produced Variables

Non-Revenue Fleet Emissions Produced			
Term	Value	Units	References
Gasoline Non-Revenue Fleet Gallons	66,674	Gallons	RFTA Tracking
Gasoline GHG Intensity	0.0107	MT CO2e/gallons	GREET WTW Calculator
GHG Emissions	711.63	metric tons-CO2e	

Source: RFTA. (2022) 2019_Inventory Data. Internal data: unpublished.

Equation 4: Non-Revenue Fleet Emissions Produced

$$Gasoline\ Non-Revenue\ Fleet\ Gallons * Gasoline\ GHG\ Intensity$$

Non-Revenue Fleet emissions, seen above in Table 17, are computed using similar methods, with the fuel consumption and GHG intensity factors for gasoline non-revenue vehicles. For Revenue Fleet (Electric) and Facilities – Purchased Electricity, the annual electricity use and regional GHG intensity factors as provided by eGRID are used to determine emissions. It's important to note that these intensity factors are based on regional averages, with the Western Electricity Coordinating Council Rockies subregion being used for this analysis. Assumptions about the GHG intensity of RFTA-specific utility providers are made for any forecasting done in this CAP. See below Table 18, Table 19, and Table 20 for electricity variables.

Table 18: 2019 Electricity for Traction Power Variables

Revenue Fleet (Electric) Emissions Produced			
Term	Value	Units	References
Annual Electricity Use	43,567.71	kWh	RFTA Utility Bills
Electricity GHG Intensity	1.15	lb-CO2e/kWh	eGRID
Metric Tons	2,200.00	metric tons/lb-CO2e	
GHG Emissions	22.81	metric tons-CO2e	

Source: RFTA. (2022) 2019 Inventory Data. Internal data: unpublished.

Equation 5: Electricity Emissions Produced

$$\frac{Annual\ Electricity\ Use * Electricity\ GHG\ Intensity}{2200\frac{tonne}{lb-CO2e}}$$

Table 19: 2019 Facility Purchased Electricity Variables

Facilities – Purchased Electricity Emissions Produced			
Term	Value	Units	References
Annual Electricity Use	5,150,666.54	kWh	RFTA Utility Bills
Electricity GHG Intensity	1.15	lb-CO2e/kWh	EPA
Metric Tons	2,200.00	metric tons/lb-CO2e	
GHG Emissions	2,696.18	metric tons-CO2e	

Source: RFTA. (2022) 2019_Inventory Data. Internal data: unpublished.

Equation 6: Facility Stationary Combustion GHG Emissions

$$\frac{Annual\ Natural\ Gas\ Use * Natural\ Gas\ GHG\ Intensity}{2200\frac{tonne}{lb-CO2e}}$$

Table 20: 2019 Facility Stationary Combustion Variables

Facilities – Stationary Combustion Emissions Produced			
Term	Value	Units	References
Annual Natural Gas Use	27,164.96	mmBTU	RFTA Utility Bills
Natural Gas GHG Intensity	116.65	lb-CO2e/mmBTU	Energy Information Administration
Metric Tons	2,200.00	metric tons/lb-CO2e	
GHG Emissions	1,440.36	metric tons-CO2e	

Source: RFTA. (2022) 2019_Inventory Data. Internal data: unpublished.

In addition to the above calculations, RFTA also considers Facilities – Stationary Combustion emissions, which includes buildings, maintenance yards, offices, and other stationary sources by tracking natural gas use.

By utilizing this comprehensive approach, RFTA can accurately calculate emissions and make informed decisions to achieve the CAP goals.

APPENDIX B: COST-BENEFIT CLIMATE CALCULATOR AND STRATEGY EVALUATION CRITERIA

As a part of the Climate Action Development process, a cost-benefit calculator was developed for RFTA to evaluate different strategies and their emissions reduction potential along with their associated costs. This appendix will go through the important aspects of the tool and how evaluation of strategies was conducted.

COST-BENEFIT CLIMATE CALCULATOR

The Cost-Benefit Climate Calculator was created by Gannett Fleming with the goal to provide a master spreadsheet tool to support RFTA planning processes going forward by using baseline emissions and service data, forecasting, and the CAP evaluation criteria. The outputs of this calculator provide planning "goal posts" to support strategies implemented by RFTA to meet their climate action goals moving forward. Figure 18 below displays an example of the tool's main interface with RFTA's final recipe of strategies selected.

Figure 18: Cost-Benefit Climate Calculator Interface

					Model Outputs									
Strategy Category		**Level of Implementation**	**Start Year**	**End Year**	**Capital Cost**	**Implementation**	**O&M**	**Fuel**	**Total Cost of Implementation**	**Cost-Benefit ($/MT)**	**Emissions Displaced through 2050 (MT CO2e)**	**Emissions Produced through 2050 (MT CO2e)**	**2030 Emission Reduction vs 2019 Baseline**	**2050 Emission Reduction vs 2019 Baseline**
1	Revenue Fleet	100% Electric	2028	2050	$25,492,679	$16,948,092	$2,153,806	$(3,957,620)	**$40,636,957**	**$438**	0	-92,790		
2	Transit Priority Lanes	Rio Grande Exclusive Corridor	2030	2033	$30,600,000	-	-	-	**$30,600,000**	**$563**	-54,320	0		
3		None	2023	2050	-	-	-	-	**-**	**-**	0	0		
4	Non-Revenue Fleet	100% Electrification	2025	2050	$1,915,818	-	$150,467	$(3,003,643)	**$(937,357)**	**$(82)**	0	-11,474		
5	Electrification of Facility Operations	Aspen Maintenance Facility	2033	2043	$698,925	-	-	$566,581	**$1,265,506**	**$644**	0	-1,966		
6		Glenwood Springs Maintenance Facility	2033	2043	$770,370	-	-	$1,242,369	**$2,012,739**	**$461**	0	-4,362		
7	Development of On-Site Renewable Energy Systems	Destination 2040 – S6: Aspen Maintenance Facility Expansion (Solar PV Addition)	2030	2030	$600,000	-	$174,000	$(333,839)	**$440,161**	**$282**	0	-1,558		
8		None	2025	2027	-	-	-	-	**-**	**-**	0	0		
9	Energy Efficiency Measures for Existing Facilities	None	2027	2030	-	-	-	-	**-**	**-**	0	0		
10		None	2027	2030	-	-	-	-	**-**	**-**	0	0	**12%**	**-83%**
11	Green Standards	None	2023	2050	-	-	-	-	**-**	**-**	0	0		
12		None	2023	2050	-	-	-	-	**-**	**-**	0	0		
13	Mobility Hubs & Expansion of BRT	West Glenwood Springs Transit Hub & BRT Extension to West Glenwood	2025	2030	$6,500,000	-	$27,950,000	-	**$34,450,000**	**$487**	-70,756	0		
14		None	2023	2050	-	-	-	-	**-**	**-**	0	0		
15	Expansion of Multi-Modal Services	None	2023	2028	-	-	-	-	**-**	**-**	0	0		
16		None	2023	2050	-	-	-	-	**-**	**-**	0	0		
17	Fare Reductions	0.2	2025	2026	-	$(35,519,740)	-	-	**$(35,519,740)**	**$(3,079)**	-11,537	0		
18	Connected Housing, Jobs and Transit (TOD)	None	2030	2035	-	-	-	-	**-**	**-**	0	0		
19		None	2023	2050	-	-	-	-	**-**	**-**	0	0		
Totals					**$66,577,791.90**	**$(18,571,648.03)**	**$30,428,273.07**	**$(5,486,150.97)**	**$72,948,265.97**	**$293.25**	**-136,612**	**-112,150**		

STRATEGY CATEGORIES & LEVELS OF IMPLEMENTATION

Below is a table of the calculator's strategy categories and levels of implementation. These strategies were derived directly through the CAP development process, particularly the literature review, emissions inventory, and stakeholder input.

Table 21: Strategies and Implementation

Strategy Category	Level of Implementation
Revenue Fleet	100% Hydrogen
	100% Electric
	1/3 CNG, 1/3 BEB, 1/3 Diesel
Non-Revenue Fleet	50% Electrification
	75% Electrification
	100% Electrification
Electrification of Facility Operations	Aspen Maintenance Facility
	Glenwood Springs Maintenance Facility
Development of On-Site Renewable Energy Systems	Aspen Maintenance Facility Expansion (Solar PV Addition)
	Park & Ride Solar PV
Energy Efficiency Measures for Existing Facilities	Aspen Maintenance Facility
	Glenwood Springs Maintenance Facility
Green Standards	Advanced Building Codes
	Green Standards for New Construction
	Energy Benchmarking and Reporting for Facilities
Transit Priority Lanes	Grand Avenue Dedicated Lanes
	Rio Grande Exclusive Corridor
Expansion of BRT (& Mobility Hubs)	Extend BRT to Downtown GWS and RFTA Local Service on Hwy 6/24
	West Glenwood Springs Transit Hub & BRT Extension to West Glenwood
	West Glenwood Springs Transit Hub & BRT Extension to Parachute
Expansion of Multimodal Services	Bike Share Expansion
Fare Reductions	20% Reduction
	50% Reduction
	75% Reduction
	100% Reduction
Connected Housing, Jobs, and Transit (TOD)	Carbondale BRT Development Case Study

The tool provides the ability to select any combination of different strategies, including years of implementation and completion. This allows RFTA to consider different "recipes" of strategies to determine what is the most optimal solution to meet their needs and the needs of the region.

CLIMATE LEVERS

To analyze the effect of each strategy on RFTA's GHG emissions, six "Climate Levers" were identified as the main drivers in emissions produced and displaced by transit:

1. **Total Passenger Miles** (and its relation to Total Bus Miles)
2. **Revenue Fleet Composition:** The percent share of Total Bus Miles by each potential bus technology (CNG, Diesel, Electric, and Hydrogen)
3. **Non-Revenue Fleet Composition:** The percent share of Non-Revenue Fleet miles by each potential non-revenue fleet technology (Gas and Electric)
4. **Facilities Fuel Use:** Any increase in decrease in natural gas or electricity purchased for facilities
5. **Mode Shift Factor:** Any change in the mode shift factor as a result of a strategy. No strategies evaluated within this plan effected the mode shift factor
6. **Land Use Effect:** Any additional reduction in regional VMT and thus emissions displaced

With any given strategy comes a resulting impact on one of the above six levers over the course of implementation. The different impact assumptions for each strategy can be seen in Table 23.

COST LEVERS

To analyze the effect of each strategy on the resulting costs related to implementing the climate action plan, four "Cost Levers" were identified as the main drivers of cost associated with the implementation of each strategy:

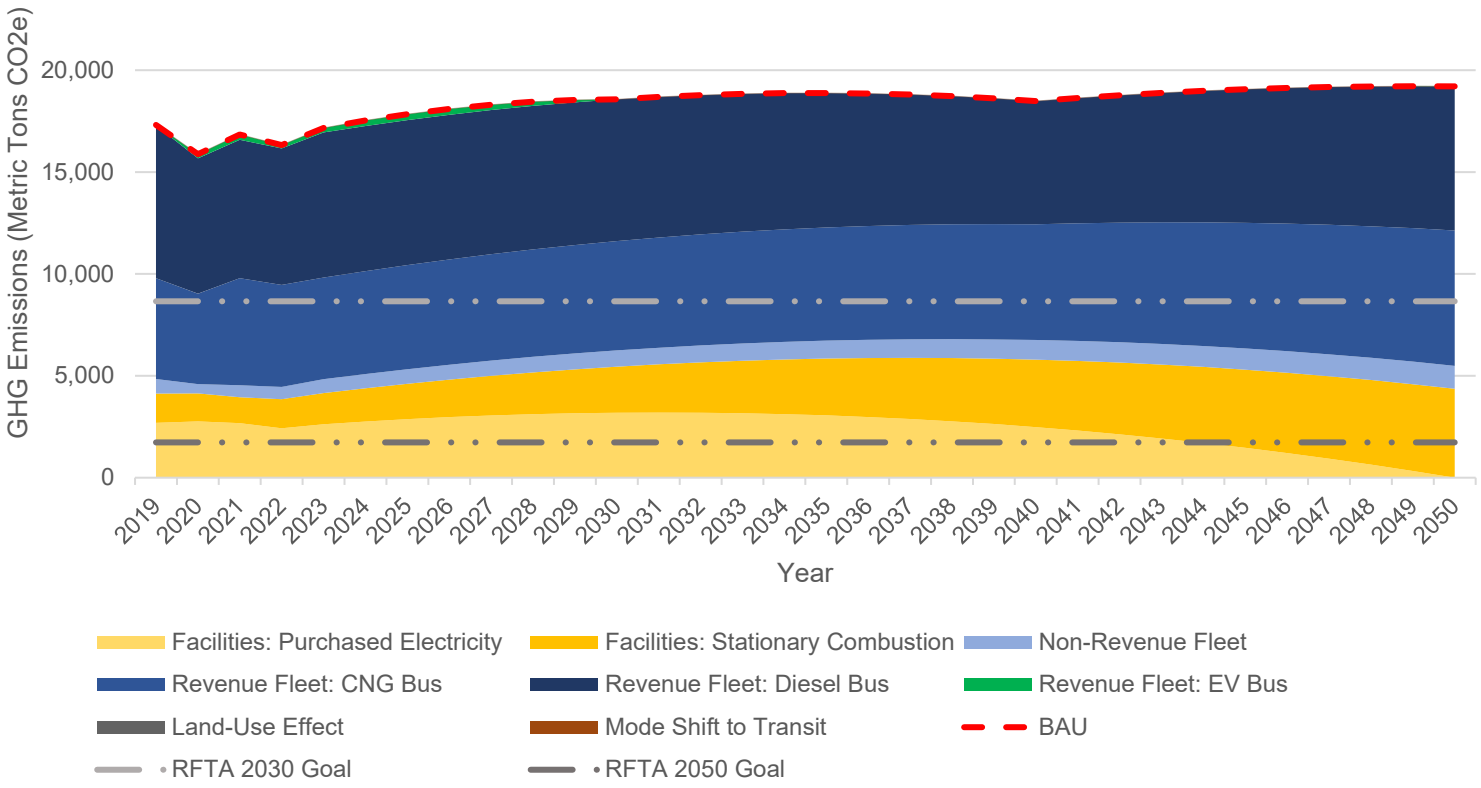
1. **Capital Costs:** The total upfront cost of implementing a strategy including initial costs, installations/construction costs, and others.
2. **Implementation Costs:** Costs associated with implementing a strategy that do not fall under operations & maintenance. This could include charging infrastructure for electric vehicles.
3. **Operations & Maintenance (O&M):** Costs associate with the operations and/or maintenance of a strategy including operating expenses, labor costs, and materials.
4. **Fuel:** Fuel costs (or savings) related to a strategy.

With any given strategy comes a resulting impact on one of the above four levers over the course of implementation. The different impact assumptions for each strategy can be seen in Table 24.

BUSINESS AS USUAL BASELINE FORECAST

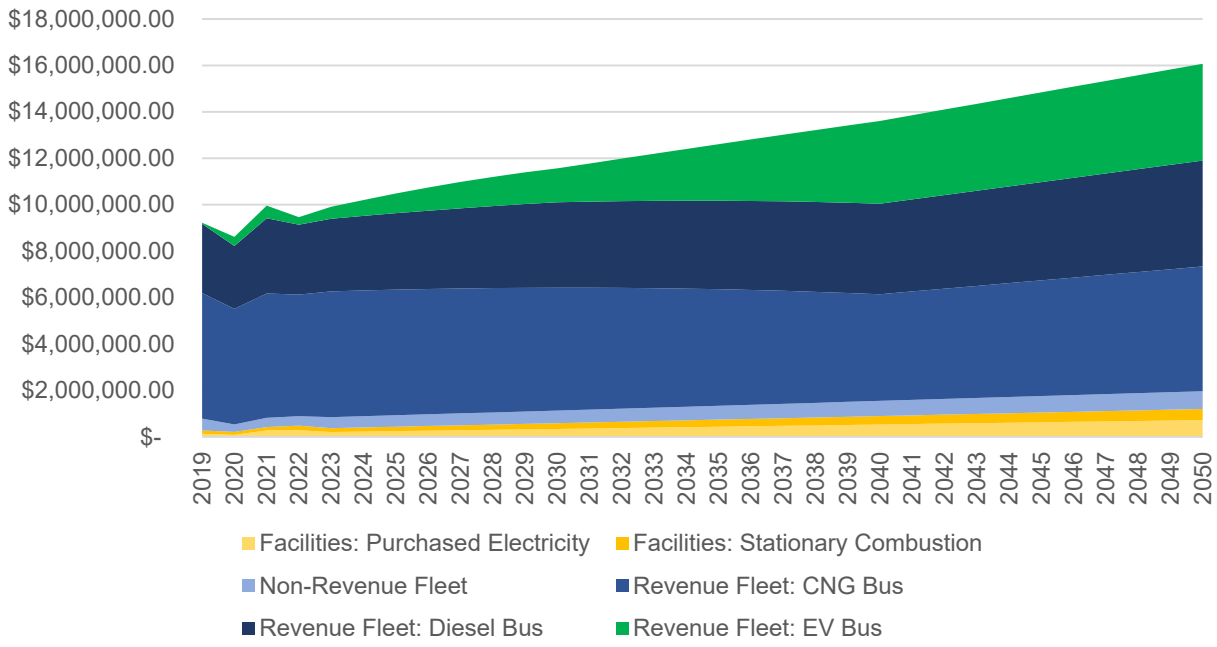
In order to compare and contrast the effects of different strategies, first a BAU baseline forecast was developed. This forecast utilized historic RFTA data, including the 2019 baseline emissions inventory, to create trends through 2050 for GHG emissions, service statistics, expenses, and revenue.

Figure 19: BAU Baseline Emissions Forecast by Category



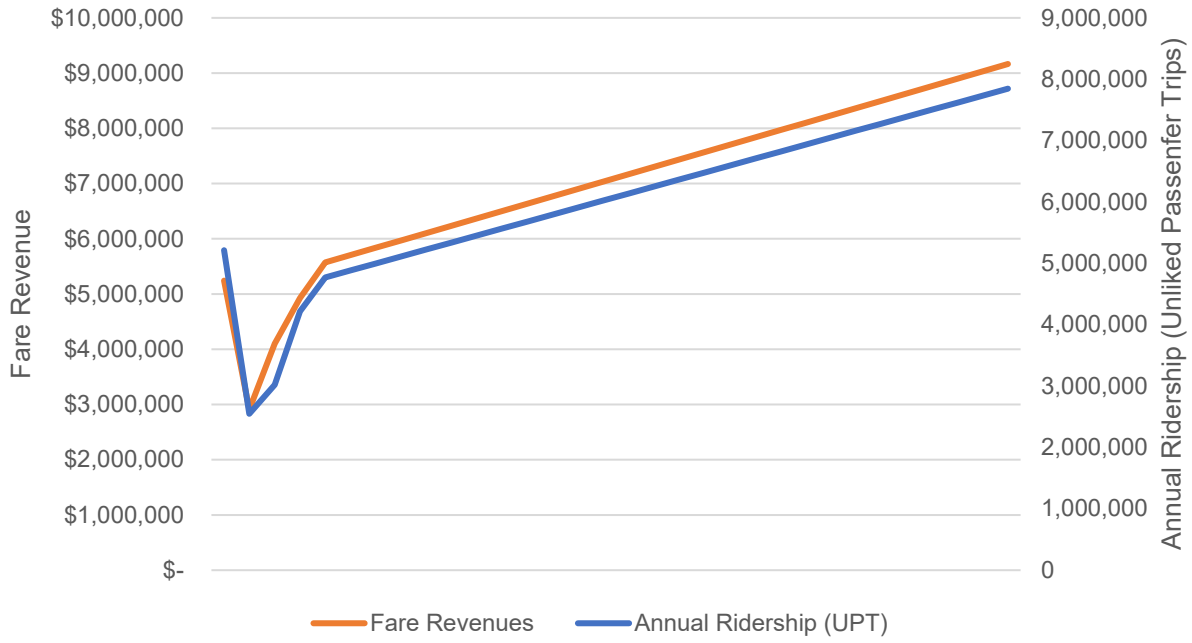
The BAU baseline emissions forecast can be seen in Figure 19. Figure 20 displays the cost forecasts as a result of the forecasted service statistics and fuel use. Cost estimations were determined using historic fuel costs and total cost of ownership (TCO) per mile metrics for revenue and non-revenue fleet. More information on different assumptions related to forecast calculations can be found in the Strategy Assumptions and Climate Lever Impacts subsection below.

Figure 20: BAU Baseline Costs Forecast by Category



The only revenue metric that was analyzed within the cost-benefit climate calculator was fare revenue. Figure 21 shows fare revenue and ridership forecasts based on RFTA historic data trends.

Figure 21: BAU Fare Revenue and Ridership Forecast



BAU Baseline Climate Lever Trends

Table 22 displays the BAU climate lever trends identified through historic data and related forecasts. It was determined that RFTA's total bus miles historically increased on average 3.3% year over year. Using this historical average, a forecast was created that resulted in a net increase in total bus miles of 74% between 2019 and 2050. Passenger miles, non-revenue fleet miles, and all other services statistics were then estimated based off the total bus miles traveled using historical metrics that compared service statistics to bus miles (Table 25). Fleet compositions determined the number of miles attributed to each type of fuel; with the final composition resulting in a 1/3 split between CNG, Diesel and Electric based on RFTA's Destination 2040 plan.

Table 22: BAU Baseline Forecast Trends

BAU Climate Levers		2019	2020	2021	2022	2030	2050
Total Passenger Miles (Percent Change from Baseline)		0%	-23%	-1%	-8%	12%	58%
Total Bus Miles (Percent Change from Baseline)		0%	-5%	9%	2%	24%	74%
Revenue Fleet Composition (Percent of Total Bus Miles)	CNG	43%	41%	42%	41%	38%	33%
	Diesel	56%	56%	54%	56%	46%	33%
	Electric	0%	3%	4%	3%	16%	33%
Non-Revenue Fleet Composition (Percent of Non-Revenue Miles)	Gasoline	100%	100%	100%	100%	100%	100%
	Electric	0%	0%	0%	0%	0%	0%
Facilities Fuel Use (Percent Change from Baseline)	Natural Gas	0%	-5%	-12%	-1%	57%	203%
	Electricity	0%	3%	-1%	-7%	72%	264%
Mode Shift Factor		32.9%	32.9%	32.9%	32.9%	32.9%	32.9%
Land Use Effect (Percent Reduction in Regional VMT)		9.5%	9.5%	9.5%	9.5%	9.5%	9.5%

The mode shift factor and land use effect were determined through the analysis done within the baseline emissions inventory and are assumed to stay the same through 2050. For more information on these metrics, see Emissions Displaced by Transit within Appendix A: Emissions Inventory Methodology.

STRATEGY MODELING

Once a BAU baseline forecast had been determined, evaluation of strategies could begin by comparing the effects of different strategies to the baseline emissions and costs. First, however, the impact of different strategies on GHG emissions and costs needed to be established.

Strategy Assumptions and Impacts

Assumptions on the effect of each given strategy on emissions and costs were determined using RFTA internal planning data, research-based assumptions, and industry standard elasticities. A summary of the different strategies and their associated climate lever impacts based on these assumptions are below in Table 23:

Table 23: Strategies with Climate Levers and Impact

Strategy Category	Level of Implementation	Climate Levers and Impact			
		Bus Miles (Percent Share by End of Implementation)			
		CNG	Diesel	Electric	Hydrogen
Revenue Fleet	100% Hydrogen[xxxvi]	0%	0%	0%	100%
	100% Electric[xxxvii]	0%	0%	100%	0%
	1/3 CNG, 1/3 BEB, 1/3 Diesel[xxxviii]	33%	33%	33%	0%
Strategy Category	**Level of Implementation**	**Non-Revenue Miles (Percent Share by End of Implementation)**			
		Gas		**Electric**	
Non-Revenue Fleet[xxxix]	50% Electrification	50%		50%	
	75% Electrification	25%		75%	
	100% Electrification	0%		100%	
Strategy Category	**Level of Implementation**	**Facilities (Percent Change by End of Implementation)**			
		Natural Gas Use		**Electricity Use**	
Electrification of Facility Operations[xl]	Aspen Maintenance Facility	-29%		45%	
	Glenwood Springs Maintenance Facility	-64%		99%	
Development of On-Site Renewable Energy Systems	Aspen Maintenance Facility Expansion (Solar PV Addition)[xli]	N/A		-8%	
	Park & Ride Solar PV[xlii]	N/A		-90%	
Energy Efficiency Measures for Existing Facilities[xliii]	Aspen Maintenance Facility	-16%		-34%	
	Glenwood Springs Maintenance Facility	-36%		-11%	
Green Standards	Advanced Building Codes[xliv]	-7%		-7%	
	Green Standards for New Construction[xlv]	-35%		-35%	
	Energy Benchmarking and Reporting for Facilities[xlvi]	-50%		-50%	
Strategy Category	**Level of Implementation**	**Total Passenger Miles (Percent Change by End of Implementation)**	**Mode Shift Factor**	**Land Use Effect (Percent Reduction in Regional VMT by End of Implementation)**	
Transit Priority Lanes	Grand Avenue Dedicated Lanes	3%	N/A	0.40%	
	Rio Grande Exclusive Corridor	12%	N/A	0.50%	
Expansion of BRT (& Mobility Hubs)	Extend BRT to Downtown GWS and RFTA Local Service on Hwy 6/24[xlvii]	5%	N/A	0.38%	
	West Glenwood Springs Transit Hub & BRT Extension to West Glenwood[xlviii]	11%	N/A	0.72%	
	West Glenwood Springs Transit Hub & BRT Extension to Parachute	24%	N/A	1.41%	
Expansion of Multimodal Services[xlix]	Bike Share Expansion[l]	2%	N/A	N/A	
Fare Reductions	20% Reduction	10%	N/A	N/A	
	50% Reduction	25%	N/A	N/A	
	75% Reduction	38%	N/A	N/A	
	100% Reduction	50%	N/A	N/A	
Connected Housing, Jobs, and Transit (TOD)[li]	Carbondale BRT Development Case Study	11%	N/A	4.00%	

Table 24 displays a summary the different costs related to each strategy. The Revenue Fleet, Non-Revenue Fleet, and Fare Reductions categories required more complex calculations to determine the costs related to implementation. More information on these calculations can be found in subsection Model Methodology and Outputs below.

Table 24: Strategies with Cost Levers and Impact

Strategy Category	Level of Implementation	Cost Levers and Impact	
		Capital Costs	O&M
Revenue Fleet	100% Hydrogen[lii]	Calculation – See Costs subsection	
	100% Electric[liii]		
	1/3 CNG, 1/3 BEB, 1/3 Diesel[liv]		
Non-Revenue Fleet[lv]	50% Electrification	Calculation – See Costs subsection	
	75% Electrification		
	100% Electrification		
Electrification of Facility Operations	Aspen Maintenance Facility	$698,924.80	
	Glenwood Springs Maintenance Facility	$770,369.60	
Development of On-Site Renewable Energy Systems	Aspen Maintenance Facility Expansion (Solar PV Addition)[lvi]	$600,000.00	$8,700.00
	Park & Ride Solar PV[lvii]	$6,000,000.00	$87,000.00
Energy Efficiency Measures for Existing Facilities[lviii]	Aspen Maintenance Facility	$1,872,120.00	
	Glenwood Springs Maintenance Facility	$2,063,490.00	
Green Standards	Advanced Building Codes[lix]		
	Green Standards for New Construction[lx]		
	Energy Benchmarking and Reporting for Facilities[lxi]		
Transit Priority Lanes	Grand Avenue Dedicated Lanes	$17,600,000.00	
	Rio Grande Exclusive Corridor	$30,600,000.00	
Expansion of BRT (& Mobility Hubs)	Extend BRT to Downtown GWS and RFTA Local Service on Hwy 6/24[lxii]	$6,500,000.00	$1,118,000.00
	West Glenwood Springs Transit Hub & BRT Extension to West Glenwood[lxiii]	$6,500,000.00	$1,118,000.00
	West Glenwood Springs Transit Hub & BRT Extension to Parachute	$6,500,000.00	$1,118,000.00
Expansion of Multimodal Services[lxiv]	Bike Share Expansion[lxv]	$1,270,750.00	$550,000.00
Fare Reductions	20% Reduction	Calculation – See Costs subsection	
	50% Reduction		
	75% Reduction		
	100% Reduction		
Connected Housing, Jobs, and Transit (TOD)[lxvi]	Carbondale BRT Development Case Study		

Strategy Modeling Methodology

Using the strategy assumptions and lever impacts listed above, the emissions and cost impacts related to different implementation strategies can be calculated.

Service Statistics

The effect on service statistics because of different strategies is directly related to the assumptions listed above and how they relate to total bus miles. Each strategy has an assumed impact on ridership. Using industry standard elasticities[lxviii][lxviii] of bus miles with respect to ridership (selectable between 1.1 – 0.5 within the calculator), the total impact on bus miles can be determined for each strategy.

Table 25: Historic Service Statistics

Year	Annual Ridership (UPT) (NTD)	Passenger Miles (RFTA)	Revenue Miles (NTD)	Total Bus Miles (RFTA)	Agency Fleet Miles (RFTA)
2011	3,615,965		3,006,816	4,040,020	
2012	3,617,872		3,019,071	4,070,491	
2013	3,868,195		3,293,374	4,406,081	
2014	4,591,741		4,571,399	5,399,129	1,132,051
2015	4,600,209		4,622,600	5,054,298	393,861
2016	4,839,502		4,659,678	5,138,915	1,421,212
2017	5,264,091		4,873,391	5,769,212	449,860
2018	4,969,920		4,703,371	5,228,764	392,020
2019	5,212,525	33,221,951	4,946,740	5,424,414	837,036
2020	2,548,332	25,642,904	3,975,273	5,157,415	523,173
2021	3,019,908	33,055,451	4,864,763	5,911,200	636,486
2022	4,218,937	30,633,066	4,581,277	5,506,714	649,930
Average Historic Ratio to Bus Miles Traveled:	**0.83**	**5.56**	**0.83**	**1.00**	**0.13**

Utilizing the average historic relationship of the above service statistics with bus miles (Table 25), the calculator uses the impact on ridership from a given strategy to determine a resulting change in service statistics. This directly feeds into GHG emissions impacts due to RFTA fleets, as well as costs and fare revenues.

GHG Emissions

Just as changes in ridership directly impact bus miles, which in turn impact all other service statistics, different strategies trigger different climate levers, which in turn change fleet composition, facility fuel use, and emissions displacement. However, different assumptions related to the carbon intensity of different fuel types must be determined to ensure the emissions impact related to climate lever changes are accurate. Table 26 displays the different carbon intensity and fuel economy assumptions used in calculations. Currently, RFTA powers its entire electric fleet using electricity from Holy Cross Energy, which has goals to have 100% clean power by 2030. It is assumed that all electric busses will continue to be powered by this electricity, thus the carbon intensity of EV bus electricity trends to 0 by 2030, while all other electricity carbon intensity trends to 0 by 2050, following conservative estimates.

From there, GHG emissions for the different emissions categories (listed within Appendix A: Emissions Inventory Methodology) are determined through a simple modeling process. A given strategy will have an assumed impact on each of the climate levers seen in Table 23, this results in a correlating impact on the forecasted GHG emissions from each category. Moreover, the tool allows RFTA to choose start years and end years to further narrow down strategies. For example, for the Revenue fleet, if one selects 100% Electric, with a start year of 2028 and end year of 2050, this will trigger the fleet composition to change from BAU trends to start a 100% EV fleet conversion that ends with 100% of bus miles being electric by 2050. This, in turn, changes the amount of fuel used to power buses through 2050, thus changing GHG emissions from the revenue fleet. In particular, it reduces all diesel and CNG fuel use to zero. Based on assumptions related to the electricity for EV busses, the emissions from all revenue fleet activity will reach zero by 2050. It is important to note, however, that just because the GHG emissions related to EV busses reaches zero by 2030, the amount of electricity used to power the buses does not. This is an important note in order to correctly calculate fuel costs for the revenue fleet.

Table 26: Carbon Intensity and Fuel Economy Assumptions

Metric	Assumption		
	2019	2030	2050
EV Bus Electricity GHG Intensity (MT CO2e/kWh)	0.00052	0.00000	0.00000
Facility Electricity GHG Intensity (MT CO2e/kWh)	0.00052	0.00036	0.00000
Hydrogen Bus Fuel Economy (Advanced) (mi/GGE)	6.00	7.43	11.00
Hydrogen Bus Fuel Economy (Conservative) (mi/GGE)[lxix]	6.00	8.57	15.00
Grey Hydrogen GHG Intensity (MT CO2e/GGE)	0.0113		
Blue Hydrogen GHG Intensity (MT CO2e/GGE)	0.0048		
Green Hydrogen GHG Intensity (MT CO2e/GGE)[lxx]	0.0000		

Costs

Along with calculating the changes in GHG emissions over time due to give strategies and levels of implementation, costs related to these changes are also calculated. The cost assumptions shown in Table 24 will be included in cost calculations, with capital costs being a one-time payment, and O&M costs assumed to reoccur annually from the start year through 2050. Costs related to facility fuel and electricity use utilize RFTA historic cost data and the forecasted usage for each fuel type.

Revenue Fleet, Non-Revenue Fleet, and Fare Reduction strategies, however, require more in-depth calculations. Both revenue fleet and non-revenue fleet cost calculations use a total cost of ownership (TCO) methodology. Research backed TCO-per-mile metrics were determined from 2019-2050 to determine both BAU costs and costs for the modeled strategies. Table 27 displays the TCO-per-mile metrics for each fuel type.

Using the metrics above paired with service statistic forecasts for BAU and different strategy implementations, the costs for each fleet technology can be calculated and compared. Fuel costs for CNG, diesel, electric, and gas fuel types utilized RFTA's historic fueling cost data instead of TCO metrics.

Fare revenues were forecasted using historic revenue data through the NTD. Figure 20. BAU Baseline Costs Forecast by Category in the Business as Usual Baseline Forecast section above displays the forecasted BAU fare revenues and the relationship to ridership (unlinked passenger trips). An average fare of $1.17 per Unlinked Passenger Trip was determined through this relationship. This metric was in turn used to forecast fare revenues as a result of different strategy implementations. RFTA has the ability to choose different elasticities of ridership with respect to fares ranging from -0.9 to -0.2 within the tool[lxxi]. This helps determine the effect on ridership as a result of changing fares, this in turn impacts both climate levers and fare revenues.

Table 27: Total Cost of Ownership per Mile

Fleet Vehicle Type[lxxii lxxiii lxxiv]	Metric	Total Cost of Ownership ($/mile)		
		2019	2030	2050
Revenue: CNG	Vehicle	0.68	0.81	0.81
	O&M	0.39	0.46	0.46
Revenue: Diesel	Vehicle	0.72	0.72	0.72
	O&M	0.41	0.41	0.41
Revenue: Electric	Vehicle	0.87	0.72	0.72
	Battery	0.95	0.14	0.14
	Charging Station	0.10	0.07	0.07
	O&M	0.26	0.26	0.26
Revenue: Hydrogen	Vehicle	1.25	1.05	1.05
	Fuel Cell	0.13	0.10	0.10
	O&M	0.18	0.18	0.18
	Fuel	1.73	1.00	1.00
Non-Revenue: Gas[lxxv]	Vehicle	0.20	0.19	0.19
	O&M	0.19	0.18	0.18
Non-Revenue: Electric	Vehicle	0.39	0.27	0.23
	O&M	0.17	0.15	0.14

INTERNAL ASSUMPTIONS

Aside from the assumptions and metrics listed in the sections above, internal assumptions, cost factors, emissions factors, and constants were used to ensure the accuracy and consistency of all calculations. Table 28 lists all these assumptions, values and sources.

Table 28: Internal Assumptions

Assumption	Value	Source
Vehicle gasoline ($/gal)	$ 2.80	RFTA Recording
Vehicle diesel ($/gal)	$ 3.20	RFTA Recording
Vehicle CNG ($/therm)	$ 0.73	RFTA Recording
Electricity, fleet ($/kWh)	$ 0.07	RFTA Recording
Electricity, facilities ($/kWh)	$ 0.04	RFTA Recording
Natural gas, facilities ($/therm)	$ 0.58	RFTA Recording
Gasoline (metric ton/GGE)	0.010673	GREET WTW Calculator[lxxvi]
Diesel (metric ton/GGE)	0.010709	GREET WTW Calculator
CNG (metric ton/mmBTU)	0.077802	GREET WTW Calculator
Electricity (lb/MWh)	1151.617	eGRID (WECC Rockies)[lxxvii]
Electricity (lb/kWh)	1.151617	
Natural Gas tons (lb-CO2e/mmBTU)	116.65	Energy Information Administration[lxxviii]
short ton/metric ton	1.1	
lb/metric ton	2200	
gge/diesel gallons	1.155	DOE Fuel Conversion Factors to Gasoline Gallon Equivalents[lxxix]
gge/CNG ccf	0.877	DOE Fuel Conversion Factors to Gasoline Gallon Equivalents
gge/kWh	0.031	
therm/ccf	1.037	Energy Information Administration[lxxx]
mmBTU/therm	0.1	Energy Information Administration
Gas Non-Revenue	11.94792	RFTA Recording
EV Non-Revenue	85	Fueleconomy.gov[lxxxi]
CNG Bus	4.32	RFTA Recording
Diesel Bus	4.73	RFTA Recording
EV Bus	15.04	RFTA Recording
Gas General	22.9	

EVALUATION CRITERIA

The main outputs of the cost-benefit climate calculator coincide with the evaluation criteria determined CAP development process. This section will go through these metrics and how they are calculated.

CAPITAL COSTS

The Capital Cost output refers to the total up-front costs associated with implementing the strategy. For most strategies, this is just simply the number inputted into the assumptions in Table 24. However, as discussed above, for revenue fleet, non-revenue fleet, and fare revenues, deeper calculations were used to determine the total cost. The capital costs associated with fleet strategies are represented as an annual capital cost number based on mileage of the fleet. Fare revenues do not have any associated “costs” within this model, other than the differences in revenue between BAU and the modeled strategies.

IMPLEMENTATION

Implementation outputs refer to the costs associated with implementing the strategy that do not fall under O&M. This metric only correlates with Revenue Fleet and Fare Reduction strategies. Different revenue fleet strategies require infrastructure investment, like charging or fueling stations. Fare revenue strategies display the changes in revenue within implementation costs.

All other strategies have no implementation costs; if they do, they are accounted for with the corresponding O&M costs.

OPERATIONS & MAINTENANCE (O&M)

O&M outputs refers to the costs related to the operation and maintenance of the corresponding strategies. Once again, for most strategies, this is simply the number inputted into the assumptions in Table 24, multiplied over the implementation period (start year through 2050). However, for fleet related strategies, O&M costs are calculated based on the amount of miles traveled and the corresponding TCO per mile metric shown in Table 27.

FUEL

Fuel outputs refer to the fuel costs (or savings) related to the corresponding strategy when compared to BAU forecasts. This is the total difference over the entire analysis period (2019-2050).

TOTAL COST OF IMPLEMENTATION

The Total Cost of Implementation refers to the sum of Capital Costs, Implementation, O&M and Fuel metrics. This is the cost to implement the strategy through 2050 and is intended to account for all estimated costs related to the strategy. This, and the metrics above, can result in a negative value if the model estimates savings when compared to BAU.

COST-BENEFIT

The Cost-Benefit ($/MT) is the Total Cost of Implementation divided by the sum of Emissions Produced and Displaced by 2050 (MT CO2e), both of which will be described below. The Cost-Benefit metric is RFTA's main criteria for evaluating the effectiveness of different strategies. It is designed to show the estimated cost per metric ton of the strategy and give RFTA staff an easy, understandable metric to compare different strategies.

EMISSIONS DISPLACED (OR PRODUCED) THROUGH 2050

Emissions displaced and produced through 2050 are metrics that refer to the total emissions impact over the entire analysis period as a result of the selected strategy. These metrics display how many metric tons of CO2e are either reduced compared to BAU or displaced as a result of ridership or land use impacts.

EMISSIONS REDUCED AND DISPLACED COMPARED TO BASELINE

The Emissions Reduction vs 2019 Baseline is the other main evaluation metric that will guide RFTA's progress toward their 2030 and 2050 emissions reduction and displacement targets. The calculations related to each of these metrics are shown below:

Equation 7: Percent of Emissions Reduced

$$20XX\ Percent\ Reduced = \frac{20XX\ Modeled\ Emissions - 2019\ Baseline\ Emissions}{2019\ Baseline\ Emissions}$$

Equation 8: Multiple of Emissions Displaced

$$20XX\ Displacement\ Compared\ to\ Baseline = \frac{-20XX\ Emissions\ Displaced}{2019\ Baseline\ Emissions}$$

The output of Equation 7. Percent of Emissions Reduced is the percent of emissions reduced in a given year when compared to the 2019 baseline emissions produced from transit (50%

reduction compared to the 2019 baseline by 2030 and 90% by 2050). This directly corresponds with RFTA's goals for emissions produced by transit. The output of Equation 8. Multiple of Emissions Displaced is the multiple of emissions displaced in a given year compared to the baseline. This directly corresponds with RFTA's goals for emissions displaced by transit (3x the baseline by 2030 and 5x the baseline by 2050).

FINAL CAP STRATEGY RECIPE AND EVALUATION CRITERIA OUTPUTS

Table 29 displays RFTA's final CAP Strategy Recipe and the resulting evaluation criteria outputs from the cost-benefit calculator.

Table 29: Final CAP Strategy Recipe and Evaluation Criteria Outputs

Strategy Category	Level of Implementation	Start Year	End Year	Capital Cost	Implementation	O&M	Fuel	Total implementation Cost	Cost-Benefit ($/MT)	Emissions Displaced through 2050 (MT CO2e)	Emissions Produced through 2050 (MT CO2e)	2030 Emission Reduction vs 2019 Baseline	2050 Emission Reduction vs 2019 Baseline	2030 Displaced vs 2019 Baseline	2050 Displaced vs 2019 Baseline
Revenue Fleet	100% Electric	2028	2050	$25,492,679	$16,948,092	$2,153,806	$(3,957,620)	$40,636,957	438	0	-92,790				
Transit Priority Lanes	Rio Grande Exclusive Corridor	2030	2033	$30,600,000	-	-	-	$30,600,000	563	-54,320	0				
Non-Revenue Fleet	100% Electrification	2025	2050	$1,915,818	-	$150,467	$(3,003,643)	$(937,357)	-82	0	-11,474				
Electrification of Facility Operations	Aspen Maintenance Facility	2033	2043	$698,925	-	-	$566,581	$1,265,506	644	0	-1,966				
	Glenwood Springs Maintenance Facility	2033	2043	$ 770,370	-	-	$1,242,369	$2,012,739	461	0	-4,362	**12%**	**-83%**	**2.62**	**2.86**
Development of On-Site Renewable Energy Systems	Destination 2040 – S6: Aspen Maintenance Facility Expansion (Solar PV Addition)	2030	2030	$600,000	-	$174,000	$(333,839)	$440,161	282	0	-1,558				
Mobility Hubs & Expansion of BRT	West Glenwood Springs Transit Hub & BRT Extension to West Glenwood	2025	2030	$6,500,000	-	$27,950,000	-	$34,450,000	487	-70,756	0				
Fare Reductions	20% Reduction	2025	2026	-	$(35,519,740)	-	-	$(35,519,740)	-3,079	-11,537	0				
Total				**$66,577,792**	**$(18,571,648)**	**$30,428,273**	**$(5,486,151)**	**$72,948,266**	**293**	**-136,612**	**-112,150**				

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