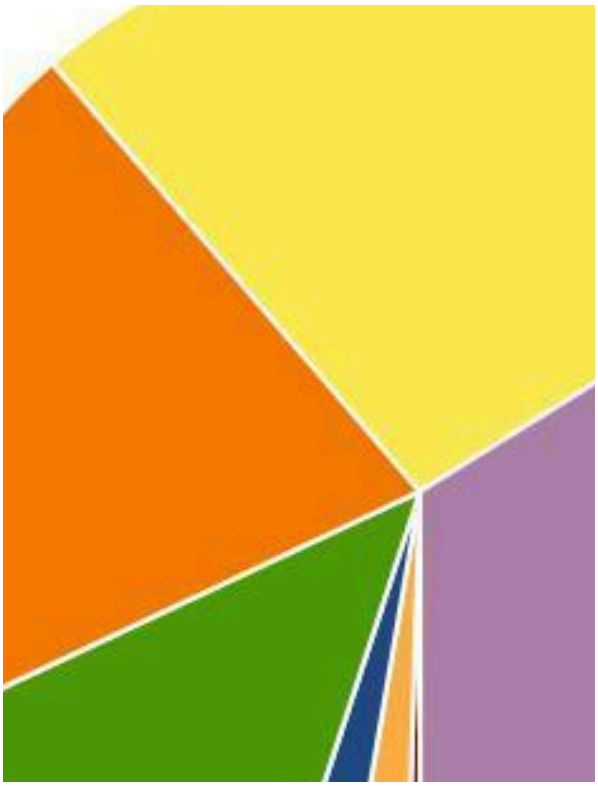

Village of Rhinebeck Local Government Operations Climate Action Plan

Published March 2024
Baseline Year 2019

Produced by the Climate Smart Rhinebeck Task Force of the Village of Rhinebeck with Assistance from ICLEI – Local Governments for Sustainability USA and the Hudson Valley Regional Council.

Credits & Acknowledgements

Local Government Officials, Staff, and Volunteers

Gary Bassett, Village Mayor
Vanessa Bertozzi, Village Trustee
Michael Forlenza, Village Climate Smart Task Force
Kyle Eighmy, Superintendent of Public Works
Bryan Alix, Water Treatment Plant Operator

External Agencies and Partners

Mary Lambert, HVRC
Caroline Dickey, ICLEI
Kale Roberts, ICLEI

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CAPI is a program of the HVRC funded in part through a grant to Dutchess County as lead applicant through the Climate Smart Communities Grant Program, Title 15 of the Environmental Protection Fund through the New York State Department of Environmental Conservation.

ICLEI-Local Governments for Sustainability USA

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Executive Summary

VISION: To be a resilient, energy efficient, and healthy workplace that reflects the climate smart values of our community.

GOAL: Reduce the Village government's Greenhouse Gas (GHG) emissions by 40% from 1990 levels by 2030.

This goal is in line with New York State goals (Greenhouse Gas Emissions Reduction - NYSERDA) and, according to our calculations, equivalent to a 33% reduction from the Village's 2019 levels. This goal represents the Village government's responsibility to our community and the planet. While the goal is not legally binding, it sets a target for the Village Board and staff to make their best effort within financial and other constraints. This goal will require a major shift in our energy use. New York State is doing its part in that we fortunately live in a region that is rapidly decarbonizing the electrical grid.

STRATEGIES:

The eventual end of the burning of any kind of fossil fuel for local government operations (e.g., in motor vehicles or for the heating/cooling of buildings) is needed to get at the big GHG emission sources. This objective can be addressed with a phased-in approach.

New York State (NYS) and the federal government are offering rebates and incentives to make this shift and the Village Board should take full advantage of these funding sources.

SUMMARY:

The Village of Rhinebeck sees its responsibility as a local government as setting goals to reduce GHG emissions and planning strategically to meet those goals. This Climate Action Plan, which was developed as part of the Dutchess County CAPI cohort with ICLEI and HVRC, analyzes the data from our GHG Emissions Inventory and marries that with the practical knowledge of our staff and officials. What follows is our best group effort to lay out how we will reduce our emissions.

NY State has set goals for 2030 and this Plan aligns with those goals. This means that the Village Board will try—within the fiscal and practical constraints—to reduce government operations GHG emissions by 40% from 1990 levels and by 33% from 2019 levels by 2030. Luckily, NYS is well on its way to decarbonizing grid electricity (41% renewable in 2019 with a goal to be 70% renewable by 2030). We factored this into our "Business as Usual" (BAU) forecast, along with our projections for growth of Village government staff and population by 2030. Our BAU forecast predicts emissions of 545 metric tons (MT) of carbon dioxide equivalent

(CO2e) in 2030 if the Village government continues on this path with no actions taken to reduce emissions.

When reviewing data from our GHG Emissions Inventory, we see certain standouts that can be addressed for the most strategic path forward:

- The Village's water and wastewater treatment facilities make up the largest operational sector, accounting for 34% of total emissions (201 MTCO2e). Some of these emissions are due to the off-gassing of the biological process of handling sewage and river water. Another part of the emissions in this sector stem from the massive amount of electricity it takes to run machinery that moves water and waste water through these systems. It was not possible to parse out electricity associated with the water and wastewater processing versus electricity for lighting, ACs in the summer, etc—but these amounts are assumed to be negligible relative to the electricity used for processing water and wastewater at the plants. Of these sources of emissions in this sector, what can we reduce? We anticipate planned upgrades and efficiencies at the Water and Wastewater plants that will mitigate the energy used in processing.

- Buildings and Facilities is the second largest GHG emitting sector of LGOs, accounting for 27% (163 MTCO2e) of total emissions. These emissions are related to heating, cooling and electrical use in municipal buildings. The burning of heating oil in the furnace at the Village Hall/Firehouse is a major contributor to the GHG emissions in the Buildings and Facilities Sector.

- The Village's fleet is the third largest GHG emissions sector, accounting for 21% (122 MTCO2e) of emissions. We can think creatively about which vehicles to replace with EVs.

ICLEI's ClearPath software platform was used to complete the Village LGO greenhouse gas inventory for the baseline year of 2019 and to prepare GHG emission forecasts based on the implementation of emission reduction strategies. The ClearPath tool allows for modeling different forecast scenarios to assess the value of various emission reduction strategies. These strategies are detailed further in this report. At a high level, we recommend these as the actions with the greatest impact:

- Tracking efficiency savings from upgrades to the Water Treatment Plant's processing and operations.

- Replacing the Village Hall/Firehouse's aged oil-burning furnace with a high-efficiency system and creating a tighter building envelope.

- Start replacing internal combustion engine municipal fleet vehicles with electric vehicles.

The Village has already made the switch to LED streetlights, reducing electrical consumption and maintenance costs. The Village Hall has solar panels on the roof, and an LED lighting project was done at all municipal buildings. Beyond these actions, however, the Village has very

aged buildings in need of upgrades, and a vehicle fleet that needs a plan for replacement. We are a small municipality (population ~2,700) with a small budget ($2.8mm General Fund). Reaching our goal will be a challenge, but climate change is not going to wait. The purpose of this Plan is to illuminate the path forward—and illustrate our commitment, which will help as we seek funding for continued sustainability.

Introduction

Overwhelming evidence has led to the scientific consensus that climate change is the greatest environmental challenge of the 21st century. It poses a serious threat not just to New York's natural resources, but also to our jobs and our health. Simultaneously, climate change presents unprecedented opportunities for creating a healthier, safer, and more equitable zero-carbon world. The Village of Rhinebeck has an unparalleled opportunity to make changes to its facilities and general operations in ways that benefit the local government and act as a model for the community and other public agencies. Scientists expect that with the current trends in greenhouse gas (GHG) emissions, New Yorkers will experience more intense heat waves, droughts, rainstorms, floods, smoke from wildfires, biodiversity degradation, and crop loss in the future. These impacts will have significant repercussions on our economy, stress our natural resources and worsen inequities facing many Americans and millions of people across the globe. Action is required at all levels, and local governments have a unique role to play in building low-carbon communities.

These impacts are caused by the accumulation of GHGs such as carbon dioxide (CO2) and methane (CH4) in the atmosphere, primarily resulting from burning fossil fuels and land use changes. Although the natural greenhouse effect is needed to keep the earth warm, human activities have created an enhanced greenhouse effect due to the rapid accumulation of GHGs in the atmosphere. Unprecedented concentrations of these gasses in the atmosphere have led to too much heat and radiation being trapped on Earth. Carbon emissions from human activities have soared in recent decades and are currently at the highest rates in human history. About half of all CO2 emitted between 1750 and 2010 occurred in the last 40 years. The energy, industry, and transportation sectors have dominated these emissions increases. With the current trajectory of population growth, urbanization, and reliance on personal vehicles, global transportation emissions are expected to double by 2050. Given the serious impacts of climate change, the time to act to reduce GHG emissions and our carbon footprint is now. While there is a great need for community-wide climate action plans, it's critical for us to address the emissions from the local government operations and lead by example.

Purpose, Scope, & Process Behind the Climate Action Plan

The 2014 Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5), written by a panel of hundreds of climate experts and scientists and approved by a team of external reviewers, states unambiguously that anthropogenic or “man-made” GHG emissions are causing global climate change.[1] For this reason, the Village of Rhinebeck is joining an increasing number of local governments committed to addressing climate change at the local level through reducing emissions in their own government operations and by supporting programs such as NY State’s Climate Smart Communities and Clean Energy Communities.

The Village of Rhinebeck recognizes the risk that climate change poses to its constituents, and is acting now to reduce the GHG emissions, or “carbon footprint,” of its government operations through the innovative programs laid out in this Climate Action Plan. Furthermore, it is recognized that the Village of Rhinebeck needs to address existing climate risks such as heatwaves and floods and adapt its systems and infrastructure to new conditions. Ultimately, action is needed to reduce the Village of Rhinebeck’s contribution toward the problem of climate change and adapt to its current and future effects. This Climate Action Plan takes advantage of common-sense approaches and cutting-edge policies that our local government is uniquely positioned to implement – actions that can reduce energy use in our municipal buildings, waste, and fuel use for the Village of Rhinebeck's vehicle fleet and employee commutes.

Purpose

By creating a clear course of action so that everyone has a role in creating and achieving climate and sustainability goals, our Climate Action Plan drives and coordinates efforts toward a 33% reduction in local government GHG emissions of 2019 levels by 2030.

The Climate Action Plan is a framework for the development and implementation of actions that reduce the Village of Rhinebeck's government operations GHG emissions. The Plan provides guiding objectives and strategies to realize the Village of Rhinebeck’s government operations GHG reduction goals. This Plan is not legally binding and indeed may need to shift because of financial or practical constraints, or the emergence of new technologies or opportunities. This is a living document that the Village Board can amend.

[1] See Appendix II for information on climate change science.

Scope

Mitigation

This Plan presents objectives and strategies for reducing GHG emissions resulting from local government operations within the Village of Rhinebeck. It addresses the major sources of GHG emissions in the Village of Rhinebeck's infrastructure and operations and sets forth objectives and strategies in two focus areas that the Village of Rhinebeck can implement to achieve greenhouse gas reductions: Energy Use in Buildings and Facilities and Fleet. We provide additional reduction strategies.

The Plan creates a framework to document, coordinate, measure, and adapt efforts moving forward. In addition to listing actions, the Plan discusses how each action will be implemented via timelines, financing, and assignment of responsibilities to departments, staff, or other partner agencies where known.

Adaptation

This Plan does not currently include adaptation planning. However, the Village of Rhinebeck is kicking off adaptation planning currently, and we look forward to the addition of adaptation planning to this body of work.

Process

Our planning process has focused on a core team with input and buy-in from stakeholders and engagement with the public:

- Village staff and officials came together to coordinate efforts in the process from the very outset. The kickoff meeting held at Cornell Cooperative Extension Dutchess County was attended by:
    - Mayor Gary Bassett
    - Village Trustee Vanessa Bertozzi
    - Climate Smart Task Force volunteer Michael Forlenza
    - Village Treasurer Karen McLaughlin
    - Village Superintendent of Public Works Kyle Eighmy
- Trustee Bertozzi and Climate Smart volunteer Michael Forlenza took part in the CAPI cohort for over a year. Trustee Bertozzi met with Village of Rhinebeck officials and staff for input throughout the process.
- As part of our CAPI cohort, Trustee Bertozzi and volunteer Michael Forlenza have participated in extremely useful and motivating peer-to-peer support and the expert guidance of HVRC and ICLEI.
- **August 2023**: Trustee Bertozzi presented the Government Operations GHG Emissions Inventory at a public Village Board meeting.

- **December 2023**: Trustee Bertozzi gave a public Village Board presentation with our suggested strategies.
- **January 2024**: The Village Board passed a resolution adopting the goal of 40% reduction from 1990 levels by 2030. This does not legally bind the Village to achieving this goal but sets a target to shoot for, within financial and other constraints.
- **February 2024:** Trustee Bertozzi asked for Board feedback and met with Supervisor of Public Works Kyle Eighmy and discussed the Plan.
- Public Outreach and Engagement Plan:
    - These reports and presentations are posted on the Village's Climate Smart website [Climate Smart Rhinebeck: Village Task Force] and the Village website [Village of Rhinebeck], as well as shared via our Climate Smart Rhinebeck email newsletter. Public Board Meeting presentations were videotaped and posted on PANDA's public access TV's archive on Youtube.
    - Shared the draft plan for feedback with the CAPI cohort.
    - The Village's Climate Smart Task Force has been receiving updates on the project throughout.
    - Shared the draft plan for feedback from the public - a draft of this report was posted on the Village Board Meeting February 2024 package, which the Village Clerk shared.
        - Trustee Bertozzi solicited feedback via social media and the Village's Climate Smart newsletter

Vision Statements and Objectives

To be a resilient, energy efficient, and healthy workplace that reflects the climate smart values of our community.

The Climate Action Plan offers a robust set of objectives and strategies that will address the local climate hazard vulnerabilities and aim for an 40% reduction in local government GHG emissions from 1990 levels by 2030, in line with New York State's Climate Leadership Community Protection Act (CLCPA) goals. Each strategy and objective were created and reviewed through an internal engagement and input process where participants considered technology limitations, funding constraints, and the feasibility of implementation. The following targets are set to maintain and support safe, efficient, and holistically sustainable Village of Rhinebeck facilities and operations:

By 2030, The Village will have:

- Sourced 100% of the municipal electricity use from renewable energy.
- Completed equipment and operations upgrades to the Water Treatment Plant that will result in an estimated 15-30% reduction in electricity usage.
- Replaced the Village Hall/Firehouse fossil fuel burning furnace with a highly-efficient new HVAC system.
- Replaced at least one fleet vehicle with an appropriate all-electric vehicle.
- Installed EV charging stations at at least 50% of municipal properties.
- Educated and incentivized employees to switch to EVs.
- Required and enforced net-zero building codes for new government buildings.

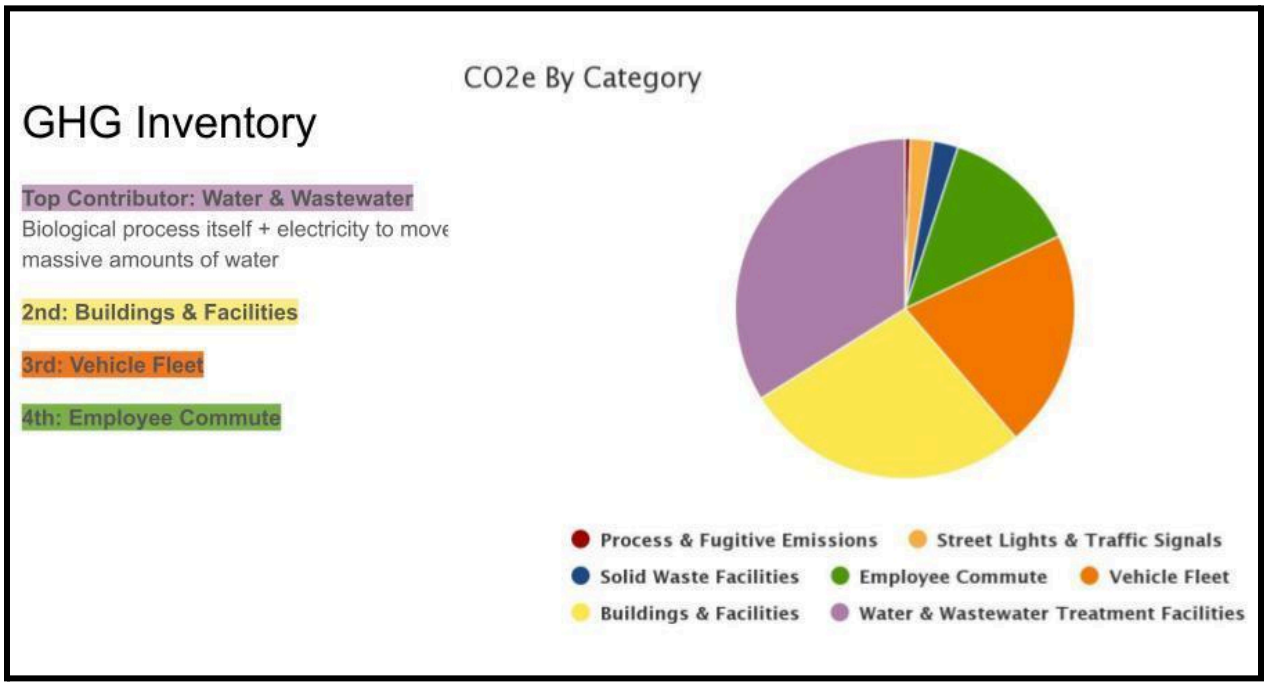
Local Government Operations Greenhouse Gas Emissions

Inventory Basics

Since the early 1990s, U.S. cities have developed community-wide and local government operations GHG inventories based on accounting protocols created by ICLEI. Known as the U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions and the Local Government Operations Protocol, these standards created a credible and defensible methodology which accelerated the number of inventories created and provided consistency within and across U.S. communities. In 2014, ICLEI partnered with the World Resources Institute and C40 Climate Leadership Group to create the Global Protocol for Community Scale GHG Emissions, which allows communities around the world to compare their emissions footprint.

The Village of Rhinebeck used the Local Government Operations Protocol to prepare a GHG emission inventory for the baseline year of 2019. The LGO GHG Emissions inventory was presented in a separate report dated 2023 and is included here as an appendix. The inventory findings indicated that LGO emissions during the baseline year were approximately 594 MTCO2e. This total was divided among seven operational sectors as illustrated in Figure 1.

Figure 1: LGO GHG Emissions by Sector for the year 2019

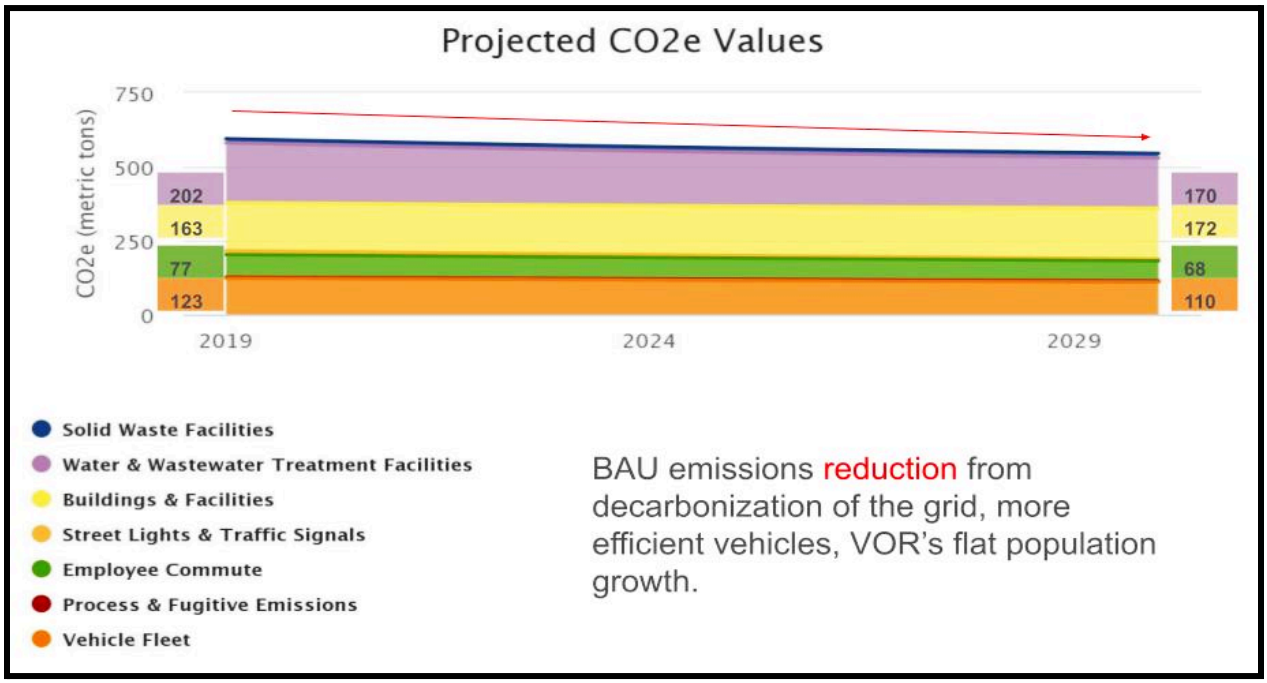


Village of Rhinebeck's Projected Growth in Local Government Operations GHG Emissions

Business-As-Usual

The Village of Rhinebeck has also completed a GHG emissions forecasting based on projections of current data and expected future community trends. The GHG emissions forecast is a "Business-As-Usual" (BAU) forecast, a scenario estimating future emissions levels if no further local actions (i.e., projects within this Climate Action Plan) were implemented. The BAU forecast as presented in Figure 2 indicates that, if the Village does not take action, GHG emissions will decline slightly due to continued decarbonization of the New York State electrical grid.

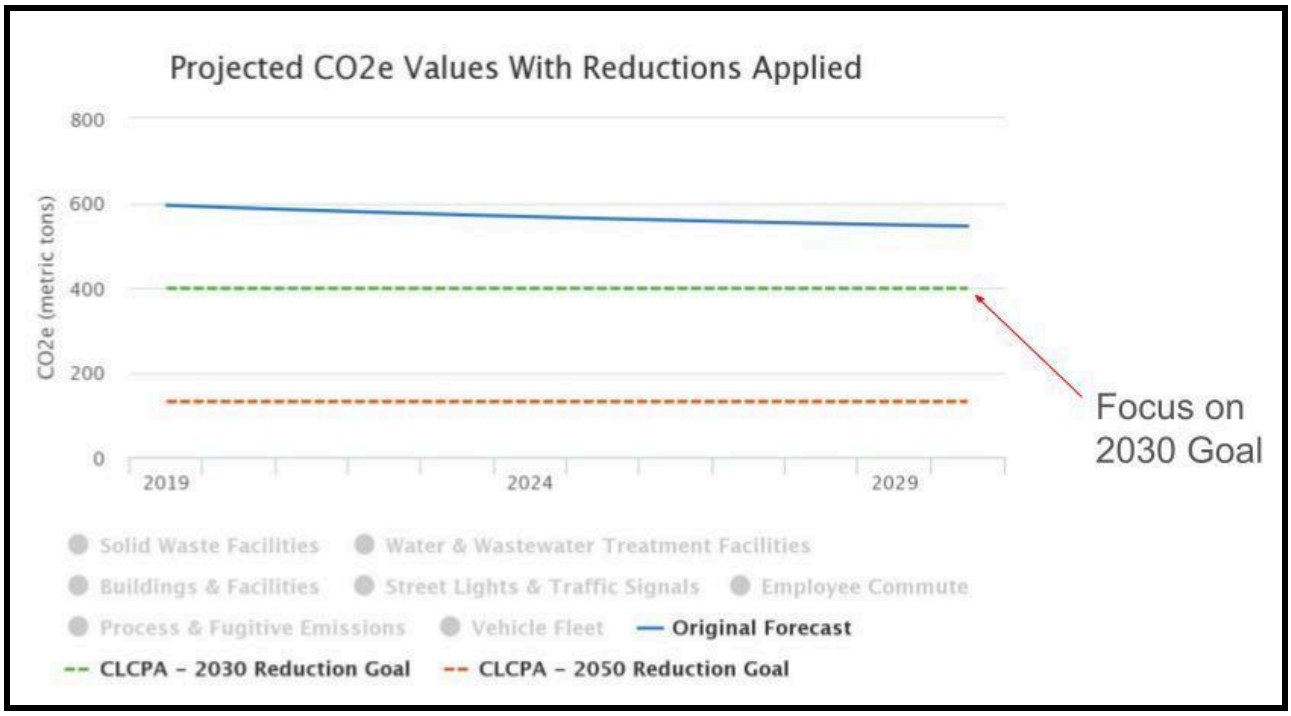
Figure 2: Projected LGO GHG Emissions from 2019 to 2030 under a "Business-As-Usual" Scenario



Projected Change in GHG Emissions

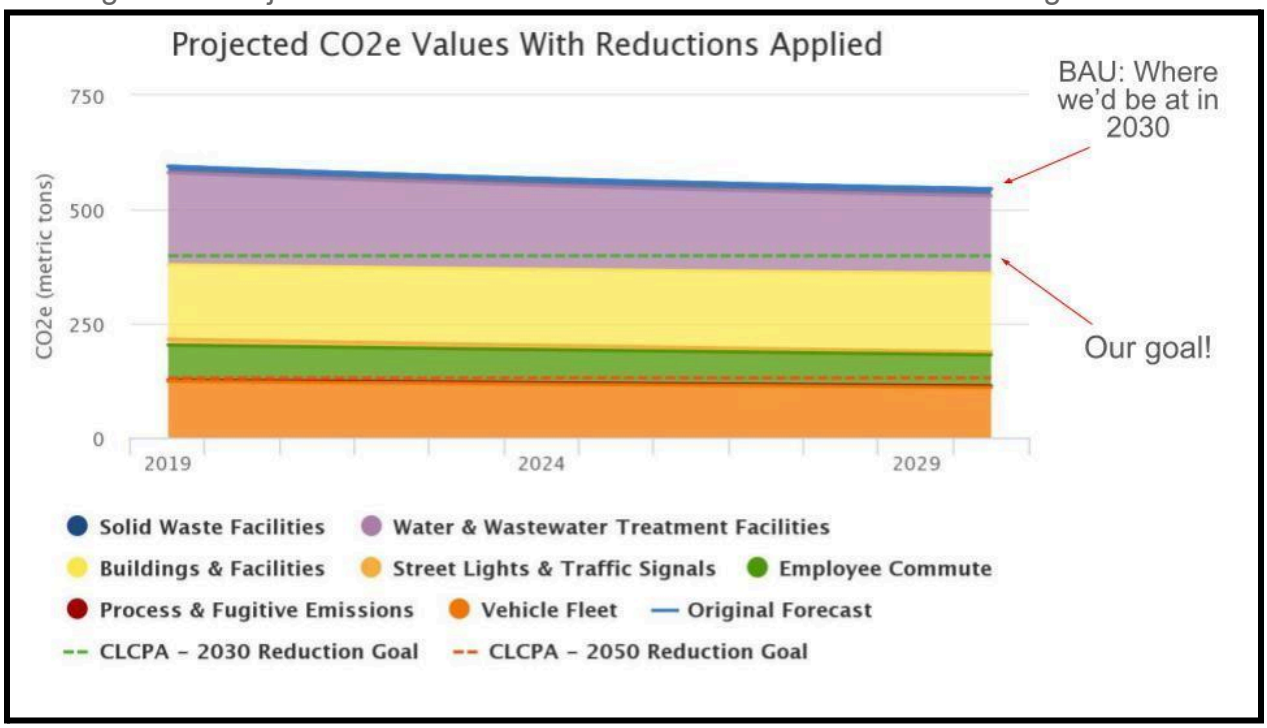
The projected change in GHG emissions in the Village of Rhinebeck from 2019 to 2030 is illustrated in Figure 2. The slight emission decline shown (top blue line) in the forecast is based on the Village's projected stasis in population growth, only nominal employee count projection changes, electricity grid decarbonization projections, and changes in automotive fuel efficiency standards. The Village of Rhinebeck's Local Government Operations business as usual forecast shows that emissions will decrease to 545 MTCO2e by 2030 if no action is taken to reduce the emissions trajectory. While the downward slope shows progress, the projection indicates that the 40% reduction goal to 400 MTCO2e by 2030 would not be achieved.

Figure 3: Projected LGO GHG Emissions from 2019 to 2030



The Village of Rhinebeck has set targets to reduce LGO emissions by 40% below 1990 levels by 2030. Figure 3 compares the reduction target with the business-as-usual forecast.

Figure 4: Projected LGO GHG Emissions from 2019 to 2030 showing sectors



Local Government Mitigation Actions

Emissions Reduction Focus Areas

Each of the GHG emissions reduction focus areas within the Village of Rhinebeck Local Government Operations Climate Action Plan is discussed in the following sections. In this Climate Action Plan, the Village of Rhinebeck has decided to focus Climate Mitigation measures on the following focus areas:

Energy Source

The Village will implement three strategies to manage local government electrical usage and reduce related GHG emissions. These three strategies are:

- Community Distributed Generation (CDG)
- Additional use of rooftop or ground-mounted solar panels
- Community Choice Aggregation (CCA) — also known as municipal aggregation—programs allow local governments to procure power on behalf of their residents, businesses, and municipal accounts from an alternative supplier while still receiving transmission and distribution service from their existing utility provider. CCAs are an attractive option for communities that want more local control over their electricity sources, more green power than is offered by the default utility, and/or lower electricity prices. By aggregating demand, communities gain leverage to negotiate rates for green power sources and projects with competitive suppliers

WTP & WWTP Processes (34% of GHG emissions)

The Village will initiate three strategies to reduce GHG emissions related to the operation of the WTP and WWTP. These three strategies are:

- More efficient processing equipment
- Energy study of the WTP
- Reduction of biosolids hauling distance

Heating and Cooling our Buildings and Facilities (27% of GHG emissions)

The Village will initiate three strategies to reduce GHG emissions related to heating and cooling of buildings and facilities. These three strategies are:

- Replacement of oil-fired furnace with a new VRF/HVAC system and insulation improvements for the Village Hall/Firehouse
- Green buildings policy for new municipal construction

- Other strategic upgrades to eliminate the burning of fossil fuels in our buildings

Fleet (21% of GHG emissions)

Village fleet operations account for 21% of LGO GHG emissions. This includes vehicles and landscaping maintenance equipment. The Plan presents five strategies to manage and reduce these emissions. The strategies are:

- Replacing gasoline and diesel vehicles with EVs and initiating a Fleet Efficiency Policy
- Replacing gas-powered landscape equipment with electric equipment
- Rightsizing heavy duty trucks to be smaller when appropriate
- Convert a portion of public greenspace/lawn to pollinator habitat
- Implement greater efficiency in curbside yard waste pickup/collection

Employee Commute

Strategy:

- Free or low cost EV charging at municipal charging stations for employees

Objectives & Strategies

In each focus area, a series of objectives with supporting strategies are outlined. An “Objective” is a goal, end result, or target that mitigates emissions in a focus area, and a “Strategy” is an action designed to help realize the objective.

Co-Benefits

In addition to measuring the GHG emission reduction potential, each strategy is also evaluated for other co-benefits such as cost savings, labor reductions, sustainability, and ecological enhancement.

Key Performance Indicators (KPIs)

KPIs give the Village a method to measure success. These are tangible results that we’ll strive for.

Energy Usage

Objective:

The Village's electricity accounts were assigned the default mix of source electricity through Central Hudson, with one net-metering account for the solar panels on Village Hall. The goal is to have more of the municipal buildings' electricity sourced from renewables, whether through Community Distributed Generation (CDG, often referred to as solar farms subscriptions) or Community Choice Aggregation (CCA). Emissions reductions see less of an impact here since our grid is already fairly clean and NY State's Climate Leadership and Community Protection Act (CLCPA) legislation is requiring a cleaner and cleaner grid. Solar installations will become important for resiliency—as in the future we may see a microgrid approach with backup batteries.

Figure 5: Reduction Strategy #1 - LGO Electricity Use from Decarbonized Sources

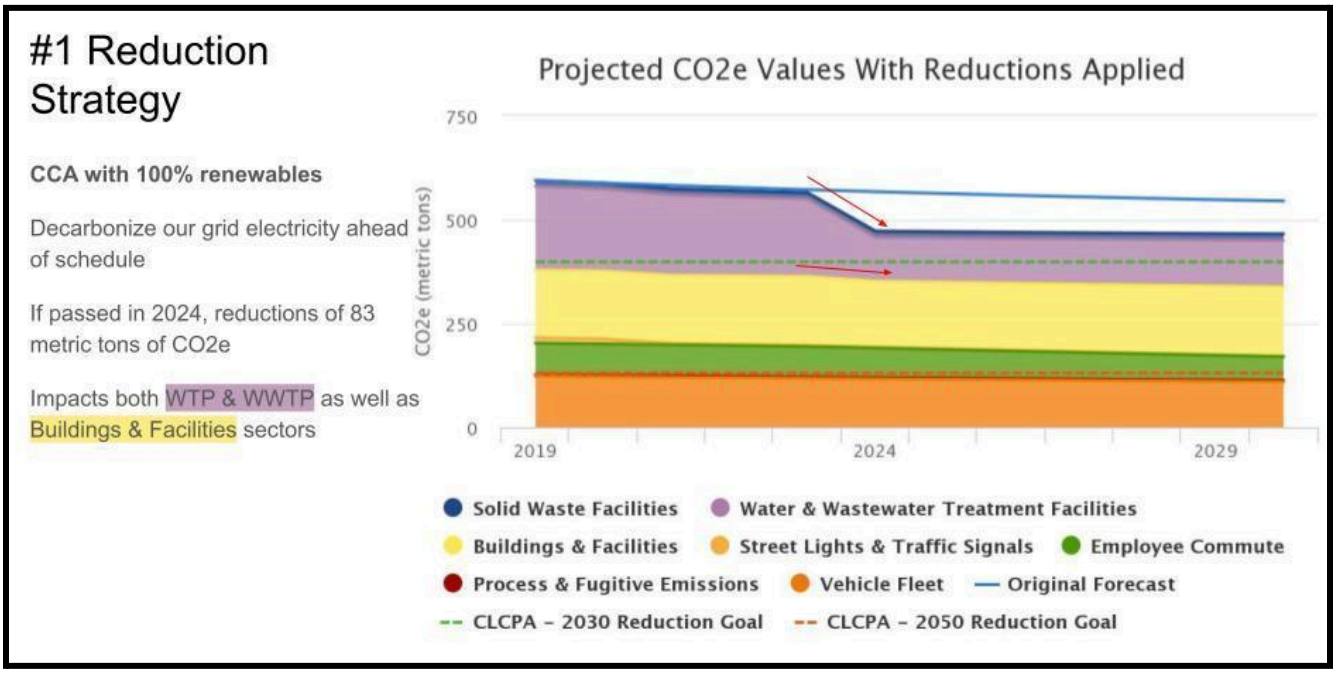


Table 1: Strategies for Sourcing Decarbonized Electricity

Strategy	Staffing	Timeline	Goal
Community Distributed Generation (CDG)	As of fall 2023, the Village Board has contracted through Sustainable Westchester with a community solar project ("Community Distributed Generation" or CDG) located in Marbletown, Ulster County, NY. The Village now uses solar generated electricity for all accounts except for the Village Hall/Firehouse (since rooftop solar-powered buildings are not allowed to "double-dip"), streetlights, and the Water Treatment		

	Plant (its energy needs were too large for this CDG). This accounts for about 50% of LGO electricity usage. The Village will pursue an additional CDG project for the remaining accounts to achieve 100% use of solar generated electricity. **Co-benefits:** Cost saving of 10% on the supply portion of our Central Hudson electricity bill for all subscribed accounts. No-cost to set up. **KPI**: % of accounts moved to the CDG subscription		
Phase 1	Trustee Bertozzi	Completed Fall 2023	50% of electricity
Phase 2	Trustee Bertozzi	Fall 2026	100% of electricity
Community Choice Aggregation (CCA)	The Village Board is currently considering legislation to prepare for a CCA. Timing depends on whether we can achieve favorable pricing for 100% renewables. **Co-benefits:** Switching to a CCA would not only help attain our LGO goal but would also apply for the entire village community. **KPI**: By 2030, 100% of Rhinebeck Village's Government Operation's electricity needs should be met by renewables or decarbonized sources.		
Phase 1	Trustee Bertozzi	Spring 2024	Research options/ Draft legislation
Phase 2	Village Board	Summer 2024	Adopt legislation
Phase 3	Village Clerk/Trustee Bertozzi	Fall 2024	Community outreach
Phase 4	Village Board	Fall 2026	Enter a 100% renewables contract
Solar Installations	Evaluate the financials and feasibility of additional solar rooftop installations on government buildings to reduce the use of grid-based electricity. Consider the installation of a shade pavilion with a solar array for the municipal parking lot. **Co-benefits**: Adding a pavilion to the municipal parking lot would serve the dual purpose of generating solar power and providing shade that would mitigate the urban heat island effect.		

	KPI: % of electricity accounted for by the additional KWHs of non-grid based solar power for Village government operations.		
Phase 1	Trustee Bertozzi	Spring 2024	Research and draft Shade Structures Policy per CSC
Phase 2	Kyle Eighmy	Summer 2024	Ascertain whether the WTP or WWTP facilities would be suitable for the installation of solar arrays
Phase 3	Village Board	TBD	Implement construction of shade pavilion in municipal parking lot or on other village property if/when financially feasible

WTP & WWTP Processes (34% of GHG emissions)

Objective:

The Village government's largest GHG emissions sources are the operations at the Water and Wastewater Treatment Plants. Our objective is to implement upgrades to increase the efficiency of these operations to reduce energy consumption.

There are emissions inherent to the biological process of treating wastewater. The board and Superintendent of Public Works should continue to follow any emerging technologies around anaerobic digestion and composting that would be beneficial for a facility of the scale of our WWTP.

One aspect of our waste that is not accounted for in our data is the final phase: disposal of biosolids, sometimes referred to as "sludge cake". Biosolids from the WWTP are currently composted in Pennsylvania and it is planned to be hauled even closer in Rockland County NY—an improvement from being hauled to Connecticut where they were incinerated. Nonetheless, we should continue to monitor any nearer compost solutions to reduce emissions associated with hauling.

Figure 6: LGO GHG Emissions from WTP and WWTP Operations by Record

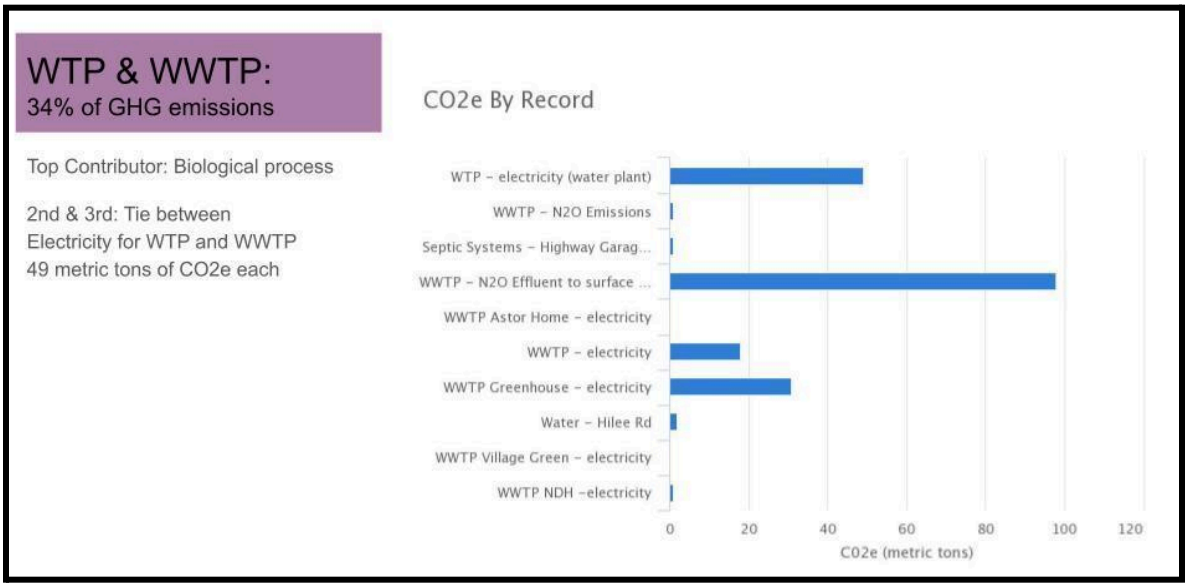


Table 2: Implementation Strategy for LGO GHG Emission Goal Reductions for WTP/WWTP Sector

Strategy	Staffing	Timeline	Goal
Upgrades to the WTP process	The Village Board is already planning upgrades and improvements to the processing equipment at the plant. Delaware Engineering has indicated that these improvements will result in greater energy efficiency. The EPA estimates that these sorts of upgrades to older, inefficient plants typically result in a 15-30% increase in efficiency with a commensurate reduction in energy use/costs. **Co-benefits:** Upgrading this equipment will result in fewer byproducts in our drinking water. **KPI**: Benchmark comparison “before and after” energy usage.		
Phase 1	Kyle Eighmy	Construction finished fall 2025	Oversee proper implementation of construction
Energy Study of WTP	Kyle Eighmy met a firm at NYCOM that does free efficiency analysis of Water and Wastewater Treatment Plants and is reaching out.		

	Alternatively, once we submit benchmarking for 2022/2023, the Village will be eligible for a free energy study through CEC. HVRC also shared this resource and this resource. In the meantime, we know from staff that doors and weatherstripping in the plant are leaky and cause drafts. We could use the Water Capital fund for these improvements. **Co-benefit:** Low-hanging fruit will make the plant more comfortable for staff. **KPI**: Implementation of at least one action recommended by energy study.		
Phase 1	Kyle Eighmy	Summer 2024	Weather stripping/ doors
Phase 2	Trustee Bertozzi	Summer 2024	Identify any recommended envelope or HVAC upgrade
Phase 3	Village Board	By 2030	Implement any recommendation the Board chooses to prioritize
Emissions from WWTP	There are emissions associated with the biological process of treating wastewater. We have researched anaerobic digesters and currently these processes make more sense for larger plants. The Village should keep in touch with Joanna Underwood of Energy Vision https://energy-vision.org, who lives in Rhinebeck and is a valuable resource. **Co-benefit:** Composting turns waste into a renewable resource.		

Heating and Cooling our Buildings and Facilities (27% of GHG emissions)

Objective:

The Village government's second largest contributor to LGO GHG emissions is the heating and cooling of our buildings. Our objective is to improve energy efficiency in buildings and reduce or eliminate the burning of fossil fuels.

Figure 7: GHG Emissions for Buildings & Facilities by Record

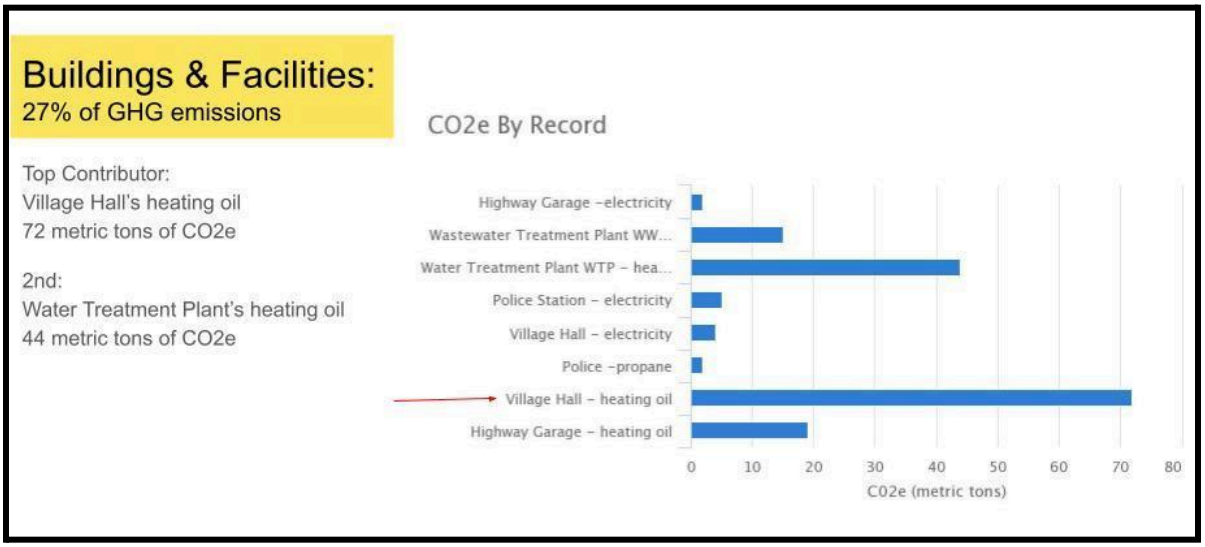


Figure 8: #2 Reduction Strategy for GHG Emissions - Village Hall/Firehouse HVAC

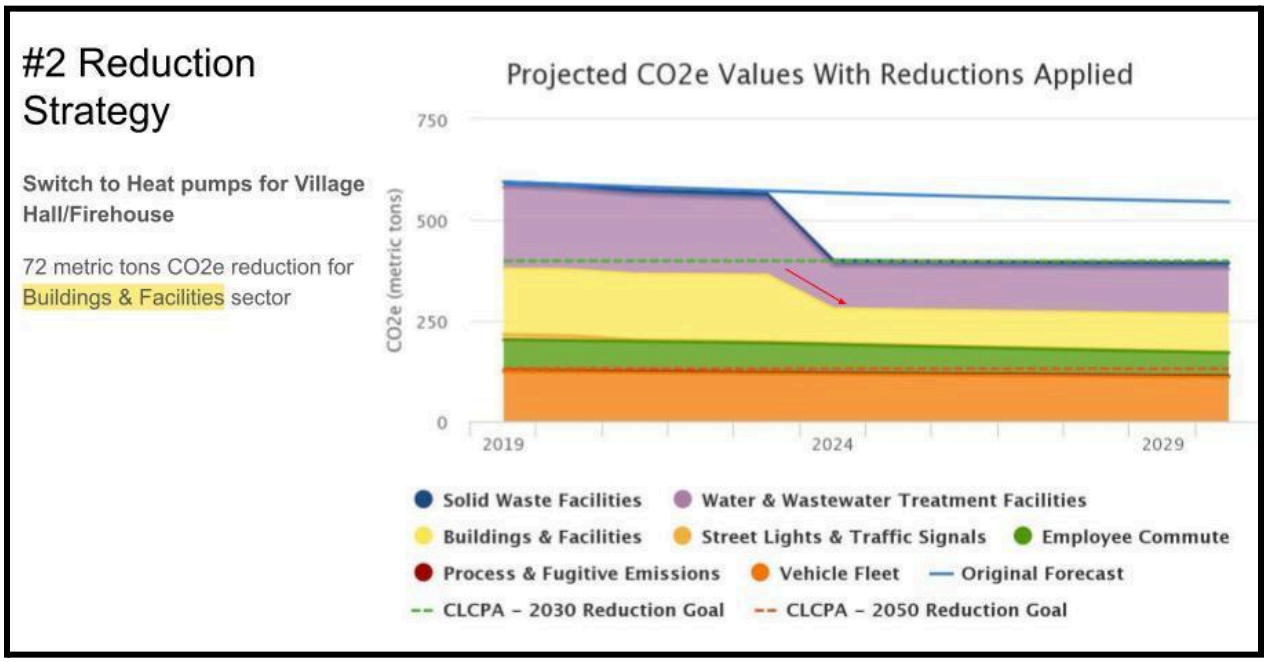


Table 3: GHG Emission Reduction Strategies for Village Buildings & Facilities

Strategy	Staffing	Timeline	Goal
Upgrade HVAC from oil furnace	**Village Hall/Firehouse HVAC project**: The Village Board had a FlexTech study done and funded a design/engineering phase with M/E Engineering. A variable refrigerant flow (VRF) system is recommended as well as additional building insulation and envelope tightening. Undertaking the recommended project for converting to a VRF heat pump system for heating and cooling would be one of the single biggest reductions in emissions that the Village government could undertake. However, M/E Engineering's preliminary budget is outside of what the Village can afford. **Co-benefit:** The project would provide building cooling during warmer months removing the necessity for noisy window-AC units. Storage of heating oil would no longer be required. The building would become a reliable emergency shelter during extreme temperature events. **KPI**: Benchmark "before and after".			
Phase 1	Trustee Bertozzi	2022 - completed	Complete Flextech energy study
Phase 2	Trustee Bertozzi	2023 - completed	Complete Design
Phase 3	Trustee Bertozzi	Spring 2024	Research funding
Phase 4	Village Board	TBD	RFP/Bid process
Phase 5	Kyle Eighmy	By 2030	Implementation
Green buildings policy for new municipal construction	This policy would ensure that any new construction of municipal buildings would be green. **Co-benefit:** Show leadership for private property owners. **KPI**: Policy officially adopted.		
Phase 1	Trustee Bertozzi	Summer 2024	Research & draft policy
Phase 2	Village Board	Fall 2024	Adopt policy

Other strategic HVAC upgrades	The Village Board should be prepared to switch to non fossil fuel infrastructure for buildings should any of their heating/cooling systems fail. We also need to go beyond being reactive. Additional energy studies of each of our buildings would provide useful planning info. The Village Board could also consider upgrading the Police Department facility—the newest building in our portfolio—since it only uses propane. This facility could easily become a fossil fuel free building in our portfolio, which would be inspiring. **Co-benefit:** If we are on a CCA and have reduced our reliance on fossil fuels to heat and cool our buildings, that means more predictable energy costs for budgeting purposes. **KPI**: Number of energy studies completed. Number of projects implemented. Before and after benchmarking.		
Phase 1	Trustee Bertozzi	Winter 2026	Research costs for Police Dept
Phase 2	Village Board	Spring 2026	Adopt budget for fossil fuel replacement
Phase 3	Kyle Eighmy	Fall 2027	Implement upgrade

Fleet (21% of GHG emissions)

Objective:

The Village government's third largest sector of GHG emissions is from operation of the vehicle fleet. Our objective is to increase efficiency of the fleet and to reduce the amount of fuel burned.

Figure 9: GHG Emissions Related to Fleet Operation by Record

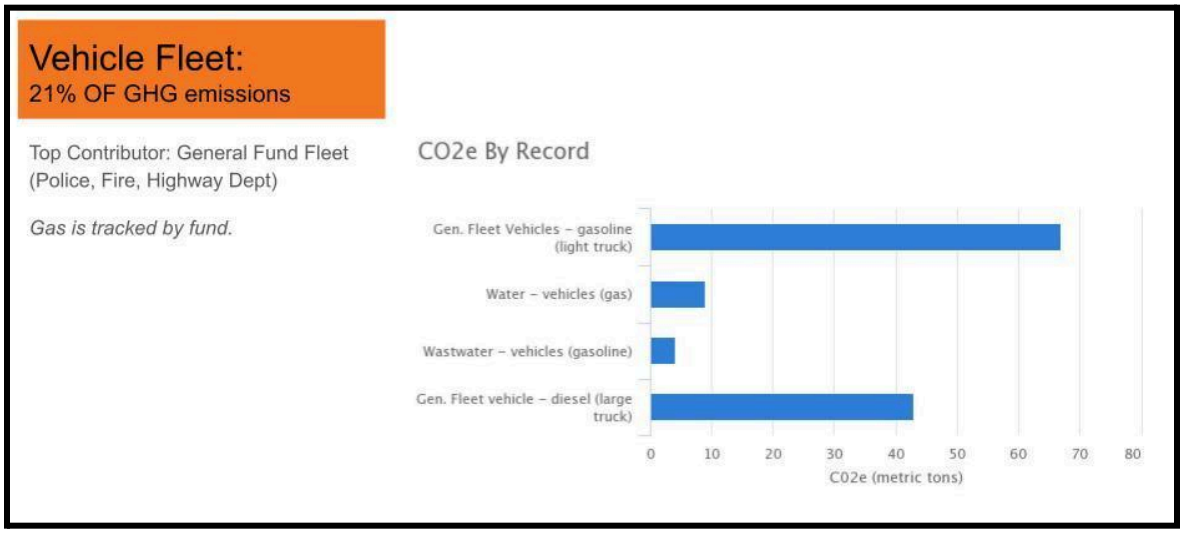


Table 4: Strategies for GHG Emissions for Fleet Operations

Strategy	Staffing	Timeline	Goal
Transitioning our fleet to EVs	The transition strategy is focused on gas vehicles rather than diesel because the market for diesel replacements is further out. Since the Village tracks gas purchases by fund (department), this analysis of estimated vehicle miles traveled (VMT) is by fund. The Village should target vehicles that burn the most gas annually (i.e., the most heavily used vehicles). But other factors come into play, such as which vehicles are old and in disrepair and need to be replaced in the short term, whether replacement vehicles need to be able to plow snow, and whether EV replacements are available on the market. Once we start purchasing EVs, consider moving electric light duty models into roles/departments where they are putting on the most miles. This will save emissions and gas—thus shortening the payback for these vehicles. **Funding**: The Federal government is offering incentives of up to $7,500 per vehicle and New York State is offering up to $2,000. **Co-benefit:** EVs can be charged overnight, resulting in a reduction in time spent refueling vehicles at the Town Highway Garage. Reduction in pollution from driving and idling. Less maintenance/oil changes, etc.		

	KPI: Reduction in gasoline purchased		
Phase 1	Kyle Eighmy	Fall 2023	DRVE research with the Electrification Coalition
Phase 2	Kyle Eighmy	New Year 2024	Fleet inventory
Phase 3	Trustee Bertozzi	Summer 2024	Draft Fleet Efficiency Policy
Phase 4	Village Board	Fall 2024	Adopt Fleet Efficiency Policy
Phase 5	Kyle Eighmy	By 2028	Install EV charging station at WTP
Phase 6	Village Board	By 2030	Purchase at least one electric vehicle
Fleet Rightsizing	Superintendent Kyle Eighmy will also work with the Village Board to identify vehicles that can be replaced with smaller vehicles when appropriate. In this way, even if we can't switch a heavy duty dump truck to an electric one, we could reduce its emissions impact by replacing it with a lighter model. Some gas pickup trucks could be replaced by an electric sedan or hatchback instead of an electric truck. The Village Board could also discuss with the Police Sergeant whether the number of vehicles we have in the police department is necessary. **Co-benefits:** Less damage done to curbs and lawns with smaller trucks. Frees up more parking/storage space. Less maintenance. **KPI**: Number of vehicles right-sized		
Phase 1	Kyle Eighmy, Sgt Dunn	Winter 2025	Analyze which vehicles could be right-sized
Phase 2	Village Board	By 2030	Right-size the fleet
Switch to electric lawn maintenance equipment	The impact of fuel burned by our non-vehicle equipment isn't specifically tracked. The Village only tracks total gas purchased and we don't track the number of hours staff specifically spend leaf blowing, weed whacking, chainsawing, trimming, lawn mowing, etc. However, we know from research that these machines are some of the most polluting. **Funding:** Employ grants won through NYSERDA's CEC program. **Co-benefit:** Reduction in noise related to landscape maintenance.		

	KPI: Number of pieces of equipment replaced		
Phase 1	Kyle Eighmy	Winter 2024	Research available suitable models of push mowers, chainsaws, trimmers, leaf blowers
Phase 2	Village Board	Spring 2024	Purchase our first pieces of electric lawn equipment
Phase 3	Kyle Eighmy	2025 on	Continue to research electric ride-on mowers
Phase 4	Kyle Eighmy	By 2030	Complete transition to electric lawn equipment
Yard waste pick up operations efficiency	Consider requiring residents to place their yard waste in green bins for pickup, thus reducing the number of and weight class of vehicles needed to go around doing yard waste pick up. **Co-benefit:** Tidier looking streets, less brush piles in the street where cyclists and pedestrians walk **KPI**: Hours of staff time saved, gallons of fuel saved		
Phase 1	Kyle Eighmy	Spring 2024	Research bins & discuss logistics
Phase 2	Village Board	TBD	Purchase bins
Phase 3	Kyle Eighmy	By 2030	Implement new process with staff
Convert a portion of public lawn to pollinator habitat	Consider converting swaths of public park lawn into pollinator meadow. This will reduce the amount of mowing and fuel burned. **Co-benefits**: Beautiful flowers and biodiversity. Save staff time spent mowing. **KPI**: Number of acres not mowed		
Phase 1	Kyle Eighmy	Summer 2024	Research which municipally-owned areas would be ideal to convert
Phase 2	Trustee Bertozzi & Climate Smart Task Force	Fall 2024	Lay down cardboard to smother lawn

Phase 3	Trustee Bertozzi & Climate Smart Task Force	Spring 2025	Plant pollinator plantings
Phase 4	Highway Dept	Ongoing	Maintenance

Employee Commute (13% of GHG emissions)

Objective:

The Village government's employees have discretion over their methods of commuting to work, but the Village could incentivize future efficiencies. The 2019 GHG inventory estimated that 77 MTCO2e are attributable to employee commuting. GHG emission reductions can be achieved by reducing the number of miles traveled and switching a number of vehicles used for commuting to EVs. Employee commute is not one of our largest contributors, but its impact is there nonetheless. Our objective is to encourage and support employees switching to EV, to the extent that is appropriate and welcomed.

In ClearPath, we modeled the organic rate of transition to electric vehicles.

Figure 10: Projected GHG Emission Reductions from Employee Commute Organic EV Adoption

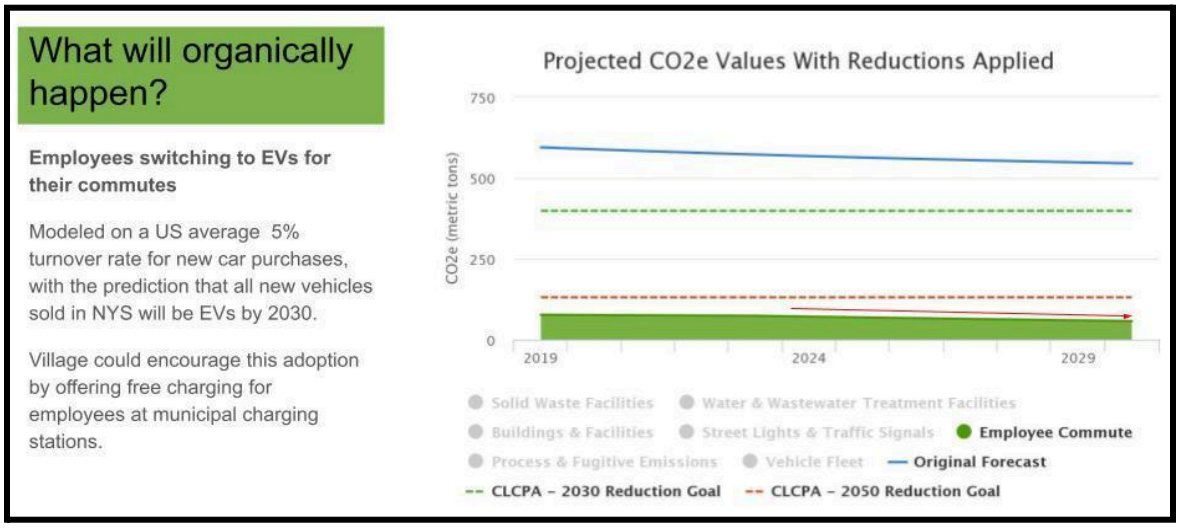


Table 5: Strategies for Employee Commute GHG Emissions Reductions

Strategy	Staffing	Timeline	Goal
Transitioning employee commute to EVs	Evaluate options to incentivise GHG emission reductions for employee commutes: ● **Low or no cost EV charging for employees:** This would incentivize employees to switch to EVs for their commute to work. Chargepoint software enables us to provide employees with a code to receive no cost or lower rate charging at our municipal charging stations. **How to estimate an organic adoption rate**: Town of Rhinebeck currently has an adoption rate of 30 electric/plugins per 1000 people (3%). Dutchess County's rate is just under 10/1000 (1%). Given that not all employees live in Rhinebeck, let's say our current rate of ownership is 2%. NYS has a goal for all *new* passenger vehicles to be zero-emission by 2035. From 2022 to 2023, NYS saw a 44% increase in the number of EVs registered (this is an increase on a small base). About 5% of the American population buys a new car each year. We factored this organic conversion rate into our ClearPath modeling. **Co-benefit:** Raising awareness of climate change amongst staff, and empowering them to take action. **KPI**: Number of staff who convert to EVs		
Phase 1	Trustee Bertozzi	Fall 2024	Research/Talk to staff about what impact this might have
Phase 2	Village Board	Winter 2024	Implement a free staff charging policy via Chargepoint

Additional Sectors

These additional sectors are not high priority areas given their relatively small impact on potential GHG emissions.

Solid Waste

- **Food Scrap Collection for Village Hall/Firehouse**: When the Village starts its municipal composting program, provide a container for the disposal of food scraps next to garbage and recycling bins and encourage food scraps to be placed into proper

receptacles. Delegate the task of dropping the scraps at the drop-off location for composting.

Potential Policies

The following potential policies and projects will not reduce *forecasted* emissions as they were not built into the forecast and have not been tracked (or at least not in a way that we could integrate).

Street Trees
The Village's urban forest provides cooling and shading services as well as being carbon sinks.

- Continue to support the Tree Commission's efforts to plant new trees twice a year.
- Pursue funding for the management and maintenance of the urban forest.

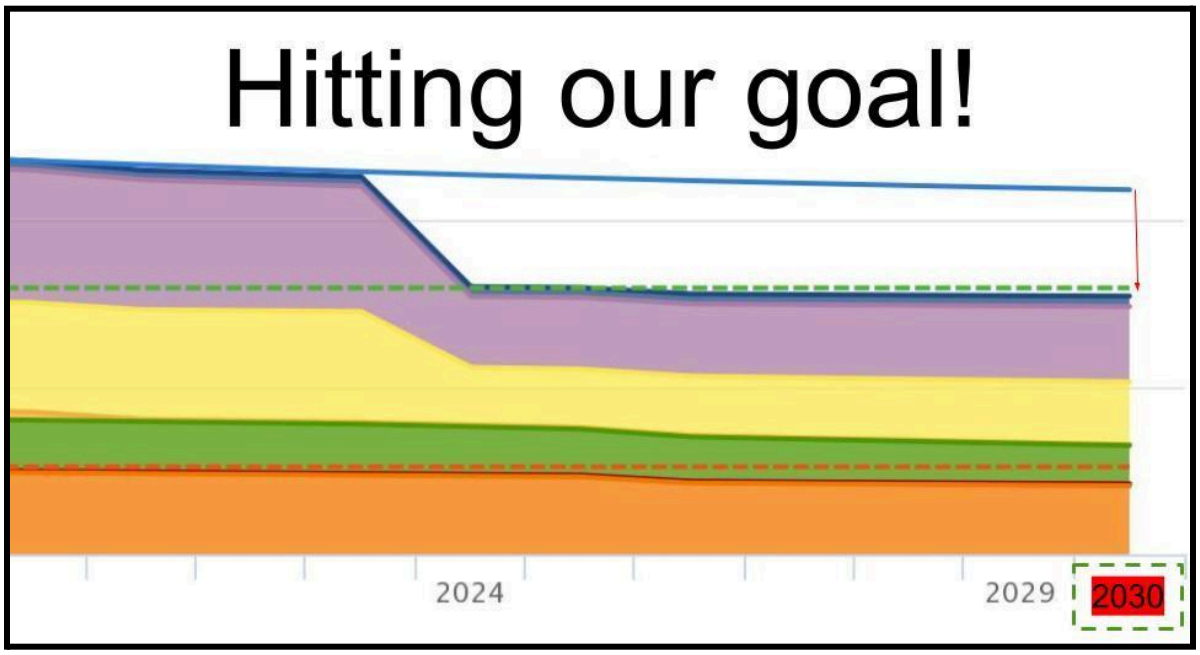
Materials Management

- Adopt policies to include responsible recycling of construction debris under government contracts.
- Adopt policies to prioritize use of low embodied or "green" concrete in municipal projects.

Goal Achievement

Using the ClearPath forecasting tool, the findings show that the goal of 33% GHG emissions reduction from 2019 levels can be achieved by the target date of 2030.

Figure 11: Summary graph illustrating goal achievement



Monitoring Plan

While some of the actions within the Village of Rhinebeck's Local Government Operations Climate Action Plan are well underway, over the coming months Trustee Bertozzi will engage with the Village Board to prepare for any prerequisite or additional actions needed to begin further implementation of the Plan and to understand financial and staffing constraints.

These prerequisite actions include:

- Gathering estimates for contracted services and equipment.
- Researching funding opportunities.
- Making necessary changes to local policies or existing programs.
- Meeting with Superintendent of Public Works, Kyle Eighmy, to understand his bandwidth for these projects.

Establishing a monitoring process enables the Village of Rhinebeck to track the impacts of the actions included in the Plan and compare estimated impacts to what is actually achieved in terms of energy savings, renewable energy production, and GHG emissions reduction. Assessing the implementation status of the actions will allow for determination of whether the action is performing well or to identify corrective measures. This process is also an opportunity to understand the barriers to implementation and identify best practices or new opportunities for moving forward.

The table below describes the components of the monitoring reports. A Government Operations Greenhouse Gas Emissions Inventory should be updated every 5 years. Updates on progress on our CAP should be included in the Village's Annual Climate Progress Report. The Village should undertake another round of major climate action planning and set a 2050 goal before the end of 2030 at the latest.

Table 6: Monitoring Status

Monitoring Report Component	Annual Update	Full Report
Overall Strategy: Reporting any changes to initial strategy as well as updated information on human and financial resources. Report progress towards goals	Yes: Include in Annual Climate Progress Report	No
GHG Emissions Inventories: Provide updated energy consumption and GHG emissions data for the reporting year	No	Yes: Complete for year 2024 by 2026
Gov Operations Climate Action Plan for Mitigation 2030: Report the implementation status (completed, in progress, on hold) of key actions and update their impacts	Yes	Yes: Complete update 2030
Gov Operations Climate Action Plan for Mitigation 2050: Create another Action Plan that digs into a 2050 goal	No	Yes: Complete by 2030

Background:

Comparison of Local to Statewide Goals

The Village of Rhinebeck has chosen to align its GHG emission reduction goals with the statewide goals. The Climate Leadership and Community Protection Act (CLCPA), signed into law on July 18, 2019, sets goals to reduce emissions to 40% below 1990 levels by 2030 and then to 85% below 1990 levels by 2050. The Village of Rhinebeck's goal is not legally binding, but sets a target for the Village Board to shoot for.

Co-Benefits of Climate Protection Measures

1. Saving Money

In addition to addressing climate change, measures taken to reduce GHG emissions have other important benefits, such as the potential for significant cost savings. In 2019, the Village of Rhinebeck spent over $234,000 on energy to power buildings and fuel its vehicle fleet. Many of the measures in this Plan pay for themselves quickly by reducing direct costs, such as fuel or energy used, as well as indirect costs such as maintenance. For instance, a "right-sized" vehicle fleet is less expensive to purchase and fuel, while also being less costly to maintain.

Improving energy efficiency, encouraging the transition to electric vehicles, installing on-site renewables, and other measures will also result in lower energy costs for the Village of Rhinebeck. Acting now will also save on runaway costs on climate change, especially in the longer term, as the cost of fossil fuels continues to increase.

2. Enhancing Resource Security

A key strategic side benefit of climate change mitigation activities is enhanced energy security through reduction in total demand. This will put less strain on the energy system as a whole as we transition to clean renewable energy. Many of the actions identified here to mitigate GHG emissions will also help the Village of Rhinebeck's government adapt to a changing climate. For example, extreme and prolonged heat waves can put considerable strain on the reliability of energy delivery in peak periods, possibly leading to service disruption during times when cooling is most needed. By increasing efficiency across the Village of Rhinebeck facilities, such service disruptions are less likely and the Village of Rhinebeck will be able to better cope with those situations.

3. Creating Jobs

The renewable energy industry has become a leading sector in job growth. In 2018, clean energy employment rose 3.6%, and the U.S. Bureau of Labor Statistics expects solar installers and wind technicians to be the two fastest-growing jobs through 2026. Energy efficiency jobs are also growing rapidly. These climate protection measures in this Plan can spur business and job growth during the design, manufacture, and installation of energy efficient technologies and other green sectors. This presents a particular opportunity to reinvest in the local economy and generate green jobs.

4. Improving Public Health

Climate change mitigation activities, particularly those related to transportation, help to clean the air by reducing vehicle emissions and therefore improve public health throughout the community. Transportation mitigation strategies often focus on encouraging the use of active transportation, such as biking and walking, to get to work. The Village of Rhinebeck employees that increase their use of active transportation will benefit from a healthier lifestyle.

5. Delivering Benefits to Frontline Communities

Social equity is a major concern for addressing climate change. Research shows that vulnerable populations such as the elderly or chronically ill, low income families and people of color are more at risk when it comes to experiencing impacts of climate change. These communities already experience institutional and systematic oppression that result in less access to resources, capital, and services. Climate change exacerbates these gaps. By targeting programs and making changes to services or infrastructure before extreme events happen, we can mitigate the most devastating impacts to already vulnerable populations. Additional measures aimed solely at climate adaptation, such as modifying flood protection and heat emergency response programs will also be addressed when we add the Climate Adaptation Chapter to this Climate Action Plan.

Appendix I:

The Village of Rhinebeck Local Government Operations GHG 2019 Inventory

Village of Rhinebeck

The Doughboy statue and memorial. Photo by Vanessa Bertozzi.

Inventory of Government Operations Greenhouse Gas Emissions for Fiscal Year 2019

JULY 2023

Prepared by the Village of Rhinebeck's Climate Smart Task Force with Assistance from *the Hudson Valley Regional Council and* ICLEI – Local Governments for Sustainability USA

Credits and Acknowledgements

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Vanessa Bertozzi, Village Trustee

Michael Forlenza, Climate Smart Task Force Member

Krissy Denu, Deputy Clerk

Karen McLaughlin, Treasurer

Kyle Eighmy, Superintendent of Public Works

Martina McClinton, Clerk

We acknowledge the support of and extend thanks to Mary Lambert and Carla Castillo from Hudson Valley Regional Council (HVRC), Kale Roberts and Caroline Dickey from the International Council for Local Environmental Initiatives (ICLEI), and the entire group of eight other municipalities in the Dutchess Climate Action Planning Institute (CAPI) cohort. CAPI is a *program* of the Hudson Valley Regional Council. *This program has been funded in part through a grant to the County of Dutchess as lead applicant through the Climate Smart Communities Grant Program, Title 15 of the Environmental Protection Fund through the New York State Department of Environmental Conservation.*

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Village of Rhinebeck incorporated in 1834. Photo by Michael Forlenza.

Executive Summary

The Village of Rhinebeck recognizes that greenhouse gas (GHG) emissions from human activity are catalyzing profound climate change, the consequences of which pose substantial risks to the future health, wellbeing, and prosperity of our community.

The Village achieved bronze certification in New York State's Climate Smart Communities (CSC) program in March 2020, and the Village's Climate Smart Task Force has been working towards silver certification. The CSC Task Force, a group of dedicated volunteers, is led by its Coordinator, Trustee Vanessa Bertozzi. We are grateful for the support of the Village Board in pursuing actions to characterize and reduce our GHG emissions, address climate resiliency, especially to flooding, and engaging with our local community. You can learn more about the Village's CSC projects and activities via www.climatesmartrhinebeck.org, where you can find the Annual Climate Progress Reports among lots of other information.

Climate Smart Bronze Certification for the Village of Rhinebeck. Photo by Vanessa Bertozzi.

This inventory report was prepared to characterize the GHG emissions related to Village government operations and to activities for the baseline year of June 2018 to May 2019, the Village's fiscal year. Information sources used to develop this inventory included administrative records, utility bills, personal reporting, and science-based estimates.

The findings from the inventory indicate that approximately 594 metric tons of carbon dioxide equivalent (CO_2e) were emitted by Village operations during the baseline year. A metric ton equals 2,205 pounds. These GHG emissions are related to the burning of fossil fuels, electricity usage, and miscellaneous related activities. The Village burns fossil fuel for the heating of buildings and the operation of motor vehicles. Suppliers of electricity generate GHGs during the generation and transmission of power.

The largest portions of Village GHG emissions are related to operations of the Water and Wastewater Treatment plants and the heating and cooling of buildings and facilities. Compiling this baseline inventory is the first step in a process to track and manage progress toward GHG emissions reductions and achievement of net zero emissions.

Key Findings

Using available administrative records and the online ClearPath software tool developed by ICLEI, the Village compiled a GHG inventory for the emissions related to government operations during the base fiscal year 2019 year. Figure 1 shows operations emissions across seven sectors equaling a total of 594 metric tons of carbon dioxide equivalent (CO2e).

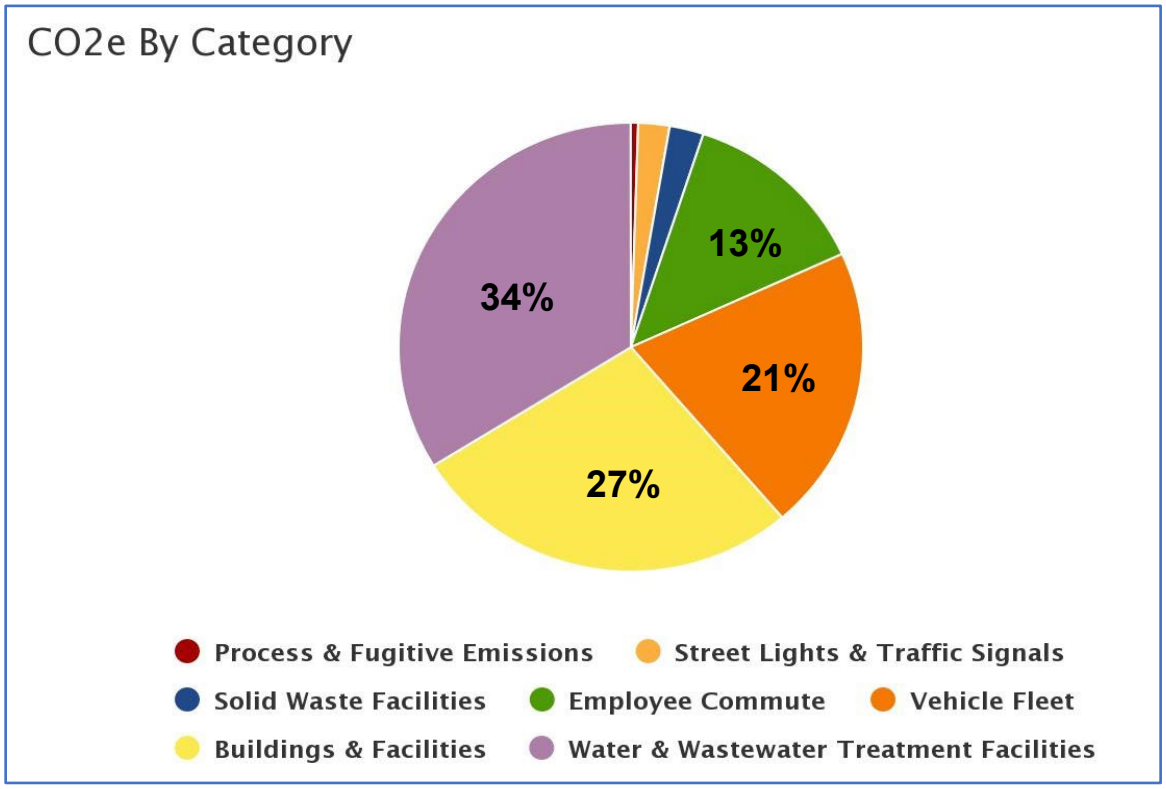


Figure 1: Village of Rhinebeck Government Operations Emissions by Sector

Emissions associated with the Water and Wastewater Treatment Facilities account for the largest portion (34% of the total or 201 metric tons) of the Village government's emissions. The second largest contributor is Buildings & Facilities (27% of the total or 163 metric tons). Together, these two sources contribute approximately two thirds (61%) of the Village government's GHG emissions. Actions to reduce emissions from these two sectors will be a key part of any future climate action plan developed by the Village of Rhinebeck.

The next largest contributor is the vehicle fleet (21% of total or 122 metric tons), followed by employee commute, which though relatively smaller, was still a significant contributor (13% of the total or 78 metric tons). Streetlights, solid waste, and fugitive emissions were responsible for the remainder (about 5% the total) of local government operations emissions.

The Inventory Results section of this report provides a detailed profile of emissions sources within the Village of Rhinebeck's government operations; information that is key to guiding local reduction efforts. The Inventory Results section also details any challenges in tracking data, such as solid waste. The GHG emissions inventory data will also provide a baseline against which the Village will be able to compare future performance and demonstrate progress in reducing emissions. Typically, a municipality our size updates its GHG emissions inventory once every five years.

The Village government selected the fiscal year June 2018 - May 2019 (FY2019) as a base year to draw on pre-pandemic data. Additionally, the year FY2019 pre-dates the recent billing and data accounting anomalies that Central Hudson Gas & Electric Corporation (Central Hudson) has experienced. Central Hudson, a regulated transmission and distribution utility, provides grid-based electrical power to the Village of Rhinebeck. Hopefully, Central Hudson will have worked out their issues by the time the Village government completes another GHG emissions inventory.

Waterfall at Asher Dam on Crystal Lake, Rhinebeck, NY. Photo by Michael Forlenza.

Introduction to Climate Change

Naturally occurring gases dispersed in the atmosphere determine the Earth's climate by trapping solar radiation. This phenomenon is known as the greenhouse effect. Overwhelming evidence shows that human activities are increasing the concentration of greenhouse gases and changing the global climate. The most significant contributor is the burning of fossil fuels for transportation, electricity generation and other purposes, which introduces large amounts of carbon dioxide and other greenhouse gases into the atmosphere. Collectively, these gases intensify the natural greenhouse effect, causing global average surface and lower atmospheric temperatures to rise, threatening the safety, quality of life, and economic prosperity of global communities. Although the natural greenhouse effect is needed to keep the earth warm, a human enhanced greenhouse effect with the rapid accumulation of GHG in the atmosphere leads to too much heat and radiation being trapped. The Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report confirms that human activities have unequivocally caused an increase in carbon emissions[1]. Many regions are already experiencing the consequences of global climate change, and the Village of Rhinebeck is no exception.

Human activities are estimated to have caused approximately 1.0°C of global warming above pre-industrial levels, with a likely range of 0.8°C to 1.2°C. At the current rate of increase, global warming is likely to reach 1.5°C in the period between 2030 and 2052. Warming from anthropogenic emissions from the pre-industrial period to the present will persist for centuries to millennia and will continue to cause further long-term changes in the climate system. These changes will include sea level rise, with associated flooding impacts. Climate-related risks for natural and human systems are higher for global warming of 1.5°C than at present, but lower than at 2°C. These risks depend on the magnitude and rate of warming, geographic location, levels of development and vulnerability, and on the choices and implementation of adaptation and mitigation options[2].

[1] IPCC, 2021: Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [MassonDelmotte, V., P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J. B. R. Matthews, T. K. Maycock, T. Waterfield, O. Yelekçi, R. Yu and B. Zhou (eds.)]. Cambridge University Press. In Press.

[2] IPCC, 2018: Summary for Policymakers. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. World Meteorological Organization, Geneva, Switzerland, 32 pp.

According to the 2018 Fourth National Climate Assessment, the northeast U.S. will experience potentially devastating impacts from seasonal changes and hazards occurring at unprecedented magnitudes. "By 2035, and under both lower and higher scenarios (RCP4.5 and RCP8.5), the Northeast is projected to be more than 3.6°F (2°C) warmer on average than during the preindustrial era. This would be the largest increase in the contiguous United States and would occur as much as two decades before global average temperatures reach a similar milestone."

Rhinebeck Dutch Reformed Church, Mill Street. Photo by Michael Forlenza.

The Hudson Valley, including Village of Rhinebeck, is at particular risk from sea level rise along the Hudson River. The Village's Water Treatment Plant is located adjacent to the Hudson River in Rhinecliff. Additionally, localized flooding, erosion, heat emergencies, habitat loss, and drought present risks to the Village as weather patterns become more intense. "With little redundancy in their infrastructure and, therefore, limited economic resilience, many rural communities have limited ability to cope with climate-related changes." (2018 Fourth National Climate Assessment).

Many people visit and move to this region to enjoy the beautiful landscape and fresh local food, but the local agriculture and farm workers are at extreme risk due to increasingly intense and abnormal weather patterns. Beyond agriculture, changing climate threatens many sectors within the Village of Rhinebeck and the greater region, most notably tourism and public health with our aging demographic[3].

"Changing climate threatens the health and well-being of people in the Northeast through more extreme weather, warmer temperatures, degradation of air and water quality, and sea level rise. These environmental changes are expected to lead to health-related impacts and costs, including additional deaths, emergency room visits and hospitalizations, and a lower quality of life." (2018 Fourth National Climate Assessment)

[3] U.S. Global Change Research Program. 2018. National Climate Assessment – Ch 18: Northeast. Retrieved from https://nca2018.globalchange.gov/chapter/18/

Many communities in the United States have started to take responsibility for addressing climate change at the local level. Energy efficiencies and reducing fossil fuel use in the community can have many benefits in addition to reducing greenhouse gas emissions. More efficient use of energy decreases utility and transportation costs for residents, governments, and businesses. Retrofitting homes and businesses to be more efficient creates local jobs. In addition, when residents save on energy costs, they are more likely to spend the savings at local businesses supporting the local economy. Reducing fossil fuel use improves air quality and increases opportunities for walking and bicycling, improving residents' health.

Rhinebeck Village Hall and Fire Department, East Market Street. Photo by Michael Forlenza.

Greenhouse Gas Inventory as a Step Toward Carbon Neutrality

Facing the climate crisis requires the concerted efforts of local governments and their partners, those that are close to the communities directly dealing with the effects of climate change. Cities, towns, and counties are well placed to define coherent and inclusive plans that address integrated climate action — climate change adaptation, resilience, and mitigation. Existing targets and plans need to be reviewed to bring in the necessary level of ambition and outline how to achieve net-zero emissions by 2050 at the latest. Some of the benefits and pathways of accelerated climate action are indicated in Figure 2. Creating a roadmap for climate neutrality requires the Village of Rhinebeck to identify priority sectors for action, while considering climate justice, inclusiveness, local job creation and other benefits of sustainable development.

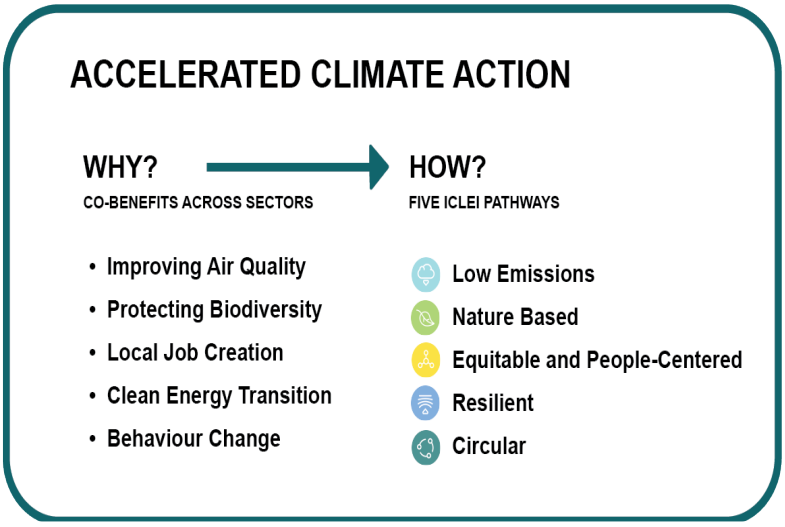


Figure 2: Benefits of Accelerated Climate Action

To complete this inventory, the Village of Rhinebeck joined eight other local municipal governments under the Dutchess County Climate Action Planning Institute (CAPI). Dutchess CAPI is a project of the Hudson Valley Regional Council and is funded by the DEC Climate Smart Communities Grant Program. Dutchess CAPI is supported by the International Council for Local Environmental Initiatives (ICLEI). ICLEI, the first and largest global network of local governments devoted to solving environmental challenges, provides tools and guidelines to help municipalities reach sustainability goals and carbon neutrality. ICLEI provides authoritative direction for greenhouse gas emissions accounting and defines carbon neutrality as:

> *The targeted reduction of greenhouse gas (GHG) emissions and GHG avoidance in government operations and across the community in all sectors toward an absolute net-zero emission level at the latest by 2050. In parallel with this, it is critical for communities to adapt to climate change and enhance climate resilience across all sectors, in all systems and processes.*

To achieve ambitious emissions reduction, and move toward carbon neutrality, the Village of Rhinebeck will need to set a clear goal and act rapidly following a holistic and integrated approach. Accelerated climate action is an opportunity for our community to experience a wide range of co-benefits, such as creating socio-economic opportunities, reducing poverty and inequality, local job creation, protecting biodiversity, enhancing sustainability, reducing risks to our built environment, and improving the health of people and nature.

ICLEI Climate Mitigation Milestones

In response to the climate emergency, many communities in the United States are taking responsibility for addressing emissions at the local level. Since many of the major sources of greenhouse gas emissions are directly or indirectly controlled through local policies, local governments have a strong role to play in reducing greenhouse gas emissions within their boundaries, as well as influencing regional emissions through partnerships and advocacy. Through proactive measures around land use patterns, transportation demand management, energy efficiency, green building, waste diversion, and more, local governments can dramatically reduce emissions in their communities. In addition, local governments are primarily responsible for the provision of emergency services and the mitigation of natural disaster impacts.

ICLEI provides a framework and methodology for local governments to identify and reduce greenhouse gas emissions. This methodology is organized along Five Milestones:

Figure 3: Climate Milestones

1. Conduct a local government operations inventory and forecast of local government greenhouse gas emissions;
2. Establish a greenhouse gas emissions target;
3. Develop a government operations climate action plan for achieving the emissions reduction target;
4. Implement the climate action plan; and,
5. Monitor and report on progress.

These milestones form an iterative process that kicks off with local leadership commitment. Figure 3 presents a diagram of the mitigation milestone process. This inventory report represents the completion of ICLEI's Climate Mitigation Milestone One and provides a foundation for future work to identify, plan, and reduce government operations greenhouse gas emissions in the Village of Rhinebeck.

Inventory Methodology

Understanding a Greenhouse Gas Emissions Inventory

The first step toward achieving tangible greenhouse gas emission reductions requires identifying baseline emissions levels and sources and activities generating emissions in the community. This report presents emissions from operations of the Village of Rhinebeck government. The government operations inventory is mostly a subset of the community-wide inventory. Figure 4 illustrates that government operations account for only a small portion of overall community emissions. For example, data on commercial energy use by the community would include energy consumed by municipal buildings, and community vehicle-miles-traveled estimates include miles driven by municipal fleet vehicles.

Figure 4: Relationship of Community Emissions to Government Operations Emissions

As local governments continue to join the climate protection movement, the need for a standardized approach to quantify GHG emissions has proven essential. This inventory uses the approach and methods provided by the U.S. Community Protocol for Accounting and Reporting Greenhouse Gas Emissions (Community Protocol) and the Local Government Operations Protocol for Accounting and Reporting Greenhouse Gas Emissions (LGO Protocol), both of which are described below.

Three greenhouse gases are included in this inventory: carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O). Many of the charts in this report represent emissions in "carbon dioxide equivalent" (CO2e) values, calculated using the Global Warming Potentials (GWP) for methane and nitrous oxide from the IPCC 5th Assessment Report. Table 1 indicates the far greater GWP of methane and nitrous oxide as compared to carbon dioxide.

Table 1: Global Warming Potential Values of Greenhouse Gases (IPCC, 2014)

Greenhouse Gas	Global Warming Potential
Carbon Dioxide (CO2)	1
Methane (CH4)	28
Nitrous Oxide (N2O)	265

Local Government Operations (LGO) Protocol

In 2010, ICLEI, the California Air Resources Board (CARB), and the California Climate Action Registry (CCAR) released Version 1.1 of the LGO Protocol.4 The LGO Protocol serves as the national standard for quantifying and reporting greenhouse emissions from local government operations. The purpose of the LGO Protocol is to provide the principles, approach, methodology, and procedures needed to develop a local government operations greenhouse gas emissions inventory.

The following sectors were included in the Village of Rhinebeck GHG emissions inventory:

- Energy use from buildings & facilities.
- Streetlights & traffic signals.
- Water and Wastewater treatment processes.
- On-road transportation from employee commute and vehicle fleet.
- Collection and mulching of yard waste.
- Fugitive emissions from work uniforms.

Note that the inventory did not include refrigerants. However, the Village government has no major cooling facilities, only a refrigerator in the Firehouse, minifridges for staff, and various window AC units.

Quantifying Greenhouse Gas Emissions

Sources and Activities

Governments contribute to greenhouse gas emissions in many ways. Two central categorizations of emissions are used in the local government inventory:

[4] ICLEI. 2008. Local Government Operations Protocol for Accounting and Reporting Greenhouse Gas Emissions. Retrieved from http://www.icleiusa.org/programs/climate/ghg-protocol/ghg-protocol

1) GHG emissions produced by "sources" under the Village government's control (e.g., furnaces and vehicles), and
2) GHG emissions produced as a consequence of operations and "activities" (e.g., the use of fossil fuel generated grid electricity).

Source	Activity
Any physical process inside the jurisdictional boundary that releases GHG emissions into the atmosphere	The use of energy, materials, and/or services by employees and officials of the government that results in the creation of GHG emissions.

Base Year

The inventory process requires the selection of a base year with which to compare current emissions. The Village of Rhinebeck's GHG emissions inventory utilizes the fiscal year June 2018 to May 2019 as its baseline year, for which the necessary data are available. This base year was selected as a typical pre-pandemic year. The fiscal year was used rather than a calendar year because administrative records for fuel and electrical purchases are maintained on a fiscal year basis. Inventories conducted for future years will use the Village fiscal year for comparison purposes.

Quantification Methods

Greenhouse gas emissions can be quantified in two ways:

- Measurement-based methodologies refer to the direct measurement of greenhouse gas emissions (from a monitoring system) emitted from a flue of a power plant, wastewater treatment plant, landfill, or industrial facility.

- Calculation-based methodologies calculate emissions using activity data and emission factors. To calculate emissions accordingly, the basic equation below is used:

Activity Data x Emission Factor = Emissions

Most emissions sources in this inventory are quantified using calculation-based methodologies. Activity data refer to the relevant measurement of energy use or other greenhouse gas-generating processes such as fuel consumption by fuel type, metered annual electricity consumption, and annual vehicle miles traveled. Please see appendices for a detailed listing of the activity data used in creating this inventory.

Known emission factors are used to convert energy usage or other activity data into associated quantities of GHG emissions. Emissions factors are usually expressed in terms of emissions per unit of activity data (e.g., pounds of CO2e per kWh of electricity used). For this inventory, calculations were made using ICLEI's web based ClearPath tool. https://icleiusa.org/clearpath/

East Market Street, Rhinebeck, NY. Photo by Vanessa Bertozzi

Government Operations Emissions Inventory Results

The results for the calculations for the government operations emissions inventory for the FY2019 base year are presented in the following sections.

Table 2: Local Government Operations Inventory

Sector	Fuel or source	FY2019 Usage	Usage unit	FY2019 Emissions ($MTCO_2e$)
Buildings & Facilities	Electricity	98,982	kWH	10.5
	Fuel Oil	14,985	gallons	152.2
			Buildings & Facilities Total	**162.7**
Streetlights & Traffic Signals	Electricity	121,857	kWH	12.9
			Streetlights & Traffic Signals Total	**12.9**
Vehicle Fleet	Wastewater Depart. - gasoline	501.8	gallons	4.4
	General Fleet - gasoline	7,520.6	gallons	66.5
	General Fleet - diesel	4,229.2	gallons	43.2
	Water Depart. - gasoline	1,035.8	gallons	9.1
			Vehicle Fleet Total	**123.2**
Employee Commute	Water Department	1,584.8	gallons	14.0
	Police Department	1,459.2	gallons	12.9
	Village Hall	2,378.2	gallons	21.05
	Wastewater Department	450.8	gallons	3.99
	Fire - Volunteer	1,381.5	gallons	12.24
	Highway Department	1,532	gallons	13.57
	Electric/EV – Village Hall workers	1.57	MMBtus	0.05
			Employee Commute Total	**77.85**
Solid Waste	Yard Waste Mulching/Composting (curbside collection)	200	tons	13.93
			Solid Waste Total	**13.93**
Water and wastewater	Water Treatment Plant - electricity	466,880	kWh	49.4
	Wastewater Treatment Plant – N2O Emissions	2,000	persons	1.48
	Septic Systems – Fugitive Emissions	12	persons	1.46
	Wastewater Treatment Plant – N2O Effluent to Surface Water	2,000	persons	98
	Wastewater Treatment Plant - Electricity	489,996	kWh	51.84
			Water and Wastewater Total	**202.2**
Process & Fugitive Emissions	Fugitive Emissions Related the Purchase of Work Uniforms	3,577	$	2.7
			Process & Fugitive Emissions Total	**2.7**
			Total Local Government Emissions	**594**

The relative portions of GHG emissions among the seven sectors tracked in the baseline inventory are illustrated in Figure 5. The operations of the Water and Wastewater plants comprise the largest sector of Village government GHG emissions. This is followed by Buildings & Facilities and Vehicle Fleet sectors. Employee Commute is the fourth largest contributor. Streetlights, Solid Waste, and Process and Fugitive emissions account for a small portion of GHG emissions. The findings for each sector are discussed in greater detail in the following sections.

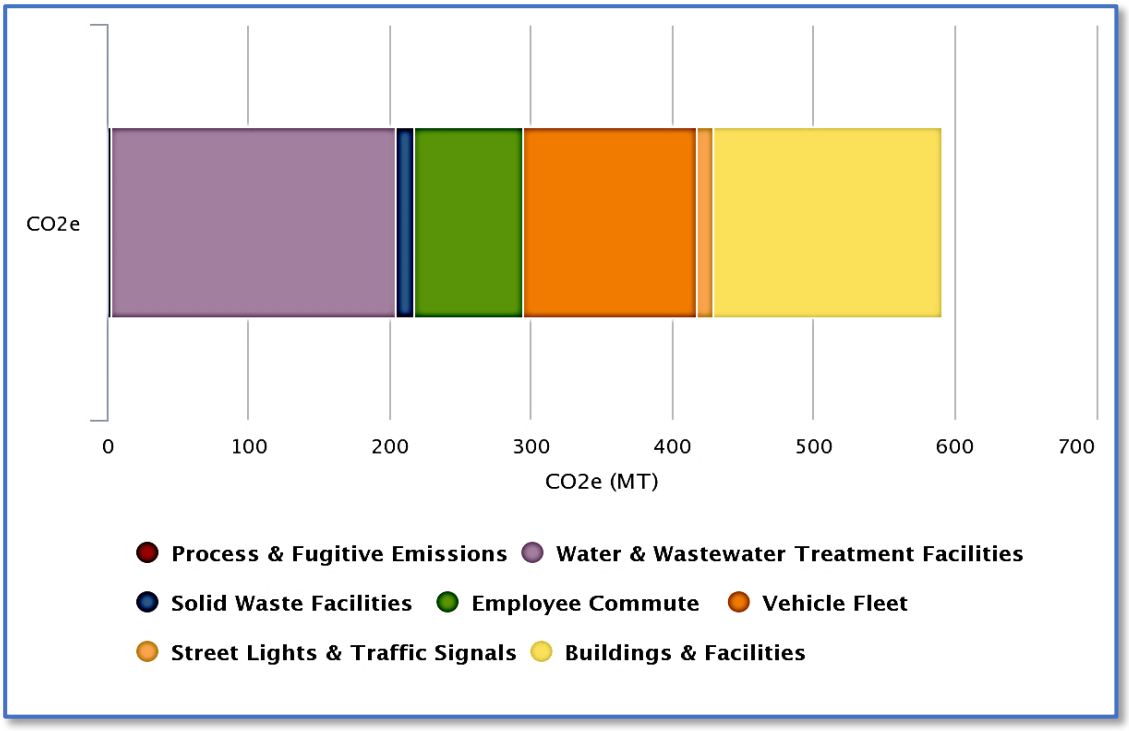
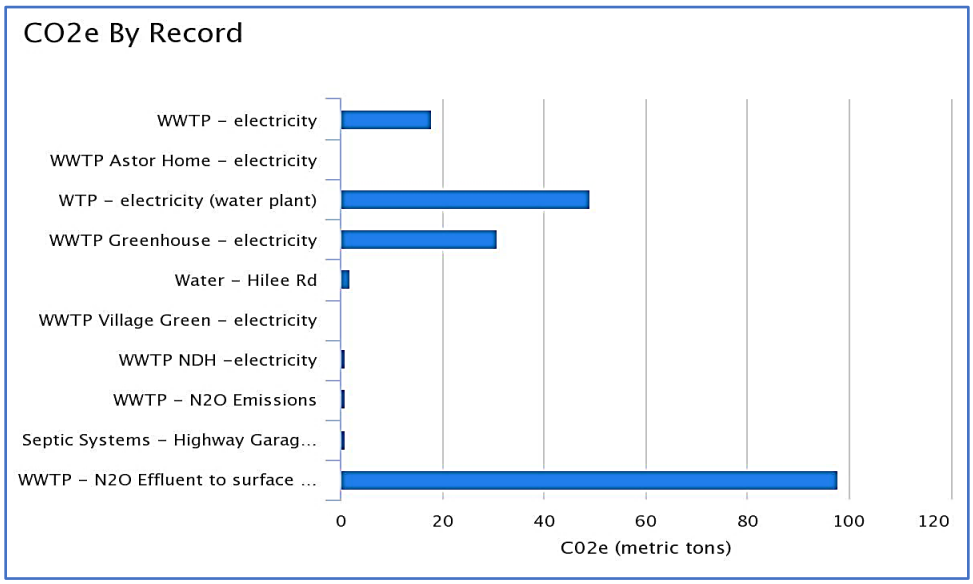


Figure 5: Village of Rhinebeck FY2019 GHG Emissions Inventory by Sector

Water Treatment and Wastewater Treatment



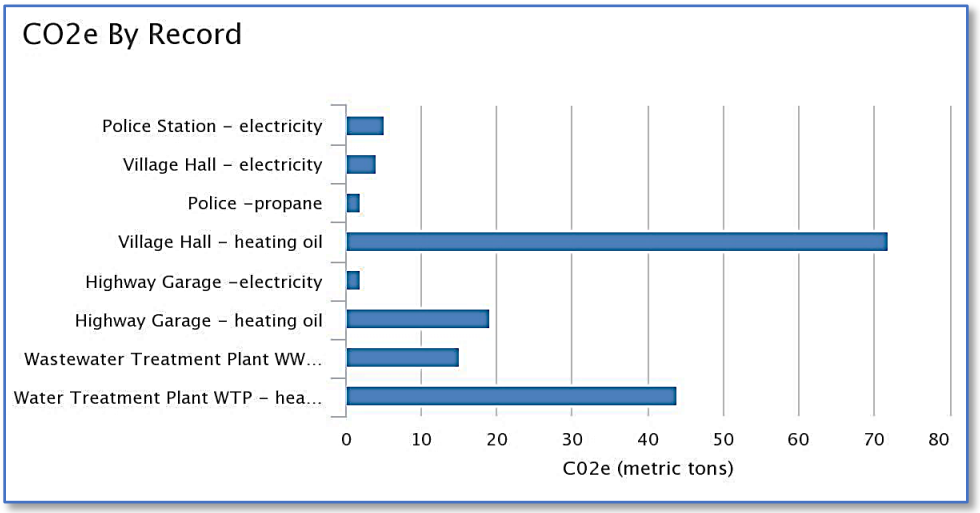
The Village of Rhinebeck Wastewater Treatment Plant serves the core Village business district and some residences including the Woods condominium development, the Garden condominium development, the Village Green apartments, Northern Dutchess County Hospital, and Tops shopping center. The plant discharges treated wastewater into the Rhinebeck Kill which flows to the Hudson River.

The Water Treatment plant treats and distributes drinking water to approximately 6,000 people throughout the village and some neighboring areas. The Water Treatment plant draws raw water from the Hudson River. The treatment process generates sludge material which is discharged to an impoundment lagoon. The quantity of potential GHG emissions related to this sludge material was not able to be calculated for this inventory because site specific testing (e.g., biological oxygen demand (BOD)) has not been conducted.

Electrical consumption for lighting, air conditioning, ancillary equipment, and treatment processes (e.g., pumping equipment) at the Water Treatment and Wastewater Treatment facilities are metered together. Accordingly, electrical use at these locations cannot be parsed between treatment processes and non-treatment uses related to the buildings. Accordingly, the electricity usage specifically associated with wastewater and water treatment processes could not be calculated. However, we know that the pumping equipment and treatment processes related to water and wastewater consume large amounts of electricity. The processing and treatment equipment is dated. Upgrades to the system and process equipment are planned or now under discussion. The Village Board should emphasize to the designers and engineers during any upgrades and renovations that energy efficiency is a priority. Note that the WWTP system, which was constructed in 1984 and has four related pumping stations, has 526 service accounts and serves about 2,000 people. Wastewater treatment demand is expected to increase with Village growth. The Village's Comprehensive Plan Committee is currently discussing ways to encourage increased density within the Village to address the housing affordability crisis.

The treatment of wastewater and the discharge of treated wastewater to surface water (Rhinebeck Kill) generates the greenhouse gas nitrous oxide (N2O) through various processes. N2O is a particularly potent greenhouse gas having a GWP 265 times greater than the warming potential of CO2. Thus, a small about of N2O emissions can equal a large value in the CO2e total of the baseline inventory. The inventory calculation indicates that the N2O release related to the discharge of wastewater effluent to surface water is the largest GHG component in the Water and Wastewater Treatment sector. Additional data and site-specific measurements may provide a better understanding of this component in the future.

Buildings and Facilities



The GHG emissions related to Village buildings and facilities were calculated by a review of records for electrical use and purchases of fuels (heating oil and propane) for heating and hot water. Electrical usage at the Water and Wastewater Treatment facilities were tallied under the Water and Wastewater sector because the machinery used to process water and wastewater operate on electricity. As each facility has only one electric meter, the electrical usage of the treatment processes could not be separated from the electrical usage for building operations such as lighting, air conditioning, etc. However, heating oil use at the Water and Wastewater facilities was tallied under the Buildings and Facilities sector since that emissions source is more related to the heating of the space and water for employees. The largest contributor to GHG emissions in the Buildings and Facilities sector was the burning of heating oil at the Village Hall. The Village Hall building additionally houses the Rhinebeck Volunteer Fire Department.

The burning of heating oil for the Village Hall's heating alone accounts for the emission of over 72 metric tons of CO2e. Each metric ton equals 2,205 pounds. The New York State Energy Research and Development Authority (NYSERDA) describes the potential benefits of switching from / discontinuing the use of combustion for heating:

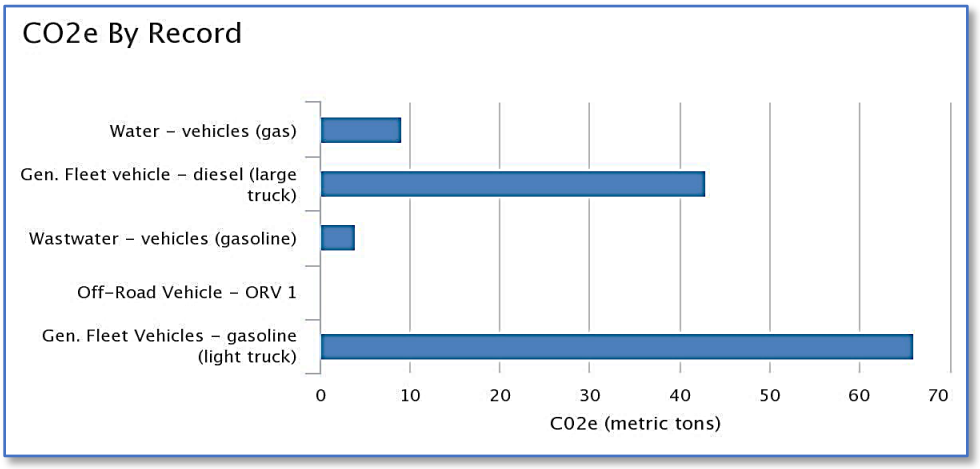
"Currently, fossil-fuel based thermal energy – primarily natural gas, propane, and heating oil – is the main energy source for space heating and domestic hot water in the residential and commercial sectors. It is responsible for about one-third of New York's energy-related greenhouse gas emissions. Clean heating and cooling technologies such as ground- and air-source heat pumps provide environmental benefits, energy bill savings, increased comfort levels and health benefits compared to conventional heating and cooling technologies. Local governments can lead by example and play an important role in encouraging adoption of ground- and air-source heat pump systems."

Converting Village Hall from an oil burning furnace and window unit ACs to a variable refrigerant flow (VRF) HVAC system could reduce the significant GHG emissions related to the operation of this building. Additionally, this climate-forward conversion/upgrade of an important public building would allow the Village to demonstrate leadership to our community. Village Hall already had a roof-mounted solar array, installed pre-FY2019, that partially offsets use of grid-based electricity. Upgrading or expanding the solar array can be assessed during future climate action planning.

The first set of government-owned EV charging stations in the village were installed in 2018 at the Village Hall. The electricity usage for these EV charging stations is metered through the neighboring Police Station.

Solar Panels on Rhinebeck Village Hall. Photo by Vanessa Bertozzi

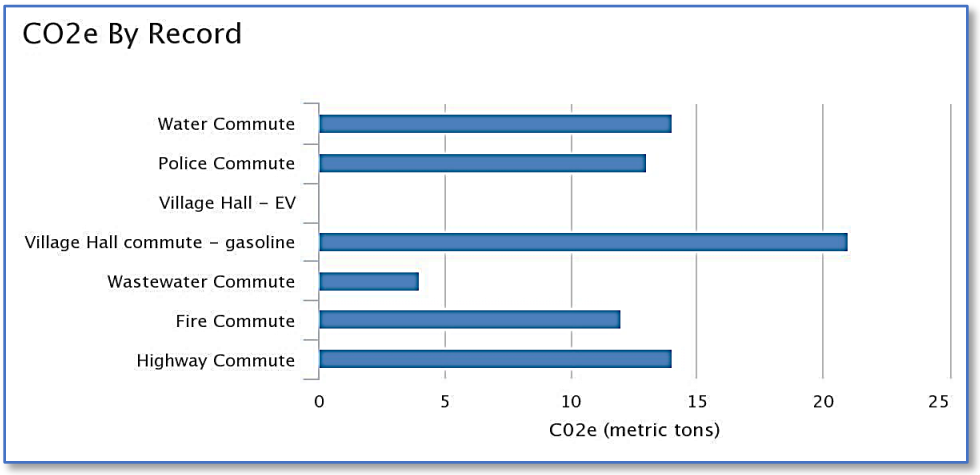
Vehicle Fleet



Findings from the Village's Inventory indicate that General Fund vehicles are responsible for the largest portion of the fleet GHG emissions. These vehicles include both the police cars and Fire/EMS vehicles, as well as Highway Department equipment. The Village has done a fleet inventory, and the Village Board has been discussing the need to transition to EVs. The transition has been slowed by the by the lack of make/model options available for pickup trucks, one of the main types of vehicles the Village should plan to replace.

Another challenge to conversion to EVs is the particular requirements of vehicles in the police car fleet. On-board computers in police vehicles draw a large amount of electricity and the cars need to be outfitted with custom interiors including rear passenger doors that do not open from inside. An EV car company that offered customized vehicles for law enforcement service would find a large, underserved market. Trustee Bertozzi has been in touch with an organization that uses a tool to help in planning the transition to electrified vehicles: www.electrificationcoalition.org/resource/drve.

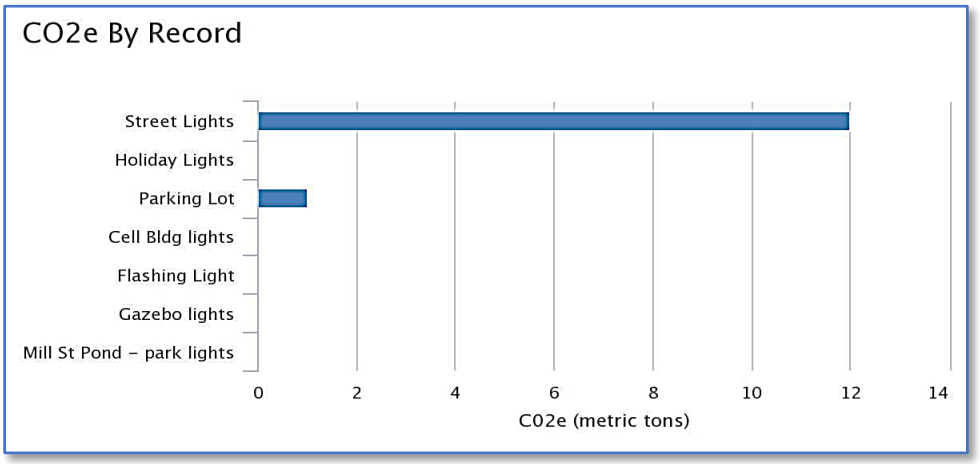
Employee Commute



Employee commute information was gathered by surveying Village Hall employees and officials. Department heads or point people facilitated the collection and development of this information by gathering data on staff commutes. For example, the Chief Water Plant Operator collected the information from the Water Department employees, and the Police Clerk gathered all the information from the police officers.

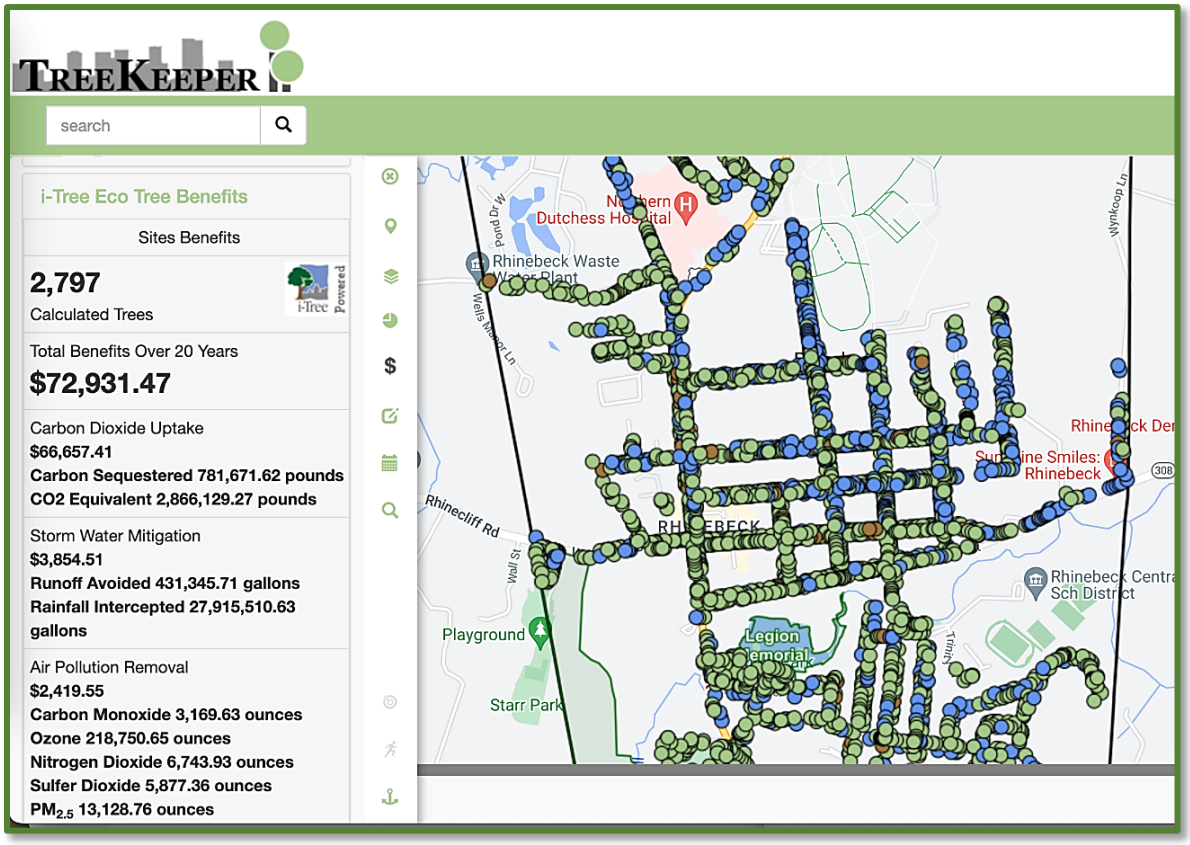
Employee commuting information calculations for the Fire Department presented an interesting challenge as the volunteer firefighters and EMS personnel may have been anywhere before responding to a call, necessitating a proxy. For this Inventory, we decided to simply calculate these potential commutes based on their home address, actual data of the number of calls they responded to during the year, plus the weekly meeting at the firehouse. In FY2019, we did have a few employees/officials who were driving EVs, hybrids, or lived close enough to walk to work.

Streetlights



The Village converted our Streetlights to light emitting diodes (LEDs) after 2019 which was after this baseline emissions inventory was compiled. LEDs provide more efficient lighting that is expected to result in energy savings reflected in subsequent GHG emissions inventories.

Urban Forest



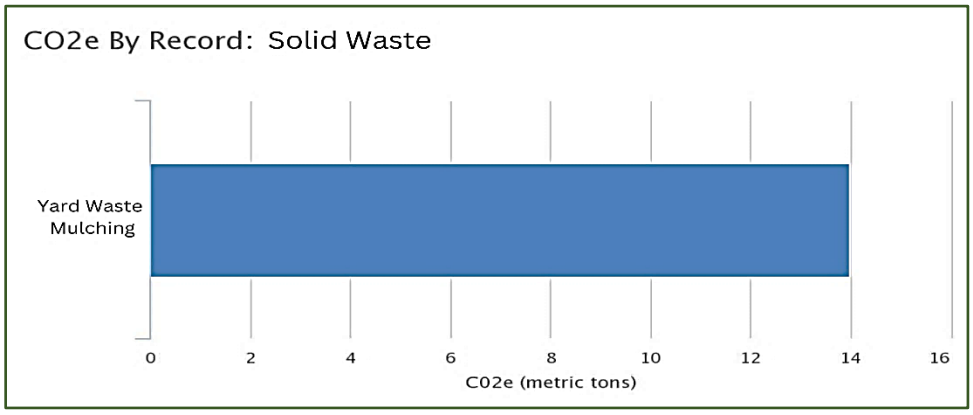
The Village is proud of our continuing status as a Tree City USA for 13 years. The Village has a local law overseeing the management of our urban forest, including the planting of trees in the public right of way and in some cases, beyond the right of way. Trees provide many environmental benefits such as removing hazardous pollutants from the air, absorbing and sequestering CO2 in their wood, controlling stormwater runoff by intercepting and absorbing rainfall, and providing cooling shade in the summer months that can reduce residential cooling demands.

The Rhinebeck Village Tree Commission oversees our urban forest and uses TreeKeeper software to track tree planting activities, tree locations and status, and tree health and diversity. TreeKeeper also includes calculations using i-Tree for a quantitative look at nature-based benefits of the street trees. The TreeKeeper inventory for the Village indicates that our nearly 3,000 street trees account for a total uptake of 2,866,129 pounds (approximately 1,300 metric tons) of CO2 Equivalent over a 20-year period. Note that this inventory does not include the numerous trees located throughout the Village on private property.

These results indicate that maintaining a healthy and diverse urban forest plays an important role in mitigating GHG emissions at the local level. However, because the TreeKeeper calculations are based on a 20-year period, the effect on the FY2019 baseline single year inventory could not be directly calculated. Calculating the value of CO2e removal is not as straightforward as simply dividing the total value by 20 to get an annual amount (65 metric tons) because the TreeKeeper calculation considers the growth rates and the characteristics of individual tree species.

For this reason, we did not include the potential CO2e reduction from our trees into the ClearPath tool and the baseline inventory. However, we hope that TreeKeeper will develop the ability to track this data in annual slices by the time we do our next GHG emissions inventory. We believe it's critically important to invest in and manage our urban forest, not only for GHG removal but also for shade/cooling, flood water absorption, traffic calming, biodiversity/habitat conservation, scenic beauty, pedestrian comfort, and general well-being. Street trees make vital contributions toward long-term sustainability goals. The Village's TreeKeeper dashboard can be viewed on the Village's website at:
https://rhinebeckny.treekeepersoftware.com/index.cfm?deviceWidth=1236

Solid Waste



The Village government does not own or operate a solid waste landfill or facility, but instead contracts for solid waste disposal with private hauler Welsh Sanitation. According to the Rhinebeck Village Climate Smart Task Force's research on Welsh: approximately 50% of the garbage is hauled to a "burn plant" in Poughkeepsie, the WinWaste / Wheelabrator facility, where it is incinerated. The remaining 50% is hauled to landfills in Syracuse or Ontario. Data are not available to quantify the solid waste the Village collects from the Big Bellies (public trash bins) or solid waste from Village municipal buildings. A municipal solid waste audit would be needed to understand the tonnage and the breakdown between garbage versus recycling from Village operations.

The Village conducts curbside collection of vegetative yard waste from residential properties and recycles the collected material into mulch. An estimated 200 tons of green waste was collected for processing. The collected materials are shredded, mulched, and composited at the Village Highway Department

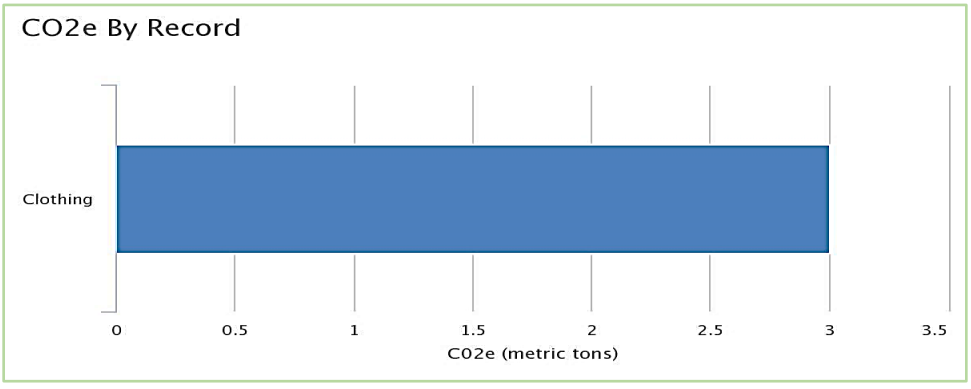
facility. The Village sells processed mulch/compost for use in gardens and landscapes. Emissions related to the composting of 200 tons of green waste are calculated in the ClearPath tool using ClearPath's factor set. The factor set draws from the USEPA's Waste Reduction Model (WARM) tool (version 15, November 2020), and documentation can be found in Chapter 2 on Yard Trimmings: www.epa.gov/sites/default/files/2020-12/documents/warm_organic_materials_v15_10-29-2020.pdf.

Note that the ClearPath factor set considers the vehicle emissions associated with bringing the yard trimmings to a processing site. This calculation may result in a small amount of the Highway Department fleet fuel usage being counted twice. However, emissions related to yard waste mulching operations were included in the inventory to present a comprehensive calculation of government operations emissions for the base year. Interestingly, the WARM model also includes emissions offsets related to "increases in soil carbon storage" and "avoided synthetic fertilizer use due to land application of compost." The WARM tool calculates that the net emissions from landfilling yard waste are four times greater than the emissions related to the composting/mulching these materials.

Currently, the Village government is attempting to create a municipal food waste composting program, and hopefully by our next GHG emissions inventory the benefits of that program can be calculated. When conducting a community-wide GHG emissions inventory, the Village should try to understand the quantity of backyard composting being conducted by residents.

Village generated solid waste can include construction and demolition materials from renovation projects. These projects are conducted by Village staff or by contracted workers. GHG emissions related to the disposal of these waste materials were not tracked and were not included in the baseline inventory. Going forward, the disposal of materials related to Village construction and demolition projects can be tracked for GHG emission inventories.

Process and Fugitive Emissions



Process and fugitive emissions related to Village operations are difficult to quantify. For the FY2019 baseline inventory, emissions associated with the manufacture and distribution of work clothing purchased for the Village's uniform program were estimated based on the annual purchase cost. We used

the default setting available in the ClearPath tool (Clothing: 750 kg CO2e/$), which is based on a factor set from University of California, Berkeley's Cool Climate research: https://coolclimate.org. During FY2019, Fire/EMS and Police had not purchased new turnout gear, so the baseline record year only represents uniform purchases for the Water, Wastewater, and Highway Departments.

Next Steps:

The findings from the baseline local government operations emissions inventory points out a need for:

- Retrofitting heating, ventilation, and air conditioning (HVAC) systems for buildings and facilities - in particular, improvements to heating for Village Hall/Firehouse stands out as high potential for cost savings and reducing emissions.
- Upgrades to our Water and Wastewater Plants – the processes themselves can be made more energy efficient with the replacement of old pumps, etc. The Village is undertaking upgrades to the WTP starting in 2024 and deciding improvements to the WWTP.
- Tracking emissions associated with the management of river water sludge deposited to the WTP lagoon. A test of the BOD5 costs $30.
- Developing a Fleet Efficiency Policy and Fleet Rightsizing Program – The Village government already maintains a Fleet Inventory. We should plan for transitioning our fleet, particularly as a greater range of EV models become available for police cars, pickup trucks, and heavy-duty vehicles: www.electrificationcoalition.org/resource/drve.
- Employee commute – The Village Board could consider incentives for employees and officials to switch to EVs.
- Conducting Government operations waste audit – to better understand the quantities of solid waste (garbage) the Village government is producing and collecting.
- Tracking Construction and Demolition - the Village government could start tracking emissions related to construction and demolition. The transportation and disposal of waste generated during these activities can be evaluated. The production and use of concrete for construction generates a large amount of GHG emissions. Hastings-on-Hudson has successfully incorporated the use of low-carbon concrete into municipal projects.
- Solar arrays for electrical generation – facilities and operations such as the Village Hall or the Water Treatment Plant may benefit from the increased use of solar arrays for electrical power generation. A cost/benefit analysis can be a part of future planning.
- Further research on nature-based solutions related to our urban forest.

Conclusion

This inventory marks the completion of Milestone One of the Five ICLEI Climate Mitigation Milestones. The findings from the inventory indicate that approximately 594 metric tons of carbon dioxide equivalent (CO2e) were emitted by Village operations across seven sectors during the baseline year. The next steps are to forecast emissions, set an emissions-reduction target, and build upon the Village's existing Climate Smart efforts with a more robust climate action plan that identifies specific quantified strategies that can cumulatively meet that target.

The Intergovernmental Panel on Climate Change (IPCC) states that to meet the Paris Agreement commitment of keeping warming below 1.5°C, we must reduce global emissions by 50% by 2030 and reach carbon neutrality by 2050. Equitably reducing global emissions by 50% requires that high-emitting, wealthy nations reduce their emissions by more than 50%. More than ever, it is imperative that countries, regions, and local governments set targets that are ambitious enough to slash carbon emissions between now and mid-century.

Science-Based Targets are calculated climate goals, in line with the latest climate science, that represent a community's fair share of the global ambition necessary to meet the Paris Agreement commitment. To achieve a science-based target, community education, involvement, and partnerships will be instrumental. The Village Board will be discussing setting a target through its participation in the CAPI program.

The FY2019 baseline inventory will form the basis for comparisons to GHG emissions calculations conducted for subsequent years and the starting point for a comprehensive climate action plan. The Village of Rhinebeck will continue to track key energy use and emissions indicators on an on-going basis and develop updated inventories on a regular basis. This tracking of emission trends is needed to assess the progress and goal achievement of any planning.

This inventory shows that efficiency improvements to our Water and Wastewater Plants, transitioning our fleet to EVs, and retrofitting our buildings to modern HVAC systems will make important progress toward sustainability goals. Through these efforts and others, the Village of Rhinebeck can achieve environmental, economic, and social benefits beyond reducing emissions.

Appendix: Methodology Details

Energy

The following tables show each activity, related data sources, and notes on data gaps.

Energy Data Sources

Activity	Data Source	Data Gaps/Assumptions
Local Government Operations		
Electricity consumption	Village Clerk	Assumption: the electrical meters in place at Village facilities are accurately and completely measuring electrical consumption.
Propane consumption	Village Clerk	Used at Police Station only for space heating.
Grid Electricity	Village Clerk/ Central Hudson	Central Hudson has experienced metering and billing anomalies during the last few years. These irregularities may cause data tracking challenges for future GHG inventories.

Emissions Factors for Electricity Consumption

Year	CO_2 (lbs./MWh)	CH_4 (lbs./GWh)	N_2O (lbs./GWh)
2018	253.11	18.0	2.0

Transportation

Transportation Data Sources

Activity	Data Source	Data Gaps/Assumptions
Local Government Operations		
Government vehicle fleet	Village Clerk	Fuel use/consumption was tracked by bulk fuel purchases for gasoline and diesel. Additional administrative efforts would be required to track fuel use by vehicle to evaluation potential future efficiencies.

Employee commute	Village Clerk	Assumption: the employee commuting data was accurately captured through self-reporting and estimates. Employee commuting information can be more accurately tracked going forward while maintaining employee confidentiality.

For vehicle transportation, it is necessary to apply average miles per gallon and emissions factors for CH4 and N2O to each vehicle type. The factors used are shown in Table 6.

MPG and Emissions Factors by Vehicle Type

Fuel	Vehicle type	MPG	CH_4 g/mile	N_2O g/mile
Gasoline	Passenger car	Vehicle use, fuel consumption, and miles per gallon were not tracked for the FY2019 baseline inventory. Vehicle fleet emissions were tracked by totaling the volume of gasoline and diesel purchased and consumed during the year. Going forward, individual vehicle fuel use and mileage could be tracked if this information is needed. Individual tracking would require additional administrative efforts.		
Gasoline	Light truck			
Gasoline	Heavy truck			
Gasoline	Motorcycle			
Diesel	Passenger car			
Diesel	Light truck			
Diesel	Heavy truck			

Wastewater

Wastewater Data Sources

Activity	Data Source	Data Gaps/Assumptions
Local Government Operations		
Nitrogen Discharge	WWTP Operations/ ClearPath Calculations	N2O discharges to air and surface water related to wastewater treatment plant operations are not well understood. Additional testing and monitoring may provide more accurate calculations.
Energy used in wastewater facilities	WWTP Operations	Separate electrical metering would allow an understanding of the electrical power requirements of the treatment processes separate from the electrical power requirements of the building operations related to lighting, heating, and cooling.

Potable Water

Potable Water Data Sources

Activity	Data Source	Data Gaps/Assumptions
Local Government Operations		
Potable water treatment	WTP operations	The potential GHG emissions related to the generation and discharge of residual sludge from raw water purification has not been addressed. The residual sludge is currently discharged and stored in an impoundment lagoon.
Water Treatment Operations	WTP Operation	Grid electrical use for the water treatment processes and the building lighting and cooling are tracked on a single meter. Separate metering would allow a greater understanding of the electrical use, and possible efficiencies, of the water treatment and distribution processes.

Solid Waste

Solid Waste Data Sources

Activity	Data Source	Data Gaps/Assumptions
Local Government Operations		
Solid Waste Generation	Estimate	Solid waste disposal from Village government facilities is conducted by a private contractor. Solid waste generated at Village government facilities is not tracked separately. Mulch sales were used to estimate the quantities of green waste collected curbside from residential properties.

Fugitive Emissions

Fugitive Emissions Data Sources

Activity	Data Source	Data Gaps/Assumptions
Local Government Operations		
Purchase and use of clothing for Village workers	Village Clerk	Purchases for Fire Department and Police Department clothing and protective gear did not occur during the base year.

Inventory Calculations

The FY2019 inventory was calculated following the US Community Protocol and ICLEI's ClearPath software tool. As discussed in Inventory Methodology, the IPCC [Intergovernmental Panel on Climate Change] 6th Assessment Report was used for global warming potential (GWP) values to convert methane and nitrous oxide to CO2 equivalent units (CO2e). ClearPath's inventory calculators allow for input of the sector activity data in various forms (i.e., gallons of fuel use, kilowatt hours, or vehicle miles travelled) with appropriate emission factors to calculate the final CO2e emissions.

Credits and Acknowledgements

Gary Bassett, Mayor

Vanessa Bertozzi, Village Trustee

Michael Forlenza, Climate Smart Task Force Member

Krissy Denu, Deputy Clerk

Karen McLaughlin, Treasurer

Kyle Eighmy, Superintendent of Public Works

Martina McClinton, Clerk

We acknowledge the support of and extend thanks to Mary Lambert and Carla Castillo from Hudson Valley Regional Council (HVRC), Kale Roberts and Caroline Dickey from the International Council for Local Environmental Initiatives (ICLEI), and the entire group of eight other municipalities in the Dutchess Climate Action Planning Institute (CAPI) cohort. CAPI is a *program* of the Hudson Valley Regional Council. *This program has been funded in part through a grant to the County of Dutchess as lead applicant through the Climate Smart Communities Grant Program, Title 15 of the Environmental Protection Fund through the New York State Department of Environmental Conservation.*

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Village of Rhinebeck incorporated in 1834. Photo by Michael Forlenza.

Executive Summary

The Village of Rhinebeck recognizes that greenhouse gas (GHG) emissions from human activity are catalyzing profound climate change, the consequences of which pose substantial risks to the future health, wellbeing, and prosperity of our community.

The Village achieved bronze certification in New York State's Climate Smart Communities (CSC) program in March 2020, and the Village's Climate Smart Task Force has been working towards silver certification. The CSC Task Force, a group of dedicated volunteers, is led by its Coordinator, Trustee Vanessa Bertozzi. We are grateful for the support of the Village Board in pursuing actions to characterize and reduce our GHG emissions, address climate resiliency, especially to flooding, and engaging with our local community. You can learn more about the Village's CSC projects and activities via www.climatesmartrhinebeck.org, where you can find the Annual Climate Progress Reports among lots of other information.

Climate Smart Bronze Certification for the Village of Rhinebeck. Photo by Vanessa Bertozzi.

This inventory report was prepared to characterize the GHG emissions related to Village government operations and to activities for the baseline year of June 2018 to May 2019, the Village's fiscal year. Information sources used to develop this inventory included administrative records, utility bills, personal reporting, and science-based estimates.

The findings from the inventory indicate that approximately 594 metric tons of carbon dioxide equivalent (CO_2e) were emitted by Village operations during the baseline year. A metric ton equals 2,205 pounds. These GHG emissions are related to the burning of fossil fuels, electricity usage, and miscellaneous related activities. The Village burns fossil fuel for the heating of buildings and the operation of motor vehicles. Suppliers of electricity generate GHGs during the generation and transmission of power.

The largest portions of Village GHG emissions are related to operations of the Water and Wastewater Treatment plants and the heating and cooling of buildings and facilities. Compiling this baseline inventory is the first step in a process to track and manage progress toward GHG emissions reductions and achievement of net zero emissions.

Key Findings

Using available administrative records and the online ClearPath software tool developed by ICLEI, the Village compiled a GHG inventory for the emissions related to government operations during the base fiscal year 2019 year. Figure 1 shows operations emissions across seven sectors equaling a total of 594 metric tons of carbon dioxide equivalent (CO2e).

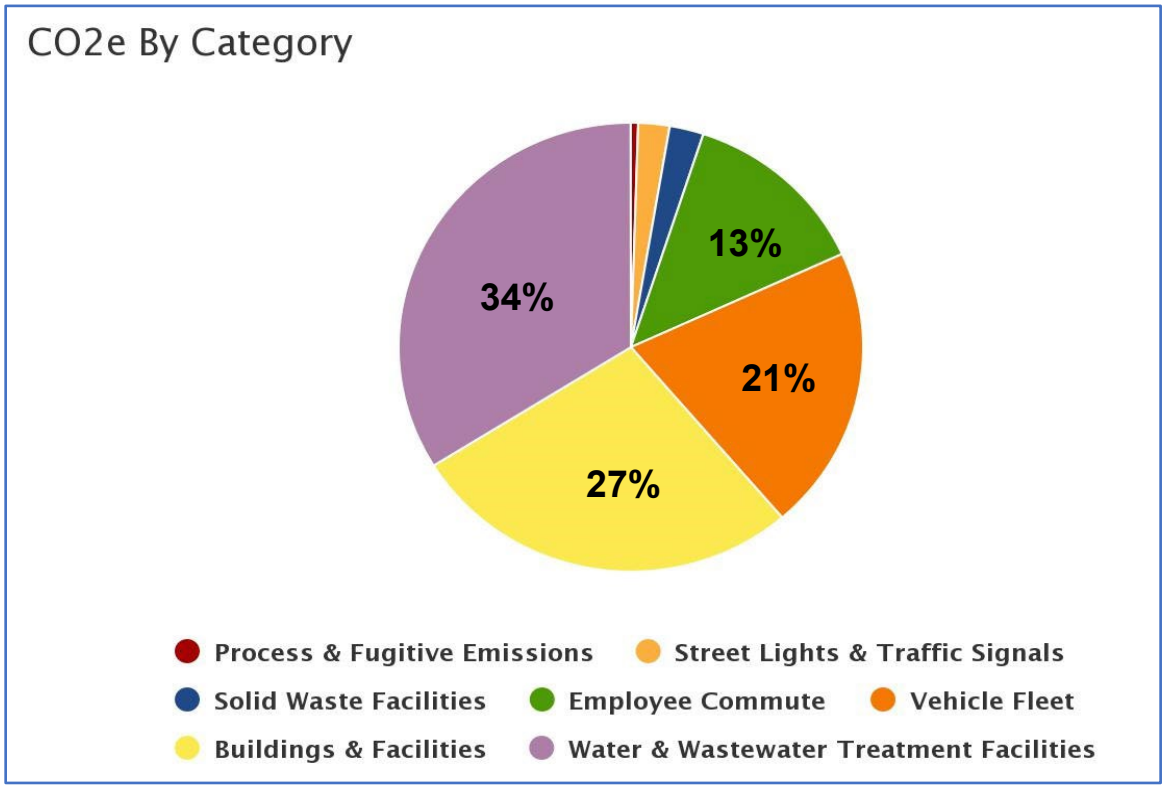


Figure 1: Village of Rhinebeck Government Operations Emissions by Sector

Emissions associated with the Water and Wastewater Treatment Facilities account for the largest portion (34% of the total or 201 metric tons) of the Village government's emissions. The second largest contributor is Buildings & Facilities (27% of the total or 163 metric tons). Together, these two sources contribute approximately two thirds (61%) of the Village government's GHG emissions. Actions to reduce emissions from these two sectors will be a key part of any future climate action plan developed by the Village of Rhinebeck.

The next largest contributor is the vehicle fleet (21% of total or 122 metric tons), followed by employee commute, which though relatively smaller, was still a significant contributor (13% of the total or 78 metric tons). Streetlights, solid waste, and fugitive emissions were responsible for the remainder (about 5% the total) of local government operations emissions.

The Inventory Results section of this report provides a detailed profile of emissions sources within the Village of Rhinebeck's government operations; information that is key to guiding local reduction efforts. The Inventory Results section also details any challenges in tracking data, such as solid waste. The GHG emissions inventory data will also provide a baseline against which the Village will be able to compare future performance and demonstrate progress in reducing emissions. Typically, a municipality our size updates its GHG emissions inventory once every five years.

The Village government selected the fiscal year June 2018 - May 2019 (FY2019) as a base year to draw on pre-pandemic data. Additionally, the year FY2019 pre-dates the recent billing and data accounting anomalies that Central Hudson Gas & Electric Corporation (Central Hudson) has experienced. Central Hudson, a regulated transmission and distribution utility, provides grid-based electrical power to the Village of Rhinebeck. Hopefully, Central Hudson will have worked out their issues by the time the Village government completes another GHG emissions inventory.

Waterfall at Asher Dam on Crystal Lake, Rhinebeck, NY. Photo by Michael Forlenza.

Introduction to Climate Change

Naturally occurring gases dispersed in the atmosphere determine the Earth's climate by trapping solar radiation. This phenomenon is known as the greenhouse effect. Overwhelming evidence shows that human activities are increasing the concentration of greenhouse gases and changing the global climate. The most significant contributor is the burning of fossil fuels for transportation, electricity generation and other purposes, which introduces large amounts of carbon dioxide and other greenhouse gases into the atmosphere. Collectively, these gases intensify the natural greenhouse effect, causing global average surface and lower atmospheric temperatures to rise, threatening the safety, quality of life, and economic prosperity of global communities. Although the natural greenhouse effect is needed to keep the earth warm, a human enhanced greenhouse effect with the rapid accumulation of GHG in the atmosphere leads to too much heat and radiation being trapped. The Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report confirms that human activities have unequivocally caused an increase in carbon emissions[1]. Many regions are already experiencing the consequences of global climate change, and the Village of Rhinebeck is no exception.

Human activities are estimated to have caused approximately 1.0°C of global warming above pre-industrial levels, with a likely range of 0.8°C to 1.2°C. At the current rate of increase, global warming is likely to reach 1.5°C in the period between 2030 and 2052. Warming from anthropogenic emissions from the pre-industrial period to the present will persist for centuries to millennia and will continue to cause further long-term changes in the climate system. These changes will include sea level rise, with associated flooding impacts. Climate-related risks for natural and human systems are higher for global warming of 1.5°C than at present, but lower than at 2°C. These risks depend on the magnitude and rate of warming, geographic location, levels of development and vulnerability, and on the choices and implementation of adaptation and mitigation options[2].

[1] IPCC, 2021: Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [MassonDelmotte, V., P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J. B. R. Matthews, T. K. Maycock, T. Waterfield, O. Yelekçi, R. Yu and B. Zhou (eds.)]. Cambridge University Press. In Press.

[2] IPCC, 2018: Summary for Policymakers. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. World Meteorological Organization, Geneva, Switzerland, 32 pp.

According to the 2018 Fourth National Climate Assessment, the northeast U.S. will experience potentially devastating impacts from seasonal changes and hazards occurring at unprecedented magnitudes. "By 2035, and under both lower and higher scenarios (RCP4.5 and RCP8.5), the Northeast is projected to be more than 3.6°F (2°C) warmer on average than during the preindustrial era. This would be the largest increase in the contiguous United States and would occur as much as two decades before global average temperatures reach a similar milestone."

Rhinebeck Dutch Reformed Church, Mill Street. Photo by Michael Forlenza.

The Hudson Valley, including Village of Rhinebeck, is at particular risk from sea level rise along the Hudson River. The Village's Water Treatment Plant is located adjacent to the Hudson River in Rhinecliff. Additionally, localized flooding, erosion, heat emergencies, habitat loss, and drought present risks to the Village as weather patterns become more intense. "With little redundancy in their infrastructure and, therefore, limited economic resilience, many rural communities have limited ability to cope with climate-related changes." (2018 Fourth National Climate Assessment).

Many people visit and move to this region to enjoy the beautiful landscape and fresh local food, but the local agriculture and farm workers are at extreme risk due to increasingly intense and abnormal weather patterns. Beyond agriculture, changing climate threatens many sectors within the Village of Rhinebeck and the greater region, most notably tourism and public health with our aging demographic[3].

"Changing climate threatens the health and well-being of people in the Northeast through more extreme weather, warmer temperatures, degradation of air and water quality, and sea level rise. These environmental changes are expected to lead to health-related impacts and costs, including additional deaths, emergency room visits and hospitalizations, and a lower quality of life." (2018 Fourth National Climate Assessment)

[3] U.S. Global Change Research Program. 2018. National Climate Assessment – Ch 18: Northeast. Retrieved from https://nca2018.globalchange.gov/chapter/18/

Many communities in the United States have started to take responsibility for addressing climate change at the local level. Energy efficiencies and reducing fossil fuel use in the community can have many benefits in addition to reducing greenhouse gas emissions. More efficient use of energy decreases utility and transportation costs for residents, governments, and businesses. Retrofitting homes and businesses to be more efficient creates local jobs. In addition, when residents save on energy costs, they are more likely to spend the savings at local businesses supporting the local economy. Reducing fossil fuel use improves air quality and increases opportunities for walking and bicycling, improving residents' health.

Rhinebeck Village Hall and Fire Department, East Market Street. Photo by Michael Forlenza.

Greenhouse Gas Inventory as a Step Toward Carbon Neutrality

Facing the climate crisis requires the concerted efforts of local governments and their partners, those that are close to the communities directly dealing with the effects of climate change. Cities, towns, and counties are well placed to define coherent and inclusive plans that address integrated climate action — climate change adaptation, resilience, and mitigation. Existing targets and plans need to be reviewed to bring in the necessary level of ambition and outline how to achieve net-zero emissions by 2050 at the latest. Some of the benefits and pathways of accelerated climate action are indicated in Figure 2. Creating a roadmap for climate neutrality requires the Village of Rhinebeck to identify priority sectors for action, while considering climate justice, inclusiveness, local job creation and other benefits of sustainable development.

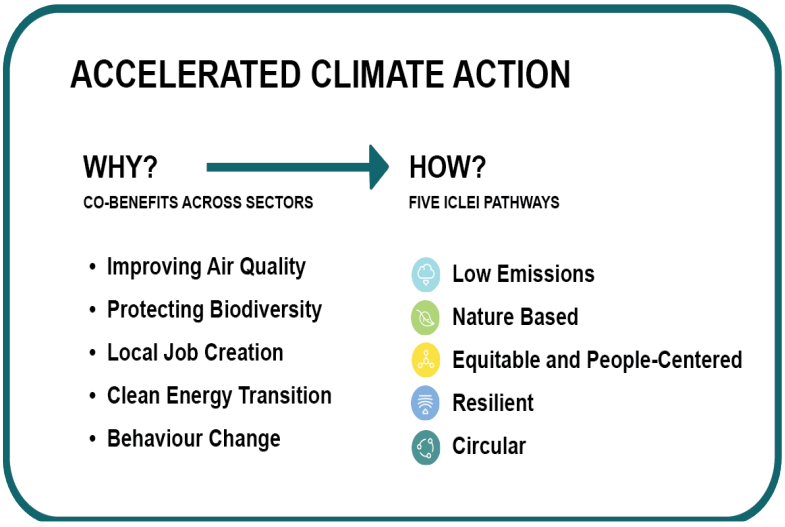


Figure 2: Benefits of Accelerated Climate Action

To complete this inventory, the Village of Rhinebeck joined eight other local municipal governments under the Dutchess County Climate Action Planning Institute (CAPI). Dutchess CAPI is a project of the Hudson Valley Regional Council and is funded by the DEC Climate Smart Communities Grant Program. Dutchess CAPI is supported by the International Council for Local Environmental Initiatives (ICLEI). ICLEI, the first and largest global network of local governments devoted to solving environmental challenges, provides tools and guidelines to help municipalities reach sustainability goals and carbon neutrality. ICLEI provides authoritative direction for greenhouse gas emissions accounting and defines carbon neutrality as:

> *The targeted reduction of greenhouse gas (GHG) emissions and GHG avoidance in government operations and across the community in all sectors toward an absolute net-zero emission level at the latest by 2050. In parallel with this, it is critical for communities to adapt to climate change and enhance climate resilience across all sectors, in all systems and processes.*

To achieve ambitious emissions reduction, and move toward carbon neutrality, the Village of Rhinebeck will need to set a clear goal and act rapidly following a holistic and integrated approach. Accelerated climate action is an opportunity for our community to experience a wide range of co-benefits, such as creating socio-economic opportunities, reducing poverty and inequality, local job creation, protecting biodiversity, enhancing sustainability, reducing risks to our built environment, and improving the health of people and nature.

ICLEI Climate Mitigation Milestones

In response to the climate emergency, many communities in the United States are taking responsibility for addressing emissions at the local level. Since many of the major sources of greenhouse gas emissions are directly or indirectly controlled through local policies, local governments have a strong role to play in reducing greenhouse gas emissions within their boundaries, as well as influencing regional emissions through partnerships and advocacy. Through proactive measures around land use patterns, transportation demand management, energy efficiency, green building, waste diversion, and more, local governments can dramatically reduce emissions in their communities. In addition, local governments are primarily responsible for the provision of emergency services and the mitigation of natural disaster impacts.

ICLEI provides a framework and methodology for local governments to identify and reduce greenhouse gas emissions. This methodology is organized along Five Milestones:

Figure 3: Climate Milestones

1. Conduct a local government operations inventory and forecast of local government greenhouse gas emissions;
2. Establish a greenhouse gas emissions target;
3. Develop a government operations climate action plan for achieving the emissions reduction target;
4. Implement the climate action plan; and,
5. Monitor and report on progress.

These milestones form an iterative process that kicks off with local leadership commitment. Figure 3 presents a diagram of the mitigation milestone process. This inventory report represents the completion of ICLEI's Climate Mitigation Milestone One and provides a foundation for future work to identify, plan, and reduce government operations greenhouse gas emissions in the Village of Rhinebeck.

Inventory Methodology

Understanding a Greenhouse Gas Emissions Inventory

The first step toward achieving tangible greenhouse gas emission reductions requires identifying baseline emissions levels and sources and activities generating emissions in the community. This report presents emissions from operations of the Village of Rhinebeck government. The government operations inventory is mostly a subset of the community-wide inventory. Figure 4 illustrates that government operations account for only a small portion of overall community emissions. For example, data on commercial energy use by the community would include energy consumed by municipal buildings, and community vehicle-miles-traveled estimates include miles driven by municipal fleet vehicles.

Figure 4: Relationship of Community Emissions to Government Operations Emissions

As local governments continue to join the climate protection movement, the need for a standardized approach to quantify GHG emissions has proven essential. This inventory uses the approach and methods provided by the U.S. Community Protocol for Accounting and Reporting Greenhouse Gas Emissions (Community Protocol) and the Local Government Operations Protocol for Accounting and Reporting Greenhouse Gas Emissions (LGO Protocol), both of which are described below.

Three greenhouse gases are included in this inventory: carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O). Many of the charts in this report represent emissions in "carbon dioxide equivalent" (CO2e) values, calculated using the Global Warming Potentials (GWP) for methane and nitrous oxide from the IPCC 5th Assessment Report. Table 1 indicates the far greater GWP of methane and nitrous oxide as compared to carbon dioxide.

Table 1: Global Warming Potential Values of Greenhouse Gases (IPCC, 2014)

Greenhouse Gas	Global Warming Potential
Carbon Dioxide (CO2)	1
Methane (CH4)	28
Nitrous Oxide (N2O)	265

Local Government Operations (LGO) Protocol

In 2010, ICLEI, the California Air Resources Board (CARB), and the California Climate Action Registry (CCAR) released Version 1.1 of the LGO Protocol.4 The LGO Protocol serves as the national standard for quantifying and reporting greenhouse emissions from local government operations. The purpose of the LGO Protocol is to provide the principles, approach, methodology, and procedures needed to develop a local government operations greenhouse gas emissions inventory.

The following sectors were included in the Village of Rhinebeck GHG emissions inventory:

- Energy use from buildings & facilities.
- Streetlights & traffic signals.
- Water and Wastewater treatment processes.
- On-road transportation from employee commute and vehicle fleet.
- Collection and mulching of yard waste.
- Fugitive emissions from work uniforms.

Note that the inventory did not include refrigerants. However, the Village government has no major cooling facilities, only a refrigerator in the Firehouse, minifridges for staff, and various window AC units.

Quantifying Greenhouse Gas Emissions

Sources and Activities

Governments contribute to greenhouse gas emissions in many ways. Two central categorizations of emissions are used in the local government inventory:

[4] ICLEI. 2008. Local Government Operations Protocol for Accounting and Reporting Greenhouse Gas Emissions. Retrieved from http://www.icleiusa.org/programs/climate/ghg-protocol/ghg-protocol

1) GHG emissions produced by "sources" under the Village government's control (e.g., furnaces and vehicles), and
2) GHG emissions produced as a consequence of operations and "activities" (e.g., the use of fossil fuel generated grid electricity).

Source	Activity
Any physical process inside the jurisdictional boundary that releases GHG emissions into the atmosphere	The use of energy, materials, and/or services by employees and officials of the government that results in the creation of GHG emissions.

Base Year

The inventory process requires the selection of a base year with which to compare current emissions. The Village of Rhinebeck's GHG emissions inventory utilizes the fiscal year June 2018 to May 2019 as its baseline year, for which the necessary data are available. This base year was selected as a typical pre-pandemic year. The fiscal year was used rather than a calendar year because administrative records for fuel and electrical purchases are maintained on a fiscal year basis. Inventories conducted for future years will use the Village fiscal year for comparison purposes.

Quantification Methods

Greenhouse gas emissions can be quantified in two ways:

- Measurement-based methodologies refer to the direct measurement of greenhouse gas emissions (from a monitoring system) emitted from a flue of a power plant, wastewater treatment plant, landfill, or industrial facility.

- Calculation-based methodologies calculate emissions using activity data and emission factors. To calculate emissions accordingly, the basic equation below is used:

Activity Data x Emission Factor = Emissions

Most emissions sources in this inventory are quantified using calculation-based methodologies. Activity data refer to the relevant measurement of energy use or other greenhouse gas-generating processes such as fuel consumption by fuel type, metered annual electricity consumption, and annual vehicle miles traveled. Please see appendices for a detailed listing of the activity data used in creating this inventory.

Known emission factors are used to convert energy usage or other activity data into associated quantities of GHG emissions. Emissions factors are usually expressed in terms of emissions per unit of activity data (e.g., pounds of CO2e per kWh of electricity used). For this inventory, calculations were made using ICLEI's web based ClearPath tool. https://icleiusa.org/clearpath/

East Market Street, Rhinebeck, NY. Photo by Vanessa Bertozzi

Government Operations Emissions Inventory Results

The results for the calculations for the government operations emissions inventory for the FY2019 base year are presented in the following sections.

Table 2: Local Government Operations Inventory

Sector	Fuel or source	FY2019 Usage	Usage unit	FY2019 Emissions ($MTCO_2e$)
Buildings & Facilities	Electricity	98,982	kWH	10.5
	Fuel Oil	14,985	gallons	152.2
			Buildings & Facilities Total	**162.7**
Streetlights & Traffic Signals	Electricity	121,857	kWH	12.9
			Streetlights & Traffic Signals Total	**12.9**
Vehicle Fleet	Wastewater Depart. - gasoline	501.8	gallons	4.4
	General Fleet - gasoline	7,520.6	gallons	66.5
	General Fleet - diesel	4,229.2	gallons	43.2
	Water Depart. - gasoline	1,035.8	gallons	9.1
			Vehicle Fleet Total	**123.2**
Employee Commute	Water Department	1,584.8	gallons	14.0
	Police Department	1,459.2	gallons	12.9
	Village Hall	2,378.2	gallons	21.05
	Wastewater Department	450.8	gallons	3.99
	Fire - Volunteer	1,381.5	gallons	12.24
	Highway Department	1,532	gallons	13.57
	Electric/EV – Village Hall workers	1.57	MMBtus	0.05
			Employee Commute Total	**77.85**
Solid Waste	Yard Waste Mulching/Composting (curbside collection)	200	tons	13.93
			Solid Waste Total	**13.93**
Water and wastewater	Water Treatment Plant - electricity	466,880	kWh	49.4
	Wastewater Treatment Plant – N2O Emissions	2,000	persons	1.48
	Septic Systems – Fugitive Emissions	12	persons	1.46
	Wastewater Treatment Plant – N2O Effluent to Surface Water	2,000	persons	98
	Wastewater Treatment Plant - Electricity	489,996	kWh	51.84
			Water and Wastewater Total	**202.2**
Process & Fugitive Emissions	Fugitive Emissions Related the Purchase of Work Uniforms	3,577	$	2.7
			Process & Fugitive Emissions Total	**2.7**
			Total Local Government Emissions	**594**

The relative portions of GHG emissions among the seven sectors tracked in the baseline inventory are illustrated in Figure 5. The operations of the Water and Wastewater plants comprise the largest sector of Village government GHG emissions. This is followed by Buildings & Facilities and Vehicle Fleet sectors. Employee Commute is the fourth largest contributor. Streetlights, Solid Waste, and Process and Fugitive emissions account for a small portion of GHG emissions. The findings for each sector are discussed in greater detail in the following sections.

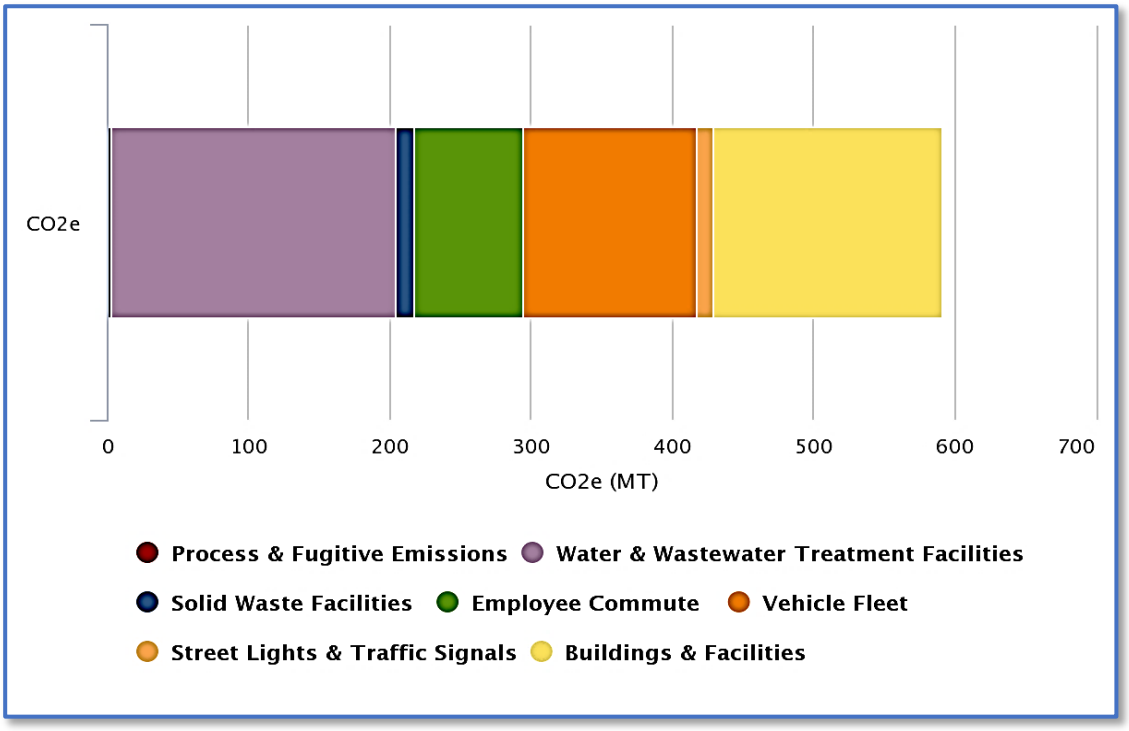
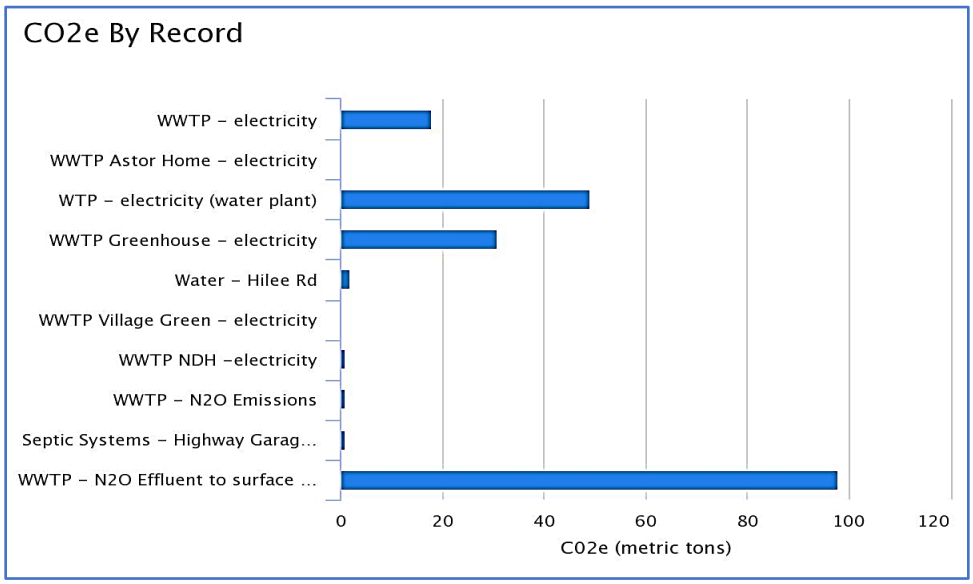


Figure 5: Village of Rhinebeck FY2019 GHG Emissions Inventory by Sector

Water Treatment and Wastewater Treatment



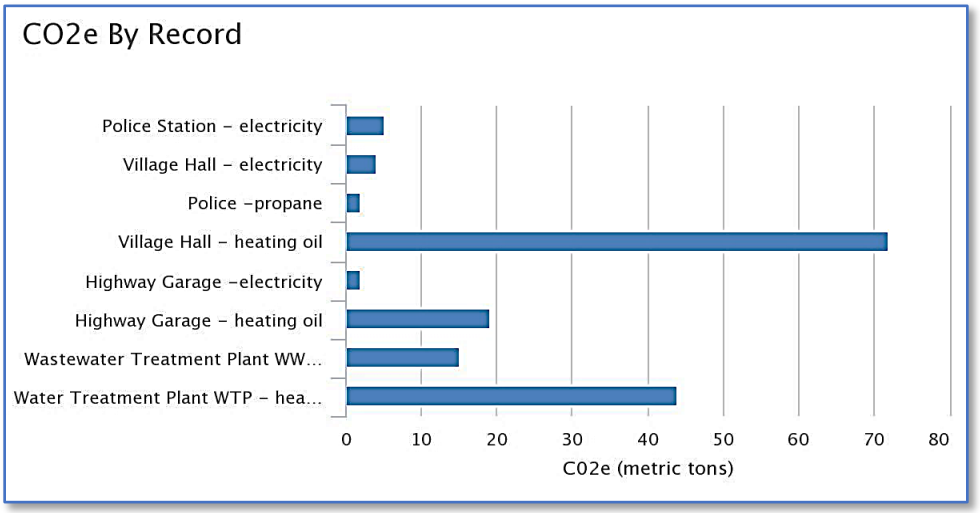
The Village of Rhinebeck Wastewater Treatment Plant serves the core Village business district and some residences including the Woods condominium development, the Garden condominium development, the Village Green apartments, Northern Dutchess County Hospital, and Tops shopping center. The plant discharges treated wastewater into the Rhinebeck Kill which flows to the Hudson River.

The Water Treatment plant treats and distributes drinking water to approximately 6,000 people throughout the village and some neighboring areas. The Water Treatment plant draws raw water from the Hudson River. The treatment process generates sludge material which is discharged to an impoundment lagoon. The quantity of potential GHG emissions related to this sludge material was not able to be calculated for this inventory because site specific testing (e.g., biological oxygen demand (BOD)) has not been conducted.

Electrical consumption for lighting, air conditioning, ancillary equipment, and treatment processes (e.g., pumping equipment) at the Water Treatment and Wastewater Treatment facilities are metered together. Accordingly, electrical use at these locations cannot be parsed between treatment processes and non-treatment uses related to the buildings. Accordingly, the electricity usage specifically associated with wastewater and water treatment processes could not be calculated. However, we know that the pumping equipment and treatment processes related to water and wastewater consume large amounts of electricity. The processing and treatment equipment is dated. Upgrades to the system and process equipment are planned or now under discussion. The Village Board should emphasize to the designers and engineers during any upgrades and renovations that energy efficiency is a priority. Note that the WWTP system, which was constructed in 1984 and has four related pumping stations, has 526 service accounts and serves about 2,000 people. Wastewater treatment demand is expected to increase with Village growth. The Village's Comprehensive Plan Committee is currently discussing ways to encourage increased density within the Village to address the housing affordability crisis.

The treatment of wastewater and the discharge of treated wastewater to surface water (Rhinebeck Kill) generates the greenhouse gas nitrous oxide (N2O) through various processes. N2O is a particularly potent greenhouse gas having a GWP 265 times greater than the warming potential of CO2. Thus, a small about of N2O emissions can equal a large value in the CO2e total of the baseline inventory. The inventory calculation indicates that the N2O release related to the discharge of wastewater effluent to surface water is the largest GHG component in the Water and Wastewater Treatment sector. Additional data and site-specific measurements may provide a better understanding of this component in the future.

Buildings and Facilities



The GHG emissions related to Village buildings and facilities were calculated by a review of records for electrical use and purchases of fuels (heating oil and propane) for heating and hot water. Electrical usage at the Water and Wastewater Treatment facilities were tallied under the Water and Wastewater sector because the machinery used to process water and wastewater operate on electricity. As each facility has only one electric meter, the electrical usage of the treatment processes could not be separated from the electrical usage for building operations such as lighting, air conditioning, etc. However, heating oil use at the Water and Wastewater facilities was tallied under the Buildings and Facilities sector since that emissions source is more related to the heating of the space and water for employees. The largest contributor to GHG emissions in the Buildings and Facilities sector was the burning of heating oil at the Village Hall. The Village Hall building additionally houses the Rhinebeck Volunteer Fire Department.

The burning of heating oil for the Village Hall's heating alone accounts for the emission of over 72 metric tons of CO2e. Each metric ton equals 2,205 pounds. The New York State Energy Research and Development Authority (NYSERDA) describes the potential benefits of switching from / discontinuing the use of combustion for heating:

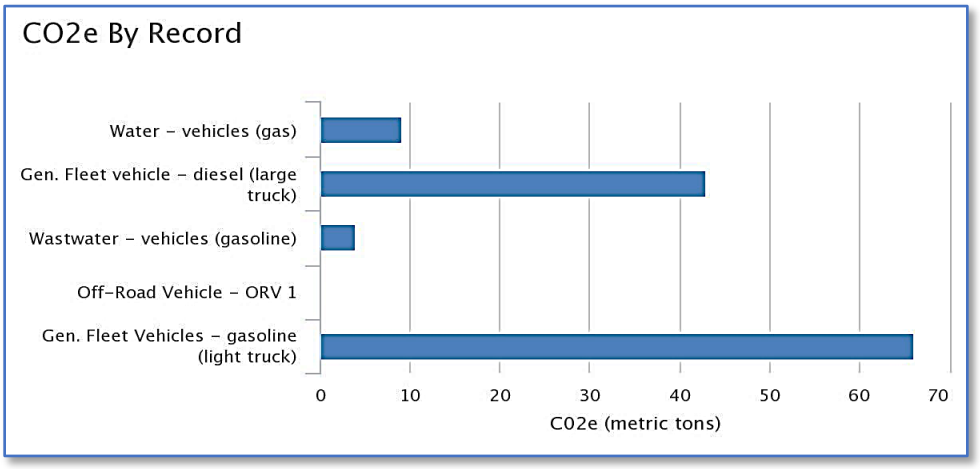
"Currently, fossil-fuel based thermal energy – primarily natural gas, propane, and heating oil – is the main energy source for space heating and domestic hot water in the residential and commercial sectors. It is responsible for about one-third of New York's energy-related greenhouse gas emissions. Clean heating and cooling technologies such as ground- and air-source heat pumps provide environmental benefits, energy bill savings, increased comfort levels and health benefits compared to conventional heating and cooling technologies. Local governments can lead by example and play an important role in encouraging adoption of ground- and air-source heat pump systems."

Converting Village Hall from an oil burning furnace and window unit ACs to a variable refrigerant flow (VRF) HVAC system could reduce the significant GHG emissions related to the operation of this building. Additionally, this climate-forward conversion/upgrade of an important public building would allow the Village to demonstrate leadership to our community. Village Hall already had a roof-mounted solar array, installed pre-FY2019, that partially offsets use of grid-based electricity. Upgrading or expanding the solar array can be assessed during future climate action planning.

The first set of government-owned EV charging stations in the village were installed in 2018 at the Village Hall. The electricity usage for these EV charging stations is metered through the neighboring Police Station.

Solar Panels on Rhinebeck Village Hall. Photo by Vanessa Bertozzi

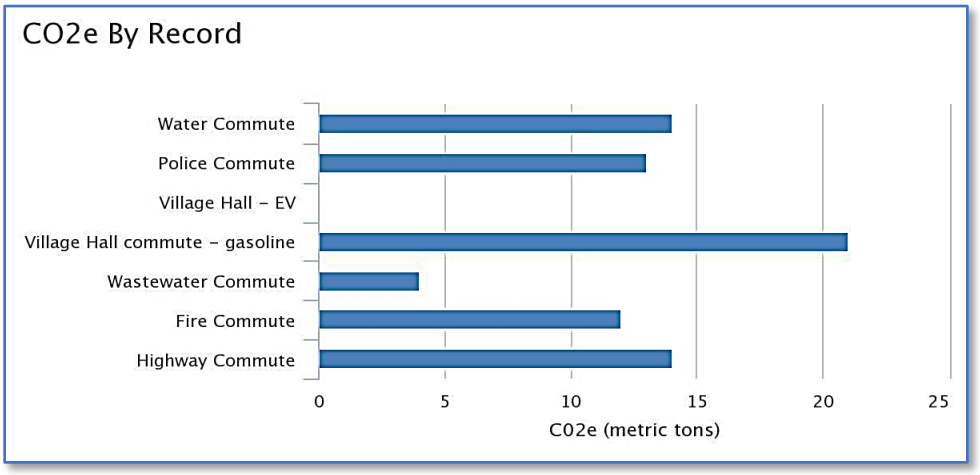
Vehicle Fleet



Findings from the Village's Inventory indicate that General Fund vehicles are responsible for the largest portion of the fleet GHG emissions. These vehicles include both the police cars and Fire/EMS vehicles, as well as Highway Department equipment. The Village has done a fleet inventory, and the Village Board has been discussing the need to transition to EVs. The transition has been slowed by the by the lack of make/model options available for pickup trucks, one of the main types of vehicles the Village should plan to replace.

Another challenge to conversion to EVs is the particular requirements of vehicles in the police car fleet. On-board computers in police vehicles draw a large amount of electricity and the cars need to be outfitted with custom interiors including rear passenger doors that do not open from inside. An EV car company that offered customized vehicles for law enforcement service would find a large, underserved market. Trustee Bertozzi has been in touch with an organization that uses a tool to help in planning the transition to electrified vehicles: www.electrificationcoalition.org/resource/drve.

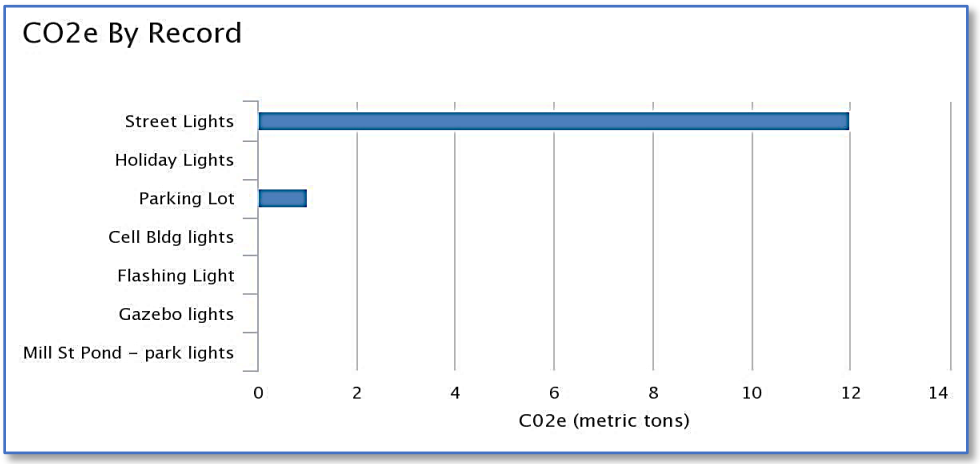
Employee Commute



Employee commute information was gathered by surveying Village Hall employees and officials. Department heads or point people facilitated the collection and development of this information by gathering data on staff commutes. For example, the Chief Water Plant Operator collected the information from the Water Department employees, and the Police Clerk gathered all the information from the police officers.

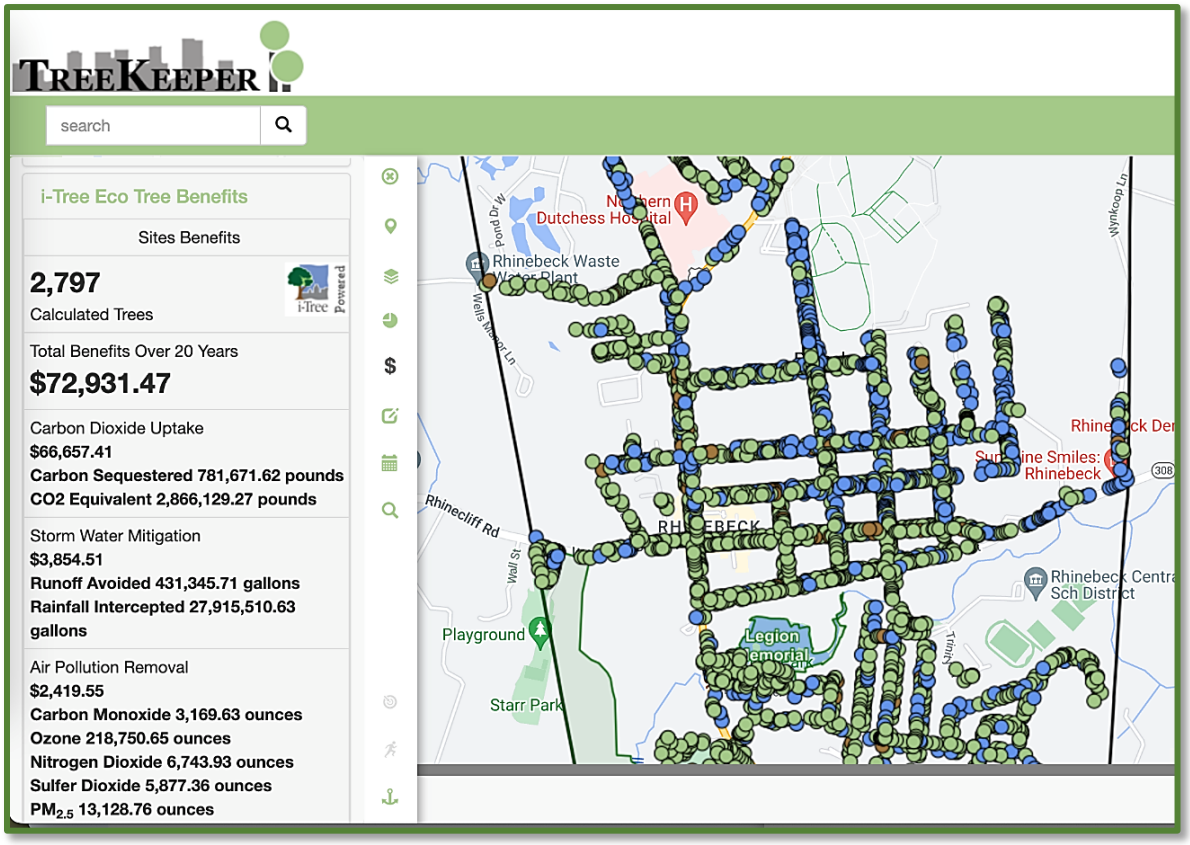
Employee commuting information calculations for the Fire Department presented an interesting challenge as the volunteer firefighters and EMS personnel may have been anywhere before responding to a call, necessitating a proxy. For this Inventory, we decided to simply calculate these potential commutes based on their home address, actual data of the number of calls they responded to during the year, plus the weekly meeting at the firehouse. In FY2019, we did have a few employees/officials who were driving EVs, hybrids, or lived close enough to walk to work.

Streetlights



The Village converted our Streetlights to light emitting diodes (LEDs) after 2019 which was after this baseline emissions inventory was compiled. LEDs provide more efficient lighting that is expected to result in energy savings reflected in subsequent GHG emissions inventories.

Urban Forest



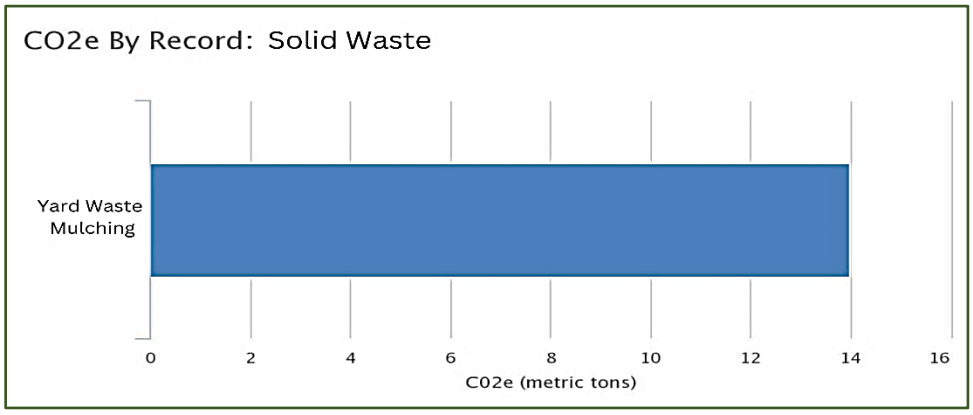
The Village is proud of our continuing status as a Tree City USA for 13 years. The Village has a local law overseeing the management of our urban forest, including the planting of trees in the public right of way and in some cases, beyond the right of way. Trees provide many environmental benefits such as removing hazardous pollutants from the air, absorbing and sequestering CO2 in their wood, controlling stormwater runoff by intercepting and absorbing rainfall, and providing cooling shade in the summer months that can reduce residential cooling demands.

The Rhinebeck Village Tree Commission oversees our urban forest and uses TreeKeeper software to track tree planting activities, tree locations and status, and tree health and diversity. TreeKeeper also includes calculations using i-Tree for a quantitative look at nature-based benefits of the street trees. The TreeKeeper inventory for the Village indicates that our nearly 3,000 street trees account for a total uptake of 2,866,129 pounds (approximately 1,300 metric tons) of CO2 Equivalent over a 20-year period. Note that this inventory does not include the numerous trees located throughout the Village on private property.

These results indicate that maintaining a healthy and diverse urban forest plays an important role in mitigating GHG emissions at the local level. However, because the TreeKeeper calculations are based on a 20-year period, the effect on the FY2019 baseline single year inventory could not be directly calculated. Calculating the value of CO2e removal is not as straightforward as simply dividing the total value by 20 to get an annual amount (65 metric tons) because the TreeKeeper calculation considers the growth rates and the characteristics of individual tree species.

For this reason, we did not include the potential CO2e reduction from our trees into the ClearPath tool and the baseline inventory. However, we hope that TreeKeeper will develop the ability to track this data in annual slices by the time we do our next GHG emissions inventory. We believe it's critically important to invest in and manage our urban forest, not only for GHG removal but also for shade/cooling, flood water absorption, traffic calming, biodiversity/habitat conservation, scenic beauty, pedestrian comfort, and general well-being. Street trees make vital contributions toward long-term sustainability goals. The Village's TreeKeeper dashboard can be viewed on the Village's website at:
https://rhinebeckny.treekeepersoftware.com/index.cfm?deviceWidth=1236

Solid Waste



The Village government does not own or operate a solid waste landfill or facility, but instead contracts for solid waste disposal with private hauler Welsh Sanitation. According to the Rhinebeck Village Climate Smart Task Force's research on Welsh: approximately 50% of the garbage is hauled to a "burn plant" in Poughkeepsie, the WinWaste / Wheelabrator facility, where it is incinerated. The remaining 50% is hauled to landfills in Syracuse or Ontario. Data are not available to quantify the solid waste the Village collects from the Big Bellies (public trash bins) or solid waste from Village municipal buildings. A municipal solid waste audit would be needed to understand the tonnage and the breakdown between garbage versus recycling from Village operations.

The Village conducts curbside collection of vegetative yard waste from residential properties and recycles the collected material into mulch. An estimated 200 tons of green waste was collected for processing. The collected materials are shredded, mulched, and composited at the Village Highway Department

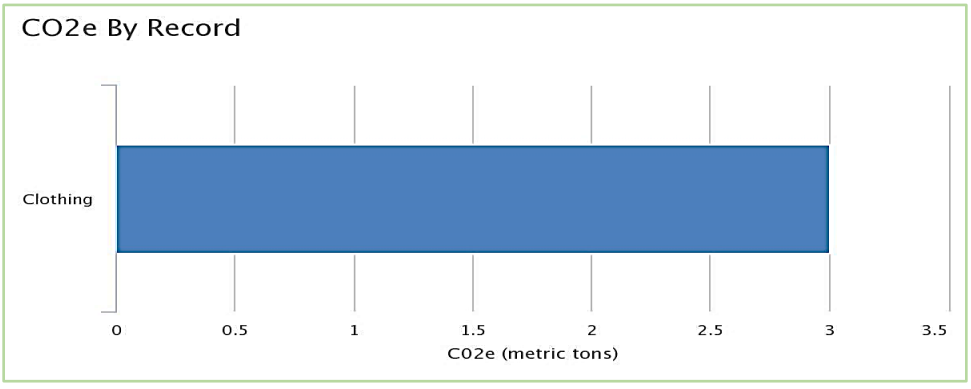
facility. The Village sells processed mulch/compost for use in gardens and landscapes. Emissions related to the composting of 200 tons of green waste are calculated in the ClearPath tool using ClearPath's factor set. The factor set draws from the USEPA's Waste Reduction Model (WARM) tool (version 15, November 2020), and documentation can be found in Chapter 2 on Yard Trimmings: www.epa.gov/sites/default/files/2020-12/documents/warm_organic_materials_v15_10-29-2020.pdf.

Note that the ClearPath factor set considers the vehicle emissions associated with bringing the yard trimmings to a processing site. This calculation may result in a small amount of the Highway Department fleet fuel usage being counted twice. However, emissions related to yard waste mulching operations were included in the inventory to present a comprehensive calculation of government operations emissions for the base year. Interestingly, the WARM model also includes emissions offsets related to "increases in soil carbon storage" and "avoided synthetic fertilizer use due to land application of compost." The WARM tool calculates that the net emissions from landfilling yard waste are four times greater than the emissions related to the composting/mulching these materials.

Currently, the Village government is attempting to create a municipal food waste composting program, and hopefully by our next GHG emissions inventory the benefits of that program can be calculated. When conducting a community-wide GHG emissions inventory, the Village should try to understand the quantity of backyard composting being conducted by residents.

Village generated solid waste can include construction and demolition materials from renovation projects. These projects are conducted by Village staff or by contracted workers. GHG emissions related to the disposal of these waste materials were not tracked and were not included in the baseline inventory. Going forward, the disposal of materials related to Village construction and demolition projects can be tracked for GHG emission inventories.

Process and Fugitive Emissions



Process and fugitive emissions related to Village operations are difficult to quantify. For the FY2019 baseline inventory, emissions associated with the manufacture and distribution of work clothing purchased for the Village's uniform program were estimated based on the annual purchase cost. We used

the default setting available in the ClearPath tool (Clothing: 750 kg CO2e/$), which is based on a factor set from University of California, Berkeley's Cool Climate research: https://coolclimate.org. During FY2019, Fire/EMS and Police had not purchased new turnout gear, so the baseline record year only represents uniform purchases for the Water, Wastewater, and Highway Departments.

Next Steps:

The findings from the baseline local government operations emissions inventory points out a need for:

- Retrofitting heating, ventilation, and air conditioning (HVAC) systems for buildings and facilities - in particular, improvements to heating for Village Hall/Firehouse stands out as high potential for cost savings and reducing emissions.
- Upgrades to our Water and Wastewater Plants – the processes themselves can be made more energy efficient with the replacement of old pumps, etc. The Village is undertaking upgrades to the WTP starting in 2024 and deciding improvements to the WWTP.
- Tracking emissions associated with the management of river water sludge deposited to the WTP lagoon. A test of the BOD5 costs $30.
- Developing a Fleet Efficiency Policy and Fleet Rightsizing Program – The Village government already maintains a Fleet Inventory. We should plan for transitioning our fleet, particularly as a greater range of EV models become available for police cars, pickup trucks, and heavy-duty vehicles: www.electrificationcoalition.org/resource/drve.
- Employee commute – The Village Board could consider incentives for employees and officials to switch to EVs.
- Conducting Government operations waste audit – to better understand the quantities of solid waste (garbage) the Village government is producing and collecting.
- Tracking Construction and Demolition - the Village government could start tracking emissions related to construction and demolition. The transportation and disposal of waste generated during these activities can be evaluated. The production and use of concrete for construction generates a large amount of GHG emissions. Hastings-on-Hudson has successfully incorporated the use of low-carbon concrete into municipal projects.
- Solar arrays for electrical generation – facilities and operations such as the Village Hall or the Water Treatment Plant may benefit from the increased use of solar arrays for electrical power generation. A cost/benefit analysis can be a part of future planning.
- Further research on nature-based solutions related to our urban forest.

Conclusion

This inventory marks the completion of Milestone One of the Five ICLEI Climate Mitigation Milestones. The findings from the inventory indicate that approximately 594 metric tons of carbon dioxide equivalent (CO2e) were emitted by Village operations across seven sectors during the baseline year. The next steps are to forecast emissions, set an emissions-reduction target, and build upon the Village's existing Climate Smart efforts with a more robust climate action plan that identifies specific quantified strategies that can cumulatively meet that target.

The Intergovernmental Panel on Climate Change (IPCC) states that to meet the Paris Agreement commitment of keeping warming below 1.5°C, we must reduce global emissions by 50% by 2030 and reach carbon neutrality by 2050. Equitably reducing global emissions by 50% requires that high-emitting, wealthy nations reduce their emissions by more than 50%. More than ever, it is imperative that countries, regions, and local governments set targets that are ambitious enough to slash carbon emissions between now and mid-century.

Science-Based Targets are calculated climate goals, in line with the latest climate science, that represent a community's fair share of the global ambition necessary to meet the Paris Agreement commitment. To achieve a science-based target, community education, involvement, and partnerships will be instrumental. The Village Board will be discussing setting a target through its participation in the CAPI program.

The FY2019 baseline inventory will form the basis for comparisons to GHG emissions calculations conducted for subsequent years and the starting point for a comprehensive climate action plan. The Village of Rhinebeck will continue to track key energy use and emissions indicators on an on-going basis and develop updated inventories on a regular basis. This tracking of emission trends is needed to assess the progress and goal achievement of any planning.

This inventory shows that efficiency improvements to our Water and Wastewater Plants, transitioning our fleet to EVs, and retrofitting our buildings to modern HVAC systems will make important progress toward sustainability goals. Through these efforts and others, the Village of Rhinebeck can achieve environmental, economic, and social benefits beyond reducing emissions.

Appendix: Methodology Details

Energy

The following tables show each activity, related data sources, and notes on data gaps.

Energy Data Sources

Activity	Data Source	Data Gaps/Assumptions
Local Government Operations		
Electricity consumption	Village Clerk	Assumption: the electrical meters in place at Village facilities are accurately and completely measuring electrical consumption.
Propane consumption	Village Clerk	Used at Police Station only for space heating.
Grid Electricity	Village Clerk/ Central Hudson	Central Hudson has experienced metering and billing anomalies during the last few years. These irregularities may cause data tracking challenges for future GHG inventories.

Emissions Factors for Electricity Consumption

Year	CO_2 (lbs./MWh)	CH_4 (lbs./GWh)	N_2O (lbs./GWh)
2018	253.11	18.0	2.0

Transportation

Transportation Data Sources

Activity	Data Source	Data Gaps/Assumptions
Local Government Operations		
Government vehicle fleet	Village Clerk	Fuel use/consumption was tracked by bulk fuel purchases for gasoline and diesel. Additional administrative efforts would be required to track fuel use by vehicle to evaluation potential future efficiencies.

Employee commute	Village Clerk	Assumption: the employee commuting data was accurately captured through self-reporting and estimates. Employee commuting information can be more accurately tracked going forward while maintaining employee confidentiality.

For vehicle transportation, it is necessary to apply average miles per gallon and emissions factors for CH4 and N2O to each vehicle type. The factors used are shown in Table 6.

MPG and Emissions Factors by Vehicle Type

Fuel	Vehicle type	MPG	CH_4 g/mile	N_2O g/mile
Gasoline	Passenger car	Vehicle use, fuel consumption, and miles per gallon were not tracked for the FY2019 baseline inventory. Vehicle fleet emissions were tracked by totaling the volume of gasoline and diesel purchased and consumed during the year. Going forward, individual vehicle fuel use and mileage could be tracked if this information is needed. Individual tracking would require additional administrative efforts.		
Gasoline	Light truck			
Gasoline	Heavy truck			
Gasoline	Motorcycle			
Diesel	Passenger car			
Diesel	Light truck			
Diesel	Heavy truck			

Wastewater

Wastewater Data Sources

Activity	Data Source	Data Gaps/Assumptions
Local Government Operations		
Nitrogen Discharge	WWTP Operations/ ClearPath Calculations	N2O discharges to air and surface water related to wastewater treatment plant operations are not well understood. Additional testing and monitoring may provide more accurate calculations.
Energy used in wastewater facilities	WWTP Operations	Separate electrical metering would allow an understanding of the electrical power requirements of the treatment processes separate from the electrical power requirements of the building operations related to lighting, heating, and cooling.

Potable Water

Potable Water Data Sources

Activity	Data Source	Data Gaps/Assumptions
Local Government Operations		
Potable water treatment	WTP operations	The potential GHG emissions related to the generation and discharge of residual sludge from raw water purification has not been addressed. The residual sludge is currently discharged and stored in an impoundment lagoon.
Water Treatment Operations	WTP Operation	Grid electrical use for the water treatment processes and the building lighting and cooling are tracked on a single meter. Separate metering would allow a greater understanding of the electrical use, and possible efficiencies, of the water treatment and distribution processes.

Solid Waste

Solid Waste Data Sources

Activity	Data Source	Data Gaps/Assumptions
Local Government Operations		
Solid Waste Generation	Estimate	Solid waste disposal from Village government facilities is conducted by a private contractor. Solid waste generated at Village government facilities is not tracked separately. Mulch sales were used to estimate the quantities of green waste collected curbside from residential properties.

Fugitive Emissions

Fugitive Emissions Data Sources

Activity	Data Source	Data Gaps/Assumptions
Local Government Operations		
Purchase and use of clothing for Village workers	Village Clerk	Purchases for Fire Department and Police Department clothing and protective gear did not occur during the base year.

Inventory Calculations

The FY2019 inventory was calculated following the US Community Protocol and ICLEI's ClearPath software tool. As discussed in Inventory Methodology, the IPCC [Intergovernmental Panel on Climate Change] 6th Assessment Report was used for global warming potential (GWP) values to convert methane and nitrous oxide to CO2 equivalent units (CO2e). ClearPath's inventory calculators allow for input of the sector activity data in various forms (i.e., gallons of fuel use, kilowatt hours, or vehicle miles travelled) with appropriate emission factors to calculate the final CO2e emissions.

Appendix II: Climate Change Science

The Intergovernmental Panel on Climate Change (IPCC)'s Fifth Assessment Report affirms that "warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level."[2] Researchers have made progress in their understanding of how the Earth's climate is changing in space and time through improvements and extensions of numerous datasets and data analyses, broader geographical coverage, better understanding of uncertainties and a wider variety of measurements.[3] These refinements expand upon the findings of previous IPCC Assessments – today, observational evidence from all continents and most oceans shows that "regional changes in temperature have had discernible impacts on physical and biological systems."

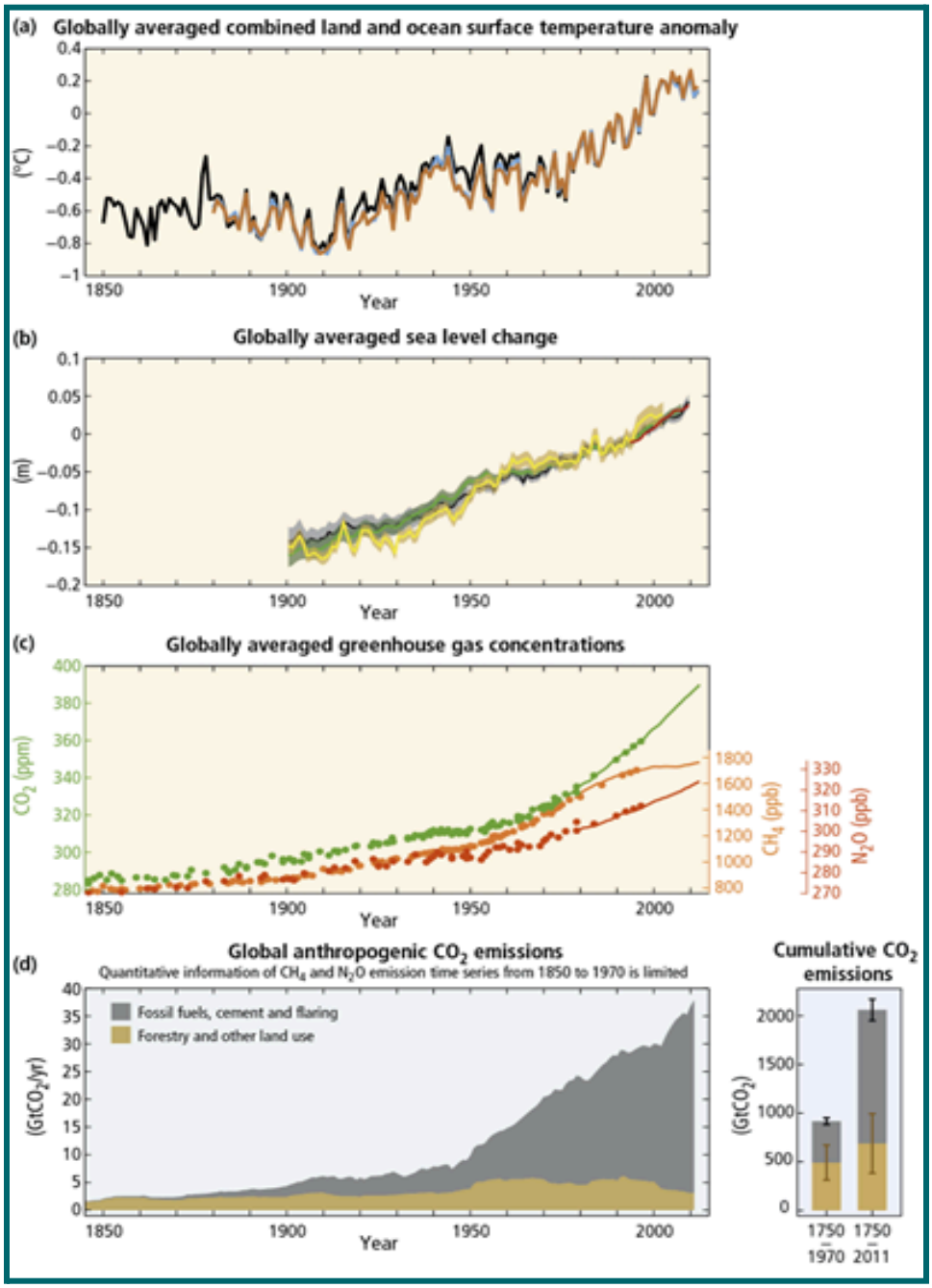


Figure A1: Observations and other indicators of a changing global climate system[4]

The Fifth Assessment asserts that "it is *extremely likely* that more than half of the observed increase in global average surface temperature from 1951 to 2010 was caused by the anthropogenic increase in GHG concentrations and other anthropogenic forces. Globally, economic and population growth continue to be the most important drivers of increases in CO_2 emissions from fossil fuel combustion. Changes in many extreme weather and climate events have been observed since about 1950. Some of these changes have been linked to human

influences, including a decrease in cold temperature extremes, an increase in warm temperature extremes, an increase in extreme high sea levels and an increase in the number of heavy precipitation events in a number of regions".

In short, the Earth is already responding to climate change drivers introduced by mankind.

Temperatures and Extreme Events are Increasing Globally

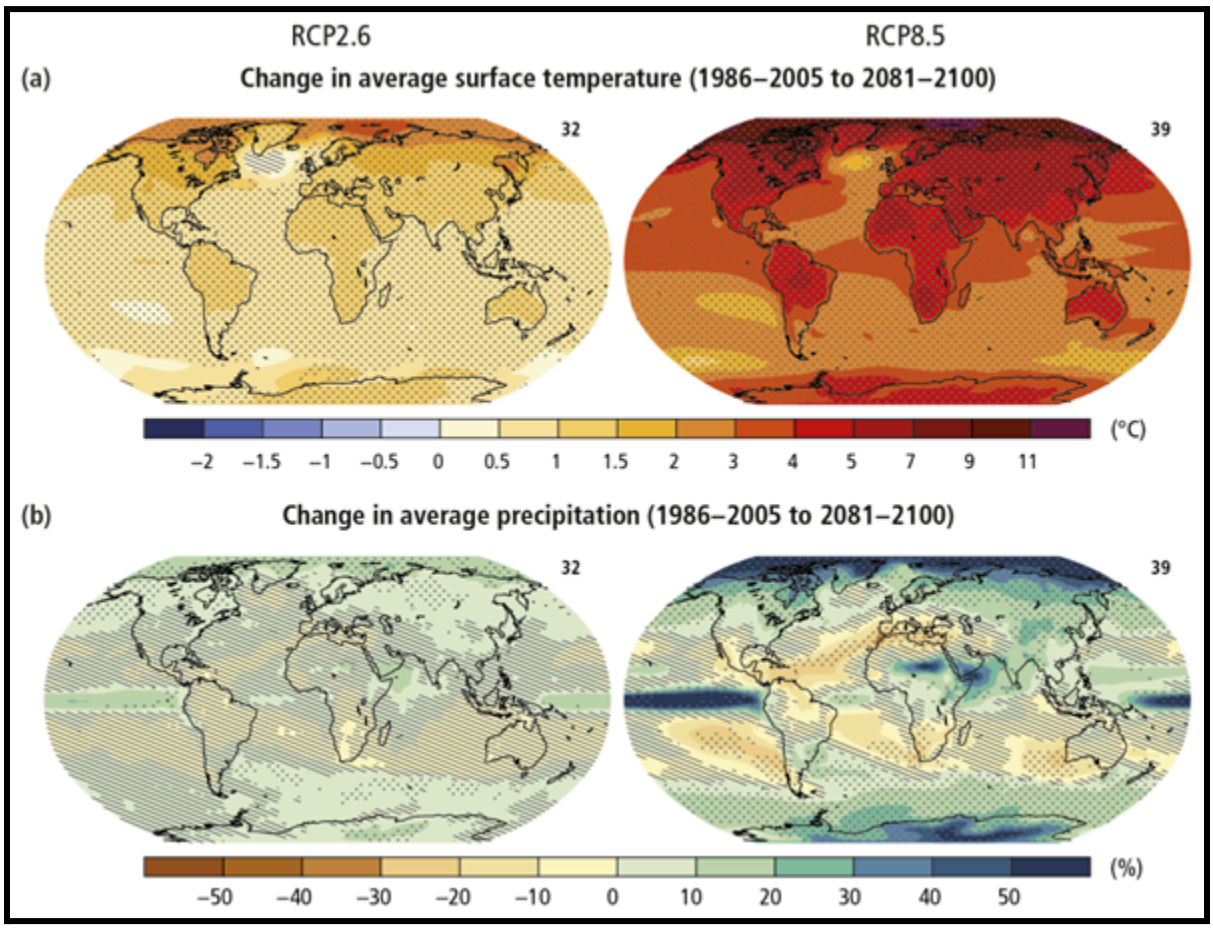


Figure A2: Change in average surface temperature (a) and change in average precipitation (b) based on multi-model mean projections for 2081–2100 relative to 1986–2005 under the RCP2.6 (left) and RCP8.5 (right) scenarios.

Surface temperature is projected to rise over the 21st century under all assessed emission scenarios. It is very likely that heat waves will occur more often and last longer, and that extreme precipitation events will become more intense and frequent in many regions. The ocean will continue to warm and acidify, and global mean sea level to rise. Changes in many

extreme weather and climate events have been observed since about 1950. Some of these changes have been linked to human influences, including a decrease in cold temperature extremes, an increase in warm temperature extremes, an increase in extreme high sea levels, and an increase in the number of heavy precipitation events in a number of regions.[5]

Climate Risks

Climate change is expected to cause significant negative effects on food security. Due to projected climate change by the mid-21st century and beyond, global marine species redistribution and marine biodiversity reduction in sensitive regions will challenge the sustained provision of fisheries productivity and other ecosystem services. For wheat, rice and maize in tropical and temperate regions, climate change is projected to negatively impact production under local temperature increases of 2°C or more above late 20th century levels, although in some cases individual locations may benefit. Global temperature increases of ~4°C or more above late 20th century levels, combined with increasing food demand, would pose drastic risks to food security globally. Climate change is projected to reduce renewable surface water and groundwater resources in most dry subtropical regions, intensifying competition for water among sectors.

Until mid-century, projected climate change will impact human health mainly by exacerbating health problems that already exist. Throughout the 21st century, climate change is expected to lead to increases in ill-health in many regions, particularly in developing countries. Health impacts include greater likelihood of injury and death due to more intense heat waves and fires, increased risks from foodborne and waterborne diseases and loss of work capacity and reduced labor productivity in vulnerable populations. Risks of undernutrition in poor regions will increase. Risks from vector-borne diseases are projected to generally increase with warming, due to the extension of the infection area and season, despite reductions in some areas that become too hot for disease vectors.

In urban areas, climate change is projected to increase risks for people, assets, economies and ecosystems, including risks from heat stress, storms and extreme precipitation, inland and coastal flooding, landslides, air pollution, drought, water scarcity, sea level rise and storm surges. These risks are amplified for those lacking essential infrastructure and services or living in exposed areas. Rural areas are expected to experience major impacts on water availability and supply, food security, infrastructure and agricultural incomes, including shifts in the production areas of food and non-food crops around the world.

Climate change is projected to increase displacement of people. Populations that lack the resources for planned migration experience higher exposure to extreme weather events, particularly in developing countries with low income. Climate change can indirectly increase risks of violent conflicts by amplifying well-documented drivers of these conflicts such as poverty and economic shocks.[6]

Regional and Local Impacts

Because the impacts of climate change vary geographically, it is important to know what effects are specifically expected for your corner of the globe.

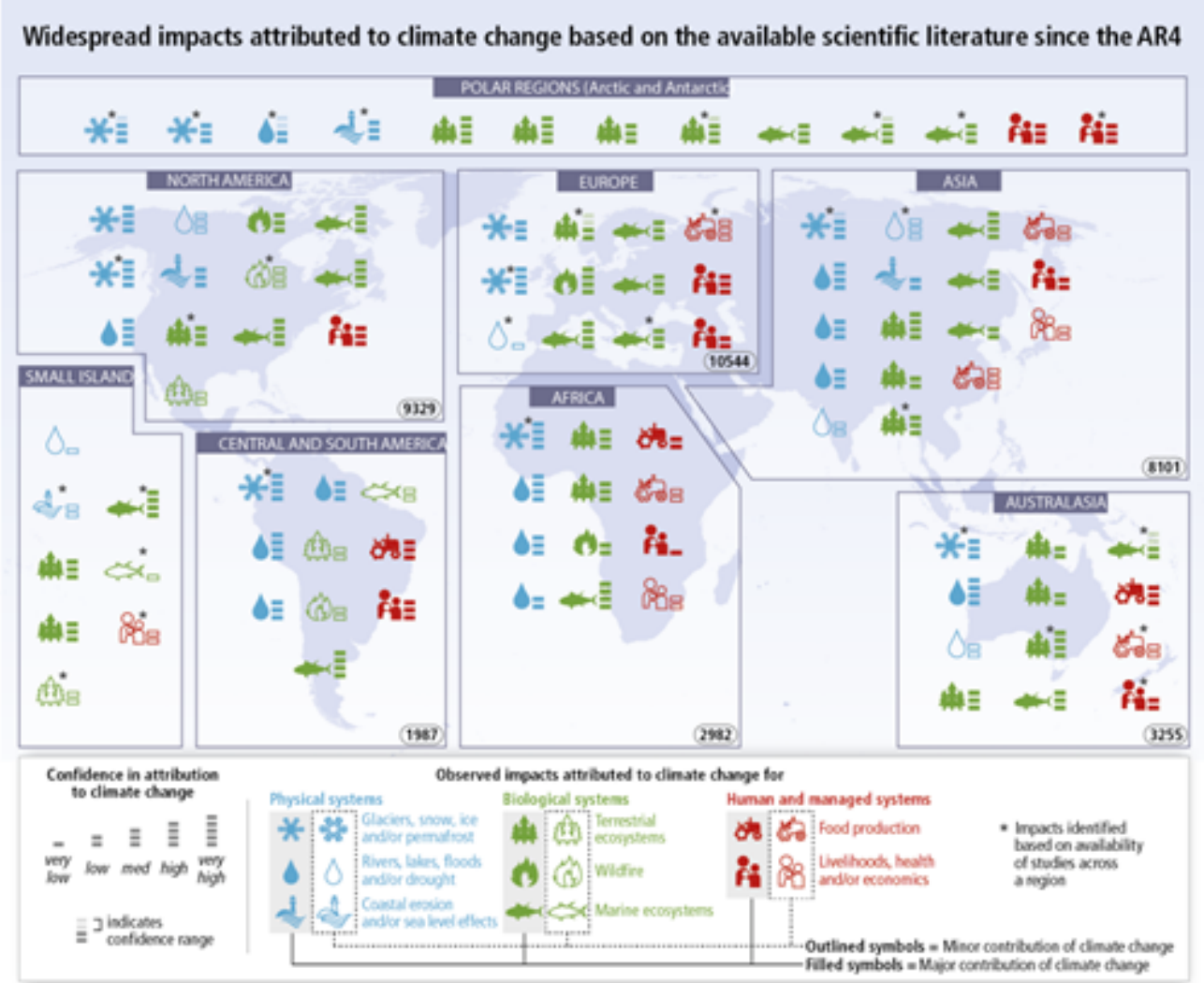


Figure A3: Climate impacts around the world. Symbols indicate categories of attributed impacts, the relative contribution of climate change (major or minor) to the observed impact and confidence in attribution.

Numbers in ovals indicate regional totals of climate change publications from 2001 to 2010, based on the Scopus bibliographic database for publications in English with individual countries mentioned in title, abstract or keywords (as of July 2011). These numbers provide an overall measure of the available scientific literature on climate change across regions; they do not indicate the number of publications supporting attribution of climate change impacts in each region. Studies for polar regions and small islands are grouped with neighboring continental regions.[7]

In the Village of Rhinebeck we are already dealing with the adverse impacts of climate change in the form of extreme weather, unseasonably warm winters and hotter summers, local flooding and sea level rise on the Hudson River (our Water Treatment Plant is located on its banks).

The Village has conducted Community Resilience Building Workshop and vulnerability assessment and completed a resiliency planning tool and a Natural Resources Inventory. We are kicking off our Climate Adaptation Chapter with the CAPI program on February 8, 2024.

This Climate Action Plan stands as the local government's responsibility to the people of our jurisdiction as well as to the rest of the planet. Our Climate Adaptation Planning will serve the necessary purpose of confronting and preparing for the imminent threats of climate change.