Appendix A: Our data collection and conversion methods

All the data in Table 2 for sectors 1 (Buildings and Facilities) through 5 (Wastewater Facilities) were calculated using the ICLEI CACP protocols. The data for sector 6, Other Indirect Emissions (including the greenhouse gas impact of village employee commutation and business travel, the village's use of solvents and fertilizer, and generation of solid waste) needed to be calculated using methods outside the CACP protocols. These non-CACP methods are explained briefly here. We welcome feedback toward improving the data collection and analysis tools.

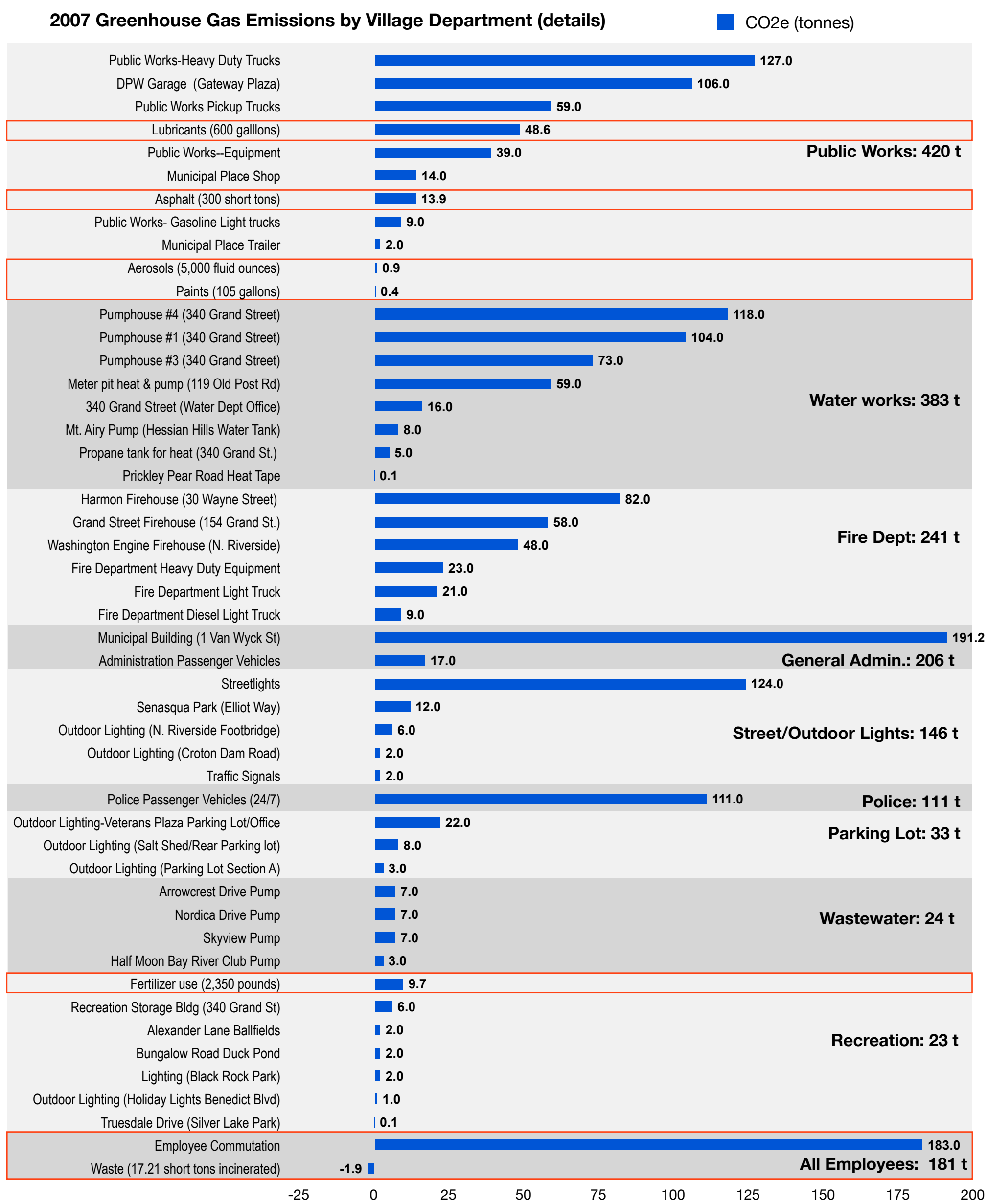


Figure A1: Bar chart of detailed emission sources by village department

The horizontal scale shows metric tonnes of CO_2e (tCO_2e) for each source within a village department. The departments are arranged in descending tonnage order and within departments by order of descending sources Emission inside a red box are indirect sources (See sector 6 in Table 2). The initial inventory yielded ~1,550 tCO_2e. These indirect sources added another ~250 tCO_2e, once they were identified and calculated. Had we limited our inventory to the direct sources available from our energy purchases, we would have underestimated the greenhouse gas emissions of village operations by over14%.

Figure A1 shows the major components of each department's emissions. Note that only one item, "Waste" under General Administration, offers a negative net emission value. Why? Because the village's solid waste is incinerated through the Westchester County facility in Peekskill, operated by Wheelabrator. Incineration to generate energy from waste avoids the methane release from landfill that same material. Hence the net reduction in greenhouse gas emission for this one item. (See Figure A1.)

The most significant indirect emission source is commutation by village employees. We used a survey completed by 57 out of 81 employees to determine commuting distances, modes, and the extent of any village-related business travel. The survey was made available to all employees in either paper or digital form. The digital form employed the free "basic"tool available at Surveymonkey.com. The survey analysis is summarized in Table A1. The text of the survey and number of responses per question is depicted in Table A3.

Table A1: Converting Employee Commutation and Travel to Emission Impacts

Employee Commute and Travel Data (2007)			
1	Average roundtrip commute	24.4	miles
2	Average number of days in 2007 commuted	208	days
3	Total commute miles reported by survey respondents	297,492	miles
4	Percent of commuters who drove automobile	100.0%	%
5	Percent of employees who responded to survey	70%	% (57 out of 81 employees)
6	Extrapolated commutation vehicle miles for all employees	**411,091**	miles
Employee Travel for Village business outside Westchester County			
7	Number of out of county trips	39	trips (in all modes of travel)
8	Percent of trips in which village employees carpooled	33%	trips (13 out of 39 total trips)
9	Total passenger vehicles miles for those trips	**1,875**	miles (22 solo and 13 carpool trips)
10	Total rail miles for travel	**1,150**	miles (3 trips)
11	Total airplane miles for travel.	**850**	miles (1 trip)
Cumulative Greenhouse Gas Emission Impacts from Employee Commutation and Travel			
		miles	**GHG impact (*tCO_2e*)**
	6.1a. Total Village Employee Passenger Car miles (line 6+9)	**412,966**	**181.840**
	6.1b. Total Village Employee Passenger Rail miles (line 10)	**1,150**	**0.082**
	6.1c. Total Village Employee Air Travel miles (line 11)	**850**	**0.826**
			182.748

Notes on conversion of miles to emission impacts *(Table A1)*

6.1a. Employee passenger car miles: Assuming an automatic 4 cylinder (2.2 liter) 2003 model sedan using regular gasoline with average 20 miles per gallon emits 8.806 kg CO_2/gallon, over the 412,996 commutation and business travel miles in 2007 by village employees, the emission result is (412,966 miles/20 mpg) * (8.8 kg CO_2/gallon)/1000= **181.84 tCO_2e.**

6.1b Employee passenger rail miles: Assuming commuter rail diesel fuel efficiency of 134.43 passenger miles/gallon, and 9.987 kg CO_2/gallon, the 1,150 passenger rail miles by village employees in 2007, the emission result is: (1,150 miles/134.43 mpg) * (9.987 kg CO_2/gallon)/1000= **0.085 tCO_2e.**

6.1c. Employee air travel miles: Assuming air travel emission of 0.972 kg/CO_2 per passenger mile, the emission result is (0.972 kg/CO_2) * (850 miles)/1000= **0.826 tCO_2e.**

See conversion factors from Clean Air–Cool Planet below (in Table A2) www.cleanair-coolplanet.org .

Table A2: Emissions conversion by fuel type

	kg CO_2 / Gallon	MMBtu/passenger mile	kg CO_2/mile	kg CH_4/mile	kg N_2O/mile
Gasoline Fleet	8.806370549				
Diesel Fleet	9.987005662				
Air		0.004931815	0.971806514	0.00000953	0.000011
Train		0.002806075	0.225702106	0.0000036	0.00000353

[Source: Clear Air–Cool Planet www.cleanair-coolplanet.org]

Table A3: Employee Commutation Questionnaire

Q1. I worked for the village for some or all of period between January 1, 2007 and December 31, 2007.
[answered question; 58 of which 50 (86%) were employees in 2007; skipped question 0]

Q2. How far did you travel each trip to work in 2007? (Enter the number of miles in a typical round trip. For most people this is the distance between your home and place of work. Round off to the nearest mile.)
[answered question 57; skipped question 1]

Average distance	24.3 miles (range: 1 - 90 miles)

Q3. What was the most common way that you commuted to your village job during 2007? (check one)
[answered question 55 ; skipped question 3]

Walk	0%
Bicycle	0%
Passenger car	100%
Mass transit bus only	0%
Mass transit train only	0%
Mass transit combination of bus and train	0%

Q4. Did you drive to work alone or carpool in 2007? (check one) We want to know the most common pattern you followed. (54 responses)
[answered question 54 ; skipped question 4]

alone 53	
carpool	1

Q5. How many days per year do you travel to work? (fill in number) You would have commuted 250 days in a year, if you worked 5 days a week for the 50 weeks and took a 2 week vacation. A typical work year has 260 work days. (57 responses)
[answered question 57 ; skipped question 1]

Average # commuting days:	209

Q6. If you travelled outside Westchester County for village-related business during 2007, tell us about the trips by selecting the transportation mode and distance for each one (trip) below. If you repeated a trip on more than one occasion in 2007, indicate that in the third menu column below.
[answered question 20 ; skipped question 38]

# of Trips	Travel Mode	# of Trips	Roundtrip Distance
22 trips	Passenger car alone	22	< 100 miles
13	Passenger car carpool	7	between 100-200 miles
3	Train	1	between 201-300 miles
0	Bus	6	between 301-400 miles
1	Airplane	1	between 401-500 miles
0	Other	1	between 501-800 miles
39	total trips	1	more than 801 mile
		39	total trips

Q7. You can leave any other comments here in this text box. Thank you.
[answered question 7 with comment; skipped question 51]

The Village contracts with the turf maintenance firm for upkeep on its lawns and athletic fields. In 2007, this work deployed fertilizer four times between early April and late October for a total of 2,350 pounds of various fertilizer compounds. We estimate this volume to have released 9.67 tCO_2e. (See Table A4).

Table A4: Converting fertilizer use to emission impacts

Converting fertilizer use to emission		
6.2. Fertilizer Use		**units**
a) volume by weight	2,350	*pounds*
b) conversion factor	0.004166173	*tCO_2e/lb*
total (a*b)	**9.79**	***tCO_2e***

How did the Village address the use of solvents in this inventory? Based in invoices and expenditures for calendar 2007, the staff came up with the following usage estimates: 600 gallons of lubricants (motor oils, grease, transmission fluid); 5,000 fluid ounces of aerosol solvents; 300 tons of asphalt; and 105 gallons of paint. (See Table A5.)

Table A5: Converting solvent volumes to emission impacts

Solvent volume to emission conversion

6.3a. **Lubricants**		**units**
a) volume	**600**	***gallons***
b) CO_2 content in lb/gallons	7.5	*lb/gal*
c) CO_2 in lb per lb of oil	23.8	*lb/gal/lb oil*
d) GWP	1	*na*
e) subtotal	107,100	*CO_2e in lbs*
f) conversion to metric tonnes	0.00045372	*metric tonne/lbs*
total (a*b*c*d*e*f)	**0.00**	***tCO_2e***

6.3b. **Asphalt**		**units**
a) volume	**300**	***short tons***
b) CO_2 content in lb/gallons	7.5	*lb/gal*
c) fuel needed per ton of asphalt mix	2	*gallons/ton mix*
d) GWP	6.8	*1/CO_2e*
e) subtotal	30,600	*CO_2e in lbs*
f) conversion to metric tonnes	0.00045372	*metric tonne/lbs*
total (a*b*c*d*e*f)	**13.88**	***tCO_2e***

6.3c. **Aerosols**		**units**
a1) volume	**5,000**	***fluid ounces***
a2) volume conversion to gallons	128	*fluid ounces/ gallons*
b) CO_2 content in lb/gallons	7.5	*lb/gal*
c) fuel needed	1	*na*
d) GWP	6.8	*1/CO_2e*
e) subtotal	1,992	*CO_2e in lbs*
f) conversion to metric tonnes	0.00045372	*metric tonne/lbs*
total (a1*a2*b*c*d*e*f)	**0.00**	***tCO_2e***

6.3d. **Paint**		**units**
a1) volume	**105**	***gallons***
a2) volume conversion to gallons	0.1	*VOC evaporation rate*
b) CO_2 content in lb/gallons	12	*lb/gal*
c) fuel needed	1	na
d) GWP	6.8	*1/CO_2e*
e) subtotal	856.8	*CO_2e in lbs*
f) conversion to metric tonnes	0.00045372	*metric tonne/lbs*
total (a1*a2*b*c*d*e*f)	**0.39**	***tCO_2e***

What is the amount of trash per employee figure that a municipality should use? That depends on a number of factors: Is there active recycling of paper, plastics, metals at the workplace? How is the resulting solid waste handled downstream? Does the municipality measure the solid waste its own operations create? Is organic waste matter handled separately?

The Village offices do recycle. Organic waste principally in the form of yard waste is handled separately, but was not calculated for 2007 as the volume data was not readily available. The remaining solid waste is handled as part of the County's refuse district. This district uses the Charles Point Resource Recovery Facility in Peekskill, an energy from waste incineration plant, that is operated by Wheelabrator (For more, visit "Environmental Facilities Department" at www.westchestergov.com.). (See Table A6.)

Table A6: Converting office employee waste to emission impact

Converting office waste to emission		
6.4. **Waste**		**units**
a) estimated per employee day	1.7	*pounds*
b) # employees	81	
c) workdays/ year	250	
d) annual waste (a*b*c)	34425	***lbs/yr***
e) conversion to short tons (d/2000)	17.21	***short tons/yr***
f) conversion factor (incineration with energy from waste)	-0.11	*tCO_2e/ short ton*
total (e*f)	**-1.89**	***tCO_2e***

Notes on conversion of fertilizer to greenhouse gas emission impact (Table A4)

6.2 Fertilizer applications: In 2007, Turf managment records showed the following applications: April, Calvacade @ 400 lbs; May, Greenyard W&F @400 lbs; June, Greenyard W&F @ 500 lbs and Triplet @ 3 gallons; September, Bifenthrin@ 500 lbs; October, 18-24-12 fertilzer @ 500 lbs. We assumed worst case that these all comprised synthetic compounds that yield 0.004166173 tCO_2e/lb in a mix of CO2, N2O, and CH4, versus 0.004166173 tCO_2e/lb from organic fertilizers. [Source: Clear Air–Cool Planet www.cleanair-coolplanet.org]

Notes on conversion of solvent to greenhouse gas emission impact (Table A5)

6.3a Lubricants: We assumed 600 gallons of lubricants (motor oils, grease, transmission fluid) would have the emission impacts as as #2 oil. The big question is how it was disposed of. We made a worst case assumption, all of it was burned in a waste boiler, since that is common. The emission impact of burning #2 oil is 7.5 lb/gallon. For 600 gallons, this yields 7.5 lb/gal x 600 = 4500 lbs @ 23.8 lb CO_2 / lb of oil / 2204 lb per tonne = **48.59 tCO_2e**.

6.3b Asphalt: Assuming 2 gallons of fuel is consumed per ton of hot asphalt mix produced, this equates to about 50 lbs CO_2e per ton mix. Multiplying this by 300 tons of asphalt yields: 300 tons x 2 gal/ton x 7.5 lb/gal x 6.8 GWP = **13.88 tCO_2e**.

[Source http://www.hotmix.org/index.php?option=com_content&task=view&id=449&itemid=72]

6.3c Aerosols: Under the conservative assumption for aerosols that both the propellant and fluid content are comprised of volatile organic compounds of with emission content of 7.5 lbs CO_2e per gallon and GWP of 6.8 factor, 5000 fluid ounces at 128 ounces per gallon and 7.5 lb /gallon yields 5000/128 x 7.5 = 293 lb x 6.8 lb CO_2e/lb = **0.90 tCO_2e**.

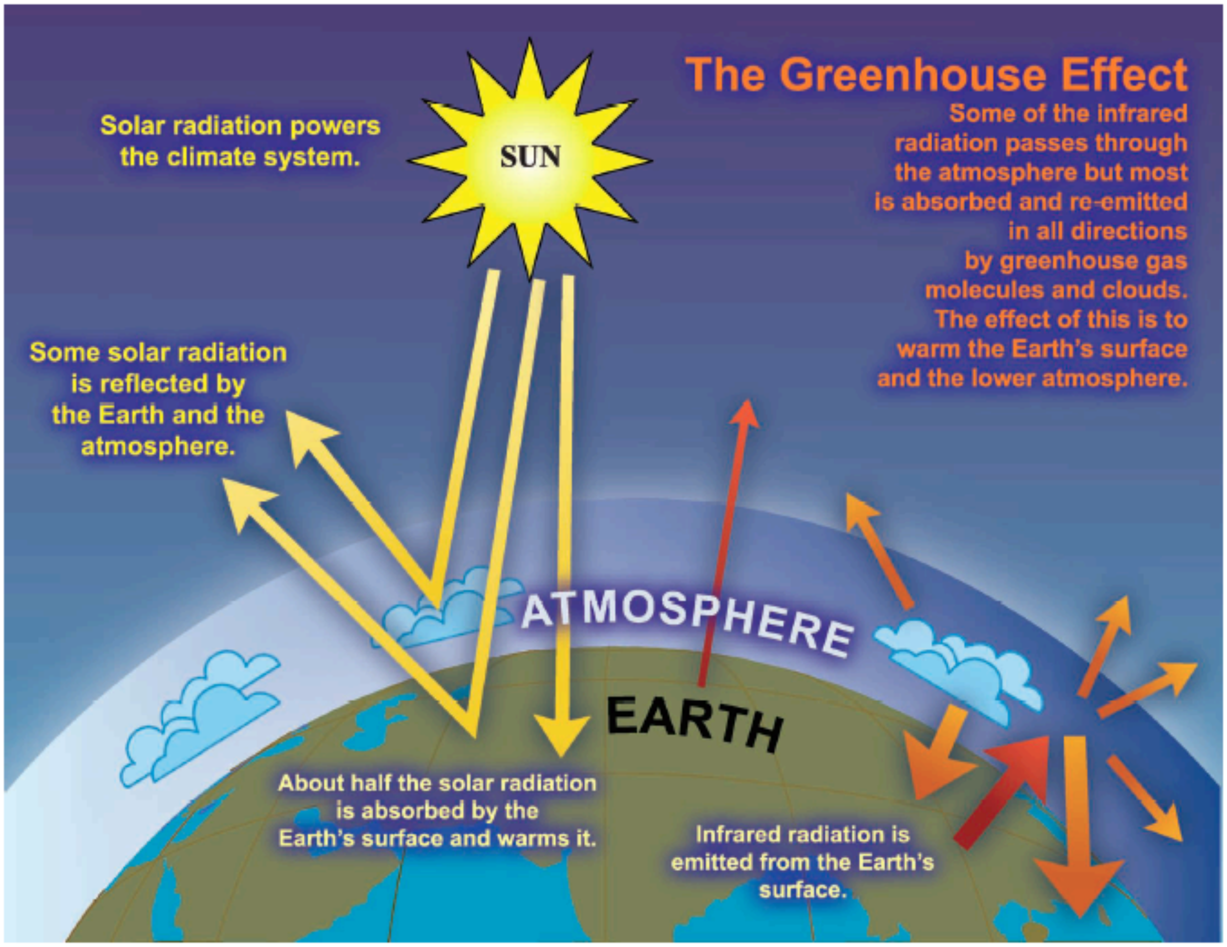
6.3d Paint: The paint volume–10 gallons for the Municipal Garage plus 25 gallons of primer and 50 gallons of paint for Municipal Building, plus 30 gallons for other miscellaneous work, bollards, fences, signs, outdoor recreation courts, etc. (assuming 300 square feet/gallon)–yields a total of 105 gallons. At 10% volatile organic compound (VOC) evaporation from the paint and an average global warming potential (GWP) in terms of CO_2e for VOC of 6.8, this yields 105 gal x .1 x 12 lb/gal x 6.8 = 856.8 lbs CO_2e/ 2204 lbs= **0.39 tCO_2e**.

Notes on conversion of village office waste to greenhouse gas emission impact (Table A6)

6.4 Solid Waste: The waste per village employee calculation relied on an average of the 1.7 pounds per workday per employee. For 81 people and 250 workdays/year, that yields 34,425 lb/yr, or 17.21 short tons per year. Incineration in energy from waste facilities eliminates any option for methane formation as would occur were the trash to be landfilled, but it also adds a component for the fuel used to burn the garbage. CACP rev. 6.4 shows a net credit for energy from waste incineration since it eliminates that methane formation: it subtracts 0.11 tCO_2e per short ton of trash. Multiplying that factor by the 17.21 short tons of office trash yields a credit of 1.89 tCO_2e. [Source: Keep America Beautiful Toolbox www.kabtoolbox.org/aboutus2.asp?id=389 :under Tools, click on Overview.]

Appendix B: Greenhouse gas science in a few pictures

Figure B1: The Earth's greenhouse gas effect

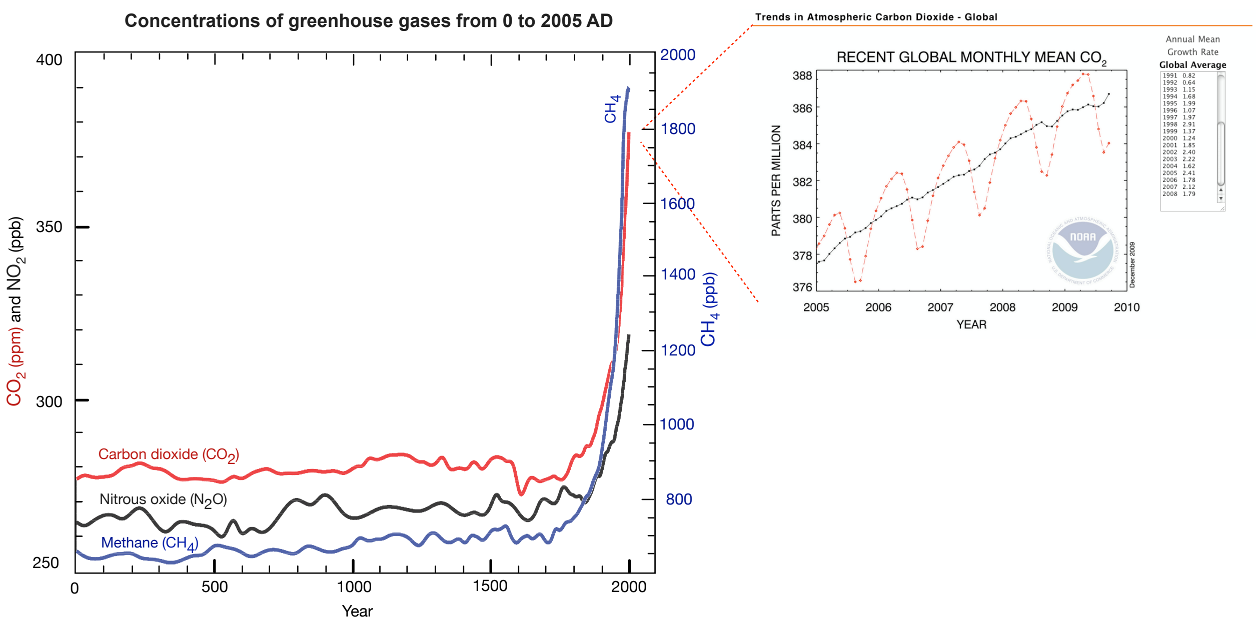


FAQ 1.3, Figure 1. *An idealised model of the natural greenhouse effect. See text for explanation.*

This figure shows an idealized and simplified of model how sunlight and the atmosphere interact to provide a life zone habitable for our species. The magic of our planet is that water, essential for life, if present simultaneously in all three of its states, as gaseos vapor (clouds), as liquid in our oceans and lakes, and as a solid (as ice and snow). About one-third of the Sun's energy that reaches the top of Earth's atmosphere is reflected directly back to space. The remaining two-thirds is absorbed by the land, ocean, and atmosphere. To balance the absorbed incoming energy, the Earth must, on average, radiate the same amount of energy back to space. But energy emitted from the Earth's surface radiates at much longer wavelengths, primarily in the infrared part of the spectrum. These wavelength are largely absorbed in the atmosphere by greenhouse gases, including water vapor and water droplets in clouds, and are reradiated back to Earth. This is called the greenhouse effect. [Source: FAQ 1.3 in IPCC (2007) FAQ (WG1) (in Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, (eds Solomon S, Qin D, Manning M, Chen Z, Marquis M, Averyt KB, Tignor M, Miller HL) AR4-WG1_FAQ-Brochure_HiRes.pdf: www.ipcc.ch]

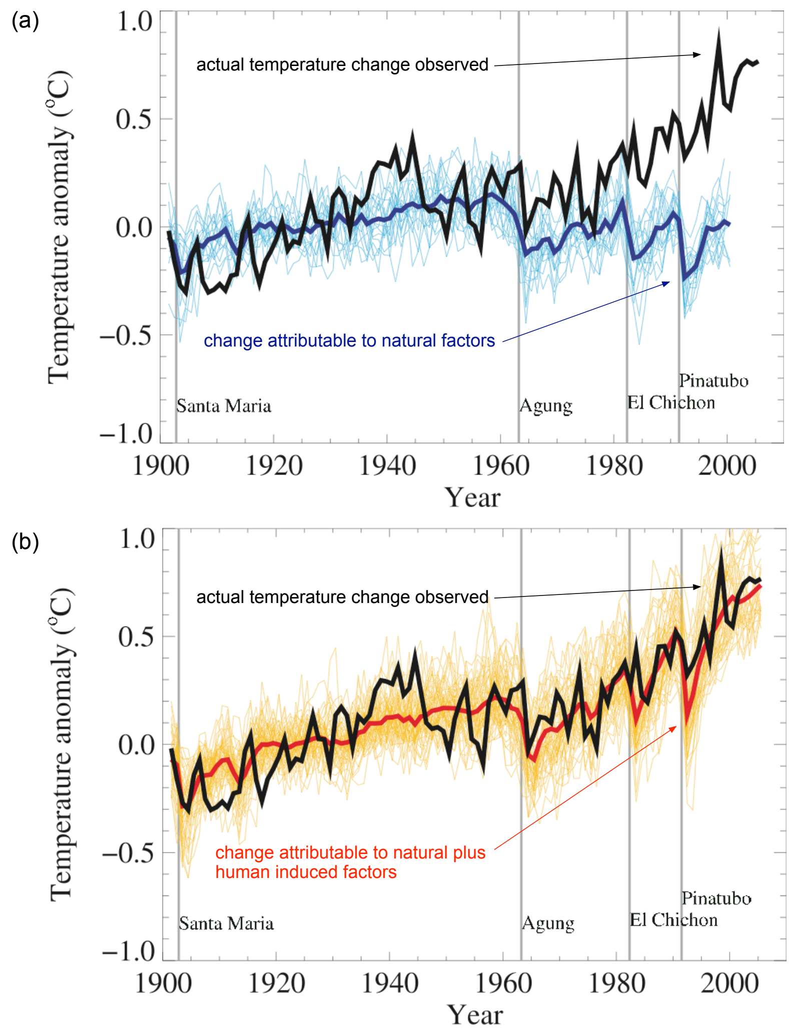
Figure B2: Past: Atmospheric concentrations of greenhouse gases: 0-2000 AD

Since about 1750, increases in atmospheric concentrations of important long-lived greenhouse gases are attributed to human activities in the industrial era. Concentration units are parts per million (ppm) or parts per billion (ppb), indicating the number of molecules of the greenhouse gas per million or billion air molecules, respectively, in an atmospheric sample. You might notice the dip in the red CO2 curve (and the other curves) in the late 1500s and early 1600s. This period coincides with the Black Death pandemic that was especially severe in Italy and Spain and recurring outbreaks during the Thirty Years War in the German states and the Low Countries. Europe lost 11,000,000 people in these episodes of famine and disease as the plaque often often killed 10% of a community in less than a year, but as many as 30% or more in some communities. These massive population drops curtailed economic activity and probably account for the dips in emissions levels in these centuries. In any case in the past century, we have witnessed only steady increases in atmospheric concentrations of greenhouse gases.



As the inset chart shows, the concentrations in the past decade, as recorded at the peak of Hawaii's Mauna Lo, have steadily pushed to new highs. [Source: FAQ 2.1 in IPCC (2007) FAQ (WG1). Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2007) file name: AR4-WG1_FAQ-Brochure_HiRes.pdf: www.ipcc.ch; Source (inset): Earth System Reserach Laboratory, NOAA, www.esrl.noaa.gov/gmd/ccgg/trends/]

Figure B3: Today: Natural vs.human forces vs.actual atmospheric temperature: 1900-2000 AD

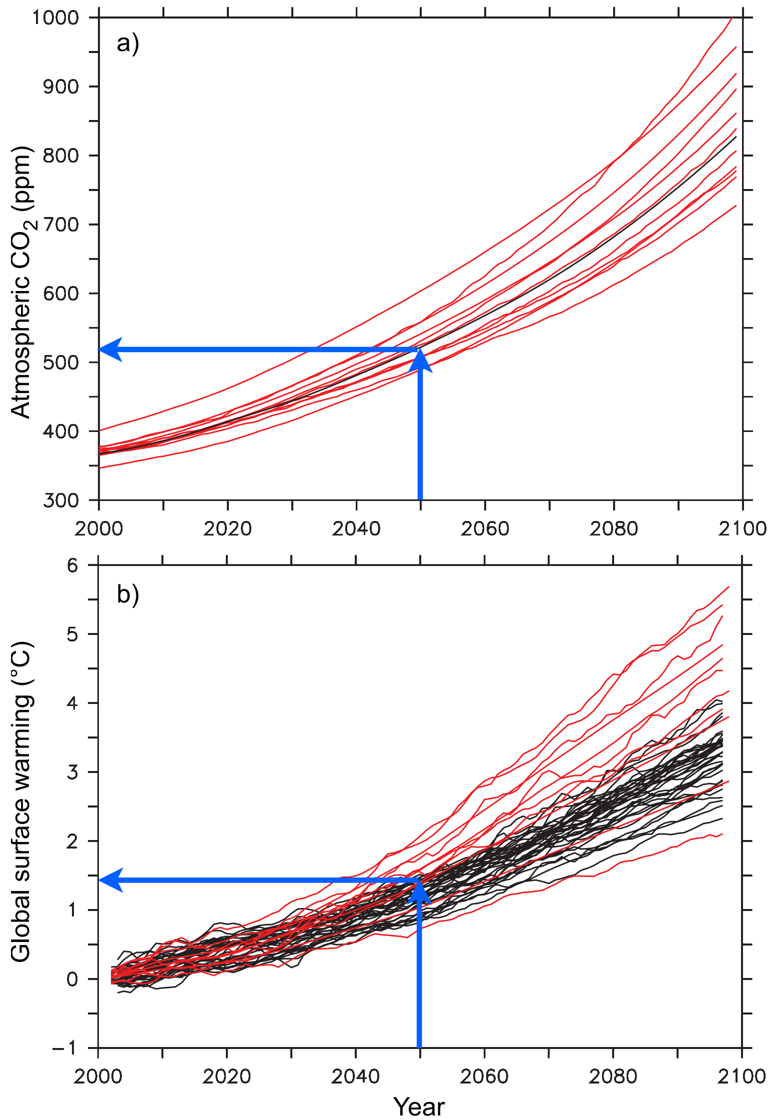


The heavy black line in both charts (a) and (b) here show the observed actual temperature changes for the past century with AD 1900 as 0 degrees of anomaly.

(a) In the top chart, the likely amount of temperature forced up or down by all natural causes is shown in blue, with the lighter blue shading showing the range for each year. Clearly, the natural causes do not match the actual temperature changes. Major volcanic eruptions are followed by global temperature decreases, due to the ejection of volcanic dust into the upper atmosphere, which blocks sunlight from reaching the Earth. Mount Pinatubo's colossal eruption of 1991 dropped Global temperatures dropped by about 0.5 °C.

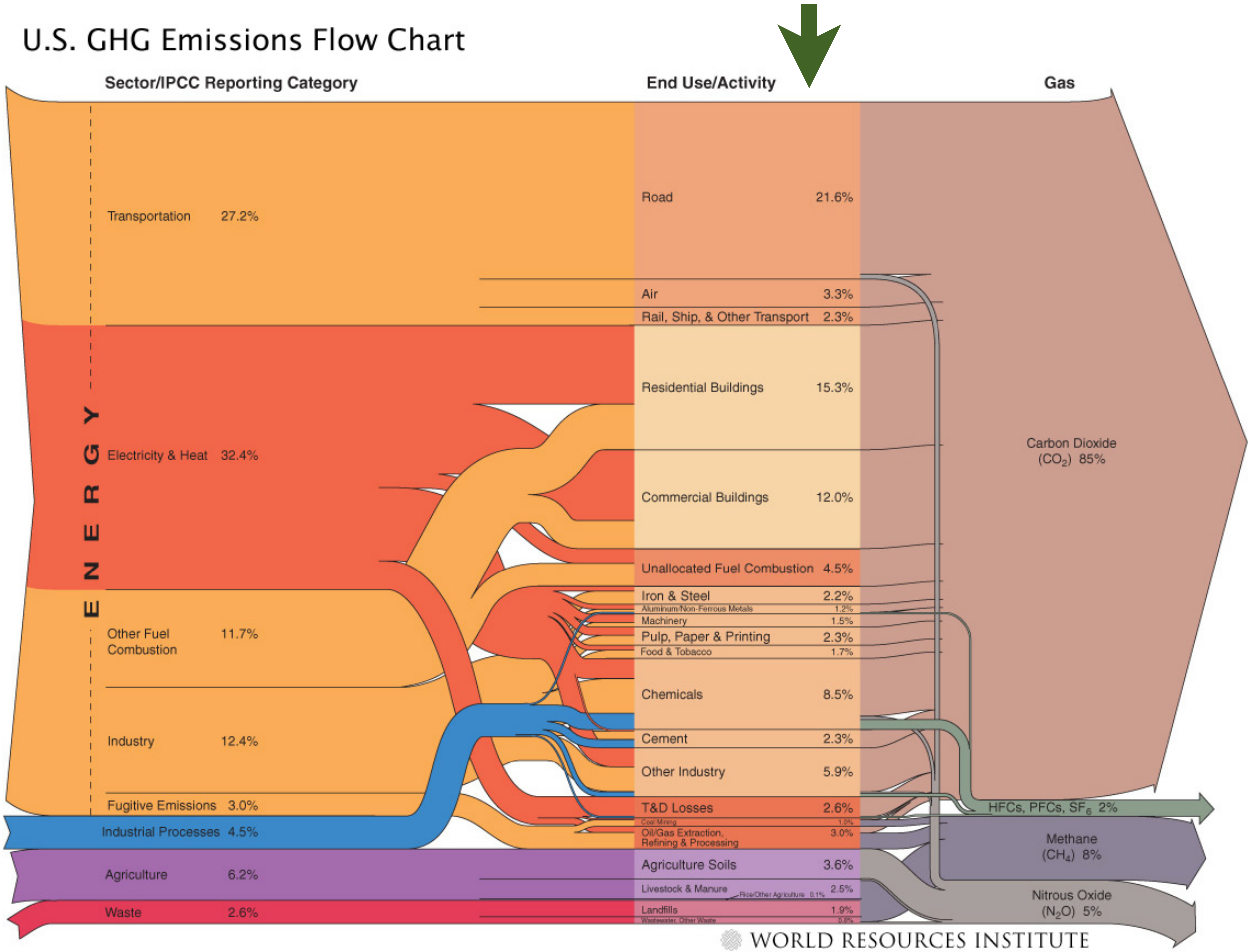
(b) The bottom chart shows the predicted impact on temperature of natural forcings combined with all the human-caused forcings in red, with the lighter red shading showing the range for each year. Adding the human impact to the underlying natural variations lifts the predicted natural temperature fluctuation to mirrors the actual rise almost perfectly. [Source: Figure 9.5 in Hegerl GC, et al (2007) Understanding and Attributing Climate Change. Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2007) file name: ar4-wg1-chapter9.pdf: www.ipcc.ch]

Figure B4: Future: Projected carbon dioxide emissions & global temperature disruption: 2000–2100 AD



The year AD 2050, a time at which many readers of this report will still be alive and active, is shown here by the vertical blue arrow. In the top chart, the average projection atmospheric carbon dioxide in 2050 is about 520 ppm, a massive increase over today's already very high levels of circa 385 ppm. By 2050 at least two things will happen: (1) carbon dioxide reaches almost double the level prior to the industrial age (before 1850) and (2) atmospheric carbon forces the average global surface temperature to rise at least another degree Celsius (2 degrees Fahrenheit), if not more. The models used by scientists for these projections of atmospheric carbon dioxide assume that we will make some attempts to reduce human causes of climate disruption, but that the large differences present now across the world will remain as barriers to pervasive, uniform action. [Source: Adapted from Figure 10.20 in Meehl GA, et al. (2007) Global Climate Projections. (Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, (IPCC, 2007) document name: ar4-wg1-chapter10.pdf: www.ipcc.ch]

Figure B5: US energy flow from use to greenhouse gas emission



This diagram shows the flow of US energy from its use to the resulting greenhouse gas emissions. This flow reflects the complexity of our diverse society and the energy pathways it uses. All the end user activities located in the center under the dark arrow represent opportunities for higher efficiency, shift to cleaner power sources, or sequestration of the currently resulting emissions. [Source: Baumert K, Herzog T, Pershing J (2005) Navigating the Numbers: Greenhouse Gas Data and International Climate Policy, (World Resources Institute) www.wri.org/chart/us-greenhouse-gas-emissions-flow-chart]

Table B1: Relative Global Warming Potentials of Some Common Greenhouse Gases

Gas	Atmospheric lifetime (years)	Global warming potential (relative to CO_2) time frames			Concentration levels (parts per billion (ppb) by volume)		Main human activity source
		20 years	100 years	500 years	Preindustrial (ppb)	2007 levels (ppb)	
Water (H_2O)	(A few days)	(NA)	(NA)	(NA)	1,000 to 3,000	1,000 to 3,000	(NA)
Carbon dioxide (CO_2)	About 1,000	1	1	1	280,000	387,000	Fossil fuel, cement production, land use change
Methane (CH_4)	12	72	23	8	250	1774	Fossil fuel, rice paddies, waste dumps, livestock
Nitrous oxide (N_2O)	114	289	298	153	270	319	Fertilizers, combustion, industrial processes
HCFC-22 (R22)	12	5,160	1,780	549	0	0.169	Refrigeration, industrial processes

Most human activities emit more than one greenhouse gas. Burning coal produces carbon dioxide but also nitrous oxide and sulfur oxide gases. Our "carbon" footprint actually includes the impact of the many greenhouse gases combined. The global warming potential of each gas depends on the atomic structure of its molecules and how it interacts to sunlight and how it mixes with other gases. Methane is powerful in the short term, but its lifetime in the atmosphere is relatively brief (10–12 years) compared with some other greenhouse gases such as carbon dioxide, nitrous oxide, or the synthetic fluorocarbons (e.g., R22). The warming potential of a given mass of methane declines strongly over the long term as it breaks down in the atmosphere. Carbon dioxide, on the other hand, is more stable molecule. Carbon dioxide concentrations drop rapidly too, at first, but significant carbon dioxide remains in the atmosphere after 1,000 years, because natural processes recycle it. To make these comparisons easier to study, researchers use carbon dioxide, the most common and long-lived greenhouse gas, as the standard unit for global warming potential. Since the warming potential varies over time at different rates for each gas, it is common to use a 100 year time frame as the GWP value, unless otherwise noted. Due to the nuances among the factors that go into calculating GWP for a given gas under given conditions, readers may find GWP values differ slightly among published sources.

Table Sources: Adapted from realclimate.org and www.esrl.noaa.gov/gmd/ccgg/trends ,

Appendix C: Climate disruption impacts in New York

The Union of Concerned Scientists published the key findings summarized below in 2007 as the Northeast Climate Impacts Assessment study. If we continue business-as-usual, we can expect the following impacts from climate disruption in New York and the Northeast. These impacts are arranged below by category of human activity or necessity they most directly affect. This information was prepared in 2006. The bad news is that atmospheric carbon growth has actually accelerated more rapidly since then than the data trend upon which these projections were based. In short, unless we act strongly and immediately, we will be locking our kids and grandkids into a higher (worse) emission scenario described below, with very little chance of avoiding the most severe impacts.

"The Northeast is already experiencing changes consistent with global warming: rising temperatures, decreasing snow cover, and earlier arrival of spring. Due to emissions in the recent past, average temperatures across the Northeast are projected to rise another 2.5 to 4 degrees Fahrenheit (°F) in winter and 1.5°F to 3.5°F in summer above historic levels over the next several decades. The extent and severity of climate change beyond mid-century, however, will be determined by emissions choices we make now—in the Northeast and around the world." –Peter C. Frumhoff and others (2007 NECIA study) www.climatechoices.org/ne

Climate disruptions

By late this century, under the higher-emissions scenario:

• Winters in the Northeast could warm by 8°F to 12°F and summers by 6°F to 14°F above historic levels.

• The length of the winter snow season could be cut in half across northern New York, Vermont, New Hampshire, and Maine, and reduced to a week or two in southern parts of the region.

• Cities across the Northeast, which today experience few days above 100°F each summer, could average 20 such days per summer, and more southern cities such as Hartford and Philadelphia could average nearly 30 days.

• Short-term (one- to three-month) droughts could occur as frequently as once each summer in the area of the Catskills and the Adirondacks, and across the New England states.

• Hot summer conditions could arrive three weeks earlier and last three weeks longer into the fall.

• New York City is projected to face flooding equivalent to today's 100-year flood once every decade on average under the higher-emissions scenario and once every two decades under the lower-emissions scenario by century's end.

Water changes

Global warming in the Northeast will alter the timing and amount of stream flow, which would:

• Create more high-flow events in winter, particularly under the higher-emissions scenario, with an associated risk of winter flooding;

• Release earlier peak flows in spring—roughly two weeks earlier under the higher-emissions scenario and 10 days earlier under the lower-emissions scenario; and extended low-flow periods in summer—nearly a month longer by late-century under the higher emissions scenario, with little change under the lower-emissions scenario.

• Increase winter precipitation (much of which is expected to fall as rain) 20 to 30 percent by late-century under either emissions scenario.

• Reduce snowpack and shorten the snow season in the typically snowy northern states—up to 50 percent by late-century under the higher-emissions scenario and more than 25 percent under the lower-emissions scenario.

• Increase the frequency of short-term (one- to three-month) droughts by late-century from an average of once every two to three years to once every year across the Adirondacks, Catskills, and most of New England under the higher-emissions scenario, with little change under the lower-emissions scenario.

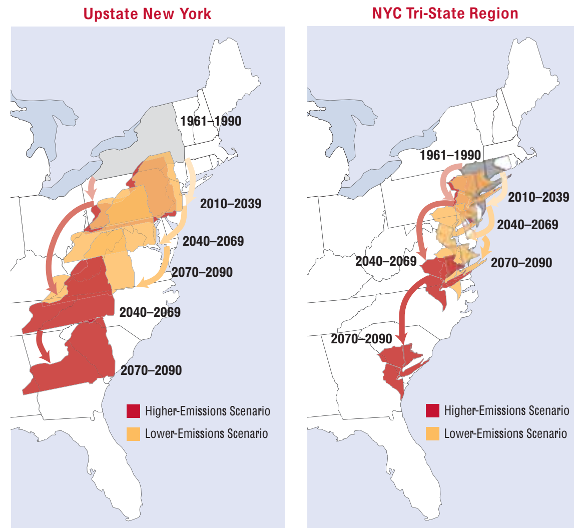
• Increase the frequency of extremely hot days (which can increase water demand) roughly five-fold under the higher-emissions scenario and two- to three-fold under the lower-emissions scenario.

• Amplify the likelihood and severity of damaging rainstorms under both scenarios.

• Raise sea levels between 10 and 23 inches under the higher-emissions scenario and 7 and 14 inches under the lower-emissions scenario, increasing the risk of saltwater intrusion into coastal aquifers.

Figure C1: Future state migrations under greenhouse gas emission impacts: 2000-2100

The maps in Figure C show two different outcomes under a lower (more preferable) and higher (less desirable) emissions outcomes. If we continue business-as-usual, the New York metropolitan area can expect climate like that of Atlanta or Savannah today. A longer golf season sounds great. But our region will undergo severe negative impacts on health, safety and welfare, including less reliable drinking water supplies, disrupted food growing capacity, and more frequent and more severe storms, as well as coastal flooding from sea-level rise. [Source: Frumhoff (2007) www.climatechoices.org/ne/]



Food changes

Our food supply will become harder to maintain:

• Weed problems and pest-related damage are likely to escalate, increasing pressures on farmers to use more herbicides and pesticides.

• An increasing number of storms producing heavy rainfall may delay spring planting and damage crops and soils, while more frequent droughts during the growing season—particularly under the higher-emissions scenario—could make irrigation essential for most high-value crops.

• Global warming may affect maple syrup production in this and other syrup-producing states in two important ways. First, warmer temperatures diminish the quantity and quality of sap flow and cause the tapping season to begin earlier and last less long. Second, climate change may cause a decline in habitat suitability for sugar maple trees.

Health changes

Global warming could worsen air pollution in the Northeast, creating more days when national air-quality standards cannot be met (particularly under the higher-emissions scenario):

• Deteriorating air quality would exacerbate the risk of respiratory, cardiovascular, and other ailments in states such as Massachusetts, which already has the highest rate of adult asthma in the United States.

• In the Philadelphia metropolitan region, for example, the number of days failing to meet the federal ozone standard is expected to at least quadruple by late-century under the higher emissions scenario if local vehicle and industrial emissions of ozone-forming pollutants are not reduced.

• Rising temperature and CO 2 levels could worsen pollen-based allergies across the Northeast, particularly under the higher-emissions scenario.

• Hotter, longer, drier summers punctuated by heavy rainstorms may create favorable conditions for more frequent outbreaks of mosquito-borne diseases such as West Nile virus.

Recreation changes

The character of the Northeast's forests may change dramatically over the coming century as the center of suitable habitat for most of the region's tree species shifts northward:

• Only western Maine is projected to retain a reliable ski season.

• The hemlock stands that shade and cool many of the Northeast's streams could be lost—much like the American elm—to a pest that thrives in warmer weather, further threatening native brook trout in the Adirondacks and elsewhere.

• Climate conditions suitable for maple/beech/birch forests are projected to shift dramatically northward, while conditions suitable for spruce/fir forests would all but disappear from the region.

As their forest habitat changes, many migratory songbirds such as the Baltimore oriole, American goldfinch, and song sparrow are expected to become less abundant, due to rising temperatures, shifting distribution of suitable habitat, or declining habitat quality.

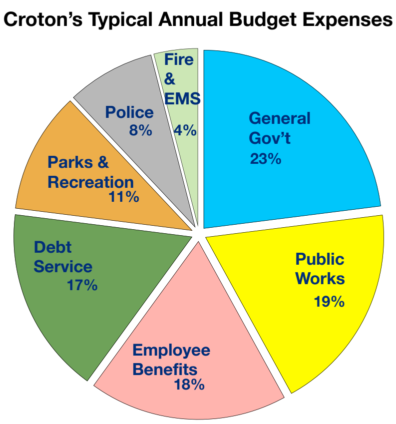
[Source: Frumhoff PC, McCarthy JJ, Melillo JM, Moser SC, Wuebbles DJ (2007) Climate Change in the U.S. Northeast: A report of the Northeast Climate Impacts Assessment (NECIA), Union of Concerned Scientists www.climatechoices.org/ne/

Appendix D: About Croton-on-Hudson, New York

The Village of Croton-on-Hudson is located in Westchester County, in the lower Hudson Valley, approximately 35 miles (50 kilometers) north of midtown Manhattan. The Village encompasses just under five square miles of land area and just over six square miles of water surface. The Hudson River and her tributary, the Croton River, meet at Croton, forming the Village's boundaries to the south and west. The Village's topography includes shoreline along the Hudson River west of Route 9, the forested Croton River Gorge, and a plateau at the Village's northern boundary that reaches elevations up to 600 feet within a mile of the Hudson. The Village offers both sweeping views of the Hudson River and Valley as well as more trails along wooded paths.

The suite of services provided to residents and business owners ranges from garbage collection to street and highway maintenance, and building codes and inspection, to police and emergency services, fire protection (through our excellent volunteer Fire Department), park and creation programs, tax assessments, village court and justice services, drinking water from our well field, sanitary sewer service, and parking lots for commuters and residents in several locations, most notably at the Croton-Harmon Station.

Croton-on-Hudson—as are all 553 villages in New York—is required to adopt a balanced budget each year before the start of the new fiscal year. For most villages, revenue is very heavily dependent on the property tax levied on local property owners. In Croton, sixty percent of the total budget is raised through the property tax levy, fifteen percent from the village-owned train station commuter parking lot, and the rest from other smaller non-tax levy revenues.



Very brief history

• The Village was incorporated in 1898 and currently has a population of just under 8,000 residents.

• The Village has a Council-Manager form of government. The five member elected Village Board of Trustees makes policy and functions on behalf of the citizens. The mayor acts as a member and the presiding officer of the board and is not a full-time position. The Board of Trustees hires a full-time Village Manager who handles the day to day activities in the Village and reports to the Board of Trustees.

• The Village's budget for 2009-2010 is circa $16 million, including a full service police department and a water delivery system based on a village-owned well field in the Croton River gorge. The Village has just over 80 full-time employees, roughly one employee for every 100 residents, or one employee for every $200,000 in the total budget. (See Figure D1.)

• The Village became a Tree City USA in 1984. The Hudson River Valley Greenway designated the Village as Greenway Model Community in 1993. The Village received the 2004 Visions in Planning Award for the development of the riverfront River Walk trail.

• The Village is home to the Croton-Harmon Train Station with frequent rail service to New York's Grand Central terminal via Metro-North and Penn Station via Amtrak.

The Local Government Public Access Television is Channel 78. Board of Trustee Meetings broadcast live, every other Monday, and again on the following Wednesday at 8:00 pm. Trustee Meetings are also available as on-demand web streams through the Village website: www.crotononhudson-ny.gov

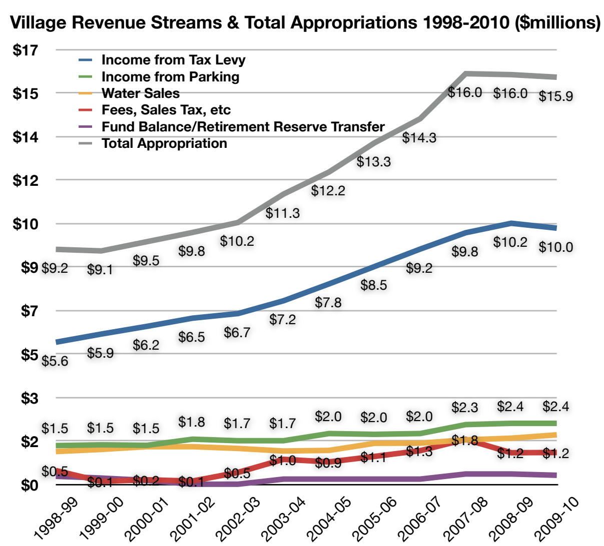


Figure D1: Village Revenue and Appropriations History

A decade of revenue sources and total budget appropriations are presented here and drawn from the Village"s annual budget books.

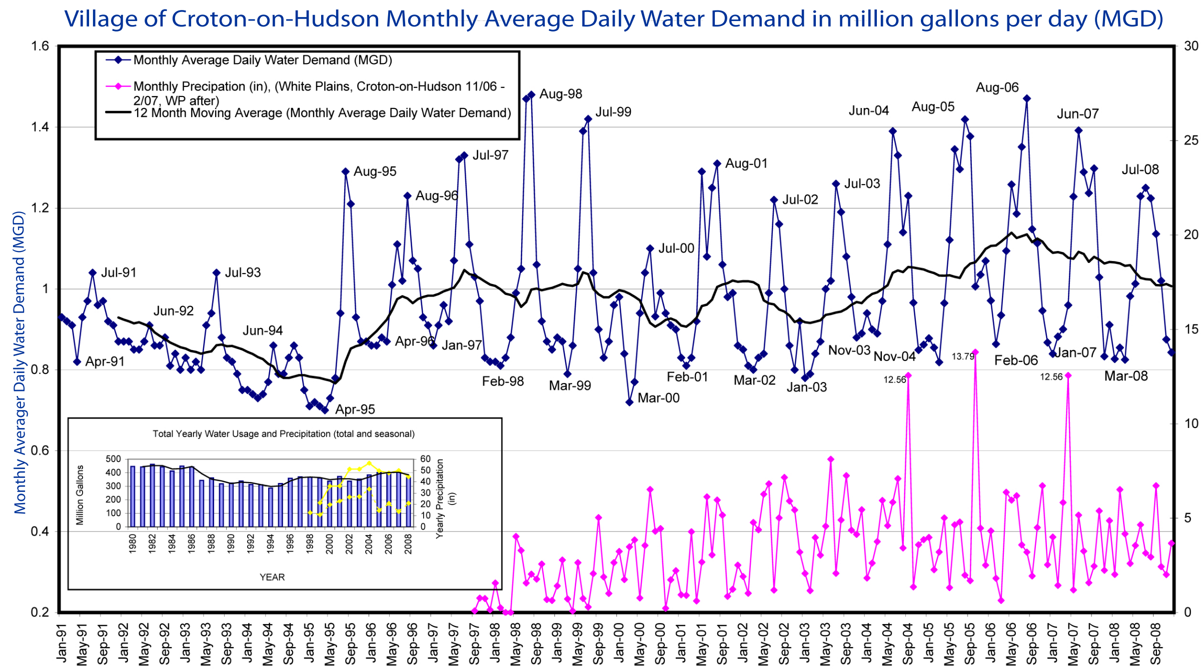


Figure D2: Croton's water use and precipitation history: 1991-2008

With water such a vital part of village services, this figure depicts annual water demand (in million gallons per day) as well as precipitation. The drop in demand from 1991 to 1995 is attributable to a vigorous leak detection program. The rise in 2004-2006 is attributable in part to the build out of residential homes and condominiums. Almost all customers now enjoy a Village-installed radio transmitter water meter which boosted accuracy of readings and improved leak detection and usage anomalies. (Source: Village Engineer's Office, 2009)

Water features prominently in this report is worth a brief look: The Village water utility bills or most customer are based on radio telemetry meter readings for accuracy and convenience. The water rate most homeowners and small businesses paid in 2007 was $4.307 per 100 cubic feet. Each "cube" of water is the equivalent of 748 gallons and weighs 6246 pounds (or 2.83 metric tonnes). Water sales revenue in 2007 was $1.73 million from delivery circa 400 million gallons to customers. (See inset in Figure D2.)

Some Croton-on-Hudson numbers	
Number of residents (2007 estimates)	c. 7,900
Number of village employees	82
Number of village buildings (heated)	10
Building space heated/cooled for village operations	60,000 square feet
Number of village police officers	22
Percent of Hudson River shoreline accessible to the public	100%
Number of public parks	13
Parking spaces at the municipally owned train station lot	c. 2,000
Year during which village first began buying wind power	2003
Village government's average electricity cost (2007)	$0.15/kWh
Square miles of surface area	4.8 sq mi. (land) & 6.1 sq. mi. (water)
Gallons of water pumped from village well fields (typical year)	400 million gallons
Marked walking trails	15 miles

Appendix E: About ICLEI Local Governments for Sustainability

ICLEI is an international membership association of local governments dedicated to climate protection and sustainable development. The organization was established in 1990 when more than 200 local governments from 43 countries convened at the World Congress of Local Governments for a Sustainable Future, at the United Nations in New York. Established as the International Council for Local Environmental Initiatives, the official name is now ICLEI-Local Governments for Sustainability.

ICLEI USA was launched in 1995 and has grown from a handful of local governments participating in a pilot project to a solid network of more than 500 cities, towns and counties actively striving to achieve tangible reductions in greenhouse gas emissions and create more sustainable communities. ICLEI USA is the domestic leader on climate protection and adaptation, and sustainable development at the local government level.

ICLEI's Communities for Climate Protection (CCP) methodology assists local governments to systematically track energy and waste related activities in the community, and to calculate the relative quantities of greenhouse gases produced by each activity and sector. The inventory methodology involves performing two assessments: a community-wide assessment and a separate inventory of government facilities and activities. The government inventory is a subset of the community inventory. Once completed, these inventories provide the basis for the creation of an emissions forecast, and allow for the quantification of emissions reductions associated with proposed measures.

The CCP campaign provides a framework for local communities to identify and reduce greenhouse gas emissions, organized along five milestones:

(1) Conduct an inventory of local greenhouse gas emissions;

(2) Establish a greenhouse gas emissions reduction target;

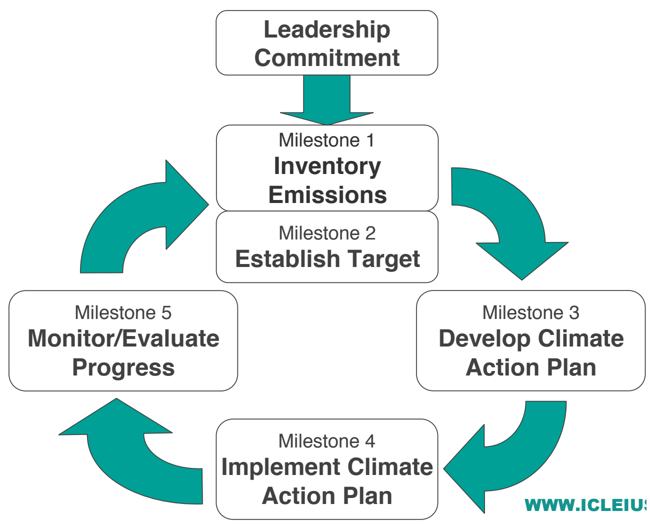
(3) Develop an action plan for achieving the emissions reduction target;

(4) Implement the action plan; and,

(5) Monitor and report on progress.

This report represents the completion of the first CCP milestone's governmental survey, and provides a foundation for future work to reduce greenhouse gas emissions in the Village of Croton-on-Hudson.

www.icleiusa.org



ICLEI Local Governments for Sustainability USA

Appendix F: Online Resources

[See also ICLEI's Climate Change Outreach and Communications Guide www.icleiusa.org]

Local Government Websites

Environmental Consortium of Hudson Valley Colleges and Universities environmentalconsortium.org
Maricopa County (CA) Clean Air Campaign www.cleanairmakemore.com
Nashua Green Team (NH) www.nashuagreenteam.org
New York State Climate Smart Communities www.dec.ny.gov/energy/44992.html
New York State Energy Plan www.nysenergyplan.com
New York State Energy Research and Development Authority www.nyserda.org
New York State Get Energy Smart Programs www.getenergysmart.org
Northeast Climate Impacts Assessment www.climatechoices.org/ne/
Pace Global Warming Central www.law.pace.edu/env/energy/globalwarming.html
Sustainable Bedford (NY) www.bedfordny.info/html/green.htm
Sustainable Hudson Valley www.sustainhv.org
Sustainable Long Island www.sustainableli.org
Sustainable Portland (OR) www.sustainableportland.org
Westchester County (NY) Global Warming Task Force www.westchestergov.com/environment_globalwarming.htm

Climate Change Educational Information

Clean Air Cool Planet www.cleanair-coolplanet.org
Environmental Defense Fund - Understanding the Forecast www.edf.org/pubs/Brochures/globalwarming
IEA Greenhouse Gas Research & Development www.ieagreen.org.uk
Intergovernmental Panel on Climate Change www.ipcc.ch
National Council on Science and the Environment Climate Solutions http://ncseonline.org/climatesolutions
Natural Resources Defense Council Global Warming Solutions www.nrdc.org/globalwarming/solutions
New Scientist Global Warming Explanation www.newscientist.com/nsplus/insight/global/faq.html
Pew Center on Global Climate Change www.pewclimate.org
Union of Concerned Scientist, Global Warming Science www.ucsusa.org/global_warming/science
United Nations Framework Convention on Climate Change www.unfccc.org
US Climate Change Science Program www.climatescience.gov
US Energy Information Administration www.eia.doe.gov
US Environmental Protection Agency Regional Impacts of Global Warming www.epa.gov/climatechange/
US NOAA Global Warming FAQ www.ncdc.noaa.gov/ol/climate/globalwarming.html
World Climate Report www.greeningearthsociety.org/climate
World Wildlife Fund Climate Change Campaign www.panda.org/climate

Appendix G: Units, acronyms and other alphabet soup

A helpful Glossary of Acronyms used in local government work on sustainability and climate change may be found at http://www.icleiusa.org/action-center/general-resources/glossary.

The terms and abbreviations used in this report are listed below for the reader's convenience:

1 (metric) tonne = 1 t = 1,000 kilograms= 2,204 pounds (US) = 1.102 short tons (US)
Btu = British thermal unit of energy = 0.293 Watt-hours = 0.000293 kiloWatt-hours (KWh)
1,000 kWh = 1MegaWatt-hour (MWh) = 3,412,141.6 Btus
1 million Btus = 1MMBtus = 293 kWh = 0.293 MWh
1 quad = 1 quadrillion Btus = 1 million billion (10^15) Btus
(A quad is the unit is used by the U.S. Department of Energy in discussing world and national energy budgets. The global primary energy production in 2004 was 446 quad. See Figure 1.6b on US energy flows.)
CH_4 methane
CHP combined heat and power
CO monoxide
CO_2 carbon dioxide
CO_2e carbon dioxide equivalents (as measured in weight)
tCO_2e metric tonnes of CO_2 equivalents
tCO_2e/y = metric tonnes of CO_2e per year
GHG greenhouse gas (emissions), used in this report as the combined impact of numerous gases as carbon dioxide equivalents.
GWP global warming potential of one unit of carbon dioxide for a given period of time. Other compounds cause more warming per mass than carbon dioxide.
IPCC Intergovernmental Panel on Climate Change
kg kilogram(s)
kWh kilowatt-hour(s)
lb(s) pound(s)
MWh megawatt-hour(s)
N_2O nitrous oxide
NO_x oxides of nitrogen

We also recommend the search engine at the Encyclopedia of Earth for reliable explanations of energy concepts and terms: http://eoearth.org. The US Department of Energy's "Energy Calculator" is helpful for converting energy units: http://tonto.eia.doe.gov/kids/energy.cfm?page=about_home-basics

Appendix H: Acknowledgements

The Village would to acknowledge the leadership and initiative taken by several key staff in compiling this report and in learning the Clean Air Climate Protection protocols through ICLEI–Local Governments for Sustainability workshops and webinars. Specifically, Ronnie Rose, part-time assistant to the Village Manager's office, devoted about ten hours a week over a period of about two and one half months as the project's lead researcher. This work included training on the CACP toolkit, and researching and inputting the data that this inaugural baseline greenhouse gas inventory required. Janine King, Assistant Village Manager, worked closely with Ms Rose and also participated in the ICLEI training. Village Engineer Dan O'Connor and Tex Dinkler of the Fire Department also assisted with this report. Our department heads were all very helpful in answering the myriad questions not obvious from our utility bills alone. Our NYPA representatives and ICLEI's support staff were very helpful as well. The Village's Sustainability Team has been instrumental in vetting the early drafts to identify both data gaps and ways to close them as well ways to make the report more accessible to the general public. The Team includes Susan Lunden (Chair), Lindsay Audin, Carl Grimm, Niall Kelleher, Lee Streisfeld Leitner, Matthew Rubenstein, and Taylor Vogt. This group of volunteers have been invaluable and indefatigable. http://www.crotononhudson-ny.gov/Public_Documents/CrotonHudsonNY_BComm/sustainable

A Holiday Example: 40% saved!

In 2001, then Village clerk Peggy Keesler generously donated a 30 foot fir tree to the Village to be replanted from her yard to the parkway on Benedict Boulevard at South Riverside Drive. Every year our Village staff decorates this tree with seasonal holiday lights. The string of incandescent bulbs took a beating from the elements and required repair and numerous replacement bulbs. In fall 2009, Croton's public works foreman, Thomas Giglio, set out to find better looking lights to replace the old strings. Mr Giglio discovered the village could purchase 1,800 light emitting diode (LED) lights for $1,700. Of the total, 1,600 are used on the tree with 200 as spare light in reserve. Mr. Giglio ordered a special mix of colored bulbs that added white lights to the traditional red, green, and blue. These LED lights have more durable housings, do not use fragile bulbs, and consume a tiny fraction of the electricity of the incandescent bulbs. The parkway has two power outlets. Due to LED efficiency, all the new light strings could be plugged into a single outlet, leaving the second one open for a menorah. Mr Giglio notes, "A typical C7 incandescent lamp uses 5 watts for a total of 8000 watts of power as opposed to the new L.E.D. lights, which only use 1.4 watts per bulb for a total of 2100 watts of power." Therefore, in 2009, the village staff was able to decorate the tree with more lights and include a menorah, all while cutting costs for this one activity by over 40% since last year.

photo courtesy of C. Romedenne

Outdoor Lighting (Holiday Lights Benedict Blvd.)

2007 (energy cost from line 4.11 on Table 2)	$491
2008 (estimated cost of electricity)	**$500**
Cost of new LED lights	$1700
Annualized cost of LED light (10 year lifespan)	$170
2009 (estimated electric bill of 1,600 new LED lights)	$125
New annual cost	**$295**
Savings (each year)	$205
	41%