SPRING 2022

The Genesee-FLX Climate Action Strategy

PHOTO BY DENVER MILLER FILMS

THE GENESEE-FLX CLIMATE COLLECTIVE

AN INITIATIVE OF

Climate Solutions Accelerator

of the Genesee-Finger Lakes Region

A Message from the Genesee-FLX Climate Collective Co-chairs

Dear Members of the Genesee-Finger Lakes Community,

We are truly grateful to everyone who contributed their time and talent to developing the Genesee-FLX Climate Action Strategy - whether providing input on your vision for a thriving region on a healthy planet, serving on the steering committee, reviewing quantitative models and reports, assessing the feasibility of mitigation measures, or inviting us to your neighborhood or place of business to demonstrate climate solutions at work. This strategy would not be possible without you. We also hope that many more will see themselves in the future put forth here, and find an area of interest, a community, or a solution that inspires them to take action.

What follows, in the Genesee-FLX Climate Action Strategy, is not a prescription for regional action over the next 25 years that guarantees we reach carbon neutrality. To think that we could, or should, develop such an edict for the entire region would be foolish in light of the dramatically shifting political, technological, and economic landscape shaping climate action. Rather, what follows is a framework for action that aims to build the capacity of our community to navigate these impending changes, while capitalizing on existing assets and remaining rooted in our shared community values.

The Genesee-FLX Climate Action Strategy is, therefore, also an invitation for individuals, organizations, and municipalities to become active participants in co-creating a regenerative economy and building resilient communities capable of tackling climate challenges. In this sense, addressing climate change is not only about reducing greenhouse gas emissions. It is about putting climate solutions to work for our community - by maximizing the co-benefits of taking climate action to address other areas of community concern. If we work collaboratively, the Genesee-Finger Lakes can be a leader in the state's transition to a clean energy economy and can reap the economic, environmental, and social benefits associated with climate solutions.

The time is now for climate solutions. Join us today by taking the organizational or individual pledge for climate action. The possibilities for participation are nearly endless, as are the possibilities for building a thriving region on a healthy planet. We look forward to working with you to accomplish this critical goal.

Sincerely,
Simeon Banister and Jan Nyrop

SIMEON BANISTER

JAN NYROP

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Executive Summary


PHOTO BY GRANT TAYLOR PHOTOGRAPHY, INC.

The Intergovernmental Panel on Climate Change's (IPCC) most recent report (Feb 2022) states that the science is unequivocal - climate change is a grave threat to the health of people and planet - requiring ambitious, accelerated, and local climate action. In New York, the Climate Leadership and Community Protection Act (CLCPA) calls for greenhouse gas emissions reductions of 40% by 2030, electrical grid decarbonization by 2040, and a net-zero economy by 2050, with 30-40% of the benefits of investment going to environmental justice communities. Transitioning the Genesee-Finger Lakes away from fossil fuels swiftly and equitably will necessitate the coordination, commitment, leadership, and investment of a broad range of stakeholders. While the CLCPA has clear targets, it does not, as of yet, provide clear guidance for implementation or tracking progress. As such, the Genesee-FLX Climate Action Strategy provides a framework for collaborative action for the next 3-5 years that 1) focuses on key enablers of systems-level change, 2) utilizes already existing technologies, 3) optimizes the co-benefits of taking climate action, and 4) provides the chance for everyone to meaningfully contribute.

"Climate change is a grave threat to the health of people and planet - requiring ambitious, accelerated, local climate action."

Our analysis shows that regional greenhouse gas emissions come largely from transportation (33%), agricultural sector (22%), and residential and commercial buildings (25%). Furthermore, decarbonizing and improving our electrical grid will provide year-over-year gains in emissions reductions as we move to electrify other sectors. Accordingly, the Genesee-FLX Climate Action Strategy focuses on reducing greenhouse gas emissions in the transportation, buildings, agriculture, and energy generation sectors, while advancing equity, public health, economic development, and ecological stewardship for the benefit of all regional residents.

Given the interdependence of our natural, social, and economic systems, particularly with regard to our transportation and electricity infrastructure and our local food-system, regional action provides the most strategic way forward. A regional approach is large enough to have a meaningful impact on the state's overall emissions, while small enough to engage local actors in making a positive impact in their community. The intention here is to integrate existing efforts into a comprehensive framework for collaborative action that advances the good work already underway and provides direction for those yet to undertake climate or sustainability initiatives.

While climate change poses significant challenges, it also offers significant opportunities to reimagine and reinvigorate our region's future. Successfully mitigating and adapting to climate change will require rehabilitating our aging housing stock, reconceptualizing our transportation system, modernizing the energy grid, and creating a sustainable food supply. It also provides the chance to reduce the

energy burden of low-income households, improve indoor and outdoor air quality, create living-wage jobs, and facilitate cooperation between members of our diverse community. These actions stimulate our local economy and make our neighborhoods cleaner, stronger, healthier, and more resilient. According to an analysis by NY Climate Action Council, achieving CLCPA goals will save approximately $260 billion by reducing the damages associated with climate change. Moreover, improvements in air quality, increased active transportation, and energy efficiency interventions will generate $160-170 billion worth of health benefits. Climate action makes financial sense - in New York State, the cost of inaction exceeds the cost of action by *at least* $80 billion.

To ensure the Genesee-Finger Lakes is a leader in the state's transition to a clean energy economy and can reap the economic, environmental, and social benefits associated with climate solutions requires we take coordinated, collaborative action at the regional level now. Accordingly, the Genesee-FLX Climate Collective, with the Climate Solutions Accelerator of the Genesee-Finger Lakes Region as the backbone organization, is employing the collective impact approach to advance a regional climate action strategy that moves the region forward in meeting CLCPA goals. Collective impact facilitates large-scale, cross-sector collaboration to address complex, urgent, social issues that cannot be solved within a single sector or by a single entity. The Climate Collective chose this approach because we believe that the only way to thwart the climate crisis is to work collaboratively. Addressing climate change provides the opportunity for every individual, business, organization, and municipality to work together in cultivating the future we want to see for the Genesee-Finger Lakes region.

"To ensure the Genesee-Finger Lakes is a leader in the state's transition to a clean energy economy and can reap the economic, environmental, and social benefits associated with climate solutions ***requires we take coordinated, collaborative action at the regional level now****."*

Because climate change is a structural issue with multiple touchpoints and intersections, the actions selected for this strategy must also multitask, reducing emissions, while addressing other areas of community concern. To accomplish this, the Genesee-FLX Climate Action Strategy moves beyond a singular focus on climate mitigation, adaptation, or resilience, focusing instead on actions that reduce greenhouse gas emissions and contribute substantially to improving quality of life, adaptability, and resilience of individuals and communities to the climate impacts we already experience and those to come. The Genesee-FLX Climate Action Strategy prioritizes climate action that addresses 1) vehicle miles traveled (VMT) 2) energy efficiency, 3) building electrification, 4) soil health and agricultural waste management, 5) the local food system, 6) the electrical grid, and 7) economy-wide greenhouse gas reducing measures.

The power of this strategy lies in the many committed individuals engaged daily in service to others and to the community. Consequently, this is an emergent strategy, one that can, and will, evolve as we continue to engage stakeholders, learn from one another, and build the capacity of our community to take climate action. Therefore, we offer the following strategy in the spirit of collaboration, and with the promise of possibility, expecting that local communities adapt the strategy to fit their needs, while seeking regional synergies and opportunities to share resources and best practices that advance the state's goal of a net-zero economy. *Together, WE are the solution to climate change.*

1. Introduction

Located on the land of the Seneca Nation, a member of the Haudenosaunee Six Nations Confederacy,[1] the Genesee-Finger Lakes region of Upstate New York is nestled between the City of Buffalo to the west, Lake Ontario to the north, and the bucolic Finger Lakes to the southeast. The nine-county region boasts bountiful natural resources, particularly fresh water, relatively clean air, and the most farmland in all of New York State.[2] A diverse population of 1.2 million lives in the region's many rural villages, suburban towns, and the cities of Rochester (the third-largest in NY), Geneva, Canandaigua, and Batavia.

Unfortunately, climate change poses multiple threats to the people and places of the region, through temperature increases, extreme flooding, fluctuations in precipitation patterns, and increases in heat-related and vector-borne illnesses (See Figure 1: Regional Climate Impacts). While climate change will impact all 1.2 million residents of the region, it will not impact everyone equally. According to the City of Rochester's Climate Vulnerability Assessment, climate change will disproportionately impact seniors/elderly, children, people of color, low-income residents, renters, people without access to vehicles, disabled individuals, individuals without the ability to access resources in a crisis, individuals dealing with substance abuse, non-native English speakers, undocumented immigrants, refugees, visually/hearing impaired individuals, individuals with mental illness and farmworkers.[3] Climate change impacts, therefore, threaten to undermine the ecological, economic, and social vitality of the region, as well as overall public health.

Against the backdrop of the COVID-19 pandemic, international public health officials warn that climate change is set to become the "defining narrative of human health,"[4] calling for immediate action to stem the rise of global temperatures. Significant health

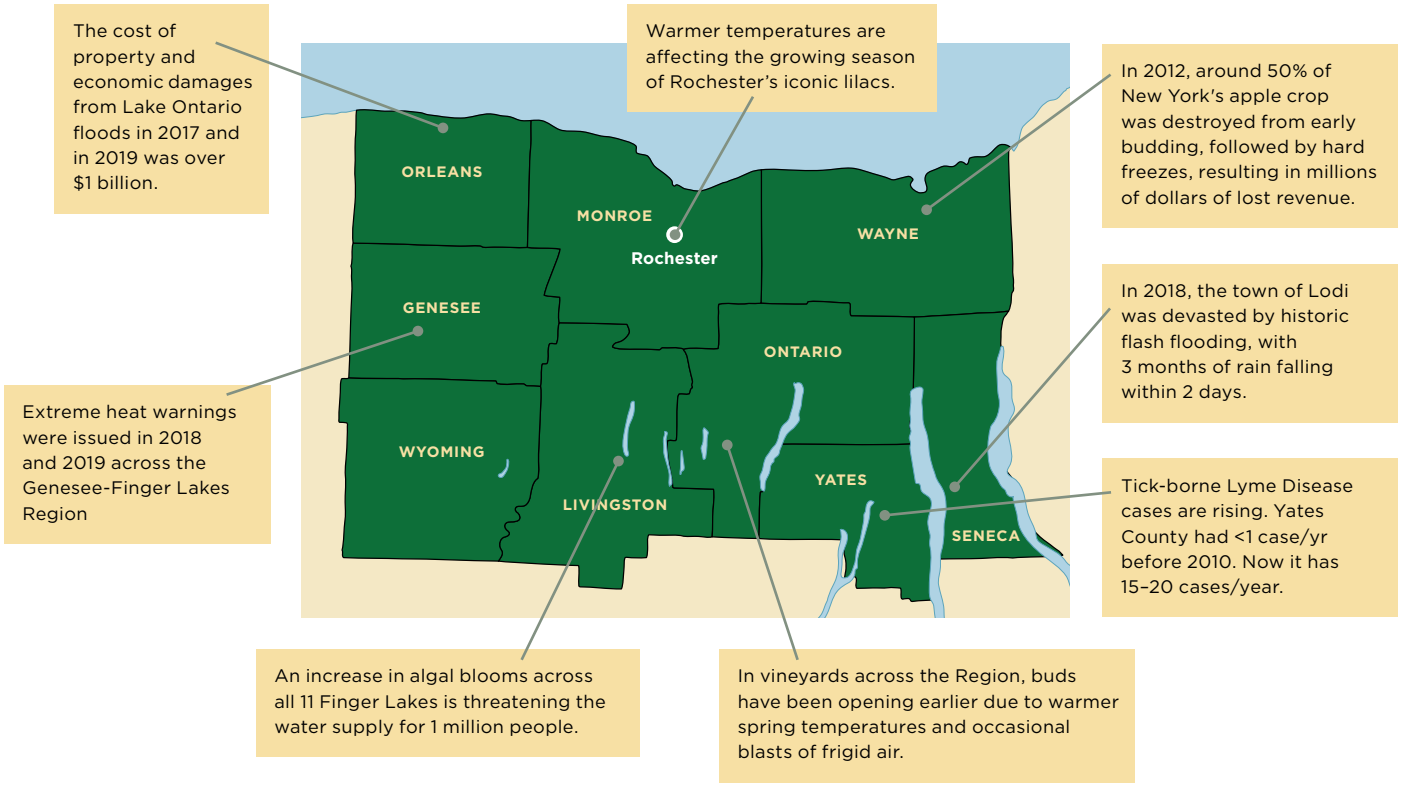


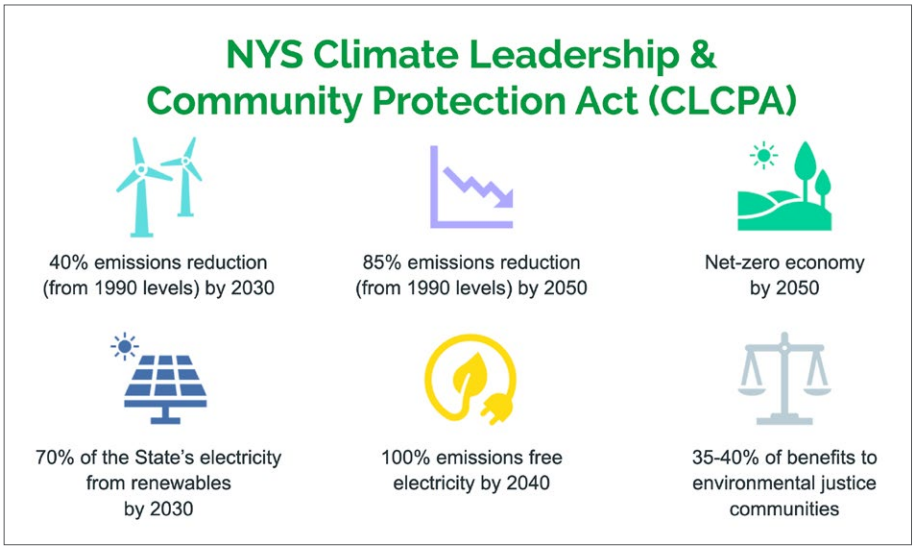
FIGURE 1: REGIONAL CLIMATE IMPACTS

inequities already plague the Genesee-Finger Lakes region,[5] and these inequities will worsen with further climate change. During the summer of 2021, as wildfire smoke from California impacted air quality in New York,[6] UN Secretary-General António Guterres declared the Intergovernmental Panel on Climate Change's (IPCC) latest report a "code red for humanity" stating that "we must act decisively to keep 1.5 (degrees) alive," referencing the temperature needed to minimize the most severe consequences of climate change.[7] Yet, if we move swiftly, the world's scientists say, there is still time to avoid the most devastating impacts to human health and to our natural and economic systems.

While climate change poses significant challenges, it also offers significant opportunities to reimagine and reinvigorate our region's future. Climate impacts and solutions touch nearly every aspect of our lives (e.g., where we live, what we eat, how we travel, our community design, and the products and services we use), thereby providing opportunities for climate solutions to address other areas of community concern (e.g., improving public health, providing jobs, and reducing poverty and racial inequality). Successfully mitigating and adapting to climate change will require rehabilitating our aging housing stock, reconceptualizing our transportation system, modernizing the energy grid, and creating a sustainable food supply. It also provides the chance to reduce the energy burden of low-income households, improve indoor air quality, build relationships, and facilitate cooperation between members of our diverse community. These actions create jobs, stimulate our local economy, and make our neighborhoods cleaner, stronger, healthier, and more resilient. Working collectively, we can maximize the abundant natural resources and considerable human capital of the Genesee-Finger Lakes region to embed environmental and economic sustainability, resilience, and climate justice into all aspects of our lives.

NY State's Climate Leadership and Community Protection Act

At the state level, the nation-leading Climate Leadership and Community Protection Act (CLCPA) establishes targets to cut emissions 40% by 2030, to decarbonize the electrical grid by 2040, and to reach a net-zero economy by 2050, with 30-40% of all benefits of investments going to environmental justice communities. In addition to reducing greenhouse gas emissions, the economic benefits of implementing the CLCPA are significant. According to an analysis by New York State's Climate Action Council, achieving CLCPA goals will save the state approximately $260 billion by reducing the damages associated with climate change. Moreover, improvements in air quality, increased active transportation, and energy efficiency interventions in low- and moderate-income homes will generate health benefits ranging from $160-170 billion. Implementing climate action makes financial sense - the cost of inaction exceeds the cost of taking action by *at least* $80 billion.[8] By taking climate action now, the Genesee-Finger Lakes region can reap the economic, environmental, and social benefits associated with climate solutions and become a leader in the state's clean energy economy.



To inform the implementation of the CLCPA, the state convened a Climate Action Council, and in January of 2022, released a draft Climate Action Scoping Plan providing state-level recommendations for achieving emissions reductions. As of this writing, the scoping plan is out for public review, with a final scoping plan expected by early 2023. By the end of 2024, the Department of Environmental Conservation (DEC), the entity tasked with regulating and enforcing the CLCPA, must develop a series of rules and regulations to ensure compliance with emissions reductions goals.[9] The CLCPA timeline, likely pushing into 2024 before going into full effect, leaves us only 6 short years to reduce emissions in line with IPCC recommendations.[10] Moreover, while the CLCPA has clear targets, it does not, as of yet, provide clear guidance on local implementation or tracking local progress. By taking coordinated, collaborative action at the regional level *now*, we are setting the Genesee-Finger Lakes on a clear path to meeting CLCPA goals and realizing a shared vision for a healthier, more equitable, and environmentally sustainable community.

Why Collective Impact? The Genesee-FLX Climate Collective

Transitioning the Genesee-Finger Lakes region away from fossil fuels swiftly and equitably will require the coordination, commitment, leadership, and investment of a broad range of stakeholders from across the region. As such, the Genesee-FLX Climate Collective is employing the collective impact approach to advance locally relevant, systems-level climate solutions via a regional climate action strategy. Collective impact is a proven method for facilitating large-scale, cross-sector collaboration to address complex, urgent, social issues - often referred to as "wicked problems." Collective impact focuses on establishing strategic partnerships, supporting mutually reinforcing activities, fostering continuous communication and learning, and building accountability through a shared measurement system.[11] The Climate Collective chose this approach because we believe that the only way to thwart the climate crisis is to work collaboratively. And, we are confident in our community and its capabilities - in the creativity, commitment, and compassion of our neighbors, working diligently to improve our region, with hopeful anticipation of the burgeoning opportunities to come. Together, WE are the solution to climate change.

After a year of conversations with community partners and research into collective impact best practices, the Genesee-FLX Climate Collective officially launched in February 2021. The Climate Solutions Accelerator serves as the backbone organization, working to convene the steering committee and facilitate the Collective thus far. The committee co-chairs are Professor Jan Nyrop, Goichman Family Director at Cornell AgriTech, and Simeon Banister, Vice President of Community Programs at the Rochester Area Community Foundation. Although they come at this work from varied backgrounds, both are committed to advancing climate solutions

"...we are confident in our community and its capabilities - in the creativity, commitment, and compassion of our neighbors, working diligently to improve our region, with hopeful anticipation of the burgeoning opportunities to come. ***Together, WE are the solution to climate change.****"*

that promote regional vitality, prosperous, resilient communities, and a regenerative local economy. The Accelerator recruited the remainder of the steering committee in this spirit, recognizing that each member brings a unique perspective that reflects the needs and interests of the broader community. The steering committee consists of a combination of rural and urban participants, representatives from large organizations, as well as grassroots organizers, and individuals with diverse lived experiences. Steering committee representation includes membership from: resident and youth consultants, agriculture, business, community development, social and racial justice, housing, workforce development, renewable energy, transportation, planning, health, higher education, and philanthropy.[12]

Over the course of the year (mainly on Zoom due to the pandemic), the steering committee and backbone staff worked to identify regional assets, brainstorm a vision for the future, evaluate systems-level conditions maintaining the problem, gather public input and feedback, understand regional emission sources, and explore climate solutions through regional field trips. As part of this work, the committee identified four "cross-cutting considerations" or values to inform the work: **equity, public health, economic development**, and **ecological stewardship**, that serve as the basis for decision-making and assessing the suitability of climate solutions for the region *(See Figure 2: Cross-cutting Considerations)*.

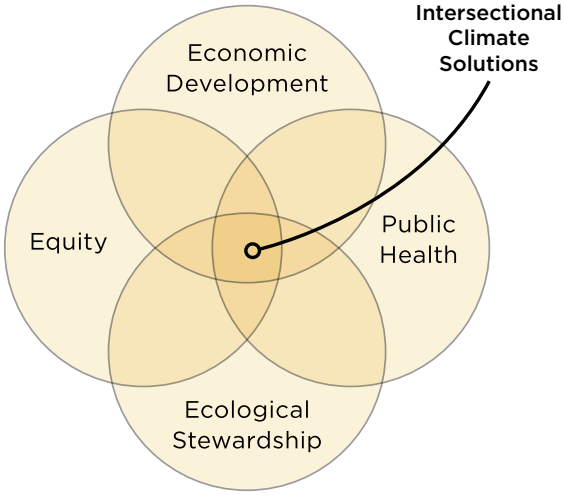


FIGURE 2: CROSS-CUTTING CONSIDERATIONS

The Collective's steering committee also consulted with the Stockholm Environment Institute (SEI) to complete a greenhouse gas (GHG) inventory of the nine-county region *(See Appendix A: Genesee-Finger Lakes Emissions Inventory)*, with a public presentation of the findings. Analysis shows gross regional emissions coming from: transportation (33%), agriculture (22%), residential buildings (16%), waste (9%), commercial buildings (9%), industrial (7%), and electricity transmission and distribution losses (2%) for 2018 *(See Figure 3: Regional Emission Sources)*. Consequently, the regional climate action strategy focuses largely on the transportation, agriculture, building, and energy generation sectors.[13]

The committee also worked to incorporate diverse public feedback from a range of stakeholders through an initial climate solutions survey and a series of sector-specific and population-specific focus groups. The objective of the sector-specific focus groups was to understand the opportunities and barriers to equitably reducing emissions in that sector and transitioning to a clean energy economy in the Genesee-Finger Lakes region.[14] The population-specific focus groups, in particular, sought to include the voices of those most vulnerable to climate change and most often left out of decision-making processes. Conversations focused on participants' vision for a thriving region on a healthy planet, as well as the opportunities and barriers to implementing climate solutions.[15] These sessions provided the foundation for selecting the mitigation measures included in subsequent scenario modeling and the broad categories of action included in this strategy. Additionally, we held consultations with municipal leaders and elected officials to present the results of the greenhouse gas inventory and community input, before discussing opportunities and barriers to meeting CLCPA goals. Public engagement efforts will be ongoing to ensure that the climate action strategy and climate solutions meet community needs.

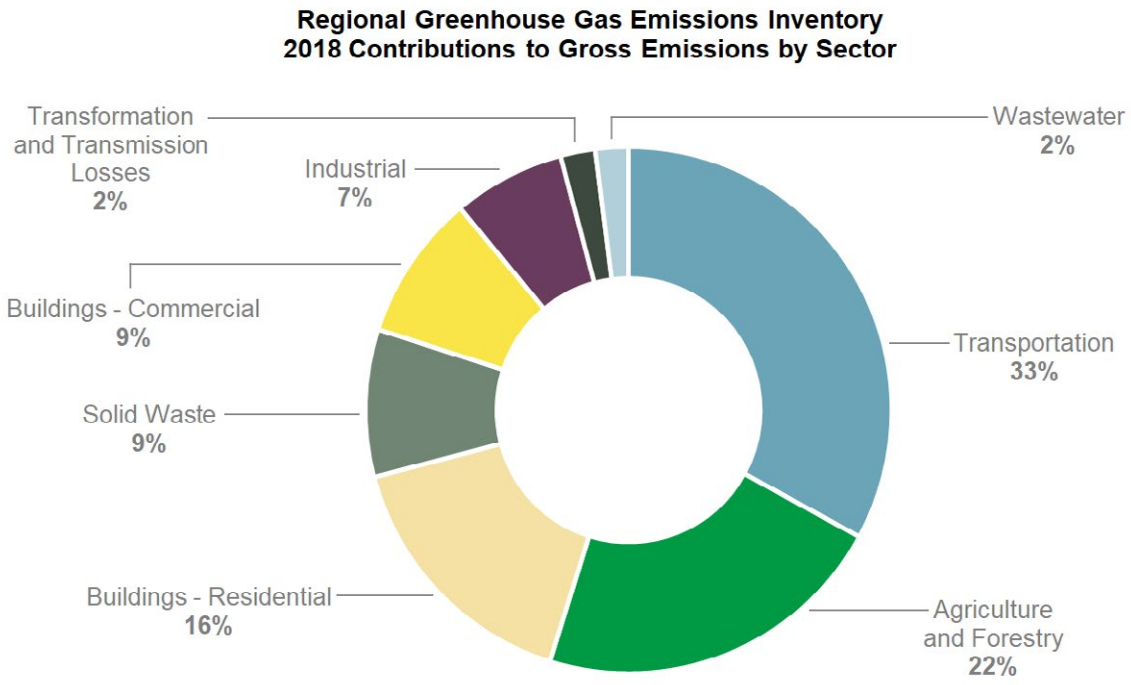


FIGURE 3: REGIONAL EMISSION SOURCES

Cultivating Climate Justice through Collective Impact

Besides the emphasis on data (shared measurement) and cross-sector collaboration, collective impact is well-suited for addressing climate change given its emphasis on equity. Research shows that inequity both drives climate change and is accelerated by climate change[16] - those who ***contribute least*** to the problem will be ***impacted first and worst*** by the effects of climate. While the Genesee-Finger Lakes region is relatively insulated from extreme natural disasters (e.g., hurricanes, forest fires, sea-level rise, etc.) the community's struggle to ameliorate poverty and structural racism means that the climate impacts we do experience will exacerbate existing inequalities in health, energy burdens, housing affordability and quality, transportation burdens, and economic outcomes, amongst others. For example, in all nine counties of the Genesee-Finger Lakes region, the energy burden for low-income households is over 6.5% and over 15% for very low-income households,[17] despite NY State's Energy Affordability Policy that low-income households spend less than 6% of their income on energy (See Figure 4: Energy Burden by County).[18] Without careful planning and thoughtful policy to transition low-income

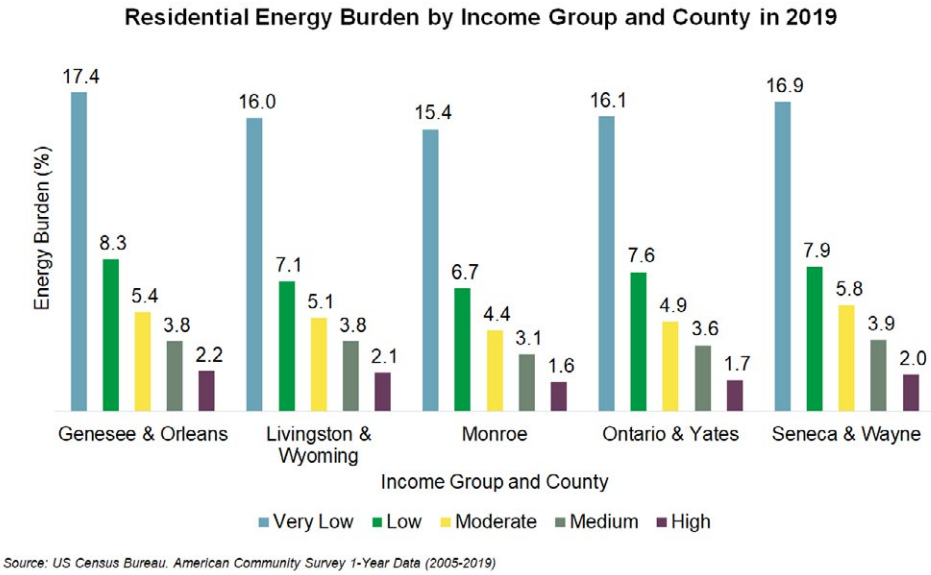


FIGURE 4: ENERGY BURDEN BY COUNTY

CONNECTED COMMUNITIES AND HEAT SMART MONROE CANVASSING EVENT TO EDUCATE ABOUT THE BENEFITS OF ENERGY EFFICIENCY AND THE POSSIBILITIES FOR ENROLLING IN STATE INCENTIVE PROGRAMS. PHOTO: EVAN LOWENSTEIN

households to clean, renewable energy, this burden is likely to increase with rising fossil fuel prices, with the need for more energy to heat and cool homes due to temperature changes, and with fewer utility gas customers remaining to pay for outdated fossil fuel infrastructure, as more customers transition to all-electric heat pumps.

Although there are many definitions of climate justice, they typically include 1) recognizing the disproportionate impacts of climate change, 2) addressing the root causes of climate change, 3) centering the voices and needs of those most impacted in decision-making processes, and 4) ensuring climate solutions are equitably distributed.[19] In New York State, the Climate Action Council's Climate Justice Working Group (CJWG) developed evaluation criteria to identify "disadvantaged communities" (DACs) for the purpose of ensuring that "frontline and otherwise underserved communities benefit from the state's historic transition to cleaner, greener sources of energy, reduced pollution and cleaner air, and economic opportunities."[20] In March 2022, the state released 45 draft criteria for identifying disadvantaged communities, based on census tract, along the dimensions of a) Potential Pollution Exposure, b) Land use and facilities associated with historical discrimination or disinvestment, c) Potential Climate Change Risks, d) Income, e) Race and Ethnicity, f) Health Outcomes and Sensitivities, and g) Housing, Mobility, and Communications.[21] Examples of criteria include a) proximity to diesel truck, bus, and vehicle density, b) proximity to active landfills, c) driving time to hospitals or urgent/critical care, d) percent <80% Area Median Income (AMI), e) percent from racial/ethnic minority groups, f) percent adults age 65+, and g) manufactured housing.[22] Additionally, any household outside of the designated census tracts earning 60% State Median Income (SMI) is included as DACs for the purposes of clean energy and energy efficiency investments.

In the Genesee-Finger Lakes, 35% of the census tracts are identified as DACs, which is on par with the state average. When including the income-eligibility criteria for the purposes of allocating clean energy and energy efficiency, the Genesee-Finger Lakes has approximately 45% of households that fit within the eligibility criteria, 29% within the designated census tracts,[23] and an additional 15% of income-eligible households.[24] Whether due to "Environmental Burden and Climate Change Risk" or "Population Characteristics and Health Vulnerability," the region has a significant proportion of the population that should be given special consideration when implementing climate solutions. The state's designation shows that climate justice concerns extend across urban centers, suburban towns, and rural areas, each with its own unique needs, challenges, and assets ready to address climate change.

To ensure the spirit and substance of the CLCPA's climate justice provisions, we must work shoulder-to-shoulder to implement climate solutions in ways that redress past environmental and economic harms and create new relationships of power needed to transition to a clean energy future. Bringing more people to the table with differing perspectives to tackle the intersectional nature of climate change is imperative for fostering climate justice and creating a cleaner, greener, more equitable Genesee-Finger Lakes region.

Why a Regional Approach?

Although there are diverse needs and concerns across the nine-county region, there is much we have in common, including similarities in climate and geography, as well as our electrical grid and transportation system, which provide a foundation for collaborative action. The geographic scope of this climate action strategy aligns with the state's Finger Lakes Regional Economic Development Council (FLREDC) boundaries, providing possibilities for community collaboration on sustainable economic development and generating a shared regional identity as leaders in the clean energy economy. Moreover, and perhaps most obviously, greenhouse gas emissions traverse county boundaries. Our mitigation efforts will be amplified when combined, given the interdependence of our natural, social, and economic systems. A regional approach is, therefore, large enough to have a meaningful impact on the state's overall emissions, while small enough to engage local actors in making a positive impact in their community. Coordinating action at the regional level provides the opportunity for communities, local institutions, and businesses to collaborate on projects and learn from one another, with the possibility of creating economies of scale. Media outlets can magnify neighborhood and community actions, thereby raising awareness and building momentum for further participation.[25] Because local residents know their community best - understanding their strengths and needs - they are best equipped to develop and implement a climate action strategy that is equitable, inclusive, and can optimize the co-benefits of climate action.

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Despite the many advantages of a local approach, there are also some difficulties associated with a regional approach to a global problem. For perspective, the Genesee-Finger Lakes region emits slightly more emissions than both the entire state of Rhode Island (with 1.1 million people) and the entire country of Nepal (with its 29 million inhabitants). See Table 1: Emissions Comparison by Geography[26]. The effects of climate change that we experience in the nine-county region pale in comparison to those experienced in developing countries, wherein individuals struggle to meet basic needs and where sea-level rise, severe storms, and drought, for example, threaten the very existence of entire nations. Though our region is privileged to have not experienced the most devastating impacts of climate change, we have contributed to the problem,[27] and are obligated to

TABLE 1: EMISSIONS COMPARISON BY GEOGRAPHY

Region	CO_2 Emissions (Million Metric Tons)	Population (Millions)
Rhode Island	11.5	1.4
Nepal	12.0	29.1
Genesee-Finger Lakes Region	**12.8**	**1.2**
Delaware	13.3	1.0
Slovenia	14.1	2.1

For comparison purposes, emissions calculated using the 100 year Global Warming Potential, in line with IPCC accounting

do our part to ensure a healthy planet for all. To be truly committed to equity means recognizing the implications of our regional decision-making for the global community. Along the same lines, because our region does not exist in a vacuum, we could effectively achieve net-zero emissions, only to have emission-generating activities increase elsewhere - in other parts of the state, outside of New York, and even globally. As such, meeting our state goals depends on many aspects outside of our immediate control or influence.

But this does not mean we can, or should, opt to do nothing. Rather, we must make decisions to reduce our own impact, honor local ecosystems, and reduce harm to those within, and outside of, our regional borders. While we recognize that climate change must also be addressed at the international and national levels, we believe we can be most impactful by mobilizing action across our shared networks to influence change at the local and state level.

Other Plans and Reports

There are a multitude of sector-specific and strategic plans throughout the nine-county region, from municipal and county governments and regional entities alike. Many of them focus exclusively on, or pay mention to, transportation, agriculture, buildings, energy generation, or the environment, generally. There are some plans focused exclusively on climate change or sustainability. In 2013, the Genesee/Finger Lakes Regional Planning Council completed a comprehensive Finger Lakes Regional Sustainability Plan that served as the roadmap for our own emissions inventory and climate action strategy.[28] Other climate and sustainability focused plans include the City of Rochester's Climate Action Plan (2017),[29] Climate Vulnerability Assessment (2018),[30] and Climate Resilience Plan (2019),[31] the Village of Fairport's Sustainability Plan (2010)[32], and the Green Genesee/ Smart Genesee Plan and Resiliency Plan (2021).[33] There are also several initiatives underway (e.g., Monroe County Climate Action Plan, and Brighton Climate Action Plan) or under revision.

To that end, the ideas we are presenting are not new, and we are grateful and encouraged to see that there is broad support for the types of actions we suggest. However, to our knowledge, there are no other entities that are working to coordinate action at the *regional* scale necessary to transition the Genesee-Finger Lakes to a clean energy economy and meet the goals of the CLCPA. To the extent that existing plans do not align with CLCPA goals, or align with the scientific consensus on the pace of change needed to tackle climate change, these plans will require revision. It is our hope that when municipal or county entities look to develop their plans or revisit them in light of the state's law, they will turn to the larger collaborative network facilitated by this regional climate action strategy to advance our mutual goals. *Overall, the intention here is to integrate existing efforts into a comprehensive framework for collaborative action that advances the good work already underway, and provides direction for those yet to undertake climate or sustainability initiatives.*

Furthermore, the intention here is to ensure that climate action does not occur in isolation, but rather aligns with other local priorities around safety, resilience, equity, and economic development, amongst others. Reports from FLREDC, RMAPI, and the RASE Commission all identified workforce development, increased income, and improved access to essential needs (e.g., housing, utilities, food, and medical care) as priorities. ROC 2025 identified downtown revitalization, regional brand development, and business attraction and retention as priorities. Investments that facilitate our region's transition to a clean energy economy will advance these priorities, while also improving public health and wellness, reducing poverty and racial inequities, and creating resilient and sustainable communities.

A Climate Action Strategy for the Genesee-FLX

Given the urgency of the climate crisis and the magnitude of the transition needed to reach net-zero, we must start reducing our greenhouse gas emissions now. There are things ***we know*** we have to do and can start doing now, while the state finalizes its policy framework. *We know* we need to build a renewable and reliable electrical grid to support the electrification of our buildings and our vehicles. *We know* we have to improve efficiency—not only of the technologies we use—but in how we move through the world, in how we use energy, in how we design our communities, and in how we produce our food. *We know* this will be no small feat; but *we also know* that the technology and information to take action already exist, and we must do so swiftly and equitably.

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What follows, therefore, is a climate action strategy for the next 3-5 years that 1) focuses on key enablers of systems-level change, 2) utilizes already existing technologies, 3) optimizes the co-benefits of taking climate action, and 4) provides the chance for everyone to plug-in and meaningfully contribute. Although we have the data to project emissions trajectories well into the future (See Appendix B: Scenario Analysis Report), there are too many unknowns to create a detailed plan out until 2050. And while we cannot shy away from the big challenges and the hard tasks that lie ahead, focusing on short-term enablers allows us to eliminate barriers that keep these bigger challenges in place. As such, this is an emergent strategy, one that can, and will, evolve as we continue to engage more stakeholders, learn from one another, and build the capacity of our community to take climate action.

Building a healthier, more equitable, and sustainable community involves a lot of moving parts and requires shifts at every level - including policy, infrastructure, financing, and individual behaviors (See Figure 5: Systems-Level Change).[34] When considered in its entirety, this can feel like an overwhelming endeavor. But it also presents an opportunity - an opportunity

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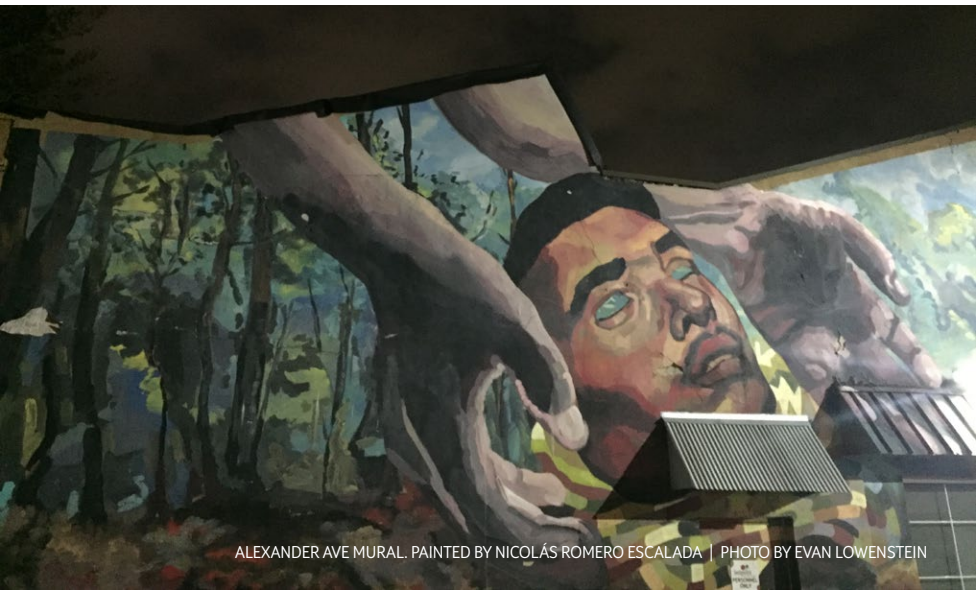
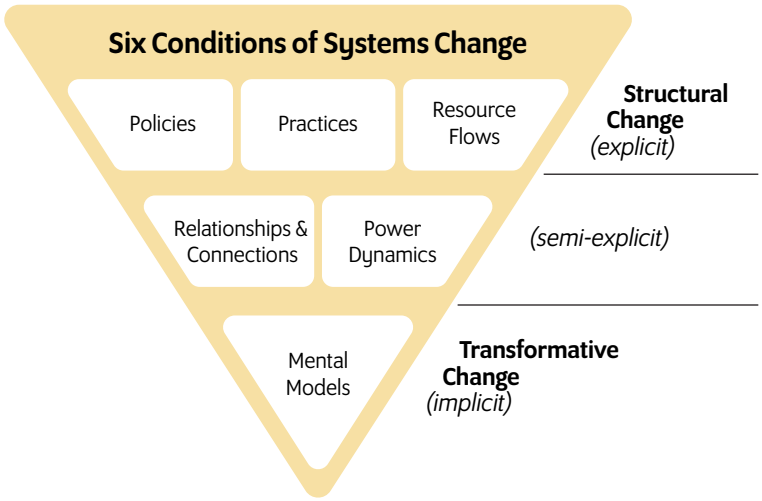


ALEXANDER AVE MURAL. PAINTED BY NICOLÁS ROMERO ESCALADA | PHOTO BY EVAN LOWENSTEIN

for every individual, business, organization, and municipality - to cultivate the future we want to see for the Genesee-Finger Lakes region. Consequently, the Genesee-FLX Climate Action Strategy provides a framework for collaborative action that aims to transform the policies, inequitable resource flows, and stale mental models preventing the adoption of equitable climate solutions in our region. It focuses on employing existing technologies to reduce greenhouse gas emissions in the transportation, building, agriculture/food/forestry, and energy generation sectors while emphasizing the cross-cutting considerations of equity, public health, economic development, and ecological stewardship. This approach enables us to move beyond a singular focus on climate mitigation, adaptation, or resilience. Rather, mitigation and adaptation strategies work together to reduce the impact of climate change and build community resilience. This broad approach to climate action means that climate mitigation and adaptation become regular co-benefits of all community decision-making. As such, the strategy contains some calls to action that may not have a sizable upfront impact on greenhouse gas reductions, but contribute substantially to improving the quality of life, adaptability, and resilience of individuals and communities to the climate impacts we already experience and those to come.

FIGURE 5: SYSTEMS-LEVEL CHANGE



2. Regional GHG Emissions and Local Challenges and Assets for Emissions Reductions:

As we enter our second full year of the coronavirus pandemic, in many ways our community is hurting - suffering from the impacts of COVID-19, suffering from the cumulative effects of structural racism and poverty, suffering from disinvestment in our urban core, and languishing economic opportunity in our rural communities, suffering from toxic and divisive politics, and suffering from the uncertainty and the existential threat of climate change. COVID laid bare the systemic inequities underpinning the disparate racial, economic, and health outcomes in our region, and climate change is poised to do more of the same if left unabated.

These challenges increase the region's vulnerability to climate impacts and present obstacles to implementing equitable climate solutions. The Genesee-Finger Lakes region, however, also possesses a myriad of natural and human assets that can be leveraged to build a healthier, more equitable, and environmentally sustainable community. Thoughtful, coordinated, and collaborative planning targeted at systems-level change can help ameliorate many of the disparate outcomes facing the regional community, while also reducing the harms associated with greenhouse gases and climate change.

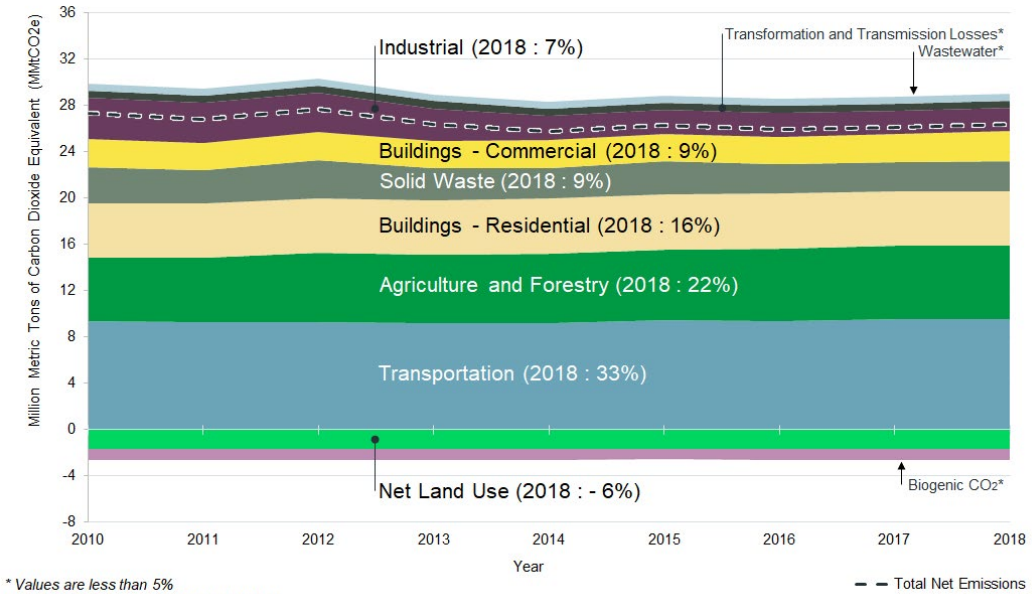
Developing a Shared Understanding of the Problem: Regional GHG Emissions

Developing a shared understanding of our regional emission sources is a necessary first step in determining where we can be most effective in taking climate action. To accomplish this, Genesee-FLX Climate Collective consulted with the Stockholm Environment Institute to conduct a high-level baseline inventory of our regional emissions sources. Greenhouse gas emissions are calculated for the historical period 2010-2018, and a baseline projection of emissions is provided through 2050 based on historical emission rates. The historical period was chosen based on data availability; there is a lack of available data before 2010 and after 2018. See Appendix A for a full description of data sources, assumptions, and methodology.

The emissions inventory is currently being stored in the Low Emissions Analysis Platform (LEAP)[35] with future plans to create a publicly accessible emissions inventory. Historical and future energy demands are modeled for all economic sectors and sources including industry, transport, households, commercial and institutional, agriculture and waste. It also includes non-energy emissions, such as from livestock and crop production, waste, and industrial processes. The model covers the consumption of all major fuels and non-energy emission sources in the region.

In line with the state's CLCPA, the model uses the 20-year global warming potential (GWP), with methane making up the largest share of emissions, followed by carbon dioxide and nitrous oxide. The results show a slight reduction in emissions from 29.92 million metric tons of carbon dioxide equivalent (MMtCO2e) in 2010 to 29.02 MMtCO2e in 2018. This decrease is from the decline in industry in the early 2010s and a shift to cleaner forms of electricity production. Among the different sectors, transport-related emissions are the highest in the region at 33% of 2018 emissions, followed by the agricultural sector (22%), and the residential sector (16%). See Figure 6.

Overall, historical emissions are largely from consuming energy rather than non-energy emissions. The availability, accessibility, and use of alternative modes of transport, including electric vehicles, is low across the region keeping transport emissions high. Residential energy consumption continues to be driven by water heating, space heating, and cooling. Agricultural emissions from energy consumption are low, but non-energy emissions, particularly from dairy farming, make up almost the entire 22% registered to the Agriculture and Forestry sector.



** Values are less than 5%*
MMtCO2e calculations based on 20GWP

FIGURE 6: REGIONAL GREENHOUSE GAS EMISSIONS INVENTORY

Among fuels, gasoline consumption in vehicles represents 24% of 2018 emissions. This is followed by natural gas use in the residential, commercial and industrial sectors resulting in 17% of 2018 emissions. Natural gas use appears to jump in 2018 compared to previous years. This coincides with a substantial increase in heating degree-days in the months of March, April, and October in 2018, suggesting that households may have kept their heating on later in the year (April) and turned it on earlier in the year (October). In the future, heating degree-days are expected to decline as a result of climate change. [36]

The regional greenhouse gas inventory is important for developing a shared understanding of our regional emission sources and the areas where directed investment and community effort can yield the most impactful results. Perhaps most importantly, the data show that "business as usual" will not take us where we need to go, and in fact, poses a threat to the economic, ecological, and social vitality of the region.

Regional Challenges

Climate change is already impacting the Genesee-Finger Lake region in terms of direct environmental impacts, such as flooding, changes in precipitation patterns, the presence of algal blooms, changes in vector ecology, and agricultural production, amongst others. For example, in 2016 much of the region experienced drought and local farmers reported significant losses in corn, hay, forage, and other feedstock crops.[37] Increasing algal blooms across all 11 Finger Lakes threaten the water supply for a million people, as well as recreational opportunities.[38] The number of extreme heat days is on the rise, posing health challenges and impacting agricultural production.


PHOTO BY EVAN LOWENSTEIN

A lack of education about regional climate impacts and misinformation about climate change and clean energy is widespread in the region, both among community leaders and the general public. Political polarization fuels the perpetuation of misinformation. Furthermore, people do not have a clear understanding of how climate change intersects with other regional challenges, such as poverty, structural racism, a housing stock unable to withstand environmental changes, and health concerns. Moving people to take climate action is difficult in light of this misunderstanding and in the face of persistent regional challenges that are more front and center in people's everyday lives.

Many in the region share the struggle for an improved quality of life, and improved economic, health, and housing outcomes. Poverty rates prior to the COVID-19 pandemic hovered around 13% in the nine-county region, just shy of the state average of 14%, but with considerably higher rates concentrated in the City of

Rochester at 31%, and near 20% in Batavia and Geneva.[39] There are also pockets of poverty in rural areas outside of regional cities, in Sodus, Lyons, Geneseo, Mt. Morris, parts of Penn Yan and Naples, among others.[40] Across the region, poverty has a significant racial dimension (See Table 2 - Race, Ethnicity, and Poverty by County[41]).

TABLE 2: RACE, ETHNICITY, AND POVERTY BY COUNTY

	NY State	G-FLX Region	Genesee	Livingston	Monroe	Ontario	Orleans	Seneca	Wayne	Wyoming	Yates
Asian	15%	14%	4%	19%	14%	10%	2%	58%	19%	17%	N/A
Black or African American	21%	32%	27%	35%	33%	26%	29%	42%	36%	36%	36%
Hispanic or Latino	22%	30%	21%	33%	32%	23%	43%	19%	20%	33%	14%
White	10%	10%	10%	12%	10%	8%	12%	11%	11%	10%	12%

COVID-19 served to deepen economic insecurity in the region, with the local economy losing one-in-five jobs at the height of the pandemic in April 2020. Economic recovery has improved since the pandemic's deepest downturn, but the regional economy, even prior to the pandemic, was not meeting the basic needs of many local residents.[42] Households living in poverty are particularly vulnerable to climate impacts and least likely to access costlier climate solutions, posing a challenge for achieving climate justice.

Inequities in wealth accumulation and the disproportionate number of Black, Indigenous, and People of Color (BIPOC) in poverty can be attributed, in part, to the history of residential segregation and redlining that scars the region's landscape, particularly in the City of Rochester. Discrimination in the housing sector continues, despite the end to formal segregation policies, impacting housing quality and access to resources and opportunities - such as employment and neighborhood safety - all of which negatively impact the social determinants of health.[43] Racial disparities are not limited to the housing sector. The Commission on Racial And Structural Equity (RASE) found that structural racism persists across every sector and system, and issued several recommendations to address racial inequality in Business Development, Criminal Justice, Education, Healthcare, Human Services, Housing, Job Creation, Mental Health and Addiction Services, and Policing.[44] Beyond the RASE Commission's recommendations, several measures to ameliorate racial inequities have been put into place, including Interrupt Racism, the Police Accountability Board, and the Person in Crisis Team. Widespread disparities in racial outcomes mean that communities of color are more likely to experience the most significant impacts of climate change. Ensuring equitable access to climate solutions will require an anti-racist and inclusive local climate movement to counteract these various longstanding inequities. A systems-level approach to addressing climate change and racial inequity increases our likelihood of success in addressing both.

Climate change worsens existing health conditions, disproportionately impacts vulnerable communities, increases health care costs, and exacerbates the effects of other social determinants of health.[45] In the Genesee-Finger Lakes region, Common Ground Health found poverty to be a major contributor to poor health outcomes.[46] According to the report, *Overloaded: The Heavy Toll of Poverty on Our Region's Health*, individuals living in neighborhoods with a poverty rate of 30% or more die on average eight years earlier than individuals living in communities with poverty rates below 5%. During the period from 2014-2016, roughly 44% of emergency room visits could be attributed to health inequality, translating to 194,000 excess emergency room visits and $340 million in additional insurance costs for the region.[47] In rural communities in the Genesee-Finger Lakes region, access to transportation and poverty are barriers to receiving emergency and preventative medical care.[48] Farmworkers in the region are more susceptible to poor working conditions and their associated health impacts.

Many farmworkers delay medical care because of concerns about immigration status.[49] The opioid epidemic has also made its mark on the Genesee-Finger Lakes, with rates of opioid overdose increasing drastically starting in 2017 and exceeding those across the state in recent years.[50] Black populations in the region experience higher rates of premature mortality due to heart disease, diabetes, and cancer.[51] Furthermore, BIPOC community members with lower incomes experience higher rates of asthma-driven emergency room visits.[52] Finally, food insecurity is a major concern throughout the region, with at least 11% of the population reporting food insecurity prior to COVID. With the onset of the COVID pandemic, the number of households experiencing food insecurity is projected to increase another 22%-27%.[53]


PHOTO BY DTRACZ/PIXABAY

Inequitable health outcomes will only worsen as climate impacts intensify. For example, burning fossil fuels associated with climate change causes both indoor and outdoor air pollution that can worsen existing respiratory illnesses. Similarly, increased exposure to extreme heat exacerbates respiratory illness and cardiovascular disease, as well as raises the possibility of heatstroke. Extreme heat disproportionately impacts farmworkers, children, the elderly, and those without access to air conditioning. Extreme weather can impact the ability of individuals to access needed or emergency medical care and cause additional stress that worsens associated health conditions (e.g., heart disease and substance abuse). Changes in precipitation patterns and temperature, both locally and globally, can also disrupt agricultural production, impacting food prices and food security. Failure to take swift and bold climate action will only worsen the region's existing illnesses and health inequities and increase health care costs.

Given the wide range of immediate concerns (e.g., poverty, racism, and health), many in the community see climate change as a distant or less pressing issue. Furthermore, taking action on climate change is not necessarily easy, in part because of a lack of clarity on what actions and options are available, and in part due to a lack of resources. The upfront costs for transitioning to clean energy can be a barrier, especially for low-to-moderate (LMI) households and smaller businesses and nonprofits. Similarly, our public engagement efforts revealed that many community and municipal leaders are interested in being more sustainable but do not have the financial resources, the bandwidth, or the knowledge to do the work. Individuals and organizations are also struggling to take advantage of existing clean energy programs and financial incentives because the programs are difficult to navigate. Therefore, the transition to clean energy that is happening in our region risks leaving behind climate justice communities and LMI households.

While many cite affordable housing as a regional asset, the benefits do not necessarily extend to low-to-moderate income households, and the aging and deteriorating housing stock pose challenges to improving efficiency and sustainability. Deferred maintenance on homes leads to expensive projects and requires extensive coordination between service providers, which does not consistently happen. Our region has a significant number of mobile/manufactured homes, which typically consume about 35% more energy per square foot than detached single-family homes and can be challenging to upgrade.[54] Rental units also pose a challenge to improving


PHOTO BY WIKIMEDIA

efficiency and sustainability. Our region is struggling to overcome the "split incentive" that is created when tenants pay the energy bills, but landlords are responsible for investing in energy improvements. Over 50% of households in the City of Rochester live in rental units, and there are a disproportionate number of BIPOC residents living in rental units.[55] The split incentive slows the adoption of weatherization measures and heat pump installations, posing equity concerns and barriers to progress.

Clean energy installations and home energy upgrades are also being hampered by supply chain problems, worker shortages, salespeople promoting gas, poorly coordinated workforce development/placement programs, and lack of wrap-around services. Moreover, the clean energy workforce in our region currently lacks diversity. To ensure that the transition to a clean energy economy does not leave behind those most impacted by climate change, there is a need for programs that support diverse participation and create more equitable employment opportunities in the clean energy sector (e.g., a clean energy business incubator, a clean energy workforce development training center, and "school to green jobs pathways" for members of historically underserved communities). Thus far, the majority of the local workforce development programs have yet to integrate the clean energy sector into their own goals and objectives.

Of course, cultural shifts and systems-level change take time, in part because of the relationship building that is necessary to open hearts and minds to the possibility of change. Given that sustainability and climate solutions are not currently seen as priorities for most individuals and organizational leaders in our region, engaging them and securing their commitment to meaningful action will not be a quick or easy process. That said, we believe that slow and effective is better than fast but ineffective or superficial. The intention behind the climate action strategy presented here is to create a space where all individuals, organizational leaders, and municipalities can identify an area of interest, community, or specific action that inspires them to engage and meaningfully contribute.

Regional Assets

Despite these challenges, we see great potential for mobilizing the region's significant natural and human assets to mitigate climate change and improve the quality of life for local residents. The region boasts a temperate climate with fertile soils, clean air, ample fresh water, and is fairly protected from severe natural disasters, such as wildfires, hurricanes, and sea-level rise. With nearly 6,000 farms, the Genesee-Finger Lakes region is a leader in NY State agriculture. Several counties rank first in sales on various agricultural products, including: milk, cattle, and maple syrup in Wyoming County, vegetables, potatoes, sweet potatoes and melons in Genesee County, grains, oilseeds, dry beans, and dry peas in Livingston County, and fruits, tree nuts, and berries in Wayne County. Five of the state's top ten counties in agricultural sales are in the Genesee-Finger Lakes, and the region is home to 111 wineries, the most of any in New York.[56] These natural assets help buttress

PHOTO BY GRANT TAYLOR PHOTOGRAPHY, INC.

the region against climate disruption and position it well to develop a diverse, resilient food and agricultural ecosystem to increase local food security and respond to the threats of climate change.

The area's built infrastructure and human capital can also be leveraged in responding to climate change. The electrical grid is already relatively clean - with just over 50% of electricity generated from non-carbon emitting sources[57] - thereby giving the region a leg up in its efforts to reduce GHG emissions via beneficial electrification. The region has a long history of innovation and entrepreneurship, from the Erie Canal to the imaging, optics, and communication industries of Eastman Kodak, Bausch & Lomb, and Xerox. This history and infrastructure, coupled with the many local institutions working in this space, including Rochester Institute of Technology's Golisano Sustainability Institute and Pollution Prevention Institute, and Venture for ClimateTech, amongst others, enables the region to become a leader in clean energy technology and clean manufacturing as we transition to a clean energy economy.

PHOTO BY BLACKBIRD SON PRODUCTIONS

The Genesee-Finger Lakes region also has a history as the nation's wellspring for racial and social justice movements, serving as the home to famed abolitionist, Frederick Douglass, and suffragette, Susan B. Anthony, who fought vociferously for the dignity, inclusion, and civil rights of African Americans and women. The legacy of these social and racial justice movements persists today and can be seen most recently in the community's response to incidents of racial violence. Furthermore, there is a strong social service and nonprofit sector, particularly in the areas of housing and racial justice. Organizations such as the Urban League of Rochester, Ibero-American Action League, Rochester Refugee Resettlement Services, City Roots Community Land Trust, Connected Communities, S2AY Rural Health Network, Foodlink, Cornell Cooperative Extension Services, and Rural Migrant Ministries, amongst others, work to empower and support the area's most marginalized populations. To ensure that climate justice principles are incorporated into the transition to a clean energy future will require partnerships and coordinated involvement of these varied movements and organizations.

The region is home to a diverse population and a number of important cultural institutions that are assets to developing an equitable and inclusive community response to climate change. Within the City of Rochester, approximately 68% of individuals identify as people of color, with a sizable Puerto Rican, Dominican, Chinese, and Nepalese population.[58] According to ACT Rochester, between 2015-2019, the region saw significant growth in Asian and Hispanic populations.[59] Wayne County has the largest migrant population in NY State, largely due to on-farm employment, as is the case in Ontario County, resulting in a burgeoning Hispanic population. Members of the Haudenosaunee can be found across the region, with a small concentration on the portion of the Tonawanda Reservation that extends into

Genesee County. Wayne and Yates counties have a growing Amish and Mennonite population, but the exact numbers are difficult to determine.[60] Beyond the region's diversity, the area's network of cultural institutions such as Ganondagan, the Wyoming County Arts Council, the George Eastman Museum, The Avenue Blackbox Theatre, Memorial Art Gallery, The Eastman School of Music, The Little Theatre, the Naples Grape Festival, the Puerto Rican Festival, the Jazz Festival, and Fringe Festival, amongst others, cultivate a sense of community and connection to place through the power of art. The idea that "art moves hearts" is especially important given the pressing need for widespread cultural shifts and new mental models necessary to respond to climate change.

Although the region is struggling to address several overlapping and persistent challenges, such as widespread poverty, structural racism, poor health outcomes, and an aging and deteriorating housing stock, the region's natural and human assets provide major advantages to responding to climate change and their potential should be thoroughly recognized and celebrated. The Genesee-FLX Climate Action Strategy seeks to capitalize on the region's natural and human assets to mount a systems-level response to the climate crisis that positions the region as a leader in cultivating an inclusive and prosperous community response to climate change.

PHOTO BY EVAN LOWENSTEIN

3. A Vision for the Future: Building a Thriving Region on a Healthy Planet

NY State's Climate Leadership and Community Protection Act is momentous for signaling the state's commitment to addressing climate change and in providing ambitious, quantitative targets for reducing greenhouse gas emissions. But *how* the CLCPA is implemented and what successful implementation looks like in each region of the state will vary significantly. For that reason, we asked local residents, sector-specific experts, and community leaders what a thriving region on a healthy planet looks like in the Genesee-Finger Lakes region. How should we implement the goals of the CLCPA in our community? This is what we heard.

The Genesee-Finger Lakes in 2050

After the worst of the COVID pandemic laid bare the vulnerabilities and inequities in the region's transportation infrastructure, health networks, and food systems, many residents in the Genesee-Finger Lakes began rethinking their relationships with their neighbors and with the Earth. They had grown tired of *reacting* to the world in ways that increased their vulnerability and chose, instead, to become *proactive* in creating a community that nurtured their relationships with each other and their environment. Even prior to the COVID pandemic, many community leaders and local organizers had the commitment, courage, and persistence to take on social change work in the community, struggling to improve the safety, prosperity, and quality of life for local residents. Existing social movements, neighborhood associations, rotaries, faith communities, and other civically engaged organizations provided the necessary infrastructure for more widespread community engagement and planted the seeds for building a sustainable future. Increasingly, town board meetings, county legislative sessions - even local zoning meetings - became hotbeds of civic engagement, with individuals eager to take action that would stem the tide of climate change, while also improving outcomes in public health, access to local food, employment opportunities, and housing quality.

Local residents, working in concert with their elected officials and community leaders, seized the opportunities and possibilities of the clean energy economy as a means of reinvigorating the region. Now, regional citizens enjoy the fruits of their labor and the benefits of an equitable and resilient community, wherein people and places can respond to disruption - whether social or natural. Overwhelmingly, local residents are able to achieve their full potential, maximize self-sustainability, and realize their self-worth. Respect for one another, for one's community, for one's self, and for the Earth is widespread across the Genesee-Finger Lakes region. Members of the Haudenosaunee community led the way in integrating the Seventh Generation Principle into local decision-making, which considers how decisions today to preserve natural and cultural resources impact the next seven generations to come. To actualize this principle, information and

PHOTO BY EVAN LOWENSTEIN

resources are readily available, and inclusive decision-making and robust civic engagement are the norm in neighborhoods and towns across the area.

Building on its history of innovation and creativity, the region is a leader in closed-loop economic development and there is a regenerative local economy with targeted investments in local people and local


PHOTO BY BLACKBIRD SON PRODUCTIONS

communities. Gone are the days of take, make, and waste. Now, the economy operates on the ethos of reclaiming, returning, and renewing. Consumer goods have been redesigned and reimagined to require fewer natural resources. Planned obsolescence is no longer the industry standard. Rather, "Take Back Programs" require companies and manufacturers to disassemble electronics, vehicles, appliances, and other retail items to recapture precious metals, minerals, and additional natural resources and regenerate them as part of the manufacturing process. There is an emphasis on building out local supply chains wherever possible to maximize self-sufficiency and minimize vehicle miles traveled. And waste is now a valuable commodity used to generate community wealth. Local unemployment is minimal, as more and more people are needed to fill positions from production to reclamation. Clean energy workforce development programs, local technical schools, and institutions of higher education focused on engineering and advanced manufacturing turn out a technically literate workforce and attract students from across the state. Clean, renewable energy powers the entire economic system. A combination of micro-grids, Community Choice Aggregation, and appropriately sited renewable energy and storage provide consistent and affordable energy for all.

Convenient, affordable, safe, and comfortable forms of transportation are the norm. Residents can access employment and community amenities in a safe, efficient, and car-free manner with improved public transportation, walk and bike-ability, and widely available micro-mobility options, such as electric scooters. All-electric public transportation is an attractive, viable, and cost-effective option that meets the everyday travel needs of residents and is the preferred mode of transport. Bus stops and park-and-rides bustle with commuters and individuals taking advantage of recreational resources, restaurants, and the region's cultural assets. An interconnected network of trails that criss-cross the region also provides a safe and aesthetically pleasing option for people to access community amenities and local recreation. Remote work is widespread due to affordable and reliable broadband and incentives that encourage working from home. For any remaining transportation needs that cannot be met otherwise, a network of publicly available electric vehicle charging stations, electric car-sharing programs, and on-demand electric shuttles are available.


PHOTO BY EVAN LOWENSTEIN

Town centers and urban neighborhoods provide opportunities for shopping, recreation, entertainment, and community gathering, without going far from home. An expansive tree canopy, flourishing community gardens, well-maintained and accessible parks, green roofs, and other green infrastructure projects blanket the region, providing shade, cooling neighborhoods, absorbing excess precipitation, improving air and water quality,

PHOTO BY EVAN LOWENSTEIN

and supplying welcoming spaces for recreation and relaxation. The region is home to a variety of indigenous flora and fauna, while songbirds trilling, crickets chirping, and bees buzzing dominate the soundscape. Children flood local neighborhoods, playing in nearby parks and frolicking through area green spaces, free from the noxious fumes and particulate matter associated with vehicle exhaust and dirty industry.

The region has become a national leader in converting an aging and dilapidated housing stock into well-maintained, affordable, and efficient housing that is heated and cooled with high-efficiency heat pumps. Elderly populations, young children, and those struggling with chronic illness no longer have to endure sweltering heat during the summer months, as their efficient homes, cooled with an electric heat pump and ample shade, provide relief from the area's hot, humid mid-August weather. Thanks to the efforts of local tenants' rights organizations, problems with absentee landlords are no longer. Rather, money spent on monthly rent stays in the local community. Widely available healthy homes and energy efficiency programming, including for rental properties, dramatically improved the quality of the area's housing stock. Municipalities developed a building benchmarking and rating system that is easy to navigate and provides residents with upfront information on energy efficiency and utility costs, so they are well informed to make the best housing choices possible. As a result, rental properties are quieter, have good indoor air quality, are pest and mold-free, and have reduced energy costs. The average household's energy burden is well under the state's recommended six percent. And rooftops glisten as the sun dances off the ubiquitous solar panels on the region's municipal buildings, schools, homes, and businesses.

Local residents, regardless of their location in urban centers or rural hamlets, enjoy access to locally sourced, healthy, and nutritious food. Revisions to regional procurement strategies mean that grocery stores carry local fruits, vegetables, meats, dairy, and other value-added products as well as a network of farm stands, farmers' markets, and produce carts. Universities, K-12 schools, and hospitals led the way in adopting local procurement, but the practice has become widespread and the "Grown in the Genesee-FLX" label has become commonplace. Agricultural lands and livelihoods are safeguarded against climate impacts and remain productive and resilient, thanks to the efforts of local land trusts and area soil and water conservation districts. Agricultural production and agro-tourism are major employers in the region. Proximity to Cornell University and its vast network of resources, as well as efforts to improve access to local farmland, has resulted in younger and more diverse farmers taking to the land. Retiring farmers are assured that bequeathing their land or selling it to the next generation will result in continued stewardship and production of the land.

PHOTO BY EVAN LOWENSTEIN

In accordance with regional economic development strategies, local agricultural producers, including dairies and commodity crop producers, lead the nation in closed-loop, regenerative practices. Due to well-funded Soil and Water Conservation District Offices,

the vast majority of the region's farms have integrated resource management plans, including carbon plans, which assist farmers in the essential work of tracking their farm's inputs and outputs. Local farms are the cornerstone of the area's rural economies and climate considerations permeate operations throughout. Improved soil health from cover-cropping, reduced and no-till practices, and the addition of compost, manure, and biochar, maximizes productivity while promoting resilience and adaptation to climate change.


PHOTO BY EVAN LOWENSTEIN

In line with national trends, plant-based, seasonal diets have become more common-place, and area demand for produce is largely met by local farmers. The region has become a beacon for agro-ecological farming practices, including organic, most notably in dairy production, and a widespread apprenticeship program ensures younger or less experienced farmers can learn from the vast knowledge of the local farming community. The elimination of synthetic fertilizers and reductions in pesticides and herbicides has improved farmworker health through reduced chemical exposure. Thanks to public-private partnerships, the region's dairy industry has become a leader in emissions reduction practices, in part from changes to animal diet, and the widespread adoption of manure management practices.

The region's extensive healthcare network led a wide-reaching community campaign about the public health implications of climate change and the benefits of taking climate action. Healthcare providers regularly distribute information about energy efficiency, clean heating and cooling, and the importance of eating locally sourced, plant-based diets to their patients. Upgrades to the regional transportation system have meant that more and more people can access quality healthcare, particularly in rural areas. Improved air quality, access to healthy, nutritious food, and better recreational opportunities have led to enhanced public health. For example, there has been a significant reduction in the number of individuals with cardiovascular disease and respiratory illnesses and far fewer premature and low-weight babies being born. Given the previous health disparities, much of these benefits have accrued for the region's communities of color - but health improvements can be seen across racial and income lines. Access to viable employment opportunities and quality housing, coupled with progressive neighborhood design and safety, and a renewed sense of community and possibility have resulted in improved mental health and fewer people struggling with addiction.

Developing equitable climate mitigation, adaptation, and resilience strategies required the commitment, leadership, and investment of a broad range of stakeholders from across the region. But by working collaboratively, the Genesee-Finger Lakes region has become a healthier, more equitable, and environmentally sustainable community. Local residents now live in concert with their local environment, with cascading benefits for public health and social and economic vitality.


PHOTO BY BLACKBIRD SON PRODUCTIONS

4. The Genesee-FLX Climate Action Strategy

The Genesee-FLX Climate Action Strategy provides a shared understanding of our regional emission sources, a framework to guide regional actors in taking impactful climate action, and the basis for a shared system of measurement to track progress and accountability. It is not a detailed plan or a prescription for action until 2050. Rather, the recommended action items are short-term enablers targeted at different scales (e.g., individual behaviors to infrastructure projects) and advanced through varied mechanisms (e.g., advocacy and policy change, market shifts, programmatic support). Some of the action items are already underway and will build off current momentum, and others will require the development of new partnerships, programs, or educational campaigns. While the intention is to provide immediate guidance for the next 3-5 years, many of these actions will continue to be ongoing priorities. Yet, tackling immediate short-term enablers at different scales, and through varied means, should spearhead the structural changes needed to move the region toward meeting the goals of the CLCPA.

What is presented here cannot be implemented by any single entity, and is not a one-size-fits-all approach. The Genesee-FLX Climate Collective welcomes local leaders, regional experts, and enthusiastic citizens to join the various working groups and citizen action teams charged with spearheading implementation. Working groups will focus on those areas where we can make the largest impact on regional emissions - housing/buildings, transportation, renewable energy generation and storage, and agriculture. There will also be two cross-sector working groups, focused on workforce development and advocacy/community organizing. Working group participants will include key stakeholders from each issue area and lived experience experts who will identify and develop the necessary partnerships to advance strategy implementation.

As such, *we offer the following strategy in the spirit of collaboration, and with the promise of possibility, expecting that local communities adapt the strategy to fit their needs, while seeking regional synergies and opportunities to share resources and best practices that advance the state's goal of a net-zero economy.*

*"...we offer the following strategy in the spirit of **collaboration**, and with the promise of **possibility**, expecting that local communities adapt the strategy to fit their needs, while seeking regional synergies and opportunities to share resources and best practices that advance the state's goal of a net-zero economy."*

Experience thus far indicates that although each sector will have its unique challenges, there are several critical elements for success that span across sectors - dollars and data, amongst them. Experience also shows that climate action is a quickly evolving and changing landscape, in terms of policy, research, data, political context, and funding. As one local farmer noted - the only constant we have is change. So rather than viewing the quantitative scenario analysis work that follows as concrete representations of our regional future, we view the scenarios as schemas, directing our focus to those areas where we can make the most impact to reduce greenhouse gases and improve quality of life for all residents. The scenario analyses do, however, concretely demonstrate that time is of the essence, and that we must be much more ambitious than we might expect. Finally, experience shows that because climate change is a structural issue with multiple touchpoints and intersections, the actions selected for this strategy must also multitask, reducing emissions, while advancing equity, and yielding improvements for the everyday lives of citizens today.

Critical Elements for Success

There are several critical elements needed to successfully implement the systems-level changes necessary to address climate change. Access to regionally specific data, equitable investment, and a streamlined system for navigating service providers and relevant resources are needed to ensure that progress is being made, to fund solutions, and to facilitate community action.

REGIONALLY SPECIFIC, RELIABLE DATA

A key feature of collective impact work is a shared system of measurement to track progress, improve transparency, and maintain accountability. Therefore, access to regionally specific, reliable, and consistent data is necessary to have a clear understanding of regional impacts and to measure progress on regional indicators. Currently, relevant data is not consistently or reliably collected, not available for our region, not publicly available, and/or not available at the correct resolution (e.g., timeframe, level of aggregation, etc.). Additionally, depending on the sector, there is not always scientific consensus on the best means of measuring greenhouse gas emissions and potential carbon sequestration. Agricultural production provides a salient illustration. The complexity of agricultural production, generally, and the variation in farm practices make generalizations about agricultural emissions and the impact of various mitigation measures complicated. Moreover, changes in weather, feed type, cow behavior (e.g., amount of food consumed), manure management practices, and markets can cause farm-based estimates to change year over year, making future projections difficult.

There is little historical precedent for collecting and analyzing the scope and scale of data needed to track local progress on climate change. Addressing data challenges will require coordination and collaboration amongst the many stakeholders already working with regionally relevant data, and that process has already begun. In some instances, changes in state and federal practices about what data is collected, and at what scale, are needed. Yet, the urgency of the climate crisis means that we cannot wait for perfect data. Rather, we must critically analyze the data we do have, and identify opportunities for taking impactful action that reduces emissions and improves equity and quality of life for local residents. (For a full explanation of the data assumptions and methodologies, see Appendix B.)

Moving forward, we will continue to advocate for guidance and direction from the state and federal government to improve data tracking and collection. But simply having data is insufficient; it also has to be accessible. As such, our intention is to develop a locally relevant and user-friendly interface to measure regional progress, learn from our efforts, ensure equitable outcomes and processes, and refine and evaluate the strategy as needed.

EQUITABLE INVESTMENT

While we know the transition to a clean energy economy is happening, there is no guarantee that it will be equitable. Currently, climate-friendly products and services are typically more expensive than their polluting counterparts, so until this market failure is corrected (e.g., through carbon pricing), fully transitioning to clean energy may be unaffordable for many households and businesses. Local municipalities also struggle with financing and affording climate-friendly upgrades and investments, particularly in smaller, rural communities. Without securing access to climate solutions for all community members, an equitable net-zero economy is not possible.

Thus far, the state has not provided a funding mechanism for the CLCPA. We will continue to advocate for full funding of the law. Even with state investment, it will be necessary to leverage federal dollars and private investment to scale up solutions at the rate needed to stem climate change. Therefore, local decision-makers must develop an understanding of the various financial tools available to implement climate solutions, with a focus on deploying resources in a manner that does not reproduce or exacerbate existing inequalities. This will require that we prioritize investments in disadvantaged and vulnerable communities first, and explore innovative financing solutions that create opportunities for community wealth-building. Local funders will have an important role to play in developing a philanthropic network to increase funding accessibility and to identify

financing gaps. Possibilities for funding solutions include American Rescue Plan Act dollars and other federal infrastructure dollars, green municipal bonds, donor-advised funds through local foundations, federal and state grants and incentives, Property Assessed Clean Energy programs, on-bill financing and repayment programs, the New York Green Bank, crowdfunding projects, revolving loan programs, climate funds, no and low-interest loan programs, and other creative financing solutions.

"Investing in climate solutions is critically important, but so is stopping investment in anything that contributes to the climate crisis."

Investing in climate solutions is critically important, but so is stopping investment in anything that contributes to the climate crisis. Public money is currently supporting development projects that use fossil fuels, are not accessible by public transit, produce excessive waste, and/or extend our reliance on fossil fuel infrastructure. We believe this to be an unwise use of taxpayer dollars and will continue to advocate for an end to the investment of public dollars in projects that do not bring us closer to meeting CLCPA goals.

STREAMLINED SYSTEM OF PROVIDERS AND RESOURCES

In addition to accessing data and financing, there is considerable need to streamline existing service providers and coordinate programs and resources. Currently, there is a dizzying array of local, state, and federal programs to improve housing access, health, and clean energy adoption. For example, there is the federally administered Weatherization Assistance Program (WAP) and the Housing and Urban Development (HUD)'s HOME program. State programs include the Home Energy Assistance Program (HEAP), and the Affordable Housing Corporation (AHC), while NYSERDA administers the EmPower program, Assisted Home Performance program, Clean Heating and Cooling Campaigns, and NY-Sun, amongst others. There are also local lead and mold abatement resources, and programs through Action for a Better Community (ABC), RENEW, NeighborWorks, PathStone, and the local utilities, to name a few. It is not surprising that residents can easily become confused and overwhelmed when trying to access these programs. Therefore, it will be necessary to establish a "no wrong door" network of partners, including healthcare providers, that work together to increase access to home/building energy upgrades, using a comprehensive "healthy homes" approach.

Scenario Analyses

After completing the baseline inventory of regional greenhouse gas emissions, the Stockholm Environment Institute modeled a suite of actions, or mitigation measures, to better understand the potential for emissions reductions. Although SEI's model did not quantitatively assess the economic or health benefits of different mitigation measures, priority was placed on modeling measures that 1) aligned with the visionary elements from the focus groups, 2) maximized co-benefits for the community, and 3) reduced greenhouse gas emissions. SEI developed three different scenarios: 1) existing federal and state policy, 2) existing policy plus low ambition targets, and 3) existing policy plus high ambition targets. Given the large uncertainties associated with projecting emissions over 25 years into the future, the scenarios do not provide a prescribed path forward for meeting CLCPA goals. Rather, the scenarios provide useful guidance in evaluating different pathways to "close the gap" between existing and projected emissions and the state's climate goals. See Figure 7: Comparison of Genesee-Finger Lakes Mitigation Scenarios.

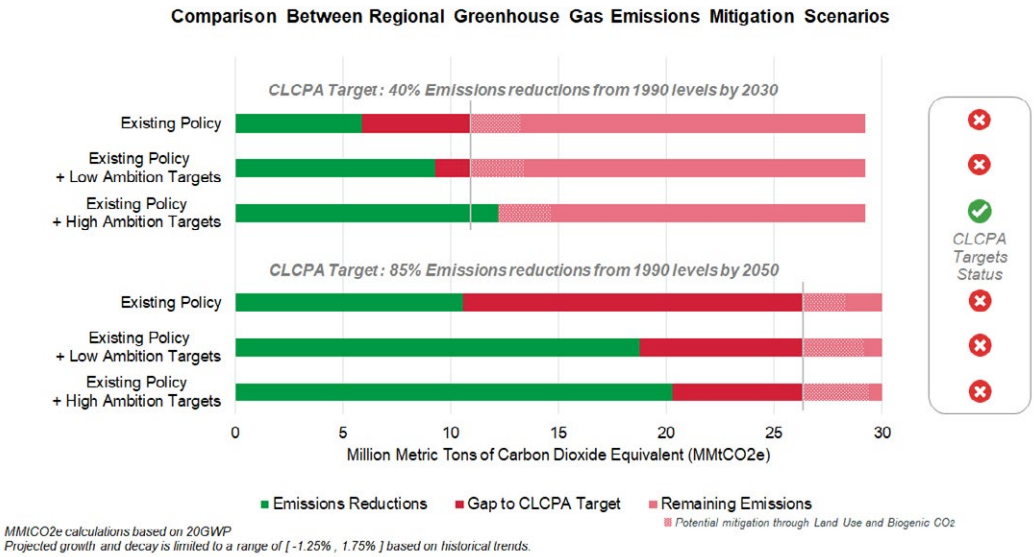


FIGURE 7: COMPARISON OF GENESEE-FINGER LAKES MITIGATION SCENARIOS

EXISTING POLICY SCENARIO

The existing policy scenario includes current state and federal policies aimed at improving efficiencies and reducing emissions. Some of the policies in this scenario include compliance with NHTSA CAFE fuel economy standards, Regional Transit Services (RTS) bus electrification, the transition of all light-duty new vehicle sales to zero-emission vehicles, basic and deep shell retrofit targets for residential and commercial buildings, and improvements to industrial efficiency, among others. See Appendix B for a full description of the policies and target dates included. According to this scenario, the largest potential for emissions reductions comes from grid decarbonization and transportation measures. Despite gains in these sectors, analysis shows that existing policies alone do not bring the region close to meeting CLCPA goals. Rather, we need well-coordinated, collaborative action to make larger gains in emissions reductions.

EXISTING POLICY + LOW AMBITION TARGETS SCENARIO

The existing policy plus low ambition targets scenario incorporates a series of mitigation measures identified through public engagement efforts, a review of various regional town, city, or county plans, a review of the scientific literature, and a review of relevant case studies or comparable examples, including the state's own scenario analyses. Broadly, scenarios include mitigation measures pertaining to 1) vehicle miles traveled (VMT), 2) efficiency standards and fuel-switching for vehicles, 3) building energy efficiency, 4) fuel-switching in buildings, 5) soil health practices, 6) agricultural waste management, and 7) grid decarbonization. Specific measures from each category were included as well as a corresponding rate of adoption or emissions reduction target date. For example, the measure "Reduce VMT" had a corresponding target of 10% reduction through public transportation, biking, walking, and working from home by 2030 and 20% reductions by 2050. See Appendix B for a full description of the methodology, assumptions, and targets involved in the scenario and Section 5 for a more detailed description of the various mitigation measures. In the existing policy plus low ambition target scenario, the largest potential for emissions reductions comes from transportation, with buildings, and agricultural/forestry bringing significant potential as well. ***In this scenario, the region comes just shy of meeting the state's 2030 CLCPA goal of 40% emissions reductions from 1990 levels, but does not meet the state's 2050 goals.***

EXISTING POLICY + HIGH AMBITION TARGETS SCENARIO

The existing policy plus high ambition targets scenario incorporates the same mitigation measures included in the previous scenario, but increases the rate of adoption or accelerates the target date for meeting emissions reduction. For example, in the low ambition

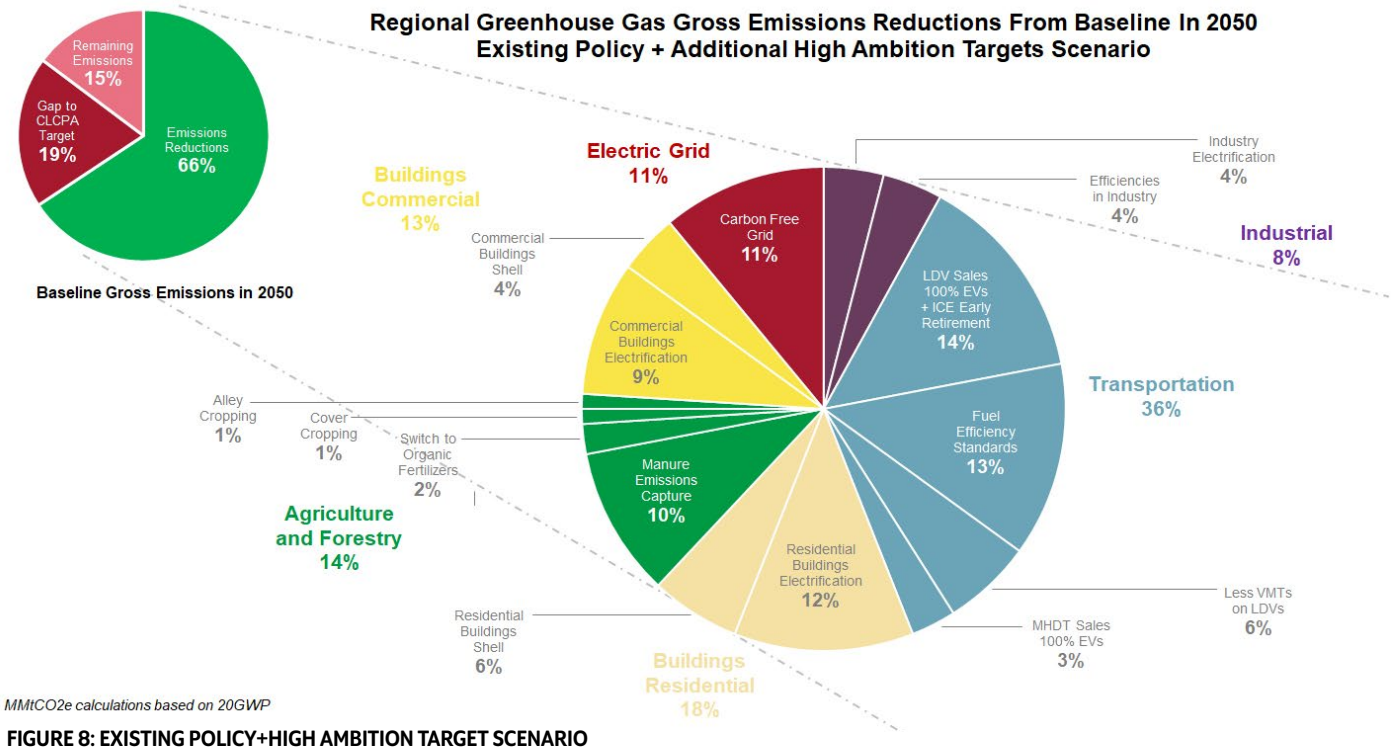


FIGURE 8: EXISTING POLICY+HIGH AMBITION TARGET SCENARIO

scenario, the adoption rate for the mitigation measure "Reduce VMT" through public transportation, biking, walking, and working from home" increases from 10% by 2030 and 20% by 2050, to 25% by 2030 and 35% by 2050 in the high ambition scenario. See Appendix B for a full description of the methodology, assumptions, and targets involved in the scenario and Section 5 for a more detailed description of the various mitigation measures. In this scenario, ***the region does meet the 2030 CLCPA goal, but does not meet the 2050 goal***, with significant emissions remaining in the agricultural, waste, and transportation sectors. See Figure 8 for the results of the high ambition scenario.

The scenario analyses indicate that implementing the high ambition target measures will be sufficient for meeting the 2030 goal, but more aggressive implementation targets (e.g., faster or more widespread adoption) and/or additional mitigation measures are still needed to meet the 2050 goal. For example, both the agricultural sector and waste sector provide significant opportunities for emissions reductions that could align the region with the state's 2050 goals. In the agricultural sector, many mitigation measures, particularly with regard to livestock emissions, are still in the research and development phases, and not widely available at a commercial scale. As such, these technologies were not included in SEI's modeling, and provide significant potential for emissions reductions as they become more widely available. Additionally, approximately 40% of the state's landfill capacity is within the Genesee-Finger Lakes region and the methane emissions from these landfills significantly impact the region's overall emissions.[61] Although the Seneca Meadows landfill in Seneca County is slated to close in 2025, the landfill will continue to produce methane emissions. Furthermore, the waste currently entering the Seneca landfill will necessarily be directed elsewhere. Reducing and diverting waste (e.g., through composting) within the region will help to decrease emissions from this sector. However, given the region's role in the state's overall waste management strategy, waste reduction and diversion practices must necessarily become a collective statewide endeavor. As we build the collective capacity of the region to take action and await the state's full regulatory framework, the data here indicate which actions are likely to be most impactful, where we should prioritize our investments, and how quickly we must move to align the region with CLCPA goals.

A Strategy for Action in the Genesee-Finger Lakes Region

The Genesee-FLX Climate Action Strategy focuses on transportation, building, agricultural sectors, and electricity generation because they provide the greatest opportunity for regional emissions reductions. While transportation, agriculture, and buildings contribute the majority of GHG emissions, the importance of a decarbonized electrical grid for meeting sectoral goals means it has been included as a major priority in this climate action strategy. What follows is not an exhaustive list of potential actions, but reflects what we know to be best practices for reducing emissions, while optimizing the co-benefits of climate action. Although there are certainly notable emissions from the industrial, commercial, and waste sectors, some of the same practices put forth here (e.g., energy efficiency and building electrification) can help reduce emissions in these sectors, while practices from the agriculture/food/forestry sector can help divert regional waste streams. Eventually, the strategy will evolve to include additional mitigation measures and other sectors necessary for reaching a net-zero economy. See Section 5 for the full details for each measure.

Energy Generation

The CLCPA requires 70% of the state's electricity to come from renewable sources by 2030 and that all electricity be generated from carbon-free sources by 2040. To meet these goals, the CLCPA also requires 6,000 MW of distributed solar by 2025 and 3,000 MW of energy storage by 2030 statewide.[62] Although over half of the electricity generated locally is from carbon-free sources, greening the remainder of the grid and building out grid infrastructure will provide year-over-year gains in emissions reductions as we move to electrify other sectors.

PHOTO BY EVAN LOWENSTEIN

Aggressive deployment of renewable energy generation is needed, particularly as the demand for electricity increases. The state estimates an increase of 65%-80% in electricity demand by 2050.[63] Although there is general consensus that the region needs renewable energy, there is no consensus about how we should meet that need. While there is precedent for large renewable energy generation projects in the region (e.g., roughly 300 wind turbines in Wyoming County), there is also tension around the scale, siting, and ownership of renewable energy generation and storage projects. Ensuring that renewable energy generation and storage projects meet the cross-cutting considerations of equity, economic development, public health, and ecological stewardship will necessitate consultative site selection processes for all new large-scale clean energy projects and innovative design, deployment, and ownership opportunities for distributed generation and distributed energy resources.

Regionally, some of the structural barriers to equitable and ecologically sound renewable energy generation include 1) spacing/siting of renewable energy projects, 2) overall grid reliability (e.g., aging infrastructure, poor vegetation management, battery storage), and 3) affordability. Action items to help overcome structural barriers and advance the cross-cutting considerations include:

Educate local municipalities and residents about the costs and benefits of renewable energy projects of varying types, the impacts for local environments and communities, and the process for navigating strong community benefits agreements (CBAs).

A variety of factors can prevent or delay the adoption of energy generation and storage projects, including misinformation and misunderstanding about the different types of projects (e.g., utility-scale, community solar, microgrids), the amount, quality, and value of land involved (particularly vis-a-vis other land-uses), the safety of generation and storage, and concerns about the decommissioning process. Additionally, there is no uniform system for payments-in-lieu-of taxes (PILOT) that is enforceable across all jurisdictions, creating confusion. Sharing information, lessons learned, and best practices amongst municipal leaders and local residents promotes transparency and collaboration and empowers communities to make informed decisions about energy generation and storage.

MORRIS RIDGE SOLAR PROJECT

The Morris Ridge Solar Project, in the town of Mt. Morris, is a renewable energy project under development for 177 MW of solar generating capacity and 83 MW of energy storage. The project is set to go online in 2023 and will produce enough electricity to power 38,000 New York households, the equivalent of almost all of Livingston County and nearby Wyoming County combined. Town officials and local community members overwhelmingly supported the project due to the many community benefits the town negotiated with the developer, EDF Renewables. Amongst the benefits, the town will be able to expand water service beyond the current boundaries to the rest of the township, providing a much-needed service to local residents. Additionally, the project will provide the Mt. Morris Central School district over $10 million during the first 20 years of the project, and a partnership with the local BOCES will provide students with hands-on learning opportunities in electro-mechanical construction and metal trades. By agreeing to host a large-scale solar project, NYSERDA provided several EV charging stations along the town's Main Street, an added draw for local tourism. Finally, local residents are looking forward to the cultivation of wildflowers, berry bushes, and other native plantings amongst the panels, promoting biodiversity and improving local ecosystems.[70]

Facilitate a community-wide conversation about the role of nuclear energy, hydrogen, and biogas in the local energy mix.

Currently, there is widespread disagreement (even amongst the climate movement) about what role (if any) nuclear energy, hydrogen, and biogas should play in the transition away from fossil fuels. Misinformation and misunderstanding about the benefits, feasibility, and effectiveness of these technologies make informed decision-making difficult. As the recertification process for the Ginna Nuclear Power Plant draws near, and as the community moves to make decisions about investing in our renewable energy infrastructure, there will be a growing need for an informed citizenry and local decision-makers.

Drive rooftop solar installations through coordination of resources for local incentives and service providers, via an "energy navigators" program.

Balancing large-scale renewable energy projects with distributed energy generation can promote energy independence, reduce grid demand, and maximize land-use opportunities. Many homeowners and businesses are interested in on-site renewable energy generation, but are unsure where to begin or how to access available resources and incentives.

Pilot/support proof of concept for renewable energy projects of varying types (e.g., community solar, microgrids, agrivoltaics) that advance innovative design and ownership models.

Developing and demonstrating the viability of renewable energy projects that generate wealth for local communities and maximize multi-use generation opportunities is necessary to equitably decarbonize the electrical grid. Community solar projects and microgrid projects can advance equitable access to renewable energy technology for those who are not homeowners or are unable to install on-site solar, with potential savings reinvested in local communities. Microgrid projects provide the opportunity for community control and management of energy resources. Multi-use generation opportunities, such as combining solar with agriculture (agrivoltaics), on multi-family housing, or parking lot solar generation and storage, can maximize land use opportunities and energy generation.

Participate in rate cases to advocate for grid reliability, equitable rate design, and programming that encourages electrification.

Until the Public Service Commission requires utilities to reduce emissions in accordance with state law, build out the grid to support electrification, and implement policies and programming to assist LMI households with building electrification, intervention in utility rate cases will remain a primary mechanism for advancing these goals.

Transportation/Land Use


PHOTO BY EVAN LOWENSTEIN

Transportation is the largest source of regional emissions at 33%. Most of the transportation emissions come from light-duty vehicles (small trucks and cars). According to the state's Draft Scoping Plan, the state will need approximately 3 million zero-emission vehicles (ZEVs) by 2030 and 10 million ZEVs in use by 2050.[64] However, upfront costs of ZEVs mean that alternatives to single-occupancy vehicles must also be prioritized as a climate justice solution. Reducing transportation emissions and improving transportation infrastructure will require changes to land-use decision-making, but will also help to address some of the regional inequities in accessing employment opportunities and community amenities. Regionally, some of the structural barriers to reducing transportation emissions include 1) land-use decisions that locate economic development and daily necessities outside of city/town/neighborhood centers, 2) deeply ingrained "car culture," 3) affordability and other inequities, e.g., commute times, and 4) inadequate EV infrastructure. Action items to help address these barriers fall into two broad categories: reducing vehicle miles traveled (VMT) and transitioning remaining VMT to zero-emissions. To accomplish this will require making multi-modal transportation (e.g., public transportation, walking, biking) the more attractive transportation option and to make zero-emission vehicle technology and infrastructure more equitably available. Action items to help overcome these barriers include:

RTS ELECTRIC BUSES

In the Fall of 2020, Regional Transit Service (RTS) unveiled its first ten electric buses and will be adding another ten electric buses in 2022. Additionally, RTS is working to secure funding for a bus storage and charging depot to facilitate the transition to zero-emission vehicles. RTS has the second-largest electric bus fleet in the state and is working to meet New York State's goal of having 25% of its bus fleet zero-emission by 2025, and 100% by 2035. According to the EPA, a single zero-emission bus is able to eliminate 1,690 tons of carbon dioxide over a 12-year lifespan of a bus, which is the equivalent of taking 27 cars off the road. By converting to ten electric buses, RTS has removed the equivalent of 270 personal vehicles from the road. Additionally, RTS can save approximately $187,000 in fuel and maintenance costs over the life of each electric bus. By going zero-emission, RTS is able to reduce greenhouse gas emissions and improve air quality along its routes. "Investing in robust public transit systems that are frequent, reliable, connected, and operated with zero-emission bus fleets, is a key solution for climate change," said RTS CEO Bill Carpenter. "Pairing an expanded public transit system that is convenient for more people with a zero-emission fleet of vehicles is a good way to get people to drive less. It also grows jobs and the economy, and strengthens community efforts related to education, healthcare, mental health, and social justice."

PHOTO BY ABBY MCHUGH-GRIFA

Advocate for more funding for RGRTA's operations budget.

Maintaining low costs for riders and improving service (e.g., increasing frequency, expanding routes) will require further investment from the state and federal government.

Local municipalities commit to pursuing Climate Smart Communities (CSC)/Clean Energy Communities (CEC) certification and begin implementing action items that advance complete streets policies, safe routes to schools, infrastructure for biking and walking, and EVs.

CSC/CEC programs are NY State programs designed to provide local governments with technical resources, grants, and rebates for implementing climate-friendly practices, many of which are aimed at altering inequitable land-use patterns. Committing to the Genesee-FLX Climate Action Strategy and working collaboratively with the Climate Collective and citizen action teams will help to advance many of the priority steps in the CSC/CEC programs.

Pilot project/proof of concept for electric vehicle sharing/electric shuttle services.

EV car sharing and on-demand shuttle services can reduce the number of individuals/households in need of personal vehicles, reduce congestion, and improve first/last mile connections to public transportation hubs. Car sharing and shuttle services also make ZEV technology more widely accessible to those who cannot afford the upfront costs of a ZEV or who do not have access to vehicle charging infrastructure.

Support local efforts to complete an interconnected, regional network of strategically placed trails that cross municipal boundaries and link people to economic opportunities and amenities.

Several organizations, including the Genesee Transportation Council, Letchworth Gateway Villages, and Friends of the Genesee Valley Greenway, among others, have worked to expand a regional network of trails to promote tourism and recreation and this work should be supported. Providing safe, alternative, and aesthetically pleasing multi-modal transportation options that take people where they need to go is necessary to outcompete single occupancy vehicles as the primary mode of transportation. A regional network of trails can improve access to natural spaces, contribute to public health, promote rural tourism, and contribute to a shared sense of regional identity.

Advocate that federal/state infrastructure funding be used to expand broadband infrastructure.

Equitable access to online information, resources, learning, and employment opportunities is both a social and economic justice issue and can potentially reduce vehicle miles traveled due to a reduced need for commuting.

Participate in rate cases and advocate for more equitable rate design for off-hours EV charging.

Lower rates or other incentives to encourage off-peak charging and/or controlled, managed charging will make electricity rates for vehicle charging more affordable and help to reduce demand on the electrical grid.

End investment of public funds for development projects that are not accessible by public transit.

Public money is currently supporting development projects that use fossil fuels, are not accessible by public transit, produce excessive waste, and/or extend our reliance on fossil fuel infrastructure. Such strategies are not in line with CLCPA goals and often do not advance equitable access to economic, social, and cultural resources.

FLOSHARE

Floshare is the first EV car sharing program in our region and is made possible by a partnership between Mobility Development and the City of Rochester. Similar to bike loan or other car sharing programs, Floshare provides access to fully electric vehicles and the charging infrastructure for an hourly fee of $5/hour. Currently, members have 24/7 access to a network of vehicles at the Rochester Public Market and St. Mary's Campus, with an official launch expected in Summer 2022. Floshare is committed to transportation equity, and is working to keep hourly rates low to make EV technology more widely accessible. Bree-Ana Dukes Program Manager of FloShare says, "As partners within the shared mobility space, we understand the need for equitable and accessible transportation as being just one of the many ways to ensure society keeps justice at the forefront of climate solutions. The use of electric car sharing services benefit communities environmentally and economically. Rochester residents can feel good that they are contributing less to greenhouse gas emissions as well as saving money on personal vehicle ownership costs and maintenance."

PHOTO BY FLOSHARE

Agriculture/Food/Forestry

Agricultural production constitutes 22% of regional GHG emissions, with the majority coming from non-energy sources, such as the manure and enteric fermentation associated with dairy production. In the U.S., the dairy industry has improved significantly in its efficiency and overall environmental impact. For example, the GHG emissions associated with the production of a gallon of milk have reduced by ⅔ since the mid-1940s. But, more remains to be done to bring the industry in line with state law.


PHOTO BY GRANT TAYLOR PHOTOGRAPHY, INC.

The dairy industry is a major economic driver for New York State and locally. New York is the third-largest producer of dairy in the U.S. and Wyoming County is the largest producer of milk in the state.[65] Emissions reductions in such a large and economically important sector will not be easy. Perhaps more than other sectors, the agricultural sector and associated emissions are highly intertwined with the global economy and with national policies that significantly impact regional farms. Moreover, local communities have a vested interest in what happens on area farms and access to nutritious, locally sourced food was a common theme amongst focus group participants. The barriers to emissions reductions and to developing a local food system are particularly complicated and include 1) accurately measuring GHG emissions associated with agricultural production, potential carbon sequestration, and mitigation impacts, 2) market prices for agricultural commodities that are heavily influenced by global trade, 3) inequitable distribution of federal farm policies and state grants, 4) access to affordable, productive land for farmers, 5) farmer access to information about climate-friendly agricultural practices and costs/access to associated technologies, 6) farmer access to local markets for farm products, and 7) inequitable community access to fresh, nutritious food due to cost and transportation constraints. Given the difficulty and complexity of reducing emissions in the agricultural sector, action items to overcome these barriers focus on developing a better understanding of the opportunities and challenges associated with climate-friendly agricultural production and improving our local food system. Action items include:

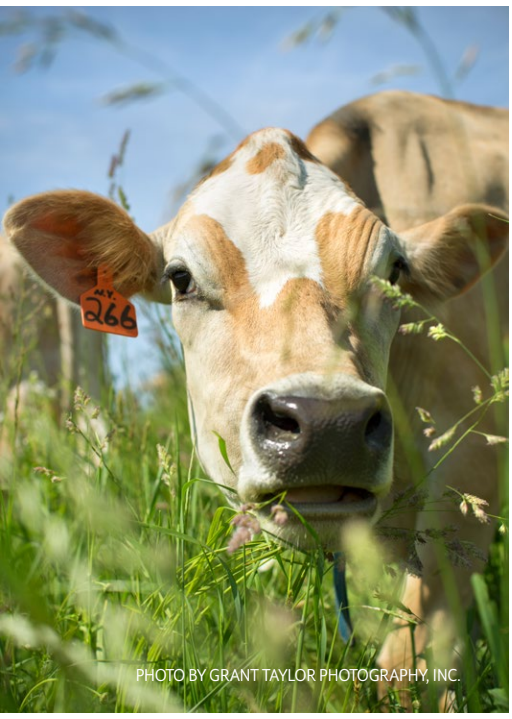


PHOTO BY GRANT TAYLOR PHOTOGRAPHY, INC.

Advocate for, and support, reliable, accessible, and locally relevant data on GHG impacts of farming and potential for carbon sequestration.

Access to good data is necessary to help farmers and farm-adjacent practitioners develop a better understanding of where farm emissions come from, the effectiveness of various mitigation measures, and the potential for carbon sequestration. This information is needed for farmers and practitioners to make informed decisions about which practices

are best suited for a particular farm. Reliable, accessible, and locally relevant data for the agricultural sector is also important from a regional decision-making/planning perspective to track local progress in emissions reductions.

Facilitate community conversations with farmers, including dairy farmers, and farm experts about the opportunities and challenges associated with greenhouse gas emissions reductions, agricultural production, and climate change.

Given the state's reliance on farmers, foresters, and others managing the state's working lands to sequester carbon emissions, their voice should be centered in conversations about how best to integrate climate-friendly production, while meeting the needs of producers and their land.

WILD HILL FARM

At Wild Hill Farm in Ionia, NY, their mission is "Building community through healthy food and love of the land." An organic vegetable farm, Wild Hill provides fresh produce, herbs, and flowers to roughly 250 members through the community supported agriculture (CSA) model. CSA models foster a direct partnership between eaters and farmers, making organic, fresh produce available at a fair price, by directly supporting farmers, and eliminating intermediaries that add additional costs. At Wild Hill farm, members are invited to the farm to pick-up their abundant share of organic carrots, greens, peppers, squash, potatoes, and more. Farmer Erin employs time-honored agricultural techniques, like cover cropping, adding compost, and planting flowers to attract beneficial insects and promote biodiversity to build healthy soil and eliminate the need for pesticides and chemical fertilizers. Besides reducing emissions and improving the land, these techniques help build resilience to climate change and promote sustainability. The 128 acres of woods and fields at Wild Hill farm will also be protected in perpetuity through a conservation easement with the Genesee Land Trust. Farmer Erin believes conservation easements are an essential tool for ensuring a future with fresh food, scenic open space, and a continued agricultural heritage.

PHOTO BY WIKIMEDIA, TIM SAXTON

Raise awareness about the impacts of dietary choices on regional emissions.

Understanding how dietary choices impact local emissions may lead to shifts toward more climate-friendly diets.

Increase peer-to-peer farmer education on the benefits of soil health practices.

Receiving information from a trusted source, and someone who has already undertaken similar practices, is likely to increase soil health adoption practices and provide space for farmers to ask specific questions unique to their farm. Farmers should be compensated for the time they take away from their own farm to educate others and learn about climate-friendly production practices.

Increase community gardens, green space, tree planting, and other green-beautification efforts.

Increasing community gardens can improve food security and provide culturally appropriate food options for individuals in the community/neighborhood. Additionally, green spaces, tree planting, and other green-beautification initiatives help to reduce temperatures, improve air quality, absorb excess precipitation/wastewater run-off and provide aesthetic benefits.

Identify two large, local institutions that will commit to transitioning their procurement strategies to locally sourced, sustainably grown, plant-based foods and regenerative meat and dairy, with preferential contracts for farmers who are using soil health practices.

Local institutions with significant purchasing power can have an impact on the local food system by providing a guaranteed market for farm products. Prioritizing locally sourced, sustainably grown, plant-based foods and regeneratively grown meat and dairy can also shift the dietary habits of individuals engaged with the institution as they become accustomed to these dietary practices.

Pilot/proof of concept for community composting systems, including municipal, residential, and institutional settings.

Composting food waste not only helps to reduce landfill emissions, but also works to improve local soil quality. Many individuals, particularly renters, do not have access to the space needed to maintain their own composting operation, and community composting systems would provide a way to divert this waste and build community value. If large institutions with a significant amount of food waste (e.g., higher education institutions, hospitals, etc.) establish composting practices, this could significantly reduce emissions, create valuable compost for their organization's campus, and provide learning opportunities.

HUNT COUNTRY VINEYARDS

Recipients of the 2020 Sustainability Award from the New York Wine and Grape Association, the Hunt family has been farming the land off Keuka Lake for seven generations. At Hunt Country Vineyards, soil health is of paramount importance for their vineyard grapes, so they amend their soil using only compost from on-farm composting operations and poultry manure. The Hunts recognize the impacts of climate change on their farm and prioritize good soil health to improve their farm's resiliency against variabilities in weather that can impact production.

PHOTO BY HUNT COUNTRY VINEYARDS

Their *Uncharted Terroir* wine is created with regional grape varieties that are able to survive under tough environmental conditions and reflect the unique identity of the Finger Lakes region. "At its best, winemaking involves capturing the unique essence of your place and practices in every bottle of wine - capturing the terroir," Hunt says. "Obviously, changes in the global climate directly impact our terroir. So by definition, if you're passionate about wine and winemaking, you have to be passionate about addressing the climate crisis." Beyond improving soil health, they have installed a 348-panel solar system and geothermal technology to power and heat/cool their operations, as well as 5 EV charging stations for customers. Their commitment to addressing climate change does not stop at the farm's edge. Hunt Country Vineyards is the first winery in New York State to join the International Wineries for Climate Action, working collaboratively to decarbonize the wine industry. "There's only so much we can do as one small family-run business," Hunt says. "But by joining up with a community of peers, including some of the largest wineries in the world, we can move faster and have a much larger collective impact."

Increase financial resources, including grants and no-to-low cost financing mechanisms, for farmers to implement climate-friendly farming methods, such as manure management practices.

Climate-friendly knowledge and technology must be accessible to all farmers. The often tight profit margins on farms and the high upfront costs associated with adopting some climate-friendly farming practices mean that these practices would remain out of reach for many farmers without access to incentives and innovative financing mechanisms.

Payment for ecosystem services and other incentivization mechanisms that support adoption of soil health practices.

Payment for ecosystem services (PES) programs compensate farmers for the ecological services they provide (e.g., water purification, carbon sequestration, reduced flooding), incentivizing or rewarding them for implementing climate-friendly practices.

Buildings

Buildings, both residential and commercial, make-up 25% of regional emissions, largely from the natural gas used to heat buildings and power stoves, water heaters, and dryers. According to the state's Climate Action Scoping Plan, more than 250,000 homes and thousands of commercial buildings each year will need to be retrofitted for energy efficiency and electrification, a tenfold increase from annual adoption today.[66] Increasing energy efficiency and electrification can make homes more comfortable and healthier and reduce GHG emissions. There are, however, several structural barriers to reducing emissions in the building sector including 1) upfront costs of technology and difficulty in financing such improvements, 2) an aging and deteriorating housing stock, 3) the difficulty of navigating local, state, and federal programs and incentives, and 4) the split incentive in rental properties. Actions to address these barriers include:


PHOTO BY EVAN LOWENSTEIN

Deploy energy navigators to conduct large-scale education and outreach efforts, especially for low-moderate income (LMI) households and those most vulnerable to climate change impacts.

Many individuals do not know the benefits of, or resources for, energy efficiency or beneficial electrification adoption. Energy navigators can provide program and loan application assistance, and coordinate with partners to enable holistic clean energy projects by leveraging relevant programs, services, and funding sources.

Streamline application processes for energy efficiency programs and develop processes to braid funding for energy efficiency work.

Streamlining access to program resources and funding mechanisms will make taking action easier and more affordable, likely increasing adoption of clean energy projects.

Pilot project/proof of concept for three district or community geothermal projects, with varying ownership models.

Community or district geothermal projects will make geothermal technology available to more households, including the potential for multi-family buildings, through shared field loops, rather than requiring individual loops for each building. This will accelerate the rate of adoption and has the potential to lower overall costs, as they are spread across the community. Different ownership models (e.g., municipal-owned, community-owned, and private, third-party ownership) will enable side-by-side comparisons of the strengths/challenges of each model and provide comparable and shareable lessons learned.

Identify two local lenders to pilot innovative financing strategies (e.g., zero-to-low interest financing, gap funding) to overcome upfront cost barriers to building electrification.

Upfront costs for energy efficiency and building electrification serve as barriers to implementation. In 2020, NYSERDA's Green Jobs-Green NY program offered limited time 0% financing for residential clean energy improvements and the entire fund was exhausted in two weeks - demonstrating that this type of financing strategy, or other innovative ones like it - can increase adoption dramatically.[67]

Intervene in rate cases to advocate for more equitable rate design to support building electrification.

As households electrify their heating systems and adopt on-site renewable energy, this shifts the currently established mechanisms for determining electricity rates, which could negatively impact low-to-moderate income customers. Equitable rate design is necessary to ensure LMI households can afford to adopt electrification practices and that the cost of our energy system is equitably distributed.

HOME LEASING

Rochester's Home Leasing is a Certified B Corp that specializes in development, construction and property management with a mission to "Improve the lives of our residents and communities in which we work." Providing energy efficient affordable housing is a top priority. Home Leasing partners with local non-profit organizations, such as Spiritus Christi and Trillium Health, to provide supportive housing for the formerly incarcerated, those struggling with substance abuse, and those with HIV/AIDS at risk of homelessness, making energy efficient housing available to those most vulnerable to climate impacts. Home Leasing builds to high standards of green energy code and often includes utility costs in the rent so that residents have predictable and affordable housing costs. Several of their properties include on-site solar, and in partnership with its founder, Nelson Leenhouts, Home Leasing utilizes an 8-acre solar farm to supply electricity for 500 of its housing units. Home Leasing has been a Certified B Corp since 2017, requiring they meet high social and environmental standards, as well as maintain a governance structure that is accountable to all stakeholders. "Home Leasing is committed to develop and manage its properties in a manner that will help address climate change through the use of green building technologies," said Bret Garwood, CEO of Home Leasing and Home Leasing Construction. "The affordable housing industry has long been at the forefront of the use of green building technologies and high standards for energy efficiency and we are proud to be part of that effort."

Local municipalities pursue Climate Smart Community/Clean Energy Community designation and implement strategies to increase building efficiency, including building benchmarking (beyond public buildings) and adoption of stretch codes.

CSC/CEC programs are NY State programs designed to provide local governments with technical resources, grants, and rebates for implementing climate-friendly practices around energy efficiency and building electrification. Committing to the Genesee-FLX Climate Action Strategy and working collaboratively with the Climate Collective and citizen action teams will help to advance many of the priority steps in the CSC/CEC programs.

Adopt minimum energy standards for rental properties.

Minimum energy standards for rental properties will spur widespread adoption of energy efficiency measures that can improve indoor air quality and reduce utility bills, thereby helping to address the "split incentive" problem.

Advocate to sunset gas in new construction by 2024 and sunset gas in end-of-life system replacements in existing buildings by 2028.

Research shows that upfront costs in new residential and commercial buildings of all-electric heating and cooling are lower than similar systems powered by natural gas and that when combined with equitable rate design, overall operating costs can be up to 5-10% less than natural gas systems.[68] This recommendation is consistent with the state's Draft Scoping Plan's recommendations.

End investment of public funds for development projects that use gas.

Public money is currently supporting development projects that use fossil fuels, are not accessible by public transit, produce excessive waste, and/or extend our reliance on fossil fuel infrastructure. Such strategies are not in line with CLCPA goals.

Miscellaneous/Economy-wide

Currently, the cost of fossil fuels does not account for the true social and environmental costs of production, distribution, and consumption. Taxpayers and individuals bear the brunt of the costs associated with rebuilding homes and businesses after damaging floods, for asthma-driven emergency room visits due to poor air quality, and for polluted water supplies associated with extracting natural gas, amongst others. Furthermore, climate impacts and stressors (e.g., extreme weather, famine, and conflict over natural resources) will negatively impact our own community, and drive individuals from outside the region here in search of a more stable and secure place to build their lives and raise their children. Welcoming new residents to the area brings exciting possibilities for our local economy and culture, but we must be prepared to meet the needs of those already here, as well as those entering the region. A well-organized, and resourced, community dedicated to creating a clean and sustainable future is necessary to revive our local economy, rehabilitate our housing stock, and reconnect our neighborhoods and towns through a robust transportation network. Key enablers to bringing about the economy-wide changes necessary to accomplish this future include:

ROCHESTER YOUTH CLIMATE LEADERS CALL FOR THE DIVESTMENT OF PENSION FUNDS FROM FOSSIL FUELS. PHOTO: TERRY SMITH

Build citizen support of, and capacity for, climate action by educating local residents about climate issues and solutions, and organizing and mobilizing local citizens to take action.

The power of this strategy lies with the people. Without the authority of government, or the leverage of money, the power of this work lies in the many committed individuals engaged daily in service to others and to community. The region's climate movement has been indispensable in building citizen support and capacity for climate action. Moving forward, we will need the continued leadership of those active in the movement as well as creating space for new leadership to 1) coordinate local campaigns and events to harness collective power, 2) recruit and engage volunteers, 3) provide leadership development opportunities to nurture existing and new local climate champions, 4) amplify local organization's efforts and successes, 5) highlight the intersectionality of the climate crisis, and 6) serve as an educational, skill-building resource for local citizens.

Commission a study to project long-term population trends for our region and corresponding implications for our local economy (especially regarding housing and transportation).

The full implications of how climate change can, and will, impact migration patterns for our region are not fully understood. Researchers at Yale have noted that northern "Rust-Belt" cities are well-positioned environmentally to receive individuals relocating due to climate change.[69] However, it is essential that the Genesee-Finger Lakes region have a better understanding of how climate migration may impact the local economy, as well as prepare our region's infrastructure to attract new residents.

Commission clean energy workforce development study focused on projected growth/ needs assessment.

Fully transitioning to a regional clean energy economy will require exponential growth in the clean energy sector. This field is rapidly evolving and the economic opportunities it presents are not broadly recognized. A regional clean energy workforce development study can identify the employment trends, educational needs, and hiring demands of the clean energy industry, as well as regional assets and gaps in meeting these needs.

MULTI-CRAFT APPRENTICESHIP PREPARATION PROGRAM (MAPP)

Rochester's Multi-craft Apprenticeship Preparation Program (MAPP) is a non-profit organization focused on building technical skills and providing on-the-job training for historically under-served populations to gain entrée into the construction trades. MAPP works in partnership with the Rochester Building and Construction Trades Council to improve the diversity of the construction industry. MAPP graduates have gone on to earn apprenticeships in the Sheet Metal Local Union, Bricklayers Union, and the International Brotherhood of Electrical Workers, amongst others. Readying our buildings and homes for the transition to clean energy and to withstand the impacts of climate change will require a highly skilled labor force. The MAPP program is necessary to ensure that we can retrofit and rehabilitate our buildings through an inclusive and equitable clean energy economy.

Advocate/coordinate a non-profit clean energy workforce development training center that targets communities typically marginalized in higher education and the labor market.

A non-profit clean energy workforce development training center to serve those typically marginalized from higher education and labor market opportunities will be important for ensuring that the clean energy economy is inclusive and accessible. The workforce development training center must also include wrap-around services, such as transportation, childcare, and cost of supplies, as well as providing earn-as-you-learn opportunities to make programming accessible.

Local municipalities commit to pursuing CSC/ CEC certification and begin implementing action items.

CSC/CEC programs are NY State programs designed to provide local governments with technical resources, grants, and rebates for implementing climate-friendly practices economy-wide. For example, "Green Economic Development Plans," "Brownfield Clean-up and Redevelopment" and "Incentives for Green Businesses" are all considered high-impact action items. Committing to the Genesee-FLX Climate Action Strategy and working collaboratively with the Climate Collective and citizen action teams will help to advance many of the priority steps in the CSC/CEC programs.

Integrate elements of the climate action strategy into FLREDC economic development planning and municipal and county comprehensive and strategic planning processes.

Integrating elements of the climate action strategy into the Finger Lakes Regional Economic Development Council's economic development strategy would set the region apart as a leader in transitioning to a clean energy economy. Moreover, integrating elements of the climate action strategy, and climate mitigation more broadly, into the comprehensive and strategic planning processes of the region's municipal and county-level entities ensures that climate mitigation and adaptation become regular co-benefits of all community decision-making.

Advocate for economy-wide carbon pricing built with an equity focus.

Currently, the cost of fossil fuels does not include the full environmental, social, and public health costs associated with the extraction, distribution, and burning of fossil fuels. Rather, these costs are subsidized by individual and taxpayer dollars. A carbon price or fee on GHG and co-pollutants would require fossil fuel companies to pay the full price for the environmental, social, and health effects of using non-renewable energy. Such a system, however, would need to be carefully designed and implemented to ensure that the costs are not borne by low-to-moderate income households. Rather, a progressive fee and dividend type program would be needed to offset the costs for LMI households.

YOUTH CLIMATE MOVEMENTS

The Rochester Youth Climate Leaders (RYCL), the local chapter of the Sunrise Movement, and school-based green teams are not waiting around for others to take action on climate change. Rather, these youth activists have led the way in educating and advocating for locally relevant climate solutions. Eden Rosales, a Mercy 6th grader says, "I think that climate activism needs to go to the youth. The youth are the future. The impact of climate change will affect everyone, but especially those who are marginalized and living in poverty." Most recently, the Sunrise movement and RYCL advocated for an "all-electric building code" to be included in the 2022 state budget. Additionally, RYCL, which started in 2015, has worked on a campaign to divest NY State pensions from fossil fuels. RYCL also urged Monroe County to develop its own climate action plan, currently underway, by consistently showing up to county meetings and demanding action on climate change. Lola DeAscentiis, a Harley School 12th grader says, "I think the climate crisis is crucial to the future of our generation because not only does it impact our environment, but it impacts all areas of our life. The climate crisis is an intersectional issue. Though many young people can't vote, I find it important that those under 18 exercise their 1st amendment rights and speak out, and those over 18 actually use their right to vote that so many people from Rochester worked so hard in the past to gain for us."


PHOTO BY CHRIS DOLGOS

5. Description of Mitigation Measures

REDUCE VEHICLE MILES TRAVELED (VMT)

Actions	Select Co-Benefits	Get Involved
Advocate for more funding for RGRTA's operations budget	• Reduces transportation inequity via improved access to jobs & amenities • Reduces commute times • Reduces pollution in neighborhoods due to fewer vehicles	**INDIVIDUALS** • Use multi-modal transportation for commuting needs and/or regional trail system for commuting needs • Support local businesses you can get to by walking or without using a motor vehicle • Join local organizations (e.g., ReConnect Rochester or Color Your Community Green [CYCG] teams) to advocate for multi-modal transportation options, funding for a regional trail network, and implementation of Climate Smart Communities/Clean Energy Communities (CSC/CEC) action items • Join or start a municipal sustainability committee to assist with CSC/CEC action items **ORGANIZATIONS** • Encourage and incentivize multi-modal transportation, including public transit, to your organization's constituents, e.g., providing bus passes • Support your municipality in CSC/CEC implementation **MUNICIPALITIES** • Incentivize businesses and organizations to locate along transit lines • Adopt zoning that encourages development along transit lines and near transit hubs • Collaborate with other levels of gov't for shuttle service or park-and-ride options • Convene a community sustainability team • Implement CSC/CEC action items • Implement GTC Regional Trails Initiative
End investment of public funds for development projects inaccessible by public transit	• Not investing public dollars in soon-to-be outdated infrastructure • Sends market signal RE: need consolidated land-use planning	
Local municipalities commit to pursuing CSC/CEC certification and complete action items for: complete streets policies, safe routes to schools, & infrastructure for biking & walking	• Can receive financial incentives/grants for participating • Co-benefits will depend on the actions completed, but may include improved public health associated with increased physical activity, increased sense of community, reduced pollution from fewer vehicles in neighborhoods, increased access to green space	
Support further development of an interconnected, regional network of strategically placed trails that cross municipal boundaries and link people to economic opportunities and amenities	• Improves access to open space • Improves safety for walking/biking • Improves access to centrally located amenities • Possibility for economic development along trail lines	
Advocate that federal/state infrastructure funding be used to expand broadband infrastructure	• Improves access to online learning/work, products, information/knowledge	

SWITCH REMAINING VMT TO ZERO-EMISSIONS

Actions	Select Co-Benefits	Get Involved
Pilot project/proof of concept for electric vehicle sharing/electric shuttle services	• Improves access to electric vehicles without the need for ownership/infrastructure • Reduces neighborhood pollution due to fewer vehicles burning fossil fuels • Sends market signal	**INDIVIDUALS** • Take advantage of electric vehicle/ridesharing opportunities • Join local organizations (CYCG teams) to advocate for equitable distribution of EV infrastructure • Join or start a municipal sustainability committee to assist with CSC/CEC action items • Submit public comments in utility rate cases to advocate for equitable rate design • When replacing a personal vehicle, choose electric **ORGANIZATIONS** • Incentivize/encourage employees and constituents to take advantage of vehicle/rideshare opportunities • Start an EV shuttle for employees/constituents to access your business or organization. • Support your municipality in CSC/CEC implementation • Install EV charging at your place of business or organization **MUNICIPALITIES** • Collaborate with other levels of gov't for EV shuttle service or park-and-ride options • Implement CSC/CEC action items to expand equitable access to EV infrastructure. • Incentivize businesses and organizations to offer EV shuttle services and/or EV charging infrastructure • Replace municipal vehicles with EVs
Local municipalities pursue CSC/CEC designation & pursue EV transit infrastructure as a main priority	• More equitable access to EV infrastructure • Reduces "range anxiety" • Incentives/grants available for EV infrastructure via CSC/CEC • Sends market signal	
More equitable rate design for off-hours EV charging	• Lower costs for EV charging • Incentives off-hour charging, reducing grid impacts • Sends market signals	

INCREASE BUILDING ENERGY EFFICIENCY (EE)

Actions	Select Co-Benefits	Get Involved
Minimum energy standards for rental properties	• Reduces utility bills • Improves home comfort & indoor air quality • Reduces exposure to pests, mold, etc. • Improves public health	**INDIVIDUALS** • Join a local organization (e.g., CYCG, City Wide Tenants Union, neighborhood association) to educate others about the benefits of EE and advocate for minimum EE standards • Join or start a municipal sustainability committee to assist with CSC/CEC action items • Become an energy navigator • Engage your landlord about opportunities/incentives for improving EE on their properties • Learn about potential incentives/programs for improving EE for your dwelling, get a free energy audit, implement EE improvements **ORGANIZATIONS** • Take advantage of utility and NYSERDA programming to get an energy audit • Implement EE measures at your business or organization (if owner) • Engage your landlord about opportunities/incentives for improving EE on their properties (if renter) • Advocate for minimum EE standards • Start/participate in a community clean heating and cooling campaign to educate community members about EE and connect them with resources to improve EE of their homes **MUNICIPALITIES** • Start a municipal campaign focused on EE (e.g., Energy Smart Rochester) • Implement CSC/CEC action items to improve municipal building performance • Establish minimum EE standards • Establish building benchmarking • Adopt NY State Stretch Codes • Provide incentives and grants for EE improvements, e.g., C-PACE
Streamline application processes for EE programs and develop processes to braid funding for EE work	• Improves access to program services and funding/incentives to make home improvements • Reduces utility costs due to improvements • Improves indoor air quality and home comfort from improvements • Reduces exposure to pests, mold from improvements • Increases awareness of links between housing and climate	
Deploy energy navigators to conduct large-scale education and outreach efforts, especially for low-moderate income (LMI) households & those most vulnerable to climate change impacts	• Improves access to trusted sources of information for EE/home improvements • Improves access to program services and funding/incentives to make home improvements • Reduces utility costs due to improvements • Improves indoor air quality and home comfort from improvements • Reduces exposure to pests, mold from improvements • Increases awareness of links between housing and climate	
Local municipalities pursue CSC/CEC designation and implement strategies to increase building efficiency, including building benchmarking (beyond public buildings) and adoption of stretch codes.	• Improves access to information to make informed choices with upfront information about utility costs • Drives market for increased adoption of EE practices • Reduces utility costs	

FUEL SWITCHING FOR BUILDINGS

Actions	Select Co-Benefits	Get Involved
Educate customers/raise awareness about heat pumps	• Improves access to program services and funding/ incentives to make home improvements • Potential to reduces utility costs due to improvements • Improves indoor air quality and home comfort from improvements (e.g., more stable temperatures, access to AC) • Increases awareness of links between housing and climate	**INDIVIDUALS** • Join a local organization (e.g., CYCG, neighborhood association, or municipal sustainability committee) to educate about the benefits/incentives for clean heating and cooling • Advocate for sunsetting gas in new construction, an all-electric building code, and for the investment of public dollars in projects that advance CLCPA goals • Submit public comments in utility rate cases to advocate for equitable rate design • Go all electric with HVAC system and appliance replacements (or ask your landlord to) **ORGANIZATIONS** • Intervene in utility rate cases to advocate for equitable rate design • Advocate for sunsetting gas in new construction, an all-electric building code, and for the investment of public dollars in projects that advance CLCPA goals • Go all electric with system and appliance replacements (or ask your landlord to) **MUNICIPALITIES** • Start a municipal clean heating and cooling campaign (e.g., Energy Smart Rochester) • Intervene in utility rate cases to advocate for equitable rate design • Provide incentives and grants for building electrification, e.g., C-PACE • Electrify municipal buildings • Pilot a district geothermal project • Coordinate with other municipalities in committing to end investment in projects that use gas and adopt an all-electric building code
Pilot project/proof of concept for 3 district or community geothermal projects, with varying ownership models	• Reduces utility costs • Improves home comfort • Reduces costs for installation • Sends market signal	
Sunset gas in new construction by 2024 & sunset gas in system replacements for existing buildings by 2028	• Improves indoor air quality in buildings • Not wasting investment dollars on soon-to-be outdated infrastructure • Sends strong market signal	
Identify 2 local lenders to pilot innovative financing strategies (e.g., zero-to-low interest financing, gap funding) to overcome upfront cost barriers to building electrification.	• Potential to reduce utility costs due to improvements • Improves indoor air quality and home comfort from improvements • Increases awareness of links between housing and climate	
More equitable rate design for building electrification	• Reduces utility costs associated with electrification • Sends market signal	
End investment of public funds for development projects that use gas	• Improves indoor air quality in buildings • Not wasting investment dollars on soon-to-be outdated infrastructure • Sends strong market signal	

IMPROVE SOIL HEALTH PRACTICES AND AGRICULTURAL WASTE MANAGEMENT

Actions	Select Co-Benefits	Get Involved
Increase peer-to-peer farmer education on benefits of soil health practices	• Improves water quality • Increases resilience to precipitation extremes • Improves plant health & productivity • Reduces soil erosion	**INDIVIDUALS** • Advocate for payment for ecosystem services and other incentives to improve agricultural sustainability • Participate in community conversations about climate-friendly agricultural production to better understand the challenges and opportunities • Ask your grocer to stock locally sourced food/agricultural products • Adopt/increase the plant-based portion of your diet • Support local farmers at farmers' markets, stands, etc. • Buy organic products when possible • Start composting at home or advocate for a residential composting system at the municipal level **ORGANIZATIONS** • Advocate for payment for ecosystem services and other incentives to improve agricultural sustainability • Participate in community conversations about climate-friendly agricultural production to better understand the challenges and opportunities • Advocate for/engage with local resources to collect on-site data • Facilitate conversations/educational opportunities on the health benefits of plant-based, or regeneratively grown, locally sourced foods • Make an organizational policy of purchasing locally sourced and/or organic products whenever possible • Adopt an on-site composting program for your organization or business and/or advocate for municipal composting programs • Learn about & commit to adopting climate-friendly agricultural practices **MUNICIPALITIES** • Encourage public appreciation for local farms through fairs, festivals, other farm events and local marketing materials • Promote health benefits of plant-based locally sourced diets • Help connect farmers with local, state, and federal agricultural and conservation resources to provide information and technical assistance • Partner with County Agricultural Boards to facilitate peer-to-peer farmer education about climate-smart agricultural practices • Implement agricultural protection plans to promote sustainability • Coordinate with other municipalities or county agricultural boards to provide microenterprise loan programs • Coordinate with other municipalities, county agricultural boards, and soil and water conservation districts to increase access to equipment and knowledge needed to implement climate-smart agriculture • Adopt municipal composting practices for municipal and residential waste and return compost to the local community
Payment for ecosystem services & other incentivization mechanisms that support adoption of soil health practices	• Acknowledges/values our natural systems, sending strong market signal • Acknowledges/values the work farmers do to provide an essential human need & steward the earth • Improves water quality, reduces erosion, increases resilience to precipitation extremes, and other soil health benefits	
Advocate/support for reliable, accessible, and locally relevant data on GHG impacts of farming and potential for carbon sequestration	• Improves understanding of local climate impacts and efficacy of mitigation measures • Improves transparency and accountability	
Facilitate community conversations with farmers, including dairy farmers, and farm experts about the challenges and opportunities associated with greenhouse gas emissions reductions, agricultural production, and climate change.	• Acknowledges/values farmer knowledge/expertise • Builds relationships with farmers • Better understanding of community needs/desires • Better understanding of barriers to implementing climate-friendly practices	
Raise awareness about impact of dietary choices on regional emissions	• Improves awareness of the links between diet and climate change • Potential to stimulate further market demand/market access for locally sourced agricultural products	
Increase financial resources for farmers to implement manure management practices, including grants and no-to-low cost financing mechanisms	• Improves water quality • Improves air quality/smells associated with dairy production • Potential for on-site usage of RNG • Potential reduced costs associated with use of organic fertilizers & bedding materials	
Pilot/proof of concept for community composting systems, including municipal, residential, and institutional settings	• Reduces amount of waste entering landfills • Potential to use compost for soil improvement projects • Raises awareness about food waste	

ACCESS TO LOCALLY SOURCED FOOD

Actions	Select Co-Benefits	Get Involved
Increase community gardens	• Increases access to open space/ green space • Reduces stormwater run-off • Potential to reduce urban heat-island effect • Increases access to local food • Increases awareness/knowledge of food production	**INDIVIDUALS** • Join or start a community garden in your neighborhood or town • Advocate to local municipalities for permissive zoning to increase access to land for community garden/urban agriculture space • Buy locally grown food from farmers markets or other locations whenever possible **ORGANIZATIONS** • Commit to procuring locally sourced, plant-based foods • Establish on-site space for community gardens for employees, constituents, or neighbors **MUNICIPALITIES** • Create a public information campaign to support local food initiatives and awareness of local food options • Include local food systems as part of comprehensive plans • Survey vacant lots and parcels that could be converted to community gardens or urban farms and facilitate access to these sites • Link hunger assistance programs to local food • Establish permissive zoning codes and ordinances that enable community gardens/urban agriculture and associated sale/ distribution of food products • Encourage local farmers to sell at farmers market(s) in municipality or nearby
Identify two large, local institutions that will commit to transitioning their procurement strategies to locally sourced, sustainably grown, fruits and vegetables, and regeneratively grown meat and dairy, with preferential contracts for farmers who are using soil health practices	• Improves public health associated with increased access to healthy, nutritious food • Potential to reduce food miles traveled • (Potential) increase in quality of food in institutional settings	

ACCESS TO GREEN SPACE

Actions	Select Co-Benefits	Get Involved
Increase community green space, tree planting, community gardens and other beautification efforts	• Reduces heat island effect/access to shade • Increases access to open space/ green space • Improves biodiversity • Potential for improved public health via lower stress, outdoor activity • Increases access to locally grown food via community gardens • Increases place-based educational opportunities	**INDIVIDUALS** • Join or start a CYCG team to advocate for, and support implementation of, efforts to increase green space and community beautification efforts • Advocate to limit urban, suburban, and rural sprawl to preserve opportunities for green space • Participate in volunteer efforts to maintain street trees, parks, and green spaces • Participate in tree planting campaigns **ORGANIZATIONS** • Organize/sponsor local tree planting and beautification efforts • Advocate for, and support implementation of, efforts to increase green space and community beautification efforts • Advocate to limit urban, suburban, and rural sprawl to preserve opportunities for green space **MUNICIPALITIES** • Design, implement, and maintain green streets, parks, and tree planting efforts • Implement the Local Forestry, Green Infrastructure, Conserve Natural Areas, Shade Structures Policy, & Brownfield Clean-up Climate Smart Communities Actions • Implement zoning policies to limit urban, suburban, and rural sprawl that protect green spaces

GRID DECARBONIZATION

Actions	Select Co-Benefits	Get Involved
Educate local municipalities and residents about the costs and benefits of renewable energy projects of varying types, the impacts for local environments and communities, and the process for navigating strong community benefits agreements (CBAs).	• Increases awareness about potential benefits that can be gained from renewable energy contracts • Dispels myths about renewable energy generation	**INDIVIDUALS** • Join or start a CYCG team, neigborhood association, United Solar Energy Supporters, Sierra Club, or other civic organization to advocate for environmentally sound renewable energy projects of varying type • Participate in community conversations on alternative energy sources to learn more about the technologies and better understand the varied perspectives about the local energy mix • Become an energy navigator to educate/assist others in renewable energy implementation • Submit comments in utility rate cases to advocate for improved grid reliability, equitable rate design, and electrification incentives and programming • Join a community solar program • Install on-site solar panels/batteries (or advocate for your landlord to do so) • Advocate for CCA that supplies 100% clean, renewable energy at an affordable rate **ORGANIZATIONS** • Support renewable energy projects in your community • Explore creating an energy cooperative that will work to build a community-based renewable energy project or join a community solar program • Intervene in utility rate cases to advocate for improved grid reliability, equitable rate design, and electrification incentives and programming • Install on-site solar, wind, battery storage and/or pilot a micro-grid project **MUNICIPALITIES** • Intervene in utility rate cases to advocate for improved grid reliability, equitable rate design, and electrification incentives and programming • Learn about, and negotiate, strong CBAs that ensure that renewable energy projects improve quality of life for local residents • Enable/expand Community Choice Aggregation programs • Install on-site energy generation on all municipal properties • Coordinate with other municipalities in your county to develop a county-wide payment-in lieu-of-taxes (PILOT) to reduce confusion • Include community goals and values with regard to renewable energy in strategic or comprehensive plans • Pilot a micro-grid project and/or other mutli-use generation projects, e.g., parking lot generation and storage, using municipal buildings • Identify brownfield sites, closed landfills, or other vacant lots suitable for renewable energy generation • Establish local stand-alone laws or zoning ordinances that enable renewable energy development while protecting other land-uses, including prime agricultural land, and community values, e.g., setbacks, screenings, etc.
Facilitate a community conversation on the role of nuclear, hydrogen, and biogas in the local energy mix	• Improves understanding of community sentiment with RE: to alternative energy sources • Improves understanding of costs/benefits of alternative energy sources	
Participate in rate cases to advocate for grid reliability, equitable rate design, and programming that encourages electrification	• Improves resilience to weather-related impacts • Potential for lower utility costs (with targeted LMI rate design programs)	
Drive rooftop solar installations through coordination of efforts/ resources and "energy navigators"/customer service	• Reduces the burden on the grid for electricity demand • Potential to lower utility costs	
Pilot/proof of concept for three renewable energy projects of varying types (e.g., community solar, micro-grid, agrovoltaics)	• Increases energy independence • Reduces the burden on the grid for electricity demand • Potential to lower utility costs	

MISCELLANEOUS/ECONOMY-WIDE

Actions	Select Co-Benefits	Get Involved
Build citizen support/capacity for climate action (educate, organize and mobilize)	• Increases civic engagement and participation in decision-making about community priorities & actions • Increases awareness about climate solutions • Increases the number of people advocating for climate solutions/funding for climate solutions • Increases the number of people available to "do the work" to implement climate solutions	**INDIVIDUALS** • Educate, advocate, and collaborate to build the climate movement in your community • Join CYCG teams or other citizen action teams to implement aspects of the strategy and support municipalities in implementing CSC/CEC and other climate-smart initiatives • Advocate that local and county governments integrate an intersectional climate perspective into their comprehensive plans • Advocate for a carbon-pricing plan that centers equity provisions and requires fossil-fuel companies to play their part by funding renewable energy and climate solutions **ORGANIZATIONS** • Educate, advocate, and collaborate to build the climate movement in your community. Talk about how/why climate change and climate solutions intersect with your own work • Support your municipality in implementing CSC/CEC action items • Advocate for a carbon-pricing plan that centers equity provisions and requires fossil-fuel companies to play their part by funding renewable energy and climate solutions **MUNICIPALITIES** • Support or commission a study to better understand the impacts of climate change on long-term population trends • Support or commission a clean energy workforce development study • Incentivize clean energy supply chain and clean energy business opportunities • Support a schools-to-green jobs pathway for historically marginalized populations • Develop comprehensive plans that include an intersectional climate perspective, including preparation for the potential influx of individuals associated with climate change • Commit to becoming CSC or CEC certified and pursuing as many high-impact action items as possible.
Commission a study to project long-term population trends for our region and corresponding implications for our local economy (especially in regard to housing and transportation)	• Identifies how changes in population could impact the region in terms of housing needs and impact to infrastructure, e.g., transportation, schools, etc.	
Commission clean energy workforce development study focused on projected growth/needs assessment	• Identifies gaps in current workforce development landscape • Identifies opportunities for developing clean energy workforce development programs	
Advocate/coordinate for a non-profit clean energy workforce development training center that targets marginalized communities	• Provides equitable access to clean energy job training • Increases workforce capable of implementing climate solutions • Potential to reduce the number in poverty due to higher wages typically associated with clean energy jobs	
Local municipalities commit to pursuing CSC/CEC certification and begin implementing action items	• Can receive financial incentives/grants for participating • Co-benefits will depend on the actions completed	
Integrate elements of the climate action strategy into FLREDC economic development planning and municipal and county comprehensive and strategic planning processes.	• Signals to local businesses and other community leaders the importance of climate solutions and sustainability for regional economic development and long-term growth • Potential to unlock funding opportunities for climate solutions	
Economy-wide carbon pricing built with an equity focus	• Discourages fossil fuel burning by making it more expensive & thereby likely increases the adoption of beneficial electrification • Provides revenue stream for climate solutions • Potential for rebates/stipends for LMI households to offset increased costs	

6. Steering Committee Members and Stakeholder Engagement

We consulted numerous individuals and organizations over the course of the collective impact process and throughout the development of the climate action strategy. We are truly grateful to everyone who shared their time and perspective, particularly our steering committee members. We are also grateful to the numerous individuals who completed anonymous surveys. Participation in the stakeholder engagement process does not necessarily mean individuals or organizations agree with everything in the final climate action strategy.

Steering Committee Members

Banister, Simeon (co-chair)
Belaskas, Dave
Berry, Kereem
Burack, Linden
Butler, Dan
Castle, Stephanie
Ferington, Haylee
Hunt, Suzanne
Kulak, Amie
Jiménez Gleason, Annette
Jordan, Julio
Lawson, Jenna
Lou, Valerie
Manapol, Nicole
McLean, Andrea
Murray, Lee
Nyame, Dr. K.
Nyrop, Jan (co-chair)
Pollack, Ronnie
Richardson, Rob
Scanlon, Joanne
Sood, Neha

Stakeholder Engagement

Adams, Robb
Anderson, Toyin
Archana, Verma
Arena, Dan
Ashworth, Emily
Bacot, Nahmese
Baker, Mike
Barclay, Anne-Marie
Bechtold, Bob
Bedoia, Hormis
Belasks, Dave
Benedict, Kaleigh
Bennett, Theresa
Blair, Allen
Boasi, Julie
Bradford, Kayla
Brown, Amber
Bullock, Erin
Burgos, Luis B
Burr, Shawn
Caputo, Adele
Cheng, Julius
Chesonis, Arunuas
Chung, Clement
Codding, Richard
Cohen, Marc
Collins, Bill
Colon Jr., Neftali
Conklin, Michele
Corbin, Amber
Corcoran, Trish
Crosman, Joanne S.
Curry, Nyriel
Daimau, Maria
Das, Christina
Davis, Shemeka
DeJesus, Elisa
DeLooze, Jason
DeMarco, Jeni
DiFiore, Joe
Dobbs Schneider, Oliva
Donahue, Trish
Doucette, Luticha
Dueppengiesser, Jessica
Ezran, Camille
Finch, Doug
Finklea, Karen
Finn, Theodora
Flender, Joan
Fox, Jacob
Franco Cruz, Sofia
Gallo, Matt
Gantt, Will
Gibson-Stevenson, Romanda
Gonzalez, Almu
Gonzalez Rivera, Jasmine
Gooch, Curt
Gotcsik, George
Gotcsik, Fran
Griffin, DeShawn

Haoran, Piao
Haremza, Jason
Harris, Pat
Haskins, Maurice
Hayes, Rob
Haynes, Anastajah
Henderson, Elizabeth
Henry, Ellen
Hensel, Candace
Hermey, Jordan
Hey, Ellen
Hill-Glover, Madison
Hirasuna, Tom
Howard, Tamara
Hudson, Rashakim
Hughes, Melissa
Hughes, Josh
Hughes, Graham
Hughes-Smith, Sue
Jee, Sandy
Johnson, Lisa
Jones, Naaman
Jordan, Tytiana
Keefe, David
Keevert, John
Kelley, Kevin
Klein, Mitch
Kone, Alex
Kothor, Djifa
LaCelle, Kim
Lewis, Shanielia
Lewis, Karen
Lewis, Anthony
Lin, Yixuan
Lomack, Melissa
Lopez, Ysabel
Lopez, Adumazs
Lopez, Jeremick
Lopo, Manuel
Lowenstein, Jenny
Luz Rosa, Alba
Lyon, Thomas
Malcho, Jade
Martens, Klaas
Martin, Kurt
Martinez-Johncox, Wanda
Mayoliz, Ray
McDade, Elizabeth
McDonald, Jason T
McDowell, David
McGowan, Tim
McIntosh, Andrea
Mclarty, Ebony
MirPaz, Lilibeth
Mittiga, Sarah
Modeste, Persephone
Moehle, William
Moran, Tim
Murray, Christina
Nabozny, Pete
Nagel, Davies
Nåter, Shalym
Odhner, Daryl
Oglvie, Dt
Oltramari, Felipe
Orotre, Anora
Partyka, Jason
Perez, Ida
Porter, Andrea
Puckett, Ryan
Quaassdorff, Margaret
Ramos-Torres, Yesenia
Ramsay, Darin
Randall, Jon
Ray, Lauren
Raymond, Chris
Reidlinger, Mike
Reitz, Margaret
Ridgeway, Nikisha
Rivera, Lydia
Rood, Daphne
Roodenburg, Mary
Ryan, Brendan
Rygg, Katie
Sanchez, Victor
Sanders, Imani
Sanderson, Sarah Jesse
Santa Cruz, Edgar
Santiago, Jeremy
Saxton, Lynn
Schaefer, Peter
Schneible, Sandy
Schumaker, Jan
Scindre, Axmir
Seneca, Dean
Sharma, Mohini
Shrivastava, Ram
Sieber, Beth
Sinclair, Lakaya
Smith, Jeremy
Smith, Duran
Smith, Jonathan
Spalding, Anne
Sportiello, Kristen
Starpoli, Mary
Stojkovic, Elisabeth
Stollery, Kathleen
Tallant, Shawn
Tappon, Jim
Taylor, Jonathan
Thompson, Shirley
Thompson, Scott
Uribe, Kristine
Vaasquez, Anel
Van Dusen, Eric
Waite, Todd
Wallace, Ryan
Waller, Maya
Warner, Steve
Wartinger, Pat
Weaver, TiCara
Weaver, Brad
Westbrook, Tammy
White, Sharron
Winnie, Paul
Woodbury, Peter
Wright, Lorna
Wright, Peter
Yockel, Elizabeth
Zeafla, Emily
Zeise, Eric
Zeltmann, Christopher
Zetkulick, Anna
Zimmer-Mayer, Heidi
Zink, Harold

7. Resources

FOR INDIVIDUALS

City of Rochester Pilot Composting Program (waste)
City of Geneva Composting Program (waste)
Climate Solutions Accelerator Volunteer Sign-up (educate/organize/mobilize)
Color Your Community Green (educate/organize/mobilize)
Color Your School Green (educate/organize/mobilize)
FloShare (transportation)
Heat Smart Monroe-Finger Lakes (buildings)
NYSERDA Assisted Home Performance (buildings)
NYSERDA EmPower NY (buildings)
NYSERDA Charge NY (transportation)
NYSERDA Comfort Home Performance (buildings)
Northeast Organic Farming Association of NY (food/agriculture)
ReConnect Rochester (transportation)
RENEW Climate Fund (carbon offsets/buildings)

FOR ORGANIZATIONS

American Farmland Trust (agriculture)
Amped (buildings/transportation)
Commercial PACE (buildings)
Cornell Cooperative Extension (agriculture)
Headwater FoodHub (food/agriculture)
NYSERDA Agriculture Energy Audit Program (buildings/operations)
NYSERDA FlexTech Program (commercial, industrial, multi-family buildings)

FOR MUNICIPALITIES

Climate Smart Communities Program
Clean Energy Communities Program
Genesee-Finger Lakes Regional Planning Council (provides assistance for CSC/CEC programs)
NYSERDA Building Energy Code Development, Compliance, and Enforcement
NYSERDA Build Ready Program for Renewable Energy
NYSERDA Carbon Neutral Economic Development
NYSERDA Clean Energy Siting for Local Governments
NYSERDA Commercial Property Assessed Clean Energy Financing Guidance
NYSERDA Energy Storage
NYSERDA Solar Guidebook for Municipalities

Endnotes

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10 45% emissions reductions from 2010 levels by 2030 to limit temperature increases to 1.5 degrees. IPCC, 2018. *Special Report: Global Warming of 1.5 ºC.*

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12 Steering committee members include organizational representation from: Rochester Area Community Foundation, Cornell Agritech, American Farmland Trust, Common Ground Health, Connected Communities, EDF Renewables, Genesee-Finger Lakes Regional Planning Council, Greater Rochester Health Foundation, Hunt Country Vineyards, Ibero-American Action League, Multi-craft Apprenticeship Preparation Program (MAPP), Native American Cultural Center, Rochester-General Regional Transportation Authority, Rochester Institute of Technology, SUNY Geneseo, University of Rochester, University of Rochester Medical Center, The Urban League of Rochester, and Ujima Rochester.

13 Although energy transmission/distribution losses comprise 2% of emissions, the State's goal to decarbonize the grid, coupled with the need for clean energy generation to drive reductions in other sectors resulted in the inclusion of this sector.

14 Sector-specific focus groups included: clean energy technology/manufacturing, economic and workforce development, health, transportation, renewable energy generation, and agriculture.

15 Population-specific focus groups included: Urban black, urban Latino, farmworkers, indigenous, high-school students, college students, rural residents, "Color Your Community Green" teams, housing, equity-focused non-profits, and a mini-feedback session at the *Interrupt Racism Summit* put on by The Urban League of Rochester.

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23 For a visual depiction of the census tracts included as DAC's, see: Disadvantaged Communities Map - Climate Act

24 Climate Justice Working Group, March 2022, Draft Disadvantaged Communities Criteria and List Technical Documentation.

25 Sustainable Hudson Valley is employing a similar approach to reducing regional emissions and advancing their community in meeting CLCPA goals. Their work has been important for guiding and inspiring our own.

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29 City of Rochester Climate Action Plan

30 City of Rochester Climate Vulnerability Assessment

31 City of Rochester Climate Change Resilience Plan

32 Village of Fairport Sustainability Plan

33 Green Genesee/Smart Genesee

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Appendices

Appendix A: Genesee-Finger Lakes Emissions Inventory Report

Appendix B: Scenario Analyses Report

Appendix A: Genesee-Finger Lakes Emissions Inventory Report

Genesee - Finger Lakes Emissions Inventory

Draft

April 2022

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Stockholm Environment Institute – U.S. Center
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Project Overview

Figure 1: Map of the Genesee-Finger Lakes Region (Source: www.gflrpc.org)

The purpose of the climate action strategy is to help guide the development and implementation of projects across the Genesee-Finger Lakes Region that have the most significant potential to decrease greenhouse gas emissions, while also improving the vibrancy, equity, resiliency and health of the region as well. The final output of this project will be an emissions reduction target for the region and a set of corresponding measures and actions to achieve this goal, all documented in a **Climate Action Strategy for the Genesee-Finger Lakes Region**. This Plan seeks to align with the state-wide emissions targets set forth in the historic Climate Leadership and Community Protection Act (CLCPA)[1] and also takes into account the wide-ranging technological improvements since the Finger Lakes Sustainability Plan from 2013[2].

These are the project objectives:

1. To develop a database of emissions and existing climate change-related plans and policies in the Genesee-Finger Lakes Region,
2. To foster dialogue amongst regional stakeholders from different sectors, government entities and community groups to determine what kind of mitigation strategies are plausible and desirable for the Finger Lakes Region,
3. To analyze potential GHG emission reduction measures and social and economic implications of those measures, with particular emphasis on equity, inclusion and climate resiliency,
4. To develop a range of scenarios to guide a climate action strategy,
5. To set an emissions target for the region and prioritize measures that are environmentally, socially, technically, and economically feasible,
6. To identify implementation actors, requirements, timing, and constraints,
7. To develop a plan to monitor progress towards the emissions target, and

[1] Environmental Conservation Law (ECL) Article 75 and as adopted in 6 NYCRR Part 496 (https://www.dec.ny.gov/docs/administration_pdf/revrissum496.pdf)

[2] 2013 Finger Lakes Sustainability Plan: http://www.gflrpc.org/sustainabilityplan.html

8. To strengthen the capacity of local and regional stakeholders to carry out updates to the climate action strategy in the future.

The following project is led by the **Climate Solutions Accelerator (CSA)** in partnership with the **Stockholm Environment Institute's (SEI's) U.S. Center**. The proposed approach consists of four phases: scoping, baseline assessment, scenario analysis, and action plan development, with stakeholder engagement with implementation agencies, sectors, and marginalized groups playing a key role in the process. A summary of the 4-phase project approach is shown in the following figure:

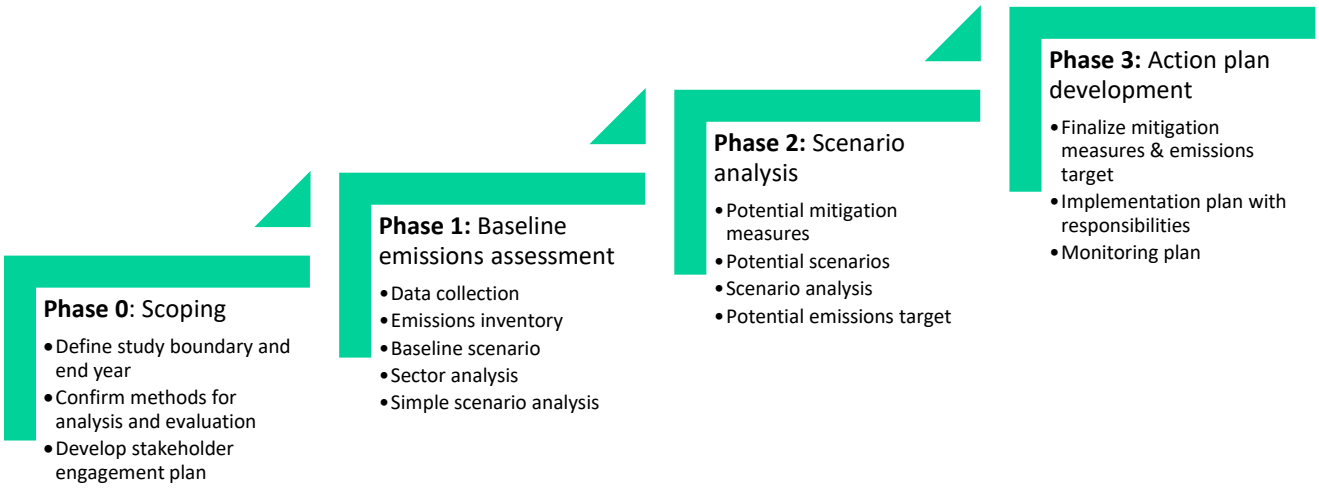

Figure 2: Phases of the Genesee-Finger Lakes Climate Action Strategy

The following report documents the results from Phase 1: Baseline Emissions Assessment.

1 Emissions inventory methodology

1.1 Framework

The baseline emissions inventory has the following objectives:

- Provide a basic understanding of the major sources of emissions in each county within the Genesee-Finger Lakes region (the "region")
- Estimate emission projections into the future (the "baseline scenario") based on historical emission rates
- Provide an idea of data gaps and areas to collect more data
- Provide a starting point for discussion on potential climate mitigation measures

This report documents the methodology and data sources used to determine county-level emissions by major economic sector for each year. The emissions inventory was developed in

accordance with the 2015 New York Community and Regional GHG Inventory Guidance[3] document ("NY GHG guidance") and has been updated to align with the methodology used in the 2021 New York State Statewide Greenhouse Gas Emissions Report[4] ("NY GHG inventory") where possible. The NY GHG inventory was developed according to the guidelines set by the International Panel on Climate Change (IPCC) Taskforce on National Inventories (IPCC 2006; IPCC 2019) and presented to meet the requirements set forth in the Climate Leadership and Community Protection Act (CLCPA), including reporting emissions using 20-year Global Warming Potential (GWP), accounting for out-of-state fossil fuel production emissions associated with energy use within the state, and incorporating biogenic carbon dioxide in the calculation of gross emissions. In some cases, additional detail beyond these documents is provided in this inventory if the data allows. Other methods are used to estimate emissions if data is scarce. Assumptions are used where data is scarce, such as downscaling state-level emissions down to the county-level. All assumptions are noted in this report.

All energy and non-energy demand data and emissions factors were obtained from publicly available data sources or local organizations. This is meant to be a high-level inventory used as a starting point for discussions around large sources of emissions and large emitters, and to illuminate where data gaps lie. This inventory is not mean to be a one-time activity, but to establish a process for continually updating the emissions inventory as more data is made available by stakeholders, institutions, facilities or organizations, and to track emissions reductions over time. Suggested future updates are described in Section 3.

The emissions inventory is currently being stored in the Low Emissions Analysis Platform (LEAP)[5] with future plans to create a publicly accessible emissions inventory. LEAP provides the structure for organizing data, calculations and results for an emissions inventory. All data, equations and assumptions used in LEAP are presented in this report. LEAP is also used for the scenario analysis conducted in Phase 2 of the project.

1.2 Inventory scope and boundaries

1.2.1 Scope

The NY GHG Guidance document recommends the inclusion of all "territorial" emissions, or emissions that directly occur within a physical boundary (in this case, the boundary is the region), and if data is available, any "consumption" emissions could also be included. Consumption emissions occur from the consumption of energy or goods produced outside of the boundary or

[3] https://climatesmart.ny.gov/fileadmin/csc/documents/GHG_Inventories/ghgguide.pdf
[4] https://www.dec.ny.gov/energy/99223.html
[5] http://leap.sei.org/

indirectly through activities like commuting to work. More specifically, emissions sources are defined in the following manner:

- **Direct emissions** that occur physically within a boundary such as those emitted by burning natural gas or fuel oil in homes and businesses; also called Scope 1 emissions.

- **Indirect emissions** at electricity power plants based on the amount of electricity consumed within the boundary, regardless of where the power plants are located; also called Scope 2 emissions.

- **Other indirect, upstream, or lifecycle emissions** attributed to community activity regardless of where they occur such as commuting, the lifecycle emissions from fuels or goods like appliances, clothes, etc.; also called Scope 3 emissions

It is often the case where direct and indirect emissions are attributed to the same source. The NY GHG Guidance does not require these overlapping emissions to be reconciled, however, for the purposes of this project, we attempt to avoid double counting, such as for electricity generation.

This inventory includes emissions for the Genesee-Finger Lakes region as a whole and for each county (see Figure 1 for a map of the region). The inventory covers the emissions from the consumption of all major fuels and non-energy emission sources in the region. Emissions from fuel combustion, including emissions from fuel used for electricity generation, are provided for all economic sectors including industry, transport, households, commercial and institutional, agriculture and waste. The inventory also includes non-energy emissions from livestock and crop production, land-use, waste and industrial processes. A comparison between the NY GHG Inventory and this regional inventory is provided Table 1. There are some differences between the two inventories as a result of data availability.

Emissions from upstream fossil fuel extraction and refining processes and fugitive emissions from natural gas pipelines are included in the emissions associated with energy use in the region. All upstream fossil fuel emissions are assumed to be generated out-of-state per the NY GHG inventory. Electricity generation is not included as a separate process or sector. The inventory attributes the indirect emissions from electricity generation to the sector that consumed it. This method prevents electricity-related emissions from being double-counted.

Table 1: Comparison between statewide and regional emissions inventories

Sector	New York Statewide GHG Inventory	Genesee-Finger Lakes GHG Inventory
Electricity	Includes: • Emissions from combustion of fuel for electricity generation • Transmission and distribution losses • Emissions from imported electricity • Emissions from fossil fuel imports for electricity generation	Includes: • Transmission and distribution losses Deviation from Statewide inventory: • Emissions from combustion of fuel for electricity generation attributed to the economic sector where electricity is consumed

Sector	New York Statewide GHG Inventory	Genesee-Finger Lakes GHG Inventory
		Currently not included: • Emissions from imported electricity to region not known • Emissions from fossil fuel imports for electricity generation not known
Transport	Includes: • Emissions from fuel combustion • Emissions from product use (this includes the use of refrigerants in vehicles with HVAC or refrigeration) • Emissions from fossil fuel imports	Includes: • Emissions from fuel combustion • Emissions from fossil fuel imports Deviation from Statewide inventory: • Emissions from product use is under industrial sector. Insufficient data to separate product use by sector.
Buildings	Includes: • Emissions from fuel combustion separated by residential and commercial buildings • Emissions from product use (this includes the use of refrigerants in HVAC or refrigeration) • Emissions from fossil fuel imports	Includes: • Emissions from fuel combustion separated by residential and commercial buildings • Emissions from fossil fuel imports Deviation from Statewide inventory: • Emissions from product use is under industrial sector. Insufficient data to separate product use by sector.
Industry	Includes: • Emissions from industrial processes • Oil and gas (including fugitive emissions) • Emissions from fuel combustion • Other uses of fuels • Emissions from fossil fuel imports	Includes: • Emissions from fuel combustion • Other uses of fuels • Emissions from fossil fuel imports Deviation from Statewide inventory: • Emissions from industrial processes, including product use in the transport sector and buildings • Fugitive emissions is separate sector • Oil and gas data (incl. abandoned wells) is not readily available
Agriculture	Includes: • Livestock • Soil management	Includes: • Livestock • Soil management
Waste	Includes: • Waste (solid waste facilities, wastewater) • Exported waste	Includes: • Waste (solid waste facilities, wastewater) Currently not included: • Unclear amount of waste that is exported out of the region (if any)
Forestry & Land Use	Includes: • Forests • Urban Trees • Wetlands • Harvested wood products	Includes: • Forests • Urban Trees • Wetlands • Harvested wood products

Greenhouse gas emissions are calculated for the historical period between 2010 and 2018 and a baseline projection of emissions is provided through 2050 based on historical emission rates for a given sector, given that these rates do not exceed the historical rates of emissions growth for the region overall. The start and end year of historical data varies between sectors depending on data availability. The historical period was chosen based on data availability; there is a lack of available data before 2010 and after 2018. Baseline emission projections start after the last historical year (2019) and extend to 2050.

1.2.2 Emissions

The inventory estimates emissions from all major greenhouse gases (GHGs), namely:

- Carbon Dioxide (CO_2)
- Methane (CH_4)
- Nitrous Oxide (N_2O)
- Flourinated gases, including hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6) and nitrogen trifluoride (NF_3)

GHG emissions are reported as carbon dioxide equivalent (CO_2e). Conversions from a given pollutant to CO_2e can be carried out using 20, 100, or 500-year global warming potentials (GWPs). The GWP shows how much energy 1 ton of GHG emissions will absorb over a given period (i.e., 20 years, 100 years or 500 years) relative to 1 ton of CO_2. The GWPs for the greenhouse gases analyzed in this inventory are listed in Table 2.

Table 2: Global Warming Potentials of greenhouse gases evaluated in the inventory

GHG	20-year GWP from IPCC's Fifth Assessment Report (AR5)[1]	100-Year GWP from IPCC's Fourth Assessment Report (AR4)[2]
Carbon Dioxide (CO_2)	1	1
Methane (CH_4)	84	25
Nitrous Oxide (N_2O)	254	298
Hydrofluorocarbons (HFCs) (as HFC-23)	10,800	14,800
Sulphur hexafluoride (SF_6)	17,500	22,800
Perfluorocarbons (PFCs) (as PFC-14)	4,880	7,390
Hydrofluoroethers (HFEs) (as HFE-125)	12,400	12,400
Nitrogen trifluoride (NF_3)	12,800	17,200

[1] 20-year GWP without climate carbon feedbacks used by the CLCPA; source: IPCC 2013

[2] 100-year GWP without climate carbon feedbacks used by the UNFCCC; source: IPCC 2007

All quantities of CO_2e reported in this report are calculated using the 20-year GWP. This is in accordance with the Intergovernmental Panel on Climate Change's (IPCC's) fifth assessment report (AR5) which has been adopted by the CLCPA. The 100-year GWP from IPCC's assessment report (AR4) is the conventional GHG accounting format utilized by the United Nations

Framework Convention on Climate Change (UNFCCC) for national reporting of GHG emissions. As shown in Table 2, unlike most greenhouse gases[6] which have long atmospheric lifetimes, methane's potency under the 100-yr GWP is lower compared to the 20-yr GWP. This is because methane decays relatively quickly (~9 years) and becomes less potent over time. Methane's ability to trap heat causes more warming in the short-term compared to the long-term. The CLCPA's choice of using 20-year GWP puts emphasis on methane-related warming in the upcoming 10 to 30 years. A discussion on why 20-yr GWP was chosen for the CLCPA over 100-yr GWP is provided in Howarth (2020).

There are several other air pollutants generated by the energy and non-energy sector. The following pollutants are also covered where emission factors are available:

- Carbon Monoxide (CO)
- Nitrogen Oxides (NO_x)
- Non-methane volatile organic compounds (NMVOC)
- Particulate matter (PM) (particle diameters less than 2.5 microns and 10 microns)
- Sulfur Dioxide (SO_2)

Based on the NY GHG Guidance document, the combustion of biofuels creates **biogenic** CO_2 emissions that are considered "carbon neutral". This is because carbon dioxide is taken from the atmosphere to grow the biomass source and upon combustion, the carbon dioxide is returned to the atmosphere resulting in net zero emissions. However, in the NY GHG inventory, biogenic CO_2 is shown in the reporting of gross emissions and is removed in the net emissions summary. This report follows the reporting method used in the NY GHG Inventory. Other contaminants from biofuel combustion, such as methane and nitrous oxide, are included since they are not released during natural decay processes.

1.2.3 Emission factors

Emission factors are used to calculate the emissions generated from the combustion of fuels at on-site or for electricity generation and emissions from different processes. The emissions from using natural gas for cooking will differ from using natural gas for a car depending on the combustion efficiency of the car and stove. Even combustion efficiencies between different stove brands and models will vary. This level of detail is very difficult to find, therefore, for this analysis, we use generic emission factors for a given sector and fuel or process, similar to what was used in the NY GHG Inventory. The following sub-section provides further detail on the emission factors used for this emissions inventory.

[6] Other GHG's that have lower potency under the 100-yr timeframe compared to the 20-yr timeframe include HFC-134a and CFC-11. In general, some, but not all, HFCs are short-lived.

1.2.3.1 Emission factors for fuel combustion

An emissions factor converts fuel consumption into pollutant emissions in units of mass (e.g., metric tons). A combination of bottom-up/end-use accounting and top-down/macroeconomic techniques are used to estimate fuel demands. The most widely applied bottom-up method is an activity analysis, which calculates demand as the product of an activity level (i.e., a measure of social and economic activity) and energy intensity (i.e., the average energy consumption for a device or an activity). For example, an "activity" could be the number of households that use natural gas stoves, and the "energy intensity" could be the amount of natural gas used for cooking on a natural gas stove.

The bottom-up approach has a history in the energy modeling literature (Landsberg et al. 1974) as both simple and transparent. As Bhattacharyya (2011) explains, it is an end-use oriented method commonly applied to demands separated into multiple sectors.

To ensure bottom-up estimates of fuel use are correct, the fuel demands are adjusted by a calibration factor. The formula representing this calculation is provided below:

$$Fuel\ Demand_{(sector,\ process,\ c,\ s,\ t)} = Activity_{(sector,\ process,\ c,\ s,\ t)} \times FEI_{(sector,\ process,\ c,\ s,\ t)} \times C_{(sector,\ c,\ t)}$$

Where:

Fuel Demand is the total fuel consumption in units of energy (e.g., GJ, MMBTU, etc.)
Total Activity is a measure of social or economic activity (i.e., number of households, GDP, etc.)
FEI is the final energy intensity, or the fuel consumption per unit of total activity
C is a calibration factor used to align bottom-up fuel estimate to actual fuel use
Sector is the economic sector
Process is the fuel combustion source
c is the county
s is the scenario
t is the year of analysis

final energy demand = activity level × energy intensity

A bottom-up analysis makes it easier to assess climate mitigation measures that tend to target specific activities. In some cases, activity data is not readily available, so a top-down analysis is made using reported fuel consumption data.

For energy-related emissions, each pollutant has an emission factor unique to each fuel, sector and combustion source (like a stove or car). Fuels also have emissions associated with upstream processes, e.g., mining, extraction, refining, and distribution. As a result, pollutant emissions are calculated using the following formulas:

$$Energy\ emissions_{(sector,\ process,\ fuel,\ GHG,\ s,\ t)} = Fuel\ Consumption_{(sector,\ process,\ s,\ t)}\ x\ Emissions\ Factor_{(sector,\ fuel,\ GHG)}$$

$$Emissions\ Factor_{(sector,\ fuel,\ GHG)} = Emissions\ Factor_{(sector,\ fuel,\ GHG)} + Emissions\ Factor_{(fuel,\ GHG)}$$

Where:

Sector is the economic sector
Process is the fuel combustion source
c is the county
s is the scenario
t is the year of analysis
fuel = type of fuel
GHG = type of greenhouse gas

The emission factors for fuel combustion and the upstream emissions associated with the fuels used in the region are provided in Appendix A.

1.2.3.2 Emission factors for grid electricity

Electricity is supplied to the region through three main utilities: National Grid, Rochester Gas and Electric (RG&E) and New York State Electric and Gas (NYSEG). There are also several municipal utilities that serve the following towns: Fairport (Monroe), Churchville (Monroe), Spencerport (Monroe), Bergen (Genesee), Holley (Orleans), Arcade (Wyoming), Castile (Wyoming), Silver Springs (Wyoming) and Penn Yan (Yates). Refer to Figure 3 for the Genesee-Finger Lakes electricity service area map.

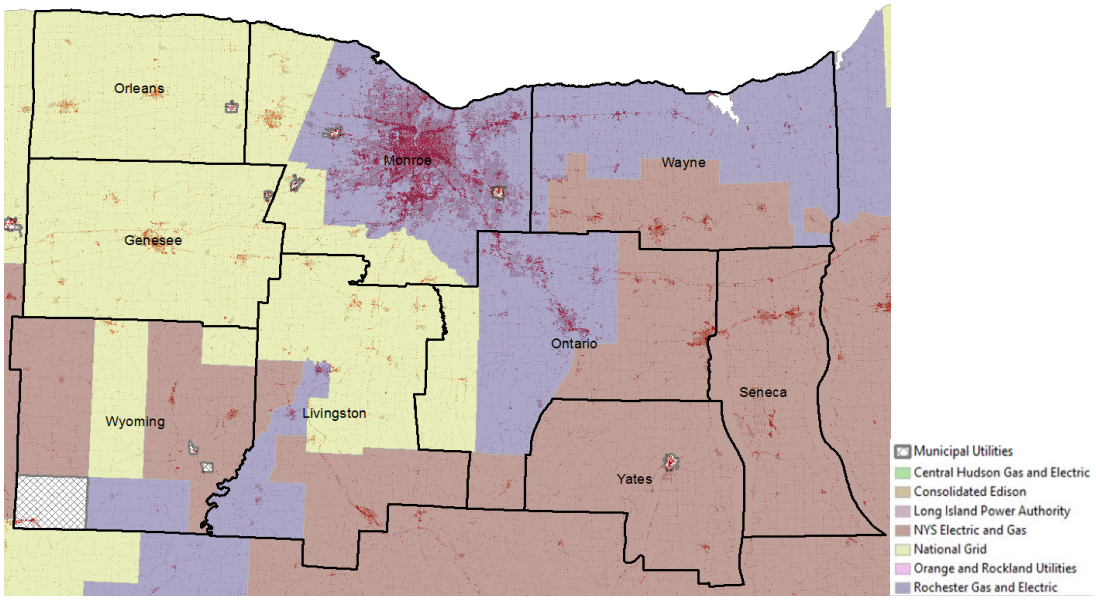

Figure 3: Genesee-Finger Lakes electricity service area map

GHG emissions from consuming grid electricity (Scope 2 emissions) are based on the carbon intensity of the grid. While the NY GHG guidance document recommends using the grid carbon intensity factor developed by NYSERDA, one was not readily available for recent years. In its place, a state-wide emissions factor was taken from the U.S. EPA Emissions & Generation Resource Integrated Database (eGRID) (US EPA 2021a). This state-wide emissions factor was adjusted based on the relative emission rates of the utilities per New York's Environmental Disclosure Labeling Program (NYDPS 2021). The 2019 grid emission factors for the state and the relative emission rates for the major electric utilities in the region are shown in Table 3. We used an average rate for the major electric utilities since they represent the majority of electricity emissions in the region.

Table 3: 2019 Grid emission factors for New York (per eGRID) and the relative emission rates compared to the New York state average for major utilities in the region

Pollutant	eGRID (lb/MWH)	National Grid[1] (lb/MWH relative to state average)	RG&E	NYSEG
Carbon Dioxide (CO_2)	376.7	107%	109%	107%
Methane (CH_4)	0.028	107%[2]	109%[2]	107%[2]
Nitrous Oxide (N_2O)	0.003	107%[2]	109%[2]	107%[2]
Nitrogen Oxides (NOx) (Annual)	0.2	107%	109%	107%
Sulfur Dioxide (SO2)	0.0	105%	108%	105%

Source: (US EPA 2021a; NYDPS 2021)

[1] Listed as Niagara Mohawk Power Corporation

[2] Assumed to be same as the CO_2 value

The relative emission rates for the major utilities are higher than the state average because the share of fossil fuel-based electricity purchased by the utilities is higher and the share of hydropower is lower. Despite significant hydropower generation upstate, for which some of the utilities have bilateral contracts for, most of the utilities rely on the wholesale electricity market to meet electricity demands. The New York Independent Systems Operator (NYISO) selects the proper mix of generators to supply electricity demands at the least cost to utilities, meaning utilities end up using downstate fossil fuel capacity to meet load requirements. A comparison between the energy mix for all of New York, Upstate New York and the major utilities that serve the Genesee-Finger Lakes region - namely National Grid, RG&E and NYSEG – are in Table 4.

Table 4: Comparison of the 2019 electricity mix between all of Upstate New York (per eGRID) and large utilities in the region (Source: US EPA 2021a; NYDPS 2021)

Type of power plant	eGRID State Avg. (% share)	eGRID Upstate[1] (% share)	National Grid[2] (% share)	RG&E (% share)	NYSEG (% share)
Coal	0.3%	0.5%	3%	3%	3%
Oil	0.4%	0.1%	<1%	<1%	<1%
Gas	36%	25%	39%	42%	41%
Other Fossil	0%	0%	0%	0%	0%

Type of power plant	eGRID State Avg. (% share)	eGRID Upstate[1] (% share)	National Grid[2] (% share)	RG&E (% share)	NYSEG (% share)
Nuclear	34%	32%	35%	38%	37%
Hydro	23%	35%	18%	11%	13%
Biomass	2.2%	1.9%	<1%	<1%	<1%
Wind	3.4%	5.1%	2%	2%	2%
Solar	0.4%	0.4%	<1%	<1%	<1%
Geothermal	0%	0%	0%	0%	0%
Waste and other unknown/ purchased fuel	0%	0%	2%	2%	2%

[1] Listed as NYUP (NPCC Upstate NY)

[2] Listed as Niagara Mohawk Power Corporation

1.2.3.3 Emission factors for non-energy emissions

For non-energy related emissions, pollutant emissions are not based on fuels, but on processes, with an emissions factor associated with the process, for example, digestion processes in animals, decomposition processes in landfills, or land conversion processes. Pollutant emissions from these processes are calculated using the following formula:

$$Non\text{-}energy\ emissions_{(process,\ GHG)} = Process\ x\ Emission\ Factor_{(process,\ GHG)}$$

The emission factors to estimate non-energy emissions are provided throughout Section 1.3.2.

1.3 Inventory structure and calculations

The inventory calculates historical emissions for 2010 to 2018 and emissions projections to 2050, the target date for achieving net zero emissions according to the CLCPA. The calculations are divided into two main categories: energy emissions and non-energy emissions. As shown in Table 5, some sectors have both energy and non-energy emissions, each with its own emissions calculation methodology and data sources, as described in the remainder of this section. For reporting purposes, emissions and non-energy emissions are reported together for a given sector.

Table 5: Breakdown of sector calculations by energy and non-energy emissions

Sector	Energy Emissions	Non-Energy Emissions
Transport	X	
Buildings (Residential)	X	
Buildings (Small Commercial)	X	
Buildings (Large Commercial)	X	
Industry	X	X
Electricity (Transmission & Distribution)	X	
Fugitive Emissions	X	
Agriculture	X	X

Sector	Energy Emissions	Non-Energy Emissions
Waste (Solid Waste)	X	X
Waste (Wastewater)	X	X
Forestry & Land Use		X

A number of data sources were compiled to develop the inventory. Where possible, an end-use oriented (aka "bottom-up") approach was taken to estimate emissions, for instance, calculating transport emissions by vehicle and fuel type, rather than just by fuel. Having this level of detail lends itself well to evaluating different climate mitigation policies during the scenario analysis phase of the project (Phase 2). This includes looking at the emissions reductions from increasing the number of EVs on the road, for example, as opposed to estimating a decrease in gasoline use in the transport sector. However, the bottom-up approach was not possible for all sectors based on data availability. All bottom-up calculations for the energy sector were calibrated to actual fuel use data, where available.

The rest of this section describes the input data, assumptions and calculations used to complete the emissions inventory.

1.3.1 Historical energy-related emissions

As shown in Table 6, final energy demands are broken down by economic sector, subsector, end use, technology, and fuel. The level of detail in each sector depends on data availability.

Table 6: Final Energy Demand Sectors and Subsectors

Sector	Subsector Level 1	Subsector Level 2	Subsector Level 3	Subsector Level 4
Residential	Urban Centre	New Building	Renter	Extremely Low Income
				Very Low Income
				Low Income
				Moderate Income
				Middle-High Income
			Owner	Extremely Low Income
				Very Low Income
				Low Income
				Moderate Income
				Middle-High Income
		Old Building	Renter	Extremely Low Income
				Very Low Income
				Low Income
				Moderate Income
				Middle-High Income
			Owner	Extremely Low Income
				Very Low Income
				Low Income
				Moderate Income
				Middle-High Income
		New Building	Renter	Extremely Low Income

Sector	Subsector Level 1	Subsector Level 2	Subsector Level 3	Subsector Level 4
	Rural or Urban Periphery			Very Low Income
				Low Income
				Moderate Income
				Middle-High Income
			Owner	Extremely Low Income
				Very Low Income
				Low Income
				Moderate Income
				Middle-High Income
		Old Building	Renter	Extremely Low Income
				Very Low Income
				Low Income
				Moderate Income
				Middle-High Income
			Owner	Extremely Low Income
				Very Low Income
				Low Income
				Moderate Income
				Middle-High Income
Small Commercial	Large Utilities	RGE		
		National Grid		
		National Fuel		
		NYSEG		
		Reserve Gas Company		
	Municipal Utilities			
Large Commercial	Large Utilities			
Industry[1]	Manufacturing	N3112 Grain and Oilseed Milling		
		N3113 Sugar and Confectionery Product Manufacturing		
		N3114 Fruit and Vegetable Preserving and Specialty Food Manufacturing		
		N3115 Dairy Product Manufacturing		
		N3116 Animal Slaughtering and Processing		
		N3119 Other Food Manufacturing		
		N3121 Beverage Manufacturing		
		N3122 Tobacco Manufacturing		
		N3132 Fabric Mills		
		N3141 Textile Furnishings Mills		
		N3149 Other Textile Product Mills		
		N3151 Apparel Knitting Mills		
		N3152 Cut and Sew Apparel Manufacturing		
		N3159 Apparel Accessories and Other Apparel Mfg		
		N3162 Footwear Manufacturing		
		N3169 Other Leather and Allied Product Manufacturing		
		N3211 Sawmills and Wood Preservation		
		N3219 Other Wood Product Manufacturing		
		N3231 Printing and Related Support Activities		
		N3241 Petroleum and Coal Products Manufacturing		
		N3251 Basic Chemical Manufacturing		
		N3254 Pharmaceutical and Medicine Manufacturing		

Sector	Subsector Level 1	Subsector Level 2	Subsector Level 3	Subsector Level 4
		N3259 Other Chemical Product and Preparation Mfg		
		N3261 Plastics Product Manufacturing		
		N3262 Rubber Product Manufacturing		
		N3271 Clay Product and Refractory Manufacturing		
		N3272 Glass and Glass Product Manufacturing		
		N3279 Other Nonmetallic Mineral Product Mfg		
		N3311 Iron and Steel Mills and Ferroalloy Mfg		
		N3312 Steel Product Mfg from Purchased Steel		
		N3313 Alumina and Aluminum Production & Processing		
		N3315 Foundries		
		N3321 Forging and Stamping		
		N3322 Cutlery and Handtool Manufacturing		
		N3323 Architectural and Structural Metals Mfg		
		N3325 Hardware Manufacturing		
		N3326 Spring and Wire Product Manufacturing		
		N3329 Other Fabricated Metal Product Manufacturing		
		N3332 Industrial Machinery Manufacturing		
		N3333 Commercial and Service Industry Machinery Mfg		
		N3335 Metalworking Machinery Manufacturing		
		N3339 Other General Purpose Machinery Mfg		
		N3344 Semiconductor and Other Electronic Component Manufacturing		
		N3351 Electric Lighting Equipment Manufacturing		
		N3352 Household Appliance Manufacturing		
		N3353 Electrical Equipment Manufacturing		
		N3359 Other Electrical Equipment and Component Mfg		
		N3371 Household and Institutional Furniture and Kitchen Cabinet Manufacturing		
		N3379 Other Furniture Related Product Manufacturing		
		N3391 Medical Equipment and Supplies Manufacturing		
		N3399 Other Miscellaneous Manufacturing		
		N3221 Pulp Paper and Paperboard Mills		
		N3252 Resin Synthetic Rubber and Artificial and Synthetic Fibers and Filaments Manufacturing		
		N3253 Pesticide Fertilizer and Other Agricultural Chemical Manufacturing		
		N3324 Boiler Tank and Shipping Container Mfg		
		N3328 Coating Engraving Heat Treating and Allied Activities		
		N3331 Agriculture Construction and Mining Mfg		
		N3336 Engine Turbine and Power Transmission Equipment Manufacturing		
		N3372 Office Furniture Manufacturing		
		N3327 Machine Shops Turned Product and Screw Nut and Bolt Manufacturing		
		N3133 Textile and Fabric Finishing and Coating Mills		
		N3334 HVAC & Commercial Refrigeration Equip. Mfg		
	Mining	N2111 Oil and Gas Extraction		
		N2123 Nonmetallic Mineral Mining and Quarrying		
		N2131 Support Activities for Mining		
	Construction	N2369 Building Construction		
		N2378 Heavy and Civil Engineering Construction		

Sector	Subsector Level 1	Subsector Level 2	Subsector Level 3	Subsector Level 4
		N2388 Specialty Trade Contractors		
Transport	On Road	Cars		
		Light passenger trucks		
		Light commercial trucks		
		Medium trucks		
		Heavy duty single unit trucks		
		Heavy duty combination trucks		
		Public Buses		
		Private Buses		
		Motorcycles		
	Non Road	Rail	Locomotive	
			Railroad Maintenance	
		Airport	Operational	
			Aircraft Landing/Takeoff	
		Marine	Pleasurecraft	
			Commerical Marine Vessels	
	Off Road	Recreational		
Agriculture[1]	N1111 Oilseed and Grain Farming			
	N1112 Vegetable and Melon Farming			
	N1113 Fruit and Tree Nut Farming			
	N1122 Hog and Pig Farming			
	N1123 Poultry and Egg Production			
	N1124 Sheep and Goat Farming			
	N1121 Cattle Ranching and Farming			
	N1119 Other Crop Farming			
	N1114 Greenhouse Nursery and Floriculture Production			
	N1129 Other Animal Production			
Solid Waste				
Wastewater				
Electricity Transmission and Distribution Losses				
Natural Gas Fugitive Emissions				

[1] The industrial and agricultural subsectors are categorized by the North American Industry Classification System (NAICS)

The following sections provides the methodology and data sources used to calculate energy-related emissions in each sector.

1.3.1.1 Residential

Emissions from residential energy demands are calculated using the formulas presented in Section 1.2.3.1 with some modification. The amount of fuel consumed in the residential sector is based on the number of households (total activity) and the energy used for various household technologies (i.e., air conditioners, furnaces, lights, etc.). The emission factors used for the residential sector are provided in Appendix A.

Per Table 6, households are divided into different groups based on geography, building age, ownership status and income classification. In total, there are 40 household types based on the various combinations of geography-building age-ownership status-income classification. Fuel demands for each household type are calculated using the following formula:

$$Energy_{c,s,t,type,fuel} = \sum_{0...T} HH_{c,s,t,type,tech} \times FEI_{tech,fuel} \times C_{c,fuel}$$

$$HH_{c,s,t,type,tech} = HH_{c,s,t} \times f_g \times f_{g,by} \times f_{g,by,own} \times f_{g,by,own,inc} \times f_{g,by,own,inc,tech}$$

Where:

Energy is the energy use in mmbtu
HH is the number of households from the U.S. Census Bureau (2021).
FEI is the final energy intensity in mmbtu per household from US EIA (2018).
C is a calibration factor
f is the fraction of total households in a specific category. Data for f_g, $f_{g,by}$, $f_{g,by,own}$ and $f_{g,by,own,inc}$ are from Ruggles et al (2021). $f_{g,by,own,inc,ech}$ is from US EIA (2018).
tech is the end-use technology (i.e., natural gas boiler, central AC, etc.)
fuel is the type of fuel (i.e., natural gas, electricity, etc.)
c is the county
s is the scenario
t is the year of analysis
type is the household type for a given combination of *g*, *by*, *own* and *inc*
g is the geographic location of a household (urban centre / rural or urban periphery)
by is the built year of a household (new / old)
own is the ownership status of a household (owner / renter)
inc is the income group of a household (extremely low / very low / low / moderate / high)
T is the maximum number of end-use technologies

Residential Activity and Energy Intensity

The number of households in each county is available from the U.S. American Community Survey (ACS) (US Census Bureau 2021). The share of households in each household type within each county is obtained from the ACS via a web tool called IPUMS[7] (Ruggles et al. 2021). Further details on the different groups are as follows:

- **Geography:** Households were divided into two geographic groups: urban centre and urban periphery (the latter includes rural households). The data used to categorize households came from the IPUMS variable called METRO. METRO indicates whether a household is in an urban centre, urban periphery or mixed area. The number of households in the "mixed" category (per the variable called HHWT) was split into

[7] https://usa.ipums.org/usa/index.shtml

"urban centre" and "rural and urban periphery" based on the share of households located in a metropolitan area (per the variable called PCTMETRO).

- **Building vintage:** Urban and rural households were further divided into two building vintages: new or old. The built year for a household was provided by the IPUMS variable called BUILTYR. In 2002, the New York State Energy Conservation Construction Code (ECCC) had a major update to align with the International Energy Conservation Code (IECC). Given that the built year of households in ACS are provided in decadal increments, new buildings are assumed to be those built after or in the year 2000 (a few years before the updated ECCC) and old buildings are assumed to be those built before 2000.

- **Ownership status:** Old and new households were further divided into two ownership statuses: renter or owner. The ownership status for a household was provided by the variable OWNERSHPD. OWNERSHPD indicates whether a survey sample represents households that are owned (or being bought), rented or neither. Households that are "neither" are excluded from the analysis due to insufficient income and energy data for these types of households.

- **Income classification:** Rental and owned households were further divided into five income groups: extremely low income, very low income, low income, moderate income and high income. The income groups are based on area median income (AMI) as defined for each county by the U.S. Department of Housing and Urban Development (HUD) (2020). The AMI and income group definitions are shown in Table 7 and Table 8. Household were categorized based on the IPUMS variable for household income, HHINCOME.

Table 7: Area Median Incomes

County	AMI
Genesee	$73,050
Orleans	$73,050
Livingston	$73,550
Wyoming	$73,550
Ontario	$73,500
Yates	$73,500
Wayne	$73,050
Seneca	$73,050
Monroe	$76,400

Source: (U.S. HUD 2020)

Table 8: Income group definition

Income Group	Definition
Extremely Low Income	0-30% of AMI
Very Low Income	31-50% of AMI
Low Income	51-80% of AMI
Moderate Income	81-120% of AMI
Middle-High Income	120%+

Source: (NYC HPD 2021)

Energy data for each household type was taken from the U.S. Energy Information Administration's latest Residential Energy Consumption Survey (RECS) in 2015 (US EIA 2018). RECS does not have data at a county-level, therefore data for the Middle Atlantic region – which the Genesee-Finger Lakes is a part of – was used instead.

RECS microdata provides activity levels and energy intensity by various end-use categories and is available for each of the household types described above. The end-uses included in the analysis are “Air Conditioning”, “Water Heating” and “Space Heating” with fuel demands from all other end-uses combined into a single category called “Other”. The technologies and fuels under each end-use category are indicated in Table 9.

Table 9: Residential end-use technologies included in the analysis

Water Heating	Space Heating	Air Conditioning
Technologies	**Technologies**	**Technologies**
Ref. Electric Large Storage	Reference Natural Gas Boiler	Reference Central AC
Ref. Electric Small Storage or Tankless	Reference Natural Gas Furnace	Reference Room AC
Efficient Electric Large Storage	Efficient Natural Gas	Efficient Central AC
Efficient Electric Small Storage or Tankless	Other Gas	Efficient Room AC
Ref. Natural Gas Large Storage	Reference Oil Furnace	Air Source Heat Pump
Ref. Natural Gas Small Storage or Tankless	Reference Oil Boiler	Both Central and Room AC
Efficient Natural Gas Large Storage	Efficient Oil	Both Heat Pump and Room AC
Eff. Natural Gas Small Storage or Tankless	Other Oil	
Fuel Oil or Kerosene	Electric Resistance	
Propane or LPG	Electric Furnace	
Wood	Electric Heat Pump	
Solar	Portable Electric Heater	
Other Fuel	Ground Source Heat Pump	
	Solar	
	Bottled Tank or LPG	
	Wood	
	Other Fuel	
Fuels	**Fuels**	**Fuels**
Electricity	Electricity	Electricity
Natural Gas	Natural Gas	
Fuel Oil or Kerosene	Fuel Oil or Kerosene	
Propane or LPG	Propane of LPG	
Wood	Wood	
Solar	Solar	
Other	Other	

Calibration of Residential Energy Use

Residential fuel demands were calibrated using NYSERDA’s Patterns and Trends reports which provides historical fuel usage in each county. Historical natural gas and electricity data are only available for 2013 (NYSERDA 2019b). For all other fuels, 2017 data is used (NYSERDA 2021b).

A calibration factor is the ratio of actual fuel demands over estimated fuel demands and is applied to the energy intensity. The residential calibration factors used for this analysis are provided in Table 10. In almost all cases, except for Propane/LPG, estimated fuel use is higher than the actual use. Improvements to county-specific activity and end-use data could improve future estimates.

Table 10: Residential calibration factors by county

County	Electricity	Natural Gas	Diesel	Fuel Oil / Kerosene	Propane / LPG	Wood
Genesee	0.57	0.64	0.26	0.24	1.86	0.14
Livingston	0.48	0.45	0.24	0.23	2.46	0.29
Monroe	0.75	0.86	0.05	0.05	0.17	0.02
Ontario	0.45	0.92	0.17	0.16	0.85	0.09
Orleans	0.53	0.59	0.32	0.30	2.37	0.25
Seneca	0.53	0.35	0.32	0.29	3.20	0.28
Wayne	0.53	0.46	0.27	0.25	2.51	0.42
Wyoming	0.49	0.43	0.18	0.17	2.06	0.34
Yates	0.36	0.78	0.24	0.23	1.34	0.21

1.3.1.2 Small Commercial

Energy consumption for the commercial sector was only available as small and large commercial, each requiring a very different calculation methodology. A top-down approach was used to calculate energy usage in the small commercial sector due to insufficient data for a bottom-up analysis. Per Table 6, small commercial energy demands are divided into "private utilities" and "municipal utilities" that deliver electricity and natural gas. Data for other fuels used in the small commercial sector was not found.

Energy consumption from private utilities

Natural gas and electricity consumption was obtained from NYSERDA's Utility Energy Registry (UER) for small commercial buildings for the years 2016 to 2018. Large commercial energy demands were grouped with industrial usage in the UER which is why the commercial sector is divided in two. The UER defines small commercial as follows:

> *Small Commercial (SC): All non-residential rates classes eligible for opt-out Community Choice Aggregation in New York. This field differs from the Commercial data field in the National UER Data Field Library since not all commercial businesses are opt-out eligible.*

The UER provides natural gas and electricity data for each census tract. The utilities withhold data from the UER when there are insufficient customers in a given tract to ensure privacy. Therefore, the reported energy consumption in the UER is less than the actual. The total consumption of each fuel in the small commercial sector is added to the consumption in large commercial and scaled to match the total commercial demands recorded in NYSERDA's Patterns and Trends reports (NYSERDA 2019b). The calibration factors are provided later in this section.

Energy consumption from municipal utilities

Since municipal utilities are not included in the UER, energy use in small commercial areas covered by municipal utilities are extrapolated from the energy use per hectare in small commercial areas covered by private utilities using the following methodology:

1. **Using GIS software, a land use map is layered on top of a utility service area map to identify size of the residential areas in hectares serviced by each utility.** The National Land Cover Dataset (NLCD) 2016[8] is a dataset which categorizes the U.S. into 15 land cover classes. This dataset when intersected with the boundaries of each county in the Genesee-Finger Lakes region, and the service area of each utility (both large and small), provides the area of each land use class, within each county, within each utility service area. There are three land use classes in the NLCD dataset that are useful for determining commercial area. These categories are not determined by zoning but by the percentage of impervious surface in a given area, so this is not a perfect predictor of areas where small commercial exist; however, it is assumed that the high intensity category likely captures where small commercial energy use is occurring.

    - **Developed, Low intensity** - Includes areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20-49 percent of total cover. These areas most commonly include single-family housing units.
    - **Developed, Medium intensity** - Includes areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 50-79 percent of the total cover. These areas most commonly include single-family housing units.
    - **Developed, High intensity** - Includes highly developed areas where people reside or work in high numbers. Examples include apartment complexes, row houses and commercial/industrial. Impervious surfaces account for 80 to 100 percent of the total.

2. **Add up the total area (in hectares)** covered by high intensity (commercial) development for each county and each utility service area.

3. **Find the energy intensity of electricity and natural gas use in the commercial areas in kWH/ha or therms/ha.** This was done by dividing total energy use from each private utility (from the UER), in each county, in each year by the corresponding area.

4. **Apply the energy intensity in kWH/ha or therms/ha of the private utilities to the residential areas within the municipal utilities to determine residential energy consumption from municipal utilities.** The energy intensity within a given county are assumed to be the same, with the exception of Monroe county, where the energy intensity from Genesee is applied to the areas serviced by municipal utilities in Monroe, as these areas are less densely developed (shorter buildings) than the majority of the "developed – high intensity" areas in Monroe County, which are largely in Rochester and have significantly taller buildings and therefore a higher energy intensity.

[8] https://www.usgs.gov/centers/eros/science/national-land-cover-database

This analysis uses the following assumptions:

1. The developed – low intensity land cover class is representative of areas where commercial energy use is occurring, and is sufficient to infer energy use based on area across different parts of the counties
2. The way electricity versus gas is used in the areas where we have data (areas served by large utilities) is the same as the area where we are missing data (areas served by municipal utilities). This may be faulty if, for example, municipal electricity suppliers are much cheaper so people use more electricity in these service areas than in others.
3. No area is served by two electric utilities. This seems to be true given the shapefile of service areas.

Calibration of small commercial energy use

While the UER is the main source of data for the small commercial energy analysis, due to privacy concerns, a sizeable portion of the data is withheld for each utility. NYSERDA's Patterns and Trends reports provides the total natural gas and electricity usage for each county and is used to calibrate the private utility and municipal utility data. Only actual fuel use data for 2013 was available.

A calibration factor is the ratio of actual fuel demands over estimated fuel demands and is applied to the energy intensity. The calibration factors for the commercial sector are provided in Table 11. The total consumption of each fuel in the small commercial sector is added to the consumption in large commercial and scaled to match total commercial demands.

Table 11: Commercial natural gas and electricity calibration factors by county

County	Electricity	Natural Gas
Genesee	1.30	2.00
Livingston	0.87	0.67
Monroe	0.55	0.36
Ontario	0.68	2.09
Orleans	1.91	13.14
Seneca	0.62	1.04
Wayne	2.37	1.08
Wyoming	12.04	2.49
Yates	12.75	7.02

1.3.1.3 Industrial and Agricultural

A top-down approach was used to calculate energy usage in the small commercial sector due to insufficient data for a bottom-up analysis. Energy data for the industrial and agricultural sector was obtained from the National Renewable Energy Laboratory's (NREL's) Industrial Energy Data

Book (IEDB)[9] for the years 2010 through 2016. This dataset compiles industrial and agricultural fuel use data by county and North American Industry Classification System (NAICS) code using a number of publicly available data sources including the U.S. Environmental Protection Agency (EPA), U.S. Energy Information Agency (EIA), Census Bureau, U.S. Department of Agriculture (USDA), and U.S. Geological Survey (USGS). It reports consumption of natural gas, diesel, liquid petroleum gas, residual fuel oil, coal, coke, net electricity, and a fuel called "other". Net Electricity represents the portion of electricity taken from the grid, as opposed to Gross Electricity which would include the electricity generated on site and used internally or sold. The disadvantage of not having gross electricity demands is that if fossil fuel-based sources of energy are used to generate electricity on-site, it would not be included in the inventory. This is a major concern, for example, of bitcoin mining which requires a large amount of electricity for its operations. For instance, the Greenridge Generation facility in Yates County opened in 2018 and is already proposing to expand its operations to over 55 MW. It uses natural gas for energy generation, but the company is said to have "invested heavily in reliable, verifiable carbon offset credits to ensure it maintains net-zero carbon emissions in its bitcoin transaction processing operations".[10] Since the Greenridge Generation facility is connected to the grid, it is assumed that its emissions are already considered in the electricity emissions factor described in Section 1.2.3.2.

A summary of the industrial and agricultural sub-sectors included in the inventory is in Table 6. The emission factors used to translate fuel usage to emissions is provided in **Appendix A**. A detailed report from Orebed Analytics in **Appendix C** provides additional results on industrial and agricultural energy demands in the Genesee-Finger Lakes region.

Calibration of industrial and agricultural energy use

NYSERDA's Patterns and Trends reports provides the total natural gas and electricity usage for each county and is used to calibrate the industrial electricity and natural gas demands using the calibration factors provided in Table 12. Fuel use data for 2013 was the only year available. The actual energy used by the agricultural sector is not known and was not calibrated.

Table 12: Industrial natural gas and electricity calibration factors by county

County	Electricity	Natural Gas
Genesee	1.77	0.69
Livingston	2.10	1.02
Monroe	0.92	0.61
Ontario	0.89	0.30
Orleans	1.16	0.15

[9] https://data.nrel.gov/submissions/122

[10] https://greenidge.com/our-operations/

Seneca	0.62	0.47
Wayne	1.61	1.44
Wyoming	1.19	0.70
Yates	0.56	0.82

1.3.1.4 Large Commercial

Energy consumption for the commercial sector was only available as small and large commercial, each requiring a very different calculation methodology. A top-down approach was used to calculate energy usage in the large commercial sector due to insufficient data to use a bottom-up approach.

Large commercial demands were calculated by subtracting the energy data from NYSERDA's Utility Energy Registry (UER) – which includes both large commercial and industrial in a single category – from the industrial demands provided by NREL's IEDB (see previous section for details). The UER presents the large commercial and industrial demands in a category named "Other", which is defined as follows:

> *Other (O): This is all non-residential rates classes not opt-out eligible for opt-out Community Choice Aggregation in New York. These are typically large commercial and industrial rate classes on demand meters.*

The UER dataset only includes natural gas and electricity. There is only one year where the UER and IEDB datasets overlap, the year 2016. Since the UER withholds some data due to privacy concerns, and, as a result, reports a lower amount of energy usage than actually consumed, the calibration factor was applied to the UER data prior the calculation.

Calibration of large commercial energy use

The calibration of large commercial was combined with small commercial since actual commercial demands were not disaggregated. Refer to Section 1.3.1.2 for calibration factors.

1.3.1.5 Transport

As shown in Table 6, the transport sector is divided into On-Road, Non-Road and Off-Road transport, with the energy and emissions calculations described below.

On-road transport

A bottom-up estimate of fuel demands was made for on-road transport. The inventory includes on-road transport energy data for the years 2010 to 2017. The on-road vehicle classes shown in Table 6 are further disaggregated by vehicle type and fuel (see Table 13).

Table 13: On-road transport vehicle types and fuels

Vehicle Class	Vehicle Type*	Fuel*
- Cars - Light passenger trucks - Light commercial trucks - Medium trucks - Heavy duty single unit trucks - Heavy duty combination trucks - Private Buses - Public Buses - Motorcycles	Gasoline	Gasoline
		Ethanol
	Flex	Gasoline
		Ethanol
	Electric Battery	Electricity
	Electric Plug In	Electricity
		Gasoline
	Propane	Propane
	Diesel	Diesel
	Compressed Natural Gas	Compressed Natural Gas

*Note: the same vehicle types and fuels are repeated for each vehicle class

The following equation is used to determine the energy consumed by each vehicle class:

$$Fuel\ Consumption_{\text{Class, Type, Fuel}} = \#\ \text{of}\ Vehicles_{\text{class}} \times VehicleMiles_{\text{class}} \times \%type_{\text{class, type}} \times (1/FE_{\text{class, type}}) \times \%fuel_{\text{class,type, fuel}}$$

Where:

- **Fuel Consumption**$_{\text{class, type, fuel}}$ = Total amount of fuel used in gallons
- **#Vehicles**$_{\text{class}}$ = Number of registered vehicles for each vehicle class is from the New York Department of Transportation (NY DOT), except for public buses which is from the Federal Transit Administration's (FTA's) National Transit Database (NTD) (2022).
- **VehicleMiles**$_{\text{class}}$ = Total community-wide miles travelled summed across a vehicle class using traffic data from the U.S. Department of Transportation (US DOT) and NY DOT, except the data for public buses is from the FTA's NTD (2022).
- **%type**$_{\text{class,type}}$ = Fraction of vehicle class made up by the specific vehicle type (%) from the NY DOT.
- **FE**$_{\text{class, type}}$ = Fuel economy for the specific vehicle type expressed in miles/gallon from the U.S. Environmental Protection Agency (EPA) and the US DOT.
- **%fuel**$_{\text{class,type,fuel}}$ = Fraction of fuel share by vehicle type (%). Electric plug-in vehicles are separated into electric and gasoline portion. It is assumed that PHEV's run on electricity 55% of the time. Also, according to the NY GHG Guidance document, all conventional gasoline is assumed to be a 10% blend of ethanol, and carbon emissions associated with ethanol are considered biogenic.

A detailed report from Orebed Analytics in **Appendix C** includes the data sources and calculations used for determining the number of vehicles, vehicle miles travelled, fuel economy and percent share of vehicle types and fuels used. This report provided data for all bus types together, therefore adjustments were made to separate out private and public buses. The total

number of buses from Orebed Analytics' report was subtracted by the number of public buses reported by the FTA's National Transit Database to determine the number of private buses. The same was done for vehicle miles.

Non-road transport

As shown in Table 6, the non-road sector includes rail, airport, and marine transport. In the model, non-road transport is further disaggregated, as shown in the following table.

Table 14: Detailed non-road transport included in LEAP model

Subsector	Type	Subtype (fuel)
Rail	Locomotive	Class I line haul (diesel)
		Class II and III line haul (diesel)
		Amtrak passenger (diesel)
	Railroad maintenance	Railway maintenance (four-stroke gasoline)
		Railway maintenance (diesel)
		Railway maintenance (LPG)
Airport	Operational	Support equipment (four-stroke gasoline)
		Support equipment (diesel)
		Support equipment (LPG)
	Aircraft Landing/Takeoff	Commercial (jet kerosene)
		Air Taxi Piston (aviation gasoline)
		Air Taxi Turbine (jet kerosene)
		General Aviation Piston (aviation gasoline)
		General Aviation Turbine (jet kerosene)
		Military (jet kerosene)
Marine	Pleasurecraft	Outboard (diesel)
		Inboard Sterndrive (diesel)
		Inboard Sterndrive (four stroke gasoline)
		Personal Water Craft (two stroke gasoline)
		Outboard (two stroke)
	Commercial Marine Vessels	C1C2 Port Emissions Main Engine (diesel)
		C1C2 Port Emissions Auxiliary Engine (diesel)
		C1C2 Underway Emissions Main Engine (diesel)
		C1C2 Underway Emissions Auxiliary Engine (diesel)
		C3 Underway Main Engine (diesel)
		C3 Underway Auxiliary Engine (diesel)

Rail

Rail is disaggregated into two sectors: locomotives and railroad maintenance. Locomotives are further divided into three categories: Class I line haul, Class II/III line haul and Amtrak, all which use diesel to run. Data was obtained for the years 2002 and 2017. The 2002 data was taken from NYSERDA's 2002 Locomotive Survey for New York State (NYSERDA 2007) which reports fuel consumption by county for Class I locomotives and Amtrak trains, and emissions data and emissions factors for Class II and III locomotives. The quantity of energy consumed by Class I

and III locomotives was estimated by dividing their total emissions by the emissions factor for nitrogen oxides[11].

The 2017 fuel consumption data for locomotives was back calculated from the emissions and emission factors reported for non-point sources in the US EPA's 2017 National Emissions Inventory (US EPA 2019b; US EPA 2020b)[12].

Airport

Airport emissions are associated with operating the airport and aircraft landing and takeoff (Scope 1 emissions). Emissions related to airplane travel (cruise emissions) has not been incorporated at the time of writing the report. The U.S. Bureau of Transportation Statistics appears to have annual air carrier statistics with mileage on flights originating in the Genesee-Finger Lakes region. However, additional carrier information would be needed to know the type of aircraft, fuel and fust combustion intensity.

Fuel consumption and emission factors for airport operations were obtained from the US EPA's MOVES3 model for non-road sources (US EPA 2021) for the years 1990 through 2050. Data was extracted across 5-year intervals. MOVES3 reports three different fuels consumed for airport support equipment including gasoline, diesel and LPG. The emissions factor changes slightly year to year.

The aircraft landing and take-off (LTO) cycle is the basis for calculating aircraft emissions around airports. Shown in Figure 4, the LTO cycle consists of all activities near the airport that occur below the altitude of 3,000 ft (1,000 m) including taxi-in and out, take-off, and landing. Cruise consists of the activities that occur above 3,000 ft (1,000 m) including the climb to cruise altitude, cruise, and descent from cruise altitudes. Cruise emissions are currently not included in the emissions inventory.

[11] Fuel consumption was estimated by dividing the total emissions by the emissions factor for nitrogen oxides. An emissions factor for another pollutant could also have been used and would have given the same result.
[12] See footnote 6

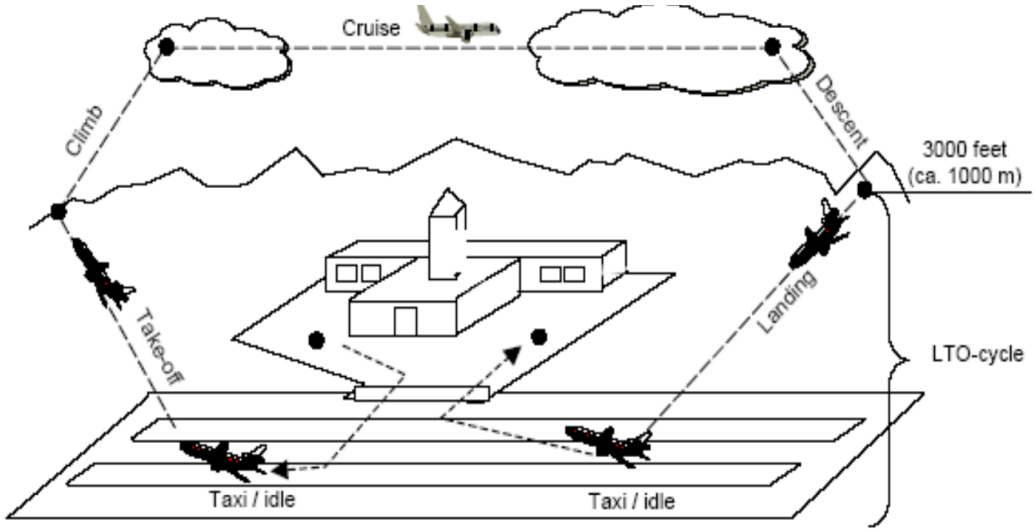

Figure 4: Aircraft landing and take-off cycle (Figure taken from: US EPA 2020)

Fuel consumption related to aircraft operations is calculated by multiplying the number of LTO cycles by the kilograms of fuel use per LTO (Total fuel use = LTO cycles x fuel use kg/LTO). The number of LTOs per aircraft type comes from the LTO database in US EPA's 2017 National Emissions Inventory (US EPA 2019a). Since this database only has data for 2017, the Federal Aviation Authority's Terminal Area Forecast was used to fill in the data between 2000 to 2045 by calculating the itinerant operations relative to 2017, and then multiplying this relative value to the 2017 LTO data to get the LTO data for all other years.

The energy intensity of 850 kg/LTO is based on the fuel use for an average domestic fleet per Table 2 in the IPCC Greenhouse Gas Inventory Reference Manual for Aircraft Emissions (IPCC 2001).[13] For this analysis, the energy intensity was assumed to only apply to commercial aviation. All other aircraft types were assumed to be a fraction of the commercial aviation fuel burn per hour data.[14] First, the weighted average fuel burn per hour for commercial aircraft was calculated to be 958 gal/hr based on fuel burn and block hour data in Tables 3-5, 3-6, 3-7, 3-8 of FAA's 2021 report on Economic Values for Evaluation of FAA Investment and Regulatory Decisions (FAA 2021). In comparison, Table 3-8 of the FAA report lists the average fuel burn of a piston engine at 45 gal/hr and a turbine engine at 71 gal/hr based on a turbopprop engine under 20 seats (FAA 2021). In the absence of better data, the average fuel burn of military

[13] This is a very conservative estimate of energy intensity as it assumes that fuel consumption per LTO has remained the same since 2001 (i.e., the date of the IPCC report).

[14] This assumes that the ratio of LTO fuel consumption to cruise fuel consumption is constant across all aircraft engine classes.

aircraft is assumed to be the same as commercial aircraft. The resulting energy intensity for each aircraft type is shown in the following table:

Table 15: Aircraft Energy Intensity

Aircraft type	Energy Intensity in kg/LTO
Commercial	850
Air Taxi Piston	850 x (45/958)
Air Taxi Turbine	850 x (71/958)
General Aviation Piston	850 x (45/958)
General Aviation Turbine	850 x (71/958)
Military	850

Marine

Marine includes pleasurecraft and commercial marine vessels.

Similar to railroad maintenance, fuel consumption for pleasurecraft were obtained from the US EPA's MOVES3 model for non-road sources (US EPA 2021) for the years 1990 through 2050. MOVES3 reports the following types of pleasurecraft:

- Outboard (two-stroke gasoline and diesel)
- Inboard sterndrive (four-stroke gasoline and diesel)
- Personal watercraft (two-stroke gasoline)

Data was extracted from MOVES3 across 5-year intervals. The 2017 fuel consumption data for commercial marine vessels was back calculated from the total emissions and emissions factors reported for non-point sources in the US EPA's 2017 National Emissions Inventory (US EPA 2020c; US EPA 2020b)[15]. The NEI reports the following commercial marine vessels:

- Category 1 (< 7 L/cyl) and Cateory 2 (7 to 30 L/cyl) Port Emissions Main Engine
- Category 1 (< 7 L/cyl) and Cateory 2 (7 to 30 L/cyl) Port Emissions Auxiliary Engine
- Category 1 (< 7 L/cyl) and Cateory 2 (7 to 30 L/cyl) Underway Emissions Main Engine
- Category 1 (< 7 L/cyl) and Cateory 2 (7 to 30 L/cyl) Underway Emissions Auxiliary Engine
- Category 3 (≥ 30 L/cyl) Underway Emissions Main Engine
- Category 3 (≥ 30 L/cyl) Underway Emissions Auxiliary Engine

All C1/C2/C3 vessels are assumed to be Tier 0 (made before 2004).

Off-road transport

[15] See footnote 6

According to the NY GHG Guidance document, off-road transport includes "agricultural machinery, construction and maintenance vehicles, lawn and garden equipment, and other equipment that uses transportation fuels but do not operate on roads". Any fuels purchased within the agricultural and industrial (construction, mining and manufacturing) sectors have already been included in the agricultural and industrial sector emissions. The off-road transport sector in the model includes recreational vehicles such as:

- All terrain vehicles (two-stroke and four-stroke gasoline)
- Off-road motorcycles (two-stroke and four-stroke gasoline)
- Specialty vehicle carts (two-stroke and four-stroke gasoline, diesel, LPG)
- Snowmobiles (two-stroke gasoline)
- Golf carts (four-stroke golf carts)

Energy consumption was estimated by dividing the total emissions by the emissions factor obtained from the US EPA's MOVES3 model (US EPA 2021c) for the years 1990 through 2050. Data was extracted across 5-year intervals. The emissions factor changes slightly year to year.

Calibration of transport energy demands

NYSERDA's Patterns and Trends report (NYSERDA 2021b) provides data on gasoline sales for the years 1995 to 2017 for each county and is used to calibrate transport demands using the calibration factors given in Table 16. Usage data for other transport fuels was not readily available.

Table 16: Transport gasoline calibration factors by county

County	2010	2011	2012	2013	2014	2015	2016	2017
Monroe	1.15	1.14	1.12	1.13	1.14	1.13	1.14	1.16
Genesee	1.36	1.30	1.29	1.33	1.46	1.46	1.42	1.49
Seneca	1.08	1.57	1.54	1.38	1.44	1.53	1.77	1.80
Yates	0.93	0.92	0.90	0.90	0.96	0.94	0.91	0.97
Wyoming	1.18	1.14	1.16	1.18	1.24	1.23	1.20	1.22
Wayne	1.11	1.12	1.13	1.16	1.27	1.26	1.25	1.29
Orleans	0.95	0.95	0.96	0.96	1.05	1.04	0.98	1.04
Livingston	1.26	1.30	1.32	1.32	1.41	1.35	1.30	1.32
Ontario	1.10	1.11	1.11	1.08	1.12	1.09	1.08	1.20

1.3.1.6 Solid Waste (Landfills) and Wastewater

All energy-related solid waste and wastewater treatment plant emissions and fuel consumption data for 2010 to 2019 was obtained from the US EPA's Facility Level Information on

GreenHouse Gases Tool (FLIGHT)[16]. All large landfills in the region have landfill gas recovery systems. The recovered landfill gas is either flared or used to generate electricity through international combustion engines. The Seneca Meadows Landfill Gas to Energy (LFGTE) facility also converts landfill gas to renewable natural gas (RNG). The RNG is purchased by the Sacramento Municipal District.

For the High Acres Landfill and Recycling Center, landfill gas emissions in the inventory do not match up exactly with what was reported due to changes in higher heating values between equipment and across years. Also, landfill gas appears to be called biogas in the years before 2012.

Table 17: Comparison of landfill capacity between Genesee-Finger Lakes region and state-wide (large landfills only)

Facility Name	County	2018 Waste Quantity (tons)	Existing Annual Permit Limits (tons/year)	Existing & Planned Capacity Under Permit (tons)	Proposed Capacity Not Under Permit (tons)
High Acres West. Exp. LF	Monroe	938,719	1,074,500	41,777,500	
Mill Seat SLF	Monroe	572,948	598,650	29,124,000	
Ontario County SLF	Ontario	914,393	920,693	6,679,796	
Seneca Meadows LF	Seneca	2,163,293	2,190,000	10,589,393	
Total in Genesee-Finger Lakes		4,589,353	4,783,843	88,170,689	
Total across New York State		**9,579,688**	**11,196,833**	**213,371,486**	**4,794,000**

Source: (NY DEC 2019)

1.3.1.7 Transmission and Distribution Losses

An electricity loss rate for New York was determined using data from the US EIA State Electricity Profiles[17]. Table 10. Supply and disposition of electricity, 1990 through 2019. It was calculated by dividing estimated losses by total electric industry retail sales for the years 1990 through 2019. The electricity loss rate was found to decline over time, from 9.7% in 1990 to 8.2% in 2010 and 6.8% in 2019.

1.3.1.8 Fugitive Emissions

A natural gas loss rate of 3.6% is taken from a recent study by Howarth (2020) on methane emissions in New York. The loss rate represents methane losses from the production, gathering, processing, transmission, and storage of natural gas.

[16] US EPA Flight tool available at https://ghgdata.epa.gov/ghgp/main.do

[17] US EIA State Electricity Profiles: New York (https://www.eia.gov/electricity/state/NewYork/)

1.3.2 Historical non-energy related emissions

Non-energy emissions are broken down in the model by economic sector, subsector and emissions. The level of detail in each sector depends on the data available to the project team. Table 18 lists the sectors and subsectors represented in the non-energy inventory.

Table 18: Non-energy Sectors and Subsectors

Sector	Subsector Level 1	Subsector Level 2
Industrial Processes	Cement Production	
	Limestone and Dolomite Consumption	
	Soda Ash Consumption	
	Ozone Depleting Substances (ODS) Substitutes	
	Iron and Steel Production	Blast Oven Furnace with coke oven
		Blast Oven Furnace w/o coke oven
		Electric Arc Furnace
	Semiconductor	
	Electricity Generation	
	Urea Consumption	
Agricultural	Enteric Fermentation	Dairy Cows
		Beef Cows
		Calves
		Goat
		Sheep
		Swine
		Llama
	Manure Management	Dairy Cows
		Beef Cows
		Calves
		Goat
		Sheep
		Swine
		Llama
		Layers
		Pullets
		Broilers
		Roosters
	Soil Animals	*Same as Manure Management*
	Soil Animal Runoff and Leaching	*Same as Manure Management*
	Soil Plant Residues	Alfalfa
		Corn for Grain
		All Wheat
		Barley
		Sorghum for Grain
		Oats
		Rye
		Soybeans
		Dry Edible Beans
		Dry Edible Peas
		Red Clover

Sector	Subsector Level 1	Subsector Level 2
		Crimson Clover
	Soils Plant Residue Burning	Corn for Grain
		All Wheat
		Barley
		Soybeans
	Soils Liming and Urea Fertilization	Limestone Use
		Dolomite Use
		Urea Fertilizer
	Soil Plant Fertilizers	Synthetic
		Dried Blood
		Compost
		Dried Manure
		Activated Sewage Sludge
		Other Sewage Sludge
		Tankage
		Other
	Soils Plant Fertilizers Runoff and Leaching	*Same as Soil Plant Fertilizers*
Solid Waste		
Wastewater		
Land Use Sequestration	Harvested Wood Products	
	Forest Remaining Forest	
	Land Converted to Forest	
	Wetland	
	Urban Trees	
Land Use Emissions	Forest Converted to Land	
	Forest Fires	

The following sections provides the data sources used to calculate non energy-related emissions in each sector.

1.3.2.1 Industrial

Industrial non-energy emissions were calculated using the methodology set forth in the US EPA's State Inventory and Projection Tool (SIT) Industrial Processes Module (US EPA 2017). Full details are provided in Table 19.

Table 19: Data sources and emissions factors for the industrial non-energy emissions calculations

SIT Industrial Processes Module	Occurs in region?	Emissions calculation methodology	Emissions Factor from SIT
Cement production	Yes	State cement clinker production data from SIT (REF) allocated to each county based on the number of employees employed in the sector according to the Census (NAICS 3273)[1]. Clinker production multiplied by emissions factor. Cement kiln dust emissions	Clinker = 0.507 MtCO2 Emitted / Mt of Clinker Produced Cement Kiln Dust = 0.020 MT CKD CO2 Emitted / MT of Clinker CO2 Emitted

SIT Industrial Processes Module	Occurs in region?	Emissions calculation methodology	Emissions Factor from SIT
		calculated based on clinker emissions.	
Lime manufacture	No	-	
Limestone and dolomite consumption	Yes	State limestone and dolomite combined usage and production data from SIT (REF) separated using US-level usage to production ratio (US EPA 2017). The resulting state-wide usage data was allocated to each county based on number of employees employed in the sectors that use limestone, including iron and steel mills (NAICS 331110) and glass manufacturing (NAICS 32721)[1,2]. The usage data is multiplied by the emissions factor.	Limestone = 0.440 MT CO2 Emitted / MT Limestone used (Calcite) Dolomite = 0.484 MT CO2 Emitted / MT Limestone used (Dolomite)
Soda ash manufacture and consumption	Yes	Soda ash consumption for the U.S. taken from the SIT (US EPA 2017) and allocated to each county based on population (US EPA 2017; NYSERDA 2021b; Vespa et al. 2020). The usage data is multiplied by the emissions factor.	Soda ash consumption = 0.415 MT CO2 Emitted / MT Soda Ash consumed
Iron and steel production	Yes	State-wide raw steel production (US EPA 2017) allocated to each county based on total energy use in the sector (NAICS 331110) (McMillan 2019). Data was disaggregated into production method using the ratios provided in the SIT. The production data by method is multiplied by the emissions factor.	BOF with Coke Oven = 1.72 MT CO2 Emitted / MT Crude Steel Produced BOF without Coke Oven = 1.46 MT CO2 Emitted / MT Crude Steel Produced EAF = 0.08 MT CO2 Emitted / MT Crude Steel Produced
Ammonia manufacture	No	-	-
Nitric acid production	No	-	-
Adipic acid production	No	-	-
Aluminum production	No	-	-

SIT Industrial Processes Module	Occurs in region?	Emissions calculation methodology	Emissions Factor from SIT
HCFC-22 production	Unsure	-	-
Consumption of Substitutes for Ozone Depleting Substances (ODS)	Yes	Emissions from ODS substitutes for the U.S. taken from the SIT (US EPA 2017) and allocated to each county based on population (US EPA 2017; NYSERDA 2021b; Vespa et al. 2020).	n/a – downscaled emissions
Semiconductor manufacture	Yes	State-wide emissions for semiconductor manufacturing (US EPA 2017) allocated to each county based on total energy use in the sector (NAICS 334413) (McMillan 2019).	n/a – downscaled emissions
Electric Power Transmission and Distribution	Yes	SF6 consumption from electricity for the U.S. taken from the SIT (US EPA 2017) and allocated to each county based on county electricity sales/use (NYSERDA 2017; US EPA 2017). The usage data is multiplied by the emissions factor.	Electric Power = 1.0 MT SF6 Emitted / MT SF6 Consumed (Sold)
Magnesium Production and Processing	No	-	-

[1] Employment data obtained from U.S. Census County Business Patterns dataset (US Census Bureau n.d.)
[2] Other industries that use limestone / dolomite that do not exist in the region include coal mining (NAICS 2121), soda ash manufacturing (NAICS 325181) and sugar refining (31131)

1.3.2.2 Agricultural

Agricultural non-energy emissions were calculated using the methodology set forth in the US EPA's State Inventory and Projection Tool (SIT) Agricultural Module (US EPA 2017). Full details are provided in Table 20. The equations and variables used to calculate emissions are provided in **Appendix B**.

Table 20: Data sources and emissions factors for the agricultural non-energy emissions calculations

SIT Agricultural Non-Energy Module	Occurs in region?	Emissions calculation methodology	Emissions Factors
Enteric Fermentation	Yes	These are the emissions from the digestive processes of animals. The number of livestock heads for each county was obtained from USDA's National Agricultural Statistics	Emision factors in kg CH_4/head Dairy Cows = 160.2 Beef Cows = 94.3

SIT Agricultural Non-Energy Module	Occurs in region?	Emissions calculation methodology	Emissions Factors
		Service (USDA 2021). This was multiplied with an emissions factor to obtain methane emissions.	Calves[1] = 54.1 Goat = 5 Sheep = 8 Swine = 1.5 Llama[2] = 8
Manure Management (methane emissions)	Yes	These are the methane emissions from managing manure. It is calculated by multiplying the amount of volatile solids produced from each animal by an emissions factor.	See Table 36: Variables used to calculate methane emissions from manure management (2018 values from US EPA State Inventory Tool)
Manure Management	Yes	These are the nitrous oxide emissions from managing manure. It is calculated by multiplying the amount of nitrogen excreted from each animal by an emissions factor.	E1, Emissions factor for anaerobic lagoons and liquid systems = 0.001 kg N2O-N/kg N E2, Emissions factor for solid storage, drylot, and other systems = 0.02 kg N2O-N/kg N
Soil Animals	Yes	These are the nitrous oxide emissions from manure on agricultural soils. It is calculated by multiplying the amount of nitrogen excreted from each animal by an emissions factor.	E3, Emissions factor for indirect volatilization to NH3 and NOx = 0.01 kg N2O N/kg N E4, Emissions factor for Ag Soils Animal Pasture = 0.02 kg N2O / kg N E5, Emissions factor for Ag Soils Animal Ground = 0.0125 kg N2O / kg N
Soil Animal Runoff and Leaching	Yes	These are the nitrous oxide emissions from runoff and leaching from livestock onto agricultural soils. It is calculated by multiplying the amount of nitrogen excreted from each animal by an emissions factor.	E6, Emission factor for Ag Soils Leaching = 0.0075 kg N2O N/kg N
Soil Plant Residues, Legumes and Histosols	Yes	These are the nitrous oxide emissions from from crop residues, and the cultivation of nitrogen-fixing crops and histosols (highly organic soils). It is calculated by	E7, emission factor for crop residues = 0.01 kg N2O N/kg N

SIT Agricultural Non-Energy Module	Occurs in region?	Emissions calculation methodology	Emissions Factors
		multiplying the amount of nitrogen in residue by an emissions factor.	
Soil Plant Residue Burning	Yes	These are the nitrous oxide and methane emissions from burning crop residues. It is calculated by multiplying the nitrogen or methane content in the burnt residue by an emissions factor.	E9, Ag Soils Burning N2O to N Emissions Ratio = 0.007 N_2O/N E10, Ag Soils Burning CH4 to C Emissions ratio = 16/12 CH_4/C
Soil Plant Fertilizers	Yes	These are the nitrous oxide emissions from the application of fertilizers. It is calculated by multiplying the volatilization rate of fertilizer by an emissions factor.	E11, Emission factor for Ag Soils Plant Direct = 0.01 kg N2O N/kg N E12, Emission factor for Ag Soils Plant Indirect = 0.01 kg N2O N/kg N
Soils Plant Fertilizers Runoff and Leaching	Yes	These are the nitrous oxide emissions from the from runoff and leaching of fertilizer in agricultural soils. It is calculated by multiplying the volatilization of fertilizer in consumed fertilizer by an emissions factor.	E6, Emission factor for Ag Soils Leaching = 0.0075 kg N2O N/kg N
Soils Liming and Urea Fertilization	Yes	These are the carbon dioxide emissions from the application of limestone and dolomite for the liming of soils and for the use of urea as fertilizer. The emissions are calculated by multiplying the application of limestone/ dolomite/urea fertilizer by an emissions factor.	EF, limestone = 0.059 tons C/tons limestone applied EF, dolomite = 0.064 tons C/tons dolomite applied EF, urea fertilizer = 0.2 tons C/tons urea fertilizer applied
Rice cultivation	No	-	
Liming	No	-	

[1] Value is average of Beef and cattle replacements 0-12 mos

[2] Assumed to be the same as sheep

1.3.2.3 Solid Waste (Landfills)

The level of methane emissions generated from landfills less the methane recovered by recovery systems between 2010 to 2019 was obtained from the US EPA's Facility Level Information on GreenHouse Gases Tool (FLIGHT)[18].

1.3.2.4 Wastewater treatment

Non-energy emissions from wastewater treatment are divided into municipal wastewater treatment plants and septic systems. The fraction of the population using septic systems was obtained from the American Housing Survey (US Census Bureau 2019). Rochester was the only city in the Genesee-Finger Lakes region with data on the share of housing units using septic systems of 18.6%.

For the population connected to municipal wastewater treatment systems, wastewater non-energy emissions were calculated using the methodology set forth in the US EPA's State Inventory and Projection Tool (SIT) Wastewater Module (US EPA 2017).

Methane emissions from septic systems were calculated using the approach taken in the NY GHG Inventory (NYDEC 2022a) whereby a default emission factor of 10.7 g CH_4 per person per day from Leverenz et al. (2010) was applied.

1.3.2.5 Land Use

The main categories of land use emissions are harvested wood products and forest ecosystems. Per Table 18, in our model, the land use sector is divided into Land Use Emissions (positive emissions) and Land Use Sequestration (negative emissions) but are reported together in the results section. To estimate land use emissions (both positive and negative) for the counties in the Genesee-Finger Lakes region, emissions were downscaled from the state level results as reported in the NY GHG Inventory's Waste Sector Report (NYDEC 2022a). The various land use categories and approach used for downscaling are described as follows:

Land use that sequesters carbon:

- **Harvested wood products (HWPs)** are wood-based materials harvested from forests and continue to sequester carbon through products like plywood, paper or wood for fuel and can be used to build houses or furniture. HWP emissions were downscaled based on the sawmill capacity in each county compared to the state's sawmill capacity using data reported by the NY Department of Conservation (NYDEC 2017).
- **Forest Remaining Forest (FRF)** emissions considers the changes in carbon stock and emissions of non-CO_2 gases from five carbon pools including aboveground biomass,

[18] US EPA GHG FLIGHT tool available at https://ghgdata.epa.gov/ghgp/main.do

belowground biomass, dead wood, litter, and soil organic matter (IPCC 2003) . The total FRF emissions across all pools were downscaled based on the amount of forest area in each county compared to the state using GIS data from the 2019 National Land Cover Dataset (MRLC 2022b). This includes deciduous, evergreen and mixed forests.

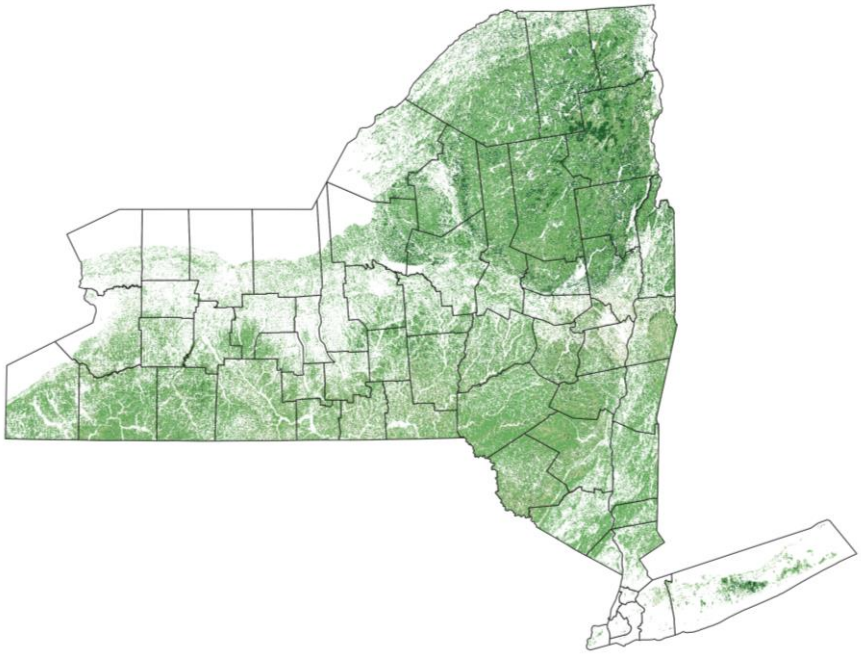

Figure 5: Deciduous, Coniferous and Mixed Forests in New York (Source: 2019 National Land Cover Dataset)

- **Land Converted to Forest (LCF)** emissions considers the sequestration of carbon through the conversion of managed lands (i.e., cropland, settlements, wetlands, other lands) to forests by afforestation and reforestation. The LCF emissions across all pools were downscaled based on the amount of land use change in each county compared to the state using GIS data from the 2019 National Land Cover Change Index Dataset (MRLC 2022a). This includes changes to/from any type of forest.

- **Urban trees** are located in settlements (developed areas) and are an important source of carbon sequestration. Emissions from urban trees were downscaled based on the amount of developed areas in each county compared to the state using GIS data from the 2019 National Land Cover Dataset (MRLC 2022b). This includes low-, medium- and high-intensity developed areas.

- **Wetlands**, particularly vegetated wetlands, are effective at sequestering carbon and storing it in plants and soils. Net emissions from wetlands were downscaled based on the wetland area in each county compared to the state using GIS data from the

2019 National Land Cover Dataset (MRLC 2022b). This includes woody wetlands and emergent herbaceous wetlands.

Land use that emits carbon:

- **Forest Converted to Land (FCL)** emissions considers the release of carbon through the conversion of forests to managed lands (i.e., cropland, settlements, wetlands, other lands) by deforestation. The FCL emissions across all pools were downscaled based on the amount of land use change in each county compared to the state using GIS data from the 2019 National Land Cover Change Index Dataset (MRLC 2022a). This includes changes to/from any type of forest.

- **Forest fires** result in the release of greenhouse gas emissions. Forest fire emissions were downscaled based on the amount of forest area in each county compared to the state using GIS data from the 2019 National Land Cover Dataset (MRLC 2022b). This includes deciduous, evergreen and mixed forests.

1.3.3 Projected emissions (baseline scenario)

Projections in the LEAP model are arranged into *scenarios*. A scenario is an internally consistent, physically plausible storyline that describes how the economy, energy system, pollutant emissions, and costs might evolve over time—in other words, a possible future. In LEAP, scenarios are developed in a hierarchy allowing each scenario to inherit assumptions from another scenario. In this way, a scenario can mirror a pre-existing scenario except for a few key parameters, isolating the effects of these changes.

The core scenario is the baseline scenario. The baseline scenario in this model extends to 2050, which is consistent with the end date specified for the state-wide emissions reduction targets per the CLCPA. It envisions a future in which no significant new mitigation policies are enacted and historical trends in key drivers of energy use and emissions continue. The other scenarios to be completed in Phase 2 of the project are mitigation scenarios, which inherit data from the baseline scenario and are measured in comparison to it. Two types of mitigation scenarios are considered: scenarios that add one discrete mitigation option to the baseline ("mitigation mini-scenarios") and scenarios that combine multiple mini-scenarios into a portfolio of mitigation options ("combined mitigation scenarios"). This arrangement facilitates the analysis of particular mitigation options in isolation, as well as their potential interactions with other options. The mitigation scenarios will be assessed in Phase 2.

In the model, projections of future energy and non-energy demands depend on forecasted activity levels of population, vehicle use, crop area, and other sector-dependent activities. Table 21 identifies the activity for sectors and subsectors where projected demands are calculated by activity analysis.

Table 21: Activity Levels in Final Energy and Non-Energy Emissions Projection

Sector/Subsector	Activity
Energy	
Residential	Population
Small/Large Commercial	n/a – projects historical energy use
Industrial	n/a – projects historical energy use
Agricultural	n/a – projects historical energy use
Transport – on-road	Number of vehicles & vehicle miles travelled
Transport – non-road	n/a – projects historical energy use
Transport – off-road	n/a – projects historical energy use
Solid Waste	n/a – projects historical energy use
Wastewater	n/a – projects historical energy use
Transmission Losses	Electricity Demands
Fugitive Emissions	Natural Gas Demands
Non-Energy	
Non-energy industrial processes	
Cement Production	Cement Production
Limestone/Dolomite	Limestone Consumption Dolomite Consumption
Soda Ash	Soda Ash Consumption
ODS Substitutes	n/a – projects historical emissions
Iron and Steel	Iron and Steel Production
Semiconductors	n/a – projects historical emissions
Electricity Generation	Electricity Generation
Urea Consumption	Urea Consumption
Non-energy agricultural processes	
Enteric Fermentation **Manure Management** **Soil Animals** **Soil Animal Runoff and Leaching**	Number of Livestock
Soils Plant Residues **Soils Plant Residue Burning**	Crop production
Soils Plant Fertilizer **Soil Plant Fertilizers Runoff and Leaching**	Fertilizer Consumption
Soils Liming and Urea Fertilization	Limestone use Dolomite use Urea fertilizer use
Non-energy waste processes	
Solid waste	n/a – projects historical emissions
Wastewater	Population
Land use processes	
Harvested wood products	n/a – projects historical emissions
Forest Remaining Forest	n/a – projects historical emissions
Land Converted to Forest	n/a – projects historical emissions
Forest Converted to Land	n/a – projects historical emissions
Forest fires	n/a – projects historical emissions
Urban Trees	n/a – projects historical emissions
Wetlands	n/a – projects historical emissions

Population projections are from the Cornell Program on Applied Demographics (2017). This projection does not include increased migration into the region from climate refugees. All other projections are estimated from historical growth rates. Growth rates were constrained to +1.75/-1.25% to avoid excessive positive or negative changes in emissions over time. These growth rate constraints are in-line with the average annual change in emissions across sectors.

Table 22: Population projections by county

County	2010	2020	2030	2040	2050[1]
Genesee	60,079	57,756	56,077	54,128	52,179
Livingston	65,393	64,054	63,726	63,954	64,182
Monroe	744,344	754,529	758,536	751,581	744,636
Ontario	107,931	111,349	114,374	114,770	115,166
Orleans	42,883	40,529	38,967	37,431	35,895
Seneca	35,251	34,724	34,487	33,850	33,213
Wayne	93,772	89,564	86,754	83,088	79,422
Wyoming	42,155	40,057	38,647	37,766	36,885
Yates	25,348	24,787	24,706	24,857	25,008
Total	**1,217,156**	**1,217,349**	**1,216,274**	**1,201,425**	**1,186,586**

Source: Cornell Program on Applied Demographics (2017)
[1] Estimated

Table 23: Household projections by county (estimates)

County	2010	2020	2030	2040	2050
Genesee	25,409	26,068	27,011	27,825	28,626
Livingston	26,774	28,084	29,919	32,154	34,555
Monroe	318,793	334,395	347,863	356,662	365,657
Ontario	47,290	51,879	56,665	60,464	64,517
Orleans	18,300	18,754	19,552	20,366	21,177
Seneca	15,810	16,821	18,045	19,131	20,274
Wayne	40,825	41,820	43,445	44,626	45,750
Wyoming	17,876	18,332	19,088	20,130	21,218
Yates	13,303	13,849	14,695	15,739	16,857
Total	**524,380**	**550,002**	**576,284**	**597,097**	**618,632**

The effects of climate change upon space heating and cooling demands in the residential and commercial sectors are incorporated into the baseline projection. Cooling and heating degree

day data for Rochester, NY between 2010 and 2020 were taken from Oikolab[19]. The average annual change in cooling and heating degree days was calculated relative to 2015, the year of the U.S. EIA Residential Energy Consumption Survey and applied to the energy intensity of space heating and air conditioning technologies in the residential sector. For the commercial sector, since a top-down analysis of energy demands was used, we needed to first estimate space heating and air conditioning demands prior to adjusting the demands based on climate change. Space heating demands were estimated to be 2.2% of natural gas consumption and air conditioning demands 9.0% of electricity consumption based on NYSERDA's Commercial Baseline Study (NYSERDA 2019a).

2 Emissions inventory results and discussion

This section presents selected results from the emissions inventory and baseline scenario at the regional and county scales, and across different sectors, fuels and greenhouse gases. Additional results can be generated upon request.

The results are reported in gross and net emissions. In accordance with the CLCPA guidelines, gross emissions include biogenic CO_2. Net emissions consider net emissions removals from the land use sector and omits biogenic CO_2.

2.1 Regional emissions

Table 24 provides a detailed summary of regional emissions both historically and under baseline projections. Figure 6 to Figure 10 illustrates the region-wide emissions in different ways – type of emissions, sector, fuel, greenhouse gas and global warming potential.

The results show a slight reduction in gross emissions during the historical period from 29.9 million metric tons of carbon dioxide equivalent ($MMtCO_2e$) in 2010 to 29.0 $MMtCO_2e$ in 2018. This decrease is from the decline in industry in the early 2010s as well as a shift to cleaner forms of electricity production. The baseline projection shows that emissions will increase to 30.9 $MMtCO_2e$ in 2050 from growth in the agricultural, industrial and commercial sectors.

Overall, historical emissions are largely from consuming energy rather than non-energy emissions. However, non-energy emissions from agricultural and industrial processes are still high making up 31% of the total emissions in 2018. Average net emissions removals from harvested wood products, land use change and forestry during the historical period are around -1.7 $MMtCO_2e$, or 5.7% of gross emissions. In the baseline projection, land use and forestry-

[19] https://climate-explorer.oikolab.com/climate-explorer

related activities will reduce emissions by -1.6 $MMtCO_2e$ on average, or by 5.2% of gross emissions.

Between the different sectors, transport-related emissions are the highest in the region at 33% of 2018 emissions, followed by agricultural emissions (22%) and residential emissions (16%). Solid waste emissions represent 11% of regional emissions due to the three large landfills that make up 41% of New York's existing and proposed landfill capacity (see Table 17 for details). Generally, a similar composition of sectoral emissions are shown in the baseline projection, with slight increases in agricultural, commercial and industrial emissions, and decreases in transport and residential emissions.

The availability, accessibility and use of alternative modes of transport, including electric vehicles, is low across the region keeping transport emissions high overall. Residential energy consumption continues to be driven by space heating, in particular natural gas-based heating systems. Agricultural emissions from energy consumption are low, but non-energy emissions, particularly from dairy farming, make up most of the emissions from this sector.

Among fuels, gasoline consumption in vehicles represents 35% of 2018 emissions. This is followed by natural gas use in the residential, commercial and industrial sectors resulting in 27% of 2018 emissions. Natural gas use appears to have jumped in 2018 compared to years prior in both the residential and commercial sectors. As discussed in Section 2.3.1, this appears to be one-time occurrence, and not part of a larger trend.

According to the 100-year global warming potentials, carbon dioxide is by far the biggest greenhouse gas emitted in the region compared to other greenhouse gases representing 72% of the share of emissions. When viewing the 20-year global warming potential, carbon dioxide emissions are reduced to 53% with methane making up a larger share of emissions (40%).

Table 24: Genesee-Finger Lakes Greenhouse Gas Emissions by Economic Sector (results in GWP20)

Sector	-Historical-				-Baseline Projection-			
	2010		2018		2030		2050	
	$MMtCO_2e$	% of total	$MMtCO_2e$	% of total	$MMtCO_2e$	% of total	$MMtCO_2e$	% of total
Transportation	9.39	31%	9.57	33%	8.93	31%	8.67	28%
On-road	8.75	29%	8.95	31%	8.26	28%	7.91	26%
Non-road	0.62	2%	0.60	2%	0.65	2%	0.73	2%
Off-road	0.02	0%	0.02	0%	0.03	0%	0.03	0%
Agricultural	5.49	18%	6.34	22%	6.88	24%	8.16	26%
Energy Use	0.20	1%	0.31	1%	0.36	1%	0.49	2%
Livestock	4.90	16%	5.58	19%	5.97	20%	6.92	22%
Soil Management	0.39	1%	0.46	2%	0.54	2%	0.75	2%
Residential	4.67	16%	4.66	16%	4.58	16%	4.38	14%
Space Heating	3.21	11%	3.24	11%	3.12	11%	2.81	9%
Water Heating	0.70	2%	0.70	2%	0.73	3%	0.79	3%
Air Conditioning	0.07	0%	0.06	0%	0.07	0%	0.09	0%

Sector	-Historical-				-Baseline Projection-			
	2010		2018		2030		2050	
Other Uses	0.68	2%	0.66	2%	0.65	2%	0.70	2%
Commercial	2.37	8%	2.60	9%	2.67	9%	3.01	10%
Large Commercial	2.00	7%	2.23	8%	2.29	8%	2.59	8%
Small Commercial	0.36	1%	0.37	1%	0.38	1%	0.42	1%
Industrial	3.62	12%	2.00	7%	2.16	7%	2.62	8%
Construction	0.27	1%	0.29	1%	0.32	1%	0.38	1%
Manufacturing	3.06	10%	1.45	5%	1.58	5%	1.97	6%
Mining	0.07	0%	0.07	0%	0.06	0%	0.05	0%
Processes	0.22	1%	0.20	1%	0.21	1%	0.22	1%
Waste	3.75	13%	3.22	11%	3.40	12%	3.42	11%
Solid Waste	3.16	11%	2.63	9%	2.80	10%	2.84	9%
Wastewater	0.59	2%	0.59	2%	0.60	2%	0.59	2%
Losses	0.62	2%	0.62	2%	0.61	2%	0.62	2%
Electricity T&D	0.19	1%	0.15	1%	0.12	0%	0.11	0%
Fugitive Emissions	0.43	1%	0.46	2%	0.48	2%	0.51	2%
Gross Emissions Total	**29.92**		**29.02**		**29.22**		**30.88**	
Net Emission Removal	-1.69		-1.64		-1.57		-1.48	
Biogenic CO_2	0.92		0.98		0.93		0.93	
Net Emissions Total	**27.31**		**26.40**		**26.72**		**28.47**	

Note: Fuel-related emissions includes upstream emissions outside of New York State. Gross Emissions includes biogenic CO_2.

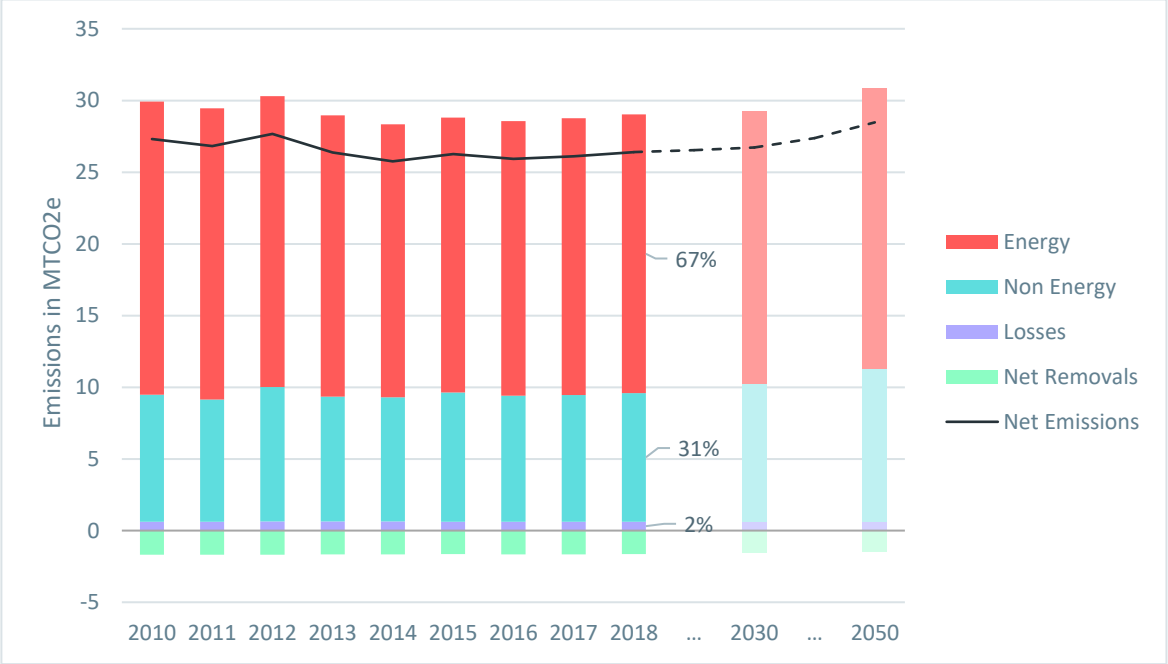

Figure 6: Historical and baseline emissions in the Genesee-Finger Lakes region by type of emissions (using 20-yr GWP)

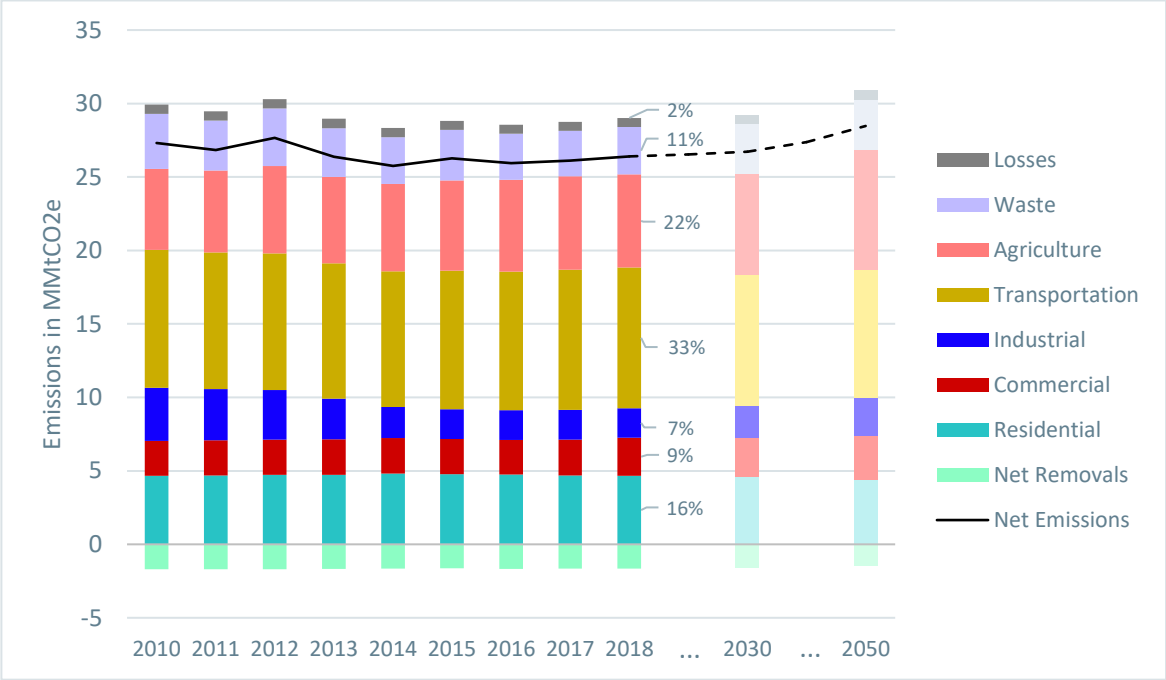

Figure 7: Historical and projected emissions in the Genesee-Finger Lakes region by sector (using 20-yr GWP)

Table 25: Genesee-Finger Lakes Greenhouse Gas Emissions by Fuel (results in GWP20)

Sector	**-Historical-**				**-Baseline Projection-**			
	2010		**2018**		**2030**		**2050**	
	$MMtCO_2e$	**% of total**	**$MMtCO_2e$**	**% of total**	**$MMtCO_2e$**	**% of total**	**$MMtCO_2e$**	**% of total**
Energy-related (Fuels)	21.06	70%	20.05	69%	19.62	67%	20.21	65%
Gasoline	6.99	23%	7.01	24%	6.14	21%	5.24	17%
Natural Gas	5.03	17%	5.42	19%	5.66	19%	5.98	19%
Diesel	2.49	8%	2.64	9%	2.95	10%	3.70	12%
Electricity	2.32	8%	2.18	8%	2.06	7%	2.27	7%
Coal Unspecified	1.67	6%	0.08	0%	0.09	0%	0.10	0%
Propane and LPG	0.80	3%	0.88	3%	0.90	3%	0.96	3%
Wood	0.47	2%	0.48	2%	0.45	2%	0.41	1%
Ethanol	0.35	1%	0.35	1%	0.30	1%	0.26	1%
Residual Fuel Oil and Kerosene	0.35	1%	0.33	1%	0.34	1%	0.36	1%
Other Fuel	0.58	2%	0.67	2%	0.75	3%	0.93	3%
Non Energy-related	8.86	30%	8.90	31%	9.60	33%	10.67	35%
Gross Emissions Total	**29.92**		**29.02**		**29.22**		**30.88**	
Net Emission Removal	-1.69		-1.64		-1.57		-1.48	
Biogenic CO_2	0.92		0.98		0.93		0.93	
Net Emissions Total	**27.31**		**26.40**		**26.72**		**28.47**	

Sector	-Historical-		-Baseline Projection-	
	2010	2018	2030	2050

Note: Fuel-related emissions includes upstream emissions outside of New York State. Gross Emissions includes biogenic CO_2.

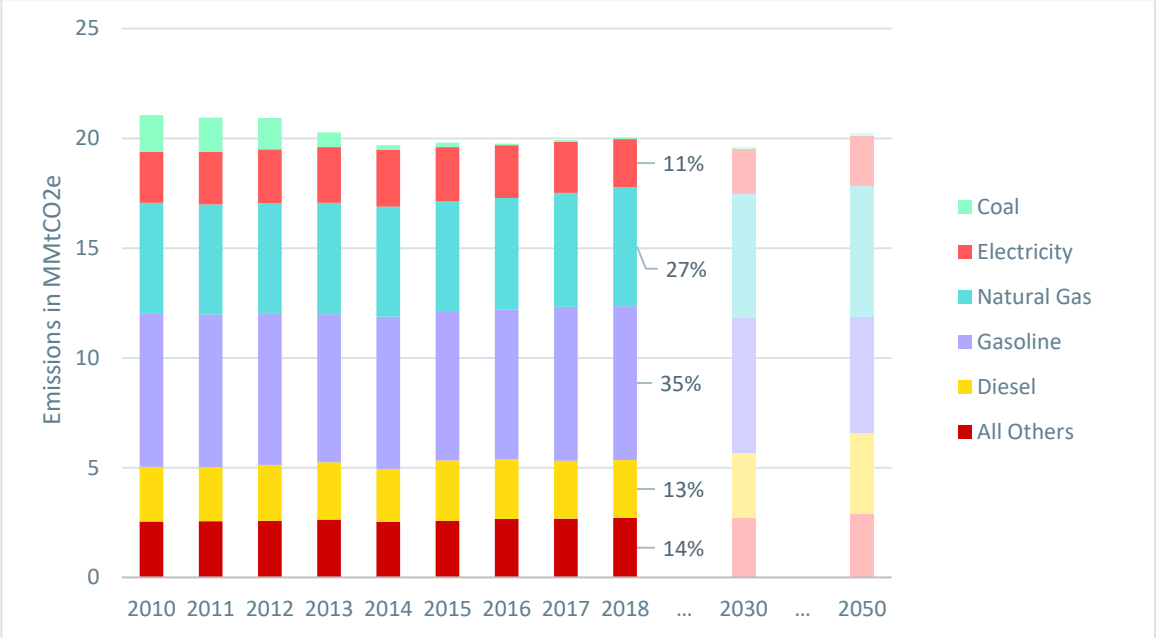

Figure 8: Historical and projected emissions in the Genesee-Finger Lakes region by fuel (using 20-yr GWP)

Table 26: Genesee-Finger Lakes Greenhouse Gas Emissions by Greenhouse Gas (results in GWP20)

Sector	-Historical-				-Baseline Projection-			
	2010		2018		2030		2050	
	MMtCO₂e	% of total	MMtCO₂e	% of total	MMtCO₂e	% of total	MMtCO₂e	% of total
GHG	29.92	100%	29.02	100%	29.22	100%	30.88	100%
CO_2 biogenic	0.92	3%	0.98	3%	0.93	3%	0.93	3%
CO_2	16.30	54%	15.41	53%	15.05	52%	15.55	50%
CH_4	11.76	39%	11.59	40%	12.12	41%	13.05	42%
N_2O	0.93	3%	1.03	4%	1.12	4%	1.35	4%
Other	<0.01	0%	<0.01	0%	<0.01	0%	<0.01	0%
Gross Emissions Total	**29.92**		**29.02**		**29.22**		**30.88**	
Net CO_2 Removal	-1.69		-1.64		-1.57		-1.48	
CO_2 biogenic	0.92		0.98		0.93		0.93	
Net Emissions Total	**27.31**		**26.40**		**26.72**		**28.47**	

Note: Fuel-related emissions includes upstream emissions outside of New York State. Gross Emissions includes biogenic CO_2.

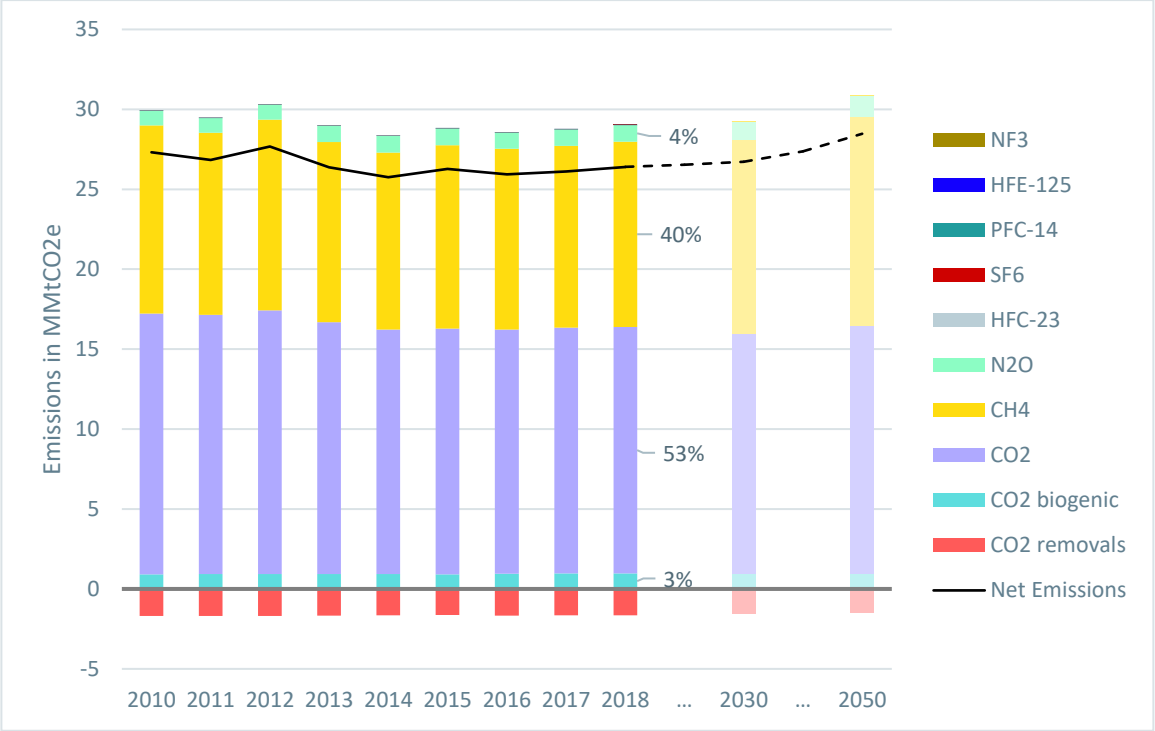

Figure 9: Historical and project emissions in the Genesee-Finger Lakes region by greenhouse gas (using 20-yr GWP)

Table 27: Genesee-Finger Lakes Greenhouse Gas Emissions by Greenhouse Gas (results in GWP100)

Sector	-Historical-				-Baseline Projection-			
	2010		2018		2030		2050	
	MMtCO₂e	% of total	MMtCO₂e	% of total	MMtCO₂e	% of total	MMtCO₂e	% of total
GHG	22.32	100%	21.53	100%	21.39	100%	22.45	100%
CO_2 biogenic	0.92	4%	0.98	5%	0.93	4%	0.93	4%
CO_2	16.31	73%	15.42	72%	15.06	70%	15.56	69%
CH_4	4.15	19%	4.09	19%	4.28	20%	4.60	21%
N_2O	0.93	4%	1.04	5%	1.12	5%	1.35	6%
Other	<0.01	0%	<0.01	0%	<0.01	0%	<0.01	0%
Gross Emissions Total	**22.32**		**21.53**		**21.39**		**22.45**	
Net CO_2 Removal	-1.70		-1.65		-1.58		-1.48	
CO_2 biogenic	0.92		0.98		0.93		0.93	
Net Emissions Total	**19.70**		**18.90**		**18.89**		**20.04**	

Note: Fuel-related emissions includes upstream emissions outside of New York State. Gross Emissions includes biogenic CO_2.

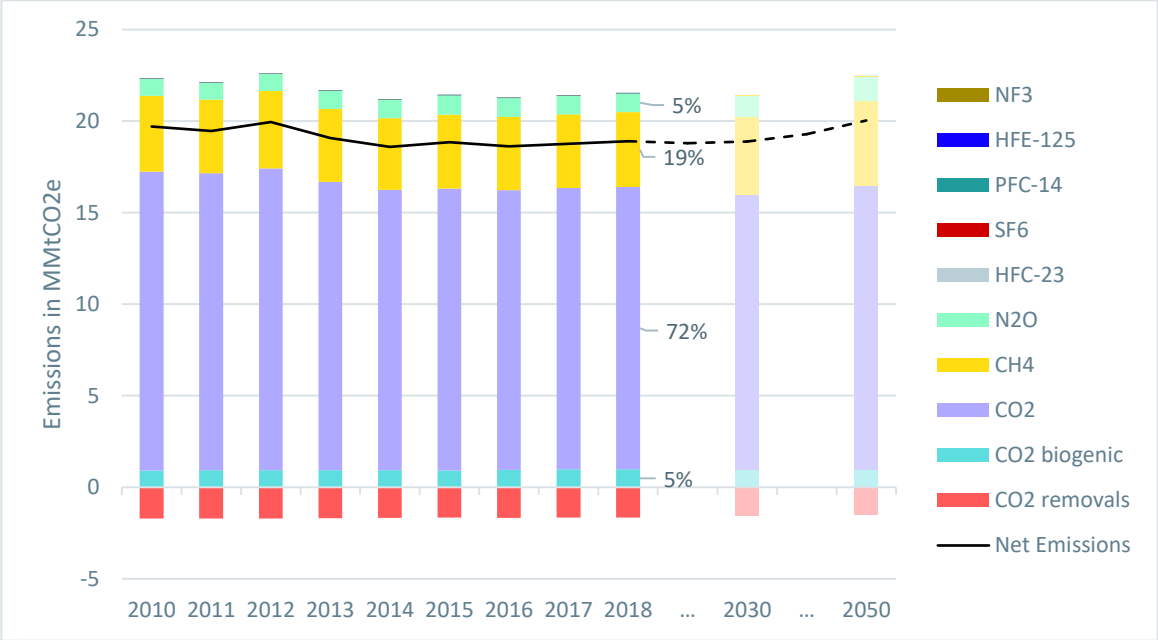

Figure 10: Historical and project emissions in the Genesee-Finger Lakes region by greenhouse gas (using 100-yr GWP)

2.1.1 Comparison to the 2013 Finger Lakes Sustainability Plan

It is important to highlight that there is slight difference in the results of the emissions inventory presented in the 2013 Finger Lakes Sustainability Plan. The 2010 emissions in the previous plan was 16.1 $MMtCO_2e$ which is slightly lower than the 17.7 $MMtCO_2e$ calculated in the current inventory when using 100-yr GWP, omitting land-use, import emissions and biogenic CO_2. There are also differences between counties and sectors. The differences between the two inventories are attributed to variations in the approach and emission factors.

2.1.2 The scale of emissions compared to other states and countries

Table 28 compares the emissions in the Genesee-Finger Lakes region to other states and countries. For comparison purposes, we use 100-yr GWP which is typically used by other countries and states for reporting emissions estimates. The comparison finds that the region's emissions are similar to states with similar population sizes, such as Rhode Island and Delaware. However, it is producing the same level of emissions as countries like Costa Rica and Benin which have significantly larger populations. Given that the remaining carbon budget is quickly diminishing, it is necessary for the region, and high-income countries in general, to take their fair share of climate action in order to avoid catastrophic climate change (Kartha et al. 2020). There are significant equity implications to this as those individuals and countries who have contributed the least to climate change will experience the most devastating climate impacts (IPCC et al. 2018). The targets set out in New York's Climate Leadership and Community

Protection Act (CLCPA) provides an indication to the level of climate action necessary in the region.

Table 28: Comparison of Genesee-Finger Lakes emissions to other geographies

Region, state or country	2018 Emissions ($MMtCO_2$ GWP100)*	Population (Millions)
Rhode Island	11.5[2]	1.1[4]
Nepal	12.0[1]	28.1[3]
Zimbabwe	12.3[1]	14.4[3]
Genesee-Finger Lakes Region	**12.8**	**1.2**
Delaware	13.3[2]	1.0[4]
Slovenia	14.1[1]	2.1[3]
Ghana	16.1[1]	29.8[3]

* CO_2 emissions in 2018 under GWP100. Excludes land use emissions, biogenic CO_2 and upstream emissions.

[1] Country CO_2 excluding Land Use, Land Use Change and Forestry (LULUCF) from CAIT (Climate Watch 2022)

[2] State CO_2 excluding LULUCF from US State Inventory (Climate Watch 2022)

[3] Country population estimates from UN DESA (2019)

[4] State population estimates from US Census Bureau (2020b)

2.2 Emissions by county

As shown in Figure 11 and Table 29, the counties with the highest populations also have the highest emissions share with Monroe County at 40% of the region's emissions, followed by Ontario County at 12%. The source of emissions varies from county to county, as illustrated in Figure 12. For example, Livingston, Wyoming and Yate's largest share of emissions is from agriculture, in particular, dairy farming. According to the US Department of Agriculture (USDA 2022), Wyoming has the highest number of cows among any county in New York State, and Yate has the highest number of dairy farms, which is likely why dairy farming emissions are so high. In the county's of Seneca and Orleans, solid waste emissions represent 45% and 25% of gross emissions. This is due to the presence of two large landfills, including the Seneca Meadows landfill in Seneca County and Orleans Sanitary Landfill in Orleans. Monroe and Wayne share similar emissions profiles whereby around 38-40% of emissions are attributed to vehicles (transport) and 21-23% of emissions to households (residential). Genesee also has a high share of transport emissions (39%) as well agricultural emissions (34%) mainly from dairy farming.

Table 29: Genesee-Finger Lakes Greenhouse Gas Emissions by County (results in GWP20)

Sector	-Historical-				-Baseline Projection-			
	2010		2018		2030		2050	
	$MMtCO_2e$	% of total	$MMtCO_2e$	% of total	$MMtCO_2e$	% of total	$MMtCO_2e$	% of total
Gross Emissions Total	**29.92**	**100%**	**29.02**	**100%**	**29.22**	**100%**	**30.88**	**100%**
Genesee	2.66	9%	3.02	10%	3.09	11%	3.34	11%
Livingston	1.98	7%	2.23	8%	2.40	8%	2.89	9%
Monroe	13.64	46%	11.29	39%	11.02	38%	10.61	34%
Ontario	3.49	12%	3.49	12%	3.78	13%	4.45	14%
Orleans	1.05	3%	1.09	4%	1.08	4%	1.16	4%

Sector	-Historical-				-Baseline Projection-			
	2010		2018		2030		2050	
Seneca	1.62	5%	2.24	8%	2.24	8%	2.59	8%
Wayne	2.10	7%	2.11	7%	2.10	7%	2.22	7%
Wyoming	2.47	8%	2.56	9%	2.56	9%	2.66	9%
Yates	0.92	3%	0.99	3%	0.96	3%	0.96	3%
Gross Emissions Total	**29.92**		**29.02**		**29.22**		**30.88**	
Net Emission Removal	-1.69		-1.64		-1.57		-1.48	
Genesee	-0.11	7%	-0.11	7%	-0.11	7%	-0.11	8%
Livingston	-0.27	16%	-0.26	16%	-0.24	15%	-0.21	14%
Monroe	-0.28	17%	-0.28	17%	-0.28	18%	-0.28	19%
Ontario	-0.23	14%	-0.23	14%	-0.21	14%	-0.20	13%
Orleans	-0.09	5%	-0.09	5%	-0.09	5%	-0.09	6%
Seneca	-0.07	4%	-0.07	4%	-0.07	4%	-0.07	5%
Wayne	-0.27	16%	-0.26	16%	-0.24	15%	-0.22	15%
Wyoming	-0.23	13%	-0.22	13%	-0.21	13%	-0.19	13%
Yates	-0.13	8%	-0.13	8%	-0.12	8%	-0.11	8%
Biogenic CO_2	0.92		0.98		0.93		0.93	
Genesee	0.07	7%	0.06	6%	0.06	6%	0.05	5%
Livingston	0.06	6%	0.06	6%	0.05	6%	0.05	5%
Monroe	0.38	42%	0.35	36%	0.31	34%	0.25	27%
Ontario	0.09	10%	0.09	10%	0.09	10%	0.08	9%
Orleans	0.04	4%	0.04	4%	0.03	4%	0.03	3%
Seneca	0.14	15%	0.23	23%	0.25	27%	0.34	37%
Wayne	0.08	9%	0.08	8%	0.07	8%	0.07	7%
Wyoming	0.03	4%	0.04	4%	0.03	4%	0.03	3%
Yates	0.03	3%	0.03	3%	0.03	3%	0.03	3%
Net Emissions Total	**27.31**		**26.40**		**26.72**		**28.47**	

Note: Fuel-related emissions includes upstream emissions outside of New York State. Gross Emissions includes biogenic CO_2.

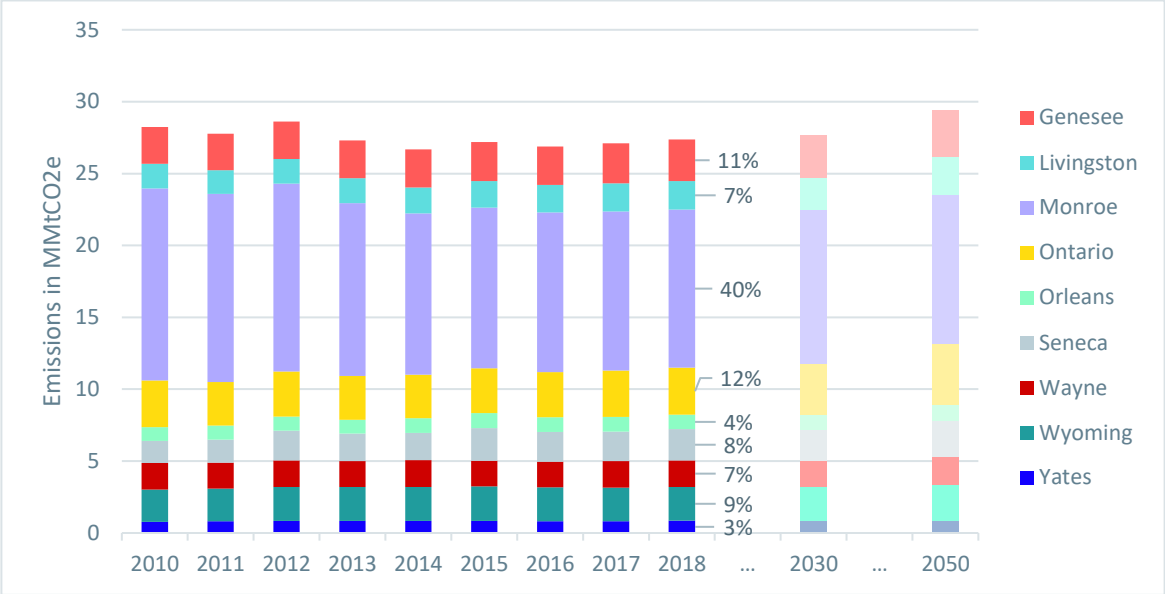

Figure 11: Net emissions by county

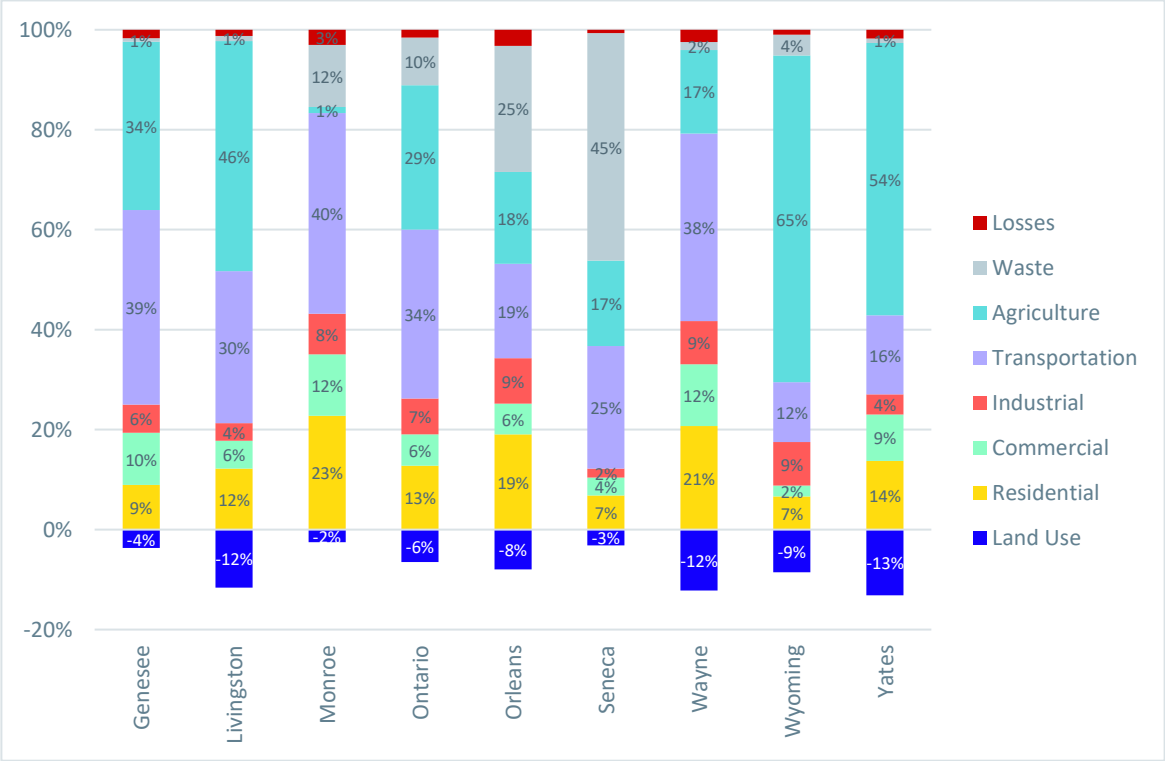

Figure 12: Sectoral share of gross emissions in each county in 2018

Note: Share of emissions is relative to the county's 2018 gross emissions.

2.3 Emissions by sector

This section takes a closer look at the emissions from each sector on a region-wide level.

2.3.1 Residential emissions

Space heating using natural gas is the dominant source of emissions in the residential sector, followed by water heating and other uses such as from appliances, lighting, electronics and more (Figure 13). Consumption of diesel, fuel oil, propane and wood such as for heating or cooking, make up around 19% of residential emissions.

Natural gas use jumps in 2018 compared to previous years. This coincides with a substantial increase in heating degree-days in the months of March, April and October in 2018 (NYSERDA 2021a)[20], suggesting that households may have kept their heating on later in the year (April) and turned it on earlier in the year (October). However, the increase in heating degree-days in 2018 does not appear to be part of a larger trend. In fact, space heating demands are expected to decrease in the baseline projection because of climate change. On the other hand, air conditioning demands are expected to increase from an increase in hotter days due to climate change. Since the emissions from electricity consumption are less than other fuels, air conditioning has a lower footprint compared to other end-uses.

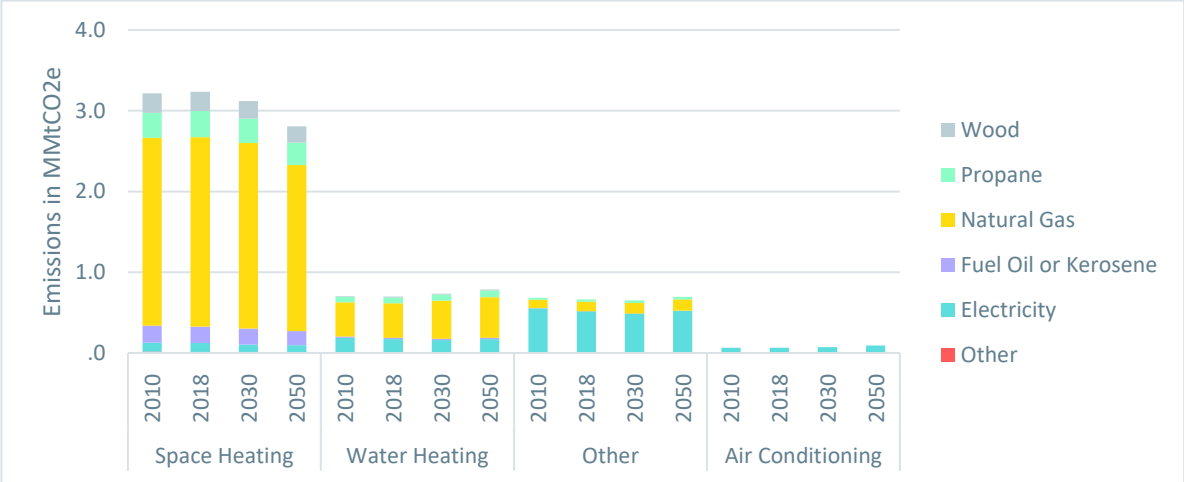

Figure 13: Historical and Projected Residential Emissions by End Use and Fuel (results in GWP20)

[20] This value for Rochester. Note that heating and cooling degree-days are indicators of heating and cooling energy needs. According to NYSERDA, heating degree days are the number of degrees the daily average temperature falls below 65° F.

Table 30: Residential sector emissions (results in GWP20)

Sector – Residential	-Historical-				-Baseline Projection-			
	2010		2018		2030		2050	
	$MMtCO_2e$	% of total	$MMtCO_2e$	% of total	$MMtCO_2e$	% of total	$MMtCO_2e$	% of total
Space Heating	3.21	68.9%	3.24	69.4%	3.12	68.2%	2.81	64.0%
Electricity	0.11	2.4%	0.11	2.3%	0.09	2.1%	0.08	1.9%
Fuel Oil or Kerosene	0.21	4.5%	0.20	4.4%	0.19	4.3%	0.18	4.1%
Natural Gas	2.33	49.8%	2.35	50.3%	2.30	50.3%	2.06	46.9%
Propane	0.31	6.7%	0.32	7.0%	0.30	6.5%	0.27	6.3%
Wood	0.24	5.1%	0.24	5.1%	0.22	4.8%	0.20	4.6%
Other	0.02	0.4%	0.01	0.3%	0.01	0.3%	0.01	0.3%
Water Heating	0.70	15.0%	0.70	15.0%	0.73	16.0%	0.79	18.0%
Electricity	0.19	4.0%	0.17	3.7%	0.16	3.5%	0.17	3.9%
Fuel Oil or Kerosene	0.01	0.3%	0.02	0.3%	0.02	0.4%	0.02	0.4%
Natural Gas	0.42	9.1%	0.43	9.2%	0.47	10.3%	0.50	11.5%
Propane	0.07	1.5%	0.07	1.5%	0.07	1.6%	0.08	1.9%
Wood	0.01	0.1%	0.01	0.3%	0.01	0.3%	0.01	0.3%
Other	0.68	14.7%	0.66	14.2%	0.65	14.2%	0.70	15.9%
Electricity	0.55	11.9%	0.52	11.1%	0.49	10.7%	0.52	11.9%
Fuel Oil or Kerosene	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
Natural Gas	0.10	2.2%	0.12	2.5%	0.13	2.8%	0.14	3.1%
Propane	0.03	0.6%	0.03	0.6%	0.03	0.7%	0.03	0.8%
Air Conditioning	0.07	1.4%	0.06	1.4%	0.07	1.6%	0.09	2.1%
Electricity	0.07	1.4%	0.06	1.4%	0.07	1.6%	0.09	2.1%
Gross Emissions Total (Residential)	**4.67**		**4.66**		**4.58**		**4.38**	
Net Emission Removal	n/a		n/a		n/a		n/a	
Biogenic CO_2	0.37		0.38		0.35		0.32	
Net Emissions Total (Residential)	**4.29**		**4.28**		**4.22**		**4.06**	

Note: Fuel-related emissions includes upstream emissions outside of New York State. Gross Emissions includes biogenic CO_2.

The majority of the Genesee-Finger Lakes' population live in older households (i.e., pre-2000) that they own. In 2018, high income households (i.e., household income of greater than or equal to 120K per year) made up roughly 35% of the region's emissions and 31% of the region's population. Generally, the emissions align with the number of households for a given household type as illustrated in Figure 14**Error! Reference source not found.**. A similar pattern of emissions is seen in the baseline projection through 2050.

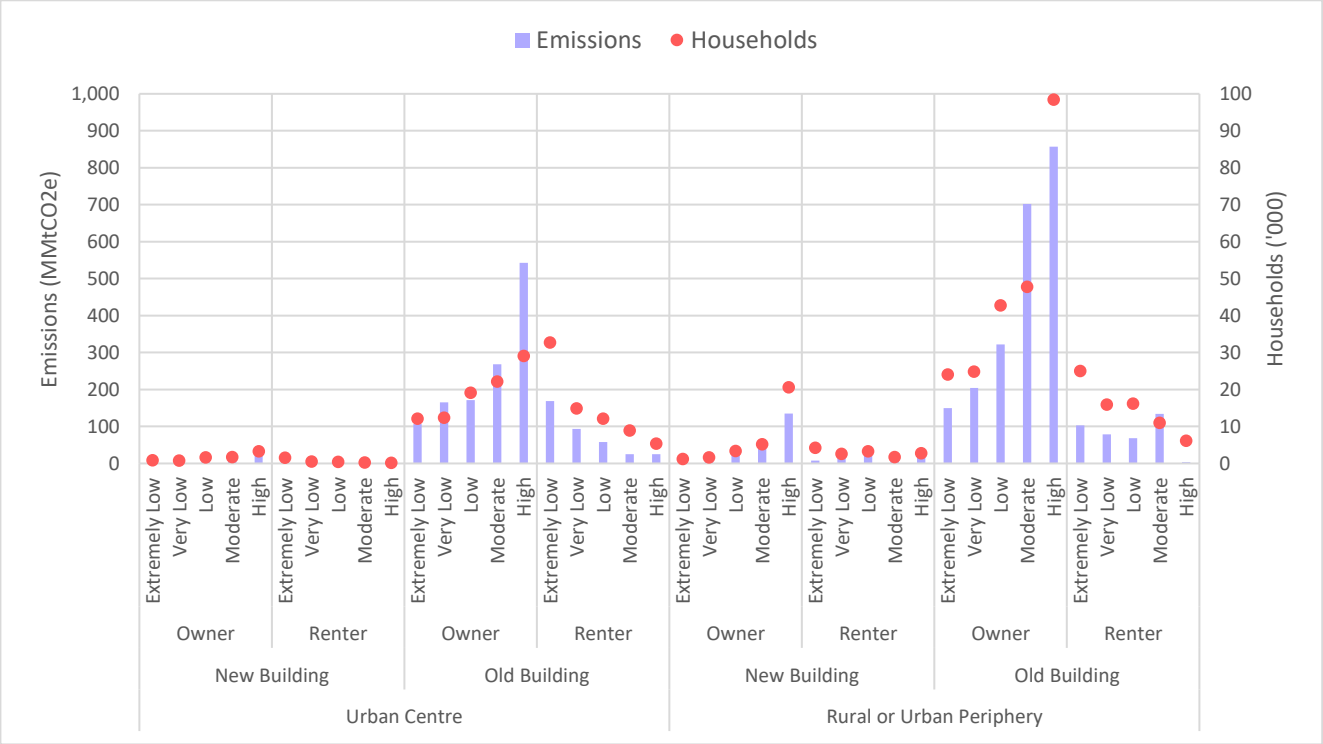

Figure 14: 2018 emissions (left axis) and number of households (right axis) by household type

The emissions under each household category are further reviewed on a per household basis in Figure 15. The results show that urban households have higher emissions compared to rural households or households in the urban periphery (i.e., suburbs). The higher footprint of urban households is attributed to high-income households using significantly more fossil-based energy for space heating compared to the average low- or moderate-income household in urban areas (12.9 $MMtCO_2e$ per high-income urban household versus an average 5.85 $MMtCO_2e$ per low- or moderate-income urban household).

Older buildings, as in buildings built before 2000, have slightly higher emissions per household compared to new buildings. This is unsurprising given that newer buildings are built under the NY State Energy Conservation Construction Code which underwent significant updates in 2002.

Owners have almost double the emissions compared to renters. This tends to correlate with the fact that lower income households are primarily renters. Lower income households have lower emissions compared to moderate- and high-income households due to differences in energy consumption. Very low-income households appear to use more natural gas for space heating compared to low-income households, although the reason behind this is unclear. Moderate-income households appear to have higher space heating demands compared to high-income households. This is because approximately 37% of moderate-income households use propane

or wood for space heating which is less energy-efficient, meaning that more energy is needed to generate the same amount of heat compared to a natural gas furnace or heat pump.

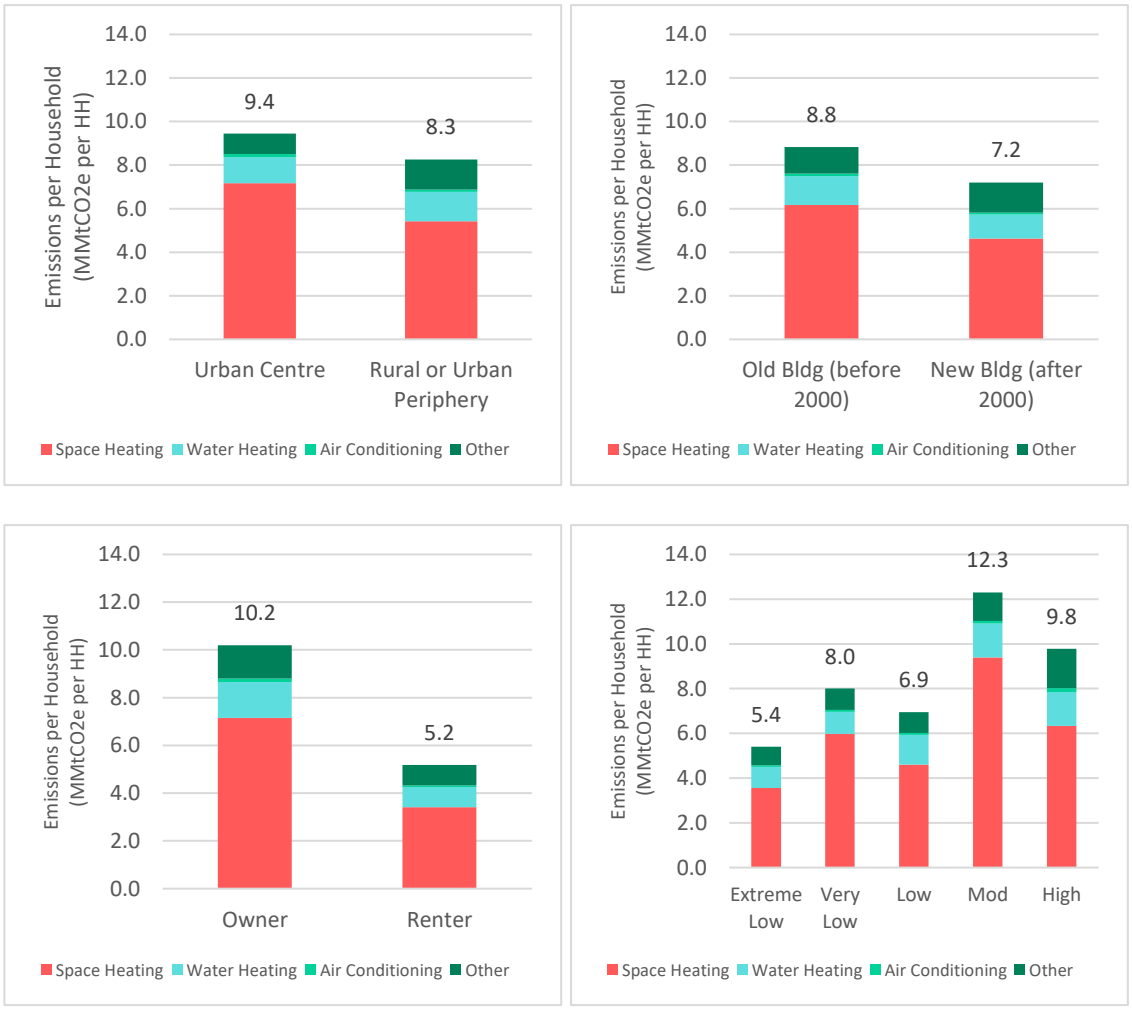

Figure 15: 2018 emissions per household by end-use – top left is by location; top right is by building age; bottom left is by ownership; bottom right is by income group

Despite using less energy, the energy burden on lower income households tends be high. The energy burden is the percentage of household income spent on energy bills. Figure 16 through Figure 19 shows the energy burden across different groups – income, race, disability and Spanish/Hispanic/Latino ethnicity - using data from the American Community Survey. According to the American Council for an Energy-Efficient Economy (2020), a high energy burden is above 6% and severe energy burden is above 10%. The figures show that in every county, extremely low-income households experience a high energy burden and very low-income households have severe energy burdens. Also, several marginalized groups have higher energy burdens than the average household, such as Black, Native American, Spanish/Hispanic/Latino households, and those with disabilities.

The energy cost burden can be high, especially in older, poorly insulated homes using inefficient heating systems. While there are financial incentives from utilities and state agencies to switch to electric heat pumps and to weatherize the home, it can be challenging for those living in rental units to access those incentives, and the time and paperwork involved can be tedious.

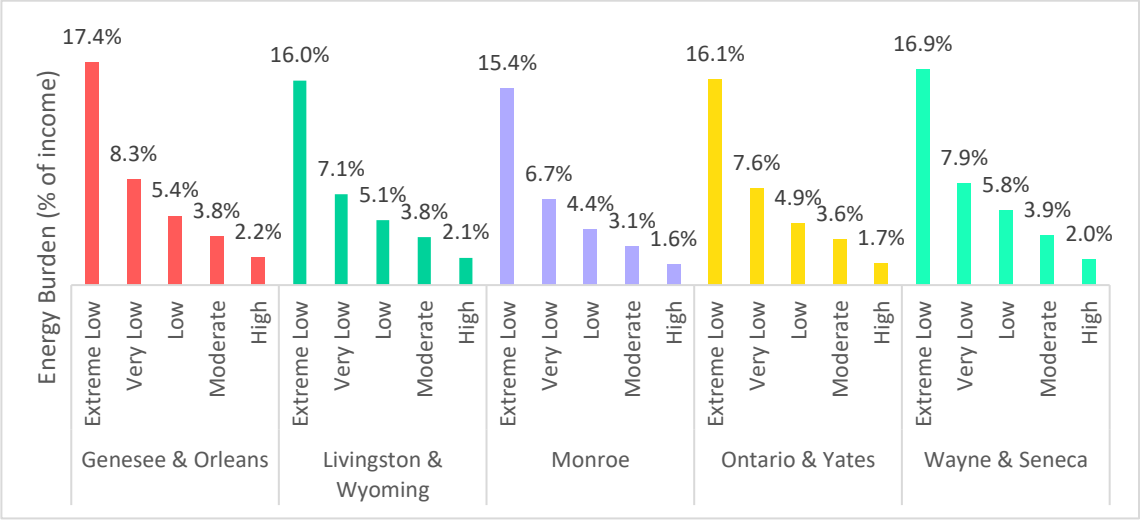

Figure 16: Energy cost burden by county and income group in 2019. Source: U.S. Census Bureau (2020a) American Community Survey

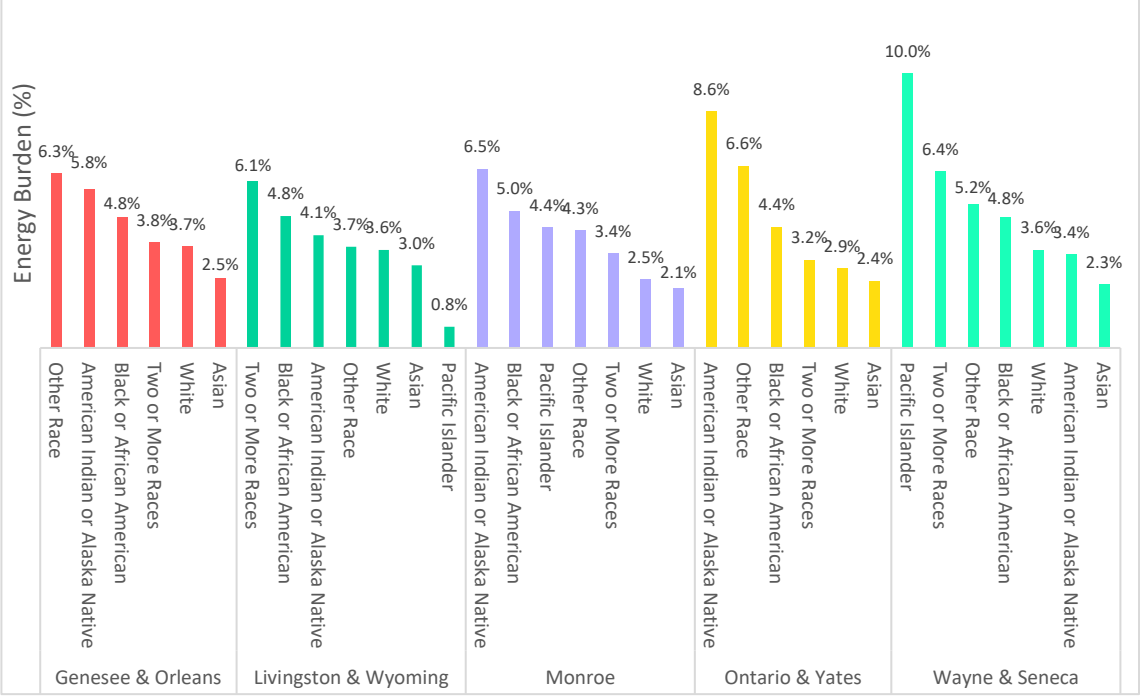

Figure 17: Energy cost burden by county and race in 2019. Source: U.S. Census Bureau (2020a) American Community Survey.

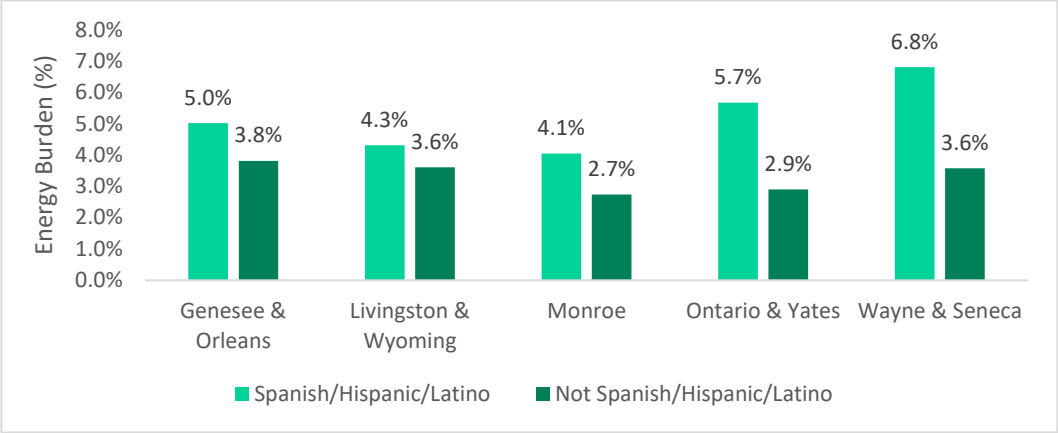

Figure 18: Energy cost burden by county and Spanish/Hispanic/Latino origin in 2019. Source: U.S. Census Bureau (2020a) American Community Survey.

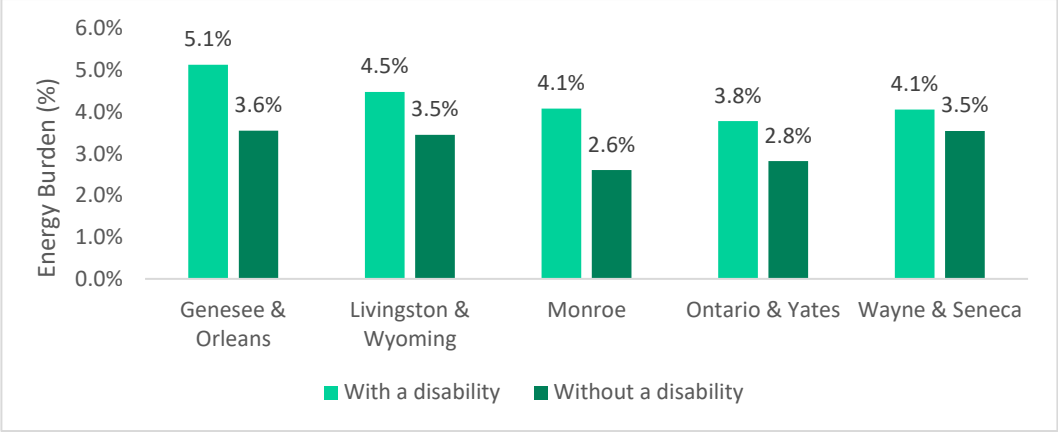

Figure 19: Energy cost burden by county and disability in 2019. Source: U.S. Census Bureau (2020a) American Community Survey.

2.3.2 Commercial emissions

Energy data for the commercial sector was limited to natural gas and electricity. As shown in Figure 20, the emissions are largely from natural gas, which jumps to 53% of total commercial emissions compared to previous years. As discussed in the section on the residential sector (Section 2.3.1), this jump coincides with increased heating degree-days in the months of March, April and October in 2018 (NYSERDA 2021a)[21], suggesting that commercial buildings may have kept their heating on later in the year (April) and turned it on earlier in the year (October).

[21] This is for Rochester. Note that heating and cooling degree-days are indicators of heating and cooling energy needs. According to NYSERDA, heating degree days are the number of degrees the daily average temperature falls below 65° F.

However, the increase in heating degree-days in 2018 does not appear to be part of a larger trend.

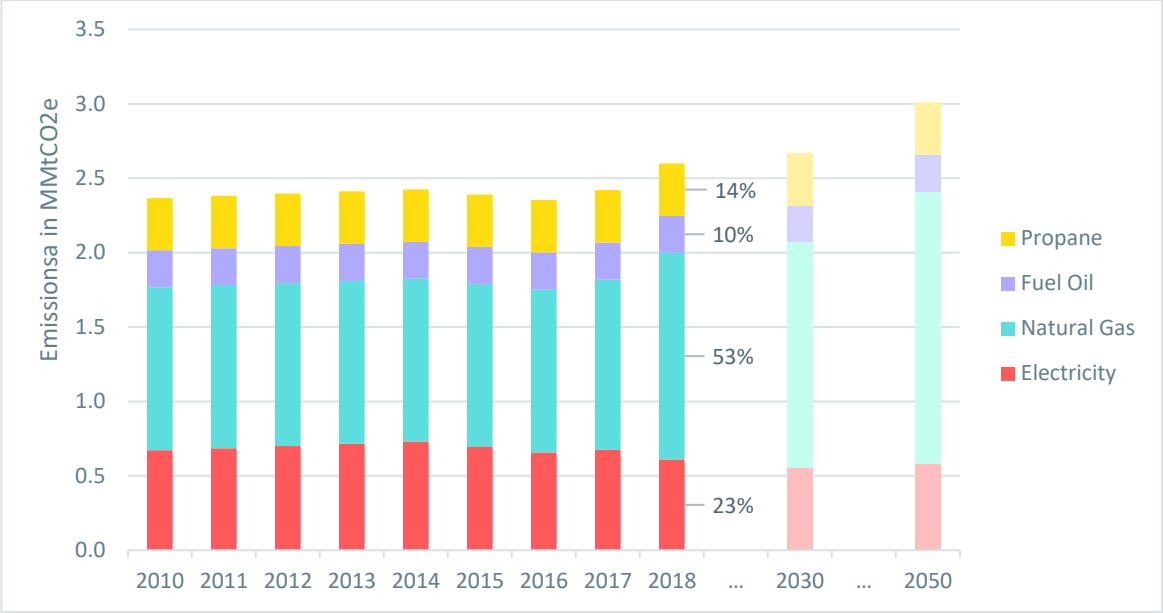

Figure 20: Historical and projected emissions in the commercial sector by fuel

Table 31: Commercial sector emissions (results in GWP20)

Sector – Commercial	-Historical-				-Baseline Projection-			
	2010		2018		2030		2050	
	$MMtCO_2e$	% of total	$MMtCO_2e$	% of total	$MMtCO_2e$	% of total	$MMtCO_2e$	% of total
Fuel	2.37	100%	2.60	100%	2.67	100%	3.01	100%
Electricity	0.67	28%	0.61	23%	0.55	21%	0.58	19%
Natural Gas	0.25	10%	0.25	10%	0.25	9%	0.25	8%
Propane	0.35	15%	0.35	14%	0.35	13%	0.35	12%
Fuel Oil	1.10	46%	1.39	53%	1.52	57%	1.82	61%
Gross Emissions Total (Commercial)	**2.37**		**2.60**		**2.67**		**3.01**	
Net Emission Removal	n/a		n/a		n/a		n/a	
Biogenic CO_2	0		0		0		0	
Net Emissions Total (Commercial)	**2.37**		**2.60**		**2.67**		**3.01**	

The commercial sector includes offices (including government), retail, restaurants, schools, healthcare, warehouses, grocery stores and lodging. In 2018, NYSERDA commissioned the *Commercial Statewide Baseline Study of New York State* to understand the energy usage across the various commercial sub-sectors. The study divides the results into three regions: Upstate

New York, Downstate New York, and Long Island/Hudson Valley. Summaries from the study from Upstate New York (which the Genesee-Finger Lakes is a part of) are provided in Table 32, Figure 21 and Figure 22. While the results may differ by county and sub-sector, generally HVAC, plug loads and lighting are major sources of electricity and natural gas use.

Table 32: Share of commercial buildings and energy usage in Upstate New York. Source: NYSERDA (2019a)

Commercial Sub-sector	Medium / Large Bldgs[1]	Small Bldgs[1]	Electric Sales	Natural Gas Sales	Fuel Oil Sales	Propane Sales
Total Quantities	**91,324 Buildings**	**21,153 Buildings**	**15,410,624 MWH**	**75,244,648 MMBTU**	**14,108,541 MMBTU**	**21,228,338 MMBTU**
Office / Government	27%	4%	36%	13%	5%	4%
Retail	23%	3%	11%	18%	17%	10%
Food Service	7%	4%	7%	11%	1%	6%
Grocery	5%	2%	7%	2%	1%	1%
Healthcare	1%	2%	8%	13%	21%	9%
Education	6%	1%	12%	24%	30%	21%
Lodging	5%	2%	4%	14%	21%	46%
Warehouse	7%	1%	16%	5%	4%	2%
Total Shares	**100%**		**100%**	**100%**	**100%**	**100%**

[1] Medium and Large buildings use greater than 75 MWH/year. Small buildings use less than 75 MWH/year.

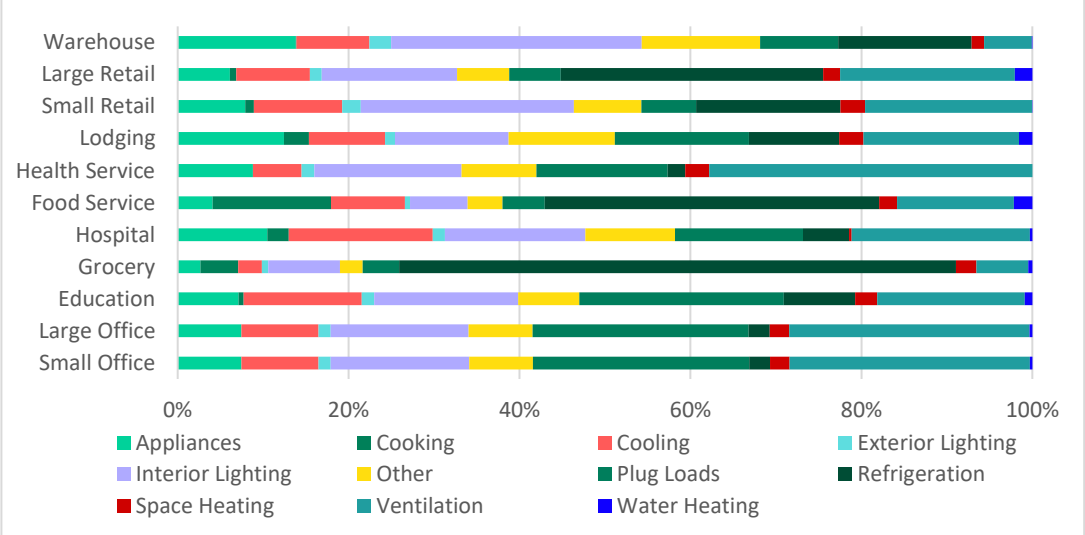

Figure 21: Electricity usage by commercial sub-sector and end-use for Upstate NY. Source: NYSERDA (2019a)

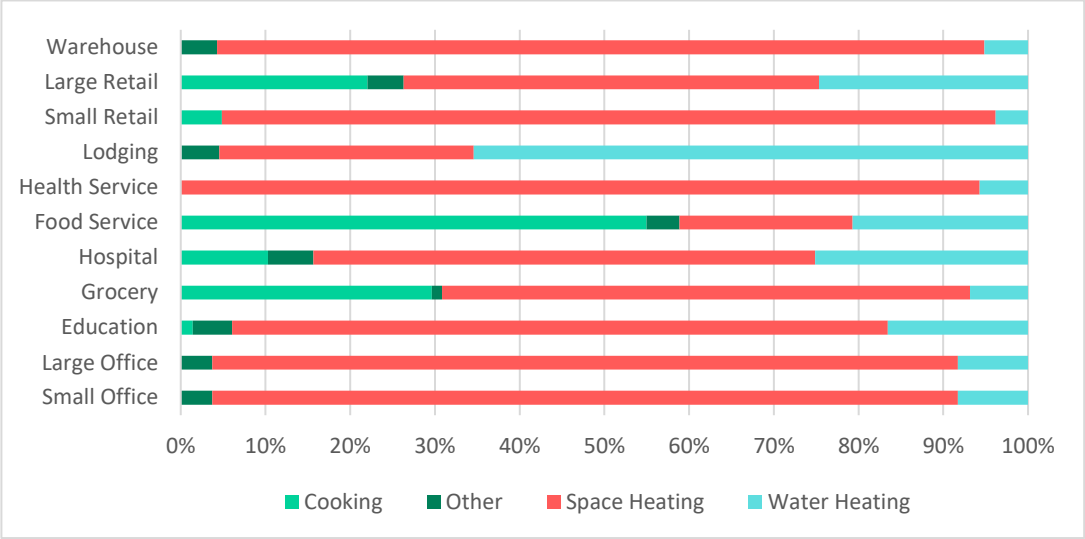

Figure 22: Natural gas usage by commercial sub-sector and end-use for Upstate NY. Source: NYSERDA (2019a)

2.3.3 Industrial emissions

The emissions inventory includes over 68 industries by North American Industrial Classification Standard (NAICS) code. Figure 23 shows the industries and industrial processes that are the most emissions intensive (including both energy and non energy emissions). In 2010, other chemical manufacturing had the highest share of emissions in the region at 49%. However, the sector experienced a steep decline as many major manufacturers in Rochester, including Kodak, Xerox, and Bausch + Lomb, significantly downscaled their operations between 2010 and 2014. Emissions in this sector reduced to 0.5% in 2014 and is now at around 10%. The highest share of emissions in 2018 came from construction-related industry called specialty trade contractors. This sub-sector includes site preparation activities, concrete work and heavy construction equipment rental and leasing, to name a few.

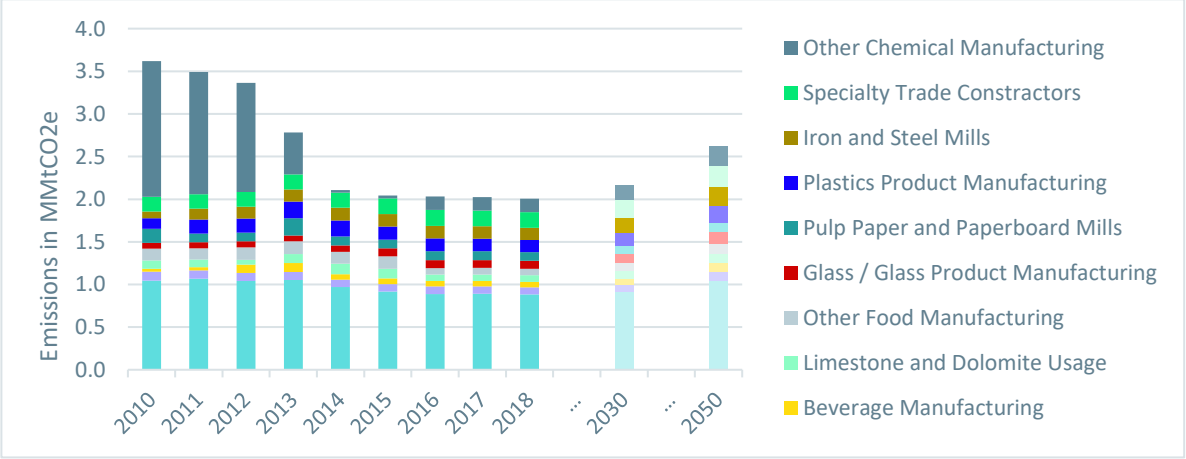

Figure 23: Historical and projected emissions in the industrial sub-sectors

Figure 24 shows that the facility closures from other chemical manufacturing led to the decline in industrial coal use in the region. Other prominent sources of emissions comes from electricity, natural gas and diesel. Using data from the US EIA's *Manufacturing Energy Consumption Survey,* Figure 25 breaks down which end uses the fuels are used for. There are four types of end-uses identified in the survey, including:

- **Indirect Uses-Boiler Fuel:** Conventional boiler use, CHP and/or cogeneration
- **Direct Uses-Total Process:** Process heating, process cooling and refrigeration, machine drives, electro-chemical processes, other process use
- **Direct Uses-Total Nonprocess:** Facility HVAC and lighting, other facility support, onsite transportation, conventional electricity generation, other nonprocess use
- **End Use Not Reported**

The survey data is reported by census region. Figure 25 shows data for the Northeast, which the Genesee-Finger Lakes region is a part of. The majority of fuel is used directly for industrial processes, with the exception of coal which is used for generating heat indirectly.

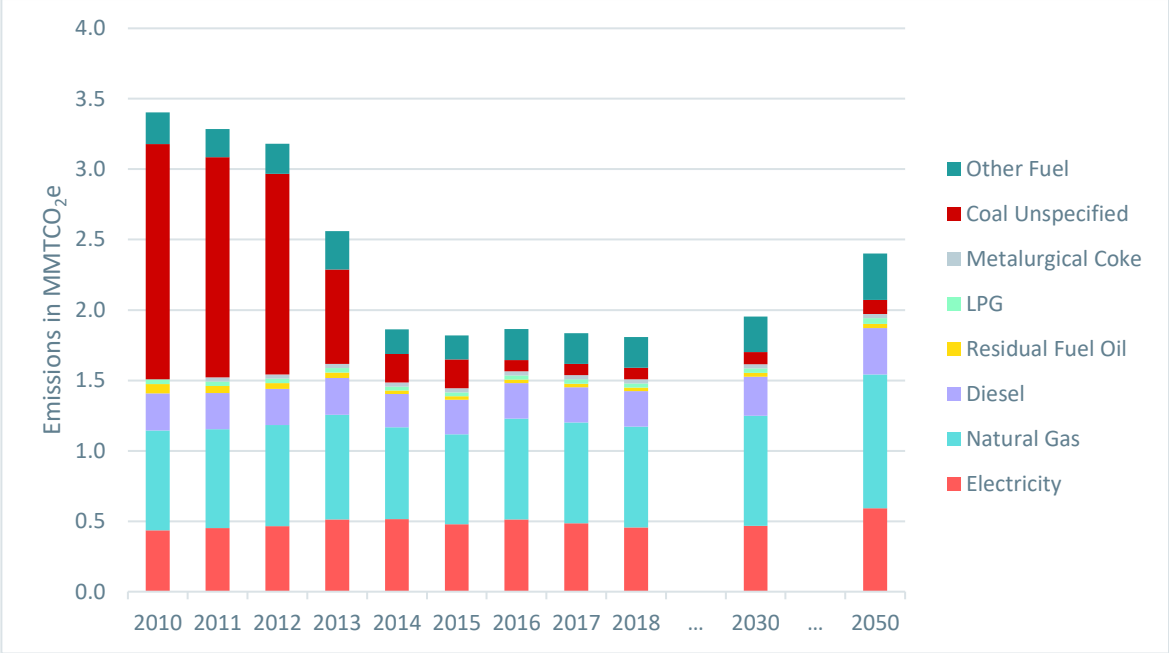

Figure 24: Historical emissions in the industrial sector by fuel

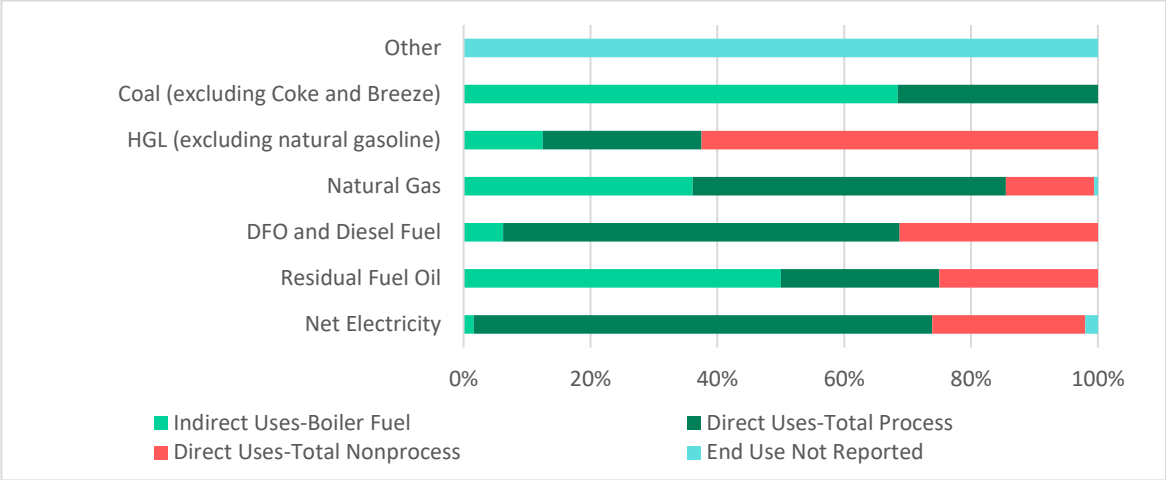

Figure 25: Industrial energy breakdown by fuel and end-use for the North-eastern US. Source: US EIA (2021) 2018 Manufacturing Energy Consumption Survey

2.3.4 Agricultural emissions

Figure 26 presents the historical emissions in the agricultural sector. Energy use in agriculture is small relative to non-energy emissions. The largest source of emissions is from livestock, including enteric fermentation (51%) and manure management (34%). During the process of enteric fermentation, carbohydrates are broken down in the digestive system by microorganisms and produce hydrogen (H_2), carbon dioxide (CO_2) and methane (CH_4). As shown in Table 33, the majority of enteric fermentation emissions in the region originates from dairy cows. In general, dairy cows produce the highest emissions per head compared to the other animals included in the analysis.

In addition to enteric fermentation, manure produces methane upon decomposition. Manure handling and climatic conditions impacts the level of methane that is emitted. Some farmers capture the methane and either flare it or convert it into bioenergy. Currently, the model uses a methane conversion factor taken from the US EPA's State Inventory Tool that is weighted based on the share of typical manure management systems in New York state. It is unclear how much of the conversion factor includes systems that capture methane gas from manure decomposition.

Crop residues and fertilizer use accounts for 8% of agricultural emissions. Residue emissions are generated when the residue left behind after a harvest decomposes. According to Table 34, alfalfa has the highest level of residue emissions, followed by soybeans. Despite a lower amount of production, soybeans are much more emissions intensive compared to alfalfa.

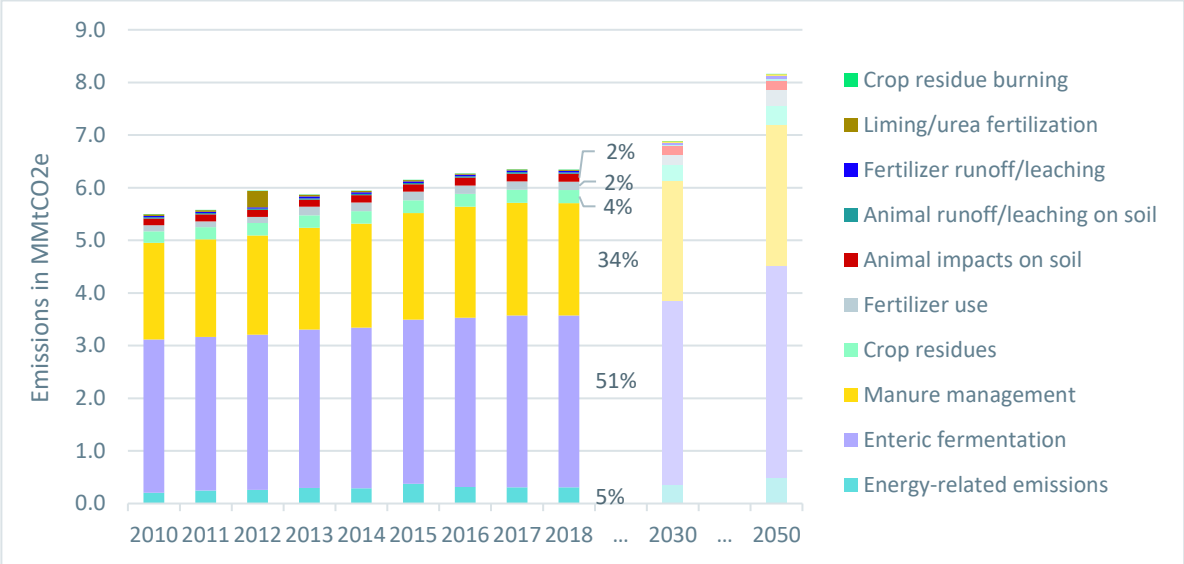

Figure 26: Historical and projected emissions in the agricultural sector

Table 33: 2018 livestock emission details

Animal	Livestock (heads)	Enteric Fermen-tation ($MMtCO_2e$)	Manure Manage-ment ($MMtCO_2e$)	Soil Animals ($MMtCO_2e$)	Soil Animal Runoff / Leaching ($MMtCO_2e$)	Total Emissions ($MMtCO_2e$)	MtCO2e per head
Dairy Cows	161,834	2.234	2.110	0.146	0.025	4.515	27.901
Beef Cows	14,184	0.119	0.002	n/a	n/a	0.122	8.576
Calves	192,040	0.890	0.006	n/a	n/a	0.896	4.665
Goat	3,852	0.001	0.000	n/a	n/a	0.002	0.407
Sheep	22,852	0.016	0.001	0.001	0.000	0.019	0.814
Swine	22,963	0.003	0.015	0.002	0.000	0.020	0.892
Llama	2,080	0.001	0.000	0.000	0.000	0.002	0.730
Layers	178,749	n/a	0.002	0.001	0.000	0.002	0.013
Pullets	1,896	n/a	0.000	0.000	0.000	0.000	0.011
Broilers	9,665	n/a	0.000	0.000	0.000	0.000	0.003
Roosters	194	n/a	0.000	0.000	0.000	0.000	0.332
Total	**610,309**	**3.265**	**2.137**	**0.150**	**0.025**	**5.578**	**9.139**

Table 34: 2018 crop emission details

Crop	Crop production (metric tons)	Crop Residues ($MMtCO_2e$)	Crop Residue Burning ($MMtCO_2e$)	Total emissions ($MMtCO_2e$)	$MtCO_2e$ per metric ton
Alfalfa	1,249	0.13660	n/a	1.37E-01	109.3
Corn for Grain	925	0.01808	2.83E-05	1.81E-02	19.6

All Wheat	125	0.00369	4.20E-06	3.69E-03	29.6
Barley	3	0.00010	1.00E-07	1.02E-04	33.3
Sorghum for Grain	0	0.00003	n/a	2.65E-05	64.3
Oats	7	0.00017	n/a	1.65E-04	23.9
Rye	2	0.00007	n/a	6.95E-05	29.9
Soybeans	186	0.09061	8.65E-05	9.07E-02	487.2
Dry Edible Beans	-	n/a	n/a	0.00E+00	0.0
Dry Edible Peas	1	0.00058	n/a	5.84E-04	440.9
Red Clover	0	0.00000	n/a	3.80E-06	152.0
Crimson Clover	0	0.00000	n/a	7.00E-07	140.0
Total	**2,499**	**0.24993**	**1.19E-04**	**2.50E-01**	**100.0**

2.3.5 Transport emissions

Among the various sectors, transport has the highest share of emissions in the region. As shown in Figure 27, light passenger trucks and cars dominate transport emissions, alongside a fair share of emissions from heavy duty combination trucks. Based on Figure 28 and Figure 29, between the various fuels, gasoline accounts 73% of emissions in 2018, with diesel at 22%. Electric vehicle use is low.

Off-road and non-road transport produce a low level of emissions compared to on-road transport, but when combined, it is comparable to the amount of emissions produced from enteric fermentation or transmission losses.

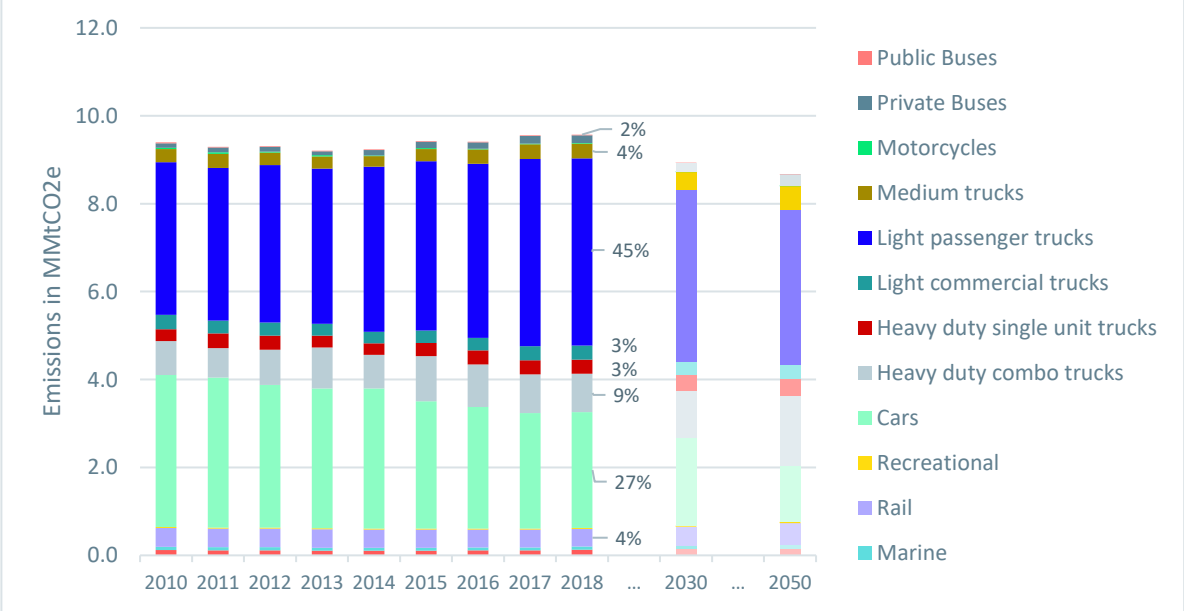

Figure 27: Historical emissions in the transport sector by vehicle type

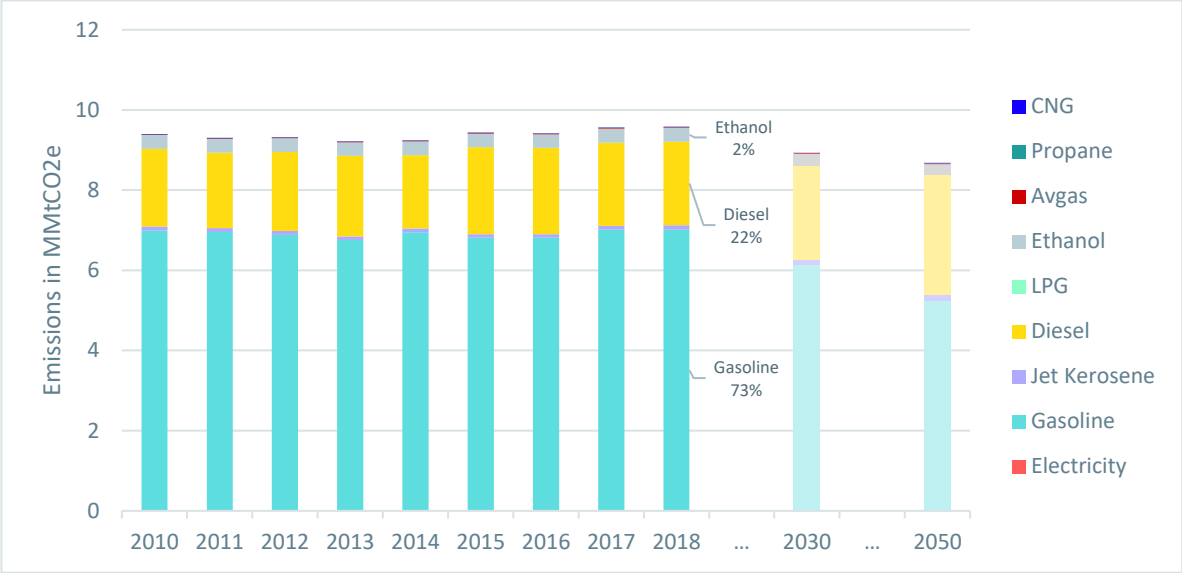

Figure 28: Historical emissions in the transport sector by fuel

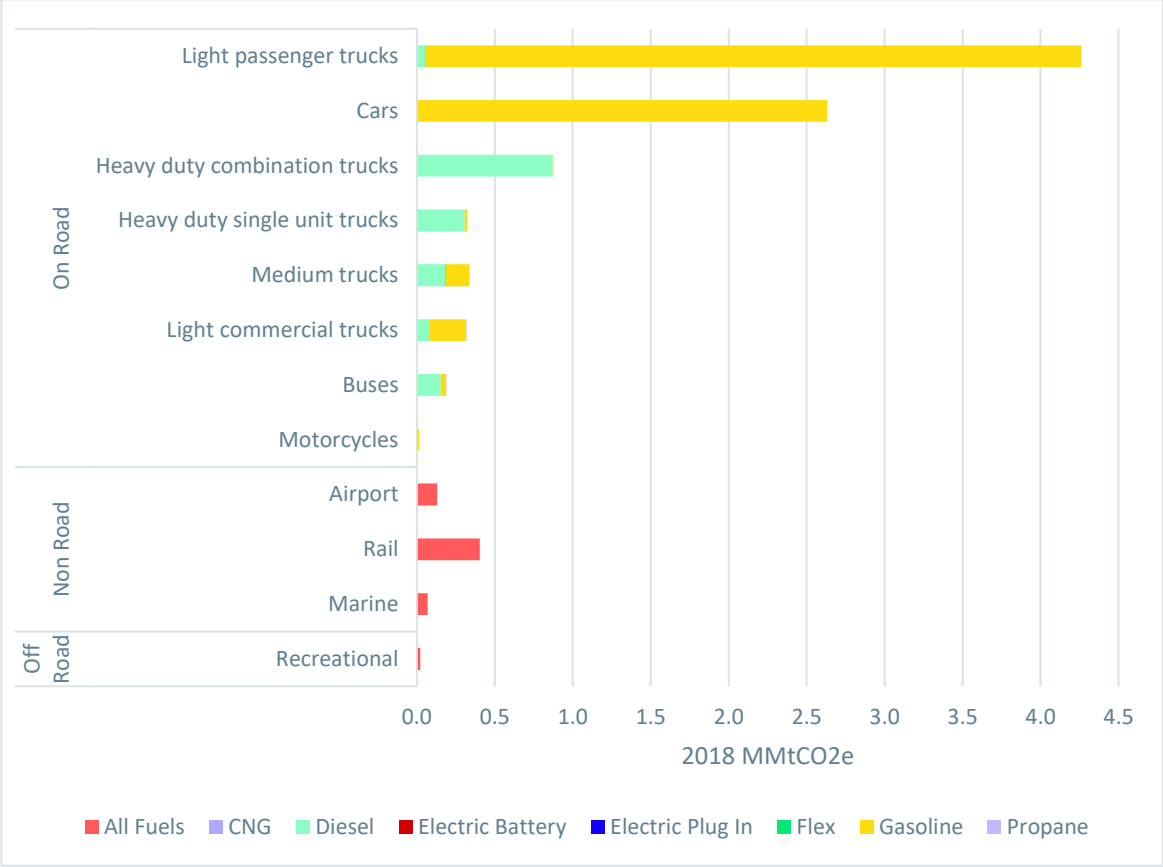

Figure 29: 2018 transport emissions by vehicle type and fuel

2.3.6 Waste emissions

Combined energy and non-energy emissions from the solid waste and wastewater sectors are presented in Figure 30. As discussed in the methodology, these emissions are from large emitters in the sector. It currently does not capture emissions from consuming goods imported from outside of the region, state or country.

The emissions appear to be decreasing over time. This could possible be due to more waste being diverted to recycling, reduced waste generation, the capture of gases and other greenhouse gases, or improved plant efficiencies.

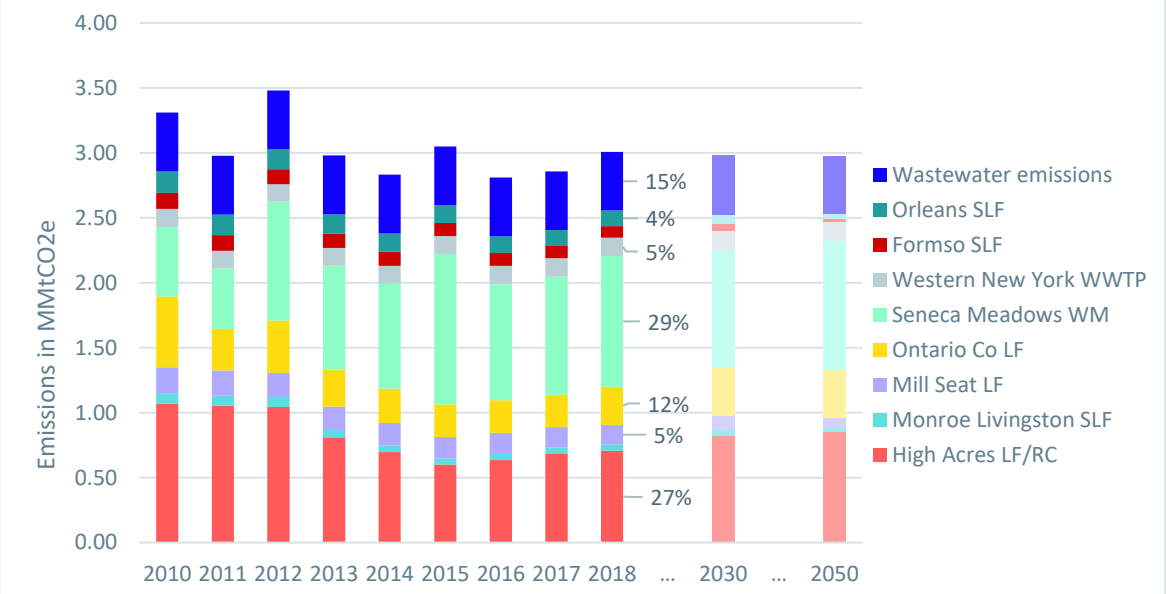

Figure 30: Historical solid waste and wastewater emissions by large facilities

2.3.7 Transmission losses and fugitive emissions

Fugitive emissions from natural gas pipelines contributed to 0.46 $MMtCO_2e$ in 2018 compared to electricity at only 0.15 $MMtCO_2e$. The decline in transmission losses during the historical period is projected into the future from 7.0% in 2018 to 4.6% in 2050. Since natural gas fugitive emissions are assumed to be the same in the future, fugitive emissions increase alongside natural gas demands.

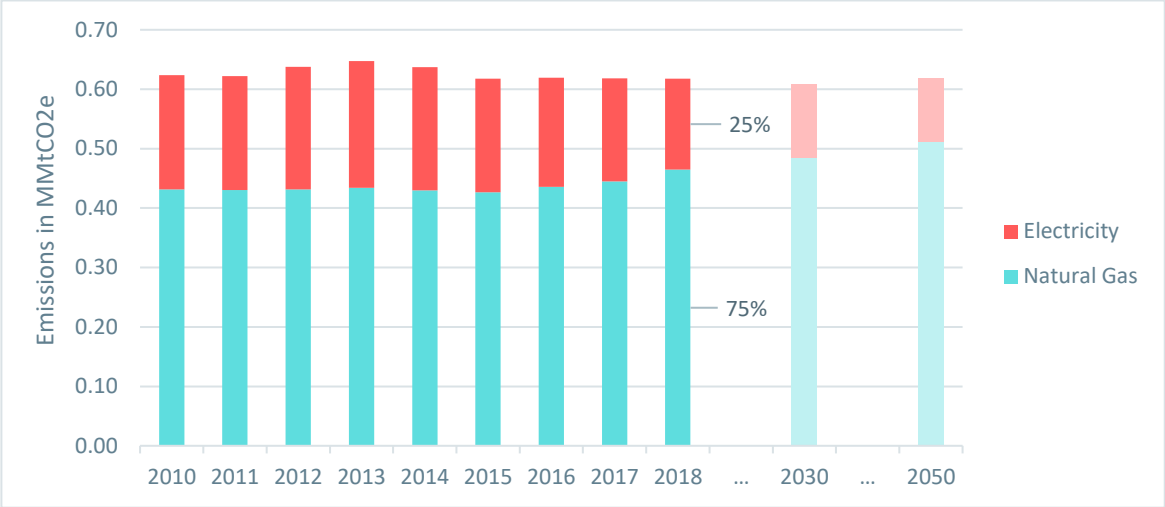

Figure 31: Historical and projected transmission losses and fugitive emissions

2.3.8 Land Use Emissions and Removals

The land use sector is the main source of removals in the region. In 2018, approximately 1.1 $MMtCO_2e$ is removed by forests remaining as forests, followed by 0.4 from urban trees. Emissions removals from forests are projected to decline to 0.9 $MMtCO_2e$ by 2050.

Forest converted to land for settlement or agriculture is the main source of emissions in the land use sector at 0.2 $MMtCO_2e$, remaining at this level through 2050.

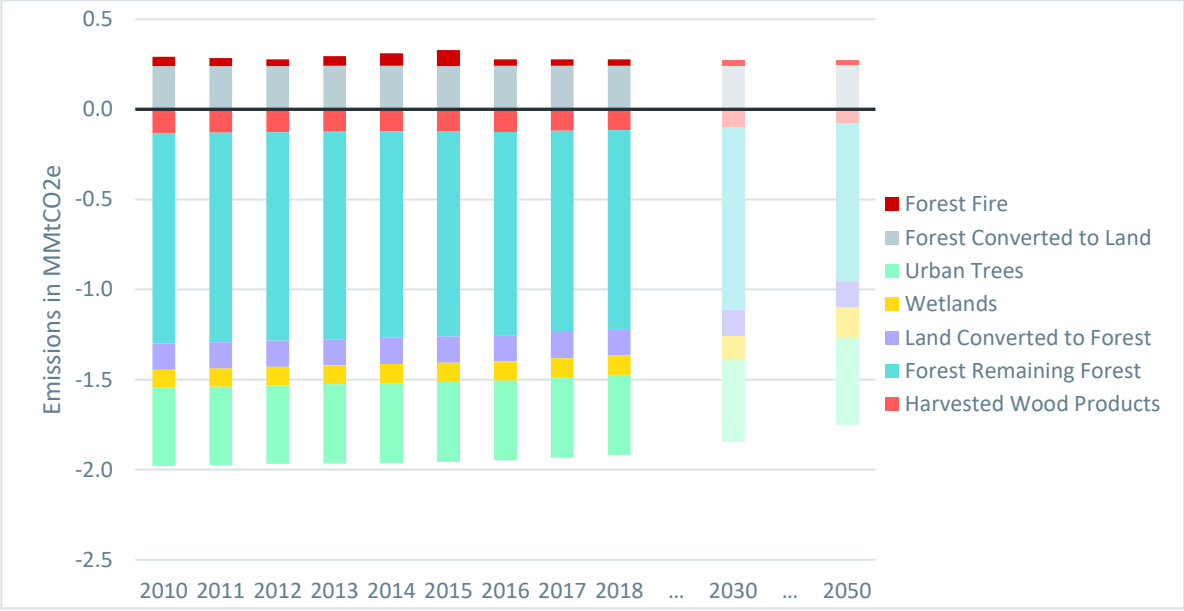

Figure 32: Historical and projected land use emissions and removals

2.4 Priority areas for emission reductions

A summary of the top 15 sources of regional emissions in 2018 is given in Table 35, reflecting 81% of the region's emissions. Climate action around these sources of emissions should be prioritized.

Table 35: Top 15 sources of emissions in 2018

Sector	Subsector	Emissions ($MMtCO_2e$)	Share of Emissions (%)
Transport	Light passenger trucks	4.3	16%
Agricultural	Enteric fermentation	3.3	12%
Residential	Space Heating	3.2	12%
Transport	Cars	2.6	10%
Agricultural	Manure management	2.1	8%
Commercial	Natural gas consumption	1.1	4%
Transport	Heavy duty combination trucks	0.9	3%
Waste	Seneca Meadows Landfill	0.8	3%
Residential	Water Heating	0.7	3%
Residential	Other End Uses	0.7	2%
Waste	High Acres Landfill and Recycling Center	0.6	2%
Commercial	Electricity	0.5	2%
Losses	Fugitive Emissions	0.5	2%
Waste	Wastewater	0.5	2%
Transport	Rail	0.4	1%
Total		**22.1**	**81%**

3 Planned future emissions inventory updates

The development of this emissions inventory is not a one-time exercise, and will need to be continually updated as new and better data is provided and

3.1 Addressing data gaps

While the current version of the model includes all major sectors and fuel types, there are a few data gaps that have been identified so far that need to be addressed in a future iteration of the inventory. It is not expected that these gaps will significantly change the findings presented in the emissions inventory but will ensure completeness.

- **Calibrate energy demands from other sectors**. Currently, county-level electricity and natural gas consumption in residential, commercial and industrial sector are

calibrated using 2013 data, and gasoline sales for the years 1995 to 2017. Data on the historical energy consumption for other sectors and fuels are needed to ensure the modelled usage matches actual consumption.

- **Street lighting.** It is unclear if the commercial usage (i.e., the energy usage reported by utilities in the UER) includes street lighting.
- **Bottom-up calculation of wastewater and solid waste emissions.** Currently, the model only includes large wastewater and solid waste facilities that are located within the region. A bottom-up calculation of wastewater and solid waste generated by households, commercial and institutional entities and industry would ensure a complete inventory of those emissions.
- **HCFC-22 production.** As of January 1, 2020, the US EPA mandated phasing out hydrochlorofluorocarbons (HCFCs) production and imports. HCFC-22, also known as R-22, is a potent greenhouse gas commonly used in residential air conditioners. It is unclear if HCFC-22 was produced in the region prior to the phase-out date, and including it in inventory can help ensure a more complete historical record of emissions.
- **Digital currency (e.g., Bitcoin mining).** The scale of bitcoin mining in the region is unclear, but there are significant concerns related to its energy consumption.

3.2 Additional sectoral detail

This first iteration of the emissions inventory was to understand the scale of emissions from each sector, in each county and the region overall. More sectoral detail will enable a better understanding of the source of those emissions to help identify targeted emissions reduction policies. Sectors to update and add further detail include:

- Disaggregating the residential sector by ownership (renter, owner) and end-use
- Disaggregating commercial sector by subsector and end-use
- Disaggregating industrial sector by end-use
- Include multiple years of data for rail, marine and airport sub-sectors

3.3 Updates to the baseline projection

The baseline projection could be updated to reflect key dynamics that a simple population-driven baseline does not readily capture, such as expected energy efficiency improvements, saturation effects, response to expected price changes, and so on. This could be done by parameterizing the results of the recent and respected regional and national analyses, such as USDOE/EIA's Annual Energy Outlook (AEO). The use of AEO captures the impact of recently enacted federal legislation and regulations on projected vehicle fuel economy, on biofuel availability and use, and other key factors. The baseline could also include other adopted policies, including national (e.g. appliance efficiency standards), state (e.g. residential building codes), regional and local plans and policies (e.g. existing climate action plans).

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APPENDIX A

Emission factors

Appendix A. Emission Factors

2019 Emission factors for Fuel Combustion

Sector	Fuel	CO_2 (kg/MMBTU)[1]	CH_4 (g/GJ)	N_2O (g/GJ)
Electricity	Coal	95.63	0.7	3.6
Electricity	Distillate fuel	74.14	0.9	0.4
Electricity	Natural gas	52.91	1	0.3
Electricity	Petroleum coke	102.12	0.7	3.6
Electricity	Residual fuel	75.09	0.8	0.3
Electricity	Wood	103.14	11	7
Residential	Coal	95.74	300	1.5
Residential	Distillate fuel	74.14	10	0.6
Residential	Kerosene	73.19	10	0.6
Residential	LPG	62.88	5	0.1
Residential	Natural gas	52.91	5	0.1
Residential	Wood	103.14	300	4
Residential	Electricity	50.03[4]	3.53[4]	0.38[4]
Commercial	Coal	95.74	10	1.5
Commercial	Distillate fuel	74.14	10	0.6
Commercial	Kerosene	73.19	10	0.6
Commercial	LPG	62.88	5	0.1
Commercial	Natural gas	52.91	5	0.1
Commercial	Residual fuel	75.09	10	0.6
Commercial	Wood	103.14	300	4
Commercial	Electricity	50.03[4]	3.53[4]	0.38[4]
Industrial	Asphalt and road oil	75.35	3	0.6
Industrial	Coal: coking	93.83	10	1.5
Industrial	Coal: other	95.59	10	1.5
Industrial	Distillate fuel	74.14	3	0.6
Industrial	Kerosene	73.19	3	0.6
Industrial	LPG	62.88	1	0.1
Industrial	Lubricants	74.07	3	0.6
Industrial	Miscellaneous petroleum products	74.47	3	0.6
Industrial	Natural gas	52.91	1	0.1
Industrial	Petroleum coke	102.12	3	0.6
Industrial	Residual fuel	75.09	3	0.6
Industrial	Special naphthas	72.38	3	0.6
Industrial	Waxes	72.60	3	0.6

Sector	Fuel	CO_2 (kg/MMBTU)[1]	CH_4 (g/GJ)	N_2O (g/GJ)
Industrial	Wood	93.87	30	4
Industrial	Electricity	50.03[4]	3.53[4]	0.38[4]
Transportation—On road	Motor gasoline	71.35	25	8
Transportation—On road	Distillate	74.14	3.9	3.9
Transportation—On road	Natural gas	52.91	5[2]	0.1[2]
Transportation—On road	Electricity	50.03[4]	3.53[4]	0.38[4]
Transportation—Aviation	Aviation gasoline	69.15	60	0.9
Transportation—Aviation	Jet fuel	72.23	0	2.5
Transportation—Railroad	Distillate fuel	74.14	0.25[3]	0.08[3]
Transportation—Military	Distillate fuel	74.14	2.01[3]	0.054[3]
Transportation—Military	Residual fuel oil	75.09	0.31[3]	0.088[3]
Transportation—Bunker Vessel	Distillate fuel	74.14	2.01[3]	0.054[3]
Transportation—Bunker Vessel	Residual fuel oil	75.09	0.31[3]	0.088[3]
Transportation—Other Nonroad	Distillate fuel	74.14	0.295[3]	0.274[3]
Transportation—Other Nonroad	Industrial/commercial equipment: gasoline—4 stroke	71.35	1.09[3]	0.6[3]
Transportation—Other Nonroad	Construction/mining equipment: equipment gasoline—4 stroke	71.35	1.085[3]	0.597[3]
Transportation—Other Nonroad	Airport equipment gasoline—4 stroke	71.35	1.39[3]	0.764[3]
Transportation—Other Nonroad	Construction/mining equipment: equipment gasoline—4 stroke	71.35	1.085[3]	0.597[3]
Transportation—Other Nonroad	Construction/mining equipment: equipment gasoline—4 stroke	71.35	1.085[3]	0.597[3]
Transportation—Other Nonroad	Lawn and garden equipment: residential gasoline—4 stroke	71.35	0.98[3]	0.537[3]
Transportation—Other Nonroad	Ships and boats: gasoline—4 stroke	71.35	0.802[3]	0.003[3]
Transportation—Other Nonroad	Recreational equipment: gasoline—4 stroke	71.35	1.54[3]	0.795[3]

Source: U.S. EPA (2021b) and IPCC (2006) as cited in ERG (2021)

[1] Converted carbon content in fuel to carbon dioxide by multiplying by 44/12

[2] Estimate based on Commercial Natural Gas

[3] Units in g/kg fuel

[4] Multiplied by utility factor per Table 3 in Section 1.2.3.2

2019 Upstream Emission factors

Sector	CO_2 (g/MMBTU)[1]	CH_4 (g/MMBTU)	N_2O (g/MMBTU)
Natural Gas	12,131	357	0.14
Diesel/Distillate Fuel	15,164	121	0.26
Coal	3,300	364	0.10

Sector	CO_2 (g/MMBTU)[1]	CH_4 (g/MMBTU)	N_2O (g/MMBTU)
Kerosene/Jet Fuel	10.071	109	0.17
Gasoline (E85)	5,097	33	0.08
Gasoline	19,604	128	0.33
LPG	17,295	121	0.27
Petroleum Coke	11,612	112	0.20
Residual Fuel	11,799	111	0.19

Source: New York Department of Environmental Conservation (2022b)

APPENDIX B

Agricultural Non-Energy Calculations and Assumptions

Appendix B. Agricultural Non-Energy Calculations and Assumptions

Enteric Fermentation

The calculation of methane emissions from enteric fermentation are described in Table 20.

Manure Management (methane emissions)

Based on the methodology from the US EPA State Inventory Tool (2017), the calculation of methane emissions from manure management are as follows:

$$\mathbf{CH_4 = [H]*[TAM]*[VS]*[MPE]*[WMCF]*[ConCH4]}$$

Where:
[H] = Livestock heads from USDA (2021) (heads)
[TAM] = typical animal mass (kg)
[VS] = volatile solids (kg VS/head/yr)
[MPE] = Maximum Potential Emissions (m^3 CH_4/kg VS)
[WMCF] = Weighted Methane conversion factors (fraction)
[ConCH4] = Convert m^3 CH_4 to kg CH_4

The Methane Conversion Factor (MCF) reflects the potential for emitting methane based on manure management practices and climate. The Weighted MCF is the weighted factor, based on the distribution of manure managment and feeding practices.

Table 36: Variables used to calculate methane emissions from manure management (2018 values from US EPA State Inventory Tool)

Animal	Typical Animal Mass [kg]	Volatile Solids [kg VS/head/yr]	Max. Potential Emissions [m^3 CH_4/kg VS]	Weighted methane conversion factors [fraction]
Dairy	na	2887	0.24	0.309
Beef	na	1674	0.17	0.009
Calves[1]	123	7.7	0.17	0.009
Goat[1]	64	9.5	0.17	0.009
Sheep[1,2]	53	8.3	0.28	0.006
Swine[1,3]	83	5.5	0.48	0.165
Llama[1,4]	53	8.3	0.28	0.006
Layers[1]	2	11	0.39[5]	0.049
Pullets[1]	2	10	0.39	0.049
Broilers[1]	1	17	0.39	0.015
Roosters[1,5]	2	11	0.39	0.049

[1]The units of volatile solids for these animals are in kg VS/head/per day, not per year.
[2] Values are based on the average of all categories of sheep
[3] Values are based on the average of all categories of swine
[4] Values assumed to be same as sheep
[5] Values assumed to be same as chickens

Manure management (nitrous oxide emissions)

Based on the methodology from the US EPA State Inventory Tool (2017), the calculation of nitrous oxide emissions from manure management are as follows:

$$N_2O = (([K\text{-}Nitrogen]*[\%AN])*E1 + ([K\text{-}Nitrogen]*[\%OT])*E2) * [ConN2O]$$

Where:
[K-Nitrogen] = [H]*[TAM]*[NEx] = Kjeldahl-Nitrogen excreted (kg)
[H] = Livestock heads from USDA (2021)
[TAM] = typical animal mass (kg)
[NEx] = Nitrogen Excreted (kg NEx/head/year)
[%AN] = Share of manure managed in anaerobic lagoons and liquid systems
[%OT] = Share of manure managed in solid storage, drylot & other systems
[E1] = 0.001 = Emissions factor for anaerobic lagoons and liquid systems (kg N2O-N/kg N)
[E2] = 0.02 = Emissions factor for solid storage, drylot, and other systems (kg N2O-N/kg N)
[ConN2O] = Conversion from N2O to N2

Table 37: Variables used to calculate nitrous oxide emissions from manure management (2018 values from the US EPA State Inventory Tool)

Animal	Typical Animal Mass [kg]	Nitrogen Excreted [kg NEx/head/yr]	Manure in anaerobic system or lagoon [%]	Manure in solid storage, drylot or other [%]
Dairy	na	160.59	43	40
Beef	na	0	43	40
Calves[1]	123	0	43	40
Goat[1]	64	0	0	0
Sheep[1,2]	53	0.45	0	50
Swine[1,3]	83	0.55	53	0
Llama[1,4]	53	0.45	0	50
Layers[1]	2	0.79	5	0.5
Pullets[1]	2	0.79	5	0.5
Broilers[1]	1	0.96	0	100
Roosters[1,5]	2	1.1	5	95

[1]The units of nitrogen excreted for these animals are in kg NEx/head/per day, not per year.
[2] Values are based on the average of all categories of sheep
[3] Values are based on the average of all categories of swine
[4] Values assumed to be same as sheep

[5] Values assumed to be same as chickens

Soil Animals

Based on the methodology from the US EPA State Inventory Tool (2017), this is the equation to calculate direct and indirect emissions from animal manure on agricultural soils:

$$N_2O = (([K\text{-}Nitrogen]*0.2*E3 + ([K\text{-}Nitrogen]*[\%P])*E4 + ([K\text{-}Nitrogen]*[\%M] + [K\text{-}Nitrogen]*[\%S])*(1\text{-}0.2)*E5) * [ConN2O]$$

Where:
[K-Nitrogen] = [H]*[TAM]*[NEx] = Kjeldahl-Nitrogen excreted (kg)
[H] = Livestock heads from USDA (2021)
[TAM] = typical animal mass (kg)
[NEx] = Nitrogen Excreted (kg NEx/head/year)
[%P] = Share of manure deposited directly into pastures
[%S] = Share of manure applied as daily spread
[%M] = Share of manure handled in managed systems
E3 = 0.01 = Emissions factor for indirect volatilization to NH3 and NOx [kg N2O N/kg N]
E4 = 0.02 = Emissions factor for Ag Soils Animal Pasture [kg]
E5 = 0.0125 = Emissions factor for Ag Soils Animal Ground [kg]
[ConN2O] = Conversion from N_2O to N2

Table 38: Variables used to calculate nitrous oxide emissions from animal manure on soils (2018 values from US EPA's State Inventory Tool)

Animal	Typical Animal Mass [kg]	Nitrogen Excreted [kg NEx/head/yr]	Manure on Pastures [%]	Manure managed [%]	Manure spread on ground [%]
Dairy	na	160.59	14	83	3
Beef	na	0	100	0	0
Calves[1]	123	0	100	0	0
Goat[1]	64	0	100	0	0
Sheep[1,2]	53	0.45	50	50	0
Swine[1,3]	83	0.55	41	54	0
Llama[1,4]	53	0.45	50	50	0
Layers[1]	2	0.79	0	100	0
Pullets[1]	2	0.79	0	100	0
Broilers[1]	1	0.96	0	100	0
Roosters[1,5]	2	1.1	0	100	0

[1]The units of nitrogen excreted for these animals are in kg NEx/head/per day, not per year.
[2] Values are based on the average of all categories of sheep
[3] Values are based on the average of all categories of swine
[4] Values assumed to be same as sheep
[5] Values assumed to be same as chickens

Soil Animal Runoff and Leaching

Based on the methodology from the US EPA State Inventory Tool (2017), this is the equation to calculate the nitrous oxide emissions from runoff and leaching from livestock onto agricultural soils:

N_2O = [K-Nitrogen] * 0.3 * E6 * [ConN2O]

Where:
[K-Nitrogen] = [H]*[TAM]*[NEx] = Kjeldahl-Nitrogen excreted (kg)
[H] = Livestock heads from USDA (2021)
[TAM] = typical animal mass (kg)
[NEx] = Nitrogen Excreted (kg NEx/head/year)
E6 = 0.0075 = Emission factor for Ag Soils Leaching [kg N2O N/kg N]
[ConN2O] = Conversion from N_2O to N2

See Table 38 for data used for each variable.

Soil Plant Residues, Legumes and Histosols (Nitrous oxide emissions)

Using the methodology from the US EPA State Inventory Tool (2017), this is the equation to calculate emissions from crop residues, and the cultivation of nitrogen-fixing crops and histosols (highly organic soils):

N_2O = (([P]*[RR]*[FD]*[FA]*[NR])*E7 + ([P]*(1+[RR])*[FD]*[NB])*E7) * [ConN2O]

[P] = Crop Production [kg] from USDA (2021)
[RR] = Residue Crop Mass Ratio
[FD] = Residue Dry Matter Fraction
[FA] = Fraction Residue Applied
[NR] = N Content of Residue
[NB] = 0.0 = N content of aboveground biomass for N-fixing crop production
E7 = 0.01 = Emission Factor (kg N2O N/kg N)
[ConN2O] = Conversion from N_2O to N_2

Table 39: Variables used to calculate nitrous oxide emissions from crop residues, legumes and histosols (2018 values from US EPA State Inventory Tool)

Crop	Residue Crop Mass Ratio	Residue Dry Matter Fraction	Fraction Residue Applied	N Content of Residue
Alfalfa	0	0.85	0	0
Corn for Grain	1	0.91	0.9	0.0058
All Wheat	1.3	0.93	0.9	0.0062

Barley	1.2	0.93	0.9	0.0077
Sorghum for Grain	1.4	0.91	0.9	0.0108
Oats	1.3	0.92	0.9	0.007
Rye	1.6	0.9	0.9	0.0048
Soybeans	2.1	0.87	0.9	0.023
Dry Edible Beans	2.1	0.87	1.6	0.0168
Dry Edible Peas	1.5	0.87	0.9	0.0168
Red Clover	0	0	0	0
Crimson Clover	0	0	0	0

Soils Plant Residue Burning (nitrous oxide emissions)

Based on the methodology from the US EPA State Inventory Tool (2017), this is the equation to calculate emissions from burning residues to clear and prepare the field for the next cropping cycle:

$$\mathbf{N_2O = [P]*[RR]*[FB]*[FD]*[BE]*[CE]*[NC]*E9*[ConN2O]}$$

[P] = Crop Production [kg] from USDA (2021)
[RR] = Residue Crop Mass Ratio
[FB] = Fraction Residue Burned
[FD] = Residue Dry Matter Fraction
[BE] = Burning Efficiency
[CE] = Combustion Efficiency
[NC] = N Content
E8 = 0.007 = Ag Soils Burning N2O to N Emissions Ratio [N2O/N]
[ConN2O] = Conversion from N_2O to N_2

Table 40: Variables used to calculate nitrous oxide emissions from crop burning (2018 values from US EPA State Inventory Tool)

Crop	Residue Crop Mass Ratio	Fraction Residue Burned	Residue Dry Matter Fraction	Burning Efficiency	Combust-ion Efficiency	Nitrogen Content
Corn for Grain	1	0.002	0.91	0.93	0.88	0.0006
All Wheat	1.3	0.002	0.93	0.93	0.88	0.006
Barley	1.2	0.002	0.93	0.93	0.88	0.008
Soybeans	2.1	0.005	0.87	0.93	0.88	0.023

Soils Plant Residue Burning (methane emissions)

Based on the methodology from the US EPA State Inventory Tool (2017), this is the equation to calculate emissions from burning residues to clear and prepare the field for the next cropping cycle:

$$\mathbf{CH_4 = [P]*[RR]*[FB]*[FD]*[BE]*[CE]* [CC]*E10*[ConCH4]}$$

[P] = Crop Production [kg] from USDA (2021)
[RR] = Residue Crop Mass Ratio
[FB] = Fraction Residue Burned
[FD] = Residue Dry Matter Fraction
[BE] = Burning Efficiency
[CE] = Combustion Efficiency
[CC] = C Content
E10 = 16/12 = Ag Soils Burning CH4 to C Emissions Ratio [CH4/C]
[ConCH4] = Conversion from CH_4 to C

Table 41: Variables used to calculate methane emissions from crop burning (2018 values from US EPA State Inventory Tool)

Crop	Residue Crop Mass Ratio	Fraction Residue Burned	Residue Dry Matter Fraction	Burning Efficiency	Combust-ion Efficiency	Carbon Content
Corn for Grain	1	0.002	0.91	0.93	0.88	0.4478
All Wheat	1.3	0.002	0.93	0.93	0.88	0.4428
Barley	1.2	0.002	0.93	0.93	0.88	0.4485
Soybeans	2.1	0.005	0.87	0.93	0.88	0.45

Soil Plant Fertilizers

Based on the methodology from the US EPA State Inventory Tool (2017), this is the equation to calculate direct and indirect emissions from soils from fertilizer application:

$$\mathbf{N_2O = ([NF]*[NN]*(1-[V]))*E11 + ([NF]*[NN]*[V])*E12}$$

Where:
[NF] = [F]*[FS] = N in Fertilizers [kg Total Nitrogen]
[F] = Fertilizer consumption [kg]
[FS] = Fraction of fertilizer consumption by type of fertilizer
[NN] = Nitrogen Content of Non-Manure Organics
[V] = Volatilization of Fertilizers
E11 = 0.01 = Emission factor for Ag Soils Plant Direct[kg N2O N/kg N]
E12 = 0.01 = Emission factor for Ag Soils Plant Indirect [kg N2O N/kg N]

County-level fertilizer consumption is estimated by taking the state-wide fertilizer consumption (US EPA 2017) and allocating it to each county based on fertilizer expenditures from USDA (2021)[22].

Table 42: Variables used to calculate nitrous oxide emissions from fertilizer consumption (2018 values from US EPA State Inventory Tool)

Fertilizer Type	Fraction of fertilizer use	Nitrogen content of non-manure organics	Volatilization of fertilizers
Synthetic	0.998	n/a	0.10
Dried blood	0	0.041	0.20
Compost	0	0.041	0.20
Dried manure	0.00007	0.01	0.20
Activated sewage sludge	0.0004	0.041	0.20
Other sewage sludge	0	0.041	0.20
Tankage	0	0.041	0.20
Other	0.001	0.041	0.20

Soil Plant Fertilizers Runoff and Leaching

Based on the methodology from the US EPA State Inventory Tool (2017), this is the equation to calculate nitrous oxide emissions from runoff and leaching of fertilizer in agricultural soils:

$$N_2O = ([NF]*[NN]*[V]*[L])*E6$$

Where:
[NF] = [F]*[FS] = N in Fertilizers [kg Total Nitrogen]
[F] = Fertilizer consumption [kg]
[FS] = Fraction of fertilizer consumption by type of fertilizer
[NN] = Nitrogen Content of Non-Manure Organics
[V] = Volatilization of Fertilizers
[L] = 0.3 = Leaching factor
E6 = 0.0075 = Emission factor for Ag Soils Leaching [kg N2O N/kg N]

County-level fertilizer consumption is estimated by taking the state-wide fertilizer consumption (US EPA 2017) and allocating it to each county based on fertilizer expenditures from USDA (2021)[23]. See Table 42 for the data used for the remaining variables.

[22] See FERTILIZER TOTALS, INCL LIME & SOIL CONDITIONERS - EXPENSE, MEASURED IN $
[23] See FERTILIZER TOTALS, INCL LIME & SOIL CONDITIONERS - EXPENSE, MEASURED IN $

Soils Liming and Urea Fertilizer

Based on the methodology from the US EPA State Inventory Tool (2017), this is the equation to calculate carbon dioxide emissions from the application of limestone and dolomite for the liming of soils and for the use of urea as fertilizer:

$$CO_2 = [A]*EF*[ConCO2]$$

Where:
[A] = Amount applied to soil [metric tons]
EF = Emission Factors [tons C/tons applied]
[ConCO2] = 12/44 = Weight conversion from C to CO2

Table 43: Variables used to calculate carbon dioxide emissions from liming and urea fertilizer application (2018 values from US EPA State Inventory Tool)

Chemical/ Mineral	Amount applied to soil [metric tons]	Emission factor [tons C/tons applied]
Limestone	County-level limestone/dolomite/urea fertilization consumption for agriculture is estimated by taking the state-wide consumption values from US EPA (2017) and allocating it to each county based on fertilizer expenditures from USDA (2021)	0.059
Dolomite		0.064
Urea		0.200

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Appendix B: Scenario Analyses Report

Genesee - Finger Lakes Scenario Analyses

Draft

April 2022

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Project summary

Figure 1: Map of the Genesee-Finger Lakes Region (Source: www.gflrpc.org)

T The purpose of the climate action plan project is to help guide the development and implementation of projects across the Genesee-Finger Lakes Region that have the most significant potential to decrease greenhouse gas emissions, while also improving the vibrancy, equity, resiliency and health of the region as well. The final output of this project will be an emissions reduction target for the region and a set of corresponding measures and actions to achieve this goal, all documented in a **Climate Action Strategy for the Genesee-Finger Lakes Region**. This Plan seeks to align with the state-wide emissions targets set forth in the historic Climate Leadership and Community Protection Act (CLCPA)[1] and also takes into account the wide-ranging technological improvements since the Finger Lakes Sustainability Plan from 2013[2].

These are the project objectives:

1. To develop a database of emissions and existing climate change-related plans and policies in the Genesee-Finger Lakes Region,
2. To foster dialogue amongst regional stakeholders from different sectors, government entities and community groups to determine what kind of mitigation strategies are plausible and desirable for the Finger Lakes Region,
3. To analyze potential GHG emission reduction measures and social and economic implications of those measures, with particular emphasis on equity, inclusion and climate resiliency,
4. To develop a range of scenarios to guide a climate action strategy,
5. To set an emissions target for the region and prioritize measures that are environmentally, socially, technically, and economically feasible,
6. To identify implementation actors, requirements, timing, and constraints,
7. To develop a plan to monitor progress towards the emissions target, and

[1] Environmental Conservation Law (ECL) Article 75 and as adopted in 6 NYCRR Part 496 (https://www.dec.ny.gov/docs/administration_pdf/revrissum496.pdf)

[2] 2013 Finger Lakes Sustainability Plan: http://www.gflrpc.org/sustainabilityplan.html

8. To strengthen the capacity of local and regional stakeholders to carry out updates to the climate action strategy in the future.

The following project is led by the **Climate Solutions Accelerator (CSA)** in partnership with the **Stockholm Environment Institute's (SEI's) U.S. Center**. The proposed approach consists of four phases: scoping, baseline assessment, scenario analysis, and action plan development, with stakeholder engagement with implementation agencies, sectors, and marginalized groups playing a key role in the process. A summary of the 4-phase project approach is shown in the following figure:

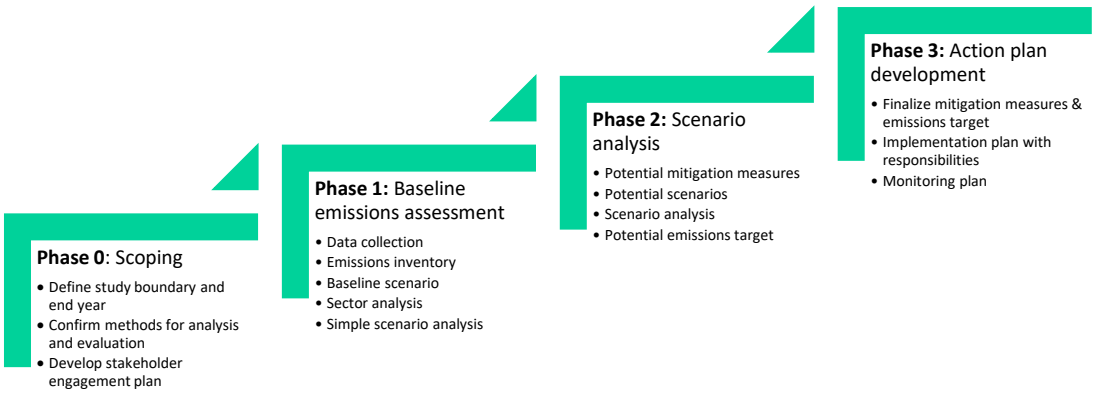

Figure 2: Phases of the Genesee-Finger Lakes Climate Action Strategy

The following report provides the results from Phase 2: Scenario analysis.

1 Scenario analysis methodology

The scenario analysis builds on the emissions inventory and baseline emissions projections developed during Phase 1. The scenario analysis assesses the long-term emissions reduction potential for the Genesee-Finger Lakes region under alternate climate mitigation pathways. To achieve this goal, the scenario analysis has the following objectives:

- Consult a wide range of stakeholders across different demographic segments, communities and economic sectors on their long-term vision for the region
- Compile stakeholder responses to identify common themes and emerging emission reduction measures of priority for the region
- Review relevant municipal, regional, state-level and federal climate action policies and plans for emission reduction measures relevant to this study
- Develop multiple scenarios each with their own set of emission reduction measures representing varying degrees of emissions reduction potential
- Calculate the emissions reduction potential under each scenario
- Review scenario results and measures with key stakeholders for feedback

- Establish a set of long-term emission reduction measures for the region, and an associated regional emissions target
- Provide a starting point for discussion on potential short-term actions needed to achieve the emissions reduction target for the region

This report documents each step of the scenario analysis, including the methodology and data sources used to assess county-level emission reductions by major economic sector and source. Assumptions are used where data is scarce and are noted in this report.

Similar to the emissions inventory exercise, this is meant to be an initial assessment of potential emission reduction measures from large sources of emissions and large emitters. This exercise will not be a one-time activity. We hope to establish a process for continually updating the emissions inventory and scenario analysis as more data and suggestions are made by stakeholders, institutions, facilities or organizations, as new technologies come into play, and to track emissions reductions over time.

The data from the emissions inventory and scenario analysis are currently being stored in the Low Emissions Analysis Platform (LEAP)[3] with plans to create a publicly available tool to view the county-level emissions inventory and potential emissions reduction under different scenarios. LEAP provides the structure for organizing data, calculations and results for an emissions inventory and scenario analysis. All data, equations and assumptions used in LEAP are presented in this report.

2 Highlights of stakeholder engagement activities

To ensure a climate action strategy that is supported by the community, a series of stakeholder engagement activities were conducted throughout 2021, including a survey, place-based and sector-based focus groups, and a workshop. These activities were led by the Climate Solutions Accelerator, with technical support and guidance from SEI as needed. A brief overview of each activity and how the input informed the scenario analysis is provided in this section.

2.1 Online Survey (April 2021)

As a first step for community engagement, an online survey of 18 questions was sent out to residents throughout the nine counties in the Genesee-Finger Lakes region in April 2021. The aim of the survey was to gain an understanding of the level of climate awareness by residents in the region, the challenges faced by community members in incorporating sustainability measures into their lifestyles and businesses, and the most favorable climate solutions. The

[3] http://leap.sei.org/

survey was distributed through online newsletters, social media channels and a webinar. The survey was anonymous and had questions on the respondent's gender, race, income bracket and education level. The survey questions are provided in **Appendix A**. In total, 648 responses were recorded, however only 450 respondents fully completed the survey.

The survey results had broad coverage across gender and income. Among the respondents that indicated their race, the majority identified as 'White or Caucasian' (83%). Most respondents had a Bachelor or Advanced degree. The coverage across each county roughly aligns with the population share between each county. A small percentage of respondents said they were located outside the region. Further details on the survey respondents are provided in Table 1.

Table 1: Only survey respondent demographics

Gender (n=429)	**Income** (n=405)	**Education** (n=429)
• Woman (54%) • Man (39%) • Non-Binary (2%) • Prefer not to answer (4%) • Prefer to self-identify (1%)	• <$25K (5%) • $25-$50K (20%) • $50-$75K (16%) • $75-$100K (23%) • $100-$125K (15%) • >$125K (21%)	• Grade school (1%) • High School (6%) • Associates or trade degree (8%) • Bachelor's degree (36%) • Advanced degree (48%)

Race (n=429)	**County** (n=423)	
• White or Caucasian (83%) • Hispanic or Latino (5%) • Other (4%) • Multiracial/Biracial (3%) • Black/African American (2%) • Asian or Pacific Islander (2%) • Native American or Alaskan Native (0.2%)	• Monroe (65%) • Genesee (13%) • Ontario (10%) • Livingston (2%) • Orleans (2%)	• Seneca (2%) • Wayne (1%) • Yates (0.7%) • Wyoming (0.2%) • Other (4%)

As shown in Figure 3, most respondents were somewhat or very knowledgeable about climate change and climate solutions. Over 73% of respondents were very willing to adopt climate solutions and 25% were somewhat willing. Only 3% of respondents were not at all willing to adopt climate solutions. The high-level findings from the survey are summarised in Table 2 below. Excel's 'Data Analysis' feature was used to identify priorities where possible. For more subjective answers, we performed a search for key phrases to capture the top 3 ideas/concepts emerging from respondent's answers.

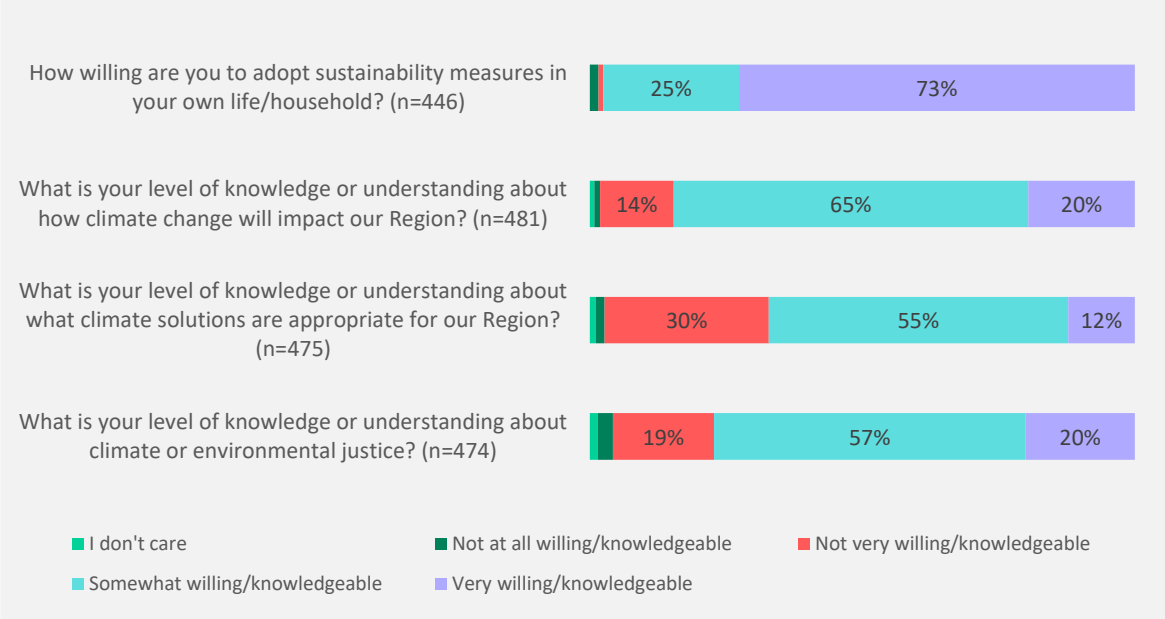

Figure 3: Climate change awareness in the Region

Table 2: Priority areas identified from the online survey

Top 3 survey answers per question
Top 3 priorities for the region[1]
• Affordable Housing (*126 ranked as priority #1*) • Access to Clean Water *(79 ranked as priority #1)* • Criminal Justice/Police Reform (*74 ranked as priority #1*)
Top 3 solutions reduce greenhouse gas emissions and provide community benefits[2]
• Agricultural practices that can increase agricultural yield and the availability of nutritious food while improving water quality of nearby waterways (*121 ranked as the top solution*) • Clean energy job opportunities that improve our infrastructure and provide above average wages and benefits (*98 ranked as the top solution*) • Active transit opportunities (e.g. bike lanes and sidewalks) that improve air quality by reducing the need for fossil fuel vehicles and improve the walkability of our communities (*84 ranked as the top solution*)
Top 3 measures for residential energy efficiency
• Increase financial incentives for weatherization (e.g. insulation and air sealing) and clean heating and cooling technologies (i.e., heat pumps). (*n=203*) • Require landlords to meet energy efficiency standards to receive a certificate of occupancy for a property. (*n=100*) • Educate property owners about the importance of reducing energy use and the availability of programs that can help them reduce energy usage. (*n=65*)
Top 3 preferred transit measures for the region
• Expanding the geographic reach and efficiency of public transit (*n=217*)

Top 3 survey answers per question
• Expanding access to electric vehicle charging stations (*n=109*) • Expanding sidewalks and pedestrian plazas to create safer, more walkable communities (*n=68*)
Top 3 preferred land and development measures for the region
• Inter-municipal and regional community planning that designates priority development and conservation areas, curbs inefficient development and over-development, revitalizes cities and villages, and preserves open space and agriculture (*n=262*) • Overhaul current zoning codes and rules to increase flexibility, innovation, and access (*n=66*) • High-density development that makes alternative transit (e.g., walking, biking, and public transit) more feasible, and preserves open space and agricultural lands (*n=61*)
Top 3 preferred agricultural practices for the region
• Provide payment to farmers for ecosystem services (e.g., carbon sequestration, soil health, pollinator services, improving water quality) (*n=148*) • Co-developing agricultural land for renewable energy projects (e.g., solar and wind projects) and agricultural production (e.g., sheep farming, beekeeping, fruit and vegetable production) (*n=138*) • Convert waste to energy by using animal and crop waste to create biogas for electricity (*n=49*)
Top 3 perceived barriers to the implementation of climate solutions
• Public perceptions that the costs associated with addressing climate change exceed the benefits of taking action. (*n=153*) • Lack of political will and community leadership in prioritizing climate change in our community. (*n=147*) • Lack of knowledge about local climate change impacts and potential solutions. (*n=95*)
Top 3 preferred sources of funding for climate solutions in the region
• Corporations should pay a carbon fee or taxes for greenhouse gas emissions. (*n=216*) • The government should prioritize funding for climate solutions without raising taxes. (*n=106*) • The government should raise taxes to fund climate solutions. (*n=45*)
Top 3 changes required to address climate change in the region
• Education. People do not understand what needs to be done to address climate change. (*n=137*) • Laws. People will not take action to address climate change unless required. (*n=106*) • Leadership. People are hesitant to take action because they do not want to be the first in their communities to do so. (*n=82*)
Top 3 barriers to implementing sustainability measures in one's own lifestyle/ household
• I do not have the necessary financial resources to implement sustainability measures. (*n=169*) • I already take advantage/implement the full range of sustainability measures. (*n=112*) • I do not have the necessary knowledge to implement sustainability measures. (*n=102*)

[1] Renewable energy development and racial justice received the top votes overall, but very few ranked these as priority #1.

[2] Land use planning decisions received the most votes overall, but few ranked it as priority #1.

2.2 Focus groups (May – October 2021)

The following community groups were consulted via virtual meetings to get input for the climate action plan. Each group was prompted to discuss existing community assets, their vision for an equitable and sustainable community, potential solutions and the barriers that exist that prevent implementation of these solution (technical, political, behavioural or financial).

1. Color Your Community Green Group (May 15th, 2021)
2. Rural residents (June 22nd, 2021)
3. College Students (July 1st, 2021)
4. Health experts (July 13th and July 27th, 2021)
5. Urban Black community members (July 17th, 2021)
6. Clean Tech/Manufacturing organizations (July 20th, 2021)
7. Equity and Non-Profit focused civil society groups (July 26th, 2021)
8. Economic Development Workforce (July 27th, 2021)
9. High School Students (July 28th, 2021)
10. Urban Latino community members (August 4th, 2021)
11. Housing experts (August 16th, 2021)
12. Indigenous community members (August 18th, 2021)
13. Farmworkers (September 17th, 2021)
14. Transportation experts (October 1st, 2021)
15. Municipal Leaders (October 18th and October 25th, 2021)
16. Farmers (February 17th, 2022)

The focus group discussions were transcribed and then coded to determine each group's vision for the community, values, what they said as viable solutions for the area as well as perceived challenges. The results from the focus groups were taken into consideration when selecting solutions for our climate scenarios. For instance – since public transportation and electric vehicles (EVs) were perceived as viable solutions by many groups our climate action scenarios for EVs and public transportation were more ambitious.

Highlights from the focus groups are provided in Table 3. All of the groups shared common elements in their vision for the region, including close-knit walkable and bikeable communities with more green space and year-round, affordable, locally grown foods. Renewable energy and affordable, energy efficient housing for all are also key to reducing greenhouse gas emissions, however in addition to financial support, significant training and growth of the clean energy workforce is necessary for this to happen. Aligning land-use planning with transit and agricultural needs were also mentioned by many groups, requiring extensive collaboration across sectors, neighborhoods, municipalities, counties and businesses.

Shared values identified across each group include connectedness, community, collaboration, equity, justice, affordability, inclusion and accountability.

Table 3: Highlights from focus groups

Visions	Values	Solutions	Challenges/Concerns
Urban Latino Community Members (August 4th, 2021; 6 attendees)			
• Safe and walkable / bikeable neighborhoods • Healthy air; reduction of respiratory illnesses from air pollution • Attractive community (parks, green spaces, artwork)	• More stable and secure society • Cleanliness and respect for nature • Accountability • Inclusivity and representation • Building community	• Energy efficiency • Redevelopment of vacant lands • Build more parks and green spaces • Smart landscaping • EV charging stations • Bicycle lanes • Glass bottle exchange over plastic bottles • Reduce light pollution	• Funding for energy efficiency • Landlords don't have incentive for energy efficiency • Fear of walking because of safety • Lack of community engagement • Need to offer climate communications in multiple languages
Urban Black community members (July 17th, 2021; 7 attendees)			
• Fossil free society • Better public transportation • Access to healthcare and local/home-grown nutritious food • Connected community • Clean air and water • Access to education, decent and affordable housing • See night sky, hear nature, be around nature and green spaces • Quality time with family and friends • Feel safe	• Justice • Peace • Accountability through love, particularly by police • Collective consciousness, shared beliefs / ideas / moral attitudes • Sharing food, resources – building community	• Partner with community to solve problems, for example create a Standing Office of Neighborhood Safety • Provide living wages • Improve public transport • Cheaper EVs	• Affordability concerns • Lack of access • Structural inequalities such as racism • Extreme weather events (flooding, drought, polar vortex, extreme heat)
Transportation experts (October 1st, 2021; 9 attendees)			
• Quality, higher density housing and mixed-use districts near transit nodes and corridors • Bikeability and walkability	• Equity • Land use planning, including limiting job sprawl, aligning with public transit needs	• Mandatory infrastructure for biking and walking • Cheaper public transit and bikeshare	• More gov't funding for biking, walking and public transit infrastructure

Visions	Values	Solutions	Challenges/Concerns
• Safe bike routes • Public transit system that is nearby, affordable, accessible, frequent and robust. Provides similar travel times as driving. • Healthy air	• Regional, municipal and sectoral collaboration. Align planning across different levels. • Public transit has similar priority to EVs	• EV buses • Expand electric car share • Improving bus / transit shelters • Public relations to support public transport uptake • More staff; engineers and architects • No new gas stations • Prioritize corridors where bus routes can be aligned • Limit economic development outside transit corridors via tax incentives. • Identify metrics and goals for public / active transport	• More funding and staff for inspection and enforcement of regulations • Will EV funding divert funding from public transportation? • NIMBY-ism towards higher density • Gentrification concerns • Car-culture in the area • Fear of renters / landlords affecting zoning of higher density areas • Reversing red-lining
Rural residents (June 22nd, 2021, 10 attendees)			
• Forests and carbon removal through trees • Protection of natural resources and lands including water bodies and forests • Alternate transit options (bikeability, walkability, snow mobiles) • Regionally- connected communities, such as through trail towns • Farm-to-table • Regenerative farming	• Close-knit community • Agriculture as part of the community and environmental / climate stewards • Land use planning revolving around building community	• Geothermal heat pumps • Light-rail to Rochester; train to Letchworth • Plant trees • Water efficiency measures (low-flow fixtures) • Electrification of homes • More local events	• Algal bloom • Sprawl • Abnormal weather events (i.e., droughts, late snow) • Tree removal (deforestation) for agricultural land • Land acquisition for renewable energy • No big movement towards regenerative farming • Car-centric culture
Color Your Community Green (May 15th, 2021)			

Visions	Values	Solutions	Challenges/Concerns
• Elimination of poverty • Green jobs, education and apprenticeship programs • Everyone is well informed on climate issues and solutions • Grow your own food or access to local farms with healthy food • Dense urban areas with walkable commons and liveable centre; less cars • Mixed urban areas with trees and native plants everywhere • Solar panels everywhere • Dedicated community services • Community gatherings (festivals, markets)	• Equity • Environmental Justice • Longevity and sustainability • Inclusivity • Local • Connectedness • Building community	• Electric school buses • Clean energy for buildings • Sustainability and climate change in curriculum • Carbon price or social cost of carbon included in price of goods • Connect with UofR engineering/health programs to get kids involved	• Existing school bus contracts limits ability to change to EV • Green gentrification • Partisanship and politics • NIMBYism • People do not see climate change as a problem or see it as someone else's responsibility • People do not see how climate goals align with other community goals
College Students (July 1st, 2021; 10 attendees)			
• Frequent, reliable, affordable, accessible public transport • More bikeability and access to bike trails and paths • Renewable energy (solar PVs, wind turbines, geothermal) and electric (EVs, planes) • Less resource waste through recycling, composting, rainwater harvesting, or natural plastics • More trees, green spaces and biodiversity	• Peace of mind - no fear of climate apocalypse • Collective responsibility - less individualism • Diversity • Equal opportunities • Accessibility	• Functioning bus stop apps • Biodiverse yards with pollinators • Building biking infrastructure (such as bike paths) • Sidewalks for walking • Approve fewer permits for new buildings in places of thriving ecosystems • Clean and sanitary buses • UofR Office of Sustainability	• Politics; need more representative government • Individualistic attitude • Car-centric culture • Public transit is not affordable for all • Public transit does not go everywhere – people are unable to get to the doctor's • Food desert (lack of access to food for people without cars)

Visions	Values	Solutions	Challenges/Concerns
• Access to local food from community gardens			
Health experts (July 13th and July 27th, 2021; 8 attendees)			
• Affordable housing with proper heating and cooling systems for climate change • Safe, accessible rural transportation systems to cities to access healthcare services • Public transit, bike paths, sidewalks, snowmobile paths • Access to low-cost, local, organic, nutritious foods, such as through community gardens • Community hubs for climate resiliency for all (emergency, off-grid power and heating/cooling centres)	• Proactive – addressing climate change reduces health issues • Climate resiliency • Community resiliency • Cross-sector collaboration • Access to healthcare by all	• Emergency power systems (off-grid solar or charging stations) • Create bike lanes and sidewalks during road repair • Media coverage and general awareness linking climate and health • Use schools as community hubs during extreme weather events • Better pay for healthcare workers	• Climate impacts on health (extreme heat or cold). Extreme heat linked to poor mental health, lower distress tolerance. • Consolidation of health services – less community resiliency. • Lack of access to primary care. Poor public transit. Adverse weather affects ability to travel to appointments. • Air quality concerns on health (asthma, allergies) • Lack of funds • Need institutional leaders / decision-makers to be part of the climate conversations.
Clean Tech/Manufacturing organizations (July 20th, 2021; 7 attendees)			
• The region is a clean-tech manufacturing hub (heat pumps, energy storage, solar panels, etc.) • Products that are based on recycled or renewable resources, and are biodegradable. Closed loop systems; circular economy. • More renewable energy (solar, biogas, RNG)	• Holistic climate solutions • Collaborative - organized supply chain; businesses working together • Circular economy • Working within the existing market • Regenerative community	• Regenerative agriculture • Put solar on available rooftops, canopy parking, other underutilized spaces, agro-voltaics • Provide technical/legal/financial services to help with grid interconnection. • Cap grid interconnection costs • Social media, education awareness on climate solutions	• Grants, incentives, subsidies • Payment for carbon capture doesn't include composting, landfill gas capture, etc. • All solar projects need to connect to the grid. Interconnection is difficult, lots of paperwork, costly. • Composting in anaerobic digesters has emissions related

Visions	Values	Solutions	Challenges/Concerns
• Efficient, sustainable industrial processes • Natural climate solutions for carbon removal (e.g., soil carbon sequestration)		• Rainwater harvesting • Carbon pricing/tax on fossil fuels • Lifecycle assessment of RE and other solutions • Set standards for RE companies • Local heat pumps or solar panels; organize supply chain for RE • Landfill capturing methane • 2 turbine systems in every SUNY school • PACE financing for RE	to trucking compost – needs to stay local • Certifications and regulatory concerns with products • Concerns that solar panels on farms will put runoff into creeks and water bodies – need to consider site design.
Equity and Non-Profit civil society groups (July 26th, 2021; 9 attendees)			
• Create clean energy jobs in the region for heating, cooling, solar installations, etc. • Affordable housing with proper heating and cooling system, especially for disabled homes • Equitable transit system with better coverage • Food security through climate resilient food production and distribution system; affordable and nutritious food available for all • Access to information, transportation, healthcare, medication and housing needs for most vulnerable communities and people, especially during climate-related emergencies	• Equity and access • Climate equity and justice • Climate resiliency • Emergency preparedness • Disability justice • Community networks and coordination • Public and community-centred land use • Everyone has what they need (food, medication, healthcare, education, housing, etc.)	• Community energy – lowers energy bills, revenue back to community • Partner with community gardens to have another avenue for local food • Go to the community and share knowledge, rather than waiting for people to come to us – tables on the street, parks, markets, etc. • Utilize existing, yet unused, rail lines. For example, electric trains. • Improve transfer system on buses. Balance between more stops and more direct buses. • Improve school curriculum to include climate change • Government funding for affordable housing	• Rooftop solar is cost prohibitive. • Underfunding of schools and communities/people vulnerable to climate change • Heavy reliance on donations from local farmers for food; concerns that climate change will affect agricultural yields • Caregiver shortage within disabled community • Gentrification • People don't believe in climate change; marginalized people are not included in conversation

Visions	Values	Solutions	Challenges/Concerns
Economic Development Workforce (July 27th, 2021; 5 attendees)			
• Access to resources to start businesses, particularly in low-income neighborhoods • Everyone has job security and have equal opportunities to jobs that are accessible • Employers assist employees with childcare, transportation, encourage time off • Access to affordable, accessible retraining programs • Everyone has access to basic needs to live without worrying (basic income, living wage, technology,	• Equitable solutions • Equitable processes (inclusion and engagement) • Social justice • Widespread awareness and opportunities • Collective investments by communities and neighborhoods • Leverage next generation of leaders	• Tax credits to help homeowners "green" their homes with green tech (solar panels, new windows) • Pay a living wage to everyone ($20-$25 per hour) • Set up governing bodies among neighborhoods to allocate savings from green energy. For example, a green energy training funded by community solar revenue • Affordable training programs - "earn as you learn" or use federal funding to pay people to do training • Generate awareness on clean energy job opportunities; target low-income neighborhoods and individuals from non-traditional educational backgrounds • Feeder programs from schools to jobs • Alleviate technological divide – free laptop and wifi for every person • Carpooling incentives, such as special parking spots • Require developers to build energy efficient buildings (building code)	• General misconception about clean energy jobs - people think that they have to go to RIT to learn this • Training programs are not affordable. Systemic disincentives for training (cost, transportation, childcare)
High School Students (July 28th, 2021; reps from 8 schools)			
• More trees, parks, gardens, cleaner areas	• Sense of togetherness • Collaboration	• Bike/skateboard paths	• Climate change is already happening here. Changes in

Visions	Values	Solutions	Challenges/Concerns
• Fossil free society, more solar, wind and hydropower • Alternative transport (bikes, electric longboards) that is safe and accessible • Improved public transit with shorter distances, subway • Jobs along transit corridor and downtown • Programs for youth	• Empathy • Caring • Safety	• Courses for helping the community and environment, and green jobs • Colleges with environmental clubs • Gardens in prisons • Tailor school curriculum towards individual interests, including climate change and climate jobs • All electric vehicles	weather, cold spells, more hot days • Stigma against 'green'; people with privilege don't want to change • Lack of jobs downtown • Public transportation is inefficient – need to go downtown first to go elsewhere
Housing experts (August 16th, 2021; 8 attendees)			
• Everyone has access to affordable, habitable, democratically managed, public housing. The housing is also close to grocery stores, public transit, green space, bike paths, schools, etc. • Everyone is aware of climate solutions for their homes. • Energy efficiency in all rental properties • Availability of training programs in clean energy and energy efficiency. • Sufficient number of local contractors are trained in clean energy and energy efficiency and have access to materials (plumbers, HVAC, electricians, engineers, etc.)	• Community ownership • Affordability (affordable housing) • Healthy standard of living • Health and safety of renters/tenants	• Use lessons from lead safety policies for implementing energy efficiency programs • Codes/standards for energy efficiency, including insulation and heat pumps on all rental properties. • Standards for maximum energy usage per square foot as part of renewing certificate of occupancy • Relief from heat considered as a standard (heat sequestering to lower heat index in concentrated urban areas) • Assess models of ownership and governance include public housing, community land trusts, cooperative housing, and mutual housing associations	• Low-income households often don't use heating and cooling – worried about high energy bills, • Renters often live in homes with poor insulation. Renters rely on landlords to buy energy efficient equipment, improve weatherization, insulation, etc. • Insufficient contractors • Is the grid capacity sufficient to handle additional electricity load from electrification? • Shortage of housing and affordable housing. Will need additional housing for migrants and climate refugees

Visions	Values	Solutions	Challenges/Concerns
		• Use ARP dollars (or other subsidies) to make homes more efficient. Heat pumps for all.	
Indigenous community members (August 18th, 2021; 5 attendees)			
• Live our promise to take care of Mother Earth for the future. Have a pristine environment. Protect the water. Protect ancestral lands. • Live off the land. Agriculture is self-sustainable; community food supply year-round • Decentralized energy sources, or use of renewable resources like geothermal • Buildings are designed to have natural, passive forms of heating and cooling (like an Earth ship)	• Connection to nature, hands-on learning • Indigenous mindset • Social justice • Peace • Healing • Kindness • Empathy • Appreciation • Community • Inclusion	• More people grow their own food, greenhouses • Water restrictions (like Genesee County) • Every house on/off reservation to use solar and geothermal energy • Proper assessment for siting of solar farms, wind turbines and industries – no siting near ancestral territories or another's territory. • Protect Great Lakes – violation if water from Great Lakes goes out of state. • Water permits to limit water-taking from large companies and prevent toxic dumping in water bodies. • Children education is more hands-on, in nature, to motivate them to want to protect it.	• Those that live off the land are vulnerable to climate impacts • Higher probability of zoonotic diseases as animals live closer to humans due to land use change • Politicization of environmentalism • Disbelief in climate science • Disbelief in science comes from deep hurt from past colonization, residential schools • Capitalism – who benefits from solar energy, etc. focus on reducing energy consumption
Farmworkers (September 17th, 2021; 12 attendees)			
• Protected environment – take care of land like its your house • Recycle and reuse materials, less meat consumption, water use (especially bottled water), material consumption	• Worker rights • Justice for immigrants • Less materialism and consumerism • Work-life balance; spend time with family and friends • Slow down	• Encourage people to fix broken items, instead of replacing them • Employers to encourage better work-life balance; reduce work hours to spend time with family	• Convenience-based, materialistic lifestyles which creates waste • Rely on children/next generation to make changes • Owners do not fix homes

Visions	Values	Solutions	Challenges/Concerns
• Renewable energy • Less pesticides and chemical fertilizers and related cancer • Liveable wage to cover health costs and other basic needs • Affordable, decent housing • Better transit, bikeability • Access to public spaces, more public spaces • More leisure time	• Representation • Inclusiveness • Empathy	• Quality over convenience – reduce waste.	• More allergies, possibly related to environmental issues (water, climate) • Work more to provide good life for family; no time to spend with family – vicious cycle
Municipal Leaders (October 18th and October 25th, 2021; 13 attendees)			
• Bikeability (comfortable, safe) • Walkability (safe routes) • Communities across the region share resources and ideas • Proper land use planning for development. Prime agricultural lands are not converted.	• Sustainability as a priority • Shared goals • Accountability • Collaboration	• Development of a climate plan that has clear metrics and measures • Make it easy for town board to take action through up-front research/knowledge exchange • Convert gov't fleet to EV • LED street lighting • Streetscapes • Canal trail programs • Community Choice Aggregation • Education and awareness on climate change issues in the region	• More climate discussions need to occur at the county level • Lack of support for small towns <50,000 people (technical, financial, admin) • Many aren't convinced climate change is an issue; sees money spent as wasteful • Urban Sprawl • Need funding for EV chargers • Unsure about viability of electrification
Farmers (February 17th, 2022; 10 attendees)			
• Improved soil health and access to water • Net zero by dairy industry; energy producers • Land use planning for development. Prime agricultural lands are not	• Value soils • Farmer justice – farmer control over control by large corporations • Farmer welfare • Look at all sectors together	• Peer-to-peer farmer education on soil health practices • Connect farmers to consumers • Payment for ecosystem services & other incentivization mechanisms for soil health practices	• Consider net zero for dairy industry before thinking about just transition. • Farmers need more financial support for manure management practices

Visions	Values	Solutions	Challenges/Concerns
converted. Land is affordable for young/minority farmers. • Urban support for local farms		• Pilot community composting; subsidies for composting • Use cover crops as feed	• More support for small farmers • Concern that soil health does not have same priority as RE

2.3 Scenario analysis workshop (August 2021)

A scenario analysis workshop was conducted in August 2021 following the completion of many of the focus groups. The output from the focus groups suggested that transportation, housing, food and energy were top interests for the area with access to nutrition, affordability, urban sprawl and equity being issues that cut across all interest areas.

We conducted a 3-hour online workshop with participants from various sectors and community groups to understand which solutions to prioritize for each interest area. During the workshop we presented highlights from our focus group discussions including overlapping visions, values and solutions. We then split the participants into breakout groups for each interest area – transport, housing, food and energy. The participants in each group discussed solutions for the region for their specific interest area. The breakout groups were then mixed together, and the new breakout groups discussed the cross-cutting issues – equity, access, affordability and sprawl with a goal to provide coherent next steps for the region that addressed all areas of interest.

The results of the discussion are summarized below:

2.3.1 Housing

Opportunities

- Conversion of office buildings downtown to residential units to promote vertical growth
- Encourage mixed residential zoning in areas traditionally limited to single family homes
- The region can increase its population, take in climate refugees, migrants, and others through higher density housing.
- Fix tax credits for mixed use, green rehabilitation, green building codes
- Align incentives for landlords and city
- Create jobs and training opportunities in green construction for housing
- Cap rent increases and prioritize ownership
- More weatherization – radiant heat under streets
- Public green spaces to improve heat islands and improve attractiveness

Tensions

- School taxes shouldn't be tied to property ownership - creates an equity issue between schools and in education
- Currently weatherization grants are tied to income level

2.3.2 Transport

Opportunities

- Bike paths which are safe and connect to public transport
- Elevated walkspaces for major intersections although this is not a priority for this region
- Access to rural areas
- Bus cubes and shelters for comfortable ridership
- Link Toronto to NYC via Western NY Cities to provide economic boom
- Increase EV charging station infrastructure

Tensions

- Rural areas require more reliance on cars and harder to provide public transit options that can reduce emissions.
- Weather is a challenge – biking, waiting at bus-stops are more uncomfortable during winter

2.3.3 Food/Agriculture

Opportunities

- Reducing the distance food travels to get to our plates. Allow schools and hospitals to establish better connections to local farmers.
- Location for alternative energy sources often has an impact on agriculture if those are placed on farm land, but it can also provide financial benefits to struggling farms. Can we consider rooftop solar as an option to address land use?
- Community gardens to lower food scarcity

2.3.4 Energy

Opportunities

- Use small-scale distributed options
- Genesee River for hydroelectric power - keep using what is available
- Solar panel on every roof in the region

Tensions

- Lack of transparency about how decisions are being made; municipal leaders in rural areas receiving templated solutions from state
- Rural areas are seen as places of extraction, not as a resource; no meaningful consultation or consideration for indigenous communities; only options are large-scale utility projects

3 Regionally relevant climate policies and plans

In addition to solutions identified by stakeholders, existing policies and plans were reviewed for solutions that are already in place to lower emissions in the region. Relevant local, regional, state-level and federal policies are summarized below.

3.1 Local/County

City of Rochester's Climate Action Plan (2017): The City of Rochester's Climate Action Plan was endorsed by the city council in May 2017. The goal of the plan is to reduce greenhouse gas emissions by 40% by 2030. To do so the plan has identified implementation actions that align with the 2013 Finger Lakes Regional Sustainability Plan.

City of Rochester's Climate Vulnerability Assessment (2018): The City of Rochester conducted a climate vulnerability assessment to investigate baseline and projected climate conditions in the area and understand how climate change will affect the community, infrastructure and natural resources.

City of Rochester's Climate Resilience Plan (2019): The City of Rochester's Office of Energy and Sustainability developed a community-wide Climate Change Resilience Plan to enhance the city's ability to withstand the impacts of climate change. This plan builds on the findings from the Climate Vulnerability Assessment.

Village of Fairport's Sustainability Plan (2010): The Village of Fairport's sustainability plan outlines strategies for the village government and community to maximise their resources and increase the quality of life in the village.

Green Genesee/Smart Genesee Plan and Resiliency Plan (2021): The Green Genesee/Smart Genesee is a science based, community led sustainable land use planning project that can be used to strengthen comprehensive planning and land use regulation in Genesee County.

Monroe County Climate Action Plan (2020): The Monroe County Climate Action Plan provides steps to improve resiliency towards climate change in Monroe County as well as alternative policies and practices to reduce emissions in the area. The plan calls for climate change planning to be integrated into other planning and decision-making processes in the county.

Brighton Climate Action Plan (ongoing): The Brighton Climate Action Plan (CAP) aims to identify climate resilience initiatives in alignment with New York State's Climate Smart Communities objectives in order to maximize positive outcomes for the Town of Brighton. The CAP will identify greenhouse gas and energy reduction goals for the community as well as activities to achieve these goals.

3.2 Regional

Finger Lakes Regional Sustainability Plan (2013): The Finger Lakes Regional Sustainability Plan outlines actions for improving the long-term sustainability of the nine-county region. The plan identifies current greenhouse gas emissions and natural resource use and then outlines strategies for greenhouse gas emission reduction and the deployment of renewable energy sources. The plan also identifies sustainability goals for energy supply, water and waste management, housing, etc as well as actions to achieve these goals and barriers to implementation.

Genesee Finger Lakes Transportation Plan (2021): The Long Range Transportation Plan for the Genesee-Finger Lakes Region 2045 (LRTP 2045) establishes transportation priorities and provides directions for transportation policy, planning, and investment decision making for the Genesee-Finger Lakes Region. The plans seeks to advance regional transportation needs such as improved safety and expanded accessibility while safeguarding environmental resources.

Regional Transit Service (2021): According to the Regional Transit Service (RTS) 2021-2024 Comprehensive Strategic Plan, 25% of the RTS bus fleet to be EVs by 2025 and 100% by 2035.

3.3 State-level

Climate Leadership and Community Protection Act (2019): New York state has set statutory targets to reduce greenhouse gas emissions to 40% below 1990 levels by 2030 and no less than 85% below 1990 levels by 2050. The targets also aim for net-zero greenhouse gas emissions by 2050 and that 70% or all electricity generated in New York be renewable by 2030. The CLCPA also set up a Climate Action Council tasked with developing a Climate Action Plan for New York to achieve its CLCPA targets.

Climate Action Plan Scoping Report (2022) – New York States Climate Action Council released a draft scoping plan for how the state can achieve the targets outlines in the CLCPA. The plan calls for eliminating the use of fossil fuels in new home construction by 2025 and prohibiting fossil fuels in commercial buildings and multi-family homes by 2030.

Regional Greenhouse Gas Initiative (RGGI): New York is a participant in the Regional Greenhouse Gas Initiative (RGGI). RGGI is a cap-and-trade program to reduce CO_2 emissions from power plants. RGGI required that all fossil fuel-fired power plants with a capacity of 25 MW of higher be required to obtain an allowance for every ton of carbon dioxide that they emit annually. Each of participating states has set a goal of reducing emissions an additional 30% compared to 2020 levels by 2030.

Clean Energy Standard (2016): New York adopted a clean energy standard which requires 50% of the electricity consumed in the state to come from renewable energy sources by 2030.

Zero emissions cars and trucks (2021): New York adopted assembly bill A.4302/S.2758 that states that 100% of all new sales of passenger cars and trucks will be zero-emissions from 2035, medium-duty and heavy-duty vehicles by 2045 and off-road vehicles and equipment by 2035.

Building electrification (2022): In January 2022, Governor Hochul announced plans for 1 million electrified homes and 1 million electrification-ready homes by 2030 (approximately 3 million households in NY State) and zero-emissions construction by 2027.

3.4 Federal

NHTSA's Corporate Average Fuel Economy (CAFE) Standards: National Highway Traffic Safety Administration's **(**NHTSA's) Corporate Average Fuel Economy (CAFE) standards regulate the average distance vehicles must travel on a gallon of fuel. As per the 2021 rule, the standards require an industry-wide fleet average of approximately 49 miles per gallon (mpg) for passenger cars and light trucks in model year 2026 which is to be achieved by increasing fuel efficiency by 8% annually for model years 2024 and 2025, and 10% annually for model year 2026.

Greenhouse gas emission standards for passenger cars and light truck 2021-2026: The final rule (effective Feb 2022) puts in place standards that increase in stringency year-over-year by 10% in model year (MY) 2023, 5% in MY 2024, 6.6% in MY 2025, and by more than 10% in MY 2026. This would effectively mandate that electric vehicles increase their market share from 7% in 2023 to about 17%.

USDA's Climate-Smart Agriculture and Forestry Strategy: The USDA's Climate-Smart Agriculture and Forestry Strategy outlines practices to decrease wildfire risk, source sustainable bioproducts and take conservation actions that reduce carbon emissions and increase carbon sequestration. Techniques includes ruminant feed management, cover crops, irrigation efficiency, and more.

US NDC: Under the USA's Nationally Determined Contribution to the UN Framework Convention on Climate Change (UNFCCC), there is an economy-wide target of reducing the country's net greenhouse gas emissions by 50-52 percent below 2005 levels in 2030.

DOE Better Buildings, Better Plants: Better Plants is a voluntary partnership program run by the Department of Energy (DOE). Better Plants works with leading U.S. manufacturers and wastewater treatment agencies to set energy, water, and waste reduction goals, and to commit to reducing energy intensity by 25% over a 10-year period. In return, partners receive technical assistance, tools, resources, and national recognition.

Clean Air Act (proposed by the EPA): In 2021 the EPA proposed new rules that would support the use of cost-effective technology in reducing methane emissions. The impact of the rules would be a reduction in 41 million tons of methane emissions from 2023 to 2035.

USDA Conservation Reserve Program: CRP is a land conservation program run by the Farm Service Agency (FSA). Farmers enrolled in the program commit to removing environmentally sensitive land from agricultural production and plant species that will improve environmental health and quality instead. In exchange they receive a yearly rental payment.

4 Priority areas for emission reductions

The baseline emissions inventory estimated emissions across each sector both historically between 2010-2018 and in the future to 2050 based on historical emission trends. A summary of the top 15 sources of regional emissions in 2018 is given in Table 4 reflecting 81% of the region's emissions. Climate action around these sources of emissions should be prioritized.

Table 4: Top 15 sources of emissions in 2018 (in GWP20)

Sector	Subsector	Emissions ($MMtCO_2e$)	Share of Emissions (%)
Transport	Light passenger trucks	4.3	16%
Agricultural	Enteric fermentation	3.3	12%
Residential	Space Heating	3.2	12%
Transport	Cars	2.6	10%
Agricultural	Manure management	2.1	8%
Commercial	Natural gas consumption	1.1	4%
Transport	Heavy duty combination trucks	0.9	3%
Waste	Seneca Meadows Landfill	0.8	3%
Residential	Water Heating	0.7	3%
Residential	Other End Uses	0.7	2%
Waste	High Acres Landfill and Recycling Center	0.6	2%
Commercial	Electricity	0.5	2%
Losses	Fugitive Emissions	0.5	2%
Waste	Wastewater	0.5	2%
Transport	Rail	0.4	1%
Total		**22.1**	**81%**

5 Potential mitigation measures

Climate mitigation measures are actions that reduce greenhouse gas emissions. To identify with potential mitigation measures, we used the output from the survey results, focus groups and scenario workshops to analyse what kind of emission reduction measures were in line with the communities needs and wants. We also looked through the existing policy landscape (on a

regional, state and federal level) to see what kind of mitigation solutions are feasible – in that the policies required already exist and there is financial support for their uptake. Finally, we tried to identify measures that addressed the priority areas for emission reduction according to the baseline emissions inventory.

Based on this, the project team came up with a number of potential mitigation scenarios. We divided the measures into technical and non-technical categories. Technical actions were further evaluated in the emissions model developed during the emissions inventory phase of the project to determine the level of emissions reduction potential that these actions could achieve. However, many mitigation measures could not be quantified either because they have not been tried before so their impact on emissions is unknown and it is unclear to what degree they will be successful in this region (for example, shift to plant-based diets, reduced urban sprawl, etc). Many others could not be quantified simply because the data did not exist or was not readily available.

All other mitigation measures were quantified in the emissions model described in detail in the Baseline Emissions Inventory report. The remainder of this section summarizes the mitigation measures that were identified for each sector, and details on how the measures were quantified, and if they were quantified.

5.1 Technical measures

5.1.1 Energy Systems

Carbon-free grid (quantified): According to the Baseline Emissions Inventory report, around 40% of the region's electricity is from fossil fuel sources (natural gas, coal and oil). Most of the major utilities in the region meet their electricity demands through the wholesale electricity market run by the NY Independent Systems Operator (NYISO). NYISO selects the energy mix for utilities based on what is least-cost and available at the time, and despite Upstate NY's clean energy mix, most of the region's needs are met through from the power plant's located Downstate. As a result decarbonization of the state's entire grid is important. Electrification of buildings and vehicles means that there will be increased demand for electricity from the grid in the future. Some of these demands will be offset using more energy efficient equipment. However, decarbonization of the electricity grid is important to meeting emission reduction goals. This mitigation measure assesses the emissions reduction from the state meeting its goal of 100% carbon free grid. Some of the carbon free electricity could be met by renewable energy production in the region, such as rooftop solar, battery storage, community energy, community choice aggregation, and other technologies and policy instruments, however specific measures were not assessed. Instead, the emissions factor for electricity was adjusted to 0 according to the target date for when a carbon free grid is desired.

5.1.2 Residential

Building shell energy efficiency (quantified): Energy efficiency is the reduction in energy consumption from improvements in infrastructure or technologies. This mitigation measure

evaluates the emissions reduction from improvements to the building shell of a house or residential building. Improvements typically include replacement of old windows with thermal windows, replacement of insulation to reduce air leakage and heat loss, or weatherstripping around doors and windows. These building shell improvements lead to a reduction in heating and cooling needs, thus reducing energy consumption. We used the same assumptions as the NY Climate Action Plan Scoping Report, namely that households either had basic or deep shell improvements, resulting in specific levels of reduction in heating and cooling demands. We used the average reductions in our analysis.

- **Basic Shell Definition**: 27-44% reduction in space heating and 14-27% AC demands
- **Deep Shell Definition:** 57-90% reduction in space heating and 9-57% AC demands

Residential energy intensity for each space heating and cooling technology represents the baseline value from the U.S. Energy Information Administration's (US EIA's) 2015 Residential Energy Consumption Survey, adjusted for climate change impacts. For the building shell measure, we adjusted energy intensity by weighting the energy intensity of inefficient households to households undertaking either basic shell improvements or deep shell improvements. The number of households undertaking building shell improvements was changed under different scenarios, as described in the next section.

Space heating electrification (quantified): Residential space heating, largely from natural gas, contributes to 12% of the region's emissions. Electrification, or switching from fossil fuel-based space heating to electric heating, is an important area of climate action. This mitigation measure evaluates the emissions reduction from shifting to electric air-source heat pumps for space heating in households. The emissions reduction would be similar if the shift were to geothermal ground-source heat pumps, though this was not measured at this time. The share of households undertaking electrification are downscaled to each county from the 2030 building electrification targets for NY state set forth by Governor Hochul in early 2022.

Water heating electrification (quantified): Residential water heating, largely from natural gas, contributes to 3% of the region's emissions. This mitigation measure evaluates the emissions reduction from shifting to efficient electric heat pumps for water heating in households. The emissions reduction would be similar if the shift were to geothermal-based water heating, though this was not measured at this time. The share of households undertaking electrification are downscaled to each county from the 2030 building electrification targets for NY state set forth by Governor Hochul in early 2022.

Electrification of other energy services (quantified): Emissions from other residential end uses, like clothes washing or drying, cooking, refrigeration, electronics, represents 2% of the region's emissions. This mitigation measure evaluates the potential emissions reduction from shifting the use of fossil fuels for other residential end uses to electricity. The share of households undertaking electrification are downscaled to each county from the 2030 building electrification targets for NY state set forth by Governor Hochul in early 2022.

Appliance efficiency (not quantified): Federal appliance efficiency standards apply to all new appliances. However, the current model does not disaggregate other energy services into specific appliances, and furthermore the age of those appliances and whether they are high or low efficiency. Therefore, appliance efficiency cannot be measured at this time.

Water efficiency (not quantified): While the water heating electrification measure evaluates the shift from fossil fuel-based equipment to non-fossil fuel-based equipment, water efficiency measures can reduce energy demands in households for water heating and by water utilities for water treatment and distribution. It can also help save on water bills. Water efficiency measures include low-flow toilets, low-flow fixtures, or efficient washing machines and dishwashers. See the appliance efficiency measure for details on why this measure not evaluated at this time.

High density development (not quantified): The impact of high-density development on energy efficiency cannot be quantified in the current model as the residential sector has not been disaggregated by building type – single detached homes, semi-detached homes, low-rise buildings, high-rise buildings, etc.

Smart landscaping / native species (not quantified): The emissions reduction potential from smart landscaping and the reintroduction of native species in residential neighborhoods is unclear.

5.1.3 Transport

Shift to active transit and working from home (quantified)**:** Active transit options such as walking, biking and skateboarding improve air quality by reducing the need for fossil fuel vehicles. The vast majority of participants would like more walkable and bikeable communities through the expansion of sidewalks, pedestrian plazas, bike paths and trail towns, and through high-density development with houses and workplaces closer to each other. There are also more residents working from home as a result of the COVID-19 pandemic. This measure evaluates the potential emissions reductions from shifting from driving to active transit options or working from home.

Federal fuel economy standards (quantified): This mitigation measure evaluates the emission reduction potential from the NHTSA's Corporate Average Fuel Economy (CAFE) standard as described in Section 3.4. The fuel economy, or the average distance vehicles must travel on a gallon of fuel (mpg), for gasoline and diesel vehicles was adjusted according to the targets set in NHTSA's standards.

Electrification of light-duty vehicles (quantified): In accordance with the New York assembly bill A.4302/S.2758, this measure assumes that all 100% of all new sales of passenger cars and trucks will be zero-emissions from 2035. The proportion of new vehicles in each year from 2035 onwards are estimated using typical passenger car and truck sales rates for NY state from the NY Climate Scoping Plan. Early retirement of existing vehicles are estimated under some

emission reduction scenarios. For this mitigation measure to occur, there will need to be sufficient expansion of electric vehicle charging stations (both private and public), and incentives for lower income individuals, such as subsidies or tax credits.

Electrification of medium- and heavy-duty vehicles (quantified): In accordance with the New York assembly bill A.4302/S.2758, this measure assumes that all 100% of all new sales of medium- and heavy-duty trucks will be zero-emissions from 2045. The proportion of new vehicles in each year from 2045 onwards are estimated using typical medium- and heavy-truck sales rates for NY state from the NY Climate Scoping Plan. Early retirement of existing vehicles are estimated under some emission reduction scenarios. For this mitigation measure to occur, there will need to be substantial investment in electric vehicle charging stations.

Electrification of public buses (quantified): This measure follows the targets set forth in the Regional Transit Service (RTS) 2021-2024 Comprehensive Strategic Plan for 25% of the RTS bus fleet to be EVs by 2025 and 100% by 2035.

Electrification of school buses (not quantified): The electrification of school buses was mentioned by several participants in the stakeholder consultation meetings. However, currently our model does not disaggregate private buses by type. Since we do not know the proportion of private buses that are school buses, we are unable to determine the emissions reduction from electrifying school buses.

Shift from light duty vehicles to public transit (not quantified): It is unclear if public transit ridership will increase in the future from those that previously drove in passenger cars without a significant change in public transit systems. Changes can include expanding the geographic reach and efficiency of public transit, increase in frequency, cheaper fares, improved bus shelters, clean and sanitary buses, functioning bus stop apps, or the improved transfer systems between buses. During the COVID-19 pandemic there was a decrease in ridership and more people working from home. It is unclear to what extent this will persist into the future.

Carpooling and ridesharing (not quantified**):** There is insufficient data on the proportion of light duty vehicles used for carpooling or ridesharing with multiple passengers from different households. Ridesharing with multiple passengers from a single household is not considered an emission reduction measure.

Low carbon fuel (not quantified): Renewable natural gas (RNG), renewable distillate and hydrogen are considered low carbon fuels. The emissions reduction potential from these fuels were not assessed at this time as hydrogen vehicles are not yet readily available at a commercial-scale, and the characteristics (i.e., fuel economy, emissions) of vehicles that use RNG and renewable distillate are unclear.

Regional rail systems (not quantified): Many focus group participants mentioned the possibility for utilizing or repurposing existing, and in some cases, unused, rail lines for public transit systems

across the region. It is worth exploring the technical and financial viability of this option in the future.

5.1.4 Commercial

Building shell efficiency (quantified): This mitigation measure evaluates the emissions reduction from improvements to the building shell of a commercial building (Office / Government, Retail, Food Service, Grocery, Healthcare, Education, Lodging, Warehouse). Improvements typically include replacement of old windows with thermal windows, replacement of insulation to reduce air leakage and heat loss, or weatherstripping around doors and windows. These building shell improvements lead to a reduction in heating and cooling needs, thus reducing energy consumption. We used the same assumptions as the NY Climate Action Plan Scoping Report as was used for households, namely that buildings either had basic or deep shell improvements, resulting in specific levels of reduction in heating and cooling demands.

- **Basic Shell Definition**: 27-44% reduction in space heating and 14-27% AC demands
- **Deep Shell Definition:** 57-90% reduction in space heating and 9-57% AC demands

We used the average reductions in our analysis. In order to apply the reductions we had to first determine the amount of commercial energy demands that was used for heating and cooling. To do this, we used NYSERDA's 2018 *Commercial Statewide Baseline Study of New York State* to find the square footage of commercial area and estimate the share of commercial energy demands for heating and cooling. We first adjusted the heating cooling demands for climate change impacts, and then for the implementation of building shell measures. The square footage of commercial area undergoing building shell improvements was changed under different scenarios, as described in the next section.

Building electrification (quantified): This measure evaluates the potential emissions reduction from electrifying equipment in commercial building. This includes fossil fuels used for space heating, water heating and cooking. Similar to the commercial building shell efficiency scenario, we used NYSERDA's 2018 *Commercial Statewide Baseline Study of New York State* to find the square footage of commercial area and estimate the energy intensity of fossil fuel consumption per sq ft. We adjusted the energy intensity based on the amount of commercial area affected, which varied depending on the scenario analyzed, as described in the next section.

LED street lighting (not quantified): Publicly available data on street lighting in each county was not readily found. As a result, street lighting was not included in the emissions inventory and therefore we were unable to measure the potential emissions reduction from switching street lighting to LEDs. Many municipalities noted that they were undertaking this action, so it would be useful to include this measure in the future.

Schools as community hubs (not quantified): Many households do not have adequate heating and cooling systems to handle extreme weather events like heat waves and cold snaps. These

events are becoming more common as a result of climate change. Many focus group participants noted how schools could be used as community hubs (heating/cooling centers) during these events. The emissions from this type of action was not measured in this study.

5.1.5 Industrial

General efficiency measures (quantified): This measure assumes an improvement in efficiency across all industrial sub-sectors per the NY State Climate Scoping Plan. The level of efficiency improvement varies by scenario, as described in the following section.

Electrification of non-fossil equipment (quantified): This measure assumes a shift from fossil fuel to electricity across all industrial sub-sectors NY State Climate Scoping Plan. The level of electrification varies by scenario, as described in the following section.

Process emissions (not quantified): The NY State Climate Scoping Plan includes emissions reductions from carbon capture and storage (CCS) from cement and iron and steel production. Since CCS is not commercially available at this time, we did not quantify it in this analysis.

5.1.6 Agricultural

Manure management (quantified): Livestock manure accounts for 8% of the region's emissions. This mitigation measure looks to reduce manure-related emissions through the storage of manure and installation of methane capture systems. This measure assumes that the captured methane is flared, but it could also be used to generate electricity or further processed to create RNG.

Alley cropping (quantified): Alley cropping is defined as the planting of rows of trees and/or shrubs to create alleys within which agricultural or horticultural crops are produced. Alley cropping is not common in the region but could have benefits like improved water quality, such as from reduced runoff, in addition to emission reduction. The mitigation potential for the Genesee-Finger Lakes counties has been determined by multiplying the mitigation potential for the state as a whole by the ratio of the crop area in each county to the crop area of New York State under different scenarios.

Fertilizer Management (quantified): Fertilizer management results in reduced nitrous oxide emissions (direct and indirect) which can reduce algae blooms. Algae blooms are occurring more frequently among many of the Finger Lakes and Great Lakes. The mitigation potential for the counties in the Genesee-Finger Lakes has been determined by multiplying the mitigation potential for the state as a whole by the ratio of the crop area in each county to the crop area of New York State under different scenarios.

Alternative fertilizer (quantified): This measure assumes that the use of synthetic fertilizer is shifted to organic sources including dried manure and activated sewage, which have lower nitrous oxide emissions and reduces water pollution.

Cover Crops (quantified): Cover crops are planted in the off-season for the purpose of securing the soil rather than for being harvested, increase organic matter and suppress weed growth. Cover crops can be very useful in Genesee-Finger Lakes region particularly in vineyards. The mitigation potential for the counties in the Genesee-Finger Lakes has been determined by multiplying the mitigation potential for the state as a whole by the ratio of the crop area in each county to the crop area of New York State under different scenarios.

Alternative livestock feed (not quantified): Enteric fermentation accounts for 12% of regional emissions. Changing livestock diet through alternative feed has the potential to reduce enteric fermentation. Currently, this is occurring on a farm-by-farm basis as diets are specific to the farm and existing feed practices. While there is ongoing research about alternative diets for dairy cows, such as seaweed, this practice has yet to be scaled up.

Reduced tillage practices (not quantified): Reducing tillage decreases soil disturbance and soil erosion. The type of fertilizer used, and the manner in which it is applied, can make or break reduced tillage's ability to control greenhouse gases. Without having a full understanding of existing tillage practices, we were unable to quantify the impacts of reduced tillage.

Community gardens/year-round greenhouses (not quantified): Access to healthy, affordable, locally-grown produce has the potential to reduce emissions from transporting food from outside the region and promotes natural carbon removal through the expansion of green space. However, it is unclear the extent of developed areas that could be converted to community gardens. This should be further explored in the future.

Plant based diets (not quantified): Action to change consumer behaviour is currently a very sensitive issue. The UK government included changing consumer behaviour to encourage a shift to plant-based diets in their climate plan but had to remove it after facing backlash. While sales of plant-based milk and meats are expected to increase substantially in the next decade or so it is unclear to what extent this will result in a decrease in consumption of dairy and meat products. Our research on dairy consumption over the past five years suggested that although sales of dairy as milk had gone down (as a result of the entry of plant-based milks) dairy consumption overall (cheese, ice cream etc) had gone up. Therefore, the extent of plant-based diets affecting dairy production in the region is unclear.

Reduction in food waste at the production side (not quantified): The USDA and EPA goal to reduce food loss and waste by 50% by 2030. Currently 31% of all agricultural products is wasted. By 2030 existing policy aims to bring that down to 15.5%. However, the current rate of food waste in the region is not known.

5.1.7 Waste

Landfill gas capture (quantified): All of the large landfills in the region have landfill gas capture systems. The reduction in emissions from landfill gas are already incorporated in the baseline scenario.

Reducing consumption (not quantified): Most of the goods that we purchase are produced outside of the region, including appliances, vehicles, clothes, etc. The emissions that result from consuming goods are currently not included in the emissions inventory because the amount of goods that were produced from outside the region is not clear.

Waste diversion (not quantified): The amount of recycling waste, reusing or fixing goods is not readily available at a county level, and was not quantified at this time. This includes the diversion of food waste to community composting. There is also potential to generate electricity or produce fuel from compost.

5.1.8 Land

Afforestation of Former Agricultural Land (quantified): This mitigation measure evaluates the potential for emissions removal from the afforestation of former agricultural land. The mitigation potential for the counties in the Genesee-Finger Lakes has been determined by multiplying the mitigation potential for the state as a whole by the ratio of the crop area in each county to the crop area of New York State under different scenarios.

Parks and green space / urban trees (not quantified): The extent of developed land or vacant lands that are available for parks and green spaces is unclear. This should be explored further in the future.

5.2 Non-technical measures

A summary of the non-technical measures to facilitate emission reduction are as follows:

Improving living standards for some; reducing consumption for others: As shown in the Baseline Emissions Inventory report there is a clear connection between income and emissions. Moderate- to high-income households are consuming twice as much energy as lower income households. Addressing inequity is important for reducing emissions. Those that consume more need to heavily invest in energy efficiency and renewable energy. For lower income households, there is concern over living wages, affordable and energy efficient housing, access to healthy food, technological divide, poor transportation options, alongside greater health and livelihood burdens from climate change.

Education and awareness on climate change: Many survey respondents noted that they had some knowledge of climate issues but were unclear of how it affected the region and the breadth of climate solutions that were available. Institutional leadership and policymakers often view climate issues as a separate issue, when in reality, it affects every aspect of our lives – where we live, how we live, how we move. More awareness is needed through media, social media, workplaces, as well as improvements to educational curriculum across levels. Hands-on learning is also encouraged to understand the importance of nature to our lives and livelihoods as many of us are disconnected from nature. Peer-to-peer learning is also encouraged.

Municipalities can share their experiences in enacting climate policies, and businesses can share sustainable business practices, farmers can share regenerative agriculture measures.

Supporting clean energy businesses and training programs: The energy efficiency and renewable energy needs will not be achieved without a sufficient workforce to do the work. There needs to be substantial investment in supporting entrepreneurs in this area, and building the workforce through affordable training programs, including feeder programs from high schools. There is strong interest in the region becoming a clean manufacturing hub for heat pumps, energy storage, solar panels and more. Plans for the full renewable energy supply chain is needed.

Funding: To make the mitigation measures happen, they need to be funded. Financial instruments including subsidies, loans, grants and taxes are necessary. This could include cost on carbon, payment for ecosystem services for farmers to invest in soil health, support for businesses, cap on grid interconnection costs for renewables, financing of energy efficiency projects and more. Funding measures also need to be easily accessible without significant paperwork.

Codes and standards: Many examples of potential codes and standards emerged from the stakeholder discussions including updated green building codes, water taking permits, requiring landlords of existing buildings and developers of new buildings to meet energy efficiency standards, limit building permits for new buildings in sensitive ecosystems, ensuring all solar farms/wind turbines/new factories under extensive siting assessments.

6 Scenario description

The emissions reduction of each of the above measures are combined with other measures to create a scenario. An integrated framework is adopted that avoids double counting of emission reductions from each measure. For example, if analyzed separately, more efficient cars, lower carbon fuels, and increased non-motorized travel may all avoid the same baseline transportation emissions, thus overstating emission reductions. The analyzed three scenarios building from the baseline scenario developed in Phase 1. The scenario descriptions are as follows and detailed descriptions of the measures and level of ambition is provided in Table 5.

Existing policies: Based on our analysis of emission reduction options, we assembled a suite of measures that each county could undertake, with active participation from businesses, residents, and partner institutions and jurisdictions. This first scenario assumes emissions reductions over the baseline scenario expected if current federal, state and regional targets and plans are met in full.

Existing policies plus low ambition: Our second scenario (low ambition) postulates further actions by each county beyond the first scenario that seems politically and socially feasible in the short term. We have based our understanding of the feasibility of these measures from the

focus group outputs – specifically the values and visions of the local communities and specific challenges identified as well as what is outlined as feasible in the NY Climate Scoping document. The target goal for this scenario is to meet the 85% reduction in emissions outlined in CLCPA.

Existing policy plus high ambition: Scenario 3 (high ambition) is more ambitious measures that need to be taken to go beyond an 85% reduction in emissions by 2050. This scenario helps to elucidate the maximum emission reductions that the Region could achieve.

While ultimately, the scenario analyses will provide useful guidance for evaluating pathways to "close the gap" between the region's projected emissions and the potential climate goals, it will be important to recognize that, given large uncertainties looking out 30 years, these scenarios will not necessarily provide a specific recommended way forward: moving from the visioning of the scenario analysis to the practical elements of strategy development is the role of Phase 3.

Table 5: Scenario details

Sector	Sub-sector	Existing Policy Scenario	Low Ambition Policy Scenario (meeting 85% reduction in emissions by 2050)	High Ambition Policy Scenario (beyond 85% reduction in emissions by 2050)
Electricity Generation	**Generation Capacity**	**GRID1: Carbon Free Grid 2040** - In line with the CLCPA, this measure seeks to have a carbon free grid by 2040. Emissions produced from Electricity Generation are slowly reduced to 0 tCO2 per unit of energy in 2040.	**GRID2: Carbon Free Grid 2035 -** Going beyond the CLCPA, this measure seeks to have a carbon free grid by 2035. Emissions produced from Electricity Generation are slowly reduced to 0 tCO2 per unit of energy in 2030.	**GRID3: Carbon Free Grid 2030 -** Going beyond the CLCPA, this measure seeks to have a carbon free grid by 2030. Emissions produced from Electricity Generation are slowly reduced to 0 tCO2 per unit of energy in 2030.
Transport	**Fuel economy**	**CAFE: Fuel Standards -** NHTSA's Corporate Average Fuel Economy (CAFE) Standards	Since it is unclear if the region can influence car manufacturers, a higher ambition scenario is likely not possible. Therefore, we will use the same assumptions as the existing policy scenario.	Since it is unclear if the region can influence car manufacturers, a higher ambition scenario is likely not possible. Therefore, we will use the same assumptions as the existing policy scenario.
Transport	**Light duty vehicles**	**EVLDV1: EV LDV Scenario Reference -** In accordance with state legislation A.4302/S.2758, this scenario assumes that 100% of all new sales of passenger cars and trucks from 2035 onwards will only be BEVs.	**EVLDV2: EV LDV Scenario Low -** This scenario assumes that through subsidies and other incentives provided by the region, it might be possible for 100% of passenger and truck sales from 2035 onwards to be BEVs, and for 10% of LDVs to undergo early retirement before 2030.	**EVLDV3: EV LDV Scenario High -** This scenario assumes that through subsidies and other incentives provided by the region, it might be possible for 100% of passenger and truck sales from 2035 onwards to be BEVs, and for 25% of LDVs to undergo early retirement before 2030.
Transport	**Heavy duty vehicles**	**EVMHV1: EV MHDV Scenario 2045 -** In accordance with legislation A.4302/S.2758, this scenario assumes that 100% of new sales of medium and	**EVMHV2: EV MHDV Scenario 2040 -** This scenario assumes that through subsidies and other incentives all new	**EVMHV3: EV MHDV Scenario 2035 -** This scenario assumes that through subsidies and other incentives all new

Sector	Sub-sector	Existing Policy Scenario	Low Ambition Policy Scenario (meeting 85% reduction in emissions by 2050)	High Ambition Policy Scenario (beyond 85% reduction in emissions by 2050)
		heavy duty trucks from 2045 onwards will only be EVs.	sales of medium and heavy trucks from 2040 onwards will only be EVs.	sales of medium and heavy trucks from 2035 onwards will only be EVs.
Transport	**Electrification of Public buses**	**EVBUS1: Electric Buses -** According to the Regional Transit Service (RTS), 25% of the RTS bus fleet to be EVs by 2025 and 100% by 2035. According to the RTS' 2021-2014 Comprehensive Strategic Plan, it has 395 buses in its fleet.	Since the RTS covers all public buses in the region, the same assumptions as the existing policy scenario are used.	Since the RTS covers all public buses in the region, the same assumptions as the existing policy scenario are used.
Transport	**Biking/walking/working from home**	Same as baseline scenario.	**BIKE1: More Biking 10 -** This scenario assumes that by 2030, 10% of vehicle miles traveled from LDVs will decline due to an increase in biking, walking, and working from home and 20% by 2050.	**BIKE2: More Biking 25 -** This scenario assumes that by 2030, 25% of vehicle miles traveled from LDVs will decline due to an increase in biking, walking, and working from home and 35% by 2050.
Residential	**Building shell efficiency**	**RESSHEL1: Residential Building Shell Reference -** This scenario uses the assumptions from the NY State Integration Analysis reference scenario which says that by 2030, 3% of households will have a Deep Shell and 4% a Basic Shell and by 2050, 5% of households will have a Deep Shell and 10% will have a Basic Shell. A more efficient building shell translates into a	**RESSHEL2: Residential Building Shell Low -** This scenario uses the assumptions from the NY State Integration Analysis scenario 1 which says that by 2030, 3% of households will have a Deep Shell and 10% a Basic Shell and by 2050, 12% of households will have a Deep Shell and 56% will have a Basic Shell. A more efficient building shell translates into a	**RESSHEL3: Residential Building Shell High -** This scenario uses the assumptions from the NY State Integration Analysis scenario 4 which says that by 2030, 7% of households will have a Deep Shell and 18% a Basic Shell and by 2050, 26% of households will have a Deep Shell and 66% will have a Basic Shell. A more efficient building shell translates into a

Sector	Sub-sector	Existing Policy Scenario	Low Ambition Policy Scenario (meeting 85% reduction in emissions by 2050)	High Ambition Policy Scenario (beyond 85% reduction in emissions by 2050)
		reduction in space heating and air conditioning needs.	reduction in space heating and air conditioning needs.	reduction in space heating and air conditioning needs.
Residential	**Space heating electrification**	**RESSPAC1: Residential Space Heating Electrification Reference** - This scenario is based off of Gov. Hochul's plan to have 31% of NY households electrified by 2030 and continuing at the same trajectory to 2050.	**RESSPAC2: Residential Space Heating Electrification Low** - This scenario is assumes that 50% of households will be electrified by 2030 and continuing at the same trajectory to 2050.	**RESSPAC3: Residential Space Heating Electrification High** - This scenario is assumes that 70% of households will be electrified by 2030 and continuing at the same trajectory to 2050.
Residential	**Water heating electrification**	**RESWATR1: Residential Water Heating Electrification Reference** - This scenario is based off of Gov. Hochul's plan to have 31% of NY households electrified by 2030 and continuing at the same trajectory to 2050.	**RESWATR2: Residential Water Heating Electrification Low** - This scenario assumes that 50% of households will be electrified by 2030 and continuing at the same trajectory to 2050.	**RESWATR3: Residential Water Heating Electrification High** - This scenario assumes that 70% of households will be electrified by 2030 and continuing at the same trajectory to 2050.
Residential	**Electrification of other energy services**	**RESOTHR1: Residential Other Electrification Reference** - This scenario is based off of Gov. Hochul's plan to have 31% of NY households electrified by 2030 and continuing at the same trajectory to 2050.	**RESOTHR2: Residential Other Electrification Low** - This scenario assumes that 50% of households will be electrified by 2030 and continuing at the same trajectory to 2050.	**RESOTHR3: Residential Other Electrification High** - This scenario assumes that 70% of households will be electrified by 2030 and continuing at the same trajectory to 2050.
Commercial	**Building shell efficiency**	**COMSHEL1: Commercial Building Shell Reference -** This scenario uses the assumptions from the NY State Integration Analysis reference scenario which says that by 2030, 3% of	**COMSHEL2: Commercial Building Shell Low -** This scenario uses the assumptions from the NY State Integration Analysis scenario 1 which says that by 2030, 3% of commercial	**COMSHEL3: Commercial Building Shell High -** This scenario uses the assumptions from the NY State Integration Analysis scenario 4 which says that by 2030, 7% of commercial

Sector	Sub-sector	Existing Policy Scenario	Low Ambition Policy Scenario (meeting 85% reduction in emissions by 2050)	High Ambition Policy Scenario (beyond 85% reduction in emissions by 2050)
		commercial buildings will have a Deep Shell and 4% a Basic Shell and by 2050, 5% of commercial buildings will have a Deep Shell and 10% will have a Basic Shell. A more efficient building shell translates into a reduction in space heating and air conditioning needs.	buildings will have a Deep Shell and 10% a Basic Shell and by 2050, 12% of commercial buildings will have a Deep Shell and 56% will have a Basic Shell. A more efficient building shell translates into a reduction in space heating and air conditioning needs.	buildings will have a Deep Shell and 18% a Basic Shell and by 2050, 26% of commercial buildings will have a Deep Shell and 66% will have a Basic Shell. A more efficient building shell translates into a reduction in space heating and air conditioning needs.
Commercial	**Electrification**	**COMELEC1: Commercial Electrification Reference -** Using the reference scenario from the NY state Integration Analysis, this scenario assumes that 2% of commercial buildings are electrified by 2030 and 3.5% by 2050	**COMELEC2: Commercial Electrification Low -** Using the scenario 1 from the NY state Integration Analysis, this scenario assumes that 11.5% of commercial buildings are electrified by 2030 and 94% by 2050	**COMELEC3: Commercial Electrification High -** Using the scenario 4 from the NY state Integration Analysis, this scenario assumes that 27% of commercial buildings are electrified by 2030 and 99% by 2050
Industrial	**General efficiency measures**	**INDEFF1: Industrial Efficiency Reference -** Using the reference scenario from the NY state Integration Analysis, this scenario assumes a 10% increase in industrial efficiency by 2025.	**INDEFF2: Industrial Efficiency Low** - Using the scenario 1 from the NY state Integration Analysis, this scenario assumes a 10% increase in efficiency by 2025, 30% by 2050.	**INDEFF2: Industrial Efficiency High** - Using the scenario 2 from the NY state Integration Analysis, this scenario assumes a 20% increase in efficiency by 2030, 40% by 2050.
Industrial	**Electrification of non-fossil equipment**	Same as baseline scenario. Based on the reference scenario from the NY state Integration Analysis, no changes are applied.	**INDELEC1: Industrial Electrification Low -** This scenario is based on the scenario 1 from the NY state Integration Analysis whereby 4% of natural gas use is electrified by 2030 and 33% by 2050.	**INDELEC2: Industrial Electrification High** - This scenario is based on the scenario 4 from the NY state Integration Analysis whereby 4% of natural gas use is electrified by 2030 and 83% by 2050.

Sector	Sub-sector	Existing Policy Scenario	Low Ambition Policy Scenario (meeting 85% reduction in emissions by 2050)	High Ambition Policy Scenario (beyond 85% reduction in emissions by 2050)
Agriculture	**Fertilizer**	Same as baseline scenario.	**SOILFERT1: Alternate Fertilizer Low -** This scenario assumes that by 2030, 25% of fertilizer use switches from synthetic sources to organic sources including dried manure and activated sewage, and 50% by 2050.	**SOILFERT2: Alternate Fertilizer High -** This scenario assumes that by 2030, 50% of fertilizer use switches from synthetic sources to organic sources including dried manure and activated sewage, and 80% by 2050.
Agriculture	**Manure management**	Same as baseline scenario.	**MANURE1: Biogas capture Low** - Using the same assumptions as the NY state Integration Analysis, this scenario assumes that by 2030, 50% of emissions from manure will be captured, and 76% by 2050.	Same as low ambition scenario
Agriculture	**Alley Cropping**	Same as baseline scenario.	**ALLEY1: Alley cropping low -** This scenario assumes a reduction of 0.140 MMT CO2e/yr downscaled from the state-level mitigation estimates from McDonnell and Sullivan (2020).	**ALLEY2: Alley cropping high -** This scenario assumes a reduction of 0.174 MMT CO2e/yr downscaled from the state-level mitigation estimates from McDonnell and Sullivan (2020).
Agriculture	**Fertilizer management**	Same as baseline scenario.	**FERTMNG1: Fertilizer management low -** This scenario assumes a reduction of 0.052 MMT CO2e/yr downscaled from the state-level mitigation estimates from McDonnell and Sullivan (2020).	**Same as low ambition scenario**
Agriculture	**Cover Crops**	Same as baseline scenario.	**COVRCRP1: Cover crops low -** This scenario assumes a reduction of 0.215	**COVRCRP2: Cover crops high -** This scenario assumes a reduction of 0.221

Sector	Sub-sector	Existing Policy Scenario	Low Ambition Policy Scenario (meeting 85% reduction in emissions by 2050)	High Ambition Policy Scenario (beyond 85% reduction in emissions by 2050)
			MMT CO2e/yr downscaled from the state-level mitigation estimates from McDonnell and Sullivan (2020).	MMT CO2e/yr downscaled from the state-level mitigation estimates from McDonnell and Sullivan (2020).
Land Use	**Reforestation of Former Ag Land**	Same as baseline scenario.	**AFOREST1**: This scenario is based on McDonnell (2020) analysis of the low ambition mitigation effect of afforestation of agricultural land in New York State. Considering the proportion of crop area in the Genesee-Finger Lakes region to that of the entire state the scenario assumes a reduction GHG Mitigation of 0.989 MMT CO2e/yr	**AFOREST1**: This scenario is based on McDonnell (2020) analysis of the high ambition mitigation effect of afforestation of agricultural land in New York State. Considering the proportion of crop area in the Genesee-Finger Lakes region to that of the entire state the scenario assumes a reduction GHG Mitigation of 1.272 MMT CO2e/yr
Waste	**Landfill gas / biogas management**	Same as baseline scenario.	Same as baseline scenario	Same as baseline scenario.

7 Scenario analysis results

The results of the scenario analyses are presented in this section. The emissions reduction possible in each scenario are compared to the targets set forth in the CLCPA of 40% reduction of gross emissions by 2030 compared to 1990 emissions, 85% reduction of gross emissions by 2050 and net zero emissions by 2050.

7.1 Existing policy scenario

Under the existing policy scenario, the total amount of emissions reductions achieved through the implementation of existing plans and policies is 10.57 Million Metric Tons of Carbon Dioxide Equivalent ($MMTCO_2e$) by 2050. This is equivalent to a 34% reduction in emissions compared to 1990 emissions, meaning that the CLCPA target for 2050 is not achievable through existing policies.

Around 57% of the emissions reductions is from transportation, followed by 21% from decarbonizing the grid and 20% from building efficiency and electrification.

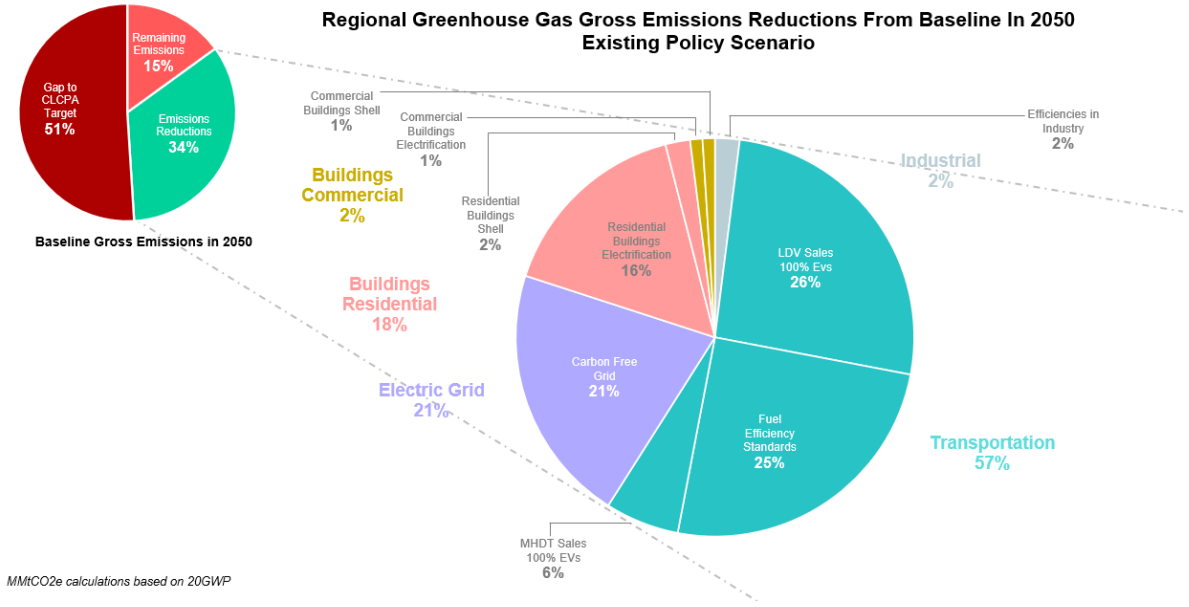

Figure 4: Results of Existing Policy Scenario

7.2 Existing policy scenario + low ambition

Under the existing policy plus low ambition scenario, the total amount of emissions reductions achieved is 18.57 $MMTCO_2e$ by 2050. This is equivalent to a 61% reduction in emissions compared to 1990 emissions, meaning that the CLCPA target for 2050 is not achievable through even with more ambitious policies.

Compared to the previous scenario where the emissions reduction from agricultural sector were limited, the agricultural sector has around 14% of the emissions reduction in this scenario. This is because most of the focus of the state-level policies are around transport and residential since agriculture only makes up 6% of the state's emissions. Since agriculture plays a much larger role in the region, there is more emphasis on agricultural mitigation measures.

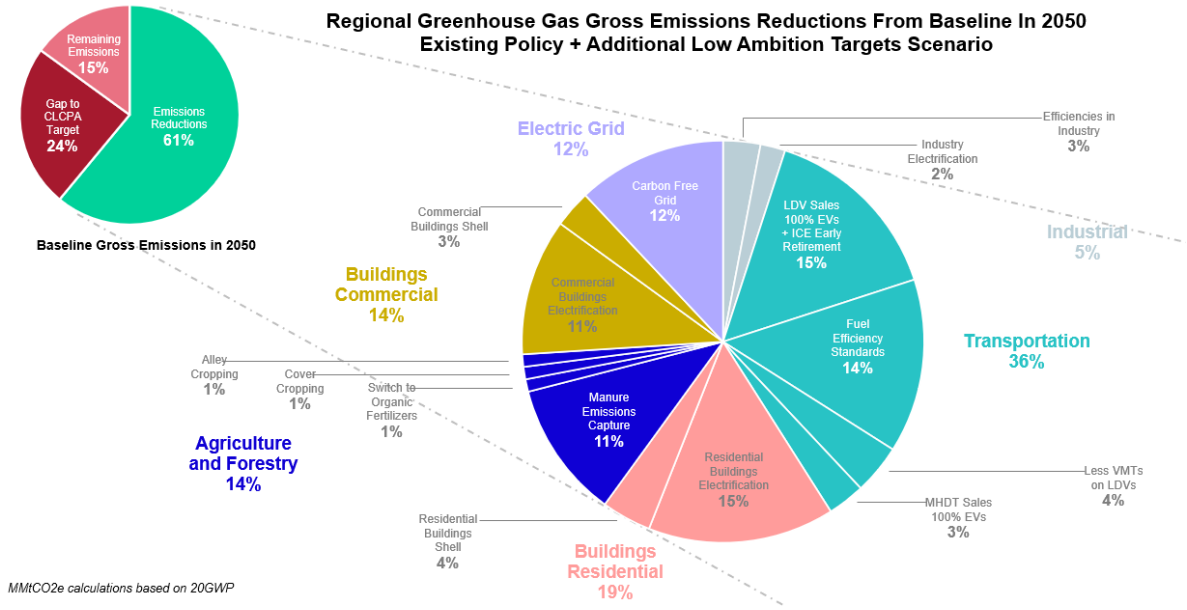

Figure 5: Results of Low Ambition Scenario

7.3 Existing policy scenario + high ambition

Under the existing policy plus high ambition scenario, the total amount of emissions reductions achieved is 20.27 $MMTCO_2e$ by 2050. This is equivalent to a 66% reduction in emissions compared to 1990 emissions, meaning that the CLCPA target for 2050 is not achievable through even with more ambitious policies.

The remaining 19% of emissions that prevents us from meeting the CLCPA goals are from solid waste (landfill) emissions and agricultural emissions. The region hosts the largest landfills in the state with waste coming in from all over New England, Canada as well as New York. Despite significant landfill capture measures, there is still some methane leakage occurring that might be difficult to contain simply due to the landfill size.

For the agricultural sector, the emissions that remain are primarily from enteric fermentation processes of dairy cows. As mentioned in Section 5, while there is significant research into alternative feed and diets to reduce enteric fermentation emissions, the scale of their uptake is unclear.

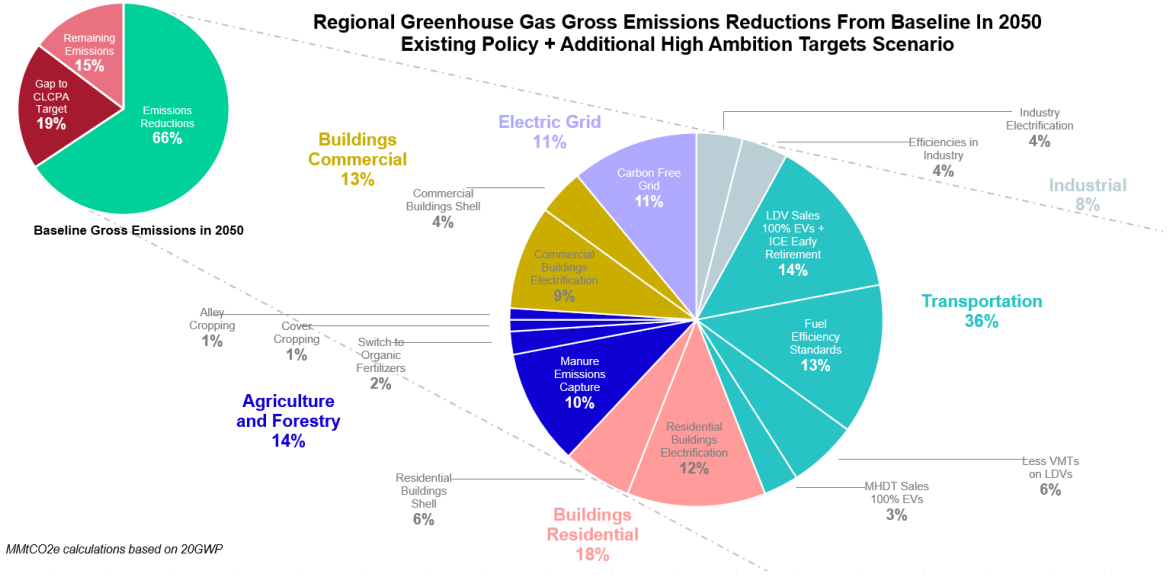

Figure 6: Results of High Ambition Scenario

7.4 Summary of regional emission scenarios

A summary of the findings from the scenarios is presented in Figure 7 below. The Existing Policy + High Ambition scenario achieves the intermediate 2030 target due from the suggested emission reduction measures proposed. As mentioned in Section 5, there are several scenarios that we were unable to quantify at this time. It is possible that the CLCPA goals could be achieved if additional data is made available to enable the quantification of all proposed measures.

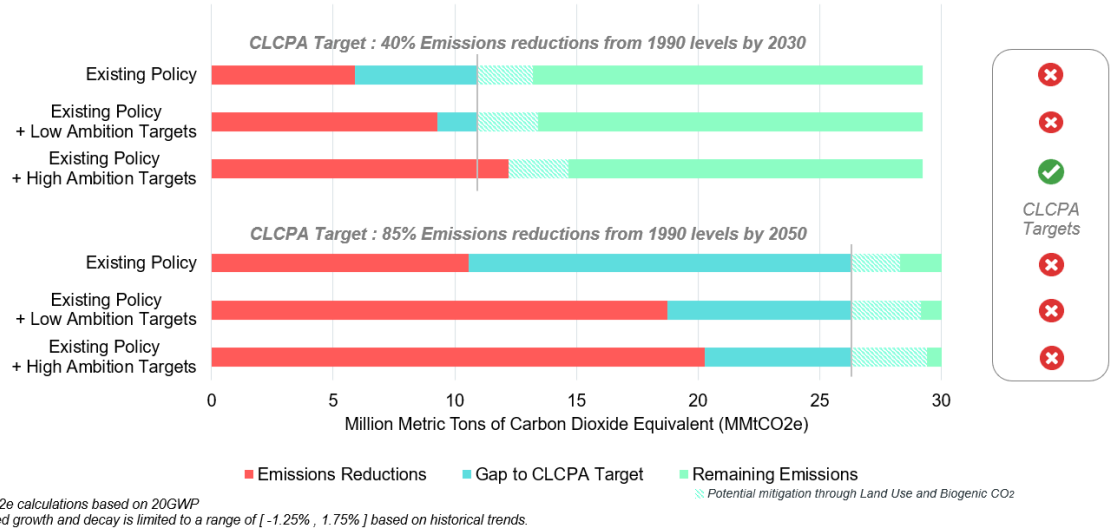

Figure 7: Comparison Between Regional Greenhouse Gas Emissions Mitigation Scenarios

APPENDIX A

April 2021 Survey Questions

Appendix A: April 2021 Survey Questions

Question Number	Question Text
Q1	Many climate solutions can be used to address other areas of community need. To better understand what community needs, please select your top three priorities for our Region. • Access to clean water • Affordable housing • Air quality • COVID relief • Criminal justice/police reform • Drug abuse prevention or rehabilitation • Economic development • Education improvements • Employment opportunities • Energy costs • Eviction prevention • Extreme weather events • Food access/quality • Health care access/quality • Local government reform • Open space improvements • Racial justice • Recreational opportunities • Renewable energy development • Transportation improvements • Violence prevention/reduction • Other_____
Q2	Climate solutions can provide additional benefits to local communities. Select your top three priorities for solutions that both reduce greenhouse gas emissions and provide community benefits. • Active transit opportunities (e.g. bike lanes and sidewalks) that improve air quality by reducing the need for fossil fuel vehicles and improve the walkability of our communities • Agricultural practices that can increase agricultural yield and the availability of nutritious food while improving water quality of nearby waterways • Brownfield remediation projects that address environmental hazards and increase property values

Question Number	Question Text
	• Clean energy job opportunities that improve our infrastructure and provide above average wages and benefits • Composting programs that reduce harmful emissions by keeping food scraps out of landfills and generating sustainable sources of fertilizer • Efficient clean heating and cooling technologies that improve home comfort and indoor air quality by providing heat and air conditioning without burning fossil fuels • Electrical grid improvements that accommodate more renewable energy sources and reduce the likelihood of power outages • Energy efficiency and weatherization improvements that reduce household utility costs indoor air pollutants mold and pests while making the home more comfortable for residents • Land use planning decisions that locate amenities e.g. grocery stores urban farms/farmers markets and parks in local neighborhoods creating more walkableprosperous communities • Open space and green space development that provides recreational opportunities and reduces temperatures • Public transportation improvements that reduce commute times and improve access to jobs and services • Renewable energy projects that reduce our dependence on imported fossil fuels • Sustainability related research and development to position our Region as a leader in next generation energy technologies • Sustainability-themed businesses that provide local economic development opportunities • Other:_____
Q3	What is your level of knowledge or understanding about how climate change will impact our Region? • I don't care about how climate change will impact our Region. • Not at all knowledgeable • Not very knowledgeable • Somewhat knowledgeable • Very knowledgeable
Q4	What is your level of knowledge or understanding about what climate solutions are appropriate for our Region? • I don't care about which climate solutions are appropriate for our Region. • Not at all knowledgeable • Not very knowledgeable • Somewhat knowledgeable

Question Number	Question Text
	• Very knowledgeable
Q5	What is your level of knowledge or understanding about climate or environmental justice? • I don't care about climate or environmental justice. • Not at all knowledgeable • Not very knowledgeable • Somewhat knowledgeable • Very knowledgeable
Q6	What is your level of knowledge or understanding about how to access energy efficiency programming or incentives? • I don't care about accessing energy efficiency programming or incentives. • Not at all knowledgeable • Not very knowledgeable • Somewhat knowledgeable • Very knowledgeable
Q7	What is your level of knowledge or understanding about how to access renewable energy programs and incentives? • I don't care about accessing renewable energy programs or incentives. • Not at all knowledgeable • Not very knowledgeable • Somewhat knowledgeable • Very knowledgeable
Q8	In your opinion, which of the following would be most helpful for increasing the adoption of energy efficiency and clean heating and cooling technologies in residential properties? • Ban all gas hookups in new building construction. • Educate property owners about the importance of reducing energy use and the availability of programs that can help them reduce energy usage. • Increase financial incentives for weatherization measures (e.g. insulation and air sealing) and clean heating and cooling technologies (i.e., heat pumps). • Reduce paperwork and other requirements to simplify and streamline the process of enrolling in residential energy programs. • Require landlords to meet energy efficiency standards to receive a certificate of occupancy for a property.

Question Number	Question Text
	• Other:_____
Q9	In your opinion, which of the following transit options should be prioritized? • Expanding access to electric vehicle charging stations • Expanding bike lanes and bike paths • Expanding sidewalks and pedestrian plazas to create safer, more walkable communities • Expanding the geographic reach and efficiency of public transit • Other:_____
Q10	In your opinion, which of the following land use and development options should be prioritized? • Consolidate/merge local governments to better coordinate development and reduce inefficiency • High-density development that makes alternative transit (e.g., walking, biking, and public transit) more feasible, and preserves open space and agricultural lands • Inter-municipal and regional community planning that designates priority development and conservation areas, curbs inefficient development and over-development, revitalizes cities and villages, and preserves open space and agriculture • Overhaul current zoning codes and rules to increase flexibility, innovation, and access • Other:_____
Q11	In your opinion, which of the following agricultural practices should be prioritized? • Co-developing agricultural land for renewable energy projects (e.g., solar and wind projects) and agricultural production (e.g., sheep farming, beekeeping, fruit and vegetable production) • Convert waste to energy by using animal and crop waste to create biogas for electricity • Develop a soil health label similar to the organic label that indicates sustainable agricultural practices • Educate farmers about climate-friendly agricultural practices • Modify crop insurance programs to provide protections for farmers practicing climate-friendly agricultural production • Provide payment to farmers for ecosystem services (e.g., carbon sequestration, soil health, pollinator services, improving water quality) • Other:_____

Question Number	Question Text
Q12	In your opinion, which of the following technologies are appropriate for our Region? • Expanding hydrogen fuel cell production • Expanding nuclear production capabilities • Expanding renewable natural gas (or biogas) • Expanding solar farms • Expanding utility-scale energy storage facilities • Expanding wind farms
Q13	In your opinion, which of the following best captures why climate solutions have not been widely implemented in our community? • Many perceive that the necessary technology to address climate change has not yet been developed. • Public perceptions that the costs associated with addressing climate change exceed the benefits of taking action. • There is a lack of knowledge about local climate change impacts and potential solutions. • There is a lack of political will and community leadership in prioritizing climate change in our community. • Other:_____
Q14	In your opinion, how should we fund climate solutions? • Corporations should pay a carbon fee or taxes for greenhouse gas emissions. • Individuals should be willing to pay more for climate-friendly products and services. • The government should prioritize funding for climate solutions without raising taxes. • The government should raise taxes to fund climate solutions. • Other:_____
Q15	In your opinion, what is most needed to address climate change in our Region? • Education. People do not understand what needs to be done to address climate change. • Laws. People will not take action to address climate change unless required. • Leadership. People are hesitant to take action because they do not want to be the first in their communities to do so. • Money. The Region does not have the resources necessary to take action. • Other:_____

Question Number	Question Text
Q16	How willing are you to adopt sustainability measures in your own life/household? • Not at all willing • Not very willing • Somewhat willing • Very willing
Q17	What barriers prevent you from adopting sustainability measures in your own life/household? • I already take advantage/implement the full range of sustainability measures. • I do not have the necessary financial resources to implement sustainability measures. • I do not have the necessary knowledge to implement sustainability measures. • I do not have the necessary time to implement sustainability measures. • I do not own my own house and that largely prevents me from implementing sustainability measures. • Implementing sustainability measures is not something I am interested in. • Other:_____
Q18	If you could implement one solution to address a community or neighborhood need, what would it be?
Q19	What is your zip code?
Q20	Which of the following best describes you? Please select one answer. • White or Caucasian • Hispanic or Latino • Multiracial/Biracial • Black/African American • Asian or Pacific Islander • Native American or Alaskan Native • Other: _____
Q21	What is your household size? • 1 • 2 • 3 • 4 • 5

Question Number	Question Text
	• 6 • 7 • 8+
Q22	Which of the following best captures your annual household income? • <$25K • $25-$50K • $50-$75K • $75-$100K • $100-$125K • >$125K
Q23	What is your highest level of education completed? • Grade school • High School • Associates or trade degree • Bachelor's degree • Advanced degree
Q24	Which of the following best describes you? - Selected Choice • Woman • Man • Non-Binary • Prefer not to answer • Prefer to self-identify:_____

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