ADIRONDACK ENERGY & GHG INVENTORY

AN ANALYSIS OF HOW ADIRONDACK COMMUNITIES USE ENERGY AND THE IMPACTS OF THAT REGIONAL ENERGY USE

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The Wild Center & ADKCAP

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List of Abbreviations and Acronyms

CAFE	Corporate Average Fuel Economy Standards
CCAP	Center for Clean Air Policy
CH_4	methane
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
°F	degrees Fahrenheit
DTF	(New York State) Department of Taxation and Finance
EIA	Energy Information Administration
EPA	(United States) Environmental Protection Agency
GHG	greenhouse gas
GSF	gross square feet
HFC	hydrofluorocarbon
ICLEI	International Council for Local Environmental Initiatives
IP	International Paper
MPG	miles per gallon
MSW	municipal solid waste
N_2O	nitrous oxide
NYS	New York State
NYSDOT	New York State Department of Transportation
NYSERDA	New York State Energy Research and Development Authority

List of Abbreviations and Acronyms (cont.)

PFC	perfluorocarbon
RFS	renewable fuel standard
SF_6	sulfur hexafluoride
VMT	vehicle miles traveled

Executive Summary

A regional energy and greenhouse gas (GHG) inventory was conducted for the Adirondack Park as part of the Adirondack Carbon Offset Project and the Adirondack Climate Action Plan in order to support efforts to assess the Park's energy use and consumption data, identify GHG mitigation opportunities and to provide a baseline so that carbon emissions reductions can be documented over time.

The inventory encompassed 6 million acres within the Park boundary (known as the Blue Line), including all or parts of 12 counties. Regional primary fuel use and emission data were generally not available, and the inventory largely relied on secondary sources, including census data, assessment data, and other data compiled by state, federal, and academic sources. The effort involved data requests and consultation with local, state, and federal governments, the support of local academic institutions, detailed information provided by a number of large emitters, and the support of members of the community at large.

Given the limitations on primary data availability, the inventory was conducted to the extent possible according to international and national accounting principles and best practices. Emission factors were obtained from The Climate Registry General Reporting Protocol (Protocol), with the exception of state-specific mobile source factors, which were obtained directly from the New York State Department of Transportation (NYSDOT). Following the Protocol, region-specific electricity use emissions factors provided by the U.S. Environmental Protection Agency (EPA) were applied. Emissions were divided into two categories:

- Scope I – Direct Emissions
- Scope II – Indirect Emissions

For the purposes of this inventory, commercial buildings were defined following conventions from the U.S. Department of Energy, Energy Information Administration (DOE EIA), and include all buildings other than agricultural, industrial, and residential structures. The inventory of Scope I and Scope II emissions are summarized on Table ES-1.

Table ES-1 Summary Adirondack GHG Emissions

Source	CO_2e Emissions (metric tons)
Scope I Emissions	
Residential Building	341,901
Commercial Building	165,639
Agricultural – Buildings	22,711
Industrial	152,924
Mobile Sources	883,158
Agricultural - Fugitive Methane	21,250
Water Treatment Fugitive Methane	27,852
Total Scope I	**1,624,446**
Scope II Emissions	
Residential	331,732
Commercial	142,046
Agricultural	2,263
Industrial	36,391
Total Scope II	**512,433**
Total Emissions	**2,136,879**
Forest sequestration	-600,000
Net Emissions (Sources and Sinks)	**1,536,879**

Key observations and conclusions drawn from the Adirondack Park GHG inventory include the following:

Limitations on primary data availability limit the inventory. During the inventory process, it became clear that much of the primary fuel use data typically used in GHG inventories were not available. Electricity and bulk fuel suppliers consider their energy delivery data to be proprietary did not provide supplied fuel and electricity data. It is concluded that political effort at the state or local level may be needed to make this data available. For bulk fuel data, local or state reporting ordinances affecting fuel suppliers may need to be enacted, given the large number of small proprietors in this category.

Mobile source emissions make up the largest emissions source in the park. As shown on Figure ES-1, mobile source emissions from cars and trucks are by far the largest emissions source in the Park. This reflects both the rural character of the region, which typically involves the use of larger-than-average vehicles and travel between relatively dispersed communities. Any attempt to attain carbon neutrality will require significant focus on mitigating emissions resulting from vehicle travel.

Residential emissions represent a significant portion of the emissions in the Park, providing opportunities for mitigation. Due to the aging housing stock and relatively high reliance on electricity and fuel oil for heat, there are significant opportunities for mitigation. The relatively large proportion of residential emissions is due, in part, to the fact that many Park residents travel outside the Park for employment, with many commercial and industrial employers being located outside of the Park boundary. Given the high energy consumption in this community and the high proportion of economically challenged residents, there is great opportunity to tie GHG mitigation to residential building energy efficiency programs that would mitigate GHG emissions and lower costs for struggling families.

Table 2-2 Residential Fuel and Electricity Use, by End Use

Energy Type	Fuel or Electricity Consumption
Space Heating	
Electricity (kWh)	148,220,508
Fuel Oil/Kerosene (gallons)	31,344,408
LPG (gallons)	8,713,787
Wood (cords)	45,750
Water Heating	
Electricity (kWh)	158,132,989
Fuel Oil (gallons)	4,609,396
LPG (gallons)	692,804
Appliance	
Electricity – Refrigerators (kWh)	129,346,819
Electricity – Other Appliances and Lighting (kWh)	489,379,900
LPG (gallons)	730,542

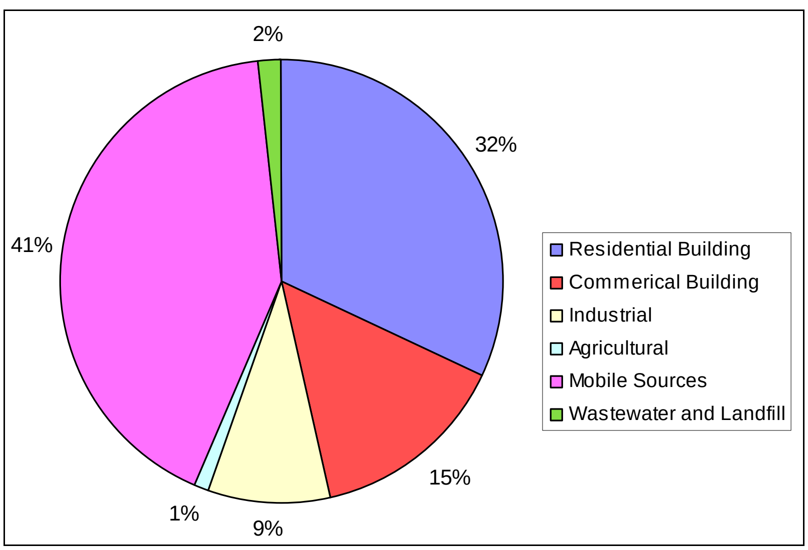

Figure ES-1 GHG Emissions by Sector

Industrial emissions are dominated by the International Paper Company's (IP's) paper mill in Ticonderoga, New York. Based on fuel use data provided by IP, it was found that the Ticonderoga mill emits about 86% of the industrial emissions in the Park, which does not include biomass burned by the mill. This is in spite of the fact that the mill combusts a large amount of relatively carbon neutral biomass. The lack of other large industrial emitters reflects the protected status of the Adirondack Park and the fact that much of the region's industry lies outside the Park boundary. Opportunities to mitigate emissions from industry are probably rather limited, as there is not a large amount of industry, and the largest emitter already has an active program of biofuels and energy efficiency initiatives.

Forests provide significant sequestration and storage of carbon in the Park. Annually, the above ground forest in the park sequesters approximately 600,000 carbon dioxide equivalent (CO_2e) metric tons per year, which is 28% of the Park's total emissions. Belowground soil sequestration is also expected to be important but was not estimated. Additionally, the Park forests store approximately 242,600,000 metric tons CO_2e, or approximately 113 times the annual emissions of the park (including belowground storage). There are significant data gaps and research needs to understanding carbon fluxes and storage in Adirondack forests, water bodies, and wetlands, and in particular to understanding how climatic variation can affect carbon storage and sequestration.

Wastewater and solid waste are modest sources of GHG emissions for the Park. All waste from the Park is land filled or incinerated at large regional facilities outside the park, and therefore constitutes a Scope III indirect emission source. Wastewater is a much larger source than solid waste, and occurs within the Park. Fugitive methane emissions from oil, gas and mineral extraction is not a significant source within the Park.

Adirondack residents may have lower GHG intensity per capita than the U.S. at large. Per capita GHG emissions were calculated for the Adirondack Park and are compared to the U.S. and a sample of other countries on Figure ES-2. These numbers do not include sequestration provided by the Park forests. The figure shows relatively low per capita emissions for the Park. This likely results from the tendency of residents to 1) have jobs outside the Park, 2) have lower incomes and therefore less energy intensive lifestyles, and 3) the lack of a large number of high emitting industrial emitters in the Park. If emissions from employers of Park residents whose facilities are located outside the Park were considered in this inventory, it is likely that Park per capita would be higher.

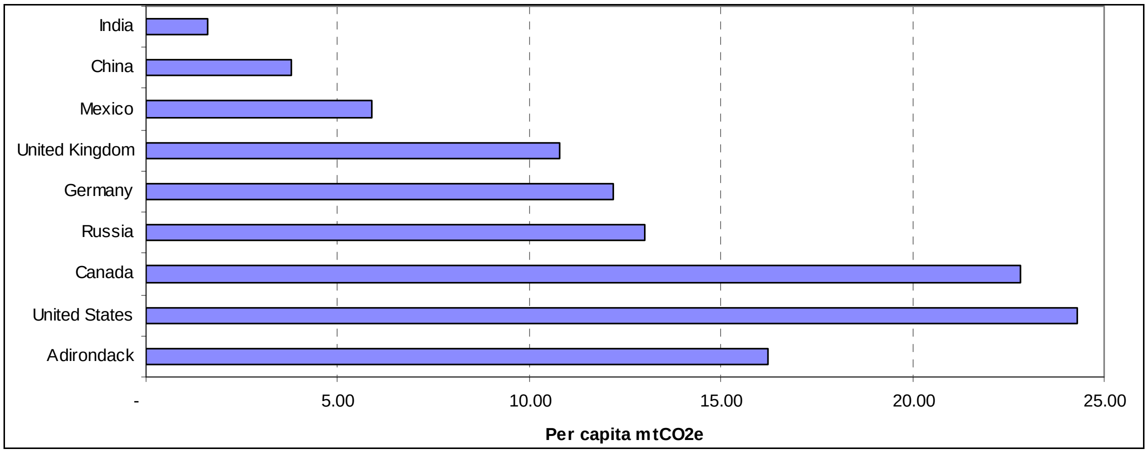

Figure ES-2 Per Capita Emissions for the Adirondacks and by Country

1 Introduction

1.1 Purpose

This inventory of greenhouse gas (GHG) emissions for the Adirondack Park (the Park) has been developed to aid in understanding the sources of GHG emissions in the Park and in planning carbon footprint reduction programs for the Park. This inventory is a component of the Phase II – Design portion of an overall Adirondack carbon offset project. It also supports the creation of the Adirondack Climate Action Plan (www.adkcap.org).

A number of organizations in the Adirondacks are pursuing the development of a carbon offset program that directly benefits the Adirondack Park and its communities. The Adirondack carbon offset initiative will mitigate GHG emissions by supporting energy efficiency projects, renewable energy production, sustainable biofuel use, and other offset options, as well as green building capacity within the 6-million-acre Park. It will join the list of voluntary emissions reductions programs currently available in the voluntary carbon market for individuals, corporations, and other organizations. Among the first of its kind as a regional program, it will serve as a replicable model for other regions to establish locally beneficial carbon offset programs. After the partner organizations conducted a Phase I effort to develop a scope of work for the overall Adirondack carbon offset program, the GHG inventory portion began with a kick-off meeting in January 2008 that was attended by critical stakeholders in the Adirondack Park community. In addition, an Adirondack Climate Conference was organized by the Wild Center in November 2008. It became clear that the GHG Inventory for the Park is also serving to establish the data and baseline information upon which the Climate Action Plan initiative, a major outcome of the conference, is developing goals and strategies.

As a scenic and wilderness resource in New York State (NYS), protection of the environment is a top priority of the Park, which includes minimizing impacts of emissions that contribute to an increase in GHGs. Compared to urbanized areas, the Park is a minor source of GHG emissions with respect to the buildup of gases in the atmosphere that can lead to climate change. However, and perhaps more importantly, the Park is already being affected by a changing climate and the potential affects to Park attributes could be significant. As noted in *A Blueprint for the Blue Line* (APA 2007), the potential for warming in the northeast United States could be as much as 6 to 10 degrees Fahrenheit (°F) in the next 50 to 100 years if current climate models are reasonably accurate.

A warming of this magnitude would undoubtedly have some effect on the character of the Park, whether economic, due to shorter duration of the winter season's snow cover that shortens the skiing and snowmobiling season, or biological, due to changes in the types of flora and fauna and amount of bogs and wetlands that make up the Park's ecosystem. Some data suggests that the length of the winter season is already being affected as measured by the length of the "snow season"; a shorter winter snow cover is reflected in lower income for tourism operators.

Thus, it is in the best interests of the Park to take action to minimize its emissions of GHG gases, to provide a model for other rural and protected areas around the world to act on climate change mitigation and adaptation, and to provide opportunities for Park and non-Park entities to develop carbon footprint mitigation projects within the Park. By being carbon neutral, or a carbon sink rather than a net carbon emitter, the Park can contribute to minimizing global changes that potentially result in alteration of the Park's current characteristics. The GHG emission inventory, as part of the Carbon Offset Project, contributes to an overall strategy to achieve energy independence for the Park within 20 years.

1.2 The Adirondack Park

The Park occupies approximately 9,000 square miles of NYS's total of 47,213.8 square miles, or approximately 19% of the total land area of New York State. "Legally, the Adirondacks are a state park, regulated by land-use legislation, and administered by a special agency," (Jenkins and Keal 2004). The Park is a mosaic in terms of ownership and land use; there is private and public land ownership comprising settled and wild areas.

Within the settled areas, residences, small business, government facilities, and, in some communities, industry exist. Throughout the Park, tourism activities occur and range from motorized activities, such as automobile travel/sightseeing, snowmobiling and watercraft use, to non-motorized activities, such as hiking, canoeing/kayaking, camping, and bicycling. Most tourism/recreational activities involve the use to some degree of motorized transportation to access various locations within the Park.

1.3 Greenhouse Gases and Climate Change

Climate change presents significant risks and challenges to the Adirondack Park. The Park could experience shortened winters, lower amounts of snow cover during the winter season, and changes to spring snowmelt and runoff. Warmer winter temperatures and shorter duration of cold "snaps" could affect the quality and duration of inland lake ice, and perhaps even annual average lake temperatures. Climate change could provide longer seasons for camping and other temperate-weather pursuits, providing longer growing seasons for many plants, and improving conditions for species at the northern limits of their range.

The buildup of GHGs in the atmosphere consisting of primarily carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) reduces the ability of the atmosphere to allow long-wave radiation (heat) to pass to space. Many scientists believe that the continued addition of GHGs to the atmosphere is likely to increase the warming rate, perhaps raising the Earth's global average temperature by 4 to 7ºF by the year 2100.

Some GHGs are produced from both natural processes and human activity; these include CO_2, CH_4, N_2O, and water vapor. Human activities also result in the emission of other higher global warming potential GHGs including hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6).

1.4 Inventory Methodology

In general, a GHG emission inventory methodology consists of 10 important steps as shown below. The inventory methodology used for this project addresses each step.

1. **Consider Goals.** As noted earlier, the goals of the inventory are to provide the underlying "starting point" GHG emission data to enable the definition of carbon offset projects that can be accomplished in the Park; and to produce the data to underpin a comprehensive Climate Action Plan for the Park.

2. **Consider GHG Accounting Principles.** As described by many GHG reporting protocols and registries, the quality goal is a verifiable inventory following best practices that allow data export into any respected registry or program.

3. **Define Community Boundary.** The community boundary is used to group all the entities that define the character of life in the area and conduct activities that may produce GHG emissions to include in the inventory. For the Park, the community includes residential, small business and commercial activities, industrial, government, tourism, and passive and active recreation. To a lesser extent, agriculture can also be included in the community.

4. **Define Operational Boundaries.** Once entities are identified within the community boundary that has the potential to produce GHG emissions, the

operational boundaries of each entity are defined. For example, within the residential category is housing. The operational boundary can be defined as each individual home, or all residences in a town or village. Further breakdown of the type of GHG emission is accomplished by identifying which emissions are direct (e.g., exhaust gas from a heating system) or indirect (e.g., emission produced at a distant power plant in order to supply electricity to the residence or group of residences).

5. **Select Base Year.** A historic year or group of years is selected against which an entity's emissions can be tracked over time and is often the first year that an entity accounts for its GHG emissions. Selection of the Park's base year is challenging due to the multitude of organizations and categories of potential GHG emitters and how each organization keeps its data up to date. This is discussed further in Section 1.5.

6. **Identify Emissions Sources.** The Park's GHG emission sources were identified by first considering which categories of emitting sources are present based on a survey of literature about the Adirondacks and discussion with stakeholders in the process. Emission sources fall into three main categories: mobile sources and stationary sources, which are both anthropogenic sources, and biogenic sources. These main categories are then broken out into direct and indirect emission sources.

7. **Calculate Emissions.** The main components of the actual GHG emission calculation procedures include: selecting a GHG calculation approach from available Protocols; collect activity data; choose emission factors; and then apply the emission factors to the activity data using a calculation tool, such as a spreadsheet or model.

8. **Verify Inventory.** When a GHG inventory has been prepared according to accepted procedures and the owner of the GHG inventory wishes to use the data contained within to establish a baseline GHG emission level, or to compare current emissions with a previously established baseline level, verification of the GHG emission inventory is used to establish the credibility of the GHG inventory. An inventory is typically verified to a specific protocol or standard. As the Adirondack inventory is novel in approach due to lack of primary fuel data and due to the its regional and community-wide nature, there is no specific standard for verification, and verification is less appropriate.

9. **Report Emissions.** For many organizations or entities, publicly reporting the GHG inventory data demonstrates an organization's activity and concern with respect to GHG emissions. Reporting may be in the form of a GHG inventory report. Reporting may also include populating the results of

an entities GHG inventory into an on-line GHG registry. As a regional, community-wide inventory, the Adirondack inventory is not reportable to existing reporting programs.

10. **Establish GHG Reduction Target.** The ultimate goal of understanding the current level of GHG emissions is to develop and apply GHG emission reduction techniques in order to lessen the carbon footprint of the entity. For many entities that are industrial in nature and with large GHG emission levels, a reduction goal is appropriate. For other organizations and communities with more flexibility to alter their method of operation or ability to develop offset projects, attainment of carbon neutrality is a reasonable goal.

The inventory methodology employed for the Park's inventory is a blend of procedures from published GHG emission inventory protocols including Community GHG inventory protocols established by the International Council for Local Environmental Initiatives (ICLEI), National Park Service methodology, and other protocols, such as those prepared by The Climate Registry (TCR 2008).

Many of these protocols are applicable to unique types of organizations or activities. The Adirondack Park is unique in that it does not consist of only park-like activities but also does not solely consist of community (i.e. town/city/village) type activities and is not solely a manufacturing organization. It does consist of a blend of some of these activity types with some industrial/manufacturing activity also present. Thus, a blend of various GHG protocol inventory methodologies was used for this study.

1.5 Base Emissions Year

A base emissions year is a specific year against which an entity's emissions are tracked over time. This is a key function of a GHG inventory, and allows for credible accounting of emissions changes over time. For the Adirondack Park community, which is initiating significant Climate Action Planning and GHG mitigation initiatives, a detailed base year inventory is critical to assessing the impact of diverse community actions.

Unfortunately, the current inventory is limited due to a lack of primary fuel use data. It is fundamental to a verifiable inventory that accurate fuel use or primary GHG monitoring data be available. In the absence of primary fuel data, this inventory employed a number of estimation methodologies in order to best assess emissions. Many of these methodologies rely on data from different years, and for which no normalization method is available. In general, the most recent year of data was used. Additionally, the building area data relies on assessment records which are not updated consistently, and for which no date of record is available. Finally, for many of the emissions sectors, energy use factors specific to the Northeast U.S. and to a northern climatic region were employed. Because these factors are not specific to the Adirondacks, they can not capture any future changes relating to improvements in energy efficiency, and therefore will not show changes due to anticipated mitigation efforts in the region.

For this reason, it is the judgment of the authors that no base year can be assigned to the inventory, and that in our best estimation the inventory represents emissions at the beginning of this decade. As the growth rate of the Park region is relatively low, it is very likely that the emissions estimates are representative of current emissions.

These limitations aside, this inventory provides a valuable service to the Adirondack community. Although year to year changes in emissions are not within the resolution of the inventory, the inventory does show where emissions are occurring, and the relative importance of different emission sources. The inventory effort has also created significant understanding of the challenges of obtaining primary fuel use data, and can serve as a learning tool for additional efforts to baseline emissions in the region.

2 Greenhouse Gas Emission Inventory

2.1 Stationary Combustion and Electricity Use

Analyses of space heating and electricity use rely on census and Real Property Service (RPS) parcel assessment data. The energy use and subsequent GHG calculations are based on numbers of residences and non-residence structures in the Adirondack Park. Because of the availability of residential census data, which includes type of space heating fuel, a more detailed analysis has been performed for residences. Analysis of non-residential space heating and electricity use rely more on parcel data, which results in a less detailed analysis. Analyses of industrial emissions, which rely on state and federal air permit data, are limited by the lack of public reporting for modest industrial emitters and do not capture electricity use.

2.1.1 Residential

The residential analysis is based on 2000 census data, which provides the number of households by county and by type of housing unit, and type of space heating fuel. In addition, RPS assessment data was analyzed using Geographic Information System (GIS) techniques in order to determine the proportion of households that are within the Adirondack Park. An RPS data set that included all parcels in the 12-county area was obtained. GIS was used to code the parcels as being within or outside the Adirondack Park using centroid latitude and longitude. The 15 primarily residential property classes were summed into categories corresponding to the four census property types (single family, two to four units, five or more units, and mobile homes). The proportion of each property type within the Park was determined using GIS, and this information was then used to proportion the county census housing units. Therefore, the analysis relies primarily on the census data, which is considered to be most reliable for estimating housing units; the proportioning of structures within and outside the Blue Line relied on RPS data, for which parcel locations were available.

Energy use factors were obtained from the Department of Energy Information Administration (EIA) Residential Energy Consumption Survey (RECS) (DOE EIA 2001). The EIA RECS, which is based on a survey of 5,500 residences across the U.S., provides energy usage by end use and fuel type and is broken out by characteristics such as geographic location and climactic region. The survey defines household types in the same way as the U.S. Bureau of the Census.

Three types of energy use factors were obtained from the RECS: space heating, water heating, and appliances. Space heating was calculated in terms of square feet of livable area (SFLA), and water heating and appliance use were calculated on a per household basis. Space-cooling energy use was estimated to be negligible and was not calculated.

Space heating calculations were performed using RECS space-heating intensity factors for common space heating fuels and electricity. For example, the RECS provides a use factor of cubic feet of natural gas per heating degree day (HDD) and per square feet. The average HDD, estimated to be 8,547, was obtained from the National Weather Service for Lake Placid and represents the average annual HDD from 1970 to 2006 (National Climactic Data Center 2009).

Square feet of livable area (SFLA) was not available from the New York State RPS data set, as most counties do not report SFLA to the state. Essex County SFLA data were available for its RPS data set. These data were averaged by property type, and this average SFLA for Essex County was used to estimate SFLA for housing units in the other counties. For example, it was found that the average SFLA for an Essex County single-family parcel was 1,527 square feet for the 13,606 parcels reporting SFLA. For the other counties, it was assumed that the SFLA for single-family parcels within the Adirondack Park had the same SFLA. Corresponding estimates were similarly applied to the other 14 RPS primary residential property classes (see Table 2-1). While extrapolating SFLA from Essex County is considered valid for areas within the park, it is probably not valid for calculating county-wide estimates for the 12-county region.

Table 2-1 RPS and Census Property Classes and Average SFLA

RPS Property Class	Census Property Type	Average SFLA per Unit
210: 1 Family Res	Single-Family	1,488
240: Rural res	Single-Family	1,488
241: Prim res w/agr	Single-Family	1,488
242: Rurl res & rec	Single-Family	1,488
250: Estate	Single-Family	1,488
260: Seasonal res	Single-Family	1,488
215: 1 Fam Res w/Apt	Two or Four Units	2,172
220: 2 Family Res	Two or Four Units	2,172
230: 3 Family Res	Two or Four Units	2,172
281: Multiple res	Five or more unites	1,923
283 Multi res w/ com	Five or more unites	1,923
280: Multiple res	Five or more units	1,923
270: Mfg housing	Mobile Home	1,106
271: Mfg housings	Mobile Home	NA

Data on unoccupied housing was provided with the Census data. For the Adirondack Park, it was estimated that unoccupied housing primarily reflects seasonal housing. For example, 2,362 of 7,965 housing units in Hamilton County were occupied according to the 2000 census, and this low rate of occupancy results from the large number of seasonally occupied structures. The RECS does not provide estimates of energy use for seasonal housing. Since seasonal units are primarily occupied during warm-weather months, it was estimated that seasonal units use 50% and 35% of the electrical energy and fuel energy, respectively, of non-seasonal units (LaPrairie 2008).

The census data do not provide water heat and appliance energy source information, or estimates of per housing unit water heat and appliance energy use, by housing type. The nationwide proportion of housing units using fuel oil and LPG for space heating that also use fuel oil and LPG for water heat and for LPG appliances, was determined based on the RECS data. This nationwide proportion was then extrapolated to the Adirondack data. For example, it was found that, 45% of households nationwide using LPG for space heating use LPG for water heating. Therefore, for the Adirondacks, it was assumed that 45% of households using LPG for space heating also heat water with LPG, and the remaining households heat water with electricity. Total residential fuel and electricity use for residences within the Adirondack Park, by end use, is shown in Table 2-2.

Table 2-2 Residential Fuel and Electricity Use, by End Use

Energy Type	Fuel or Electricity Consumption
Space Heating	
Electricity (kWh)	148,220,508
Fuel Oil/Kerosene (gallons)	31,344,408
LPG (gallons)	8,713,787
Wood (cords)	45,750
Water Heating	
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Appliances	
Electricity – Refrigerators (kWh)	129,346,819
Electricity – Other Appliances and Lighting (kWh)	489,379,900
LPG (gallons)	730,542

Total GHG emissions were calculated by applying GHG emissions factors to estimated fuel use by fuel type. Emissions include all Kyoto GHGs and are shown in terms of CO_2e. Factors were obtained from The Climate Registry General Reporting Protocol (Registry GRP) published May 2008. Indirect emissions from electricity use were estimated by applying the U.S. Environmental Protection Agency's eGrid Upstate New York power pool emission factor, which represents 2004 emission rates. GHG emissions, by county, for areas within the Adirondack Park are shown in Table 2-3. Scope I emissions are direct emissions from stationary combustion. Scope II emissions are indirect emissions from electricity use.

Table 2-3 Adirondack Park Household CO_2e Emissions, by County for Areas Within the Park (metric tons)

County	Scope I	Scope II	Total
Essex	82,428	66,342	148,770
Hamilton	18,235	20,696	38,931
Clinton	22,333	29,364	51,697
Franklin	36,280	34,707	70,986
Fulton	26,947	24,020	50,967
Herkimer	22,241	21,604	43,845
Lewis	4,928	4,999	9,926
Oneida	227	196	423
Saratoga	40,616	40,949	81,565
St. Lawrence	12,079	12,001	24,080
Warren	66,012	67,797	133,809
Washington	9,576	9,057	18,633
Total	**341,901**	**331,732**	**673,633**

Figure 2-1 shows the residential GHG emissions by county for areas of the counties within the Park boundary. Indirect emissions from electricity use vary by county as a proportion of total GHG emissions. This partly reflects the varying rate of use of electricity for space heating, as reported in the 2000 census for these counties. Some results appear counterintuitive but are explained by variations in fuel and electricity use. For example, Essex County has more households and lower indirect emissions from electricity use than Warren County. This difference is mostly attributed to higher electricity use for space heating in Warren County; 5.5% of Essex County households use electricity for space heating, while 19.1% of households in Warren County and within the Adirondack Park use electricity for space heating.

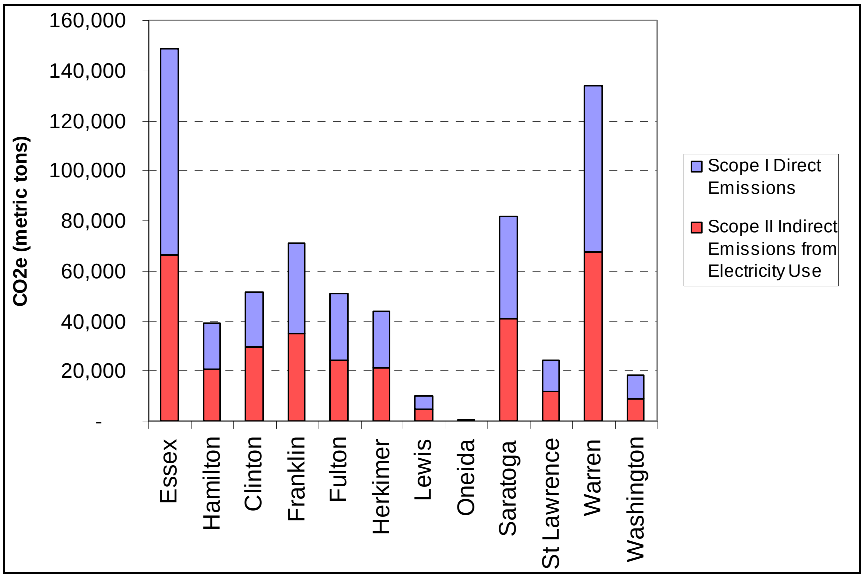


Figure 2-1 Residential Adirondack Park GHG Emissions, by County

Figure 2-2 shows GHG emissions by property type. The housing mix between census property types is similar to the national average, with the exception that there is a higher rate of mobile homes. Mobile homes make up 13% of the Adirondack housing, compared to 8.2% nationally. Mobile homes tend to be inefficient, using 40-60% more energy per square foot of a single-family residence, according to the EIA RECS, and the large number of mobile homes contributes to high GHG emissions.

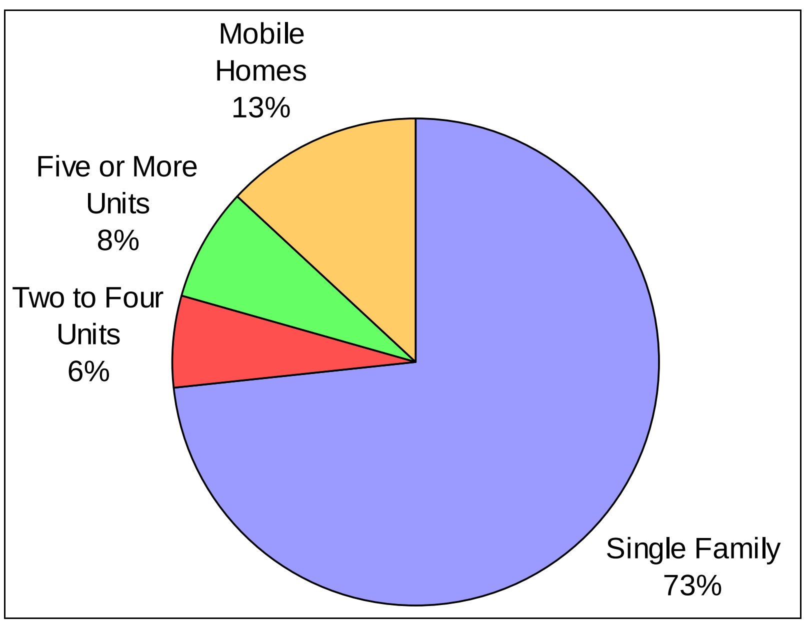


Figure 2-2 GHG Source, by Property Type

Direct and indirect emissions, by energy source and energy end use, are shown on Figure 2-3. Electricity is used for space heating in an estimated 19% of households within the park; this is a higher proportion compared to the national average. The EIA RECS shows that, nationwide, only 9% of households in climactic regions with greater than 7,000 HDD heat with electricity. Water heating fuel corresponds to space heating fuel, although the EIA RECS finds that, nationally, about 38% of homes heating with fuel oil or LPG heat water with electricity.

Using electricity for space heating and water heating is relatively GHG intense. In the Adirondacks, heating with fuel oil or LPG emits approximately 90% and 72%, respectively, of the emissions from electrical space heating use on a heating energy equivalent basis. Electricity related GHG emissions are somewhat mitigated by the high proportion of electricity generation producing zero emissions in Upstate New York, including hydro, nuclear, and increasingly, wind energy.

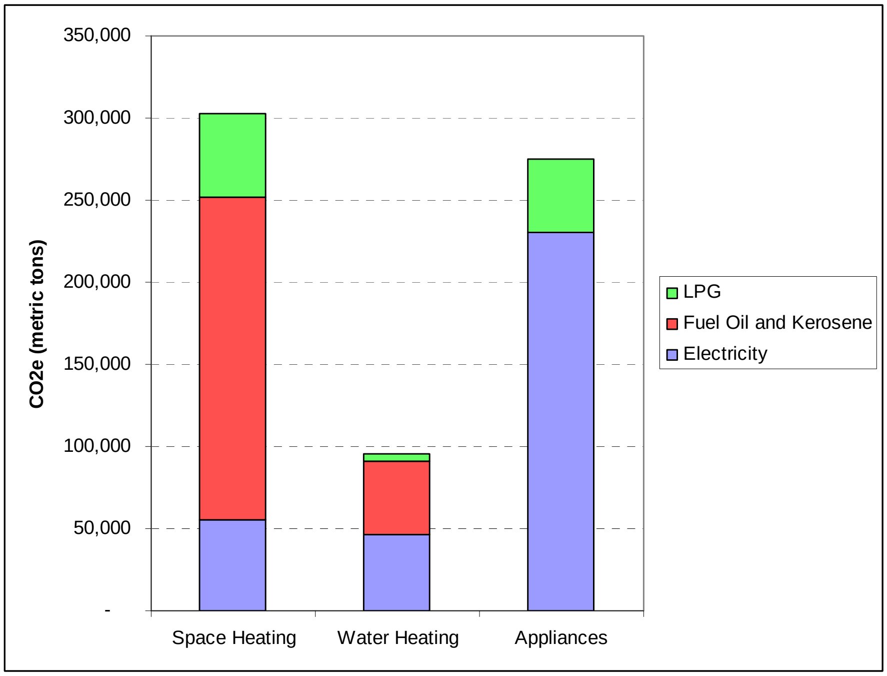


Figure 2-3 Indirect and Direct Residential GHG Emissions, by Energy Source and Energy End Use

2.1.2 Commercial

For the purpose of this study, commercial buildings include all structures except industrial, agricultural, and residential structures. By this definition, commercial buildings include those used for governmental and non-profit purposes. As with residential stationary combustion emissions, direct emissions from commercial buildings result primarily from the burning of fuel oil and propane for space heating. Indirect emissions are from building electricity use.

For some of the largest organizations, energy use data were obtained directly, and precise GHG emissions were calculated. For others, such as the Adirondack Medical Center, building area was used to estimate emissions. For the remaining building stock, gross square feet (GSF) estimates were developed by property type and multiplied by energy intensity factors. To estimate GSF, Essex and Hamilton county parcel data was obtained from county assessment offices for every commercial building parcel. This data included GSF for each of 217 RPS commercial property types. The Essex and Hamilton County average GSF data, by property type, was then extrapolated to the remaining counties. Note that Hamilton and Essex do not contain all of the possible commercial building property types; only about 47% of the commercial building property types are represented by Essex and Hamilton County data. For cases where there were no examples in Essex or Hamilton counties, a similar property type was substituted.

To estimate energy usage, the U.S. Department of Energy, Energy Information Administration (DOE EIA) Commercial Building Survey energy use factors were used (DOE EIA 2003). These factors are specific to climactic and geographic regions and provide 13 activity types (e.g., hospital, retail, warehouse). The GSF estimates by property type from the RPS data were sorted by the 13 EIA activity types, and the respective EIA energy use factors were applied. These energy use factors break out electricity in terms of kWh and fuel in terms of BTUs. The resulting energy use was then used to calculate GHG emissions by emissions type, county, and DOE EIA commercial property type. The ratio of LPG to fuel oil use was assumed to be the same as that estimated for residential properties using census data.

For several organizations, energy use or GHG emissions were obtained directly. These included Paul Smiths College, the New York State Department of Corrections (DOC) prisons, the Olympic Regional Development Authority ski resorts, and the Sunmount Developmental Center. Emissions for the federal prison at Ray Brook were extrapolated from the DOC Adirondack Corrections Facility based on inmate capacity, as both facilities are similar in size and age. Provided emissions are shown in Table 2-7 below.

Table 2-7 Provided GHG Emissions Data (metric tons CO_2e)

Organization	Scope I	Scope II
Paul Smiths College	4870	1758
Gore Mountain Ski Resort	247	4,177
Whiteface Mountain Ski Resort	731	6,304
Camp Gabriels Correctional Facility	1,040	525
Clinton Correctional Facility	17,296	4,775
Adirondack Correctional Facility	2,939	1,210
Federal Correctional Institution, Ray Brook	3,137	1,291
Sunmount DDSO	3,912	3,119
Total	34,172	23,160

As shown on Figure 2-4, lodging was the largest source of commercial building emissions, followed by miscellaneous provided emissions. Lodging has a high proportion of electricity consumption relative to residential buildings, which partly reflects that lodgings are more likely to use single-room electrical heating units.

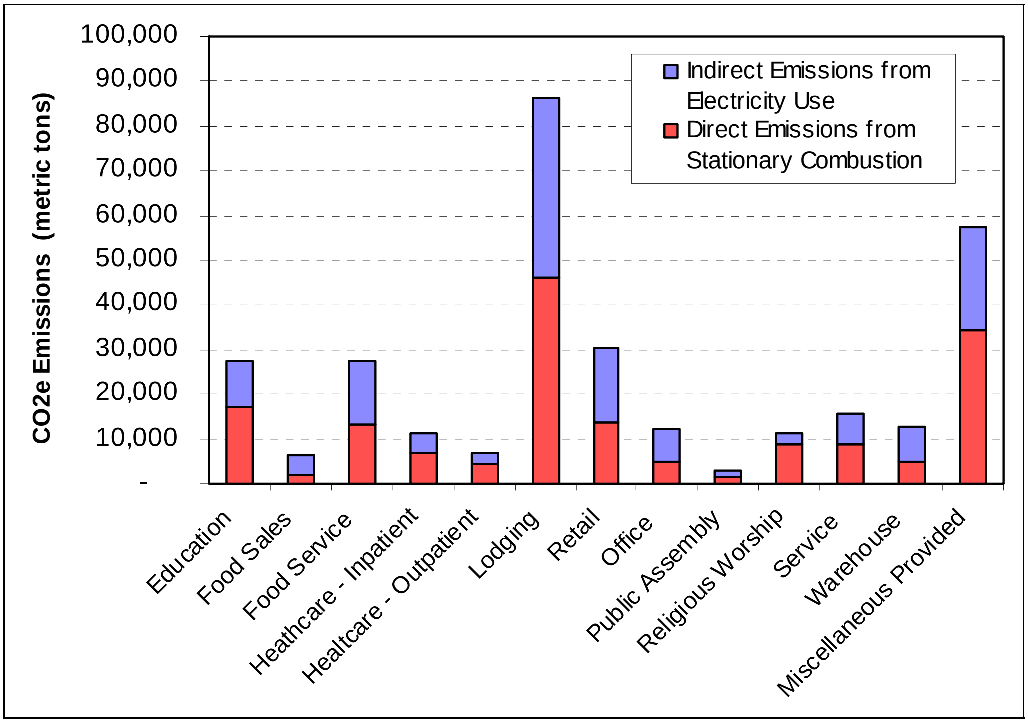


Figure 2-4 Commercial Building Emissions by Building Activity

As shown on Figure 2-5, Essex County had, by far, the largest commercial building emissions, reflecting its high number of visitor accommodations and the state and federal prisons within its border. Having commercial emissions relatively localized to Essex County suggests that a focused effort on mitigating commercial emissions in this county, perhaps targeting the hospitality industry, may be a good use of community resources.

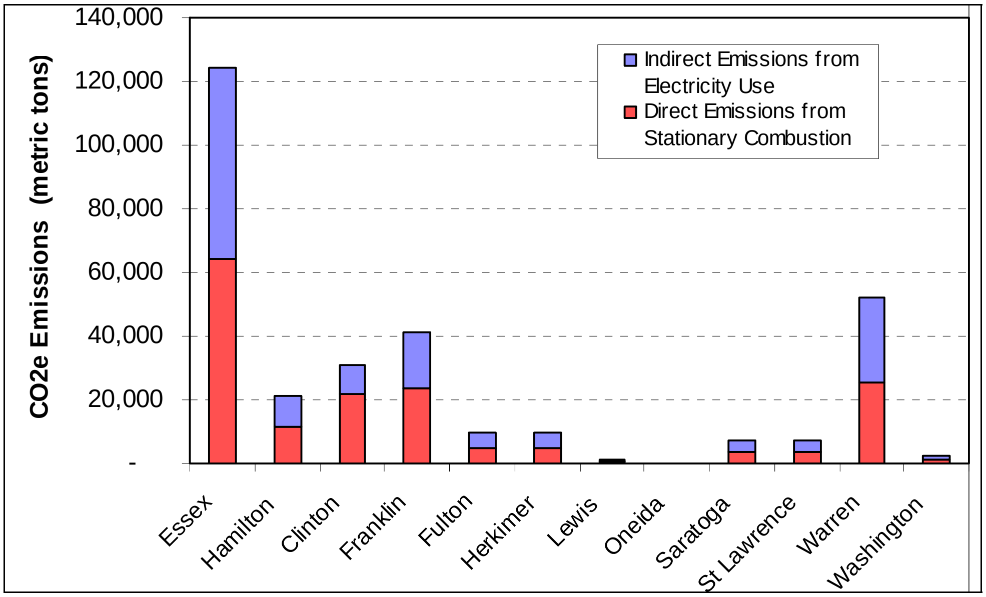


Figure 2-5 Commercial Building Emissions by County

2.1.3 Industrial

Industrial GHG emissions are less dependent on building size than commercial buildings; therefore, other estimation methods were used that accounted for the significant process heating requirements, electrical use by machinery, and off-road equipment use typical in industry. The 2002 DOE EIA Manufacturing Energy Consumption Survey provides energy use per employee for 70 manufacturing types, broken out by employer size categories, and allows for proportioning of electrical and fuel-based energy used (DOE EIA 2002). The Adirondack Atlas (Jenkins and Keal 2004) provides data on total industrial employment for several of the larger Adirondack Park industrial employers for 2001. These data were used with the EIA factors to estimate fuel use (see Table 2-8). One very large facility, the IP Ticonderoga Mill, was contacted directly and provided energy use information.

The energy use shown in Table 2-8 was used with EIA emission factors to calculate GHG emissions. Table 2-9 shows GHG emissions, by scope, for individual industrial emitters. In terms of emissions, the IP Ticonderoga mill significantly surpasses the other sources, and alone comprises about 8% of the entire Adirondack Park emissions. This is a lynchpin business in the region with more than 600 employees and purchasing fiber from an additional 600 to 700 loggers and truckers. Reported electricity consumption is relatively low, as the mill generates approximately 80% of its own electricity in a combined heat and power plant. In addition to its fossil fuel based GHG emissions, the mill burns 51,648 short dry tons of woody material per year, emitting 74,580 metric tons of CO_2 (not included on Table 2-9 or in the emissions summaries provided elsewhere, in accordance with international conventions for biogenic emissions). The large amount of biomass burned considerably reduces the mill's fossil fuel requirements and associated emissions.

Table 2-8 Industrial Emitter Employment And Annual Energy Use Estimates

Industrial Employer	EIA Sector[1]	Employment	Electricity (MWh)	Fuel (MMBTU)
IP Ticonderoga Mill[2]	Paper Mill	600	55,960	3,401,117
Oval Wood Dish	Plastics and Rubber Products	230	14,920	35,357
NYCO Minerals	Miscellaneous	145	2,435	8,286
Barton Mines	Miscellaneous	130	2,183	7,429
Lewis Concrete	Miscellaneous	100	1,679	5,715
Lincoln Log Homes	Miscellaneous	55	471	1,604
Commonwealth Home Fashions	Textile Products	200	2,119	10,862
Other	Miscellaneous	1740	18,106	61,617
Total		**3200**	**97,874**	**3,531,988**

Notes:
[1] 2002 EIA Manufacturer Survey (DOE EIA 2002)
[2] The IP Ticonderoga Mill provided energy use directly (Wadsworth 2009).

Table 2-9 Industrial Emitters (metric tons CO_2e)

Business	Scope I Emissions	Scope II Emissions
IP Ticonderoga Mill	142,847	20,807
Oval Wood Dish	2,723	5,548
NYCO Minerals	638	905
Barton Mines	572	812
Lewis Concrete	440	624
Lincoln Log Homes	124	175
Commonwealth Home Fashions	836	788
Other Industrial Emitters	4,745	6,732
Total	**152,924**	**36,391**

2.2 Mobile Sources/Transportation

2.2.1 Mobile Combustion Emissions

Mobile combustion emissions are very significant in the Adirondack Region, particularly with its low population density, large distance between population centers, and high proportion of light trucks. The typical method to assess mobile source emissions is to obtain gasoline and diesel fuel use data, and apply appropriate emission factors. Unfortunately, bulk fuel deliveries to the region are not centrally tracked, and fuel distributors and retailers consider sales volumes to be proprietary. In order to best estimate GHG emissions, two approaches were employed, one relying on a New York State Energy Research and Development

Authority (NYSERDA) study and based on sales tax data (Sales Tax Approach), and a second using vehicle miles traveled (VMT) and vehicle registration data (VMT Approach).

Sales Tax Approach

In January 2008, NYSERDA published a study of energy use trends in New York that includes a table of average annual gasoline consumption by county. The analysis supporting the gasoline data relies on tax data reported to the NYS Department of Taxation and Finance (DTF). Per gallon, state excise taxes are collected at the point of import into New York State and there is no per gallon tax information available at the county level. DTF does receive tax receipts for sales tax on fuel sold at individual fueling stations. This data is aggregated resulting in the combining of on-road diesel, off-road diesel, different grades of gasoline, and kerosene, and only the value of the sale is reported, not the fuel quantity. An additional complication is that fuel prices change daily and vary between locations. NYSERDA estimated the county gasoline sales by estimating average fuel prices for each fuel type and assuming proportions of fuel types sold. This is an estimate of sales in a given location and not necessarily consumption since a vehicle may travel significant distance on the fuel purchase. For this reason and because of the other challenges in creating this estimate, the NYSERDA results should be viewed as approximate.

Fuel use and carbon dioxide equivalent (CO_2e) emissions for gasoline consumption using NYSERDA data are shown, by county, in Table 2-10. For this study, emissions are calculated for entire counties and proportioned by population to provide Adirondack Park emissions. CO_2e emissions are calculated from gallons of gasoline using USEPA emission factors. As almost all diesel or gasoline fuel is oxidized in an internal combustion engine, the amount of CO_2 emitted per gallon of fuel is nearly constant across engines and only varies by fuel type. There is greater variation in emission rates for N_2O and CH_4, particularly for gasoline vehicles with catalytic converters. But as N_2O and CH_4 are less than 1% of total GHG emissions, this variation is not significant to this inventory. The EPA fleet-wide N_2O and CH_4 emission factors are applied in this report and are used to calculate CO_2e emissions.

Table 2-10 GHG Emissions using Sales Tax Approach

County	County Wide Gasoline (gallons)	Adirondack Park Gasoline (gallons)	County Wide CO_2e (metric tons)	Adirondack Park CO_2e (metric tons)
Saratoga	94,898,000	3,574,372	880,054	33,148
Warren	41,007,000	16,004,280	380,286	148,419
Washington	20,389,000	1,099,580	189,081	10,197
Herkimer	57,264,000	3,229,083	531,048	29,945

Table 2-10 GHG Emissions using Sales Tax Approach

County	County Wide Gasoline (gallons)	Adirondack Park Gasoline (gallons)	County Wide CO_2e (metric tons)	Adirondack Park CO_2e (metric tons)
Oneida	110,923,000	161,578	1,028,665	1,498
Essex	21,041,000	21,038,834	195,128	195,107
Fulton	27,737,000	5,260,526	257,224	48,784
Hamilton	2,743,000	2,743,000	25,438	25,438
Clinton	43,065,000	8,512,849	399,371	78,945
Franklin	16,962,000	5,747,986	157,300	53,305
Lewis	13,265,000	446,040	123,015	4,136
St. Lawrence	40,424,000	1,292,199	374,879	11,983
Total	**489,718,000**	**69,110,327**	**4,541,490**	**640,907**

VMT Approach

Given the limits of the Sales Tax Approach and its consideration of gasoline sales, but no analysis of diesel sales, a second method was employed using VMT and other data obtained from the New York State Department of Transportation (NYSDOT) and the EPA. Periodically, NYSDOT estimates total VMT by county for use in transportation planning and for emissions reporting to the EPA. The most recent estimate is from 2002. These values are derived from a complex analysis that primarily relies on traffic count data obtained by the Highway Performance Monitoring System, which measures vehicle traffic on most state and federal highways. The analysis also includes population data, economic data, total road miles, and vehicle registration data to arrive at total county VMT, including both state and non-state roadways. The NYSDOT county VMT data is shown in Figure 2-6, by roadway type.

NYSDOT provided the proportion of driving by road functional class (e.g., rural expressway, and urban arterial), and by county. NYSDOT also provided vehicle type distribution data (proportion of cars, trucks by size, and buses) by NYSDOT region and by roadway functional class. This functional class and vehicle distribution data were used to disaggregate the total county VMT data to VMT by individual roadway functional classes and vehicle classes. Vehicle class specific GHG emission factors were provided by the EPA and were developed using the MOBILE6.2 emission factor model that represents 2008 national fleet average emissions. These factors were then applied to the county-specific, functional class specific VMT data to provide countywide and Adirondack Park GHG emissions.

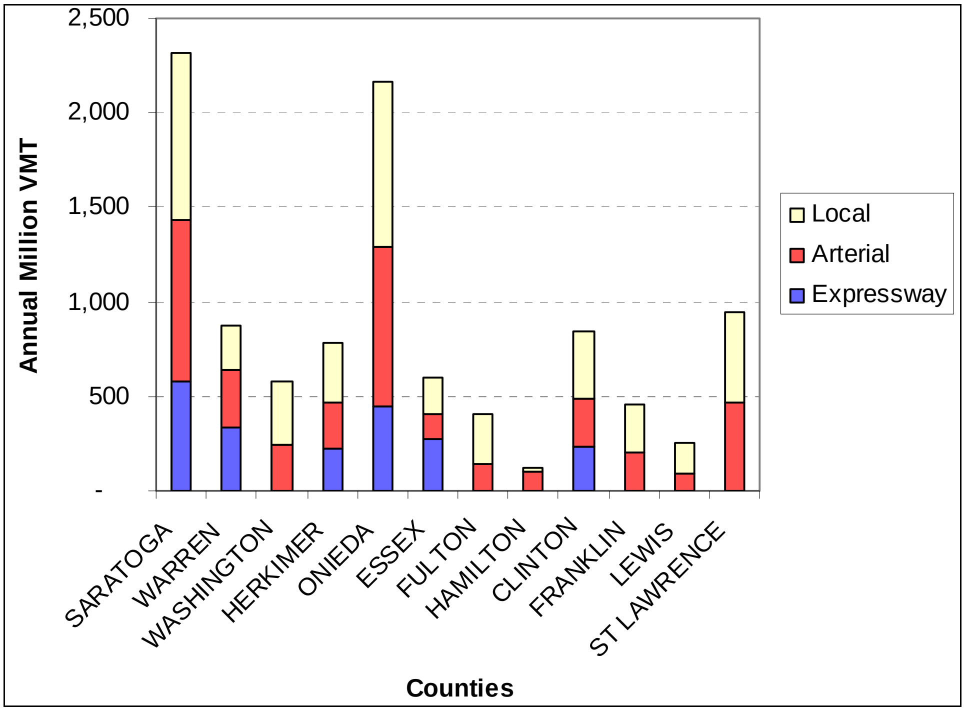


Figure 2-6 Countywide Vehicle Miles Traveled in 2002, by Roadway Type

Countywide and Adirondack Park estimated fuel consumption and GHG emissions, by county, are shown in Table 2-11. Note that the resulting total county-wide CO_2e using the VMT Approach (4,493,621 metric tons) is very similar to that the total county-wide CO_2e using the Sales Tax Approach (4,541,490 metric tons), suggesting that the approaches are valid.

Table 2-11GHG Emissions using VMT Approach

County	CO_2e From Gasoline Vehicles (metric tons)		CO_2e From Diesel Vehicles (metric tons)		Total CO_2e From Vehicles (metric tons)	
	Countywide	Adirondack Park	Countywide	Adirondack Park	Countywide	Adirondack Park
Saratoga	1,003,632	37,802	176,549	6,650	1,180,181	44,452
Warren	376,334	146,876	86,775	33,867	463,109	180,743
Washington	255,786	13,795	38,609	2,082	294,395	15,877
Herkimer	338,401	19,082	65,312	3,683	403,712	22,765
Oneida	938,029	1,366	154,944	226	1,092,973	1,592
Essex	255,913	255,886	74,556	74,548	330,469	330,435
Fulton	180,397	34,214	24,564	4,659	204,961	38,872
Hamilton	53,659	53,659	9,497	9,497	63,156	63,156
Clinton	362,365	71,630	77,949	15,408	440,314	87,039
Franklin	201,064	68,135	30,771	10,428	231,835	78,563
Lewis	113,568	3,819	17,487	588	131,055	4,407
St. Lawrence	414,474	13,249	62,834	2,009	477,308	15,258
Total	**4,493,621**	**719,515**	**819,846**	**163,644**	**5,313,467**	**883,158**

Countywide mobile source emissions are dominated by the effect of large population centers within each county. For counties that are only partially within the Adirondack Park, most of the mobile source emissions in these counties are outside of the blue line, as shown on Figure 2-7. Essex County, which is entirely within the Park, has the highest annual mobile source emissions within the Park.

Non-Road Equipment

The sales tax and VMT approaches do not capture diesel fuel used for non road equipment. This category includes off-road mobile sources used in logging, construction, and farm equipment. Given the proprietary nature of fuel distribution, data to support analysis of off-road equipment emissions is sparse. In order to provide an order of magnitude type estimate for non-road equipment, the proportion of on road to off road diesel fuel use was extrapolated from an end use study of 2006 fuel sales published by the United States Department of Energy's Energy Information Administration (EIA). The application of the EIA study results for the non-road activity in the Park must be considered as an approximation given the high amount of non-road equipment use for forestry activity in the Park. The ratio of non-road to on-road diesel fuel use in the Park may be higher than the EIA study. Thus, the resulting actual emissions from non-road diesel fuel use may be greater that estimated here. Figures 2-8 and 2-9 show the GHG emissions by fuel type for the countywide and Adirondack Park regions, respectively. It is estimated that non-road sources constitute about 1% of the mobile source combustion inventory.

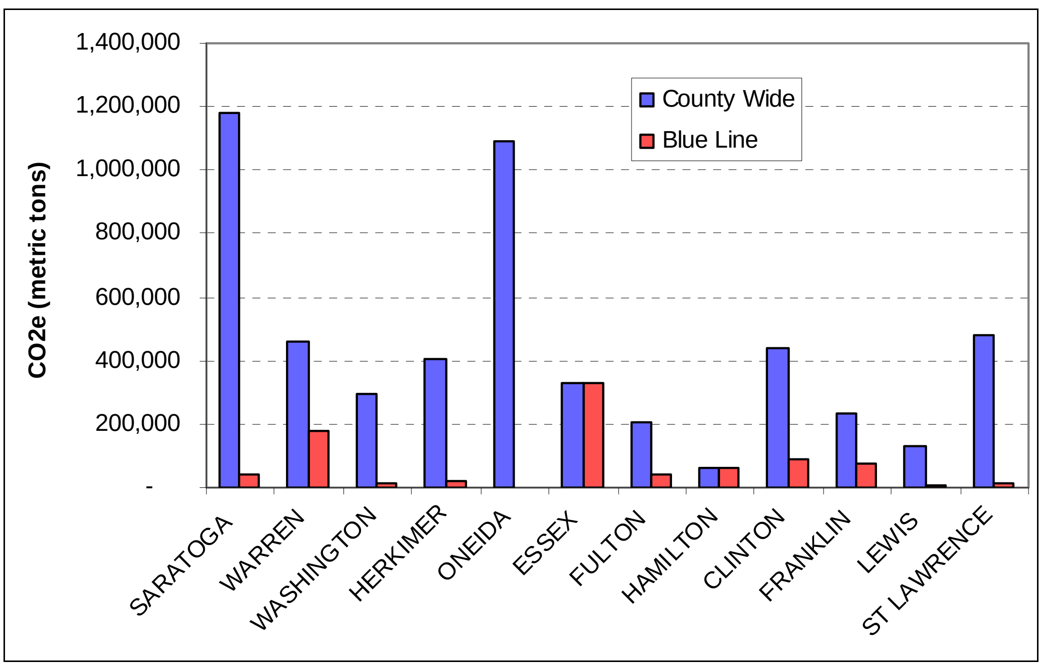


Figure 2-7 Annual GHG Emissions, by County, using VMT Approach

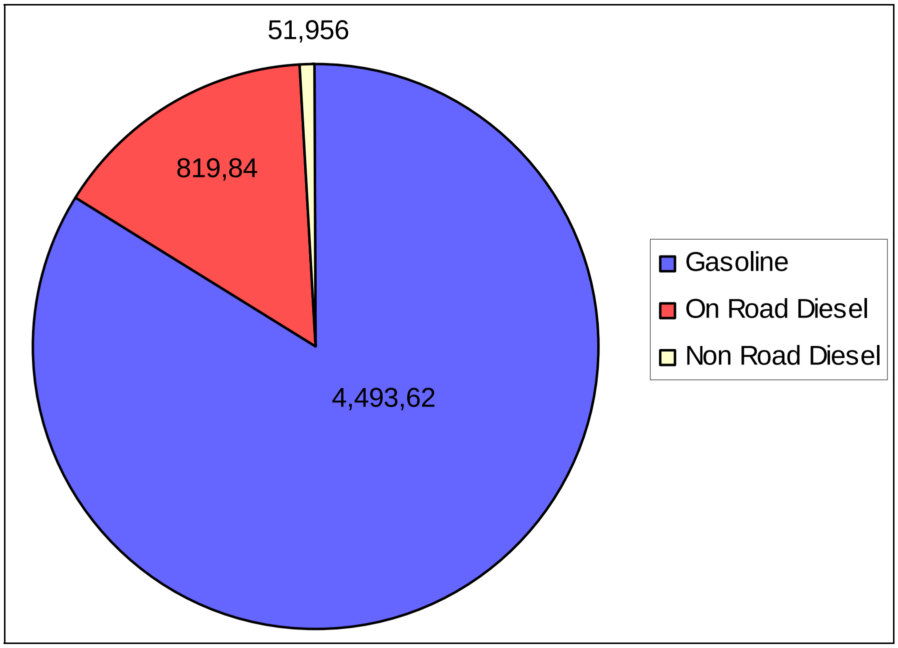


Figure 2-8 Countywide GHG Emissions, by Fuel Type (CO_2e metric tons)

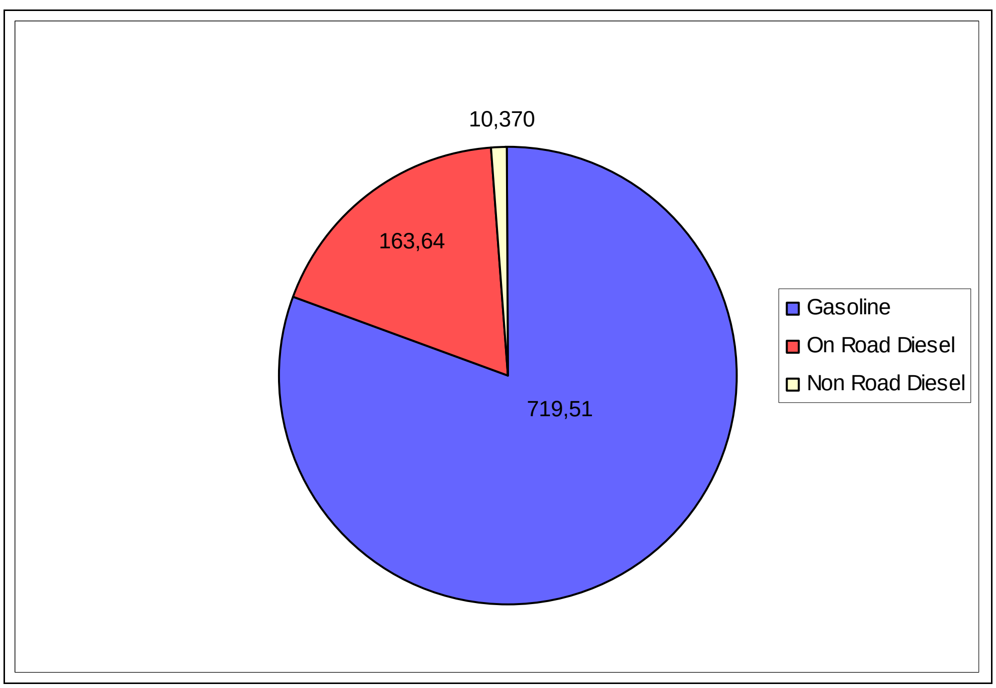
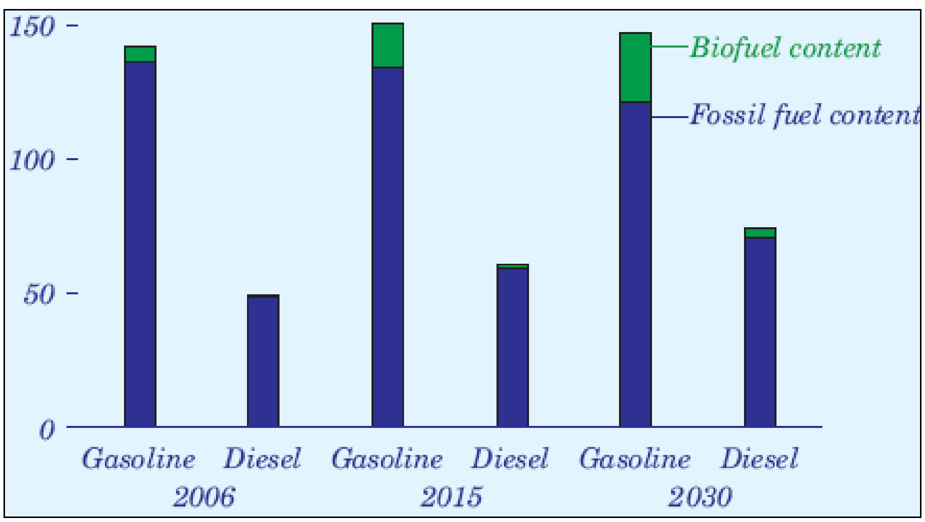


Figure 2-9 Adirondack Park Emissions, by Fuel Type (CO_2e metric tons)

Mobile Source Combustion Reductions

Transportation emission reductions can be viewed as taking one of three forms: increasing vehicle fuel efficiency, reducing fuel GHG intensity, and reducing VMT. Recently there have been national policy initiatives that will affect vehicle fuel efficiency and fuel GHG intensity in the Adirondack Park. The Energy Independence and Security Act of 2007 (EISA 2007) updated the federal Corporate Average Fuel Economy Standards (CAFE) for the first time in 30 years. The new CAFE standard removes exemptions for most SUVs and light trucks and requires fleetwide fuel economy for all new cars and light trucks of 35 miles per gallon (MPG) by 2020 (versus 27.5 MPG and 20.7 MPG for cars and trucks today).

The U.S. primary fuel GHG intensity reduction program is the Renewable Fuel Standard (RFS). Each year, the EPA sets an annual standard representing the amount of renewable fuel that must be used to ensure the RFS set by Congress is achieved (the 2008 RFS announced by EPA on November 27, 2007 was 4.66%). EISA 2007 extended and increased the requirements of the RFS, requiring 36 billion gallons of renewable fuels by 2022. EIA projects that the fossil fuel content of gasoline and diesel will be reduced from 96% today to 83% by 2030 through the use of biofuels such as ethanol and biodiesel (see Figure 2-10). Note that biofuels do have significant GHG impacts over their life cycle, and reduction of fossil fuel content in this context does not reflect a proportional reduction in anthropogenic GHG emissions.

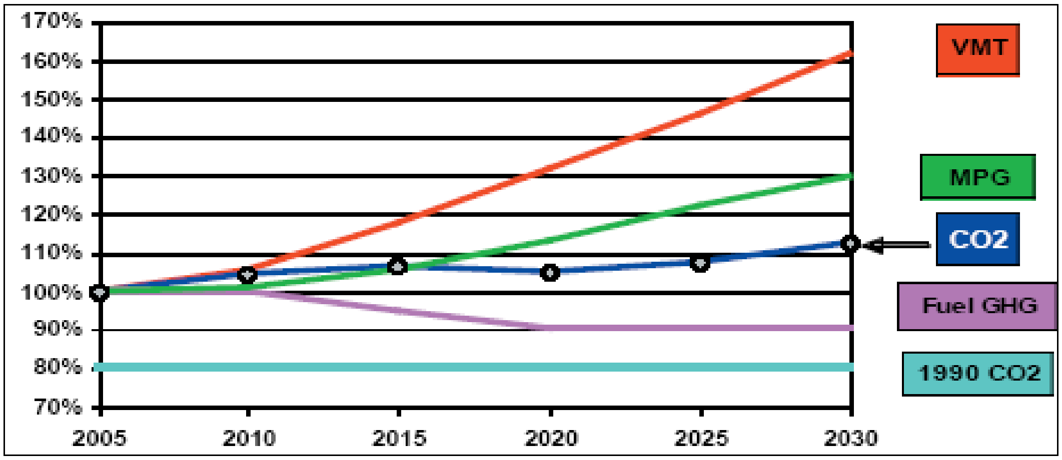


Source: DOE EIA 2008.

Figure 2-10 Supply Trends of Biofuel Content of U.S. Motor Fuels

Figure 2-11 shows an analysis by the Center for Clean Air Policy (CCAP), which projects effects of fuel economy and fuel GHG intensity initiatives, in the context of increasing VMT in relative terms versus the 2005 base year. For reference, 1990 emissions are shown. The 2020 CAFE standard and a 10% reduction in GHG fuel intensity is applied.

Clearly, even with the RFS resulting in a 10% GHG emissions reduction and the increase in the CAFE standard, the increase in national VMT overwhelms the effects of the reduction initiatives, and GHG emissions greatly exceed stabilization targets. By 2030 VMT in the United States increases by 60%, and CCAP estimates that even with the EISA 2007 initiatives, GHG emissions will increase more than 10% for on-road vehicles.



Source: Center for Clean Air Policy 2009.
Assumes: 1. 2020 CAFE Standard of 35 MPG.
2. 10% reduction in fuel GHG intensity.
3. 100% represents 2005 emissions.

Figure 2-11 U.S. Projected Growth in CO_2 Emissions from Cars and Light Trucks

Between 2002 and 2028, NYSDOT predicts a 45% increase in the 12-county Adirondack region VMT. This is an unsophisticated estimate used for transportation planning and simply projects forward the historic growth rate. VMT growth is driven both by increases in population, economic growth, and changes in land use. Following the CCAP analysis approach, a roughly 5 to 10% decrease from 2005 emissions would be expected by 2030 given the two reduction initiatives discussed above (see Figure 2-12). Even with the relatively lower VMT projection for the Adirondacks, it is projected that this modest increase in VMT will mostly negate reductions from the CAFE standard and RPS.

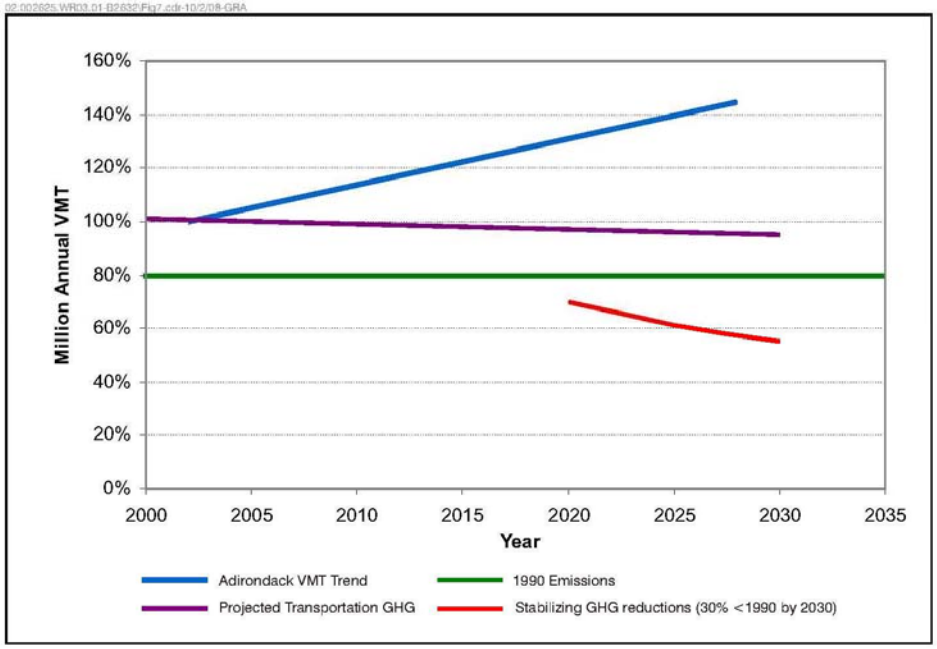


Figure 2-12 Adirondack VMT and GHG Trend

Initiatives that target VMT, such as access to public transportation, ride sharing, trip reduction, and land use planning, should be part of initiatives aimed at reducing transportation GHG emissions in the Park.

This inventory and projections suggest that mobile combustion is very significant to the Adirondacks and that a primary driver is sharply increasing vehicle use, which corresponds to but is somewhat less than the national trend. Recommendations for mitigating mobile emissions are beyond the scope of this inventory, but clearly an array of efforts will be needed that may include initiatives that reduce vehicle use.

2.3 Solid Waste and Wastewater Treatment

This sector is comprised of two main categories: generation of solid waste by entities within the Park and generation of wastewater in the Park that is collected and treated at municipal waste water treatment plants or treated with septic systems. Each is discussed separately and evaluated for GHG emission potential below.

2.3.1 Solid Waste

The solid waste category consists of any unwanted solid materials generated by human activity within the Park that are disposed of after removing recyclable materials. Solid waste is generated from households, commercial activities, industry, and municipal organizations. The majority of solid waste is collected by waste transport companies and trucked to transfer stations and ultimately to a disposal site.

Solid waste, generally called municipal solid waste (MSW), produces “landfill” gas when disposed of in a landfill. Methane (CH_4) and carbon dioxide (CO_2) are the primary gases produced from the decomposition of organic materials (i.e., materials containing carbon) in an anaerobic (oxygen-limited) environment. Both are greenhouse gases, but methane has a global warming potential approximately 21 times greater than carbon dioxide. Landfill gas can be directly emitted to the atmosphere either by leaking out of the ground through pores or cracks in landfill covers, from vents in a landfill gas collection system that does not have a combustion control system installed, or as fugitive emissions from active landfill cells. If the landfill gas is captured by a landfill gas collection system and burned in a flare or landfill gas to energy facility, only emission of CO_2 will result. The NYSDEC general estimate for landfill gas generation rate is 0.15 cubic feet per pound per year (NYSDEC 2009).

Closed Landfills

There are currently no open landfills (i.e., landfills accepting waste) within the Park’s boundary. Historically, many landfills existed in the Park; approximately 60 landfills existed at one time or another during the 1900s (see Table 2-12). Many of these landfills were simply unlined pits into which municipal solid waste and construction debris was deposited. Active landfills ceased operation in the Park by year 2000; the most recent landfill closures include the Essex County Landfill, and smaller landfills in Lake Pleasant and Indian Lake. Although these landfills are no longer accepting waste, the waste that is in the landfill continues to decompose and generate landfill gas. As part of the closure process for some of these landfills, gas venting and collection systems were installed.

Table 2-12Closed Landfills in the Adirondack Park

County	Closed Landfills within Park Boundary
Franklin	8
Clinton	2
Essex	14
Warren/Washington	14
Fulton	2
Hamilton	8
Herkimer/Oneida/Lewis	2
St. Lawrence	8
Saratoga	2

Source: Jenkins and Keal 2004.

Estimates of landfill gas emissions from all closed landfills within the Park cannot be completed due to difficulty in finding information regarding the amount of MSW that was disposed of in the landfill and the landfill closure date. If this data becomes available, an estimate of landfill gas emission from these closed landfills can be made.

Current MSW Management

Currently, MSW is collected via trucks, transported to a transfer station, and then compacted and shipped out of the Park to landfills or a waste to energy facility. Table 2-13 presents a summary of the solid waste stream data and the waste destination. The collection and transport of MSW in this manner results in emissions of GHGs from transport trucks. Emissions associated with collection and transport of waste is captured in the on-road mobile source/transportation activity section of the GHG inventory (see Section 2.2). The landfilling and/or incineration of solid waste at facilities outside of Park boundaries results in GHG emissions that are directly related to activity within the Park.

These relatively large "regional" landfills consist of several cells, with some cells full of waste and closed, other cells open and actively accepting waste, and some cells under construction for receipt of waste in the future. All regional landfills are of sufficient size to require (per NYSDEC regulation) the installation of landfill gas collection systems. Waste deposited into active cells begins generating landfill gas after a short period of time (approximately one week); landfill gas from active cells can be controlled if the landfill incorporates the proper design (wells and collection trenches) for active cells. The major regional landfills and the characteristics of their landfill gas collection and treatment systems are discussed below.

The Rodman landfill, operated by the Development Authority of the North Country, accepts waste from Hamilton County and portions of Herkimer/Oneida/Lewis counties within the Park. This landfill controls emissions of landfill gas via a gas collection system and newly constructed landfill-gas-to-energy power plant, which is scheduled to become operational in late fall 2008. Landfill gas generated from decomposition of the waste is collected in wells and piped to a facility that burns the gas to generate heat/steam and electrical power. In this process, methane (a more potent greenhouse gas per ton emitted) is combusted which results in the emission of CO_2 that has a lower global warming potential per ton emitted. The Rodman landfill recently completed an expansion of its capacity, installed additional landfill gas collection wells, and connected these new wells to its landfill gas to energy plant.

The Westville landfill, operated by the County of Franklin Solid Waste Management Authority accepts waste from Franklin, Essex, and St. Lawrence counties. Private individuals, waste haulers, and trucks from the Authority's transfer stations in Tupper Lake, Lake Clear, and Malone (outside the Park) bring waste to the landfill. According to the final scoping document, issued in June 2008, for a planned expansion of the landfill, the current landfill operates a landfill gas collection system and would install a gas collection system for the expansion. Expansion of the landfill's capacity is currently under study and an environmental impact statement (EIS) is being prepared; the EIS will contain an analysis of GHG emissions and a discussion of potential mitigation measures.

The Clinton County (Schuyler Falls) landfill, owned by Clinton County and operated by New England Waste Services of New York, accepts waste from Clinton County. Approximately 46% of the land area of Clinton County is located within the Park boundary. However, the portion of Clinton County within the Park has a small fraction of the County's population and thus generates a very small fraction of Clinton County's annual total solid waste. The landfill has an active gas collection system that captures the landfill gas and directs it via piping for treatment by combustion with open flares. Both closed and active cells are connected to this gas collection system.

The Hudson Falls Waste to Energy Plant, owned by the Washington and Warren County IDA and operated by Wheelabrator, Inc., accepts waste from several Adirondack counties. This facility combusts solid waste and uses the heat to produce electricity. The plant has a capacity to burn 500 tons per day of waste; the waste generated in the portions of counties within the Park that go to this facility contribute approximately 47 tons per day on average. Thus approximately 10% of the annual emissions of GHG from this plant can be attributed to waste generated within the Park.

The Fulton County (Johnstown) landfill is owned and operated by Fulton County. Approximately 4,070 tons of solid waste generated in the Park portions of Fulton and Saratoga counties was sent to this landfill in year 2000. This waste quantity is approximately 5% of the average annual acceptance rate of 83,000 tons at the Fulton County landfill. The landfill has installed a landfill gas collection system.

Some solid waste that is generated has value as a recyclable material. Collection and transport of recyclables still generates emissions during the transport phase as is the case for waste that is disposed of. In most cases, recycling sorting is conducted at the source and hauled separately to the transfer station. Table 2-13 shows the percent of solid waste that is recycled for counties in the Park.

Table 2-13 Characteristics of Current Solid Waste Management for Waste Generated within the Park

County	Tons of Waste (year 2000)[1]	Recycling Percentage, Approximate	Tons of Waste to Landfill or Incineration	Landfill Gas Combustion System Installed?	Waste Destination
Franklin	9,900	3	9,600	No	Franklin County Regional (Westville) Landfill
Clinton	800	10	720	Yes	Clinton County (Schuyler Falls) Landfill
Essex	14,800	30	10,360	Not applicable	Hudson Falls Incinerator
Warren/Washington	15,900	63	5,883	Not applicable	Hudson Falls Incinerator
Fulton	3,500	12	3,080	No	Fulton County (Johnstown) Landfill
Hamilton	6,500	16	5,460	No	DANC (Rodman) Landfill
Herkimer/Oneida/ Lewis	2,000	45	1,100	No	DANC (Rodman) landfill and Utica-Rome Transfer
St. Lawrence	800	30	560	No	Franklin County Regional (Westville) and DANC (Rodman) landfills
Saratoga	2,100	6	1,974	Not applicable No	Hudson Falls Incinerator Fulton County (Johnstown) Landfill
Total	**56,300**	**NA**	**38,737**		

Data Source: Jenkins and Keal 2004.

Note:
[1] From the portion of the county within the Adirondack Park boundary.

Key:
DANC = Development Authority of the North Country.
NA = Not applicable.

The GHG emission estimate for solid waste management is shown in Table 2-14.

The estimates are based on the amount of waste generated in the Park and sent to the four regional landfills and the Hudson Falls Waste to Energy Facility (according to year 2000 data [Jenkins and Keal 2004]). For MSW sent to landfills, the annual GHG emission estimate is derived by using the NYSDEC general landfill gas generation rate of 0.15 cubic feet per pound of waste per year multiplied by the total amount of waste sent to landfills and assuming that 50% of the landfill gas is methane and 50% is CO_2. For the Hudson Falls waste to energy plant, total CO_2 emissions from the plant and amount of waste combusted were obtained for year 2000 from the United States Department of Energy's Energy Information Administration data base. The proportion of the facility's CO_2 emissions from waste sent to the plant from Adirondack Park counties (or portions of counties in the Park) was derived from the ratio of total waste burned at the facility to the amount of waste sent to the plant from the Park.

Table 2-14 Greenhouse Gas Emission Estimate for Solid Waste Management for the Adirondack Park

Waste Destination	Tons of Waste in year 2000	Amount of Landfill Gas Generated (ft^3)[1]	Methane (CO_2e metric tons)[2]	CO_2 (metric tons)
Landfill	21,507	6,452,100	4,156	181
Waste to Energy Plant	17,230	Not applicable	none	3,177
Total	-	-	**9,011 metric tons CO_2e**	

Notes:

1 Tons of waste *2,000 lb/ton * 0.15 cubic feet per pound per year = gas generated. Assume gas is 50/50 methane/carbon dioxide. Convert cubic feet to cubic meters, multiply by CH_4 (1.82 kg/m^3) and CO_2 (1.98 kg/m^3) to get raw emissions, convert to CO_2e and to metric tons.

2 Landfill gas resulting from waste decomposition in the Clinton County landfill is treated with a landfill gas flaring system resulting in emissions of only CO_2. The amount of waste sent to this landfill from the portion of the Park in Clinton County is a very small fraction of the total waste received based on the fraction of total County population in the Park. Since the Rodman landfill waste to energy facility is expected to begin operation in late 2008, existing emissions of landfill gas are assumed to not pass through the combustion control system.

Key:

CO_2 = Carbon dioxide.
CO_2e = Carbon dioxide equivalent.
ft^3 = Cubic feet.

2.3.2 Wastewater Treatment

While all old municipal solid waste management facilities within the Park have been closed and solid waste transported to regional landfills or to a waste to energy plant, wastewater treatment plants (WWTP) are by necessity located in many villages and towns within the Park and continue to operate. In addition, many residences not connected to a municipal WWTP utilize a septic system to treat their wastewater.

Wastewater treatment can produce methane and nitrous oxide (N_2O) emissions. The treatment process generally consists of the application of methods to remove soluble organic material, suspended solids, organisms, and chemicals. Microorganisms are used in a biological process to remove the soluble organic material which generates a biomass (sludge). Other mechanical and chemical treatment processes are used to remove suspended solids, kill pathogenic organisms, and remove chemicals. The decomposition of the soluble organic material by microorganisms and the further decomposition of the sludge results in the generation of methane if purposely (or accidentally) conducted in an anaerobic condition (i.e., limited oxygen). Nitrous oxide can be emitted from wastewater treatment due to the interaction of nitrogen bearing compounds such as urea, ammonia, or proteins in the wastewater with the treatment process. Operation of equipment at the WWTP uses electricity and results in indirect (Scope II) emissions of GHGs. Nationally, the EPA estimates that 0.64% of the country's GHG emissions originate from wastewater treatment (EPA 2009a).

The quantity of methane generated at a WWTP primarily depends on the amount of incoming biological material in the wastewater and the degree or percentage of the process that is conducted anaerobically. N_2O emissions are dependent on the amount of nitrogen in the incoming wastewater.

The quantity of sludge generated and the fate of the sludge also contribute to the quantity of methane generated. Sludge may be shipped off-site to a landfill or treated on-site at the WWTP. If the sludge decomposition occurs in an anaerobic environment, such as in a landfill or an on-site anaerobic sludge digester, the methane can be captured. However, methane can be emitted during the handling of the sludge prior to receipt of the sludge at a landfill or prior to entering an on-site anaerobic digester.

The *NYSDEC Division of Water's Descriptive Data of Municipal Wastewater Treatment Plants in New York State* (January 2004) was used to identify WWTPs in the counties within or partially within the Park. The list was then narrowed to identify just those facilities within the Park or very near the Park boundary. There are 26 municipal WWTPs treating a combined design flow of 19.5 million gallons per day and serving 75,176 people (NYSDEC 2004).

The remaining population within the Park is assumed to use septic systems. The exact population living within the Park is not known but is approximated at 150,000 (Jenkins and Keal 2004). Thus, taking the total Park population and subtracting the people served by municipal WWTP results in a population of about 75,000 using septic systems.

According to the NYSDEC Division of Air list of facilities with either Title V or State Facility air operating permits, none of the WWTPs within the Park has an air permit. This indicates that these facilities do not contain significant point source emissions. The single WWTP facility in the Adirondack region (but not within the Park) with a State Facility air permit is the Glens Falls WWTP due to its use of a sludge incinerator.

Table 2-15 lists the 10 largest WWTPs within the Park in terms of population served.

Table 2-15 Ten Largest Municipal WWTP within the Adirondack Park

WWTP Name	County	Receiving Water Body	Design Flow (MGD)	Population Served	Type of Sludge Digestion	Sludge Disposal
Lake George (Town and Village)	Warren	Groundwater	1.750	20,000	anaerobic	composting
North Elba (Lake Placid)	Essex	Chubb River	2.500	15,000	anaerobic	landfill
Saranac Lake WWTP	Essex	Saranac River	3.660	7,500	anaerobic	landfill
Dannemora WWTP	Clinton	Saranac River	1.500	4,004	none	not specified
Port Henry/Moriah Joing WWTP	Essex	Lake Champlain	0.440	4,000	none	not specified
Tupper Lake WWTP	Franklin	Raquette River	4.500	4,000	none	not specified
Corinth WWTP	Saratoga	Hudson River	0.600	3,700	none	not specified
Ticonderoga WWTP SD #5	Essex	Lachute River	1.700	3,500	none	not specified
Schroon Lake WPCP	Essex	Schroon Lake	0.350	2,950	none	not specified
Speculator WWTF	Hamilton	Sacandaga River	0.120	2,500	aerobic	land spreading

Key:
WPCP = Water Pollution Control Plant.
WWTF = Waste water treatment facility.
WWTP = Waste water treatment plant.
SD = Sewer District

Methane emissions from wastewater treatment within the Park are a sum of the emissions from septic system use and municipal WWTPs. For the municipal WWTPs, all biological treatment processes are assumed to be aerobic. Since aerobic systems may accidentally operate anaerobically at times, it was assumed that 10% of the aerobic systems, on average, operate anaerobically. Three of the aerobic systems, shown in Table 2-15, use anaerobic sludge digestion. None of the anaerobic digester systems were found to have a flare or other combustion device, thus for these systems it is assumed the methane is released to the atmosphere. Methane emissions from wastewater treatment systems (septic systems, centrally treated aerobic systems, and anaerobic digesters) were derived using the methodology from the EPA Inventory of United States Greenhouse Gas Emissions and Sinks (EPA 2009a), Chapter 8.2. Total methane emissions were converted to metric tons of CO_2e using a global warming potential factor of 21 and are shown in Table 2-16.

Nitrous oxide emissions from wastewater treatment are the sum of emissions from the WWTP and from wastewater effluent discharged to aquatic environments. The method of calculation of N_2O emissions from a WWTP depends on whether the WWTP applies or does not apply nitrification and/or denitrification in the treatment process. For the WWTPs within the Park, none of the facilities use nitrification/denitrification in the treatment process according to 2004 NYSDEC WWTP data (NYSDEC 2004). Also, the emission of N_2O from discharge of effluent to aquatic environments is determined but is calculated using national default values for some of the parameters in the equation. Nitrous oxide emissions were derived using the methodology from the EPA Inventory of United States Greenhouse Gas Emissions and Sinks (2009a), Chapter 8.2. Using a global warming potential factor of 310 for N_2O, emissions are shown in Table 2-16 in terms of metric tons of CO_2e.

Table 2-16 Estimated Greenhouse Gas Emissions from Wastewater Treatment within the Adirondack Park

Wastewater Emission Source	Methane (metric tons CO_2e)	Nitrous Oxide (metric tons CO_2e)	Total CO_2e (metric tons)
Septic System	15,532	None	15,532
Aerobic WWTP	555	4,377	4,932
Anaerobic Digestion	7,388	None	7,388
Totals	**23,475**	**4,377**	**27,852**

Notes:
Nitrous oxide emission occurs from WWTP with no nitrification/denitrification and effluent discharge to waterbodies per NYSDEC 2004.

Distribution of wastewater processed by septic and WWTP based on population served by WWTP versus total estimated Park population.

Key:
CO_2 = Carbon dioxide.
CO_2e = Carbon dioxide equivalent.
WWTP = Waste water treatment plant.

2.4 Overview of the Carbon Services (Storage and Sequestration) Provided by the Forests of the Adirondack Park, New York[1]

2.4.1 Summary

This report provides a preliminary estimate of the carbon storage and sequestration functions of the forests in the Adirondack Park and vicinity. Our purpose was to generate rough approximations of the carbon sink functions of the Adirondack Park for the following purposes: (1) for comparison with greenhouse gas (GHG) inventories to understand the Adirondack Park 'carbon footprint', in part for the purposes of estimating carbon offsets; (2) for scoping and building consensus on forest management and land use policy options to optimize Adirondack Park carbon services; and (3) to identify information needs for further decision-making. All estimates are based on the USDA Forest Inventory and Analysis (FIA) data and related information and have been derived from both our own calculations as well as existing sources. The current estimates are an aggregate, non-

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spatial measure of the carbon storage (existing pool) and sequestration functions of forest trees and soils (i.e., both above- and belowground). Though carbon fluxes of wetlands, streams, and other water bodies have not been explicitly considered, they likely contribute significantly to the overall carbon footprint of the Adirondack Park. Overall, we emphasize that the figures presented here are preliminary and should be interpreted with caution—more data collection and modeling is needed to accurately estimate carbon services in the Adirondack Park and how these functions may be affected by climatic and land use changes in the region.

2.4.2 Study Area

The Adirondack Park comprises approximately 5.8 million acres in northern New York State, roughly half of which is state-owned and managed as the NYS Forest Preserve, and the remainder is privately owned or held by municipal governments. The Park includes all of Hamilton and Essex counties, large portions of Clinton, Franklin, Herkimer, St. Lawrence, and Warren counties, and small portions of Lewis, Oneida, Saratoga, and Washington counties (see Table 2-17).

Table 2-17 Counties Represented in the Adirondack Park and Percentages of Public and Private Land

County	Total Acreage	% County Land in ADK Park	% Privately Owned in ADK Park	% State Owned in ADK Park
Hamilton	1,155,952	100.0	28.1	66.8
Essex	1,225,614	99.9	50.3	43.5
Warren	595,647	93.9	57.7	35.2
Franklin	1,085,624	67.9	60.1	34.3
Herkimer	932,009	60.0	33.4	61.6
Fulton	340,861	59.6	51.7	37.0
Clinton	714,763	45.7	78.1	15.9
St. Lawrence	1,804,007	34.5	69.0	26.5
Saratoga	539,888	27.6	83.4	9.9
Lewis	825,798	20.0	62.9	34.4
Washington	541,314	18.8	74.5	22.2
Oneida	804,112	2.1	56.1	39.5

2.4.3 Methods

County-level data from the USDA Forest Inventory and Analysis (FIA) archives were retrieved from the FIA Web site and related sources, including the NCASI-USDA Carbon Online Estimator (COLE) Web site. Most data presented here are based on 2004 FIA estimates and related products. Data were provided for belowground (soil) carbon storage estimates and standing aboveground biomass and related growth rates, mortality rates, and removals. Carbon sequestration rates were estimated as a function of net volume of annual growth minus removals and mortality, multiplied by a conversion factor (0.55) reflecting the percent carbon in dry biomass. Because spatially explicit data at a higher resolution were not available, we present county-level estimates for all counties represented in the Adirondack Park. To generate an estimate for the Adirondack Park only, we calculated the direct proportion based on the percentage of county land within the Blue Line. This approach assumes that forest lands inside the Blue Line are equivalent to those outside of the Park, which we know not to be accurate. However, without the better spatial data on forest and soils that would allow a high-resolution focus on the Adirondack Park, we are limited to this level of analysis. Overall, we suggest that our current estimates are likely conservative, because we expect forest lands within the Park to support greater storage (because of intact soils) and sequestration (because of forest management and conservation) than lands outside of the Blue Line. Results are presented in million metric tons (MMT) of dry biomass or the converted units for carbon footprints: teragrams of carbon dioxide equivalent (Tg CO2e).

2.4.4 Results

Table 2-18 provides the estimated carbon storage—or the existing carbon pool—of the Adirondack Park, based on FIA data and related products.

Table 2-18 Carbon Storage in Forest Biomass and Soils and the Estimated Proportion Attributed to the Adirondack Park

County	Aboveground Biomass (MMT)	Estimated Soil C (Tg CO2e)	Percent County in ADK Park	Adirondack Park		
				Aboveground Storage (Tg CO2e)	Belowground Storage (Tg CO2e)	Total Storage (Tg CO2e)
Hamilton	18.49	38.89	100.0	9.24	38.89	48.13
Essex	35.29	38.70	99.9	17.63	38.66	56.29
Warren	17.09	17.53	93.9	8.03	16.46	24.49
Franklin	25.84	32.81	67.9	8.77	22.27	31.04
Herkimer	22.41	25.85	60.0	6.72	15.50	22.22
Fulton	11.10	8.85	59.6	3.31	5.28	8.59
Clinton	16.09	16.13	45.7	3.68	7.37	11.05
St. Lawrence	21.45	44.88	34.5	3.70	15.50	19.2
Saratoga	45.99	14.05	27.6	6.34	3.87	10.21
Lewis	24.86	14.05	20.0	2.48	4.72	7.2
Washington	18.54	9.85	18.8	1.75	1.86	3.61
Oneida	20.62	17.27	2.1	0.21	0.36	0.57
			Total	71.86	170.74	242.6

Note:
Based on percentage of county within the Blue Line. Biomass is presented in millions of metric (dry) tons (MMT). Carbon equivalent (CO2e) units are presented in teragrams (Tg). One Tg = 1,000,000 metric tons. Estimated soil carbon is derived from the NCASI-USDA Carbon Online Estimator (COLE) Web site.

Table 2-19 provides a county-level estimate of changes in forest biomass, or growing stock, based on 1993 and 2004 FIA data and related products. Changes in growing stock are used to estimate changes in aboveground carbon content, which provides a rough approximation of carbon fluxes from forest lands. A positive number suggests net carbon sequestration, while a negative number suggests net carbon emission (or loss through other means). Overall, these are highly aggregated estimates that should be interpreted with considerable caution.

Table 2-19 County-level Estimates of Changes (Δ) in Forest Biomass and C Storage (ΔC Biomass)

County	Net Growth (MMT)	Mortality (MMT)	Removals (MMT)	Δ Biomass (MMT)	ΔC Biomass (Tg CO2e)	County Weighting	ADK Park ΔTg CO2e yr^{-1}
Hamilton	0.71	0.24	0.49	-0.01	-0.01	1.000	-0.01
Essex	1.04	0.28	0.34	0.42	0.23	0.999	0.23
Warren	0.72	0.15	0.52	0.05	0.03	0.939	0.03
Franklin	0.80	0.34	0.75	-0.29	-0.16	0.679	-0.11
Herkimer	0.38	0.12	0.34	-0.08	-0.04	0.600	-0.02
Fulton	0.38	0.05	0.09	0.24	0.13	0.596	0.08
Clinton	0.54	0.20	0.14	0.21	0.11	0.457	0.05
St. Lawrence	1.93	0.10	0.66	1.17	0.64	0.345	0.22
Saratoga	0.92	0.48	0.28	0.16	0.09	0.276	0.02
Lewis	1.14	0.21	0.34	0.60	0.33	0.200	0.07
Washington	0.53	0.08	0.09	0.36	0.20	0.188	0.04
Oneida	0.94	0.09	0.16	0.69	0.38	0.021	0.01
Total	**10.03**	**2.34**	**4.2**	**3.52**	**1.93**		**0.60**

Note:
Estimates are weighted by county representation to provide a rough measure of net carbon fluxes for the Adirondack Park (ΔTg CO2e yr^{-1}. Positive numbers suggest net C sequestration, while a negative numbers suggest net C loss. Units are million metric tons (MMT) of dry biomass and teragrams of carbon dioxide equivalent (Tg CO2e).

2.4.5 Conclusions

Based on conservative and spatially aggregated estimates, the forest biomass and soils of the Adirondack Park contain roughly one-quarter billion metric tons of carbon. Net sequestration rates into aboveground biomass in the Adirondack Park are roughly 600,000 metric tons of CO_2 equivalent per year, while insufficient data was available to evaluate soil carbon fluxes. We again emphasize that, while these estimates are probably conservative, the data and methods used have introduced a significant amount of error, and the results should not be used directly for land use planning or forest management. The importance of wetlands and water bodies for carbon storage and sequestration, as well as the emission of greenhouse gases from natural processes (e.g., methane from acid bogs), was not reflected in our analysis. Both wetlands and water bodies represent a major knowledge gap for understanding the Adirondack Park carbon footprint and how it may change in a changing climate. In general, better information is needed to account for variation in site productivity, forest composition, management history, soil chemistry and climatic variation, each of which influences carbon storage and sequestration. The results presented here are provided mainly for comparison with the greenhouse gas inventory developed for the Adirondack Park to understand the overall Adirondack Park carbon footprint.

2.5 Agriculture and Animal Husbandry

Agricultural activities produce greenhouse gas emissions from a number of activities/sources. According to the U.S. Greenhouse Gas Inventory, agricultural sources of GHG emissions include the following (USEPA 2006):

- Indirect GHG emissions from electricity consumption;
- Direct GHG emissions from fuel consumption in equipment and buildings;
- Direct non CO_2 emissions from livestock husbandry (flatulence and manure management); and
- Direct GHG emissions from soil management (e.g., fertilizer application).

Agriculture and animal husbandry activities are concentrated along the eastern and northeastern boundary of the Park with a few farms located within the Park. Of the approximately 6,000 farms in the 12-county Adirondack region, 216 farms (3.6% of all farms in the Adirondack Region) are in the Park or along the Park boundary (Jenkins and Keal 2004).

Direct GHG emissions from stationary combustion and indirect GHG emission from farm electricity consumption within the Park is not likely to be a significant source of indirect GHG emissions. In comparison to the number and square footage of non-farm residences and other non-farm commercial activities in the Park that consume electricity, the number of farms, at 216, is very small. Within the agricultural sector, the direct stationary combustion and indirect electricity use component of GHG emissions is considered very small and not of consequence to the overall emission total.

Direct GHG emissions from fuel consumption in farm equipment are included in the non-road emission category discussed in section 2.2.1 of this inventory report. It was found that all categories of non-road equipment (non-farm and farm combined) produce approximately 10,370 metric tons of CO_2e in the Park. Given the relatively small number of farms active in the Park (216), it is expected that the contribution of farm equipment to the non-road total is no more than 10%, or 1,037 metric tons of CO2e.

New York agricultural statistics are available by county from the New York Agricultural Data Statistics Service, but are not readily available broken out by Town (NASS 2009). Therefore, the GHG analysis first calculated emissions from agricultural activities from the twelve county Adirondack Region. For counties partially within the Park, GHG emissions for agricultural activities within the Park boundary in these counties were determined by multiplying the total county emissions by the ratio of agricultural land use parcels inside and outside the Park determined in a GIS analysis.

Within the animal husbandry sector of agricultural activities, the most significant GHG emission occurs from beef and dairy cattle's digestive processes. These ruminant animals have a fore-stomach used in digestion that produces a significant amount of methane due to enteric fermentation resulting in release of methane from the animal. Manure management for these animals produces less methane than the digestive process, but is still significant. Significantly less methane is produced from other domesticated farm animals such as swine and horses due to differences in these animal's digestive systems (i.e. lack of the fore-stomach) (USEPA 2006). The emission factor for non-ruminant animals (e.g. swine and horses) is more than a factor of 10 less than for ruminant animals. Thus, non-ruminant animal methane emissions were ignored in this inventory.

Table 2-20 shows the estimated population of all cattle in the twelve county Adirondack Region, methane emission factors, and total estimated emissions in CO2e. For purposes of this GHG analysis, one-half of the cattle population was categorized as dairy with the other one-half beef cattle and all were counted as mature cattle. Agricultural data statistics for each County support this assumption; they indicate that on average the total number of cattle in the Adirondack region is evenly divided between dairy and beef (NASS 2009). Average number of calves was not reported, however immature animals have lower methane emission factors, thus assuming all cattle are mature results in a conservative estimate of total direct GHG emissions from cattle and manure management. Finally, cattle related methane emissions within the Park boundary was summed for counties entirely within the Park and for portions of counties within the Park.

Greenhouse gas emissions from soil management result from the application of fertilizer to the soil resulting in emissions of nitrous oxide (N_2O). There are several different values for emission factors for N_2O emissions from soil depending on the type of soil tilling used to maintain the crop land. Data describing the distribution of soil tilling practices for farms within the Park could not be found. Therefore, it is not feasible to prepare an acceptable estimate of N_2O emissions from soil management at this time.

2.6 Fugitive Greenhouse Gas Emissions from Oil, Gas, and Mineral Extraction

Production of crude oil and/or natural gas from a well can release methane to the atmosphere due to fugitive leaks from the wellhead, piping, and associated equipment. The annual production of each well in New York State that produces oil and/or natural gas must be reported to NYSDEC by March 31 of the following year.

The NYSDEC data base of annual oil and gas well production was queried to determine whether any oil and gas production occurred within the Adirondack Park. The latest year of data available is 2007. The results of the query indicate that active wells are present in the following counties: Herkimer (4), Lewis (8), Oneida (1), and Washington (1) (NYSDEC 2008a). The locations of these wells were plotted on a map, and none are within the Adirondack Park or close to the Park

Table 2-20 Beef and Dairy Cattle Population and Estimated GHG Emission from Enteric Fermentation and Manure Management within the Park Boundary

County	Cattle (Dairy and Beef) Population (head)[1] (2003)	Enteric Methane Emission factor – Mature Beef Cattle (pounds of CH_4/head/year)[2]	Manure Management Methane Emission Factor – Mature Beef Cattle (pounds of CH_4/head/year)[2]	Enteric Methane Emission factor – Mature Dairy Cows (pounds of CH_4/head/year)[2]	Manure Management Methane Emission Factor – Mature Dairy Cattle (pounds of CH_4/head/year)[2]	Total Emissions Within the Park (metric tons CO2e)
Clinton	37,000	198.4	7.7	297.2	65.3	4721
Essex	5,500	198.4	7.7	297.2	65.3	14,894
Franklin	32,000	198.4	7.7	297.2	65.3	0
Fulton	6,200	198.4	7.7	297.2	65.3	183
Hamilton	<100	198.4	7.7	297.2	65.3	271
Herkimer	34,000	198.4	7.7	297.2	65.3	0
Lewis	50,000	198.4	7.7	297.2	65.3	0
Oneida	47,100	198.4	7.7	297.2	65.3	0
Saratoga	14,700	198.4	7.7	297.2	65.3	0
St. Lawrence	76,500	198.4	7.7	297.2	65.3	451
Warren	~200	198.4	7.7	297.2	65.3	0
Washington	53,100	198.4	7.7	297.2	65.3	730
Total	**356,400**	**-**		**-**		**21,250**

Source: New York Agricultural Statistics Service, accessed 2009; latest available data sheets (year 2003) at http://www.nass.usda.gov/ny

Notes:

[1] According to each County data summary, total number of cattle is on average composed of 50% beef cattle and 50% dairy cattle.

[2] Emission factors for mature beef cattle and mature dairy cattle; Environment Canada National Inventory Report, April 2006, Annex 13.5. While there are calves included in the total cattle population, the number of calves is not broken out in the Agricultural statistics data sheets.

boundary. For comparison to the rest of New York, over 35,000 oil and gas wells are registered state-wide in the NYSDEC database. Therefore, it is concluded that oil and gas production is not a significant source of greenhouse gas emissions in the Adirondack region due to the small number of active wells, and there are no greenhouse gas emissions from this category within the Adirondack Park because no wells are located within the Park.

Mineral extracting (i.e., mining) can produce greenhouse gas emissions from two sources. Equipment used to conduct mining operations produces emissions due to combustion of fuel, and disturbance of the earth for the extraction of certain minerals can release methane.

Methane is primarily released during coal mining, since the biological decomposition processes that form coal also form methane and other hydrocarbons. Methane and other hydrocarbons are often collocated with coal and can be encountered during coal mining. Extraction of materials and minerals that are not of biological origin (e.g., sand and gravel, granite, garnet, and sandstone) are not likely to have collocated methane associated with them.

The NYSDEC database of mines regulated under the Mined Land Reclamation Law (MLRL) was queried for the 12 counties of the Adirondack region to assess the type of mining conducted in the Adirondack region as well as within the Adirondack Park (NYSDEC 2008b). Data retrieved for these counties was then sorted by commodity mined and by town. Included as a result of the sorting process were mines in towns that are entirely within the Adirondack Park or within towns that are partially within the Park.

Analysis of the database indicated that coal is not mined in the Adirondack Park or Adirondack region. Therefore, a potentially major source of greenhouse gas (methane) from mining does not exist in the Adirondack Park or region. The vast majority of mines in the Adirondack Park and region are sand and gravel mines consisting of open pit excavations. Other commodities that are mined include topsoil, sandstone, limestone, clay, garnet, and wollastonite.

2.7 Uncertainty

As discussed in Section 1.5, Base Emissions Year, the uncertainty provided by this report is significant. To the degree possible uncertainties were reduced, and the highest quality data and methodologies available were employed. But, because of the lack of primary fuel use and electricity use data, estimation approaches were employed with varying degrees of uncertainty.

Table 2-21 shows an estimate of data uncertainty by data type, and the impact that uncertainty has on total inventory uncertainty. For example, a high degree of uncertainty in a source that is relatively inconsequential to the inventory will have a low potential impact on the total inventory uncertainty.

Table 2-21 Data Uncertainty by Data Type

Data	Source	Type of Uncertainty	Estimated Degree of Uncertainty	Impact on Total Inventory
Residential and Commercial Emissions				
RPS Property Counts by Property Type	NYS Real Property System	Assessment departments may have errors or be inconsistent with property classification.	Low	Low
Residential Square Feet Livable Area	County RPS offices, U.S. Census	Extrapolated property type average square feet livable area from Hamilton and Essex Counties to other counties. Data was cross checked with 2000 census survey data.	Low	Low
Residential Seasonal Units	2000 Census	While the Census does indicate seasonal units, its survey technique suggests that there will be some error involved. Additionally, no data was found for energy use for seasonal units, and therefore a proportion of energy use was assumed based on discussion with local cabin proprietors (LaPrairie, 2009).	Moderate	Low
Commercial Square Feet Occupied Area	Hamilton and Essex County RPS offices, EIA Commercial Building Energy Consumption Survey	1. Extrapolation from Hamilton and Essex County to other counties by RPS property type. 2. Some less common properties estimated from EIA national average area or assumed the same as similar property types.	Moderate	Moderate
Fuel type estimate – residential	2000 Census	Error associated with census sampling. There is up to 20% difference in carbon content per unit energy between different fuels used in the Adirondacks.	Low	Low
Fuel type estimate – commercial	2000 Census	Residential fuel type proportions were assumed to be the same for commercial buildings. Electricity is not affected.	Low	Low
Energy Use Factors – Residential	DOE EIA	These factors are specific by climactic region, geographic region and property type. Error may result from Adirondacks having a typical housing stock and more extreme climate.	Moderate	Moderate
EIA Energy Use Factors – Commercial	DOE EIA	These factors are specific by climactic region, geographic region and property type. Error may result from Adirondacks having atypical commercial activity and buildings.	Moderate	Moderate

Table 2-21 Data Uncertainty by Data Type

Data	Source	Type of Uncertainty	Estimated Degree of Uncertainty	Impact on Total Inventory
Industrial Emissions				
EIA Energy Use Factors – Industrial	DOE EIA	Factors are per employee by manufacturer type. Source of uncertainty is the survey itself, and that for some manufacturers there was no matching category available, and a miscellaneous category was used. Additionally, no information was available for smaller employer industry type, and these were combined into the miscellaneous category.	Moderate to High	Low
Fuel Use Type	Assumption of the Inventory	Assumed to be fuel oil based for all industrial emitters, based on conversation with IP Ticonderoga Mill employee.	Moderate	Low
Transportation Emissions				
VMT Estimates	NYSDOT	Based on vehicle count data on state highways. Local road VMT is estimated.	Moderate	Moderate
Fleet Emission Factors	NYSDOT	Based on vehicle registration data by NYSDOT region and model runs of the USEPA Mobile6.2 emission factor model. Region fleet may not represent Adirondack Park fleet, and the emission factor model has does not accurately estimate real world emissions.	Moderate	Moderate
Non Road Vehicle Emissions	NYSDOT	Based on the national proportion of non-road fuel relative to on road fuel. This may significantly underestimate Park equipment emissions, as the logging industry and other aspects of a rural community are likely to involve a high amount of non-road vehicle and equipment use.	High	Moderate
Other Emissions				
Agricultural emissions Buildings	County RPS data and commercial building energy use factors	No agricultural GHG intensity factors were identified except for fugitive emissions (which were applied). Therefore a building size and EIA building type (warehouse) was assumed. Small number of farms makes this a very low impact on the inventory.	High	Very Low
Agricultural emissions – fugitive	County fact sheets and per head emission factors	The counts are relatively accurate, while the per head emissions are estimated to be moderately inaccurate.	Moderate	Very Low

Table 2-21 Data Uncertainty by Data Type

Data	Source	Type of Uncertainty	Estimated Degree of Uncertainty	Impact on Total Inventory
Landfill and water treatment	NYSDEC methane rates, and Jenkins 2004 landfill data	It is unclear how much error there may be in these parameters. Methane emissions from closed landfills within the Park were not estimated due to lack of readily available data documenting amount of waste deposited per year. As overall emissions are relatively small, there is little impact on the overall inventory.	Moderate	Very Low

Generally, the most significant uncertainty for the residential and commercial inventory include the use of regional rather than local energy intensity factors and the use of assessment data to determine property footprint – both are subject to error. The energy intensity factors are derived by DOE EIA from large, periodic, national surveys of residential and commercial buildings. Additionally, average Hamilton and Essex County square feet data by each of the 217 RPS property types was extrapolated to the other counties, and causes additional uncertainty. Uncertainty was reduced by obtaining primary energy data directly from several large organizations.

The industrial inventory also has uncertainty relating to the use of national survey energy intensity factors, and in this case, the use of per employee factors. The lack of detailed data on the nature of industrial jobs in the Adirondacks adds to this uncertainty. To mitigate uncertainty, primary fuel use data was obtained directly from the largest industrial employer, and this probably accounts for the overwhelming share of industrial emissions in the park. Therefore, even though the estimation methods for industrial emissions have high uncertainty, the risk to the inventory is low.

Transportation emissions were estimated using the approach used by NYSDOT to estimate emissions for its federal reporting requirements. As discussed with NYSDOT, there is a relatively high degree of uncertainty to this approach, because VMT for the entire region is largely estimated based on traffic counts exclusively on state highways (NYSDOT 2008). Additionally, county wide data was proportioned by population for the ten counties that are only partly in the Park, adding additional uncertainty. To mitigate uncertainty, a secondary estimation approach was employed using NYSERDA estimates of county gasoline consumption. That approach relies on sales tax information. This second approach was in agreement with the NYSDOT VMT approach.

Data Gaps

Data gaps have been discussed elsewhere in the inventory. The primary data gap is the lack of records of fuel consumption data. In order of importance, the primary data gaps are:

1. Vehicle fuel delivery volume;
2. Fuel oil delivery volume;
3. LPG delivery volume;
4. Electrical energy delivery; and
5. Off road fuel delivery.

Additionally, as discussed in the forestry section of the document, there are data gaps and research needs to more accurately characterize the overall carbon sink provided by the Adirondack Park. Both wetlands and water bodies represent major knowledge gaps for understanding the Adirondack Park carbon footprint, and in particular how it may change in a changing climate. In general, better information is needed to account for variation in site productivity, forest composition, management history, soil chemistry, and climactic variation, each of which influences carbon storage and sequestration. Forestry research specific to the Adirondack Park would be required to facilitate development of this information.

2.8 Summary and Discussion

A regional greenhouse gas (GHG) inventory was conducted for the Adirondack Park as part of the Adirondack Carbon Offset Project. The inventory supports efforts to identify GHG mitigation opportunities and to provide a baseline so that carbon emissions reductions can be documented over time.

The inventory encompassed 6 million acres within the Park boundary (known as the Blue Line), including all or parts of 12 counties. Regional primary fuel use and emission data were generally not available, and the inventory largely relied on secondary sources, including census data, assessment data, and other data compiled by state, federal, and academic sources. The effort involved data requests and consultation with local, state, and federal governments, the support of local academic institutions, detailed information provided by a number of large emitters, and the support of members of the community at large.

Given the limitations on primary data availability, the inventory was conducted to the extent possible according to international and national accounting principles and best practices. Emission factors were obtained from The Climate Registry General Reporting Protocol (Protocol), with the exception of state-specific mobile source factors, which were obtained directly from the New York State Department of Transportation (NYSDOT). Following the Protocol, region-specific electricity use emissions factors provided by the U.S. Environmental Protection Agency (EPA) were applied. Emissions were divided into two categories:

- Scope I – Direct Emissions
- Scope II – Indirect Emissions

For the purposes of this inventory, commercial buildings were defined following conventions from the U.S. Department of Energy, Energy Information Administration (DOE EIA), and include all buildings other than agricultural, industrial, and residential structures. The inventory of Scope I and Scope II emissions are summarized on Table 2-22.

Table 2-22 Summary Adirondack GHG Emissions

Source	CO_2e Emissions (metric tons)
Scope I Emissions	
Residential Building	341,901
Commercial Building	165,639
Agricultural – Buildings	22,711
Industrial	152,924
Mobile Sources	883,158
Agricultural - Fugitive Methane	21,250
Water Treatment Fugitive Methane	27,852
Total Scope I	**1,624,446**
Scope II Emissions	
Residential	331,732
Commercial	142,046
Agricultural	2,263
Industrial	36,391
Total Scope II	**512,433**
Total Emissions	**2,136,879**
Forest sequestration	-600,000
Net Emissions (Sources and Sinks)	**1,536,879**

Key observations and conclusions drawn from the Adirondack Park GHG inventory include the following:

Limitations on primary data availability limit the inventory. During the inventory process, it became clear that much of the primary fuel use data typically used in GHG inventories were not available. Electricity and bulk fuel suppliers consider their energy delivery data to be proprietary and thus did not provide supplied fuel and electricity data. It is concluded that a significant data sharing initiative at the state or local level may be needed to make this data available. For bulk fuel data, local or state reporting ordinances affecting fuel suppliers may need to be enacted, given the large number of small proprietors in this category.

Mobile source emissions make up the largest emissions source in the park. As shown on Figure 2-13, mobile source emissions from cars and trucks are by far the largest emissions source in the Park. This reflects both the rural character of the region, which typically involves the use of larger-than-average vehicles and travel between relatively dispersed communities. Additionally, although this study did not segment out tourist emissions, it is likely that tourist travel contributes significantly to vehicle emissions in the Park. Any attempt to attain carbon neutrality will require significant focus on mitigating emissions resulting from vehicle travel.

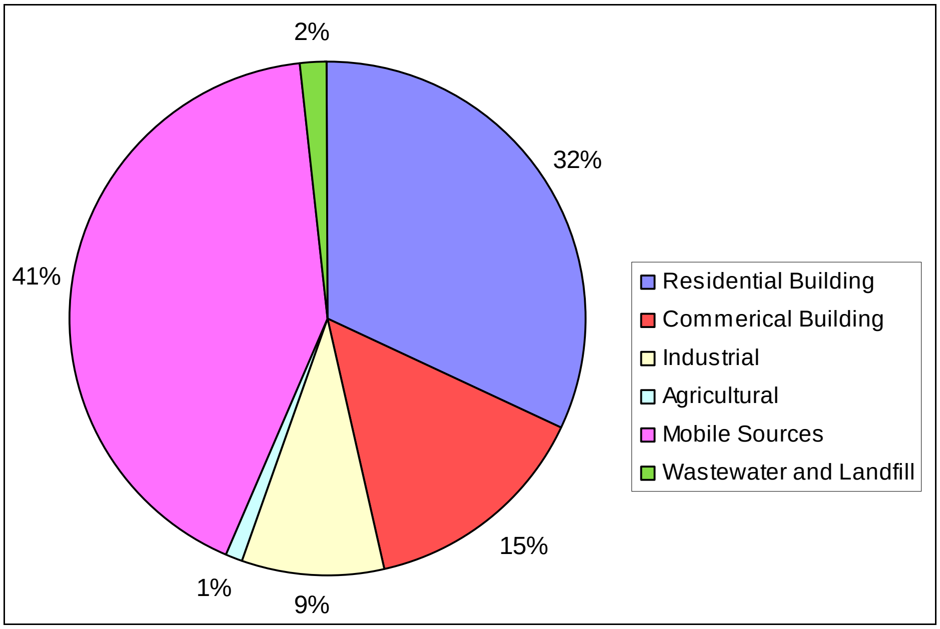

Figure 2-13 Adirondack Park GHG Emissions, by Sector

Residential emissions represent a significant portion of the emissions in the Park, providing opportunities for mitigation. As shown in Figures 2-14 and 2-15, compared to the United States, the Park has a much higher proportion of residential stationary combustion emissions. Because of the aging housing stock and relatively high reliance on electricity and fuel oil for heat, there are significant opportunities for mitigation. The relatively large proportion of residential emissions is due, in part, to the fact that a disproportionate number of employers in the region are located outside the Park boundary. Given the high residential energy consumption in this community and the high proportion of economically challenged residents, there is great opportunity to tie GHG mitigation to residential building energy efficiency programs that would mitigate GHG emissions and lower costs for struggling families.

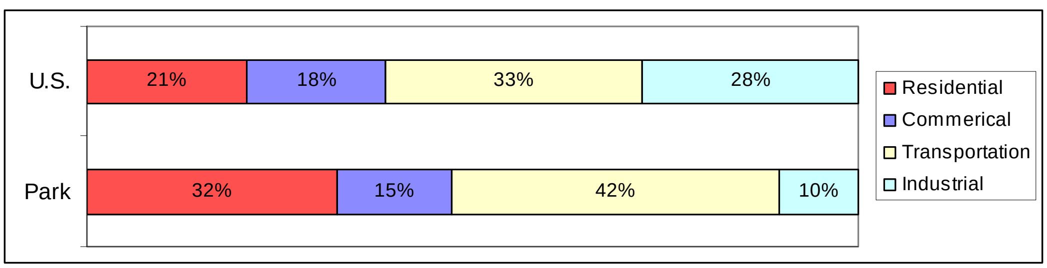

Figure 2-14 Comparison of U.S. and Adirondack Park Emissions by Sector

Source: EPA 2009.

The Park community has relatively less electricity consumption relative to the entire United States. Compared to the rest of the United States, this observation is likely because the high electricity consuming industrial and commercial sectors are under represented within the Park. This suggests that there will be more opportunities to mitigate fuel use from mobile and stationary sources than to lower electricity consumption. For example, there may be more limited opportunities to deploy large combined power and heat systems to industrial emitters, a practice that can make a large impact in more industrialized areas.

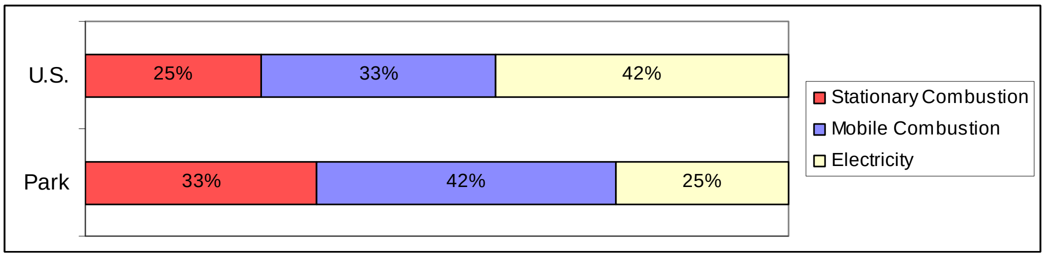

Figure 2-15 Comparison of U.S. and Adirondack Park Emissions by Source Type

Source: EPA 2009.

Industrial emissions are dominated by the International Paper Company's (IP's) paper mill in Ticonderoga, New York. Based on fuel use data provided by IP, it was found that the Ticonderoga mill emits about 86% of the industrial emissions in the Park. Although the mill combusts a large amount of relatively carbon neutral biomass, it nonetheless uses additional fossil fuel in its operation. The lack of other large industrial emitters reflects the protected status of the Adirondack Park and the fact that much of the region's industry lies outside the Park boundary. As discussed above, opportunities to mitigate emissions from industry are probably rather limited, as there is not a large amount of industry, and the largest emitter already has an active program of biofuels and energy efficiency initiatives.

Forests provide significant sequestration and storage of carbon in the Park. Annually, the above ground forest in the park sequesters approximately 600,000 carbon dioxide equivalent (CO2e) metric tons per year, which is 28% of the Parks total emissions. Belowground soil sequestration is also expected to be important but could not be estimated due to lack of available data to do so. Additionally, the Park forests store approximately 242,600,000 metric tons CO2e, or approximately 113 times the annual emissions of the park (including belowground storage). Significant research is needed in order to better understand the carbon flux and storage by forests and other ecosystems within the Park.

Wastewater and solid waste are modest sources of GHG emissions for the Park. All waste from the Park is land filled or incinerated at large regional facilities outside the park, and therefore constitutes a Scope III indirect emission source. Wastewater is a much larger source than solid waste, and occurs within the Park. Fugitive methane emissions from oil, gas and mineral extraction is not a significant source within the Park.

Adirondack residents have lower GHG intensity per capita than the U.S. at large. Per capita GHG emissions were calculated for the Adirondack Park and are compared to the U.S. and a sample of other countries on Figure ES-2. These emissions do not include sequestration provided by the Park forests. The figure shows relatively low per capita emissions for the Park. This likely results from the tendency of 1) energy intensive employers to be located immediately outside the Park boundary, 2) residents to have lower incomes and therefore less energy intensive lifestyles, and 3) the relative lack of a large number of high emitting industrial emitters in the region (both within and outside the Park). Although resident per capita emissions are less than the average for the U.S., they are significantly higher than those from most industrialized and non-industrialized countries in the world.

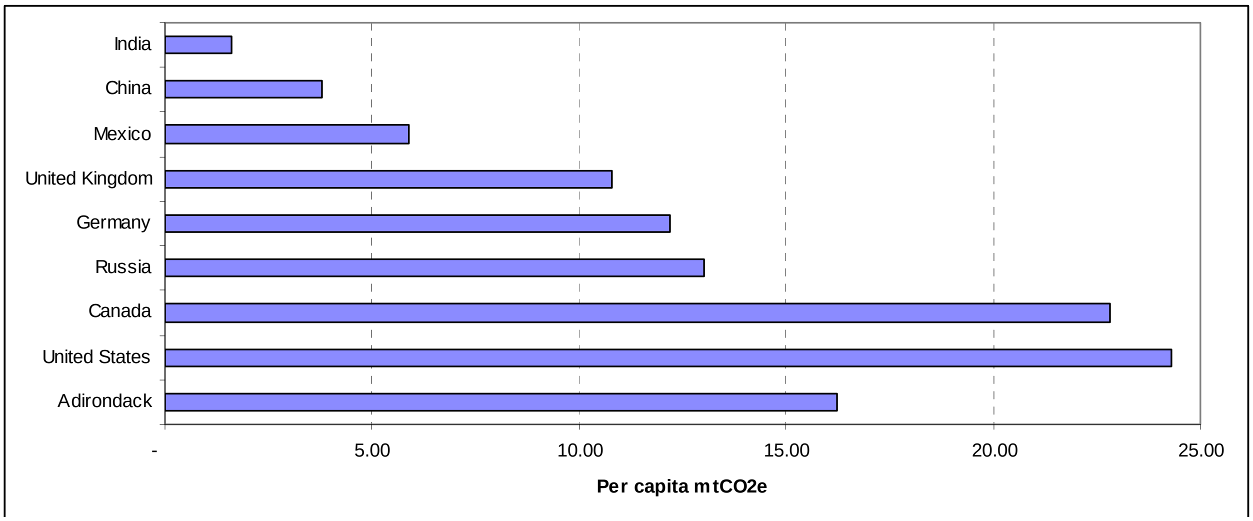

Figure 2-16 Per Capita Emissions for the Adirondacks and by Country
Source: World Resources Institute 2008.
Note: Does not include sequestered carbon.

2.9 Recommendations From the GHG Inventory

As discussed in Section 1.5 of the report, this inventory does not provide the detailed, primary fuel consumption-based, base year inventory that is desirable at the beginning of a climate action planning process. An inventory relying on national per square foot or per industrial employee energy use factors, by definition, will not capture changes in energy efficiency that do not reduce building sizes or industrial employees. This limitation aside, the inventory serves several critical intended purposes, including estimating the magnitude of emissions by source and energy type, suggesting areas ripe for mitigation, and providing an understanding of local energy use data availability. That the inventory will not readily allow for future year tracking of emissions reductions is not decisive to the overall success of the larger initiative of mitigating emissions in the Park.

There are opportunities to improve the inventory in the short term. A concerted community effort to reach out to the power utilities is likely to have success, especially if local government leaders work to achieve greater transparency. With a Governor sympathetic to this issue, and with a new state Office of Climate Change, those people in the community with access to these levels of state government may be able to support greater transparency from New York's power utilities.

Access to bulk fuel data will be more challenging to improve, given the more distributed nature of this business. One possibility for obtaining this data is the recent EPA Proposed Mandatory GHG Reporting Rule. This will require reporting of GHG emissions by large emitters and upstream fuel suppliers for 2010 emissions in 2011. Generally, there is increasing awareness, and regulatory movement, towards transparency with regards to GHG and energy consumption.

Finally, there may be opportunities to improve the inventory using local energy use surveys. The Adirondack Association of Towns and Villages (AATV) has undertaken a broad and ambitious survey of local governments that may be useful for improving the inventory. A local and periodic survey of building energy intensity could dramatically improve the inventory, and allow the inventory to capture the reductions in emissions resulting from the projects actions.

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