Go All Electric
Community Impact Initiative
Phase A: Community Strategy

September 25, 2019
Updated April 14, 2021

CAUSEWAVE community partners

HOW CHANGE GETS GOING℠

About Causewave

Causewave Community Partners is a nonprofit organization that partners with causes and organizations to ignite change around their missions. Local businesses and volunteers partner with Causewave staff to serve over 200 nonprofits each year in the areas of nonprofit management, professional development, fundraising, strategic planning and marketing. Causewave was founded in 1950 as The Advertising Council of Rochester.

Mission

We make communities stronger by bringing voice to diverse public issues and needs and building capacity within nonprofit organizations.

About Climate Solutions Accelerator

Climate Solutions Accelerator
of the Genesee-Finger Lakes Region

The Climate Solutions Accelerator, formerly Rochester People's Climate Coalition, is an inclusive, non-partisan 501(c)(3) nonprofit dedicated to inspiring and facilitating a large-scale climate mobilization in the nine-county Genesee-Finger Lakes Region.

Mission

To create a healthier, more equitable, and environmentally sustainable community by catalyzing local efforts to eliminate greenhouse gas emissions and address the effects of climate change.

Phase A Funding for Go All Electric was provided by the Accelerator

Go All Electric Phase A Steering Committee

This report would not have been possible without this group's dedication and hard work.

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Glossary of Terms

Below is a non-exhaustive list of terms along with definitions for how they are used in this report

- **Carbon-free**: emits no no carbon dioxide or other Greenhouse gasses (CO2 equivalent).
- **Carbon neutral**: minimal greenhouse gas emissions are emitted but the are removed in equal proportion, in other place in the community.
- **Charging infrastructure**: All infrastructure relating to charging electric vehicles, ranging from public charging stations to at-home charging ports.
- **Dispatchable demand:** Electricity demand (heating, air conditioning, etc.) that responds to electricity system needs in order to operate when energy is plentiful and shut down when it is scarce. Eliminates energy over-production and manages renewables.
- **Energy burden**: The amount of household income spent on energy costs. Lower-income customers usually spend less on energy, but it is a higher percentage of their income.
- **Extreme weather events**: Severe weather events relative to the historical norm of an area. These include heat waves, heavy downpours, major hurricanes and tornados, drought and wildfires.
- **Fossil fuel**: A natural fuel formed from the remains of dead plants and animals. Fossil fuels include petroleum, coal and natural gas.
- **Fossil fuel emissions**: Greenhouse gases generated from extracting and burning fossil fuels, including carbon dioxide, methane, nitrous oxide, and fluorinated gases, all of which cause global climate change.
- **Grid**: The grid refers to the electric grid, a network of transmission wires, substations, transformers and more that deliver electricity from power plants to buildings.

Glossary of Terms (cont'd)

- **Grid management:** The regular maintenance of wires, substations, etc. and the improvements and upgrades of the infrastructure to properly handle the integration of many generators and changing demand patterns.
- **Heat pump:** A replacement for a furnace that consumes electricity in order to move heat between the inside and outside of a structure. It can be used for both cooling and heating.
- **Just transition**: The process of moving to beneficial electrification in a fair and equitable manner, ensuring that everyone has the ability to participate without enduring financial hardship
- **Load management:** The management of energy demand, with the goal of reducing demand when energy is scarce/expensive.
- **Microgrid:** A small network that mimics the larger infrastructure in form but that can be disconnected and run autonomously.
- **On-site combustion:** The burning of fossil fuels at a fixed location (e.g. house, office building, factory)
- **Smart grid:** The adoption and integration of new technologies to include additional sharing of data and monitoring of energy use. Fast data sharing between energy users and producers, from individual devices to multiple large and small generators, is coupled with software that uses algorithms intended to improve performance of individual devices and the grid as a whole.

What is Beneficial Electrification?

The Beneficial Electrification League is a nonprofit organization established by the Natural Resource Defense Council and the National Rural Electric Cooperative Association, focused on promoting market acceptance for beneficial electrification concepts, policies, practices, technologies and business models. They define beneficial electrification as follows:

The application of electricity to end-uses that would otherwise consume fossil fuels (e.g., natural gas, propane, oil, gasoline) where doing so satisfies at least one of following conditions, without adversely affecting the others:

- *save consumers money over time;*
- *benefit the environment and reduce greenhouse gas emissions;*
- *improve product quality, public health[1] and/or consumer quality of life; or*
- *foster a more robust and resilient grid.*

Beneficial Electrification programs are a valuable opportunity to engage both electric utilities and environmental groups in the effort to identify solutions that work well for the end-use consumer, local communities and the environment.

Beneficial Electrification can be implemented in buildings (residential, commercial, industrial), the transportation sector, and to meet other other energy needs.

Benefits

- Efficient technologies = lower operating costs
- Improve public health
- Limit economic risks associated with volatility of fossil fuel prices
- Enable better management of the electric load on the grid
- Reduce greenhouse gas emissions and mitigate climate impacts

Go All Electric Project Overview

Go All Electric Project Overview

The Climate Solutions Accelerator (formerly Rochester People's Climate Coalition) approached Causewave Community Partners in December 2018 to begin planning for a community impact initiative in support of the overall mission to achieve carbon neutrality by 2027. The community impact initiative undertaken with this report will focus on moving Rochester to an all-electric energy model - the most impactful way to achieve this mission. There's growing recognition that using carbon-free electricity to meet our community's energy needs is the most environmentally and economically sustainable option[2].

The portion of the grid that includes Upstate NY is amongst the most climate-friendly. According to the New York Independent System Operator (NYISO) (see Appendix) it is 91% fossil fuel free. This helps us start closer to the finish line than most other communities. Other areas that are heavily reliant on fossil fuels to power their communities need to wrestle with moving to carbon-free electricity sources as their primary starting point. Our area, on the other hand, can focus on more readily achievable transition tasks, such as conversion to electric vehicles and heat pumps, while growing the base of carbon-free sources of electricity to meet new demand.

Powering our community with carbon-free electricity allows progress on attaining carbon neutrality and associated environmental benefits. Importantly, it supports improving public health as well. Burning fossil fuels harms our health in the short- and long-term. Physicians say the most common ways in which climate change is harming their patients' health are through poor air quality, worsening allergies, injuries due to storms, heat-related illness, and infections spread by mosquitoes and ticks.[3]

Go All Electric Project Overview (cont'd)

Beneficial electrification is appealing to customers, employees and investors who see their decisions as having a positive impact on climate change. It's a way for people to be engaged on an issue that often feels overwhelming and impossible to impact at an individual level.

While achieving 100% usage of carbon-free electricity is not a likely outcome due to technology barriers and practical limitations currently associated with certain manufacturing processes and industries with high-temperature needs, "Go All Electric" provides a north star approach to our work. We want to be viewed as a national leader through our local efforts.

Why This is a Local Issue

We recognize that climate change is a global issue that Rochester cannot address on its own. Our air quality, for example, is influenced by neighboring regions and extreme weather is out of our direct control. But there are ways in which we can have a direct, positive impact on the health and well-being of our community by transitioning to carbon-free electricity. In addition, this work provides the opportunity to enhance the overall power grid operations, resulting in better load management and cost reductions.

Here are some of our area's specific issues and opportunities:

- **Rochester's high poverty rate**: Climate change disproportionately affects people living in poverty through higher financial energy burden and greater vulnerability during extreme weather events.
  - For very low-income households in New York State, the average energy burden is 19.4% of household income, as compared to 6.4% for moderate-income households[4]. A heat pump can lower winter heating costs for those who currently heat with oil, propane or electric resistance, and double as a cooling system in the summer. More efficient, carbon-free electricity powered homes can result in an increase in the affordability of basic needs, though policies and incentives will be necessary to transition lower-income households to modern, efficient electric technologies. The recently passed NY Climate Leadership and Community Protection Act directs the state to identify the barriers to access to renewable energy resources and energy efficiency for low-to-moderate-income households and environmental justice communities and make recommendations to increase access. It mandates at least 40% of the state's energy funds (RGGI, Clean Energy Fund, etc.) are to be utilized to the direct benefit of low-to-moderate-income households and environmental justice communities[5]. Several communities in Monroe County qualify for this support, including neighborhoods in the city of Rochester that have high concentrations of poverty.
  - Low-income households are less likely to have central A/C. Higher crime rates, violence, less physical activity and health issues are associated with heat. The urgent need for access to cool spaces was made clear through a recent box fan distribution for low income seniors. Lifespan ran out of fans after giving away more than 600 in a single day. Heat pump technology eliminates this disparity as air conditioning is generated through the same unit that generates heat.

Why This is a Local Issue (cont'd)

- **Health effects of air quality**: Rising temperatures exacerbate the harmfulness of air pollutants. Between 2011-2013, the City of Rochester had a rate of 160 emergency department visits for asthma per 10,000 population (all ages), nearly 60% higher than the NYS rate (including NYC)[6]. That rate for ages 0-4 is 379, nearly double the NYS rate. Given the City's demographic composition, this represents a higher health burden on people of color and on people with lower incomes. Air pollution from the burning of fossil fuels is a key contributor to chronic respiratory illnesses like asthma, bronchitis, emphysema, and COPD. Reducing emissions through electrification should improve local air quality and result in better health, fewer missed work and school days, lower healthcare costs, and a better quality of life.
- **Household health and safety**: An electricity-powered home is safer and healthier because there is no combustion at all inside the home. Homes using fossil fuels generate carbon monoxide (CO) from incomplete combustion, one example being stove pilot lights. Whether burning natural gas, coal, kerosene, propane or wood in a furnace, fireplace, dryer or stove, CO poses a risk. While CO detectors protect against lethal levels of CO, sublethal levels can go undetected creating health threats. Low levels of CO are hard to quantify and link directly to health outcomes, but the risk of CO poisoning is completely eliminated when homes are powered by electricity. Eliminating combustion in the home can also reduce particulate matter and other harmful gases that affect the heart and lungs, sometimes with serious long-term health impacts. Electric-powered homes also remove the risks of a natural gas leak or explosion. Many of the electric stoves manufactured today include a 600°F cap to minimize the risk of grease fires. Lastly, electric vehicles eliminate the risk of CO poisoning from cars that are parked and running in a confined space.

Why This is a Local Issue (cont'd)

- **Household cost savings**: Heat pump technology for both heating and A/C is more efficient than traditional units. Although installation costs are generally more expensive, ground source heat pumps are up to 65% more efficient than traditional HVAC units and pay themselves back over time in energy savings—typically within 10 years[7]. Technology and scale will continue to drive heat pump prices down making the payback period even shorter. Conservation and weatherization efforts that would accompany the transition to electrification of homes and businesses would benefit all audiences, immediately.
- **Economic development**: Transitioning our community to carbon-free electricity will create local jobs and drive economic investment. Work needed to transition to carbon-free infrastructure will create jobs in a myriad of areas. Workers will be needed to upgrade the efficiency of our buildings, install electric vehicle charging stations, and build new solar and wind farms. As good environmental stewardship becomes the norm, more and more people will endeavor to patronize businesses employing sustainable practices. The faster companies evolve with this trend, the more they will be rewarded by the increasing population of people who value sustainability. As more businesses, organizations, and individuals are looking to be good climate citizens, a region aligned with carbon-free power has the potential to attract them.
- **Building the region's brand:** National recognitions continue to pour in for the Finger Lakes region, from top wine, spirits and craft beer awards to distinction as a "best place to bike" to leadership in advanced manufacturing, photonics and optics, to a higher-ed hub, complete with 19 colleges and universities. Beneficial electrification supports all of these distinctions, and positions the Finger Lakes as a pristine region, attractive as a place to live, work and play.

Why This is a Local Issue (cont'd)

- **NYS Climate Leadership and Community Protection Act**: The CLCPA requires significant changes in all NY communities in order to achieve the goals set forth in the legislation. The most efficient way to achieve the mandated 85% reduction in greenhouse gas emissions is a large-scale conversion to electricity, due to the degree to which the electric grid is already decarbonized. New electricity demands must also be met with new renewable generation. Our work will help our area comply with the legislation requirements.

The American Council for an Energy-Efficient Economy praised the City of Rochester for its recent efforts on the Sustainable Homes Rochester and bike share programs. However, they ranked the City 58th out of 75 US cities on the Clean Energy Scorecard[8]. The Scorecard, using information collected as of April 1, 2019, ranks cities in five policy areas:

- Local government operations
- Community-wide initiatives
- Buildings policies
- Energy and water utilities
- Transportation policies

The Go All Electric efforts can make significant progress in closing gaps in each of their five categories.

Reasons To Believe

There are a number of proof points that support the achievability of going to an all-electric energy model in the Greater Rochester region:

- Due to our use of nuclear and hydropower, our portion of the grid is 91% fossil fuel free according to the New York Independent System Operator (NYISO). This makes ours amongst the most climate-friendly grids in the nation[9]
- The current energy infrastructure is able to support significant increases in electricity demand.
- RTS is electrifying their fleet, with grant dollars supporting the addition of multiple electric buses and charging infrastructure.
- NYS, the federal government and energy providers are offering more incentives, policies and tax credits for heat pumps and electric vehicles to help enable families to go all electric.
- The City of Rochester is committed to a Climate Action Plan that supports beneficial electrification (e.g. charging stations and a user-friendly app to find them) and is actively driving a clean heating and cooling campaign (Sustainable Homes Rochester) initiative to lower heating and cooling costs via heat pumps for City residents.
- A wide range of industries and local organizations and businesses are highly engaged in sustainable business practices, including beneficial electrification efforts.
- Corporate social responsibility is a growing priority for all segments of the business community.

This report represents the work to define and frame the initiative – Phase A of Causewave's Community Impact Initiative process. The process uses a collaborative model involving community stakeholders to build consensus around an overall goal and defining the necessary steps to achieve it. The report is a comprehensive summary of the Phase A work and serves as input for subsequent steps including attracting community leader participation and support.

The Facts

The Facts: Local Emissions Sources and Energy Usage

Fossil fuel emissions significantly contribute to climate change and the resulting adverse effects. Rochester's leading source of emissions by far is on-site combustion of natural gas (mainly to heat buildings and hot water). Vehicles are the second major contributor. Both of these sources can be mitigated through electrification.

Residential energy consumption drives most of Rochester's emissions, followed by Commercial and then Industrial.

Almost 75% of energy used in a typical New York home is for heating and cooling.

A combination of switching to carbon-free electricity and energy conservation strategies are needed to reduce greenhouse gases at a level that allows for benefits to the environment and human health.

City of Rochester Emissions by Source

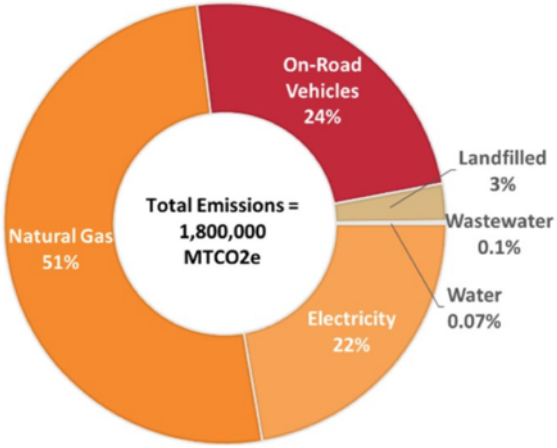


Figure 12: Emissions by Source/Activity (CAP Inventory), 2014

City of Rochester Emissions by Sector

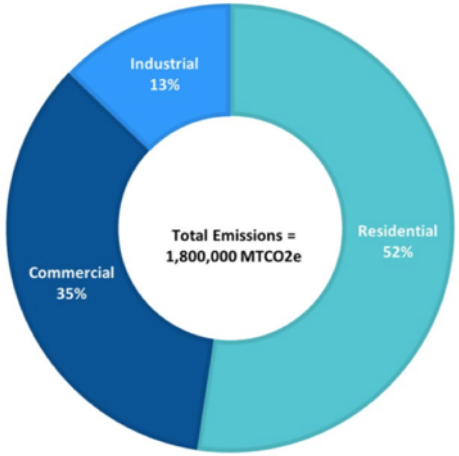
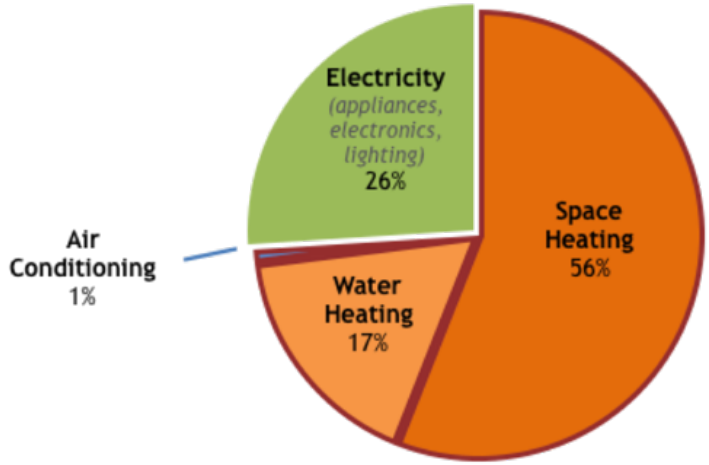


Figure 13: Emissions by Sector, 2014

Average NY Home Energy Use



Source: Residential Energy Consumption Survey, US Energy Information Administration (EIA)

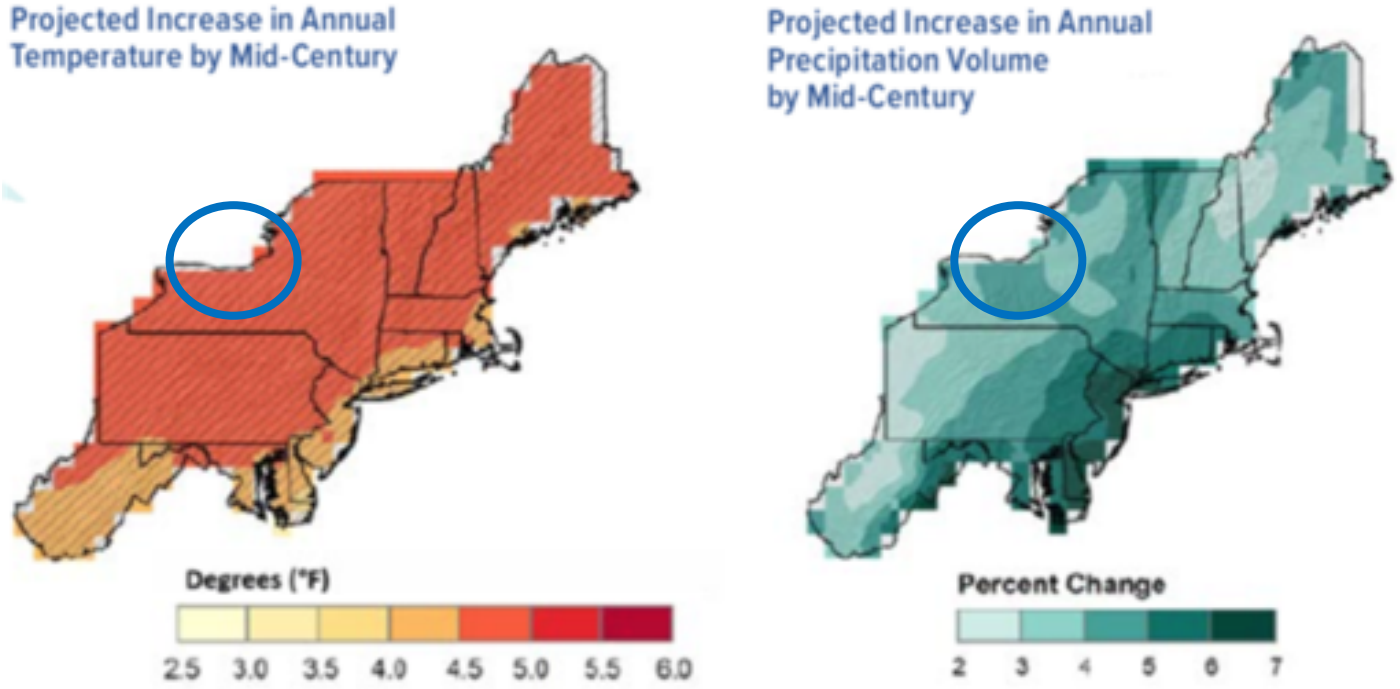
Source: City of Rochester Climate Action Plan. Data provided by RGE, Genesee Transportation Council, City of Rochester, and Monroe County

The Facts: Local Climate Impacts

If world-wide inaction on reducing emissions continues, the Rochester region will be on a path of higher temperatures and increased precipitation. Models show Rochester 4.5 to 5 degrees F warmer by 2050.

These models also show that Rochester will be impacted by a 4% to 5% increase in precipitation by 2050.

Adverse effects of increased heat and precipitation will impact our area's health, farming and overall economy.



Source: NOAA Technical Report NESDIS 142-1, "Regional Climate Trends and Scenarios for the U.S. National Climate Assessment. Part 1, Climate of the Northeast U.S."

The Facts: Fossil Fuel Combustion and Our Health

Fossil fuel combustion is harming our health. Greenhouse gas emissions have resulted in increased extreme weather events, more extreme periods of heat, the spread of disease and threats to our food and adverse mental health. 88% of air pollution is caused by fossil fuel combustion and is exacerbated by rising temperatures.

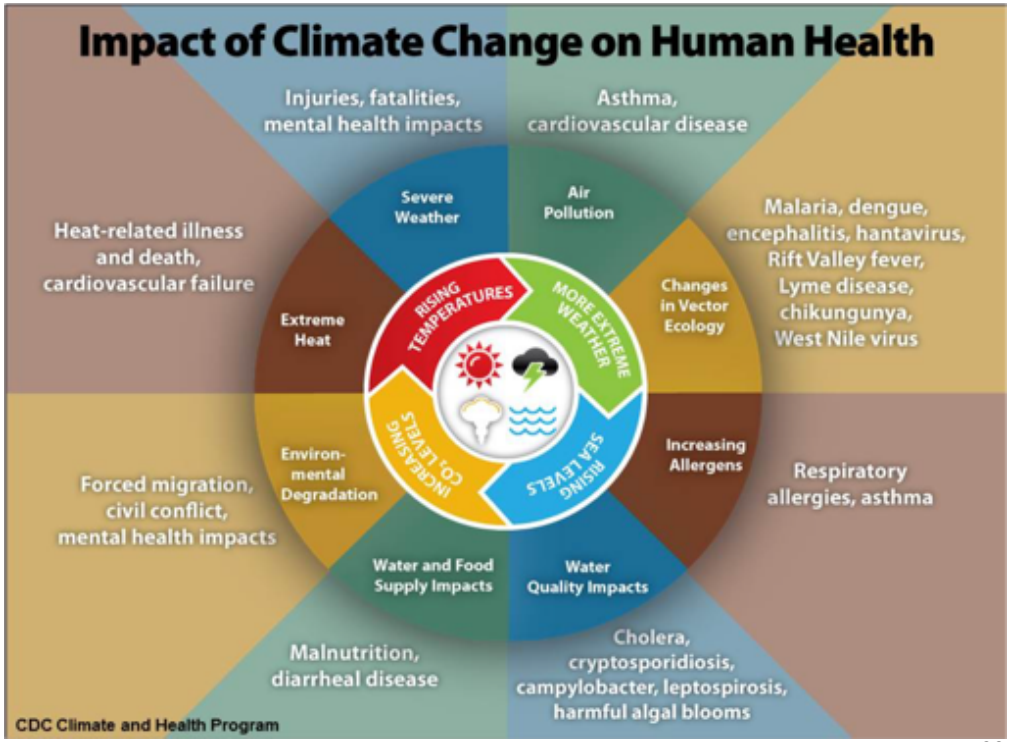
Most heat-related deaths occur from long exposure to extreme heat with little or no air-conditioning[10]. Health impacts of heat can be avoided if timely measures are taken to reduce long periods of heat exposure. This can be achieved with the help of air-conditioning, which can delivered by a heat pump without having to install a separate A/C unit.

Only about one in three Americans are aware that people in the US are being harmed right now by climate change.[3]

Public awareness of health impacts is necessary to catalyze the community to action.

Fossil Fuel Impact	Health Impacts
Air Pollution*	Asthma, Chronic Obstructive Pulmonary Disease (COPD)
Extended seasons of heat	Pollen-related allergies, increase in ticks and mosquitos season (disease), heat-related illnesses
Extreme weather	Injury, death, stress/mental health, contaminated food and water, nutrition

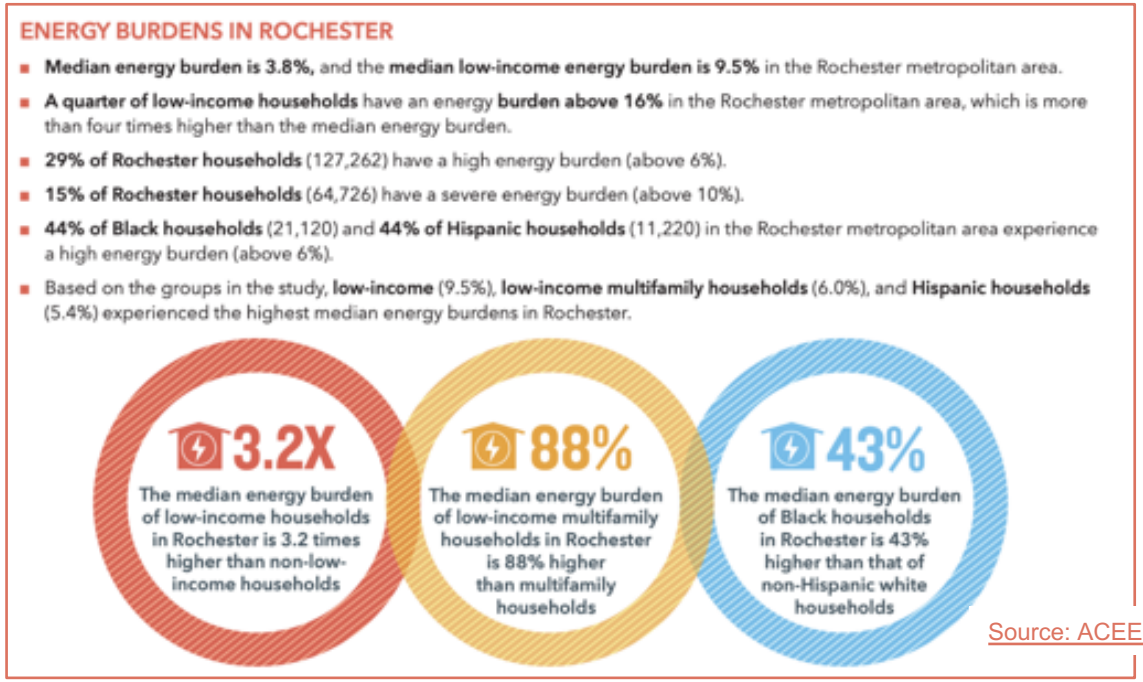
*According to the Lancet Commission on Pollution and Health, 2017, pollution caused 16% of deaths worldwide in 2015.



The Facts: Impacts on Our Most Vulnerable Populations

Our community's work MUST be guided by principles of diversity, equity and inclusion so that no one is left behind in the transition to carbon-free electricity.

Climate change does not impact all equally. Without good health and ample resources certain populations are more vulnerable to climate change. The young, elderly, pregnant women, people with chronic illnesses, and those with limited incomes are among those most exposed to the adverse effects of climate change. A household's energy burden is the percentage of income spent on home energy bills. Very low income New York residents have the highest energy burden by far.



Not only are these populations more affected by climate change, they are also often less able to participate in the transition to a carbon-free electricity powered community (e.g. affordability of new cars, home improvements, new appliances, lack of influence as renters, lack of information on available energy improvement programs and opportunities).

Source: ACEEE.org "Energy Burdens in Rochester", Sept 2020

Local programs, such as the City's Sustainable Homes Rochester, show that focusing on energy efficiency and conversion to electricity for those using oil, propane or electric resistance for heating, can reduce energy costs by 25% leading to more disposable income. Our community's high poverty rate means that this initiative has more opportunity to reduce poverty directly by reducing the costs of basic needs.

The Facts: Natural Gas Does Not Solve the Problem

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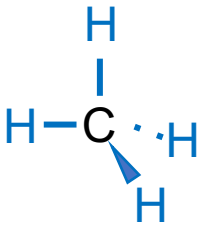


Facts about Methane (CH4) and Carbon Dioxide (CO2)

- Both methane (CH4) and carbon dioxide (CO2) are greenhouse gases that contribute to climate change.
- Methane has a higher short-term impact on our climate while CO2 lasts longer in the atmosphere.
- Methane is is commonly called natural gas and is the primary type in use today. Leaks occur at each step in both traditional and hydraulic natural gas drilling and distribution.
- Actual leakage rates associated with the use of methane are widely distributed, highly variable, and very hard to pin down. Using figures from a variety of sources, the researchers found the overall range to be somewhere between 1.5 percent and 4.9[11] percent of the amount of gas produced and distributed, equating to between 9 – 30 million metric tons of methane leaks. 9.8 million metric tons of methane leaks equates to enough gas to meet the annual heating and cooking needs of 7 million homes and represents nearly $2 billion worth of wasted gas[12].

While burning natural gas is cleaner and produces less CO2 than burning coal and oil, it DOES produce CO2.

While natural gas burns more cleanly than other fossil fuels and is therefore better from a short-term public health perspective, it remains a significant climate risk due to the greenhouse gases that are emitted during its production, distribution, and consumption.

Methane is especially problematic because of its high global warming potential, and because leaked methane is difficult to monitor and measure.

Because of the nature of natural gas as a fossil fuel, any efforts to get to zero-emissions will ultimately require the elimination of natural gas as an energy source. Beneficial electrification must include building community awareness around the relationship between natural gas and climate change as well as building pathways to carbon-free replacement of natural gas as an energy source.

The Facts: Grid Implications

The electrical grid that supports our community has ample capacity for our current electricity consumption. But moving to carbon-free electricity as our primary, and default, energy source will require both capacity expansion as well as technology upgrades over time. This necessitates investment in upgrades to transmission and distribution systems.

Models for the transition to carbon-free electricity show that upgrades to our electrical grid can be done gradually and predictably. Conservation efforts will also be important to ease the requirements on the grid.

Grid Implications

- Estimates suggest almost a doubling of electricity generation required to supply demand at the point of full conversion to carbon-free electricity.
- Significant investment and improvement is required in our electricity systems to support this transition.
- Reliability of the grid will be increasingly important.
- Peak demand will shift to the winter and be much higher than current levels during prolonged cold periods.
- Smart grid technology and the integration of microgrids will be rolled out over time. The pace of adoption will be determined by cost considerations, as well as by policy making processes.
- Supportive infrastructure policy is critical – new energy demand must be met with renewables, such as wind and solar or other zero-carbon generation sources.

The Facts: Cost Implications

Investments are required to achieve a community powered by carbon-free electricity. Those investments span the full spectrum from energy generation to energy consumption. On the generation side we need to invest in carbon-free sources of energy, making solar and wind a priority. Utilities must maintain and improve the transmission and distribution system. On the consumption side we need to invest in buildings, vehicles and appliances that use electricity.

Policies and financial incentives play a key role in helping catalyze the changes needed for a successful transition to carbon-free electricity.

Public awareness is also critical so that costs, benefits, return on investment and choices are well understood.

Cost Implications

- The four main costs:
  - Switching to electric vehicles
  - Switching to heat pumps, including necessary building envelope upgrades
  - Scaling up electricity transmission and distribution infrastructure
  - Scaling up zero-carbon power generation
- The consumer cost model for electric vehicles is changing quickly, with predictions that ownership costs will match gasoline and diesel vehicles globally by 2022[13].
- Utilities will seek to raise rates to cover infrastructure upgrades, including new capacity requirements to meet heat pump winter peak demand.
- Rate structures will have to change in order to enable on-demand peak energy needs (dispatchable demand). Programs that incentivize sustained lower building temperatures in the winter can help balance the load during periods of extreme cold blasts. This is very compatible with current plans under "NY Reforming the Energy Vision".
- The return on investment model for heat pumps is multifaceted. While beneficial for new builds, it can be costly for retrofits. Costs are trending in the right direction but adoption of this technology would be accelerated by incentive programs that offset any additional costs.

The Facts: Challenges and Barriers

The previous slides have identified some of the specific challenges of transitioning to carbon-free electricity to power our community. The Phase A Steering Committee summarized a list of the high-level challenges and barriers that we face in making progress on Go All Electric.

The “Theory of Change,” developed by the Steering Committee and shared in a subsequent section of this report, embodies these challenges and barriers. Subsequent phases of this initiative will tackle these through identification of required behavior changes; the development of program and message strategies to accomplish the “Intended Impact” (Goal) of Go All Electric, also shared in a subsequent section of this report.

<u>Challenges and barriers to achieving a community powered by carbon-free electricity</u>

- There is a lack of public awareness on the need, the opportunity, the benefits and choices they have available with beneficial electrification.
- Significant upfront investment may be required and insufficient incentives are in place to support those costs.
- Some community members may have concerns about nuclear in terms of safety, waste, and capacity for future growth
- Our area has a high percentage of rental housing where cost-savings accrue to occupants but investments must be made by landlords.
- Current building codes are not aligned with the opportunities associated with beneficial electrification. As a result buildings constructed today will need to be renovated to reduce energy use to meet our needs for emissions reductions under CLCPA.
- The low cost of natural gas today – subsidized by federal and state policy - disincentivizes transition to carbon-free electricity power. These policies continue to advance natural gas infrastructure, counter to the need to address the climate crisis or the goals of the CLCPA.

The Facts: Electric Vehicle Adoption is Promising

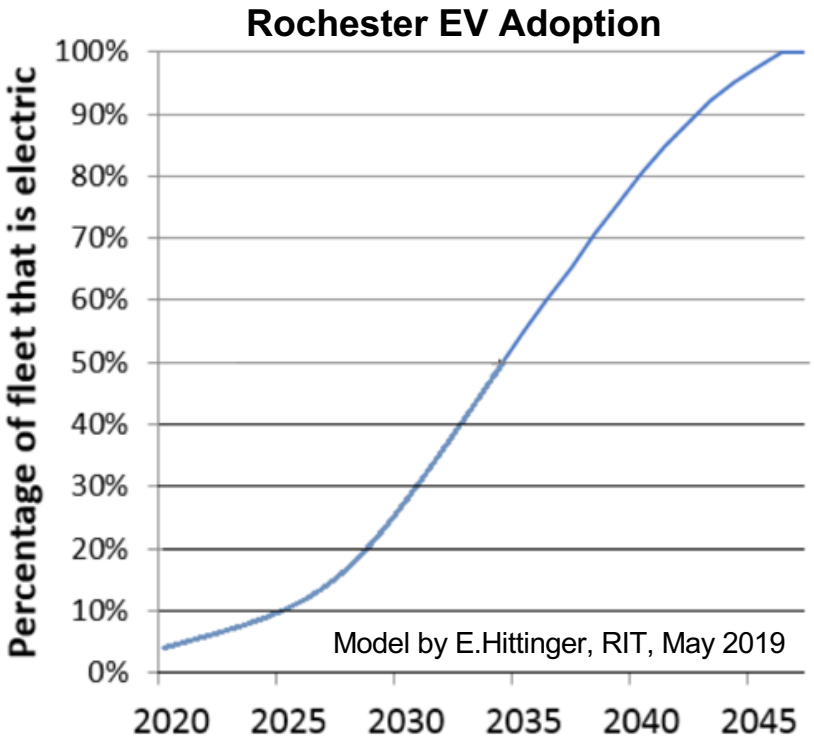
There's much to be excited about with the adoption of electric vehicles (EV). The favorable economics of consumer EVs and commercial EV fleets make it advantageous to accelerate the transition of fossil fuel based vehicles to EVs. A 2018 study from the University of Michigan's Transportation Research Institute found that electric vehicles cost less than half as much to operate as gas-powered cars; the average cost to operate an EV in the United States is $485 per year, while the average for a gasoline-powered vehicle is $1,117[14]. EV charging can be flexible and distributed over time helping to manage electric load on the grid. Bloomberg New Energy Finance (BNEF) projects that 57% of all passenger vehicle sales, and over 30% of the global passenger vehicle fleet, will be electric by 2040[15]. EV prices continue to decline, driven primarily by falling battery prices, and programs such as the 2018 Nissan Leaf incentive (rebates from Nissan, RGE, RIT) will continue to fuel consumer adoption.

Locally, the Rochester EV Accelerator is focused on this effort and cites the following:

- EVs account for 1.79% of all new car sales in Monroe County
- 1,036 Test Drives
- 13 Workplace Charging Partners

The chart to the right shows one model for Rochester's aggressive but possible EV adoption based on these assumptions:

- the percentage of replacement vehicles starts at 5% in 2020, gets to 50% by 2034 and surpasses 80% by 2039.
- vehicle ownership is typically 11 years



The Facts: Our Community Is Already Engaged

Our community is already addressing this issue across a broad spectrum of efforts. This work can build on already-established momentum through supporting and scaling those initiatives. Our existing clean-energy infrastructure gives us a smaller gap to close versus virtually any other community, due to their heavy reliance on fossil fuels for electricity.

In order to make progress we must ensure that everyone in our community understands the need for this work and their role in the transition. We must also paint the picture of success and inspire our community in understanding that it is very possible to achieve a community powered by carbon-free electricity.

Local Beneficial Electrification efforts (not all-inclusive)

Sustainable Homes Rochester: Community education campaign to build interest and demand for energy efficiency and clean heating and cooling technologies (i.e., heat pumps).

EV Accelerator: ROC EV is an innovative, community-wide initiative aimed at achieving widespread deployment of plug-in EVs. ROC EV is now administered by the The City of Rochester and Greater Rochester Clean Cities.

RTS electric buses: RTS has 20 electric buses as part of their fleet.

RG&E rebate programs: DC Fast Charging incentive program. Previous/Future intentions: Nissan Leaf $5,000 discount, Heat pump rebates.

Rochester Energy Efficiency and Weatherization (RENEW): A collective impact initiative established in 2015 to support income-qualified homeowners in making their homes more energy-efficient, safer. Grants are made to qualified homeowners for improvements that include insulation, furnaces, hot water heaters, or emergency health and safety repairs including sewer lines and electric panels. Efforts are increasing the number of installations of high-efficiency clean heating and cooling technologies like heat pump hot water heaters and furnaces.

City of Rochester Climate Action Plan: Endorsed by City Council in May 2017, the City of Rochester Climate Action Plan has a goal to reduce greenhouse gas emissions by 40% from 2010 levels by 2030. Transportation and Energy Use and Supply are two of the five focus areas. Fuel switching is recommended by this plan.

Monroe County is developing a Climate Action Plan

Connected Communities' Environmental Justice Collaborative

Parent-led campaigns to promote electric school buses

Renewable Heat Now campaign

The Facts: New York State Climate Leadership and Community Protection Act

The Climate Leadership and Community Protection Act (CLCPA), was signed into New York State law on July 18th, 2019.

The CLCPA requires the State to achieve a **carbon-free electricity system** by 2040 and **reduce total NYS greenhouse gas emissions** 85% below 1990 levels by 2050 with an interim mandate of 40% reduction by 2030.

A **Climate Action Council** has been established and will develop the necessary plan to achieve a carbon-neutral economy by 2050 and the NYS Department of Environmental Conservation will be tasked with implementing new regulations.

Importantly, implementation will **target investments to benefit disadvantaged communities**. Relevant state agencies are mandated to invest 35% of clean energy program resources to benefit disadvantaged communities, and asked to target 40% to the extent possible. Additionally, the just transition working group will try to ensure that individuals working in conventional energy industries are provided with **training and opportunities in the growing clean energy economy**.

The Cuomo administration expects the CLCPA to create tens of thousands of new jobs, improve public health and quality of life while also providing all New Yorkers with more robust clean energy choices.

Text of CLCPA located at https://nyassembly.gov/leg/?bn=A08429&term=2019

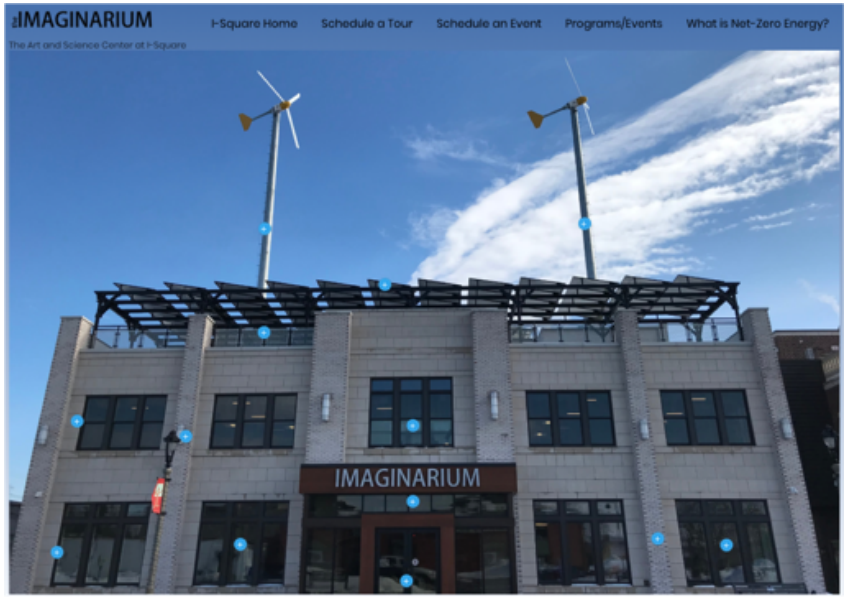
Local Beneficial Electrification Example: The Imaginarium at I-Square

The Imaginarium at I-Square is a two-story, 9,000 sq. ft. Net-Zero-Energy (NZE) Education Center for Art and Science. In addition to a geothermal heating, cooling and ventilating system, the Imaginarium generates electricity on site with the following renewable sources:

- 26kW Solar PV system (60%)
- 2- 8.9 kW Small Wind Turbines (35%)
- 21 Power-generating Exercise Machines (5%)

The geothermal ground-sourced heat pump system allows less energy to be consumed because only the gap between desired room temperature and incoming water temperature needs to be heated or cooled.

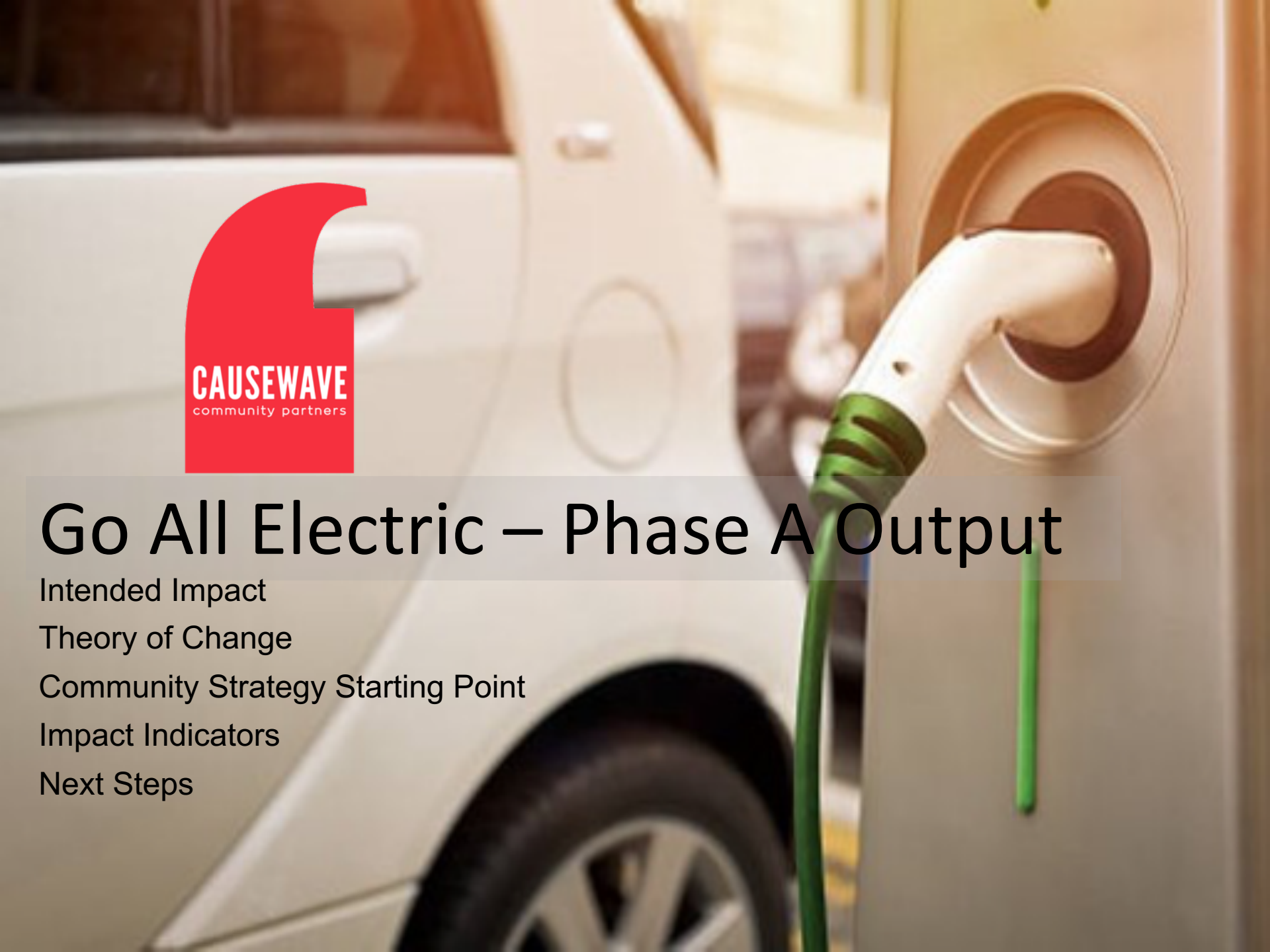
While the building managers are still pursuing the net-zero goal, much is being learned and incorporated into plans for future improvements.



The investment to achieve this net-zero carbon-free powered facility was $2.4M, 24% covered via NYSERDA incentives and tax credits (NYS, Federal). The facility was developed as an education center so the payback period was not a primary goal. However, projections for each major component range from 6 to 14 years.

Key learnings from the project include the need to reduce demand through conservation measures and maximizing opportunities for solar panel placement.

https://imaginarium.i-square.us/



CAUSEWAVE
community partners

Go All Electric – Phase A Output

Intended Impact

Theory of Change

Community Strategy Starting Point

Impact Indicators

Next Steps

Go All Electric Intended Impact

An Intended Impact is "a statement or series of statements about what the organization is trying to achieve and will hold itself accountable for within some manageable period of time."[16] Developing an Intended Impact serves to align stakeholders to a common goal. It describes the change we want to see. This statement was developed by the Phase A Steering Committee.

Carbon-free electricity will power our entire community, showing the nation that this transformation is possible.

- **Carbon-free electricity**: Electricity can be generated from a variety of sources, both renewable and fossil-based. This work will focus on electricity that is generated without fossil fuels.
- **Will power our entire community**: Power is used for all facets of our lives as residents, consumers and businesses. We endeavor to convert our residential, commercial and industrial buildings as well as our transportation system – the vehicles we drive and the supporting infrastructure – to carbon-free electricity. While buildings and transportation will be our primary focus (currently the largest emissions sources), all energy needs that are currently met by fossil fuels should be switched to electricity (e.g. lawnmowers, gas grills).
- **Showing the nation that this transformation is possible**: At this time no other region in the nation has transformed to a carbon-free electric power infrastructure. We have a great head-start with 91% of our electricity coming from carbon-free sources. By being out front on this issue we can help provide confidence, resources and inspiration for other communities to make this transformation.

Go All Electric Theory of Change

"A Theory of Change describes how our intended impact will actually happen; the cause-and-effect logic by which resources will be converted into the desired social results."[16] Each element represents a critical step that needs to be addressed in order to achieve Go All Electric's intended impact. This is the Theory of Changed developed by the Phase A Steering Committee.

1. **Community leaders and the general public understand the benefits of electrification and embrace their roles in this endeavor**

   In order to catalyze and make progress on this work, the community must be aware of its importance, the benefits of carbon-free electricity, and the achievability of this transformation. We need to debunk myths and misperceptions and help the community understand and be excited about their roles.

2. **Policies incentivize a transition away from fossil fuels to carbon-free electrification**

   Policies include regulations as well as financial incentives and are set at the Federal, State and local levels. Policies and resulting incentives (such as a carbon fee and dividend) are important for all facets of power generation and consumption.

3. **Investment in infrastructure ensures that we have the ability to meet the demand for carbon-free energy, and serves as a means of attracting, retaining, and growing businesses and developing the workforce in our region**

   Our region's electricity is already 91% fossil-fuel free and we are recognized as having an abundance of clean air and fresh water. As more businesses look to use climate-friendly practices, we have the opportunity to provide the resources to make that possible. Similarly, as people look to live, work and play in climate-friendly, healthy environments we have the opportunity to serve that population.

4. **Fossil-fuel powered vehicles are replaced by electric modes of transportation**

   Vehicle turnover rates suggest that transitioning to electric vehicles is a very attainable goal in our region. Personal vehicles, commercial fleets, and public transportation are all included in this category as well as the required supporting infrastructure.

Go All Electric Theory of Change (cont'd)

5. **Commercial, industrial and residential buildings are converted to electric power systems through renovation and new build**

   This work will look for creative solutions for housing and commercial building renovations that are efficient, affordable and achievable. New builds offer immediate opportunities to invest in heating, cooling and appliances that are powered through carbon-free electricity – with a lifetime of benefits.

6. **Efficiency and conservation are incorporated into all aspects of the transition**

   A key principle of this effort is to lower overall energy use. This will be accomplished by focusing on ways to help residents and businesses adopt practices to conserve energy as well as sourcing and using appliances, heating and cooling systems that are most efficient.

7. **Principles and practices are used to ensure an equitable and inclusive transition**

   This work should facilitate a "just transition" to carbon-free electricity. We will strive to ensure that no one is left out of the transition. Vulnerable communities can sometimes benefit the most when fossil-fuel based power is replaced with carbon-free electricity. On the other hand, these communities can be disproportionately burdened by policies and practices if not carefully planned.

8. **All stakeholders track and share their progress towards our goal of a community powered by carbon-free electricity**

   In order to know if we are making progress we must establish measures, track against them and share our results with the community. These measures will be owned by a variety of stakeholders, from municipalities to businesses to individual households. We will use progress indicators to adjust our efforts and make necessary course corrections to ensure we achieve our intended impact.

Community Strategy: Our Starting Point

Given the broad and deep scope of work involved in achieving the Go All Electric Intended Impact it is not feasible to work on all Theory of Change elements at once. The Phase A Steering Committee assessed the elements and decided that those shown in **bold** should be the initial focus of the community impact process. **Building awareness** is seen as a critical first step to gain community support and begin making progress on the transition. **Incentives** are viewed as necessary in order to remove cost barriers that prevent or slow the transition. And **developing and tracking progress** measures is considered fundamental in bringing legitimacy and excitement to the work as well as supporting the need to secure funding for the effort.

Carbon-free electricity will power our entire community, showing the nation that this transformation is possible.

1. **Community leaders and the general public understand the benefits of electrification and embrace their roles in this endeavor**
2. **Policies incentivize a transition away from fossil fuels to carbon-free electrification**
3. Investment in infrastructure ensures that we have the ability to meet the demand for carbon-free energy, and serves as a means of attracting, retaining, and growing businesses and developing the workforce in our region
4. Fossil-fuel vehicles are replaced by electric modes of transportation
5. Commercial, industrial and residential buildings are converted to carbon-free electricity through renovation and new build
6. Efficiency and conservation are incorporated into all aspects of the transition
7. Principles and practices are used to ensure an equitable and inclusive transition
8. **All stakeholders track and share their progress towards our goal of carbon-free electrification**

Impact Indicators

- Leading indicators are point toward future events and are used as predictors of future results.
- Lagging indicators are output measurements confirming results.

In order to help identify progress towards the goals of Go All Electric, outcome measures were developed as part of Phase A work. These are a set of high level targets that consider what is expected from successfully accomplishing work outlined in this report.

Lagging Indicators

- The percentage of energy used made up by carbon-free electricity
- State and Local policies influenced by this initiative
- The percentage of the vehicle fleet made up by electric vehicles (light and heavy duty)
- Increased awareness of beneficial electrification among community leaders and the general public
- Equity and inclusion indicators:
  - The number of residential units with clean energy and efficiency upgrades
  - Increased access to sustainable transportation networks
  - The number of people entering the workforce into jobs created as a result of the transition to beneficial electrification
- The number of new businesses in the area citing our community's work on beneficial electrification as a contributing factor in locating here.
- Number of jobs created in the efficiency / clean energy field.
- Reduction in energy burden
- Reduction in missed school / work days due to asthma / COPD
- Recognition as a national leader in beneficial electrification

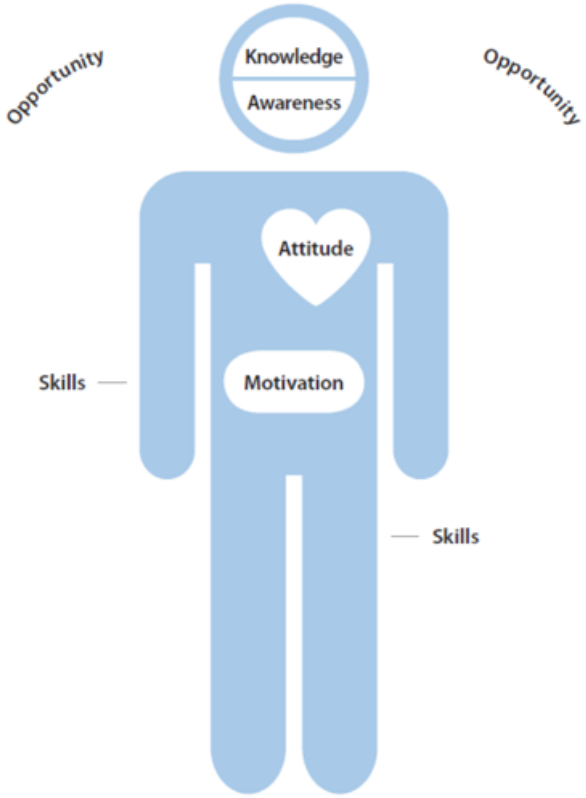
Leading indicators will be developed in Phase B after specific strategies have been defined.

Go All Electric Next Steps

With Phase A complete, the next step for Go All Electric is to begin to identify specific behavior changes that are required to accomplish the initial, prioritized Theory of Change elements. This Phase B work is necessary to help breakdown the complexity of behavioral change and focus on the largest gaps in current state versus ideal state.

Causewave recommends the use the "AKAMSOB" model[17] to guide the work. This model looks at different parts of the outcome chain for achieving the desired behavior change.

- **Awareness**: Those we are targeting need to be aware of the change being sought.
- **Knowledge**: They need to acquire the detailed knowledge to be able to make the change.
- **Attitude**: They need to develop an attitude, the belief in or valuing of the change.
- **Motivation**: They need to develop the motivation to want to make the change.
- **Skills**: They need to develop the skills necessary to achieve the change.
- **Opportunity**: They need to have the opportunity to make the change, including resources, tools, time, space, etc. to do so.
- **Behavior Change**: moving from current state to the ideal state for each of the elements above will create the desired behavior change.



References

1) "Public health" is not part of the stated Beneficial Electrification League definition but was added by this steering committee so that its significance would be specifically identified.

2) "A Plan for a Sustainable Future", Jacobson and Delucchi, Scientific American, Nov 2009

3) "Medical Alert! Climate Change is Harming our Health" The Medical Society Consortium on Climate & Health, August 2017

4) NYSERDA Low- to Moderate Income Market Characterization Study, Special Topic Report - Household Energy Burden

5) New York State Climate Leadership and Community Protection Act, July 2019

6) City of Rochester Health Equity Report (Rep.). (2017)

7) "5 Things You Should Know About Geothermal Heat Pumps", Office of Energy Efficiency and Renewable Energy, August 2017

8) The American Council for Energy-Efficient Economy (ACEEE), Rochester scorecard, July 2019

9) EPA: Emissions & Generation Resource Integrated Database (eGRID)

10) Monroe County Heat-Health Profile Report. Developed by New York State Department of Health, Center for Environmental Health. 2019

11) Gas infrastructure leaks methane: fix it, or accelerate to clean energy, David Chandler, Jan 2013

12) Latest EPA Greenhouse Emission Numbers Demonstrate Success Of Methane Standards, David Lyon, EDF, Oct 2016

References (cont'd)

13) "21 million more electric vehicles expected worldwide by 2030", Deloitte, January 2019.

14) Relative Costs of Driving Electric and Gasoline Vehicles in the Individual U.S. States, Sivak and Schoettle, University of Michigan, Jan 2018

15) Electric Vehicle Outlook 2019, Bloomberg New Energy Finance

16) "Zeroing In On Impact", Colby, Stone, Carttar, SSIR, Fall 2004

17) "Success by Design – How R&D Activates Program Innovation and Improvement in the Nonprofit Sector", Peter York, TCC Group, July 2011

Appendix

Community Impact Process

Go All Electric Phase A Steering Committee

Differences in Emissions Reporting

Rochester EV Charging Infrastructure

Background Information shared with the Steering Committee at the Phase A kickoff meeting

Community Impact Process

Community Impact Initiatives are collaborative efforts that bring together community stakeholders to solve issues that cannot be solved by one organization working alone. Causewave uses principles of collective impact to guide its work on topics from City school attendance to traffic safety. Typically community impact initiatives take multiple years, if not decades, to achieve the full change being sought.

Causewave uses an agile, four-phase process:

- Phase A: Scoping challenge and developing a community strategy with a prioritization of initial focus areas.
- Phase B: Identification and assessment of behavior changes associated with the strategy developed in Phase A.
- Phase C: Development of a message platform and creative assets; development of programmatic components that will support the message platform.
- Phase D: Implementation of the integrated program and message strategy.
- Post-Phase D: Evaluate, improve, and further the develop strategies and tactics to achieve the initiative's intended impact – sometimes requiring a return to Phase B to tackle a different part of the community strategy or target audience.

While the output of the full process involves a multi-media message campaign along with supporting programmatic activities, each phase of the process is intended to stand alone in its usefulness on the journey to making progress on the community issue.

When launching a new community impact initiative it's critical to start by spending time understanding the problem and identifying what's needed to generate impact at the community level. This report represents the output of Phase A for the Go All Electric community impact initiative.

Go All Electric Phase A Steering Committee

Community impact work is guided by leaders in the community representing a diverse cross-section of businesses, organizations and individuals connected to the issue being addressed.

The Go All Electric steering committee was carefully selected by Causewave and RPCC to represent organizations and populations that influence and are affected by energy generation and consumption in our community. This includes representation from government, health, development/construction, housing, energy, planning, transportation, climate, and underserved populations.

Three steering committee planning sessions were held where each participant was asked to listen, learn and contribute to developing an Intended Impact and Theory of Change for this work.

The list of steering committee participants can be found at the beginning of this report (page 4).

Phase B will begin by developing a new steering committee, inclusive of some of Phase A members plus new participants who best fit the nature of Phase B work.

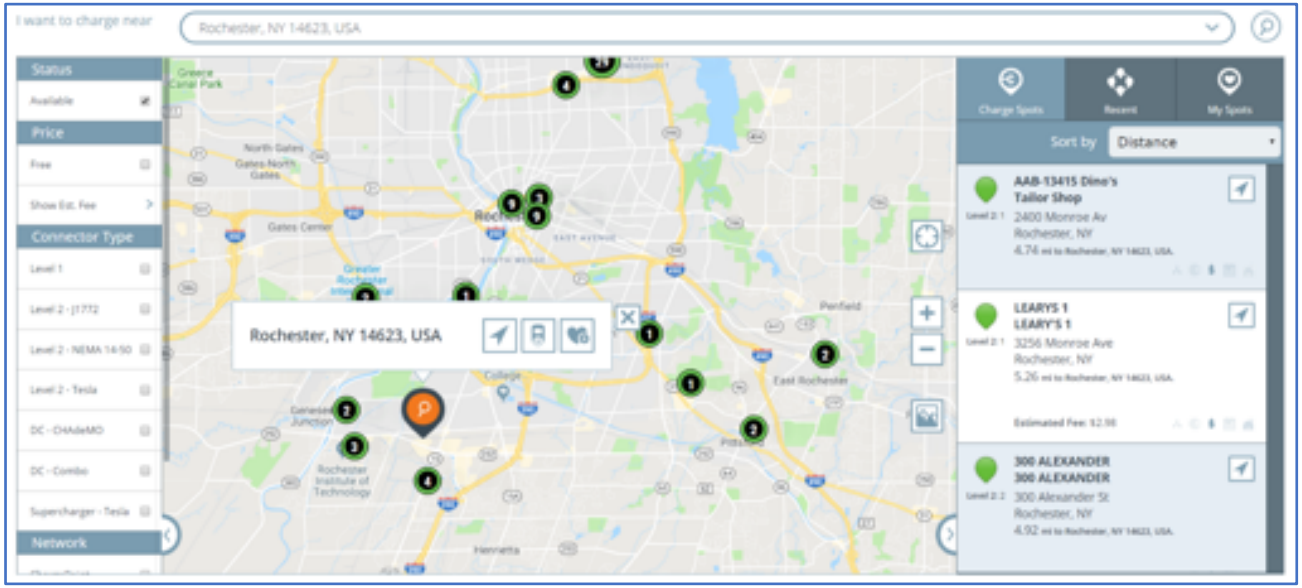
Differences in Emissions Reporting

According to the New York Independent System Operator (NYISO) our power grid is 91% fossil fuel free whereas the Environmental Protection Agency (EPA) reports our region to be only 71% fossil fuel free. The reason for this discrepancy is zoning. The NYISO divides the state into 12 zones to target specific regions within upstate New York. However, the EPA only has 3 zones for the entire state, lumping all areas outside of NYC into the same upstate zone. This makes the EPA's 71% more of an average of all areas outside the city rather than the NYISO's 91% that reflects a smaller portion of upstate New York, including the Greater Rochester Area.

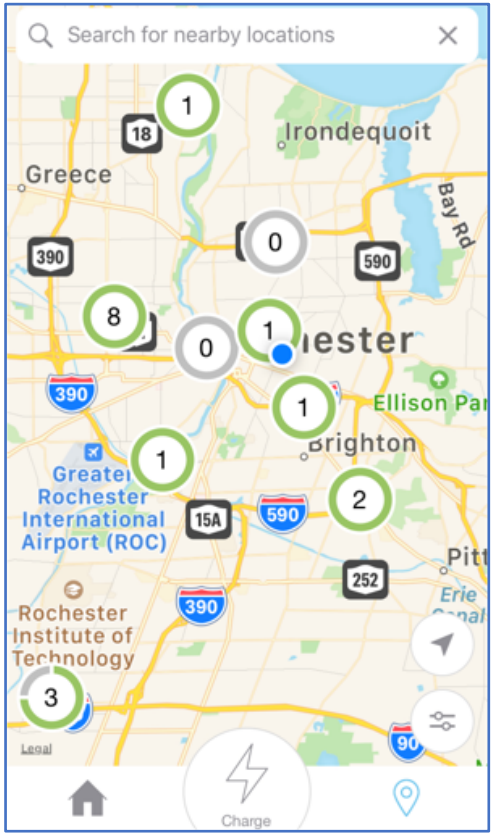
The EPA also works with estimations based on purchases made by utilities, a common method for calculating emissions. NYISO manages the grid themselves and can have direct access to where the energy in the system is coming from moment to moment.

Rochester EV Charging Infrastructure

On the City of Rochester website there is an EV charging page that links to available apps for charging stations. Both have interactive maps that allow for searching for nearby charging points and can sort by connector type as well.



https://na.chargepoint.com/charge_point



https://www.evconnect.com/ev-driver-charging-app/

Rochester Go All Electric Campaign

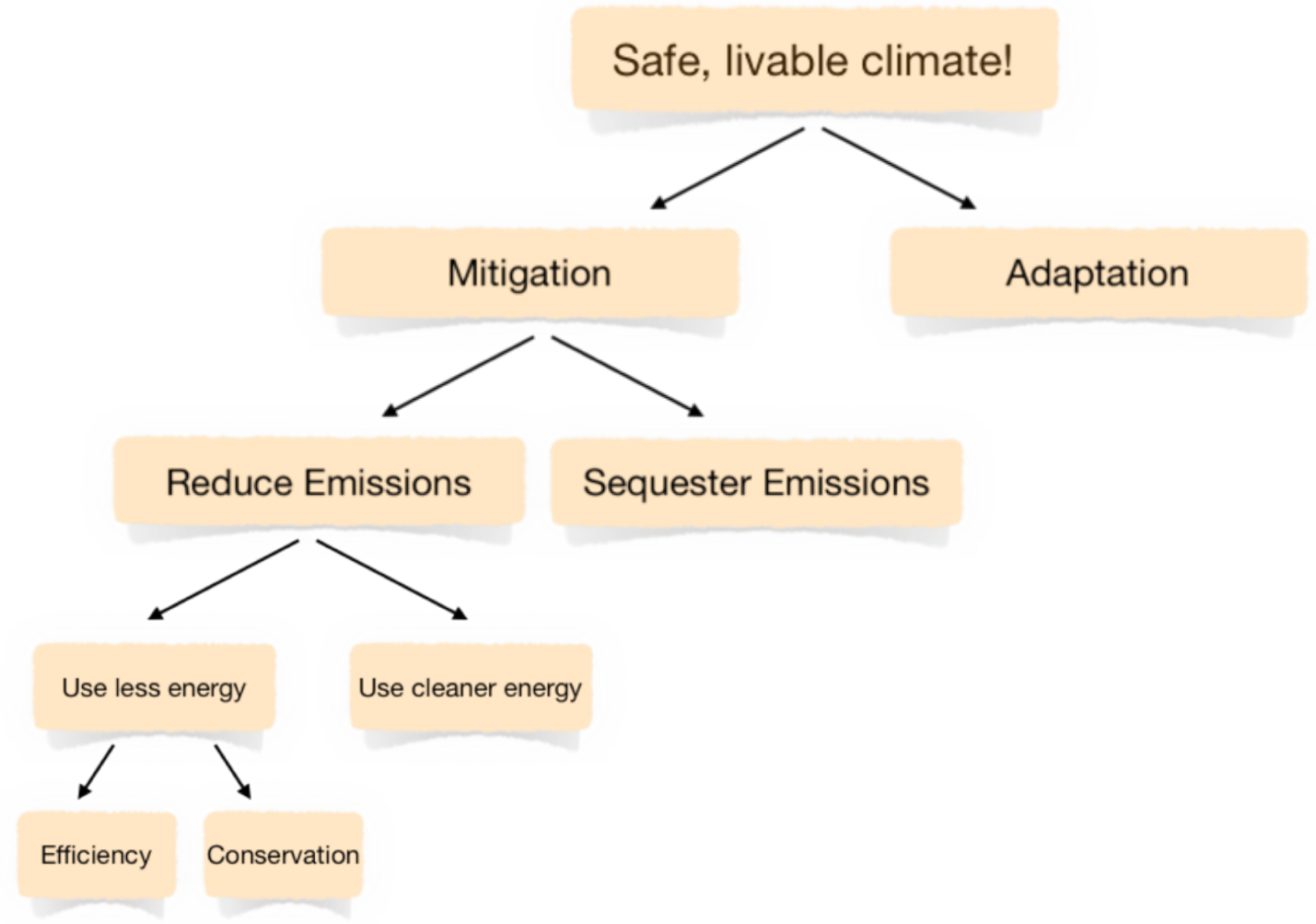
Background Information

CAUSEWAVE community partners

HOW CHANGE GETS GOING™

Agenda

- What is beneficial electrification?
- Why is beneficial electrification important for our region?
  - Local emissions sources
  - Regional grid mix
  - Negative impacts of fossil fuel use
  - Positive impacts of electrification
- Existing programs/resources for electrification
- Challenges/barriers
  - The problem with natural gas
- Other considerations
  - Implications for the grid
  - Cost/benefit analysis


Safe, livable climate!
Mitigation
Adaptation
Reduce Emissions
Sequester Emissions
Use less energy
Use cleaner energy
Efficiency
Conservation

What is Beneficial Electrification?

- Heating & cooling
- Hot water heater
- Cooking
- Transportation
- Clothes dryer
- Lawnmower, leaf blower, etc.

Why Electrify?

- Efficient technologies = lower operating costs
- Improve public health
- Limit economic risks associated with volatility of fossil fuel prices
- Enable better grid management
- Reduce greenhouse gas emissions and mitigate climate impacts

Proposed Definition

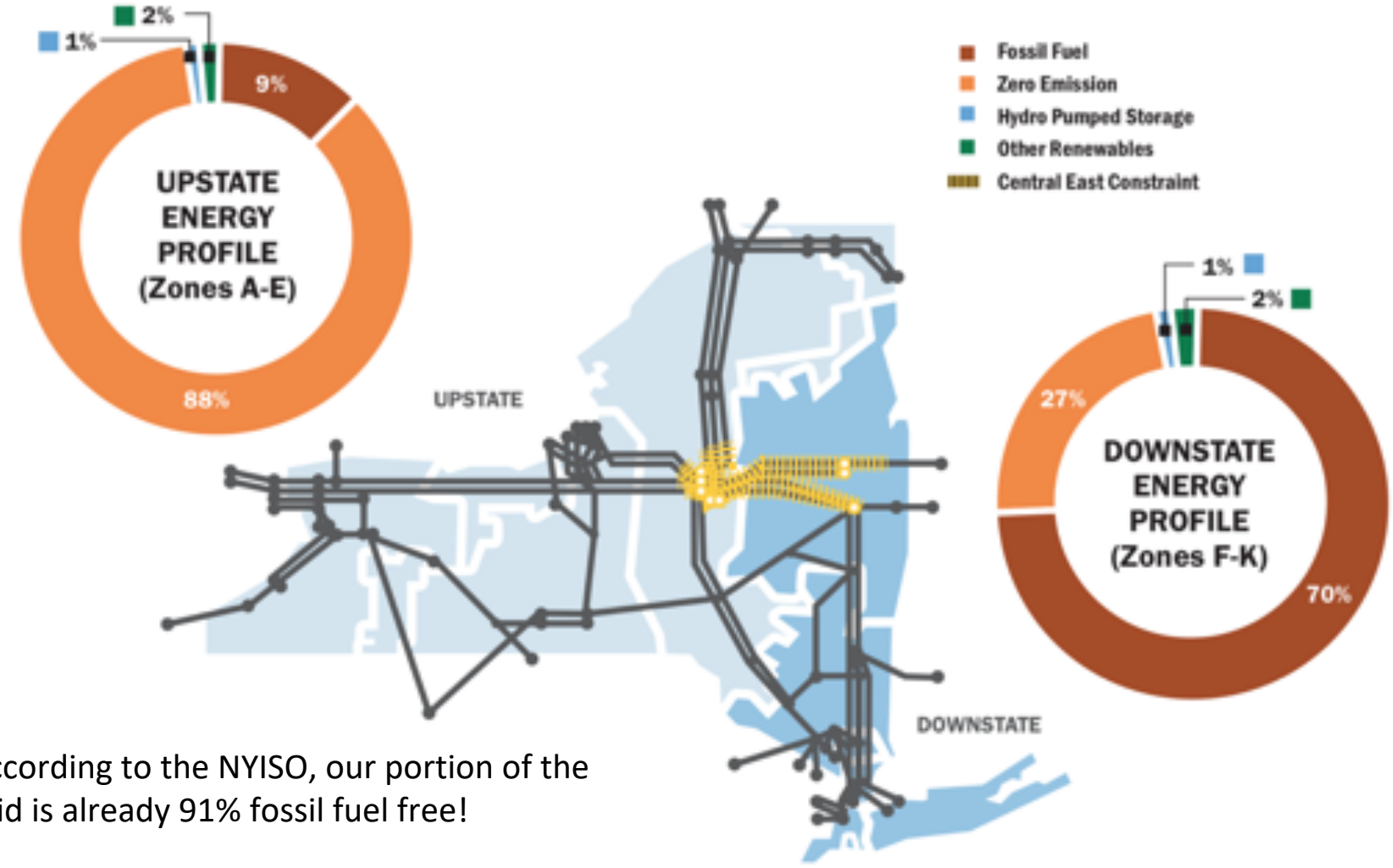
The application of electricity to end-uses that would otherwise consume fossil fuels (e.g., natural gas, propane, oil, gasoline) where doing so satisfies at least one of following conditions, without adversely affecting the others:

- Save consumers money over time;
- Benefit the environment and reduce greenhouse gas emissions;
- Improve public health and/or consumer quality of life; or
- Foster a more robust and resilient grid.

GO ALL ELECTRIC*

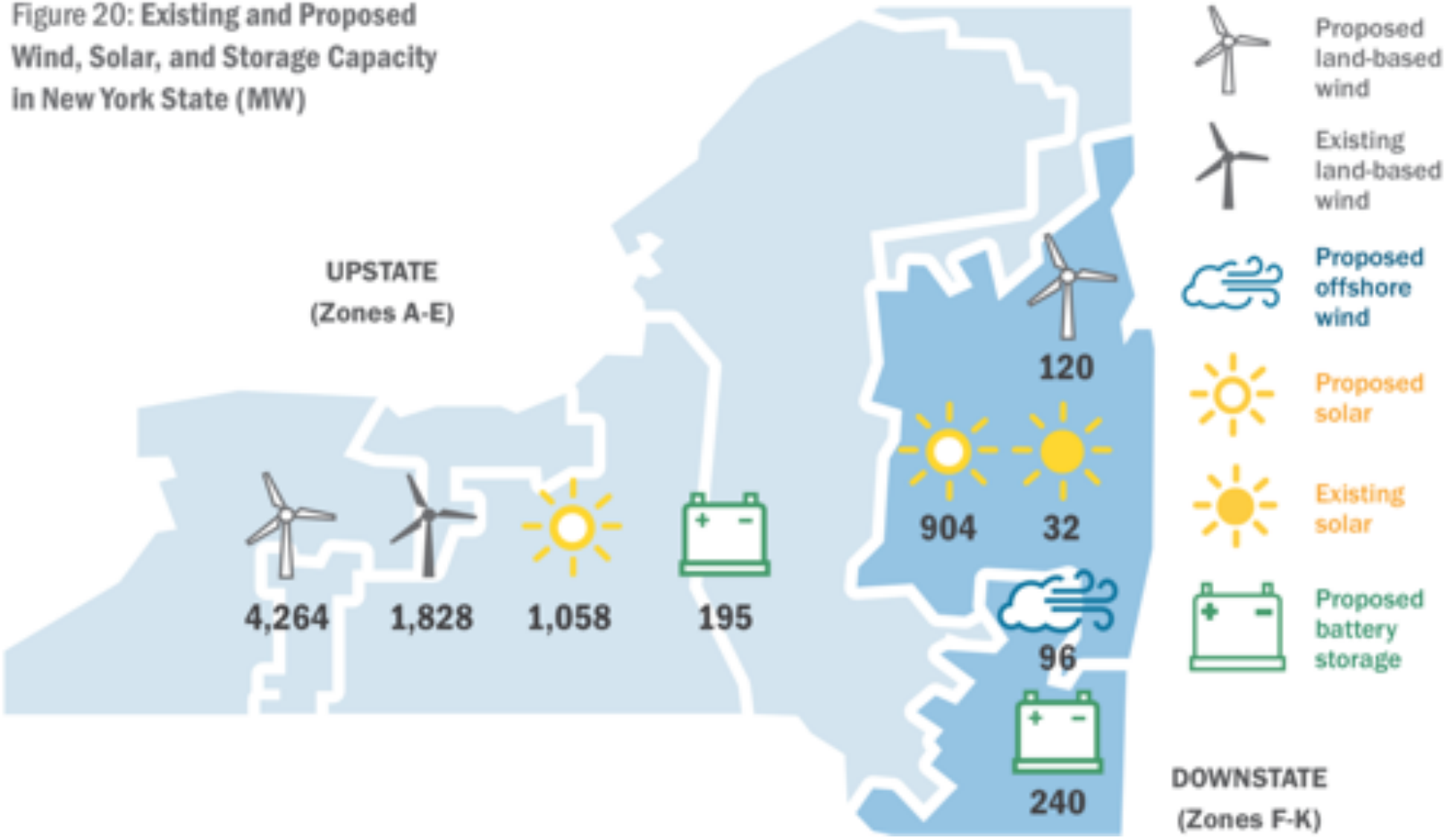
*with modern, energy efficient technologies and behaviors that conserve energy

(i.e., We must not forget the importance of energy efficiency and conservation!)



According to the NYISO, our portion of the grid is already 91% fossil fuel free!

Figure 20: **Existing and Proposed Wind, Solar, and Storage Capacity in New York State (MW)**



Source: NYISO Power Trends 2018

Local Emissions Sources

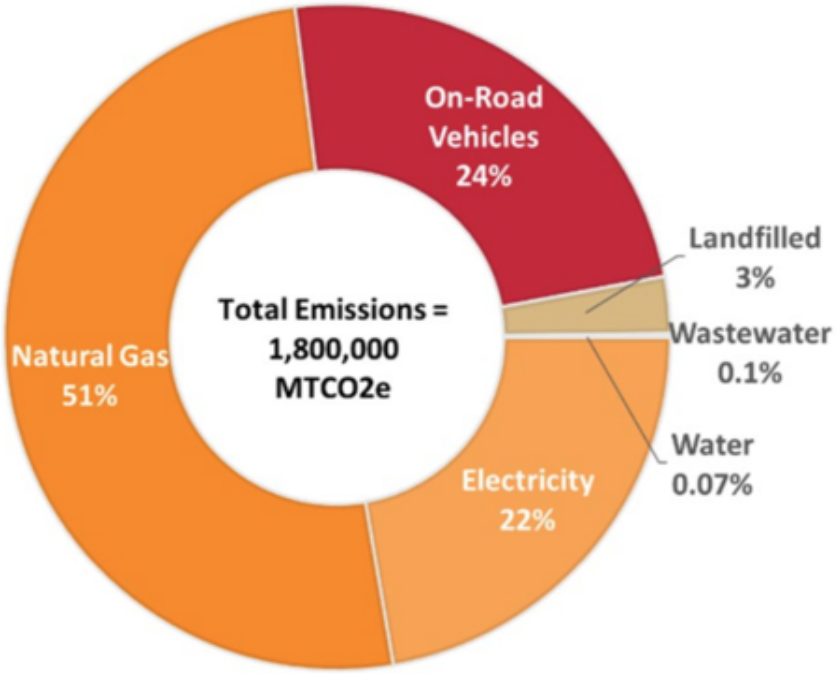


Figure 12: Emissions by Source/Activity (CAP Inventory), 2014

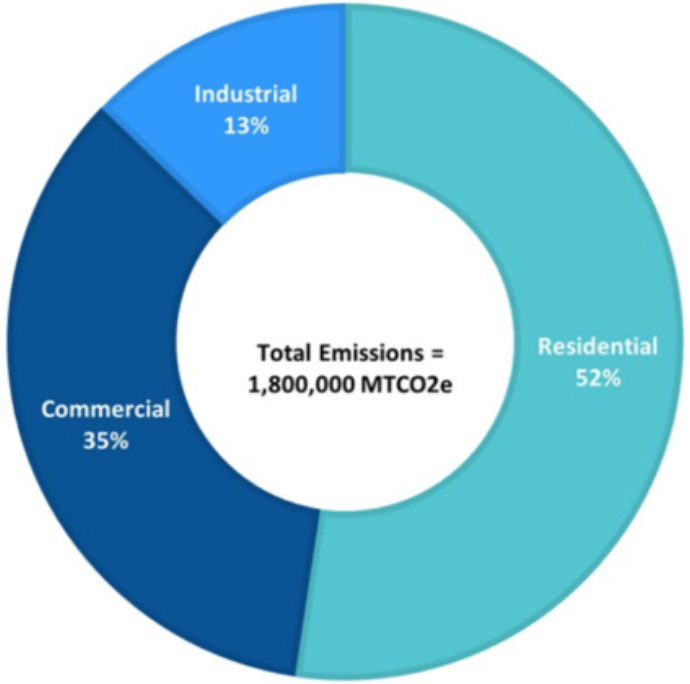


Figure 13: Emissions by Sector, 2014

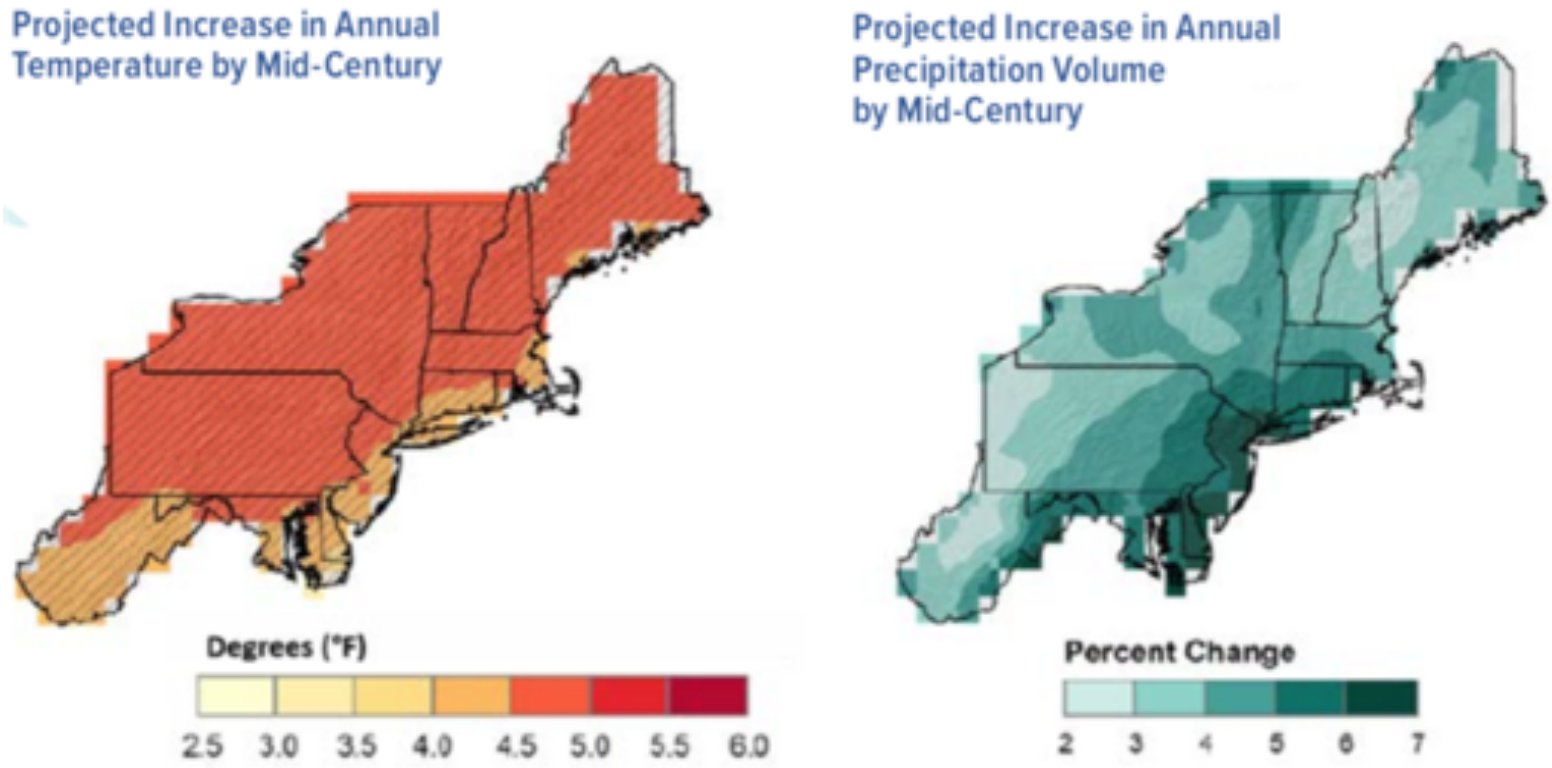
Source: City of Rochester Climate Action Plan

Greenhouse Gas Emission Inventory Summary
Transportation: On-Road Vehicles
Finger Lakes New York Region

County	Annual Vehicle Miles Travelled[1] (VMT)	Annual GHG Emissions[2] (metric tons CO2e/yr)			
		CO2	N2O	CH4	Total
Genesee	1,097,199,275	530,382	1,329	455	532,166
Livingston	786,257,742	386,095	967	331	387,393
Monroe	6,486,644,052	2,832,972	7,095	2,432	2,842,498
Ontario	1,424,348,585	658,566	1,616	565	660,747
Orleans	298,777,408	138,335	347	119	138,800
Seneca	461,842,036	218,810	548	188	219,546
Wayne	744,612,295	311,467	780	268	312,515
Wyoming	359,002,158	162,186	406	139	162,731
Yates	198,538,063	98,299	246	84	98,630
Finger Lakes NY Total	**11,857,221,614**	**5,337,111**	**13,334**	**4,580**	**5,355,025**

Source: Finger Lakes 2010 Greenhouse Gas Inventory

Local Climate Impacts



Source: City of Rochester Climate Vulnerability Assessment

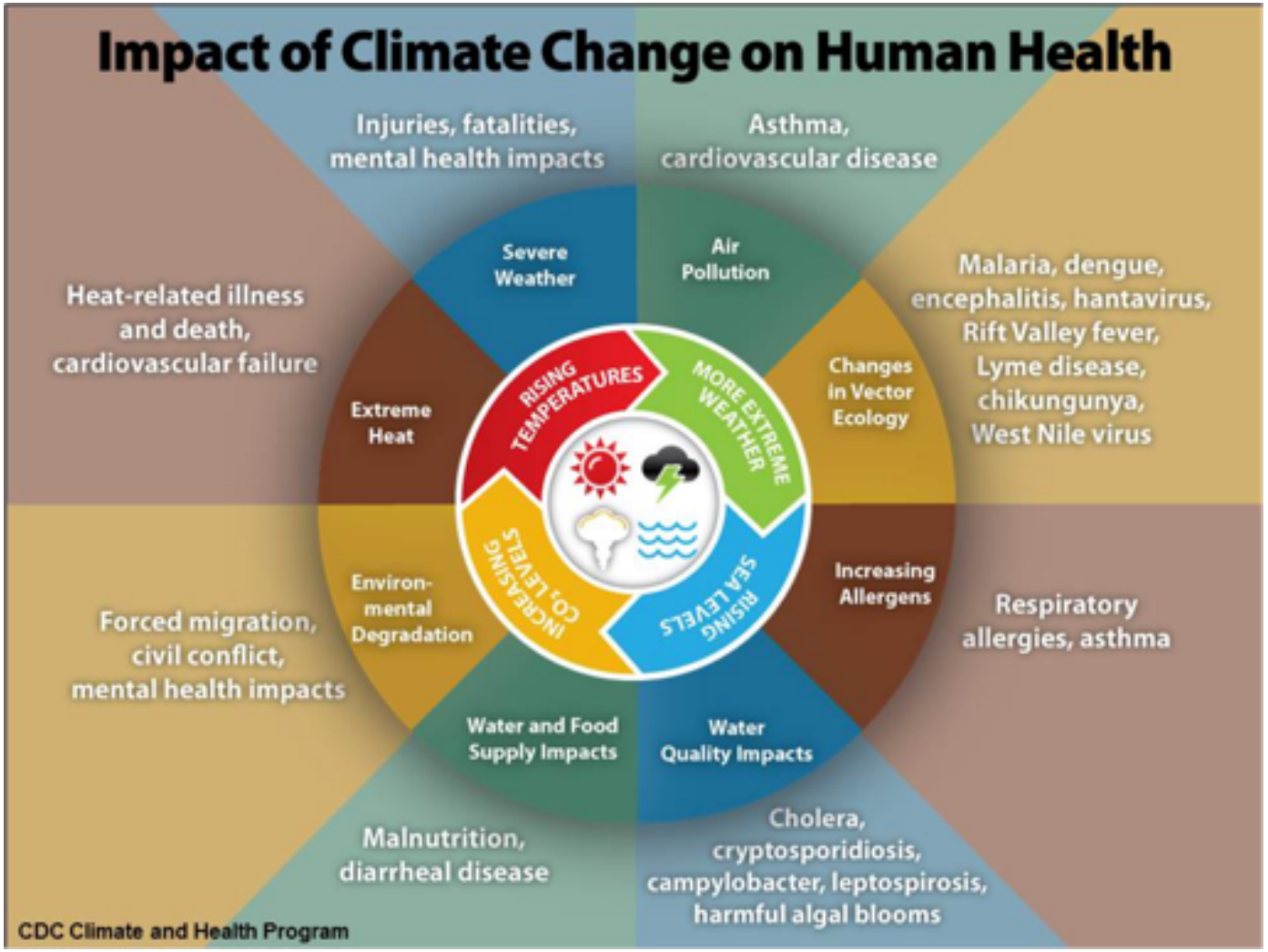
Impact

Level of Vulnerability

Low	Medium-Low	Medium	Medium-High	High
Increased water demand/cost	Changes in water pumping and treatment patterns	Decreased stormwater quality, increased combined sewer flows	Greater algae growth	Increased infrastructure maintenance
Increased pollutant toxicity	Increased water storage needs and related impacts	Decreased snow pack and river freezing	Increased survival and transmission of parasites and bacteria	Increased infrastructure disruptions due to extreme events
Longer composting season	Longer growing season	Increased soil erosion	Reduced fisheries production	Decreased food production, increased crop loss
	Increased walking/ biking opportunities	Increased diseases, vector borne illness, and pests	Decreased groundwater levels	Higher intensity of heating and cooling degree days
	Changes in public transportation use	Decreased winter road treatment	Greater threat of invasive species	Increased disease concerns
	Increased odor concerns	Increased freeze/ thaw cycles	Decreased walking/ biking due to higher heat days	Air quality impacts on health
	Increased organic waste generation	Increased energy cost, decreased availability	Increased electricity demand	Loss of winter recreation activities
		Decreased heating degree days and associated energy use	Increased risk to vulnerable populations	
		Changes to population distribution and infrastructure needs	Increased heat and drought related health impacts	

Energy Waste Water Transportation Land Use Health

Source: City of Rochester Climate Action Plan


Impact of Climate Change on Human Health
Injuries, fatalities, mental health impacts
Asthma, cardiovascular disease
Severe Weather
Air Pollution
Heat-related illness and death, cardiovascular failure
Malaria, dengue, encephalitis, hantavirus, Rift Valley fever, Lyme disease, chikungunya, West Nile virus
Extreme Heat
Changes in Vector Ecology
RISING TEMPERATURES
MORE EXTREME WEATHER
INCREASING CO2 LEVELS
RISING SEA LEVELS
Environ-mental Degradation
Increasing Allergens
Forced migration, civil conflict, mental health impacts
Respiratory allergies, asthma
Water and Food Supply Impacts
Water Quality Impacts
Malnutrition, diarrheal disease
Cholera, cryptosporidiosis, campylobacter, leptospirosis, harmful algal blooms
CDC Climate and Health Program

Health Impacts from Fossil Fuel Combustion

Fossil fuel combustion by-products significantly affect public health.

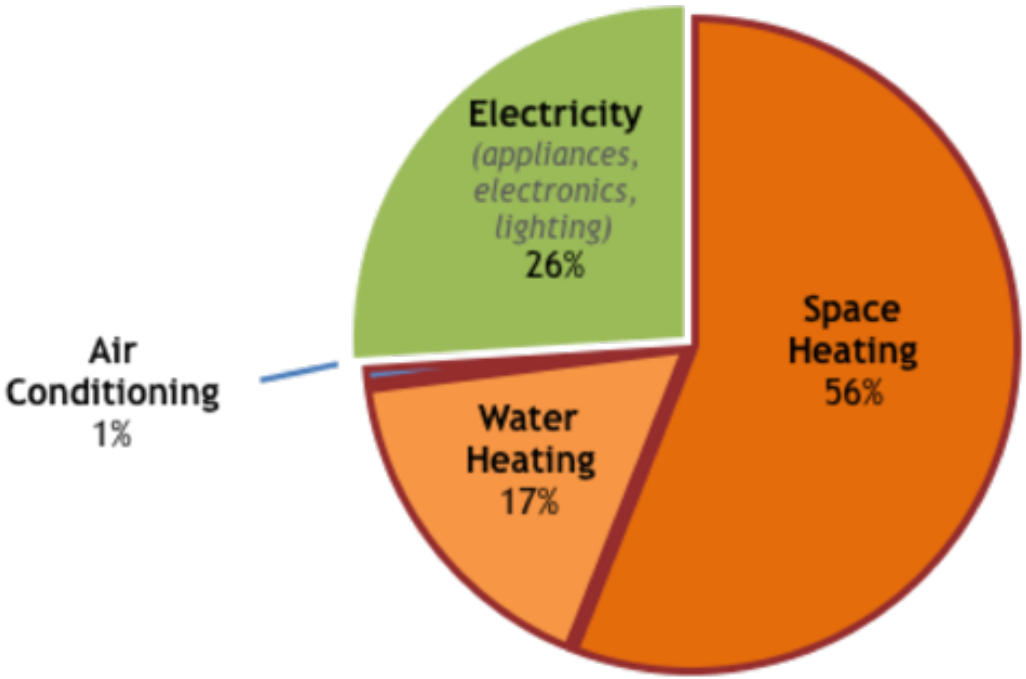
- According to the Lancet Commission on Pollution and Health, 2017, pollution caused 16% of deaths worldwide in 2015
  - 85% of air pollution is caused by fossil fuel combustion
- Toxic emissions and elevated CO2 have been associated with a number of health conditions such as: premature birth, respiratory illnesses such as asthma, neurological conditions and certain cancers
- Children are most at risk due to rapid growth and increased respiration rates
- Children of color and underserved populations are most exposed to air pollution, thus exacerbating an already vulnerable public health situation

Health Benefits from reducing Fossil Fuel Combustion

"Reductions in airborne particulate matter between 2001 and 2010 in Taiyuan, Shanxi province, China associated with 2810 fewer premature deaths, 31,810 fewer hospital admissions, 141,457 fewer outpatient visits, 969 fewer emergency department visits, 951 fewer cases of bronchitis and more than 30,000 fewer DALYs [disability adjusted life years] attributed to air pollution in Taiyuan in 2010 compared to 2001. The decrease in the estimated cost of premature death due to air pollution: 3.83 billion Yuan, or approximately $621 million USD."

Perera, F.

Average NY Home Energy Use



Source: EIA RECS

Almost 75% of energy used in a typical New York home is for heating and cooling!

The average New York household pays over $3,000 a year in energy bills.

As part of the Reforming the Energy Vision (REV) initiative New York State established an Energy Affordability Policy that set the goal of limiting energy costs for low-income utility customers to an average of no more than 6 percent of income.

Table 2.1 - Energy Burden for New York State Households by Income Group

Household Group	Average Energy Bill	Average Income	Average Energy Burden
Low-Income Households	$2,712	$21,074	12.9%[4]
Moderate-Income Households	$3,064	$48,048	6.4%
Non-LMI Households	$3,452	$142,243	2.4%
All Households	$3,186	$93,860	3.4%

Source: ACS (2013-2015) / Households that pay energy bills directly to energy suppliers

Table 4.2 - Energy Burden for LMI Households by LMI Group

LMI Group	Percent of LMI Households	Average Energy Bill	Average Income	Average Energy Burden
Very Low Income	35%	$2,616	$13,488	19.4%
Low Income	29%	$2,830	$30,230	9.4%
Moderate Income	36%	$3,064	$48,048	6.4%
All LMI Households	100%	$2,839	$30,726	9.2%

Source: ACS (2013-2015) / Households that pay energy bills directly to energy suppliers

Key point: Very low income NYers have the highest energy burden by far

Table 4.3 - Energy Burden for LMI Households by Main Heating Fuel

Main Heating Fuel	Percent of LMI Households	Average Energy Bill	Average Income	Average Energy Burden
Natural Gas	65%	$2,681	$31,117	8.6%
Fuel Oil	13%	$4,477	$34,892	12.8%
Electricity	15%	$1,857	$25,246	7.4%
Propane	4%	$3,503	$29,970	11.7%
Wood/Coal	2%	$3,288	$33,633	9.8%
All LMI Households	100%	$2,839	$30,726	9.2%

Source: ACS (2013-2015) / Households that pay energy bills directly to energy suppliers

Key point: Energy burden is highest for oil and propane customers

Existing Programs/Resources

- Sustainable Homes Rochester
- EV Accelerator
- RTS electric buses
- RG&E rebate programs
- RSEHI
- *RUSH²*
- *Mothers Out Front campaign for electric school buses*
- *Renewable Heat Now campaign*

Sustainable Homes Rochester

- Community education campaign to build interest and demand for energy efficiency and clean heating and cooling technologies (i.e., heat pumps)
- No-cost energy assessments
- NYSERDA rebates and Federal tax credit
- Low-income program coming soon
- Currently focused on the City of Rochester, but likely to expand to nine-county region.

sustainable homes rochester
Clean. Comfortable. Affordable.

Rochester EV Accelerator - ROC EV By the Numbers

- EVs account for 1.79% of all new car sales in Monroe County
- 1,036 Test Drives
- 35 Ride and Drive Events
- 13 Tabling Events
- 13 Workplace Charging Partners

RTS Electric Buses

Bus Purchase Update

- Selected New Flyer to provide 6-10 buses
- Reviewing Bus Specification
- Pilot bus arrives January 2020
- Rest of buses arrive June 2020

Charger Update

- Selected EV connect
- Chargers arrive January 2020

RTS Electric Buses

Infrastructure Update

- Reviewing 95% plans
- August award of construction contract
- Construction complete December 2019

Current Infrastructure

Main Gear

New Charger Locations

RG&E rebate programs

- DC Fast Charging Incentive Program
- Nissan Leaf $5,000 discount
- Heat pump rebates

Rochester Safe & Efficient Homes Initiative (RSEHI)

- 4 yr project created with 1.0M in NYS AG settlement funds.
- Collective impact initiative of Rochester Area Community Foundation.
- RSEHI & community partner braided monies for nearly $3.0M in weatherization, health & safety, & energy efficiency projects for 200+ low-income Rochester homeowners.
- Clients average 23% savings in energy costs.
- Clients w/ self-reported respiratory conditions report health improvements.
- 2,000+ tonnes of carbon eliminated.
- Working to educate housing partners on #goallelectric options.
- Promoting and supporting #goallelectric choices & programs.
- Actively seeking additional funding to continue this work.

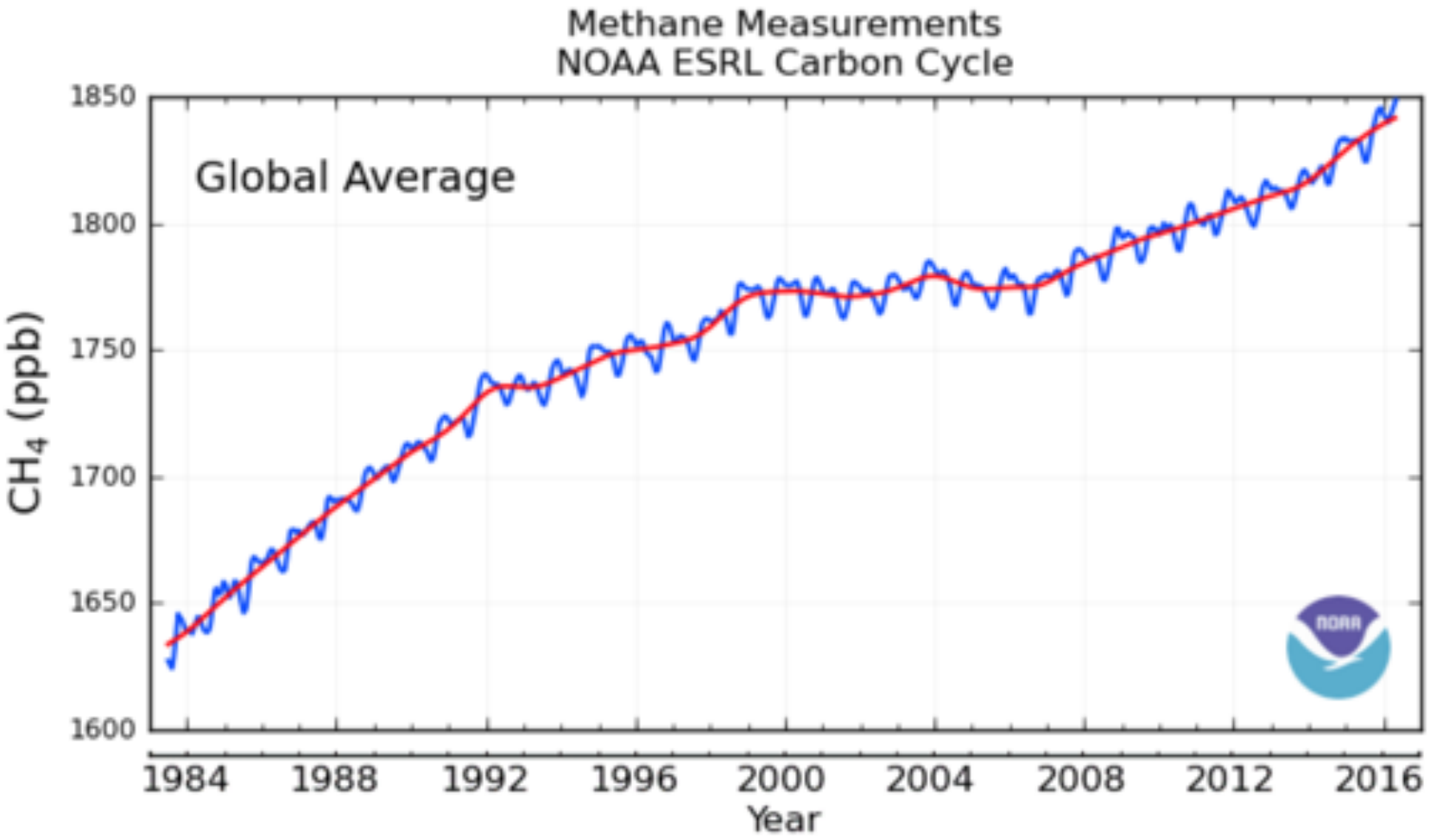
ROCHESTER SAFE & EFFICIENT HOMES

Challenges/Barriers

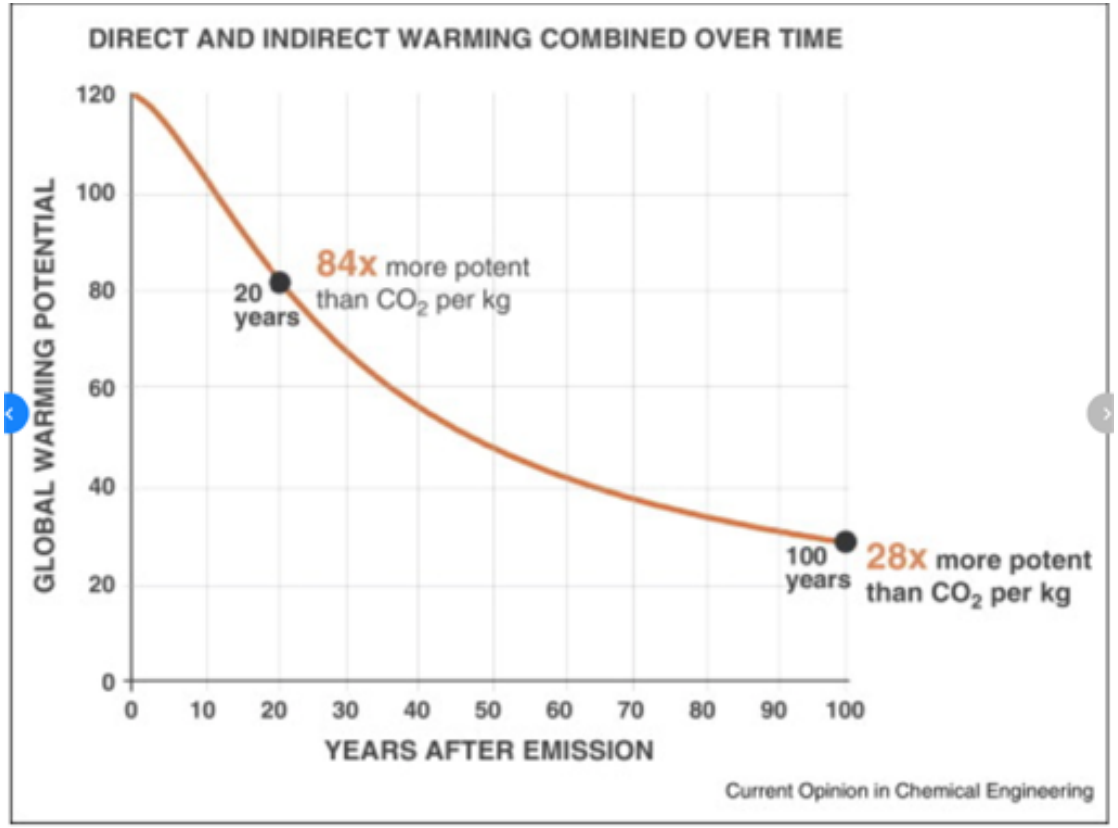
- Lack of public awareness
- Significant upfront investment/insufficient incentives
- Concerns about nuclear
- High percentage of rental housing
- State and Federal policies that don’t reflect the scale and urgency of the crisis (e.g., current building codes and gas expansion policies)
- Cheap natural gas
- Lack of accurate accounting for methane leaks

Understanding Carbon Dioxide (CO_2) vs. Methane (CH_4)

- Natural gas is mostly CH_4, but when you burn it, it produces CO_2
- There is more CO_2 in the atmosphere and it lasts much longer, but it's significantly less potent than CH_4
- Methane is very potent over the first 20 years after emission, and thus has more impact on our climate in the short-term
- Burning natural gas produces significantly less CO_2 than burning coal or oil does
- Natural gas does not have major contributions to acid rain, heavy metal and mercury deposition, or particulate matter pollution (so it's much better than other fossil fuels from a health perspective)
- However, most GHG inventories don't account for methane leaks that occur during the extraction and distribution of natural gas
- There is much debate about how to appropriately account for methane leaks
- Leakage rates from fracking are higher than from conventional drilling


Methane Measurements
NOAA ESRL Carbon Cycle
Global Average
CH_4 (ppb)
1850
1800
1750
1700
1650
1600
1984
1988
1992
1996
2000
2004
2008
2012
2016
Year

Global Warming Potential of Methane



Global warming potentials for methane (kgCO2 emissions equivalent to a kg of methane emissions), as a function of the time horizon used in the GWP calculation

(Underestimated) Regional Methane Leaks

GHG Emissions from Natural Gas Use Transmission and Distribution Losses[1]

	% T&D Loss	Total Natural Gas (mcf)	CH4 Losses in mcf	CH4 Losses in lbs	Total CO2e
Natural Gas T&D Losses	**1.8%**	**45,042,256.11**	**810,761**	**36,322,075**	**345,984**
Genesee	1.8%	1,838,708.48	33,097	1,482,734.52	14,124
Livingston	1.8%	1,594,009.33	28,692	1,285,409.13	12,244
Monroe	1.8%	32,394,057.24	583,093	26,122,567.76	248,829
Ontario	1.8%	3,437,967.35	61,883	2,772,376.87	26,408
Orleans	1.8%	900,339.68	16,206	726,033.92	6,916
Seneca	1.8%	793,106.79	14,276	639,561.31	6,092
Wayne	1.8%	2,667,768.45	48,020	2,151,288.48	20,492
Wyoming	1.8%	1,017,465.83	18,314	820,484.45	7,815
Yates	1.8%	398,832.96	7,179	321,618.90	3,064

Notes

1. CO2e from T&D losses calculated based on ratio of estimated % fuel loss and total residential natural gas use within the region.

Source: Finger Lakes 2010 Greenhouse Gas Inventory

Why Natural Gas is NOT a Bridge Fuel

- The majority of local emissions come from on-site combustion of natural gas (even without accounting for methane leaks)
- To avoid climatic tipping points, we need to focus on reducing methane (because that will have more impact in the short-term)
- Gas leaks are a public safety risk
- To get to zero-emissions, natural gas consumption has to be eliminated

Implications for our grid

- This effort would require significant investment and improvement in our electricity systems.
- It implies almost a doubling of electricity consumption.
- Because most of that demand is at the consumer level, this will require changes at all levels and regions.
- If done gradually and predictably, this would allow for much-needed upgrades and updates to the transmissions and distribution systems (smart grid).

Electric Grid Energy Needs

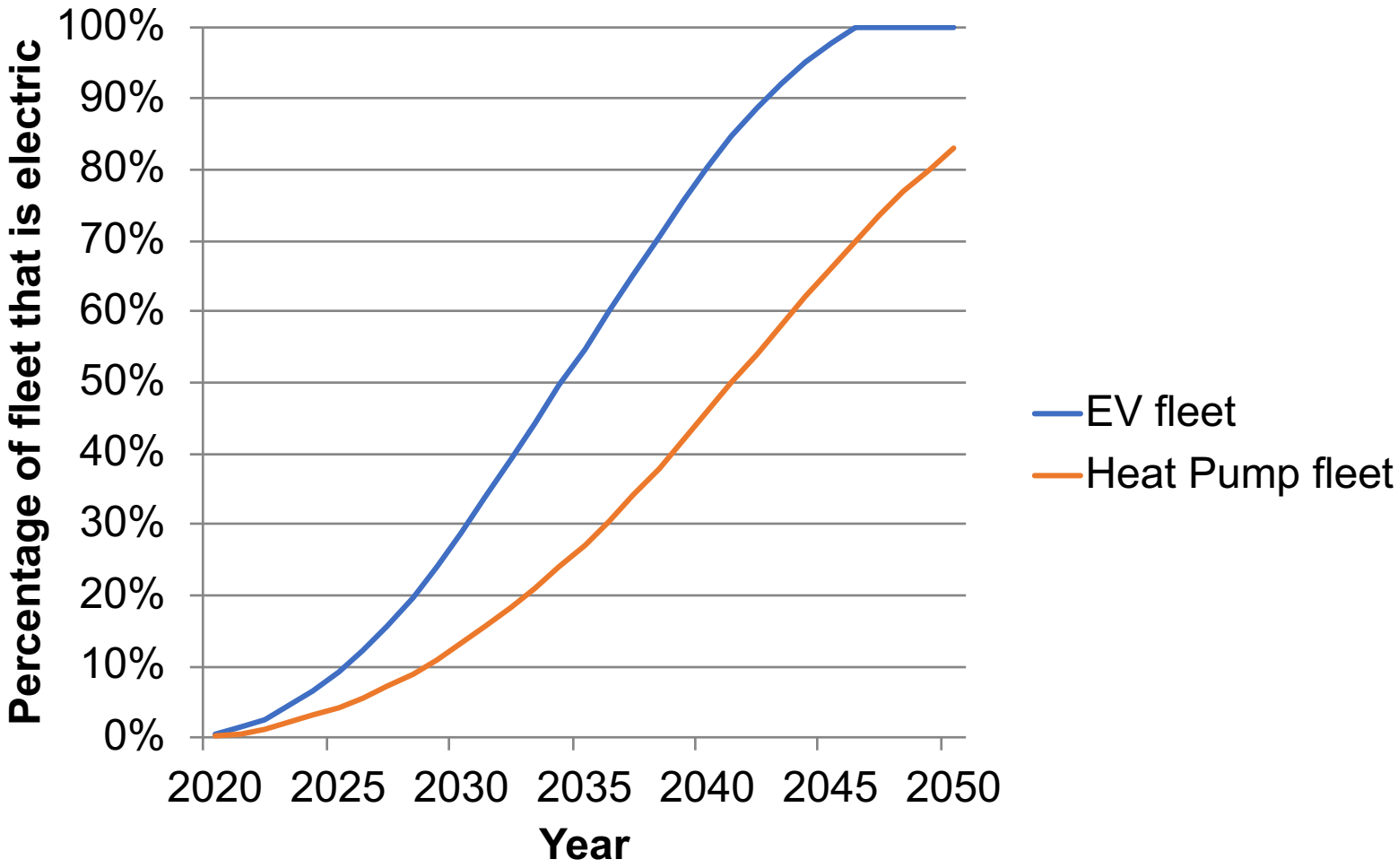
- Current NYS Vehicle Miles Traveled of passenger cars is 130B miles/yr
- At 3 miles/kWh, this requires **43,000 GWh/yr** of electricity
- Commercial and residential Natural Gas usage is 730T BTU/yr
- Assuming that is all for heat and replaced with air source heat pumps with COP of 3, this would require **61,000 GWh/yr** of electricity
- Currently, NYS uses 134,000 GWh/yr, so this would be a 77% increase in total generation (lower if efficiency & conservation are used).
- NYS is currently 55% zero-emissions generation, so meeting this would require a 140% increase in zero-emissions electricity state-wide.
- Upstate NY is 91% zero-emissions today, so it is an 85% increase for the upstate region.'
- Efficiency would reduce these numbers.

Electric Grid Capacity Needs

- A 2009 NYS study found that natural gas use by commercial, residential, and industrial users on the peak consumption day was around 6300 million cf.
- On that (very cold) winter day, heat pumps may have to run in resistance mode (1/3rd efficiency). If so, 6300 MMcf would be replaced by 1500 GWh of electricity, or 65 GW of continual firm generation for the whole day, just for heat.
- NY only has 43 GW of generation in total, though winter peak demand is around 35 GW.
- Meeting a new winter peak from HPs running in resistance mode would require a 100% increase in firm generation capacity in the state.
- If we could guarantee that the HPs always had a COP of 3, we only need a few percent more firm generating capacity (this may not be physically possible with air source heat pumps).
- For perspective, the peak day of NG consumption for a NYS house is around 1 MMBTU, equaling 293 kWh of electricity. My house now uses 450 kWh in an average month. It would take 22 Powerwall 2 batteries ($150K today) to store 293 kWh of energy.

Adoption Model

- I made a model of EV and HP adoption, assuming that only end-of-life replacement (or new build) would be targeted, with an increasing share of replacement going electric.
- I assumed that the percentage of *replacement* vehicles and heating starts at 5% in 2020 and goes linearly to 100% by 2039.
- I assumed vehicles last 11 years and furnaces last 25 years.


Percentage of fleet that is electric
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2020
2025
2030
2035
2040
2045
2050
Year
EV fleet
Heat Pump fleet

Costs

5/24

- Utility costs would be significant, especially the new capacity requirements to meet heat pump winter peak. It would be far easier to meet the EV demand – I would guess 5% of the cost of meeting both. These costs would be mitigated by lower concurrent peak demand from HPs, through efficiency or other measures.
- Consumer costs for EV adoption are relatively small and falling. Plausible projections from entities like Bloomberg New Energy Finance suggest that the unsubsidized lifecycle costs of an EV will be lower than an equivalent ICE vehicle within a few years.
- A friend that does all-electric home conversions near Cleveland talked about HP conversion costs and we found that a “good/easy” HP project costs about $2-5K more than a furnace replacement and has the same operating cost if you take out the gas meter and associated costs. But if the house needs efficiency upgrades, it could be more like $30k of upfront costs to breakeven on operating cost. NY has 8M housing units (4M single-family homes)

Costs and implementation

- The four main costs are in scaling up zero-carbon generation, scaling up T&D infrastructure, switching to electric vehicles, and switching to heat pumps.
- The net costs of all four are strongly related to speed of the transition - replacement at end-of-life is cheapest.
- Vehicles are an easier transition than heat pumps, due to more favorable economics in the near future and a shorter lifespan (15 yrs versus 20-30 yrs).
- A logical plan would be to encourage a growing share of vehicle/furnace *replacement* to be electric. This would result in lowest net capital cost and gradual increases in demand. New generation to meet that demand could be limited to zero-emissions, with eventual phaseout of the small number of fossil plants.

Other considerations

- Composition of new electricity generation (hydro/nuclear/wind/solar/other?)
- Reliability of the grid will be increasingly important
- Smart grid/microgrid integration will have to be rolled out
- Supportive infrastructure policy is critical - this plan requires huge amounts of new transmission, wind, solar, and other assets
- Rate structures will have to change to enable “dispatchable demand” (though this is very compatible with current plans under NY REV)
- Peak demand would shift to the winter and be much higher than current levels during prolonged cold periods