January 20, 2010

2009 Connecticut GHG Inventory Update

1.0 Introduction:

Public Act 08-98[1], An Act Concerning Connecticut Global Warming Solutions (GWSA) established mandatory greenhouse gas (GHG) emission reduction requirements (Table 1). The mandatory reduction targets are 10% below 1990 levels by 2020 and 80% below 2001 levels by 2050. Although not part of the GWSA, the 2005 Connecticut Climate Change Action Plan (CCAP) contains a short term goal of returning to 1990 GHG emission levels by 2010. The GWSA also directed the Department of Environmental Protection (DEP) to publish an inventory of GHG emissions and establish a baseline for the GHG emission reductions required by the GWSA. In accordance with the GWSA, the DEP entered into a contract with Northeast States for Coordinated Air Use Management (NESCAUM) to examine previous approaches utilized by DEP in preparing the 2003 and 2006 GHG Inventories, to evaluate current GHG inventory approaches and methodologies utilized within the region and nationally and to determine if any changes or improvements were necessary to the DEP's methodologies.

NESCAUM assessed Connecticut's GHG inventory needs in the context of data availability, existing programs, and proposed/future programs at the State, Regional, and National level. As a result of their review, NESCAUM found a lack of common "bottom-up[2]" approaches in the Northeast region, and widespread adoption of "top-down"[3] tools such as the State Inventory Tool (SIT) developed by the Environmental Protection Agency (EPA). NESCAUM validated DEP's approach to developing a GHG inventory and recommended DEP continue development of a "top-down" inventory based on the EPA SIT. In addition, NESCAUM identified several areas where more specific data could be developed, however this data reflected a small portion of overall GHG emissions in Connecticut. NESCAUM's final report is contained in Appendix C.

1.1 Overview

This inventory quantifies anthropogenic GHG emissions from within the borders of the State of Connecticut. The GHG's of interest are Carbon Dioxide (CO_2), Methane (CH4), Nitrous Oxide (N2O), Hydrofluorocarbons (HFC), Perfluorocarbons (PFC), and Sulfur Hexafluoride (SF6). Approximately 90% of all anthropogenic GHG emissions in Connecticut (CO_2, CH4, and N2O) are the result of fossil fuel combustion, related to transportation, space heating and electricity generation.

[1] Section (3) of the GWSA amended section 22a-200b(a) of the general statutes as follows: "The Commissioner of Environmental Protection shall, with the advice and assistance of a nonprofit association organized to provide scientific, technical, analytical and policy support to the air quality and climate programs of northeastern states: (1) Not later than December 1, 2009, publish an inventory of greenhouse gas emissions to establish a baseline for such emissions for the state and publish a summary of greenhouse gas emission reduction strategies on the Department of Environmental Protection's Internet web site"…

[2] A "bottom-up" approach to data collection is based on data collected from individual sources.

[3] A "top-down" approach to data collection is based on large scale consumption data.

The remaining 10% of anthropogenic GHG emissions in Connecticut (HFC, PFC, and SF6) are fluorinated compounds used in industrial processes.

Table 1 below contains a summary of Connecticut's annual GHG emissions for 2007 and establishes base year emissions for 1990 and the mid-term target of 2020 as required by the GWSA. Although not part of the GWSA, the 2005 CCAP contained a short-term goal of returning to 1990 emissions by 2010. As of 2007, Connecticut GHG emissions exceeded 1990 base year emissions by 4%. Part of this overage is attributable to changes in methodologies, such as increased use and reporting of Hydrofluorocarbons (HFC) following widespread adoption of the *Montreal Protocol on Substances That Deplete the Ozone Layer* beginning in 1996.

Table 1 – Summary of Connecticut GHG Annual Emissions and Targets

Greenhouse Gas Emissions/Targets	MMTCO2e
1990 Gross GHG Emissions	44.30
2020 Target (10% Below 1990)	39.90
2001 Gross GHG Emissions	46.50
2050 Target (80% Below 2001)	9.30
2007 gross GHG Emissions	46.10
2005 CCAP 2010 Goal	44.30

While the bulk of the inventory is complete between 1990 and 2007, several sections of the United States Environmental protection Agency's (EPA) State Inventory Tool (SIT) have not been updated past 2006. Gross GHG data is analyzed through the 1990 to 2006 time period only, while fossil fuel combustion data through 2007 is used where appropriate. The DEP expects data completeness issues to be resolved by mid 2010.

1.2 Methodology

Emissions inventories can be developed by direct measurement of emissions from point sources, or by analysis of activity data. In the case of GHG emissions there is a lack of direct GHG emissions monitoring, but there is reliable indicators of activity (such as, fuel use, and industrial and agricultural activity) that has been collected in a consistent manner. Many States, including Connecticut, have utilized the SIT to generate inventories of annual GHG emissions. EPA created the SIT to assist states in developing consistent and accurate assessments of their GHG emissions. The SIT is one of a class of inventory tools utilizing a "top down" methodology, which is based on large scale consumption data. The top-down approach provides a high degree of coverage of GHG emissions activity, but contains limited "bottom up" data (individual sources). While Connecticut continues to develop "bottom up" data for sources participating in permit and tracking programs, the data is not of sufficient quantity to develop a comprehensive GHG inventory for Connecticut.

The SIT provides an overview of GHG emissions both as a statewide gross emissions, statewide net emissions, and emissions on a sector-by-sector basis, beginning in 1990 through the year of latest data availability (typically 2007). Data sources for the SIT include the United States Energy Information Administration (EIA), United States Department of Energy (DOE), United States Department of Agriculture (USDA), United States Department of Transportation (USDOT), Connecticut Department of Transportation (CTDOT), and United States Census Bureau. These sources provide annual data of high quality, resulting in a consistent methodology for GHG and activity calculations. Statewide net GHG emissions are derived from the combination of all emissions and all GHG sinks (activity associated with GHG uptake). Land Use Change and Forestry (LUCF), owing to the various methods used to estimate aforestation, deforestation, agricultural land use, and land use conversion, is generally believed to be a source of GHG uptake, a "sink" of greenhouse gases, and results in a lower net GHG emissions if factored in to the total.

This inventory addresses gross GHG emissions, CO_2 from fossil fuel combustion (CO2FFC). LUCF data is addressed separately (Section 3.5). Figures 6 through 19 are available in Appendix A. A tabular summary of the annual data for gross GHG emissions and emissions from fossil fuel combustion is available in Appendix B.

1.3 Measurement

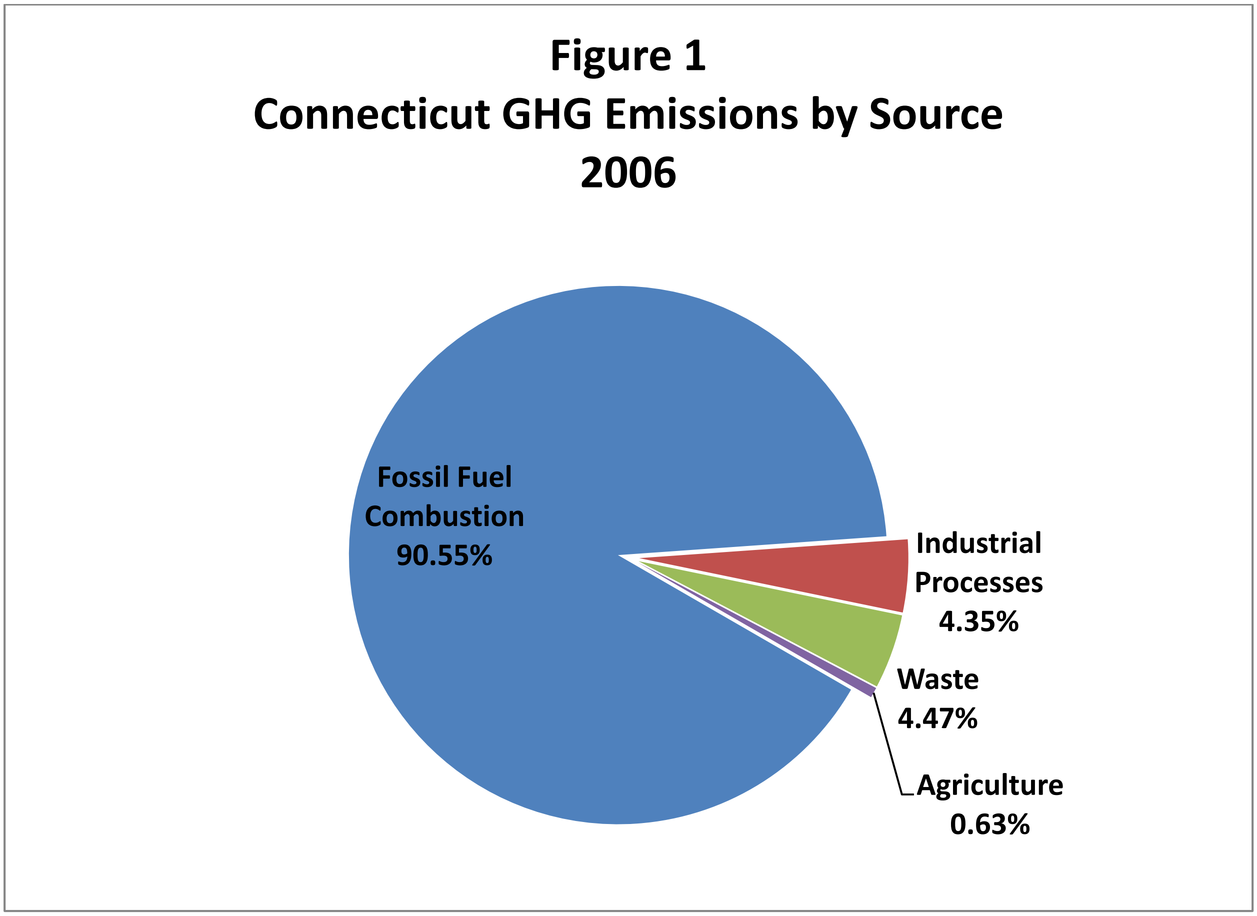
Greenhouse gas emissions are expressed in units of Carbon Dioxide (CO_2), or Carbon Dioxide Equivalent (CO2e). GHG emissions are measured based on a variety of activity data, and the activity is converted to a GHG emission total through the use of Emission Factors. These factors convert quantities of fuel use, energy generation, energy consumption, or other activity data into an equivalent CO_2 emissions level expressed in metric tons (1000 kilograms, or 2,204 pounds). Non-CO_2 GHGs have been assigned Global Warming Potential (GWP) values, expressed by equivalent quantities of CO_2 (CO2e). For example, one metric ton of Methane (CH4), with a GWP of 21, is equivalent to 21 metric tons of CO2e. Much of the data in this report is expressed as Million Metric Tons of CO_2 (MMTCO2) or Million Metric Tons of CO_2 Equivalent (MMTCO2e).

2.0 Statewide Emissions 1990 – 2007

Connecticut's statewide GHG emissions are linked to energy consumption. Carbon dioxide (CO_2) emissions related to the combustion of fossil fuels make up approximately 92% of overall statewide GHG emissions (see Figure 1). These GHG emissions are derived from combined fossil fuel consumption in the Residential, Commercial, Industrial, Transportation and Electric Power Generation sectors (Figure 3, Figure 4).

Table 2: Global Warming Potentials

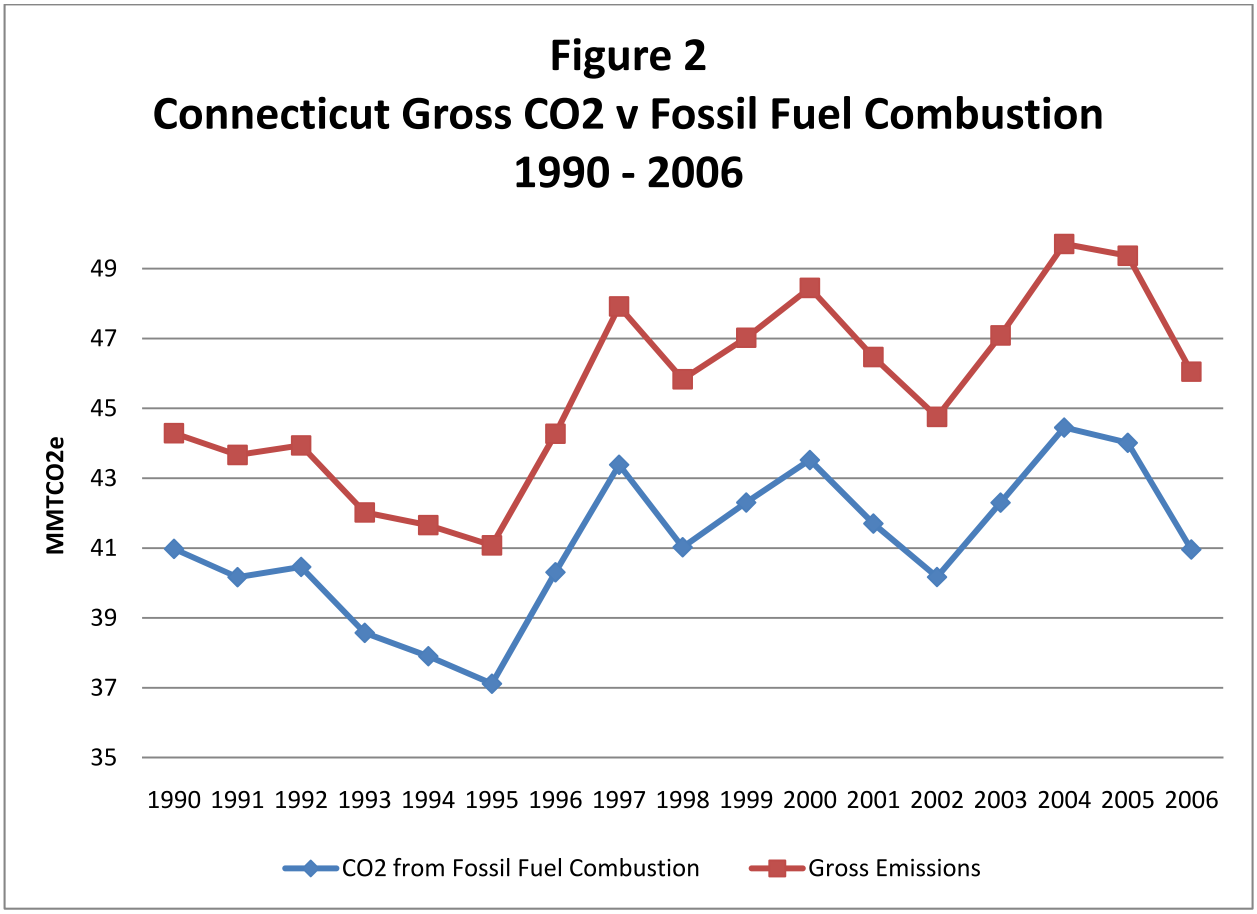
Greenhouse Gas (GHG)	Global Warming Potential (GWP)
Carbon Dioxide (CO_2)	1
Methane (CH_4)	21
Nitrous Oxide (N_2O)	310
Hydrofluorocarbons (HFCs)	140 – 11,700
Perfluorocarbons (PFCs)	6,500 - 9,200
Sulfur Hexafluoride (SF_6)	23,900



2.1 Baseline Conditions

The GWSA requires that DEP utilize 1990 as the base year from which to identify required emission reduction targets. As such, a 1990 baseline is central to Connecticut's GHG inventory process. While 1990 is a baseline year for Connecticut and many other GHG Inventory programs, the 1990 base year does not hold any programmatic significance. According to the most recent version of the EPA SIT (September 2009) Connecticut's gross GHG emissions for 1990 was 44.3 MMTCO2e. In 2006, the last year for which complete SIT data is available, the total has increased to 46.1 MMTCO2e (Figure 2). In 2007, emissions from fossil fuel combustion have returned to the 1990 level of 41 MMTCO2e. 2006 Emissions from the Industrial Processes and Waste sectors (Figures 14 and 15) have increased[4] from 1.9 to 4.1 MMTCO2e (an increase of 115% as compared to the 1990 base year).

[4] The increase in Industrial Sector emissions could be related to improved reporting and/or the shift in use from stratospheric ozone depleting substances (ODS) to ODS-substitutes. Improved reporting could result in a larger presence of related data sources used in the SIT, and a larger contribution to gross GHG emissions in Connecticut. Furthermore, the transition to ODS substitutes involved greater use of compounds with higher GWP than the replaced substances.



3.0 Sector Summaries

The EPA SIT attributes GHG emissions based on the type of activity and the emissions related to that activity (Figure 3). Each activity type falls under a broad "sector." The sector divisions used in this report are: Electric Power, Transportation, Residential, Industrial and Commercial, and land Use Change/Forestry (LUCF).

Figure 3
ConnecticutFossil Fuel Combustion CO2 by Sector
1990 - 2007

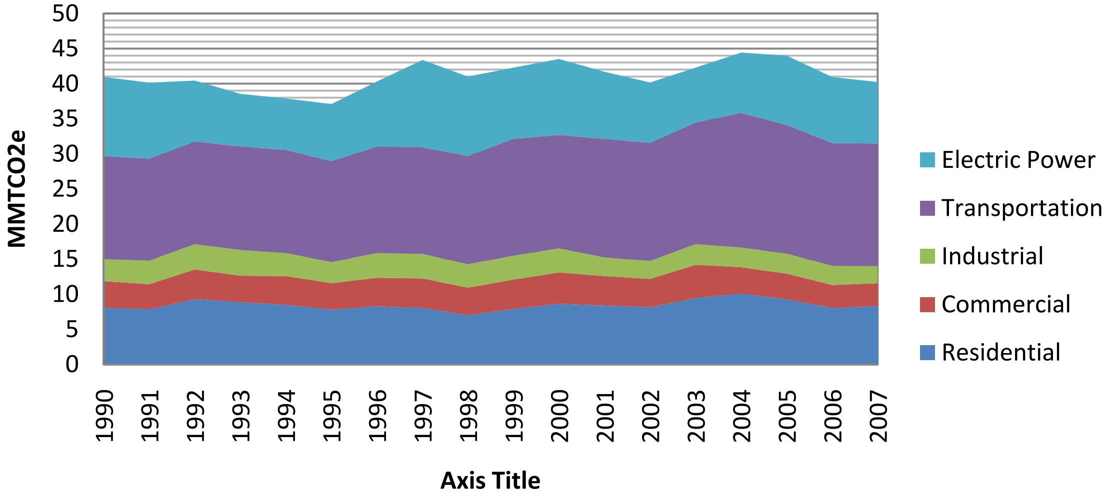
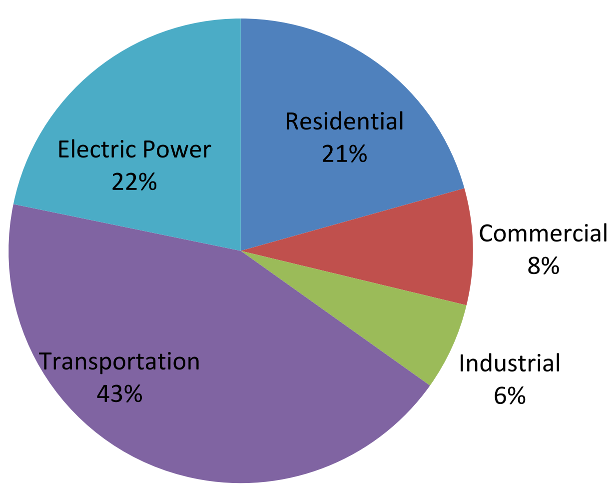


Figure 4
Connecticut CO2 from Fossil Fuel Combustion
2007



3.1 Electric Power Sector: 22 % of 2007 Connecticut GHG emissions

GHG emissions from electric power generation (Figure 6, Figure 7)[5] in Connecticut are directly related to the type and quantity of fuel burned by electricity generating units. Since Connecticut is part of the regional power grid controlled by ISO-NE, these emissions are also dependent the dispatch of generating units located in all 6 NE states.

The reliable operation of the New England electricity grid requires the dispatch of EGUs as directed by ISO-NE. Given that electricity may be imported into or exported from Connecticut, EGU related emissions may not correspond completely to the amount of power consumed in Connecticut. The GHG data for Connecticut is based on reported fuel consumption as monitored by the United States Department of Energy (DOE) and the United States Energy Information Administration (EIA). Fossil fuel comprises only a portion of the electricity generated in Connecticut and within the ISO New England region. In addition, Nuclear and Hydroelectric power contributed approximately 25.2% of the total capacity in the region in 2009.

3.2 Transportation Sector: 43 % of 2007 Connecticut GHG emissions

Gasoline and diesel fuel consumption accounts for the bulk of transportation related emissions noted in Figure 8. Emissions of CO_2 are directly related to the quantity of fuel consumed, while N2O and CH4 emissions are more variable due to the use of control technology. The trend of increased CO2 emissions (increased consumption of fossil fuel) in the transportation sector follows a similar increase in motor vehicle use (Figure 9) as measured in Vehicle Miles Traveled (VMT). Fuel consumption data from 2005 through 2007 indicates a reduction in motor vehicle use, while the VMT estimates (Connecticut Department of Transportation) show a level or slightly increasing use pattern. At the present time the disparity exists in the most recent data and may be subject to revision in future releases of VMT or fuel consumption data. The DEP hopes to verify or reconcile this disparity as better data becomes available.

3.3 Residential Sector: 21 % of 2007 Connecticut GHG emissions

GHG emissions from residential activity are largely related to space heating. Connecticut relies heavily on heating oil, with about half of Connecticut households using it as their primary source of heating fuel. Natural gas and electricity make up 44%, and small amounts of propane, and other fuels comprise the balance (2000 Census data). Figure 10 shows the proportion of Connecticut's Residential CO2 emissions by fuel used. Petroleum fuel consumption contributes approximately 75% of the CO2 emissions from the residential sector, with Natural Gas accountable for the remainder, and trace amounts of coal reported as used in residential applications. Figure 11 illustrates N2O and CH4 emissions from residential sources. These are based on combustion byproducts and account for approximately 1% of overall residential CO2e emissions.

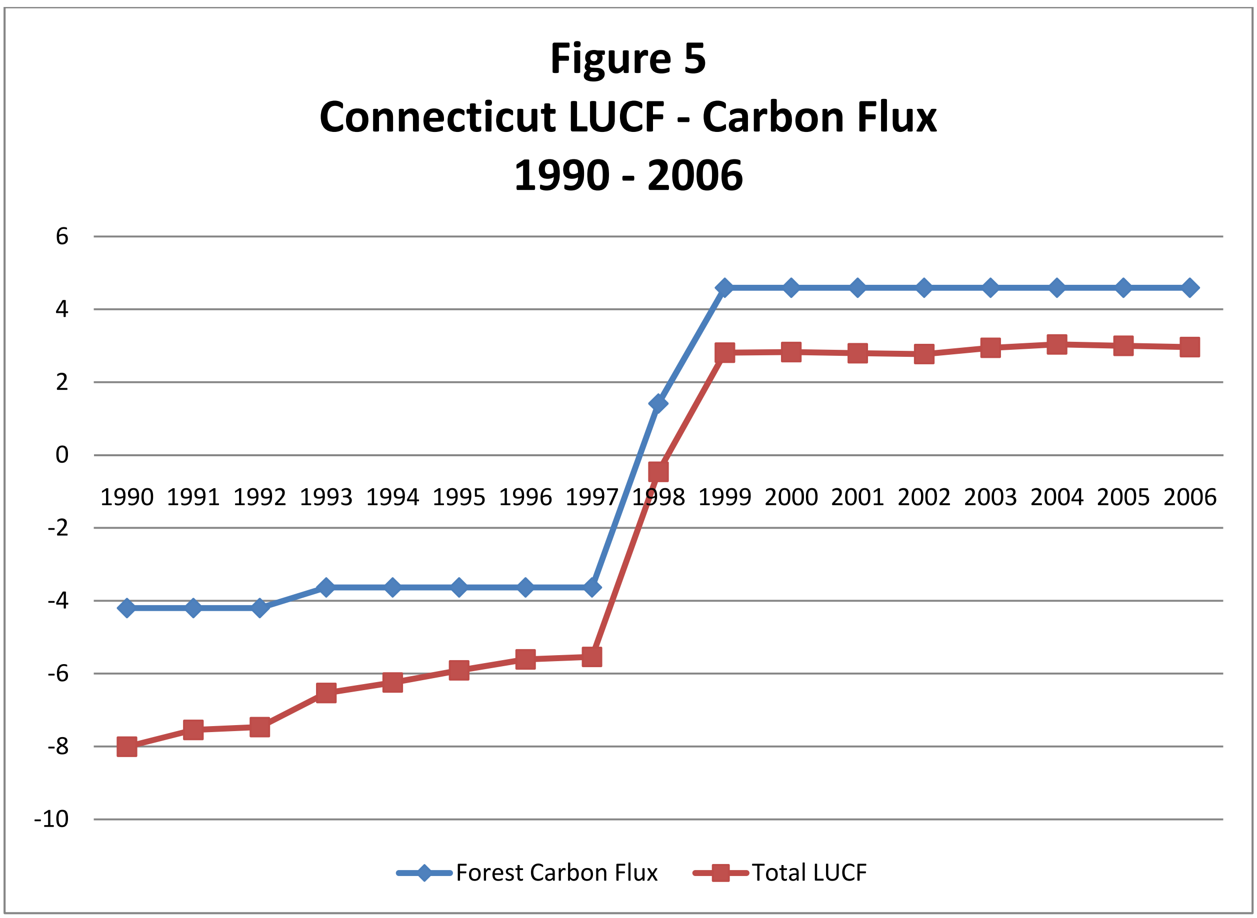
[5] In 1997 Connecticut's in-State nuclear generation dropped to zero due to a plant shutdown at Millstone Units 1-3 and Connecticut Yankee. The missing electric power was partially compensated by increased operation of fossil-fuel powered generators. This resulted in increased GHG emissions from the electric power sector

3.4 Industrial/Commercial Sector: 14 % of 2007 Connecticut GHG emissions

The industrial sector generates GHG emissions from activities such as fossil fuel combustion, space heating, loss of HFC and PFC compounds, consumption of SF6, and methane emissions from waste treatment. GHG emissions related to electricity use are not considered as they are accounted for by the generation facility. On-site electricity generation is accounted for as a fuel consumption process and is not considered in this section.

GHG Emissions from the Industrial and Commercial sectors are illustrated in Figures 12 through 17 in Appendix A.

While the data shows no significant increase in emissions from the Industrial and Commercial sector, Industrial Process emissions have increased from less than 0.5 MMTCO2e prior to 1997, to greater than 2.0 in 2004 to 2006. This increase may be due to an increase in the use of HFCs and PFCs in place of Freon and other Ozone Depleting Substances (ODS) following widespread adoption of the Montreal Protocol on Ozone Depleting Substances in the mid-1990s.



3.5 Land Use Change/Forestry Sector: 0% of 2007 Connecticut GHG emissions

Land Use Change and Forestry (LUCF) is the only sector that is capable of negative GHG emissions (it can be a GHG sink rather than a GHG source). In addition to GHG emissions from fertilizer use, tillage, and composting, LUCF includes aforestation and other changes in land use that result in CO_2 uptake and storage. The effect can be an overall net negative CO_2 emissions rate for this sector. While the impact of this sector on Statewide emissions has the potential to account for as much as 10% of the total Connecticut GHG Inventory, the available data is of lower quality than comparable data on fuel consumption or industrial processes.

Changes in methodology and reporting between 1997 and 1999 created a significant change in the data, which result in net GHG emissions data from this source category. Figure 16 illustrates the effects of changing methodologies in the SIT with regard to forest carbon flux. With no known causal change in actual conditions to accompany it, the change from 1997 to 1999 (over 200% increase) is indicative of a change in source data or methodology as opposed to an actual increase in LUCF related GHG emissions. No event or series of events can explain the shift from a steady state of sequestration to a steady state of net emissions increase over such a short period of time. Based in large part on this historical dichotomy, NESCAUM identified the Land Use and Forestry sector as an area where significant improvements to the SIT can be made as part of a State or Regional effort.

Appendix A – Connecticut 2009 Greenhouse Gas Inventory Data Graphics

Index to Figures

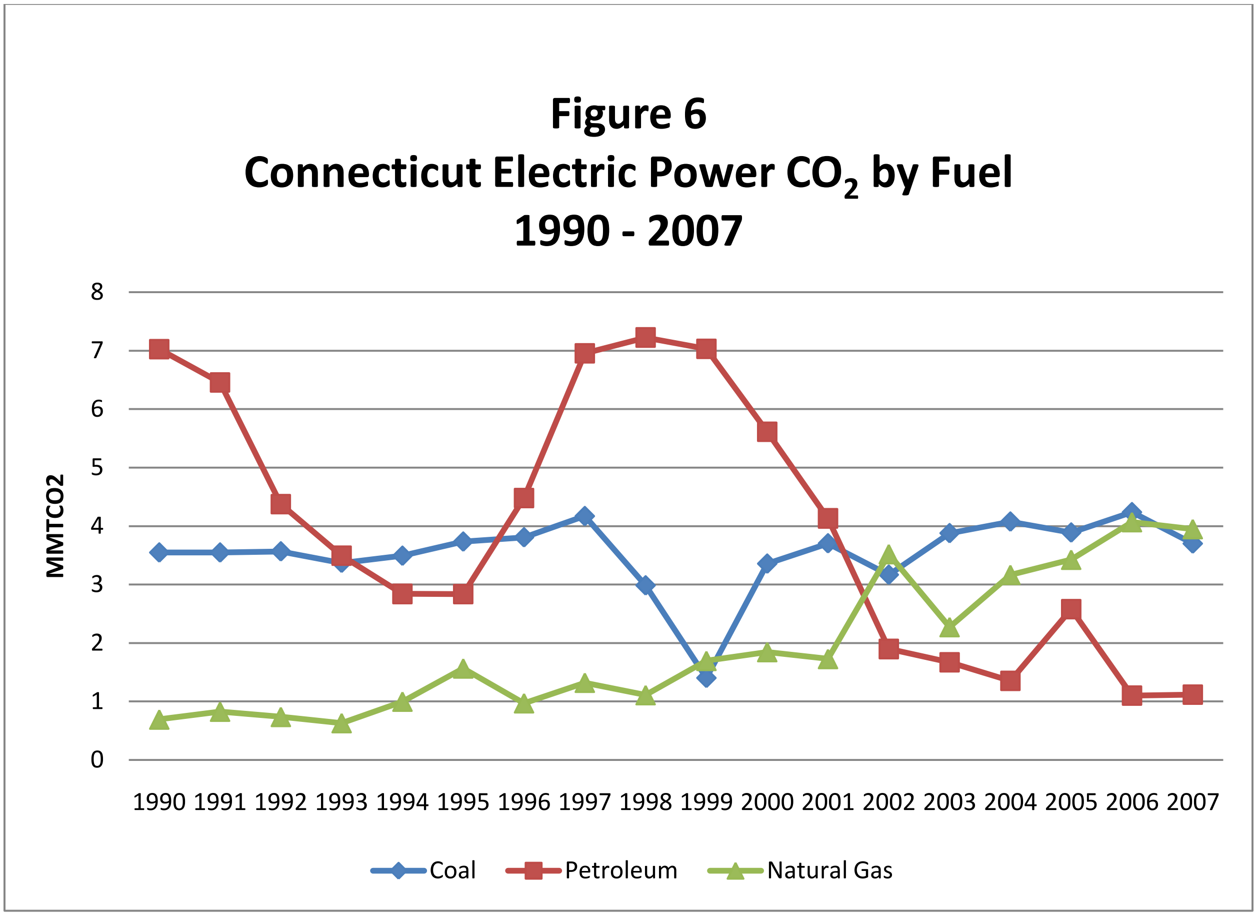


Figure 6
Connecticut Electric Power CO_2 by Fuel
1990 - 2007
MMTCO2
0
1
2
3
4
5
6
7
8
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007
Coal
Petroleum
Natural Gas

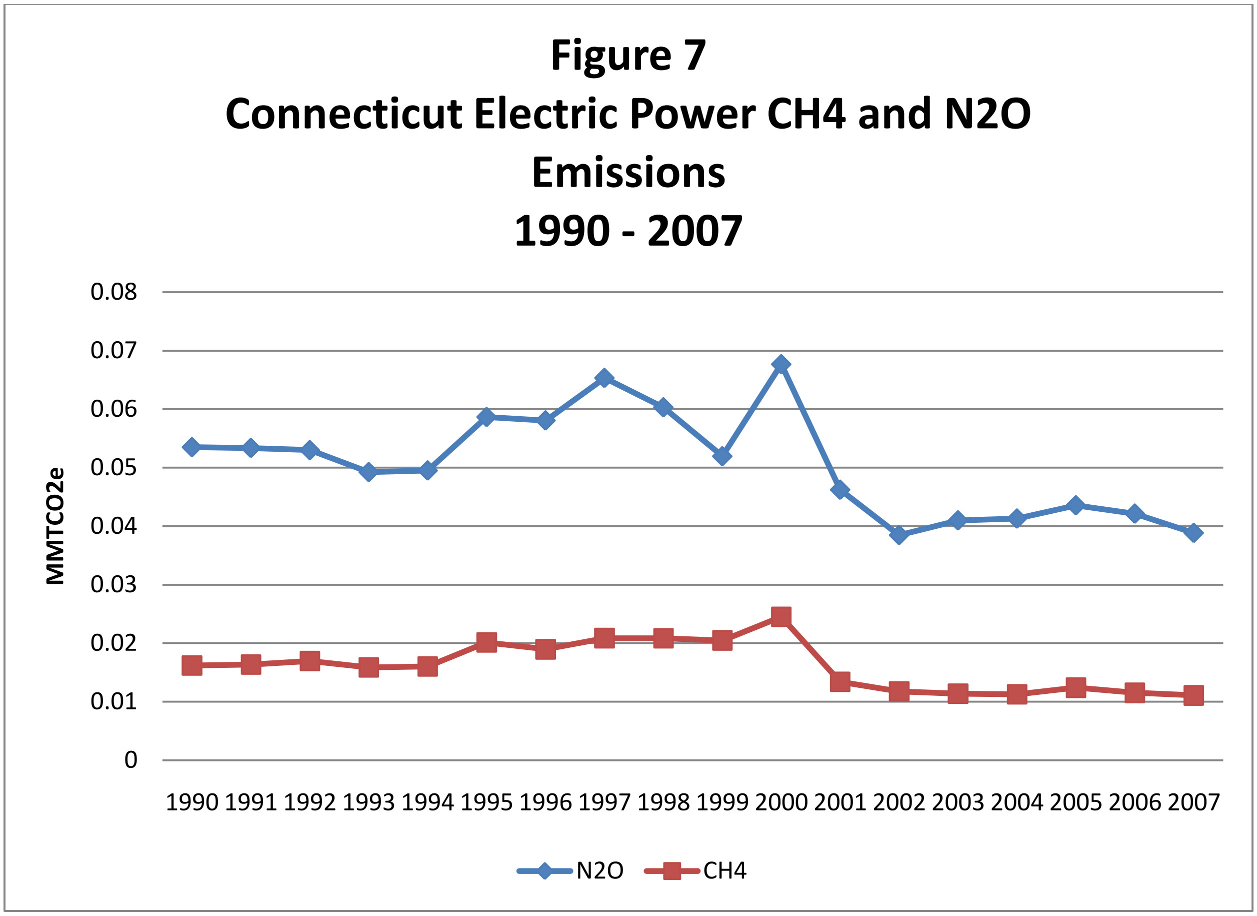


Figure 7
Connecticut Electric Power CH4 and N2O Emissions
1990 - 2007
MMTCO2e
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007
N2O
CH4

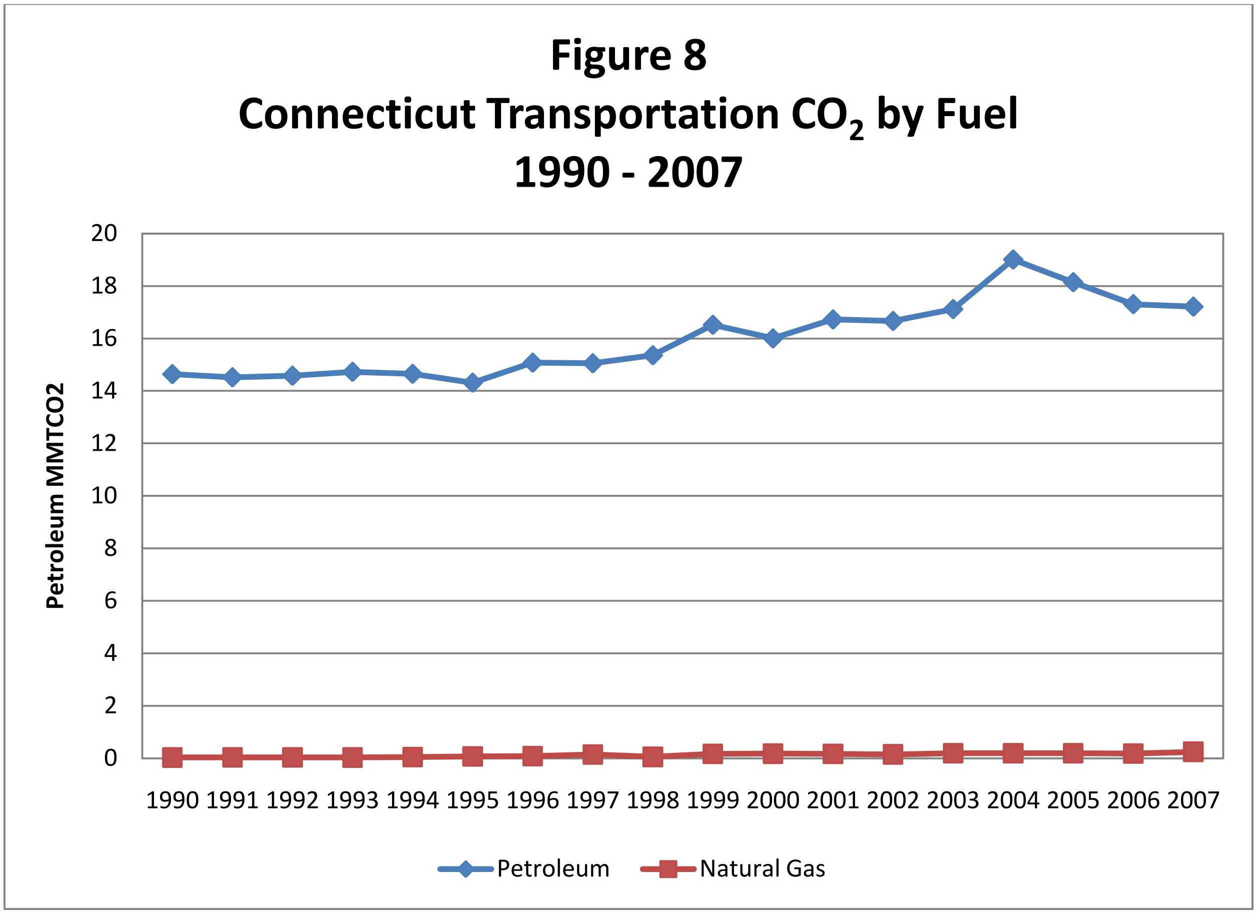
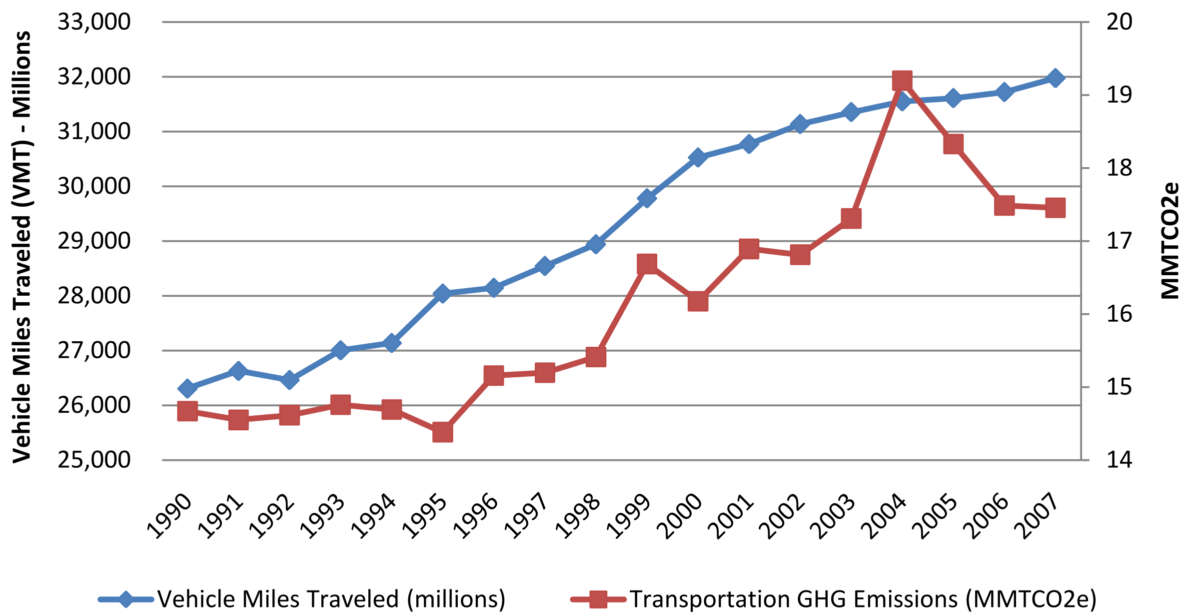


Figure 8
Connecticut Transportation CO2 by Fuel
1990 - 2007
Petroleum MMTCO2
20
18
16
14
12
10
8
6
4
2
0
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007
Petroleum
Natural Gas

Figure 9
Connecticut Vehicle Miles Traveled vs GHG Emissions
1990 - 2007



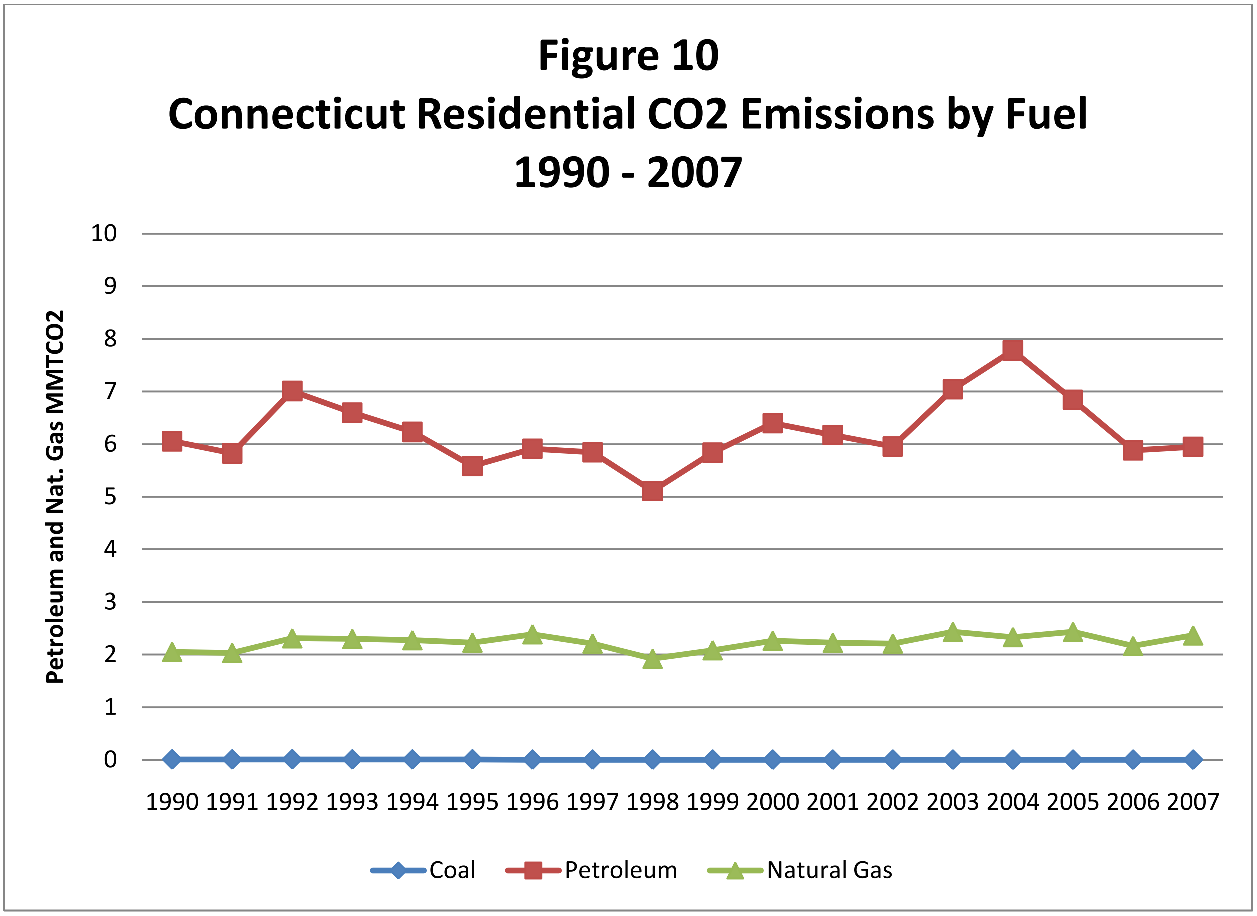


Figure 10
Connecticut Residential CO2 Emissions by Fuel
1990 - 2007
Petroleum and Nat. Gas MMTCO2
10
9
8
7
6
5
4
3
2
1
0
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007
Coal
Petroleum
Natural Gas

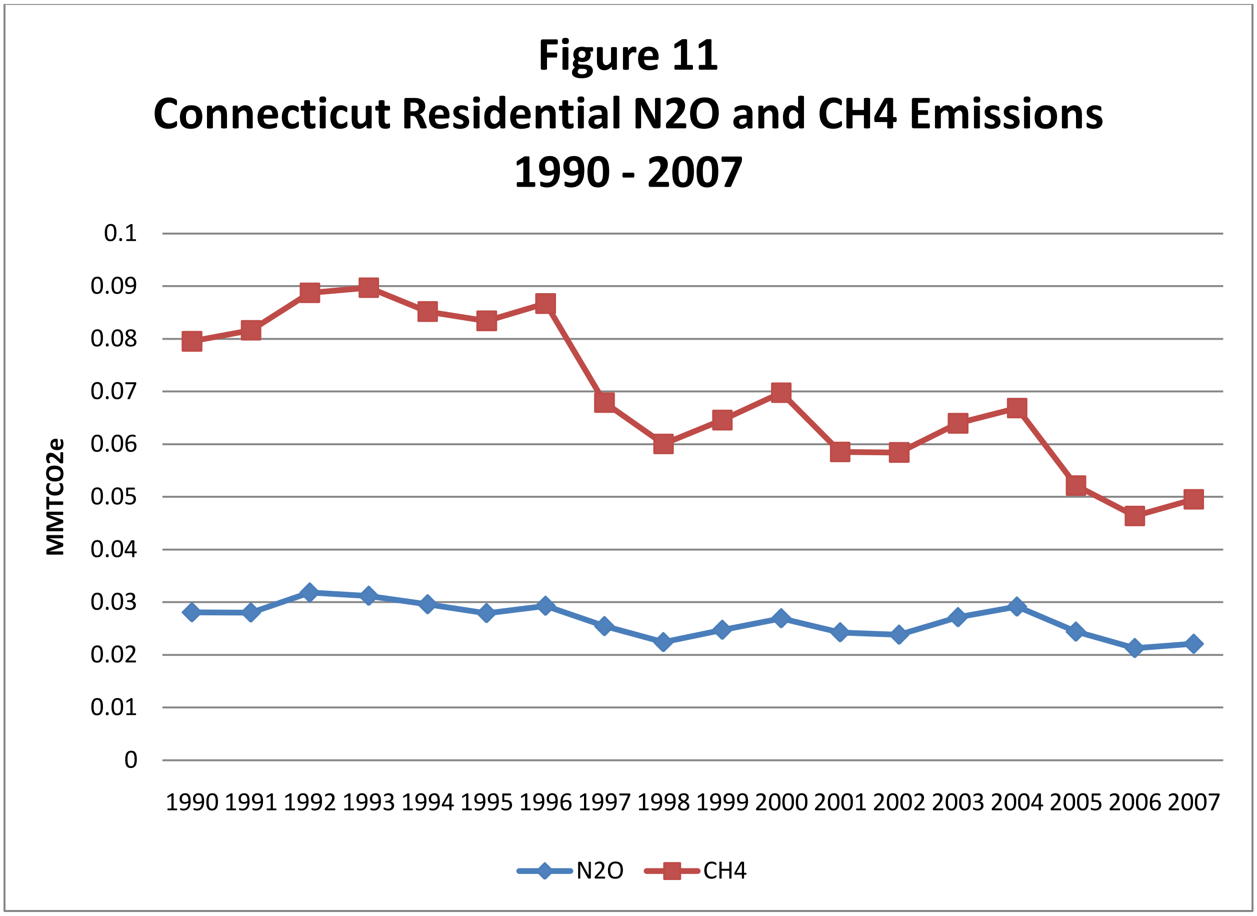


Figure 11
Connecticut Residential N2O and CH4 Emissions
1990 - 2007
MMTCO2e
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007
N2O
CH4

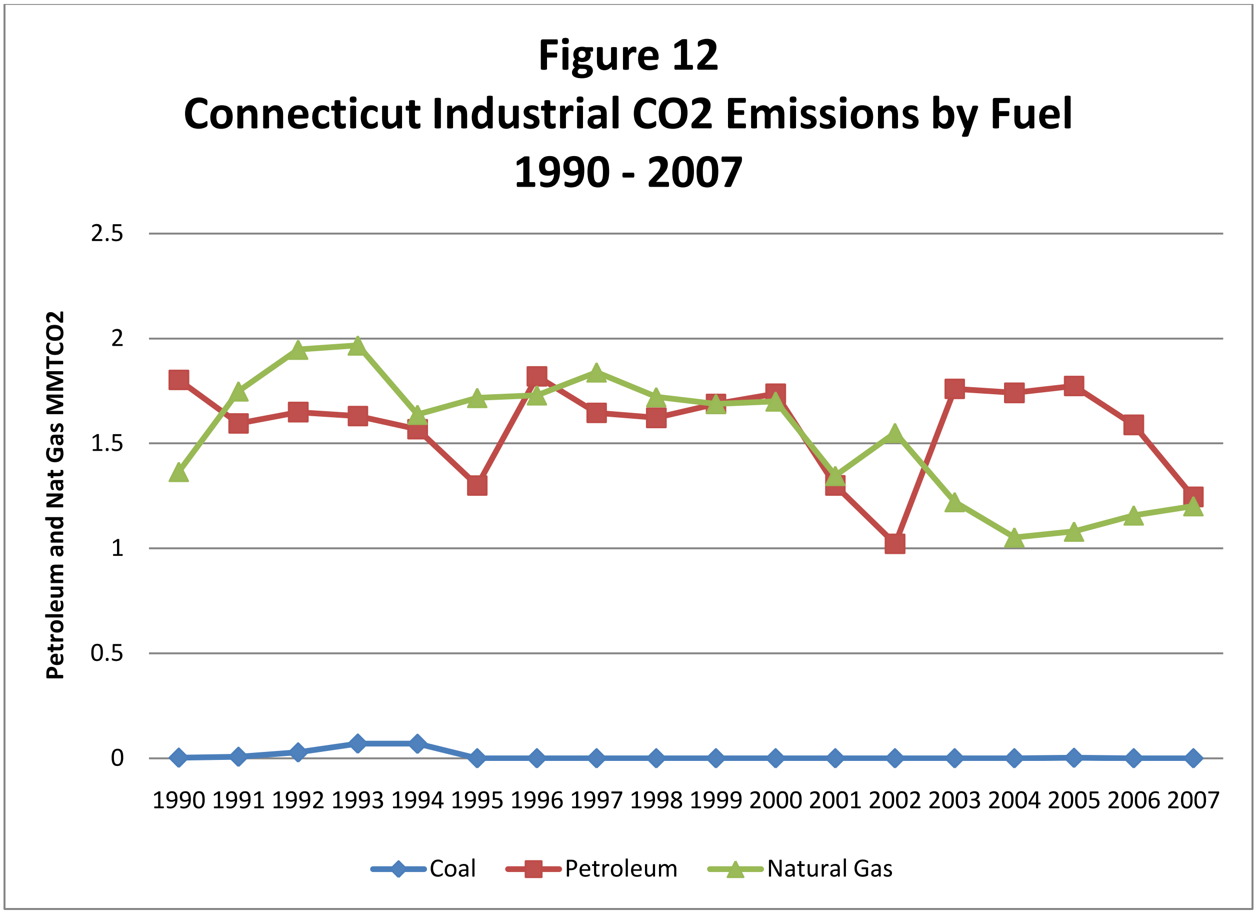


Figure 12
Connecticut Industrial CO2 Emissions by Fuel
1990 - 2007
Petroleum and Nat Gas MMTCO2
2.5
2
1.5
1
0.5
0
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007
Coal
Petroleum
Natural Gas

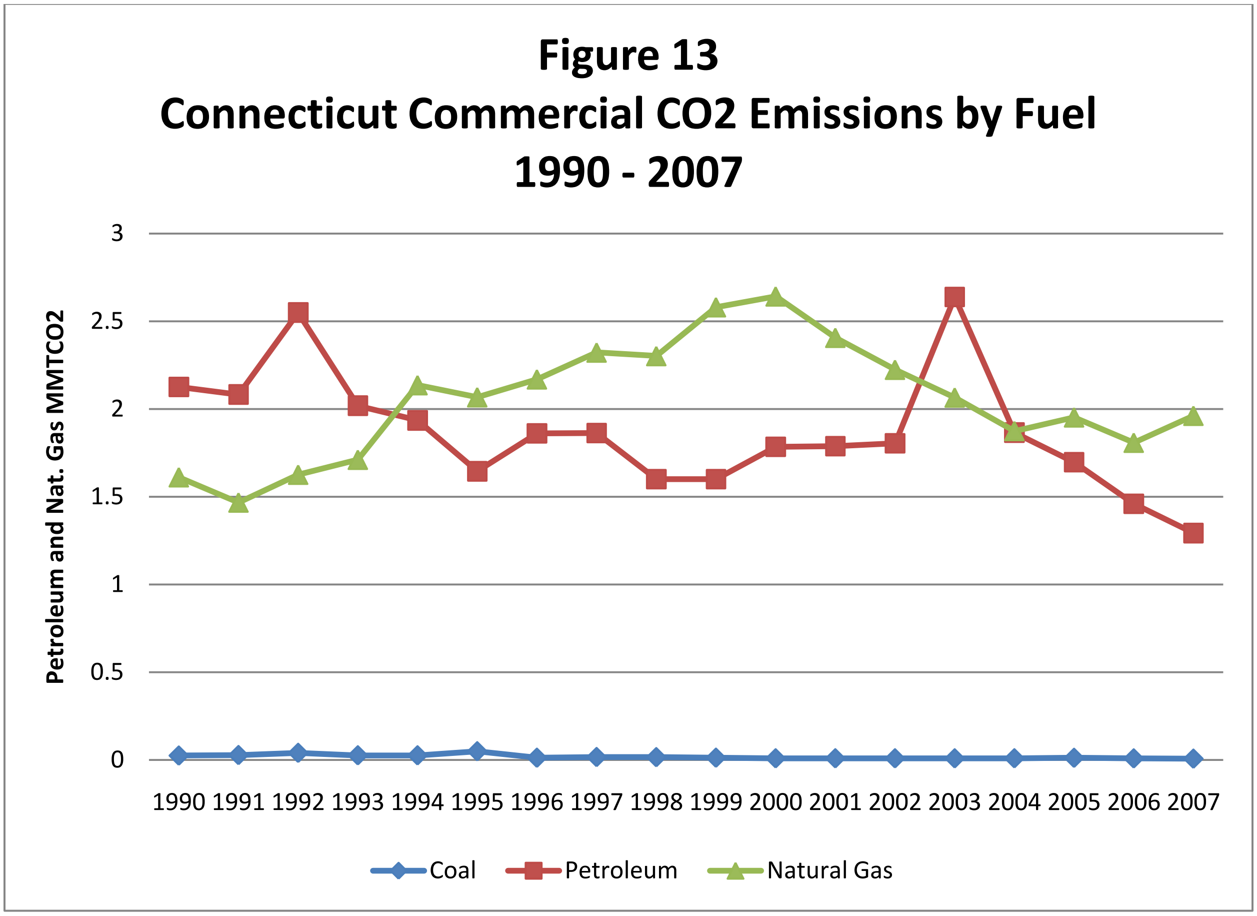


Figure 13
Connecticut Commercial CO2 Emissions by Fuel
1990 - 2007
Petroleum and Nat. Gas MMTCO2
3
2.5
2
1.5
1
0.5
0
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007
Coal
Petroleum
Natural Gas

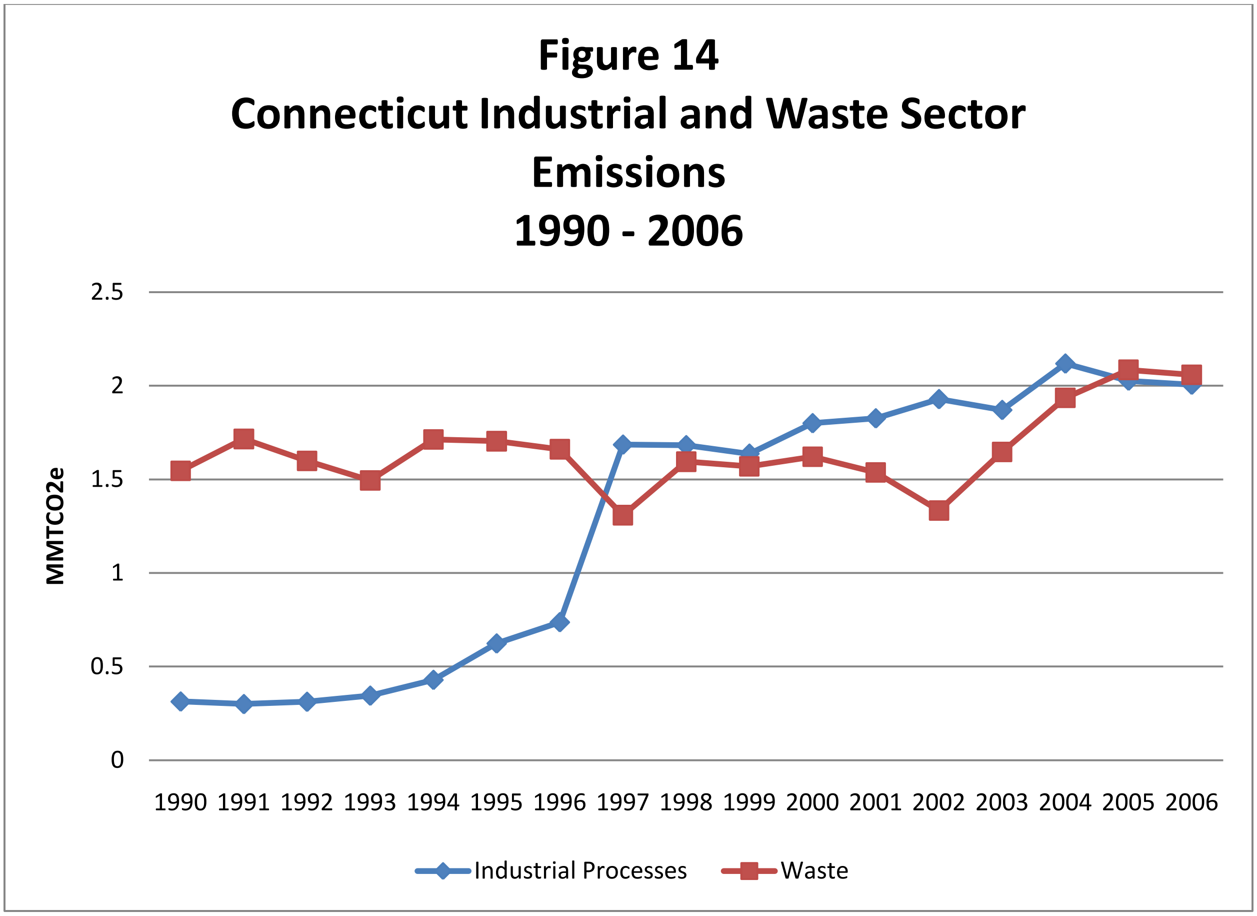


Figure 14
Connecticut Industrial and Waste Sector Emissions
1990 - 2006
MMTCO2e
2.5
2
1.5
1
0.5
0
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006
Industrial Processes
Waste

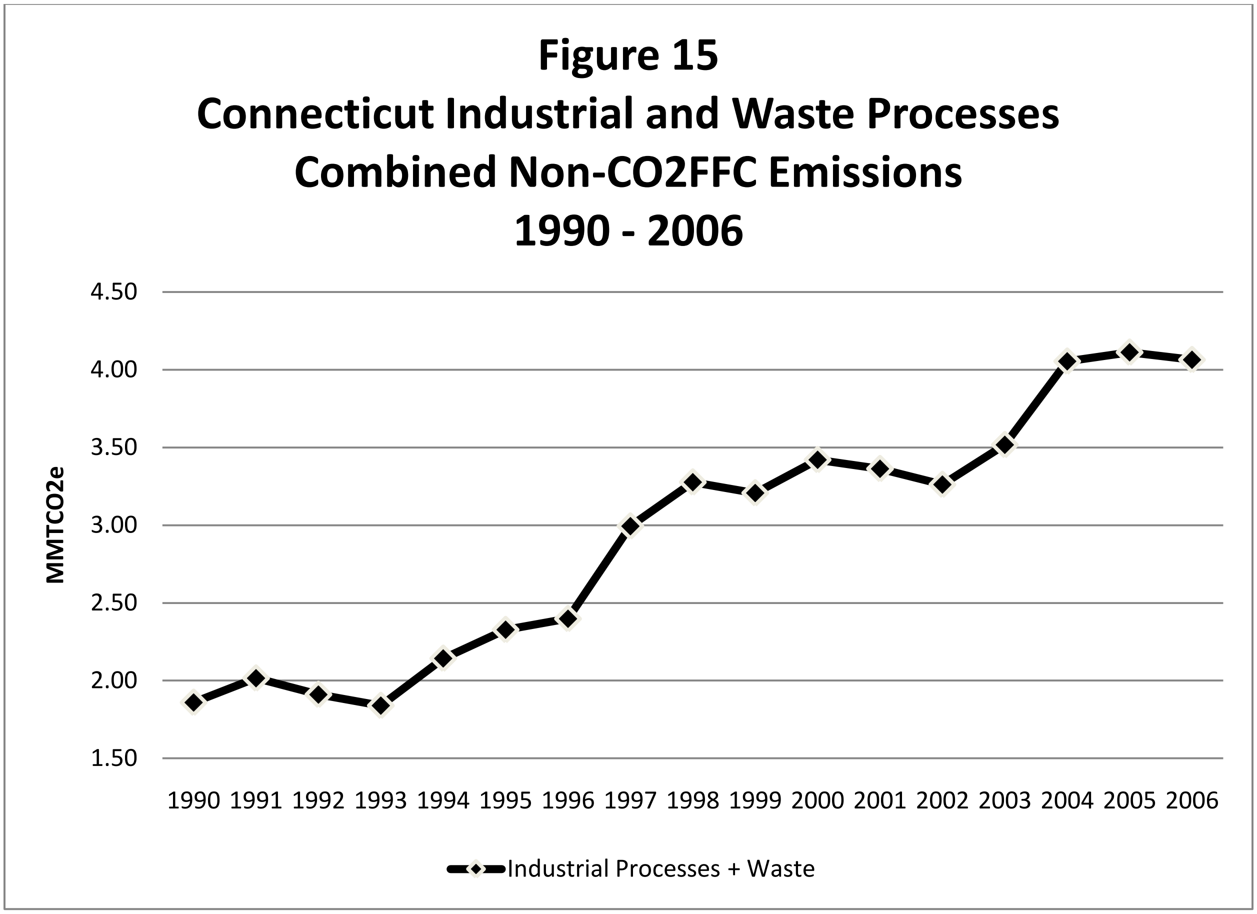


Figure 15
Connecticut Industrial and Waste Processes
Combined Non-CO2FFC Emissions
1990 - 2006
MMTCO2e
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006
Industrial Processes + Waste

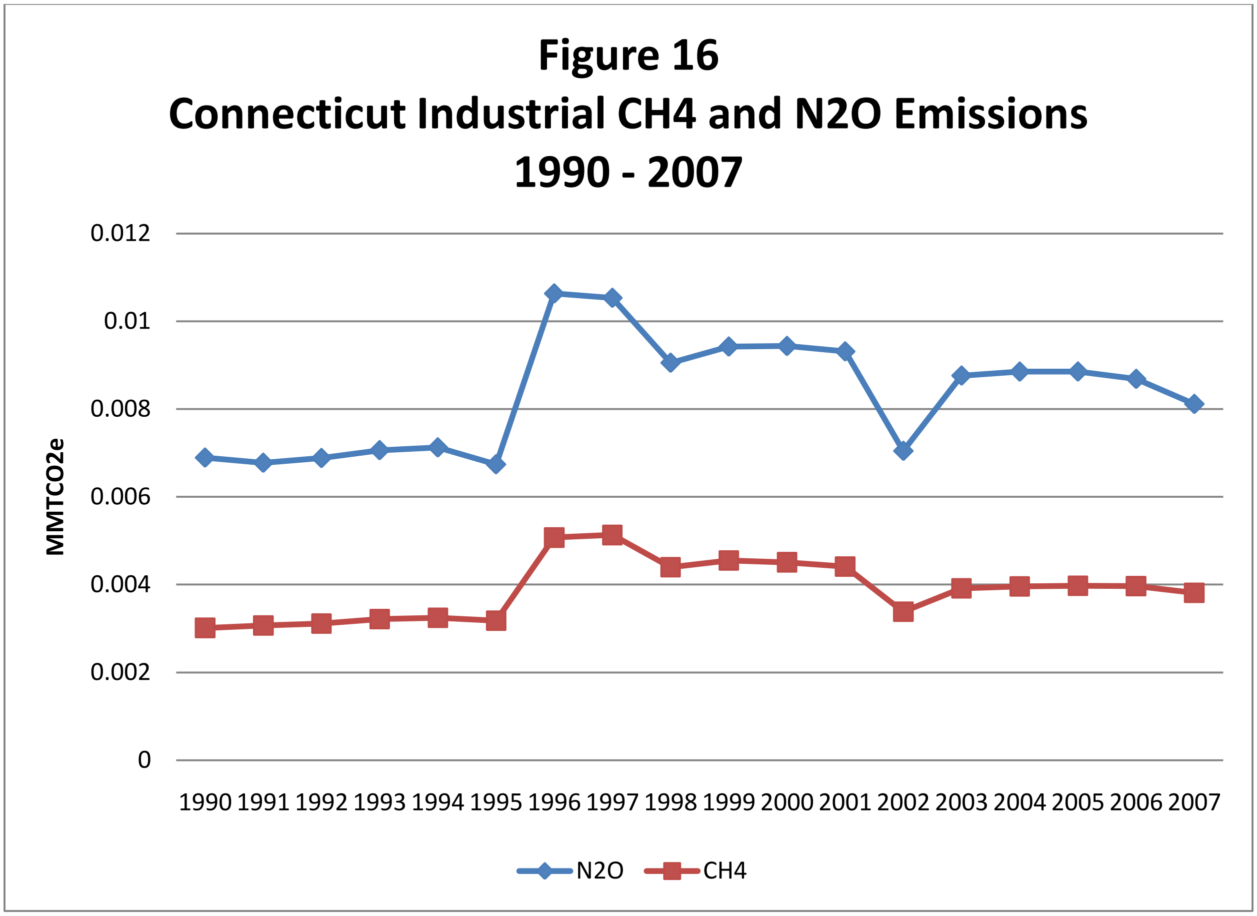


Figure 16
Connecticut Industrial CH4 and N2O Emissions
1990 - 2007
MMTCO2e
0.012
0.01
0.008
0.006
0.004
0.002
0
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007
N2O
CH4

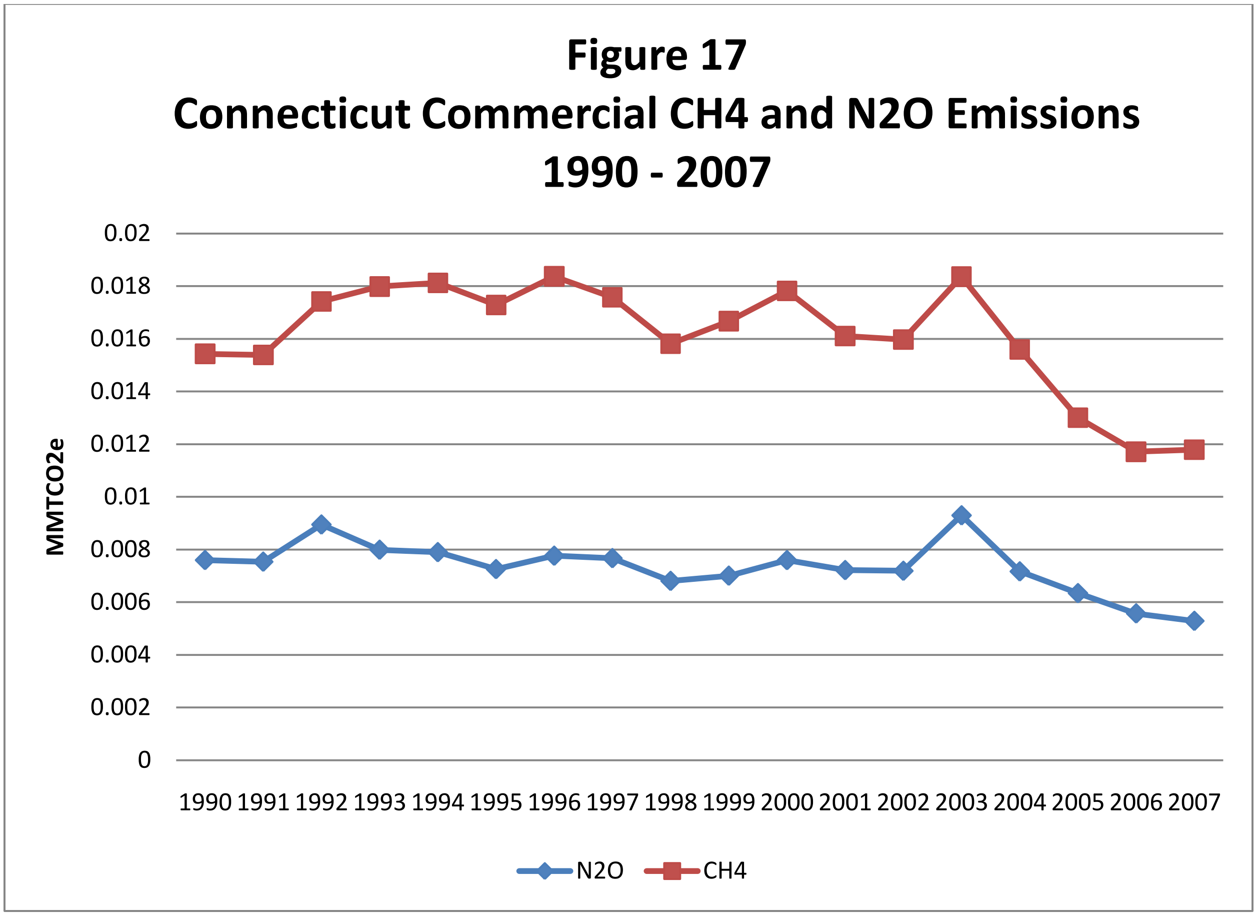


Figure 17
Connecticut Commercial CH4 and N2O Emissions
1990 - 2007
MMTCO2e
0.02
0.018
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007
N2O
CH4

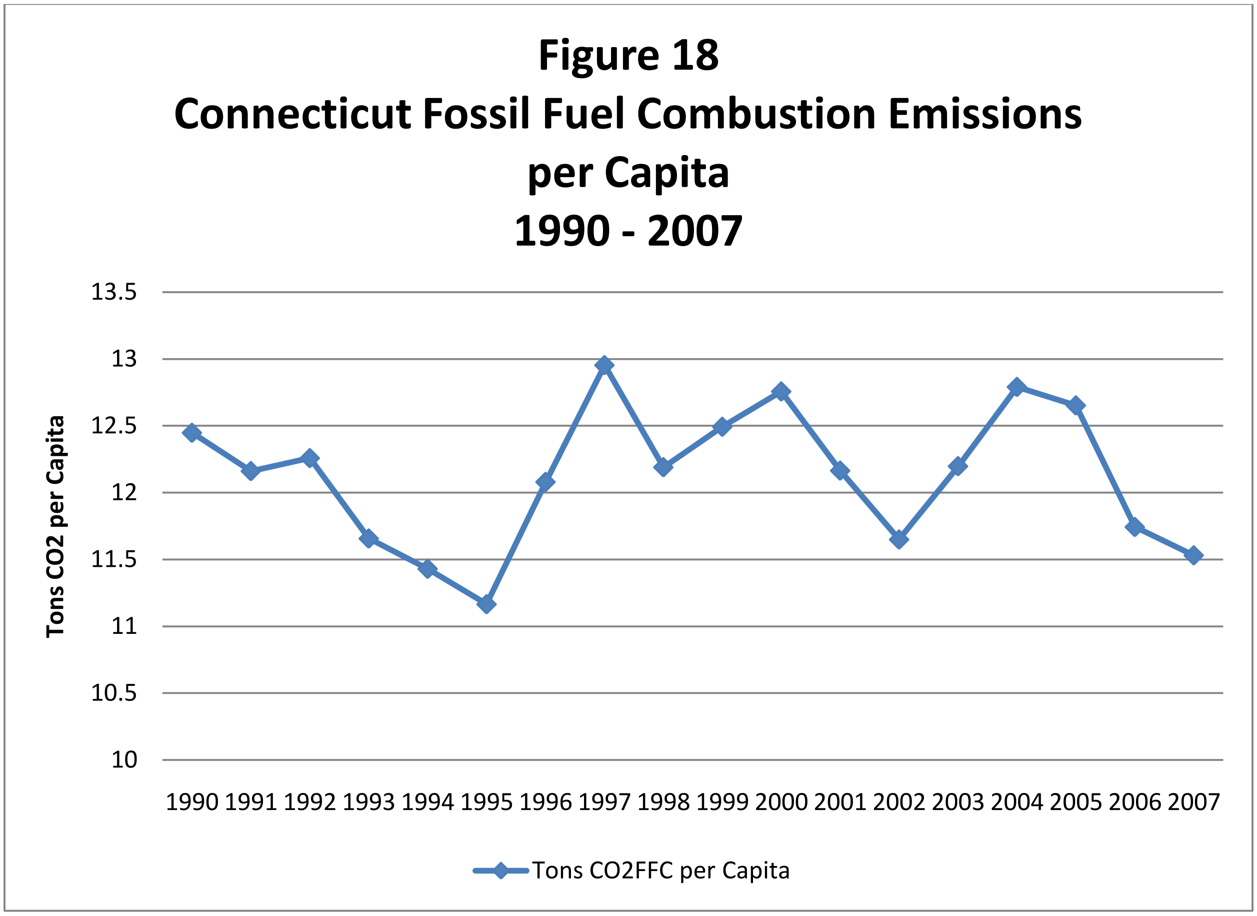


Figure 18
Connecticut Fossil Fuel Combustion Emissions per Capita
1990 - 2007
Tons CO2 per Capita
13.5
13
12.5
12
11.5
11
10.5
10
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007
Tons CO2FFC per Capita

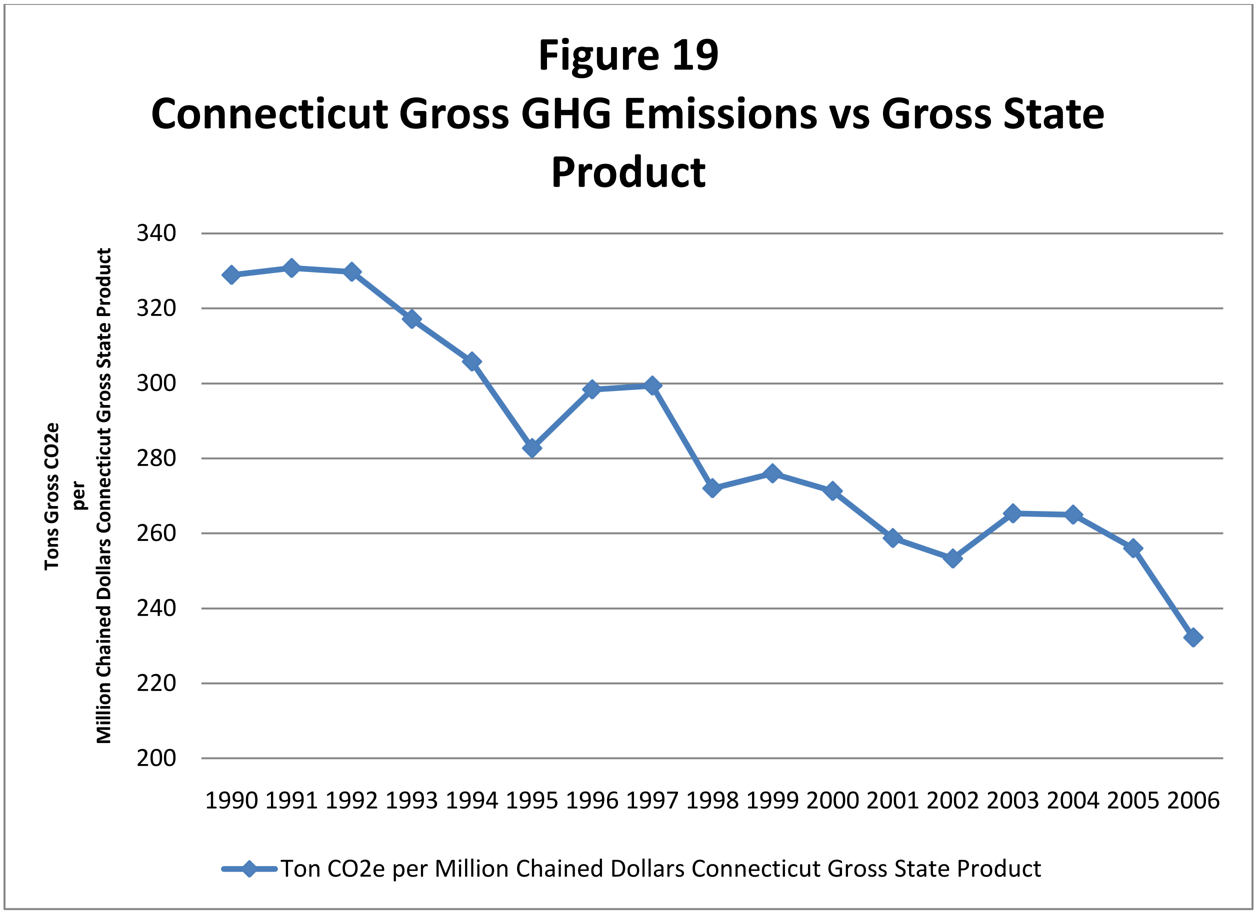


Figure 19
Connecticut Gross GHG Emissions vs Gross State Product
Tons Gross CO2e per Million Chained Dollars Connecticut Gross State Product
340
320
300
280
260
240
220
200
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006
Ton CO2e per Million Chained Dollars Connecticut Gross State Product

Appendix B – Connecticut 2009 Greenhouse Gas Inventory Data Graphics

Table 1

Connecticut Greenhouse Gas Emissions 1990 – 2007 – Million Metric Tons Carbon Dioxide Equivalent

Emissions (MMTCO2E)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Energy	42.090	41.326	41.651	39.797	39.126	38.369	41.559	44.616	42.232	43.477	44.704	42.775	41.143	43.236	45.333	44.825	41.698
CO2 from Fossil Fuel Combustion	40.978	40.169	40.463	38.576	37.906	37.118	40.308	43.387	41.026	42.306	43.523	41.704	40.172	42.302	44.452	44.015	40.960
Stationary Combustion	0.210	0.212	0.227	0.222	0.217	0.225	0.235	0.220	0.200	0.199	0.228	0.179	0.166	0.184	0.184	0.165	0.151
Mobile Combustion	0.902	0.945	0.961	0.999	1.003	1.027	1.016	1.009	1.007	0.972	0.953	0.892	0.805	0.750	0.696	0.645	0.587
Industrial Processes	0.313	0.300	0.312	0.345	0.429	0.624	0.737	1.685	1.682	1.637	1.800	1.826	1.928	1.870	2.118	2.027	2.005
Agriculture	0.340	0.325	0.379	0.384	0.390	0.383	0.316	0.308	0.326	0.337	0.325	0.332	0.352	0.334	0.319	0.433	0.288
Enteric Fermentation	0.137	0.134	0.134	0.131	0.131	0.131	0.120	0.116	0.120	0.117	0.118	0.112	0.109	0.103	0.099	0.100	0.095
Manure Management	0.046	0.046	0.070	0.071	0.071	0.069	0.045	0.043	0.047	0.047	0.045	0.045	0.044	0.042	0.040	0.102	0.041
Agricultural Soil Management	0.157	0.145	0.175	0.182	0.188	0.183	0.151	0.148	0.159	0.172	0.162	0.174	0.199	0.188	0.180	0.232	0.152
Waste	1.546	1.716	1.599	1.495	1.714	1.704	1.661	1.309	1.594	1.570	1.621	1.537	1.333	1.647	1.936	2.085	2.059
Municipal Solid Waste	1.235	1.404	1.286	1.183	1.401	1.393	1.349	0.997	1.282	1.255	1.292	1.205	1.001	1.312	1.599	1.747	1.720
Wastewater	0.311	0.312	0.312	0.312	0.313	0.311	0.312	0.312	0.313	0.315	0.329	0.333	0.332	0.335	0.337	0.338	0.339
Gross Emissions	44.290	43.667	43.940	42.021	41.659	41.080	44.273	47.918	45.835	47.022	48.450	46.470	44.757	47.087	49.706	49.370	46.051

Table 2

Connecticut Greenhouse Gas Emissions from Fossil Fuel Combustion 1990 – 2007 – Million Metric Tons Carbon Dioxide Equivalent

MMTCO2E	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Residential	8.113	7.863	9.328	8.901	8.511	7.819	8.301	8.059	7.033	7.921	8.663	8.399	8.165	9.476	10.116	9.276	8.046	8.315
Coal	0.006	0.006	0.009	0.006	0.005	0.007	0.002	0.002	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Petroleum	6.056	5.825	7.009	6.597	6.232	5.583	5.913	5.847	5.109	5.837	6.397	6.173	5.953	7.043	7.782	6.843	5.882	5.949
Natural Gas	2.051	2.032	2.310	2.298	2.274	2.228	2.386	2.210	1.921	2.082	2.264	2.225	2.210	2.432	2.332	2.431	2.163	2.364
Commercial	3.761	3.577	4.216	3.756	4.098	3.762	4.043	4.201	3.918	4.194	4.436	4.204	4.038	4.714	3.750	3.661	3.277	3.262
Coal	0.025	0.028	0.041	0.026	0.026	0.050	0.012	0.016	0.016	0.013	0.009	0.009	0.009	0.009	0.009	0.012	0.009	0.007
Petroleum	2.126	2.083	2.550	2.019	1.935	1.645	1.861	1.863	1.600	1.600	1.784	1.788	1.804	2.639	1.866	1.697	1.460	1.293
Natural Gas	1.611	1.467	1.626	1.711	2.136	2.068	2.170	2.323	2.302	2.581	2.643	2.407	2.224	2.066	1.875	1.953	1.808	1.962
Industrial	3.170	3.350	3.624	3.668	3.274	3.016	3.549	3.484	3.343	3.377	3.437	2.646	2.572	2.981	2.794	2.856	2.746	2.446
Coal	0.003	0.007	0.028	0.070	0.069	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.000
Petroleum	1.802	1.595	1.649	1.630	1.568	1.299	1.819	1.645	1.622	1.689	1.736	1.300	1.021	1.760	1.741	1.773	1.588	1.245
Natural Gas	1.365	1.749	1.947	1.967	1.637	1.718	1.730	1.839	1.721	1.689	1.701	1.346	1.551	1.221	1.053	1.080	1.158	1.202
Transportation	14.670	14.549	14.615	14.757	14.693	14.382	15.157	15.196	15.412	16.685	16.173	16.892	16.812	17.308	19.197	18.328	17.488	17.456
Petroleum	14.643	14.521	14.581	14.730	14.653	14.317	15.078	15.056	15.362	16.519	16.002	16.724	16.666	17.118	19.008	18.141	17.307	17.213
Natural Gas	0.027	0.029	0.033	0.027	0.040	0.065	0.079	0.140	0.050	0.166	0.172	0.168	0.146	0.190	0.189	0.187	0.180	0.243
Electric Power	11.264	10.829	8.680	7.495	7.331	8.138	9.258	12.446	11.320	10.129	10.814	9.564	8.585	7.823	8.596	9.894	9.405	8.766
Coal	3.547	3.547	3.566	3.370	3.492	3.734	3.807	4.170	2.984	1.401	3.356	3.704	3.167	3.878	4.076	3.888	4.237	3.700
Petroleum	7.024	6.455	4.376	3.493	2.840	2.838	4.480	6.953	7.225	7.032	5.611	4.132	1.897	1.672	1.354	2.580	1.099	1.117
Natural Gas	0.693	0.828	0.738	0.632	0.999	1.566	0.972	1.322	1.110	1.696	1.846	1.728	3.521	2.274	3.167	3.425	4.068	3.949
TOTAL	40.978	40.169	40.463	38.576	37.906	37.118	40.308	43.387	41.026	42.306	43.523	41.704	40.172	42.302	44.452	44.015	40.960	40.244
Coal	3.581	3.587	3.644	3.472	3.591	3.791	3.821	4.188	3.002	1.416	3.367	3.714	3.177	3.888	4.086	3.903	4.246	3.708
Petroleum	31.651	30.478	30.165	28.469	27.228	25.682	29.151	31.364	30.918	32.676	31.531	30.116	27.342	30.232	31.750	31.035	27.336	26.817
Natural Gas	5.747	6.104	6.654	6.635	7.087	7.645	7.337	7.835	7.106	8.214	8.626	7.873	9.653	8.182	8.616	9.077	9.377	9.719

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Arthur N. Marin, Executive Director

Appendix C

Memorandum

Date: June 17, 2009

To: Tracy Babbidge, Paul Farrell

From: Paul Miller

Re: NESCAUM Findings and Recommendations for CT GHG Inventory

Please find attached three memos describing NESCAUM's initial findings and recommendations for greenhouse gas (GHG) inventory development in Connecticut (CT). In brief, some of our key findings and recommendations drawn from the attached memos are:

- CT DEP's current approach in developing its GHG emissions inventory remains valid and is consistent with EPA's State Inventory Tool (SIT) and approaches taken by other states in the Northeast.
- Most of the NESCAUM states have "top-down" GHG inventories developed using EPA's SIT or its predecessor Emissions Inventory Improvement Program (EIIP) (Volume 8 guidance).
- There has been limited development (hence common methodologies) of "bottom-up" GHG inventories among the NESCAUM states. Therefore, CT in many cases may need to break new ground in developing methods for a bottom-up GHG inventory approach that, through regional cooperation, could be followed in other states of the region.
- In 2006, the SIT approach indicates that almost 90% of CT's CO_2-equivalent GHG inventory is composed of carbon dioxide CO_2 from fossil fuel combustion. The remaining 10% is split among sources of methane (CH_4), nitrous oxide (N_2O), and the other non-CO_2 GHGs.
- Based on CT's 2006 SIT GHG inventory, NESCAUM recommends in light of limited resources that CT's initial steps for a bottom-up inventory focus on CO_2 emissions from fossil fuel combustion, and, where readily available source-specific data are lacking, rely on SIT top-down methods for the non-CO_2 emissions as a placeholder until future refinements can be made.
- NESCAUM finds that that in CT's 2006 SIT GHG inventory, the largest CO_2 source sectors are transportation with 44% of total CO_2 emissions, electric power generation at 23%, residential 19%, commercial 8%, and industrial 6%.
- There are several potential methods to estimate GHG emissions from different transportation sectors (highway vehicles, construction and farm equipment, locomotives, marine vessels, and aviation) that could form the basis of a regionally consistent approach. These methods are described in the first accompanying memo.
- Electricity power generators report CO_2 emissions through EPA's Emissions Tracking System/Continuous Emissions Monitoring (ETS/CEM) requirements. Another EPA database, eGRID, provides the same information as well as CH_4 and N_2O emissions data, and covers additional sources not part of the Clean Air Act's Acid Rain Program. These databases provide

a readily accessible, annually updated source of GHG emissions information for a significant portion of a bottom-up GHG inventory for CT.

- There are at least two levels to the type of information CT may want from the residential and commercial sectors. First, there are direct sources of GHG emissions, such as residential combustion of oil and natural gas for space heating. Second, it may be useful to try collecting non-emissions information, such as extent of weatherization, for the residential and commercial sectors to inform potential GHG reduction policy decisions.
- CT's new reporting rule for annual GHG emissions for all Title V permit holders provides a source of facility-specific emissions information. For historical emissions and non-Title V sources, information may be obtainable through a review of state air permits and other information databases to determine if fuel type and consumption are reported that can be coupled with standardized GHG emission factors for estimating source-level emissions.
- NESCAUM recommends that CT focus its efforts for the land use change and forestry (LUCF) sector on identifying new data and/or refining the underlying USFS Forest Inventory and Analysis (FIA) survey data, rather than considering any major changes to SIT methodologies.
- NESCAUM recommends that CT maintain a baseline year of 1990 for GHG emissions when referencing the goals of future climate plans and policies.

Additional detail and further recommendations are given in the accompanying attached memos.

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Arthur N. Marin, Executive Director

Memorandum

Date: April 3, 2009

To: Tracy Babbidge, Paul Farrell

From: NESCAUM

Re: Task 1 – State inventories overview and recommendations

This memo summarizes the state inventory information provided in the following attachments and summary tables and provides recommendations to CT DEP on developing a regionally consistent greenhouse gas (GHG) inventory. The attached discussion sections provide further details according to source sectors. Two summary tables at the end provide an overview of state GHG inventories in the NESCAUM region and California (Table 1) and data sources for developing a CT GHG inventory (Table 2).

Current GHG inventories in NESCAUM region and California

As a threshold matter, extensive experience is lacking among the NESCAUM states in developing bottom-up GHG inventories. Most of the NESCAUM states have used EPA's State Inventory Tool (SIT) or its predecessor Emissions Inventory Improvement Program (EIIP) (Volume 8 guidance) to develop top-down state GHG inventories (see Table 1).

According to EPA's website "Resources for Inventory Development" (http://www.epa.gov/climatechange/emissions/state_guidance.html):

> The State Inventory Tool (SIT) is an Excel-based tool that uses methods from the Intergovernmental Panel on Climate Change and the U.S. National Greenhouse Gas Inventory. The SIT updates and replaces the previously published Emissions Inventory Improvement Program (EIIP) volume 8 guidance. The tool generates a top-down estimate of greenhouse gas emissions at the U.S. state level. Estimates include direct emissions only; they do not include emissions from indirect sources such as offsite waste disposal or electricity consumption. The state inventory guidance and tool contain methods and data that are specific to U.S. states and may not be appropriate for scales other than the state-level or for countries other than the U.S.

In light of the regional reliance on SIT for state GHG inventories, CT in many cases may need to break new ground in developing methods for a bottom-up GHG inventory approach that, through regional cooperation, could be followed in other states of the region.

Common methodologies for bottom-up approach

While top-down GHG inventories across the region appear largely consistent using SIT or its predecessor EIIP, there appears to be limited development (hence common methodologies) of bottom-up GHG inventories among the NESCAUM states. New York, through work by NYSERDA, may provide some limited opportunity to adopt or adapt methods it may be developing for estimating bottom-up emissions. NYSERDA is updating New York's GHG inventory, which is a combination of bottom-up and top-down (although still largely top-down – ~90%). There is an opportunity to coordinate with NYSERDA on specific elements of a GHG inventory where emission factors and estimation methods are being applied or developed for elements of a bottom-up inventory. California, through its recent mandatory reporting rule for large facilities, may also be a source of potential methods. Aside from these two states, Connecticut is likely in the position of breaking new ground in identifying and applying methods for the region in regard to developing a bottom-up GHG inventory. As the first state to take the lead on this, it can establish the methods that other states in the region can follow.

Recommendations

The CT GHG inventory developed through SIT provides some guidance on where to focus attention in developing the beginnings of a bottom-up emissions inventory. For 2006, the SIT approach indicates that almost 90% of CT's CO_2-equivalent GHG inventory is composed of CO_2 from fossil fuel combustion. The remaining 10% is split among sources of methane (CH_4), nitrous oxide (N_2O), and the other non-CO_2 GHGs. Therefore, as an initial matter (and assuming limited resources), a first-cut bottom-up GHG inventory might want to focus on CO_2 emissions from fossil fuel combustion, and, where readily available source-specific data are lacking, rely on SIT top-down methods for the non-CO_2 emissions as a placeholder until future refinements can be made.

For fossil fuel combustion, SIT gives the largest CO_2 source sector in CT as transportation with 44% of total CO_2 emissions, followed by electric power generation at 23%, residential 19%, commercial 8%, and industrial 6%.

Transportation

There are several potential methods to estimate GHG emissions from different transportation sectors (highway vehicles, construction and farm equipment, locomotives, marine vessels, and aviation) that could form the basis of a regionally consistent approach. These methods are described in the accompanying Mobile Sources Sector discussion section, along with several recommendations for developing more refined GHG emissions information from transportation sources in CT.

Electric power generation

Power plants (as well as some large industrial boilers) subject to the Clean Air Act's acid rain provisions report CO_2 emissions through EPA's Emissions Tracking System/Continuous Emissions Monitoring (ETS/CEM) requirements. Another EPA database, eGRID, provides the same information as well as CH_4, and N_2O emissions data, and covers additional sources not part of the acid rain program. These databases provide a readily accessible, annually updated source of GHG emissions information for a significant portion of a bottom-up GHG inventory. The discussion piece on Industrial and Electric Power General Sectors provides additional detail on recommendations.

Residential and commercial

Residential and commercial GHG sources present perhaps the most labor-intensive portion of an initial bottom-up GHG inventory. There are at least two levels to the type of information CT may want from these sectors. First, there are direct sources of GHG emissions, such as residential combustion of oil and natural gas for space heating. Second, it may be useful to try collecting non-emissions information, such as extent of weatherization, for the residential and commercial sectors to inform potential GHG reduction policy decisions. For example, while power plants may directly emit GHGs associated with electrical space heating of residential and commercial structures, targeting and evaluating measures to improve the efficiency of home heating by electricity requires other types of information, such as extent of weatherization, that would not be an attribute associated with power plant emissions in a typical inventory. The ability to track the performance of weatherization and energy efficiency programs would also need this information over time in order to relate program effectiveness with changes in power plant emissions. More detailed recommendations are given in the Residential and Commercial Sectors section.

Industrial

CT's new reporting rule for annual GHG emissions for all Title V permit holders provides a source of facility-specific emissions information. For historical emissions and non-Title V sources, information may be obtainable through a review of state air permits and other information databases to determine if fuel type and consumption are reported. These data, in conjunction with standardized emission factors, such as EPA AP-42 and EIA factors, would provide a basis for estimating CO_2 fuel combustion emissions according to source type and fuel in addition to other GHG emissions. Other information databases could include compliance record keeping (including non-Title V sources) kept in EPA's Online Tracking Information System (OTIS) and Air Facility System (AFS).

Land use change and forestry

The best currently available estimates of net GHG emissions from land use change and forestry (LUCF) in Connecticut come from US EPA's State Inventory Tool (SIT). There is a significant change in the SIT's estimate of LUCF emissions for Connecticut between 1997 and 1998, showing a reversal of a forest sink of 3.6 $MMTCO_2e$ in 1997 to net forest emissions of 1.4$MMTCO_2e$ in 1998. This is significant enough a shift over a one-year interval that it appears to be a break either in the data series or the underlying methodology, which NESCAUM could investigate with the developers of EPA's SIT.

In addition, NESCAUM can investigate the availability of additional state-level data from Connecticut DEP that may be used to improve upon the estimates provided by SIT's LUCF module. For example, while the occurrence of large, catastrophic forest fires is highly unlikely in Connecticut, the Connecticut DEP's Division of Forestry indicates that the state loses an average of 2,000 acres of forest per year to fire. This is the type of data that could be used to override default assumptions in the SIT calculations in order to further enhance and refine estimates for Connecticut's LUCF GHG inventory.

Other considerations

In developing many of the first elements of a bottom-up GHG inventory, this will necessarily be a "learning by doing" effort. While there are many traditional approaches that would go into a GHG emissions inventory, such as an accounting of GHGs directly emitted by a smokestack or tailpipe, there are additional areas that may be worth incorporating, to the extent resources allow, or to at least be mindful of for future work. One issue is the scope of CT's GHG "footprint." Would the state's GHG inventory cover only in-state emissions, as traditionally done for criteria pollutants, or include out-of-state emissions associated with in-state consumption, such as electricity generated by fossil fuel power plants located out-of-state?

As indicated previously with regard to the possible utility of collecting non-emissions information, such as the extent of residential and commercial weatherization, information on additional areas may be useful in future tracking of the effectiveness of GHG reduction programs. While not inclusive, these might include information on combined heat and power, distributed renewables, industrial process changes, mass transit to reduce passenger vehicle VMT, and regional land planning decisions by MPOs.

CT GHG Emissions Inventory
Mobile Sources Sector

Transportation GHG emissions result mainly from the combustion of fossil fuels, with a relatively small contribution due to leakage from mobile air conditioning systems. Gasoline and #2 distillate (diesel) fuel comprise most of the energy consumed in the sector. Specific GHGs attributable to transportation sources include CO2, CH4, N2O, NOx, CO, NMHC, and HFC.

The State Inventory Tool, following IPCC guidelines, considers emissions from five highway vehicle classes, (cars, light trucks, heavy trucks, buses, and motorcycles); three types of aviation fuels (kerosene, naphtha, and gasoline); three types of marine fuels (residual oil, diesel, and gasoline); three types of locomotive fuel (residual oil, diesel, and coal); and three categories of land-based nonroad equipment (farm, construction, and other).

Accounting for GHG emissions from mobile sources generally requires three steps: 1) characterizing the existing fleet; 2) identifying the activity associated with each equipment class (e.g., VMT, engine hours, or fuel consumption); and 3) applying emission factors for each pollutant. Emission factors are typically defined in grams per unit of fuel consumed, and are published in Annex 3 of EPA's *Inventory of U.S. GHG Emissions and Sinks.* Fleet characterization and activity data collection methods will vary with source category as described below.

Data Sources and Methods

Highway Vehicles —Detailed characterizations exist for highway fleets in the form of vehicle registration databases maintained by state Departments of Motor Vehicles. Activity data are monitored by each state's Department of Transportation for reporting to the Federal Highway Administration (FHWA) - ConnDOT presently makes VMT data available on its website for years 2000 through 2007; FHWA posts annual data beginning in 1982. Future-year fleet characteristics and GHG emissions for highway vehicles can be projected using the VISION-NE model, which calculates fleet penetration rates, energy use, and emissions based on annual rates of fleet turnover and VMT growth.

Combustion emissions are readily calculated based on fuel consumption, which in turn is a function of the distributions of age, vehicle type, and emission control technology across the state's fleet. HFC emissions from mobile air conditioning systems are less well understood, though CARB and NESCAUM have each conducted preliminary research toward improving emission projections from cooling systems. At present, the best available data are national estimates that can be apportioned to individual states according to fleet size.

- **Construction and Farm Equipment**—Detailed fleet inventory data are not readily available for nonroad land-based equipment, as these machines are not registered with any state authority. EPA's NONROAD model contains state-level estimates of fleet characterization data and can generate fuel consumption estimates by equipment type for construction, farm, and other types of nonroad land-based engines. NONROAD's default population data are based on years 1996-2000, and the model can extrapolate population estimates for any year between 1970 and 2050. Emissions of CO2, CH4 and N2O can be calculated based on fuel consumption using emission factors from EPA's *Inventory of U.S. GHG Emissions and Sinks.*

- **Locomotives**—EPA developed emissions and fleet inventory data for marine and locomotive engines at the national level as part of its regulatory impact analysis (RIA) for the 2008 marine/locomotive emissions rule. The RIA includes annual projections for years 2002 through 2040. In addition, NESCAUM conducted an inventory of locomotive emissions in Connecticut for 1999. Emissions of CO2, CH4 and N2O can be calculated using emissions factors from EPA's *Inventory of U.S. GHG Emissions and Sinks.*

- **Marine Vessels and Aviation**—Energy consumption for marine vessels and aviation fuels is tracked at the state level by FHWA and EIA, respectively. Emission factors for CO2, CH4 and N2O are published in EPA's *Inventory of U.S. GHG Emissions and Sinks*.

Recommendations

With the exception of highway vehicles, most equipment population and activity data are available only based on "top-down" inventories from DOE, EPA, or DOT. Ground-level survey data collection would be required to improve upon the data available in SIT for most categories in a given baseline year. For highway vehicles, key parameters are VMT and distribution of the fleet by age and control technology. SIT estimates historical VMT based on highway traffic monitors deployed by the state Department of Transportation – these data probably can not be improved upon. Age and control technology distributions are based on EPA estimates of national averages. It may be possible to develop state-specific modifications by comparing CT and national fleet registration data.

Future-year projections of highway vehicle emissions can be generated using the VISION-NE fleet turnover model. This model will generate detailed fleet characterizations based on user-input rates for VMT growth and penetration or specific advanced vehicle technologies. NESCAUM can use this modeling tool to compare the effects of policy incentives for certain vehicle types. For non-highway vehicles, SIT estimates future energy demand based primarily on sector-specific growth rates from EIA's Annual Energy Outlook. NESCAUM can develop a spreadsheet model to compare the effects of modified growth rates or improved emission factors for each transportation category in future scenario years.

CT GHG Emissions Inventory
Industrial and Electric Power Generation Sectors

Fossil fuel combustion is by far the largest contributor to greenhouse gas (GHG) emissions in Connecticut. Electric power generation and industrial stationary source combustion contribute a significant percentage of these fossil fuel combustion GHGs, with electric power generation emissions exceeded only by those from the transportation sector. Most of these emissions are in the form of carbon dioxide (CO_2); however fuel combustion produces nitrous oxide (N_2O) and methane (CH_4) emissions as well. Industrial processes like semiconductor manufacturing, substitution of ozone depleting substances (ODS), electric power transmission and distribution, and limestone/dolomite/soda ash usage contribute additional emissions of CO_2 and N_2O, hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6).

GHG emissions are generally estimated as a function of activity data (e.g., fuel consumption) and activity/fuel/gas-based emission factors. In past efforts, a number of states, including Connecticut, have employed the EPA's State GHG Inventory Tool (SIT) to construct GHG inventories. The SIT, which employs up-to-date methods based on the Inventory of US Greenhouse Gas Emissions and Sinks and IPCC emissions guidelines, is an update to the Emissions Inventory Improvement Program volume VIII guidance. It was developed by the EPA to offer states a comprehensive tool to consistently and quickly develop their own GHG emission inventories. The SIT is a series of ten Excel workbooks or "modules" that combine to offer a comprehensive picture of GHG emissions from all sectors at the state level.

The electric power generation and industrial sector emissions can be calculated using four modules of the SIT: (1) CO_2 from fossil fuel combustion, (2) CH_4 and N_2O from Stationary Source Combustion, (3) Natural Gas and Oil Systems, and (4) Industrial Processes. The data requirements, sources, and methodologies employed in the SIT for the electric power and industrial sectors are described below and represent a basis for a regionally-consistent GHG inventory. This description is followed by recommended data improvements to further disaggregate the inventory and represent GHG emissions at the facility level.

Data Requirements and Sources

In the SIT, the methods to calculate GHG emissions for the electric power and industrial sectors largely follow those steps described in the EIIP volume VIII guidance (2004), with updates from the latest Inventory of U.S. Greenhouse Gas Emissions and Sinks and the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Default fuel consumption data for the electric power and industrial sectors have been taken from the Energy Information Administration's State Energy Consumption, Price, and Expenditure Estimates from the State Energy Data System (SEDS). Additional data from the EIA and EPA are used to calculate combustion emissions of CO_2, CH_4, and N_2O. These data include heat and carbon contents of various fuels, fuel combustion efficiency, the fraction of stored carbon when fossil fuels are employed for non-energy uses in the industrial sector (e.g., asphalt usage in highway construction), and emission factors for N_2O and CH_4.

Additional sources of default data in the SIT include USGS mineral yearbooks and US population/economic census data. The following methodologies are employed with default data assumptions in order to calculate GHG emissions for the industrial and electric power generation sectors.

CO_2 from Fossil Fuel Combustion

This module accounts for the largest fraction of GHG emissions from the industrial and electric power generation sectors. CO_2 emissions from fossil fuel combustion are calculated from fuel consumption by fuel type and sector (on an energy basis), carbon content coefficients per fuel type, percentage of carbon oxidized during combustion, and, in the case of non-energy industrial fossil fuel usage, the amount of carbon stored in products. Default data were based on information obtained from the EIA, EPA, and IPCC. With default assumptions, the SIT estimates 6% and 23% of the CO_2 from fossil fuel combustion was attributable to the industrial and electric power generation sectors, respectively, in 2006.

CH_4 and N_2O from Stationary Combustion

CH_4 and N_2O emissions from fossil fuel and wood combustion are calculated from consumption data by fuel type and sector (including non-energy consumption by fuel type for the industrial sector), global warming potential of CH_4 and N_2O, and emission factors by fuel type and sector.

CH_4 and N_2O emission factors vary based on a number of factors, including fuel type and size/vintage/maintenance/operation/control of the combustion technology. Default data for CH_4 and N_2O emission factors were based on the IPCC guidelines for National Greenhouse Gas Inventories. eGRID 2007 now includes these emissions at the facility-level in its database.

Natural gas and Oil Processes

CT emissions for this category come mainly from natural gas transmission and distribution, with the majority coming from distribution activities. These emissions are due to leaks, fugitive emissions, meters, regulators, and mishaps. Data on miles of pipeline for transmission and distribution of natural gas can be taken from the US Department of Transportation's Office of Pipeline Safety, and this is the primary data used to estimate emissions from these processes.

Industrial Processes

The USGS (mineral yearbooks) are used to estimate minerals activities. Emissions from other industrial processes like semiconductor manufacturing, SF_6 usage in electrical transmission and distribution equipment, and HFC/PFC usage are estimated from ratios of state to national population/economic data in conjunction with national emissions levels.

Recommendations – Possible Data Improvements

While the SIT offers default data to estimate emissions from different sectors and activities within a state, there is facility-level GHG data available through EPA and other sources. An example might be to replace EIA SEDS fuel consumption data with data from a state energy/public utility commission. Additional information that should prove useful in further disaggregation of the GHG emission inventory for large sources will result from CT's new GHG reporting requirement for Title V facilities.

Power plants and some industrial boilers subject to Clean Air Act's acid rain provisions report CO_2 emissions at the facility level through EPA's Emissions Tracking System/Continuous Emissions Monitoring (ETS/CEM) requirements. In addition, EPA's eGRID database contains this same information as well as estimated emissions for smaller units, cogen units, and non-utility sources not subject to EPA's ETS/CEM reporting. The most recent version, eGRID2007, now also includes estimates of CH_4 and N_2O emissions at the facility level.

CT could use the ETS/CEM data from EPA's Clean Air Markets Division (CAMD) database, which covers generators and boilers in the acid rain program, to supplement the existing EIA data in the State Inventory Tool. CAMD tracks CO_2 and criteria pollutant emissions at the unit level.

eGRID is another possible data source that could be used to enhance the CO_2 emissions data in the State Inventory Tool, as well as supplement with facility-specific CH_4 and N_2O emissions. eGRID covers more units than the CAMD database, specifically smaller point sources in the commercial and industrial sectors.

In either case above an analysis should first examine the underlying data collection methods and estimation methodologies used by the EIA to estimate fuel consumption in each sector and determine how comparable the universe of generators in eGRID and CAMD is to the EIA's definition of the power sector.

For industrial sources, CT's new GHG reporting rule and a review of state air permits and EPA compliance record keeping databases could provide reported GHG emissions or fuel use data that, coupled with standardized emission factors such as those from EPA AP-42 and EIA, could provide a basis for estimating GHG emissions. The compliance databases could include non-Title V sources that are found in EPA's Online Tracking Information System (OTIS) and Air Facility System (AFS).

CT GHG Emissions Inventory
Residential and Commercial Sectors

The main source of greenhouse gas emissions in both the residential and commercial sectors is the combustion of fossil fuels for space heating, air conditioning, water heating, and use of home and office lighting and appliances. Fossil fuels include coal, natural gas, and petroleum-based fuels, such as distillate fuel, kerosene, and LPG for both sectors, as well as motor gasoline and residual fuel for the commercial sector. Wood used in fireplaces and woodstoves might also be considered in the residential and commercial emission categories.[1] The amount of energy dedicated to space heating and air conditioning is closely related to geographic location and physical characteristics of the unit, such as the thermal envelope and furnace efficiency. Electricity use for lighting and appliances correlates to the number of residents in a home[2] and the type of company, number of employees, and the amount of time per day or year a business is in operation.

Specific greenhouse gas emissions attributable to the residential and commercial sectors include carbon dioxide and nitrous oxides from the combustion of fossil fuels, sulfur hexafluoride emissions from electricity transmission and distribution systems, and methane emissions from the inefficient combustion of wood.

Data and Methods

Using default data, the Environmental Protection Agency's (EPA's) State Inventory Tool (SIT) calculates that 19 percent (~ eight million tons of carbon dioxide equivalent) of greenhouse gas emissions from fossil fuel combustion was attributable to the residential sector in 2006. Eight percent (~3.3 million tons of carbon dioxide equivalent) was attributable to the commercial sector. The State Inventory Tool follows *IPCC Guidelines for National Greenhouse Gas Inventories*.[3] The IPCC Guidelines promote attribution of greenhouse gas emissions from energy use to the residential, commercial, industrial, and transportation sectors. Other inventory guidelines, such as the *World Business Council for Sustainable Development/ World Resources Institute Corporate Accounting and Reporting Standard*,[4] suggest separating emissions from each sector into the categories of direct and indirect emissions. Direct emissions occur on site, such as the emissions from a natural gas-powered home water heater. Indirect emissions occur off site, but are controlled at the indirect emissions source, for example, the power plant emissions associated with turning on a light at an office.

Designation of direct and indirect emissions is used to avoid double-counting and to properly track emissions reductions. A power plant may install cleaner technology or begin providing renewable energy, but at the same time a family or business may switch to more efficient lighting sources, choose to reduce their appliance usage, or better insulate their home (assuming electric heating/cooling).

SIT could be used as a framework for calculation of the residential and commercial sectors, with certain data enhancements and disaggregation of the data to make the inventory more meaningful and robust. The three main areas that require data input specific to the residential and commercial sectors are:

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[1] EPA's State Inventory Tool assumes that biomass has net-zero carbon emission and therefore does not capture point carbon dioxide emissions from the combustion of wood.
[2] Emrath, Paul, PhD and Helen Fei Lui, PhD. *Residential Greenhouse Gas Emissions*. Housing Economics. National Association of Home Builders. Special Studies. April 30, 2007.
[3] IPCC/UNEP/OECD/IEA (1997). *Guidelines for National Greenhouse Gas Inventories.*
[4] World Resource Institute and World Business Council for Sustainable Development. (2004). The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard.

(1) Energy Use Data—SIT uses consumption data from the State Emissions Data System (SEDS) managed by the Energy Information Administration (EIA). SEDS data come from surveys of suppliers and marketers of energy sources and end users of energy.[5] End use surveys include the Residential Energy Consumption Survey (RECS) and the Commercial Building Energy Consumption Survey (CBECS). End use surveys provide states with the percentage of total energy consumed by each of the sectors.[6]

SIT presents total energy consumed by the state as the amount actually generated in state. However, net import of electricity would be a more useful calculation when assessing energy consumption. Net imports may be calculated using EPA's Emissions & Generation Resource Integrated Database (eGRID).

(2) Carbon Content in Fuels—SIT uses *EIA Electric Power Annual 2003* values as the default carbon content for most fuels. Due to variability in the carbon content of coal, these values are updated annually with EIA data.[7]

(3) Combustion Efficiencies—SIT assumes that the percent of carbon oxidized is 100 percent during combustion of petroleum, coal, and natural gas.[8] This default assumption may be exchanged for higher level data.

Recommendations

Potential enhancements and disaggregation of these data categories could be achieved by incorporating existing data from the Connecticut Department of Environmental Protection and Public Utility Commission. Data from the US Census Bureau, including County Business Patterns, and other consumer surveys should be compared to SEDS data to gauge consistency and potential for data improvements or disaggregation to the census tract or county level. CT could use the Census Bureau's American Community Survey (ACS) to identify residential areas within the state that have high concentrations of oil furnaces or radiators, as well as obtain community-scale breakdowns of other types of fuels used for residential space heating (e.g., electric). This type of information could be used to better target programs promoting cleaner fuels and energy efficiency measures for residential space heating.

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[5] Energy Information Administration. (2006). State Energy Data System 2006: Consumption. Technical Notes. http://www.eia.doe.gov/emeu/states/_seds.html.

[6] SEDS sector definitions:
Residential Sector: An energy-consuming sector that consists of living quarters for private households. Common uses of energy associated with this sector include space heating, water heating, air conditioning, lighting, refrigeration, cooking, and running a variety of other appliances. The residential sector excludes institutional living quarters.
Commercial Sector: An energy-consuming sector that consists of service-providing facilities and equipment of: businesses; Federal, State, and local governments; and other private and public organizations, such as religious, social, or fraternal groups. The commercial sector includes institutional living quarters. It also includes sewage treatment facilities. Common uses of energy associated with this sector include space heating, water heating, air conditioning, lighting, refrigeration, cooking, and running a wide variety of other equipment. Note: This sector includes generators that produce electricity and/or useful thermal output primarily to support the activities of the above-mentioned commercial establishments.

[7] ICF Consulting. (2004). Methods for Estimating Carbon Dioxide Emissions from Combustion of Fossil Fuels. State and Local Climate Change Program. U.S. Environmental Protection Agency, Emissions Inventory Improvement Program. Volume VIII: Chapter 1. August 2004.

[8] ICF International. (2008). Draft User's Guide for Estimating Carbon Dioxide Emissions from Fossil Fuel Combustion Using the State Inventory Tool. Clean Energy Environment State Program, U.S. Environmental Protection Agency. Module I. July 2008.

Additional data might be available from residential and commercial realtor associations, insulation manufacturers and installers, trade associations (e.g., American Society of Heating, Refrigerating, and Air-Conditioning Engineers), utilities, and energy service companies (ESCOS).

The best currently available estimates of net GHG emissions from land use change and forestry (LUCF) in Connecticut come from US EPA's State Inventory Tool (SIT). Estimated GHG emissions from land use changes in Connecticut over the period 1990 to 2007 show that this sector underwent significant changes that resulted in an increase of emissions. Land use and forests shifted from being a net "sink" of 4.2 million metric tons of CO_2-equivalent ($MMTCO_2e$) in 1990 to an emissions source of nearly 4.5 $MMTCO_2e$ in 2007. This is a shift of nearly 9 MMTCO2e, which represents about one-quarter of CT's total annual 2007 CO2e emissions. The categories of land use change and forestry which accounted for the most significant changes include forest carbon, soil organic carbon, and landfilled yard waste. Urban trees increased carbon uptake moderately from 0.70 $MMTCO_2e$ in 1990 to 0.89 $MMTCO_2e$ in 2006. This increase was likely due to an expansion of urban area in Connecticut over that same time period. Other categories of LUCF included in the EPA SIT estimates—agricultural soil liming, non-CO_2 emissions from forest fires and N_2O emissions from settlement soils—are estimated to have zero or negligible impact on Connecticut's LUCF GHG inventory.

Data and Methods

EPA has updated the LUCF module in the SIT with recent activity data, the addition of a new source category of N_2O emissions from settlement soils, and updates to emission factors and methods for estimates for urban trees and landfilled yard trimmings and food scraps. The LUCF categories covered by the SIT which contributed significantly to Connecticut's LUCF GHG inventory include the following:

- **Forest carbon flux**—the SIT estimates changes in forest carbon using data from the US Forest Service's *Forest Inventory and Analysis* (FIA), which provides annualized state-level estimates of carbon stocks and flows for five forest carbon pools: aboveground biomass, belowground biomass, dead wood, litter, and soil organic carbon. Agroforestry operations, such as tree farms, are not included in new state-level data from the US Forest Service.

- **Urban trees**—the SIT estimates carbon storage in urban trees by multiplying the percent of urban area covered by trees by a carbon sequestration factor. Newly available data describing urban area from the 2000 US Census were used to update historical estimates (1991 to 1999) and to extrapolate estimates for subsequent years (2001 to 2005).

- **Carbon Stored in Landfilled Yard Trimmings**—this category consists of estimates of carbon stored in dry grass, branches, food scraps and other wastes, and is calculated on a mass balance basis to account for the contribution of methane emissions from decomposition of organic matter as well as carbon stored.

The contributions of the following categories of LUCF included in the SIT are either zero or negligible for Connecticut's LUCF GHG inventory:

- **Agricultural soil liming**—this category includes the calculation of increases in CO_2 emissions from the application of limestone and dolomite to acidic agricultural soils. Estimates are based on revised emission factors based on recent research that replace IPCC emission factors.[9]

[9] EPA's SIT uses emissions factors developed in: West, T. and A. McBride (2005). "The contribution of agricultural lime to carbon dioxide emissions in the United States: dissolution, transport, and net emissions," *Agricultural*

- **N_2O from settlement soils**—this category is new to the SIT's LUCF module, and includes estimates of emissions from fertilizer application to lawns, golf courses, and other landscaping within settled areas.

- **Non-CO_2 Emissions from Forest Fires**—the SIT documentation for the LUCF module does not contain a description of the underlying data or methodology for this category of LUCF.

Recommendations for Completing LUCF Inventory

- **Conduct further research on underlying LUCF data series**: There is a significant change in the SIT's estimate of LUCF emissions for Connecticut between 1997 and 1998, showing a reversal of a forest sink of 3.6 $MMTCO_2e$ in 1997 to net forest emissions of 1.4$MMTCO_2e$ in 1998. This is significant enough a shift over a one-year interval that it appears to be a break either in the data series or the underlying methodology. NESCAUM can investigate this with the developers of EPA's SIT.

- **Contact CT forestry and resource officials to determine availability of relevant state-level data and other enhancements to SIT assumptions.** Under Task 2 of this project, NESCAUM can investigate the availability of additional state-level data from Connecticut DEP that may be used to improve upon the estimates provided by SIT's LUCF module. For example, while the occurrence of large, catastrophic forest fires is highly unlikely in Connecticut, the Connecticut DEP's Division of Forestry indicates that the state loses an average of 2,000 acres of forest per year to fire. This is the type of data that could be used to override default assumptions in the SIT calculations in order to further enhance and refine estimates for Connecticut's LUCF GHG inventory.

Ecosystems & Environment 108: 145-154. These new emission factors are about half the value of IPCC's default emission factors, and thus result in a downward adjustment in the SIT's emissions estimates for liming of agricultural soils.

References

E.H. Pechan & Associates, Inc. (2008) The Emissions and Generation Resource Integrated Database for 2007 - (eGRID2007) Technical Support Document. Prepared for the Climate Protection Partnerships Division, Office of Atmospheric Programs, U.S. Environmental Protection Agency. Pechan Rpt. No. 08.09.006/9011.239. http://www.epa.gov/cleanenergy/documents/egridzips/eGRID2007TechnicalSupportDocument.pdf.

Energy Information Administration. (2008) State Energy Data System: Consumption, Price, and Expenditure Estimates. www.eia.doe.gov/emeu/states/_seds.html.

ICF Consulting. (2004) Emission Inventory Improvement Program, Volume VIII. Prepared for: State and Local Climate Change Program, U.S. Environmental Protection Agency & Emission Inventory Improvement Program.

ICF International. (2008) Draft User's Guide for Estimating Carbon Dioxide and Methane Emissions from Natural Gas and Oil Systems Using the State Inventory Tool. Prepared for the Clean Energy Environment State Program, U.S. Environmental Protection Agency. Distributed with the State GHG Inventory Tool.

ICF International. (2008) Draft User's Guide for Estimating Carbon Dioxide Emissions from Fossil Fuel Combustion Using the State Inventory Tool. Prepared for the Clean Energy Environment State Program, U.S. Environmental Protection Agency. Distributed with the State GHG Inventory Tool.

ICF International. (2008) Draft User's Guide for Estimating Carbon Dioxide, Nitrous Oxide, HFC, PFC, and SF_6 Emissions from Industrial Processes Using the State Inventory Tool. Prepared for the Clean Energy Environment State Program, U.S. Environmental Protection Agency. Distributed with the State GHG Inventory Tool.

ICF International. (2008) Draft User's Guide for Estimating Methane and Nitrous Oxide Emissions from Stationary Combustion Using the State Inventory Tool. Prepared for the Clean Energy Environment State Program, U.S. Environmental Protection Agency. Distributed with the State GHG Inventory Tool.

IPCC. (1997) IPCC Guidelines for National Greenhouse Gas Inventories, 3 volumes: Vol. 1, Reporting Instructions; Vol. 2, Workbook; Vol. 3, Draft Reference Manual. Intergovernmental Panel on Climate Change, Organization for Economic Co-Operation and Development. Paris, France.

IPCC (2000) Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories. National Greenhouse Gas Inventories Programme, Intergovernmental Panel on Climate Change. Montreal. May 2000. IPCC-XVI/Doc. 10 (1.IV.2000).

IPCC (2006) 2006 IPCC Guidelines for National Greenhouse Gas Inventories. The National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change, H.S. Eggleston, L. Buendia, K. Miwa, T. Ngara, and K. Tanabe (eds.). Hayama, Kanagawa, Japan.

Northeast States for Coordinated Air Use Management, CT Department of Environmental Protection, and CT Clean Energy Fund. (2003) Connecticut Greenhouse Gas Inventory 1990-2000. http://www.ctclimatechange.com/pdf/CC_Inventory_Report.pdf.

U.S. EPA (2009) eGRID. http://www.epa.gov/cleanenergy/energy-resources/egrid/index.html.

U.S. EPA. (2008) Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 – 2006. http://www.epa.gov/climatechange/emissions/downloads/08_CR.pdf.

U.S. EPA (2009) Resources for Inventory Development. http://www.epa.gov/climatechange/emissions/state_guidance.html (information on State Inventory Tool).

USGS. (2007) Minerals Yearbook. U.S. Geological Survey, Minerals Information Service. Reston, VA. http://minerals.usgs.gov/minerals/pubs/commodity/myb/.

Table 1. Summary table of state GHG inventories

STATE	GHG Inventory? Status?	How do you plan to use the inventory?	Pollutants	Base year	Methods used	Levels of Aggregation	Stakeholder process?	Issues/Notes
Maine Kevin McDonald: 207-287-7598; Tammy Gould: 207-287-7036	Yes; 2003 Bill requires reporting by facilities subject to criteria pollutant reporting EPA State Inventory Tool (SIT) used to calculate total state emissions	Planning/ tracking	Point Source Inventory: CO2, methane, nitrous oxide, sulfur hexachloride SIT inventory: six GHGs (CO2, CH4, N2O, HFCs, PFCs, SF6.	1990	Satellite I-steps for collecting data from criteria pollutant reporters EPA SIT tool with state-specific upgrades	Point Source data at the source level aggregated to the facility level Sector/ fuel type data	Yes	Facilities may choose which emission factors to use See document "Maine Emissions and Sinks Summary"
Vermont Brian Wood: 802-241-3885	Yes, EPA SIT used by consultant, being updated by ANR	Contains forecasts—for planning purposes	Six GHGs	1990	EPA SIT with state-specific upgrades	By sector with some fuels and some power plant/ specific emitter data included in report	Yes	See document "GHG Inventory and Reference Case Projections"
New Hampshire Joanne Morin: 603-271-5552. Contacts for forestry info are: Cameron Wake: cpw@gust.sr.unh.edu, (603) 862-2329 and Matt Frades: mcfrades@gmail.com	EPA SIT used for inventory since 2002, concurrent with NH's Climate Action Plan Completed. Updated with EIA data through 2005. Projected to future years 2012, 2025, and 2050. (other NH materials say projected to 2030)	To see how the state makes progress on GHG emissions reductions -- determine current emissions levels, identify trends	Six GHGs (black carbon not considered)	Historical emissions 1990-2004, then projections.	Primarily used EPA's SIT with state-specific upgrades. Used NH-specific EIA data, and defaults as necessary. Forestry sequestration (considered the weakest part of the EPA tool) was done by UNH.	Gross emissions aggregated by source sectors: electric generation, transportation, residential, commercial, industrial, ag and waste, land use change and forestry	No public process. The forestry section had a workgroup.	1. Cameron did an extensive forestry model specific to NH, which will probably be published in the near future – took into account development and forestry practices. 2. If states want to do bottom up inventories, use TCR protocol. 3. Sequestration is very controversial. Look into what CA has done as well. 2.Summary presentation from 2008 found at: http://des.nh.gov/organization/divisions/air/tsb/tps/climate/action_plan/documents/080118_skoglund1.pdf
Massachusetts Bill Lamkin: 978-694-3294	NESCAUM developed using SIT. NESCAUM inventory completed; Inventory for Global Warming Solutions Act not started.			1990-2000 (possibly 2003 as well)	Used EPA SIT. Started with national defaults, across all sectors. Memo to Sonia Hamel from Jennie Weeks re: data assumptions (2004)	Sectoral data through EIA.	Global Warming Solutions Act (GWSA) requires some Advisory Committees, but not clear whether they are needed for inventory, specifically.	Working on mandatory reporting (which is not an inventory). In GWSA, there is a requirement to establish an emissions inventory with 1990 base year and make projections re: BAU in 2020. MA will assess whether NESCAUM's 1990 data are sufficient for establishing base year. Will make reductions from 1990 BY (10-20%). Important to have comparable benchmarks from state-to-state.

Rhode Island Frank Stevenson: 401-222-2808, x 7021; Karen Slattery, x7030	Developed in 2000 by Brown University. Completed	Provides estimates of GHG emissions	CO2, methane, and nitrous oxide	1990 and 1996; for fossil fuel combustion: 1986-1996	Followed the protocols of EPA's EIIP Document Series, Volume VIII: Estimating Greenhouse Gas Emissions, December 1998 Review Draft. Data for combustion of coal, petroleum, and natural gas were taken from EIA's State Energy Data Report of the Energy Information Administration, and combined with default emissions factors from EPA's Workbook. For EGU emissions, the EIA data were in error, so data from the RI PUC were used. Reported an estimate of emissions resulting from imported electricity, too. For non-CO2 emissions from stationary sources, used EPA's "simple method." For VMT, used FHWA data (used conservative assumptions about emissions control technologies for vehicle/fuel type). Some discussion of how dealt with landfill emissions in report.			Did not include in the inventory the emissions from fossil fuel combustion used to generate imported electricity. Link to inventory is: http://www.brown.edu/Research/EnvStudies_Theses/GHG/index.shtml
New York David Gardner: 518-402-8448 at NYSDEC; Carl Mas: 518-640-2424 x3294 at NYSERDA	Being developed, updated and housed by NYSERDA Still in draft form.	Will be used as the basis for the NY Energy Plan. Primarily to look at patterns and trends.	The six IPPC GHG pollutants	2005 base year, and being updated for 2006 and 2007.	Combination of a bottom-up and top-down inventory. Over 90% of the inventory is top-down (e.g., energy and other proxy metrics and calculations). General approach was to follow EPA's EIIP documents for volume VII, VIII (methane emissions) and X (soil management). Mostly used fuel use consumption by sector (residential, commercial/industrial, ag, power supply, transportation). Used CAMD, EIA, DOE data. Transportation and gas usage is top-down, as are off-road vehicle assumptions. Trying to reconcile with modeled VMT in states and average vehicle efficiency. Not appropriate to attribute gas sales to only on-rd. Not only registrations. Having consultant (EH Pechan) look at cost curves for Ag, Forestry and Waste Management, and possibly develop a suite of methods. For non-energy sectors,	Sectoral data		Relied on a lot of assumptions because not all info was available. Doing bottom-up is incredibly labor intensive. Note quirk in aviation sector: FAA publishes fuel by flight type (70% domestic/30% international); use only domestic shipping fuels. EPA is updating its EIIP methods, and will be starting a workgroup on that. CCS is doing an adaptation study for NY. Bigger issues to think about: (1) production based approach v. point of sale approach (e.g., dealing with gas purchased out of state, leakage); (2) imports of electricity (NY is not including as a category, but might include some data on it); (3) sinks v. an emissions inventory (how to quantify in general, and as biofuels are developed, this will need to be included; EPA's protocol assumes net zero land use change).; (4) consumption-based approach --not

					working on landfills and dairy farm fermentation using bottom up approach.			state specific. A lot of people want this metric, but don't understand the difference between this and production-based metric. They are very different approaches with 20-30% differences. 2. DRAFT (to be updated) memo from NYSERDA provides good background information.
New Jersey	Yes; EPA SIT tool used	Required by state law to create inventory of 1990, 2006 and current emissions to set long-term reduction targets for climate change program	Six GHGs	1990	EPA SIT tool with state-specific upgrades; CCS for inventory and projections, with data from EIA and NJ BPU	Sector and fuel use and by gas		See document "NJ Greenhouse Gas Inventory and Projections," http://www.state.nj.us/globalwarming/pdf/emissions-inventory-09-07.pdf
California	Yes, statewide GHG emission inventory updated annually. Facility-based mandatory reporting regulation	Mandatory reporting data used to update statewide inventory and serve as foundation for future Cap and Trade regulation for GHG reductions.	Six Kyoto GHGs	1990	Developed inventory using CA tools and data but relied on previous work by the CA Energy Commission, U.S. EPA, and IPCC. Largely a top-down inventory.	Statewide aggregation	Held four public workshops to discuss the data sources and methodologies to estimate GHG emissions. Numerous meetings with different industrial sector representatives to discuss the initial draft estimates and other data sources to improve estimates.	More details about the inventory at http://www.arb.ca.gov/cc/inventory/inventory.htm

Table 2. Connecticut Greenhouse Gas Emissions Inventory Initial Data Assessment

SECTOR	AVAILABLE DATA SOURCES			POTENTIAL DATA ENHANCEMENTS		
	SOURCE OR DATA TYPE	**LOCATION**	**NOTES**	**POTENTIAL SOURCE OR DATA TYPE**	**POSSIBLE LOCATION**	**NOTES**
Commercial	SEDS data from EPA's State Inventory Tool	http://www.eia.doe.gov/emeu/states/_seds.html; ICF International. (2008). *Draft User's Guide for Estimating Carbon Dioxide Emissions from Fossil Fuel Combustion Using the State Inventory Tool*. Clean Energy Environment State Program, U.S. Environmental Protection Agency. Module I. July 2008.	SIT uses consumption data from the State Emissions Data System (SEDS) managed by the Energy Information Association (EIA)	Fuel usage data	Utilities, and energy service companies (ESCOS)	
	Commercial Building Energy Consumption Survey (CBECS)	http://www.eia.doe.gov/emeu/cbecs/		Square footage, insulation, and appliance data	Commercial realtor associations, insulation manufacturers and installers, trade associations, such as the American Society of Heating, Refrigerating, and Air-Conditioning Engineers	
	US Census Bureau, e.g., County Business Patterns	http://www.census.gov/econ/www/index.html				
Industrial	EIA SEDS fuel consumption data by fuel type and sector	www.eia.doe.gov/emeu/states/_seds.html	EIA fuel consumption data are used in the SIT and by CA. For GHGs: CO_2, CH_4, N_2O	State GHG reporting for Title V sources	CT DEP	Reporting form: www.ct.gov/dep/lib/dep/air/compliance_monitoring/emission_statement/2008-ghg-reporting-form.pdf
	Guidance documents for emission factors and fuel	2006 IPCC Guidelines for National Greenhouse Gas		Additional facility-specific activity or	CT DEP facilities permitting; EPA	Compliance data may provide

	characteristics: IPCC and EPA documentation	Inventories (www.ipcc-nggip.iges.or.jp/public/2006gl/index.html); US Greenhouse Gas: Emissions and Sinks: 1990-2007 (www.epa.gov/climatechange/emissions/usinventoryreport.html) Emission Inventory Improvement Program and SIT guides (distributed with the SIT)		fuel information for major/minor sources; EPA OTIS, AFS compliance tracking systems	databases	facility-specific fuel consumption, other info relevant to estimating GHG emissions
	USGS-Minerals Yearbooks	http://minerals.er.usgs.gov/minerals/pubs/state/ct.html	For CO2 from mineral usage/production			
	Activity data for electric transmission and distribution from EIA Electric Power Annual	http://www.eia.doe.gov/cneaf/electricity/epa/epa_sum.html	For SF6 from electric power transmission and distribution			
	US Census Bureau economic census and American Factfinder	http://factfinder.census.gov/home/saff/main.html?_lang=en and http://www.census.gov/econ/census/index.htm	To calculate the fraction of state emissions for HFCs, PFCs, and SF6			
Residential	EPA's State Inventory Tool	http://www.eia.doe.gov/emeu/states/_seds.html; ICF International. (2008). *Draft User's Guide for Estimating Carbon Dioxide Emissions from Fossil Fuel Combustion Using the State Inventory Tool*. Clean Energy Environment State Program, U.S. Environmental Protection Agency. Module I. July 2008.	SIT uses consumption data from the State Emissions Data System (SEDS) managed by the Energy Information Association (EIA)	Fuel usage data	Utilities, and energy service companies (ESCOS)	

	Residential Energy Consumption Survey (RECS)	http://www.eia.doe.gov/consumption/		Square footage, insulation, and appliance data	Residential realtor associations, insulation manufacturers and installers, trade associations, such as the American Society of Heating, Refrigerating, and Air-Conditioning Engineers	
	EPA's Emissions & Generation Resource Integrated Database (eGRID)	http://www.epa.gov/cleanenergy/energy-resources/egrid/index.html				
	US Census Bureau, ACS	http://www.census.gov/hhes/www/housing.html		Type of fuel used for residential heating by census tract		
EGUs	EIA SEDS fuel consumption data by fuel type and sector	www.eia.doe.gov/emeu/states/_seds.html	Fossil fuel combustion leads to GHG emissions of CO2, CH4, and N2O	More accurate or detailed fuel characteristics/consumption data for CT utilities from CT utility and energy organizations	CT Dept. of Public Utility Control (www.ct.gov/dpuc/site/default.asp); CT Office of Policy and Management, Energy Management Unit (www.ct.gov/opm/cwp/view.asp?a=2994&q=386250&opmNav_GID=1808); CT Energy Advisory Board (www.ctenergy.org); CT Energy Cons. Mgmt Board (www.ctsavesenergy.org/ecmb)	
	Guidance documents for emission factors and fuel characteristics: IPCC and EPA documentation	2006 IPCC Guidelines for National Greenhouse Gas Inventories (www.ipcc-nggip.iges.or.jp/public/2006gl/index.html); US Greenhouse Gas: Emissions and Sinks:		State GHG reporting for Title V sources	CT DEP	Reporting form: www.ct.gov/dep/lib/dep/air/compliance_monitoring/emission_statement/2008-ghg-reporting-form.pdf

		1990-2007 (www.epa.gov/climatechange/emissions/usinventoryreport.html) Emission Inventory Improvement Program and SIT guides (distributed with the SIT)				
	eGRID	www.epa.gov/cleanenergy/energy-resources/egrid/index.html				
Transportation	FHWA Highway Statistics 2007	http://www.fhwa.dot.gov/policyinformation/statistics/2007/	VMT 2007 and earlier annual	ConnDOT	VMT	Annual
	EPA GHG Inventory	http://www.epa.gov/climatechange/emissions/usinventoryreport.html	Vehicle Class, Control Type, and Age Distribution (Based on MOBILE6)	CT DMV	Vehicle Class, Control Type, and Age Distribution	Annual
	EPA GHG Inventory	http://www.epa.gov/climatechange/emissions/downloads09/07_Annex_3.pdf	CO2 Emission Factors (g/btu) Source: EIA		NESCAUM/Meszler Pavley Analysis	2009
	EPA GHG Inventory	http://www.epa.gov/climatechange/emissions/downloads09/07_Annex_3.pdf	CH4 & N2O Emission Factors (g/mi) Source: ICF 2004			
	EPA GHG Inventory	http://www.epa.gov/climatechange/emissions/downloads09/07_Annex_3.pdf	US Transportation Emissions of NOx, CO and NMVOC (1990, 1995, 2000, 2005-2007)	MOBILE6	CT Emissions	
	EPA GHG Inventory	http://www.epa.gov/climatechange/emissions/downloads09/07_Annex_3.pdf	US Transportation Emissions of HFCs (1995, 2000, 2005 – 2007)	Lit Search and recent ARB research ?		Need vehicle-specific leakage rates for faulty AC systems
	NONROAD Model	http://www.epa.gov/otaq/nonrdmdl.htm	Nonroad equipment population (annual)	CT DEP ?	Nonroad Population	
	NONROAD	http://www.epa.gov/otaq/nonrdmdl.htm	Nonroad activity (annual)	CT DEP ?	Nonroad Activity	
	NONROAD	http://www.epa.gov/otaq/nonrdmdl.htm	Emission Factors – CO2, CO, NOx, NMHC			
	EPA GHG Inventory	http://www.epa.gov/climat	Emission Factors – CH4,			

		echange/emissions/usinventoryreport.html	N20			
	NESCAUM 1999	NESCAUM Library	Locomotive Fuel Consumption 1999	Update baseline fuel cons?		
	EPA RIA	http://www.epa.gov/otaq/locomotives.htm	Locomotive EF CO2			
	EPA GHG Inventory	http://www.epa.gov/climatechange/emissions/usinventoryreport.html	Locomotive EF CH4 & N2O			
	EPA RIA	http://www.epa.gov/otaq/locomotives.htm	Marine Activity			
	EPA RIA	http://www.epa.gov/otaq/locomotives.htm	Marine EF CO2			
	EPA GHG Inventory	http://www.epa.gov/climatechange/emissions/usinventoryreport.html	Marine EF CH4 & N2O			
Forest, Agriculture, Land Use Change	EPA State Inventory Tool, based on USDA Forest Inventory Analysis data	SIT website	Ag sector emissions are not included	CT Division of Forestry	CT Department of Environmental Protection	

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Arthur N. Marin, Executive Director

MEMORANDUM

TO: Tracy Babbidge, Paul Farrell, CT DEP
FROM: Michelle Manion, Allison Reilly, Tom Nickerson, Paul Miller
RE: 1. *Connecticut Options for GHG Emissions Baseline Year*
2. State Approaches to Land Use Change and Forestry Sectors
3. Data Sources for In-State Energy Demand: Net GHG Emissions from Electricity Sector
4. CT Natural Gas Service Territories
DATE: June 10, 2009

1. CT Options for GHG Emissions Baseline Year

Connecticut is considering the option of either maintaining 1990 as the baseline year referenced in their greenhouse gas (GHG) plans and policy development, or switching from 1990 to a more recent baseline year such as 2004 or 2005. Selection of a baseline year against which future GHG reductions from state and regional climate policies and plans are measured is important for both technical and political reasons. The baseline year has technical repercussions because it determines how GHG reductions are calculated and compared to stated goals. The choice of baseline also has political implications because it will affect how progress (or lack thereof) towards GHG reduction goals are interpreted and communicated to the public.

The primary benefit to Connecticut of maintaining a 1990 baseline year is for consistency in both calculating and communicating progress towards climate goals. Maintaining a 1990 base year would allow Connecticut to be consistent both with its own public communications on climate change, including the 2005 Connecticut Climate Change Action Plan,[10] as well the New England Governors/Eastern Canadian Premiers (NEG/ECP) Climate Change Plan of 2001.[11]

In addition, maintaining 1990 as a baseline year would allow easy comparison to the other jurisdictions to which Connecticut is most often compared—i.e., the "frame-of-reference" states in the Northeast and West that have led the nation on climate change planning and policies. A majority of the climate action plans published by northeastern states refer to 1990 as their baseline year, including: Maine, Massachusetts, New Hampshire, New Jersey, Rhode Island, Vermont, and New York. States outside of the Northeast also support the case for use of a 1990 baseline. California is the most important among these,[12] but Florida, Oregon,[13] and Washington[14] have also established 1990 baselines for their respective climate plans. At the national level, the United States has established a baseline year of 1990 for all climate legislation. And, at the global scale, the Kyoto Protocol states that GHG reductions should be determined in relation to 1990 levels.

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[10] The CT plan states that "[Climate actions] will ensure Connecticut's success in meeting the reduction goals identified by the NEG/ECP and reflected in state law: to reduce its GHG emissions to 1990 levels by 2010 and to 10 percent below 1990 levels by 2020, eventually reaching the long-term reduction goal of 75 percent."

[11] New England Governors/Eastern Canadian Premiers Climate Change Action Plan 2001. Available at http://www.negc.org/documents/NEG-ECP%20CCAP.PDF (accessed June 10, 2009).

[12] California Air Resources Board. 2006. *Assembly Bill 32*. September 27, 2006.

[13] Oregon Legislature. 2007. *House Bill 354.* June 25, 2007.

[14] State of Washington DOE. 2008. *Growing Washington's Economy in a Carbon-Constrained World: A Comprehensive Plan to Address the Challenges and Opportunities of Climate Change*. December 2008.

It is worth noting that some states are establishing non-1990 baseline years. However, most of the states that are choosing base years other than 1990 are relatively new to climate change planning. These states include: Colorado (2005); Utah (2007); and the Midwestern states of Illinois, Iowa, Kansas, Michigan, Minnesota, and Wisconsin (2007). Their rationale for these states' selection of baseline years other than 1990 is that the year their state legislation takes effect and the baseline year are the same.

In considering an alternative to a 1990 baseline, the primary benefit to Connecticut of choosing a more recent year such as 2006 as a baseline would be greater confidence in the actual emissions estimates for this year than for 1990. Data collection and quality and GHG calculation methodologies have improved substantially since EPA first began conducting GHG inventories in the 1990s, so it is reasonable to assume that a 2005 estimate is a more accurate depiction of Connecticut's actual GHG inventory than a 1990 estimate.

Moreover, shifting from a 1990 to a 2006 baseline year would not necessarily require a major change to stated GHG targets or goals in absolute terms. Our review of GHG emissions trends for Connecticut between 1990 and 2006 shows that Connecticut's emissions have stayed surprisingly stable over this period, with 1990 emissions estimated at 41.0 million tons of CO_2-equivalent, and 2006 emissions estimated at 41.6 million tons of CO_2-equivalent.[15] So, a reduction target for 2020 that is expressed as a specific percentage below Connecticut's 2005 levels is virtually the same, in absolute terms, as a target referenced against 1990 levels.

However, it is important to note that GHG data, emission factors, and calculation methodologies are constantly undergoing improvements and refinements. As a result, it will likely always be the case that an emissions estimate for a more recent year is of a higher quality and/or confidence level than estimates for an earlier year (or period of years). So, in our opinion, GHG data and methodological improvements alone do not warrant a shift from a 1990 baseline to a later year as this will be a continually shifting situation in future years as well. Therefore, anticipating future revisions means that whatever baseline year is selected, it will likely always be the case that improvements in GHG data and methodologies will always occur after the baseline year, regardless of year chosen.

Recommendation: CT DEP's current approach in developing its GHG emissions inventory remains valid and is consistent with EPA's State Inventory Tool and approaches taken by other states in the Northeast. While opportunities for additional information exist, NESCAUM recommends that Connecticut maintain a baseline year of 1990 for referencing the goals of future climate plans and policies. On balance, we find it would be more challenging for Connecticut to communicate in public forums and documents on climate planning why 1990 has been replaced with a later base year without a clear technical advantage to doing so. Such a shift would be particularly challenging to explain, given that so many of Connecticut's frame-of-reference jurisdictions still reference 1990. Maintaining 1990 as a base year will provide the public and other stakeholders more confidence in Connecticut's stated progress towards goals, and greater comparability with other leading states and jurisdictions that also use 1990 as a baseline year.

2. Representation of Land Use Change and Forestry Sector in Greenhouse Gas Inventories

States in the Northeast region use the State Inventory Tool (SIT) developed by the U.S. Environmental Protection Agency. SIT has modules representing each sector, including a module for the Land-Use

[15] While total GHG emissions in Connecticut have remained relatively constant over this period, this masks relatively large shifts in emissions of individual sectors–emissions from the transportation sector rose by nearly 25 percent over this period, while emissions from the industrial, electric power, and commercial sectors declined substantially, effectively offsetting the increase in transport emissions.

Change and Forestry (LUCF) sector. The LUCF module calculates forest-based GHG emission sources and sinks, including: forest carbon flux, non-carbon dioxide emissions from forest fires; carbon flux in urban trees; carbon emissions from liming of agricultural soils; carbon storage in landfilled yard trimmings and food scraps; and nitrous oxide emissions from settlement soils.

EPA has updated the *forest carbon flux* category to include state-level annualized data from the Carbon Calculation Tool (CCT) developed by the U.S. Forest Service (USFS) as default data. The CCT retrieves data from the Forest Service's *Forest Inventory and Analysis* (FIA) data to estimate yearly carbon stock and flux for five forest carbon pools (aboveground biomass, belowground biomass, dead wood, litter, and soil organic carbon). The *urban trees* category uses 1990 and 2000 U.S. Census Bureau data on urban area to estimate carbon storage in urban trees. The *liming of agriculture soils* and *landfilled yard trimmings and food scraps* source categories use default data extracted from the National Inventory Report (NIR), which is the annual inventory of U.S. Greenhouse Gas Emissions and Sinks. Emissions factors in these source categories have recently been updated from IPCC estimates to reflect new research results.[16]

The EPA identifies additional source and sink categories that are included in the NIR but not yet incorporated into SIT, including the carbon flux associated with managed cropland and grassland soils and the nitrous oxide emissions from forest soils.[17]

State Approaches to Greenhouse Gas Emissions from LUCF
Below we provide a description of other states' approaches to estimating the net GHG contribution of land use and forestry to their state's overall GHG inventory. For the most part, these approaches involve improvements or additions to the underlying data used by the SIT LUCF module, rather than changes to SIT's methodology for calculating net LUCF emissions.

California. California estimates carbon dioxide flux using an atmospheric flow approach adapted from the 2006 IPCC *Guidelines for National Greenhouse Gas Inventories*[18] and the *Baseline Greenhouse Gas Emissions for Forest, Range, and Agricultural Lands in California* developed by the California Energy Commission.[19] The atmospheric flow approach accounts for removal of carbon dioxide from the atmosphere as a result of vegetation biomass growth (also known as carbon sequestration or carbon uptake) and emissions to the atmosphere from activities including oxidation of timber harvest slash, fuel wood, biomass consumed in wildfires, other disturbances, and the decomposition of landfilled or composted wood products consumed in the state. California anticipates developing a process to account for carbon uptake and emissions by urban forests that will be included once relevant data has been collected.[20]

Maine. Maine utilizes SIT to inventory state-wide emissions, in addition to collection of emissions data from regulated entities and entities that voluntarily report emissions. Maine inputs forestry and land use

[16] Denny A, Asam S, Choate A, Thompson V, Pederson L. *Recent Improvements to the State Inventory Tool Land-Use Change and Forestry Module.* U.S. EPA and ICF International. 2007.
[17] Ibid.
[18] Intergovernmental Panel on Climate Change (IPCC). *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. Available at http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html (accessed June 10, 2009).
[19] California Energy Commission, *Baseline Greenhouse Gas Emissions for Forest, Range, and Agricultural Lands in California*. March 2004. Available at http://www.energy.ca.gov/pier/project_reports/500-04-069.html (accessed June 10, 2009).
[20] California Air Resources Board. *Forested Lands and Wood Products Biodegradable Carbon Emissions & Sinks*. Available at www.arb.ca.gov/cc/inventory/data/tables/net_co2_flux_00-06_2009-03-13.pdf (accessed June 8, 2009).

data into SIT from FIA, which incorporates data from the Forest Inventory, an annual survey of Maine's forest lands collected by the Maine Forest Service.[21] Maine DEP staff indicate that changes were also made to the SIT estimates of Maine's LUCF emissions during the 1990s, based on a closer review and refinement of underlying FIA data.[22]

Massachusetts. Massachusetts anticipates using the SIT to calculate land use and forestry sector emissions and sinks. In past years, Massachusetts used *Carbon in United States Forests and Wood Products 1987-1997: State by State Estimates* by R.A. Birdsey and G.M. Lewis of the USDA Forest Service.[23] Massachusetts' current GHG emissions baseline and 2020 business-as-usual projection reflect gross LUCF emissions only, not net emissions that incorporate estimates of carbon sinks. At present, the state believes that the level of uncertainty surrounding historic and future carbon sequestration estimates is too high for their inclusion.

New Hampshire. New Hampshire uses SIT default data to inventory emissions for most sectors, but recently relied on data supplied by the University of New Hampshire to represent net emissions from forestry and land use. These data are expected to be made public in the near future.[24] New Hampshire anticipates improving annual forest and land use data, including more frequently updated land cover, by improving statewide geographic information system data and services through the Geographically Referenced Analysis and Information Transfer (GRANT).

New Jersey. New Jersey utilizes SIT with some modifications to default data in the LUCF sector. New Jersey estimates land cover using the Carbon On Line Estimator (COLE)[25] and incorporates FIA data, aerial photography interpreted by the NJ Department of Environmental Protection's Geographical Information Systems Unit, and information from the Center for Remote Sensing and Spatial Analysis at Rutgers University. Agricultural default data in SIT is checked against data from the New Jersey Department of Agriculture Annual Reports and replaced with the local data when differences are found.[26]

New York. New York currently uses SIT to inventory emissions, relying mainly on program defaults and other top-down data.[27] New York State Energy Research and Development Authority (NYSERDA) is currently developing new methods for the calculation of agriculture, forestry, and waste management emissions and sinks.[28]

Vermont. Vermont also uses SIT with some modifications to the LUCF sector. The state reports estimating forest carbon flux using data from the USFS, with carbon pool data taken from the Forest

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[21] Maine Department of Environmental Protection. *Report to the Joint Standing Committee on National Resources: Second Biennial Report on Progress Toward Greenhouse Gas Reduction Goals.* January 2008.
[22] Personal correspondence with Michael Karagiannes and Melanie Loyzim, Maine DEP, May 27, 2009.
[23] Birdsey RA, Lewis GM. *Carbon in United States Forests and Wood Products 1987-1997: State by State Estimates*. USDA Forest Service. 2002. Available at http://www.fs.fed.us/ne/global/pubs/books/epa/ (accessed June 10, 2009).
[24] NESCAUM communication with Chris Skoglund, New Hampshire Department of Environmental Services. March, 2009.
[25] National Council for Air and Stream Improvement & U.S. Forest Service. *Carbon On Line Estimator Version 2.0.* Updated April 27, 2009. Available at http://ncasi.uml.edu/COLE/ (accessed June 10, 2009).
[26] Aucott M. *Draft New Jersey Greenhouse Gas Emissions and Projections*. New Jersey Department of Environmental Protection. September, 2007.
[27] New York State Energy Research and Development Authority. *New York State Greenhouse Gas Emissions Inventory and Forecasts for the 2009 State Energy Plan*. March 4, 2009.
[28] NESCAUM communication with Carl Mas, New York State Energy Research and Development Authority. March, 2009.

Service's Forest Carbon Model (FORCARB), which takes data from the USFS Forest Inventory and Analysis (FIA) survey. Adjustments to the SIT estimates were made to account for increases in livestock attributable to Vermont's "Cow Power" program. Agriculture data were retrieved from the USDA Fertilizer Institute and the National Agricultural Statistics Survey (NASS).[29]

Recommendations: NESCAUM recommends that Connecticut focus its efforts for the LUCF sector on identifying new data and/or refining the underlying FIA data, rather than considering any major changes to SIT methodologies. EPA has been improving the LUCF module in accordance with recommendations from the Kyoto Protocol process for national GHG inventories, so any changes from these methods would result in a lack of comparability with national and international standard approaches. Moreover, the quality of the estimates for the LUCF sector can be best enhanced through improvements to underlying data. NESCAUM can work with CT DEP staff to explore additional sources of information and data to enhance FIA estimates.

3. Data Sources for In-state Energy Demand met by In-state and Out-of-State Activity: Net GHG Emissions from the Electricity Sector

Through information from EIA, EPA, and ISO-NE, NESCAUM has come up with a profile for eighteen years (1990-2007) of Connecticut electricity generation, use, and emissions. Looking at electricity generation and import/export amounts for Connecticut allows us to get an estimate as to the amount of electricity used and the resulting emissions in Connecticut on a yearly basis.

Using the EPA's State Inventory Tool (SIT), we were able to analyze the amount of carbon dioxide equivalents emitted through the generation of electricity, every year.[30] Multiplying this number by the percentage of electricity that was generated in Connecticut and subsequently exported to other states, we calculated the emissions levels for electricity use in the years the state generated excess power.

To analyze the greenhouse gas emissions associated with electricity imports, we took the amount of electricity imported (during years when imports were needed) and multiplied them by a year-specific Marginal Emission Rate provided by ISO-New England.[31] The ISO-New England figures supplied us with an aggregate emission level for the electricity generation for the region. This was needed because electricity imports usually come from more than one location. However, while this helps to reduce the problems associated import emissions data, it does not solve the problem completely. Although it is assumed that Connecticut draws some of its imported electricity from the New England region, we do not have numbers that say how much comes from the region and how much come from other areas like the ISO-New York, etc. Our current analysis offers a rough estimate of emission levels but is by no means the exact measure. Another problem we ran into was that the ISO-NE numbers were available for years between 1993 and 2006. Import emissions from 1991 were calculated from the 1993 rate and import emissions from 2007 were calculated from the 2006 rate. When 2007 data become available, more accurate analysis can be done for that year. Suggestions are welcome for how to refine this analysis.
In addition to electricity imports, there is the issue of the "embedded emissions" of other imported goods brought into CT but produced outside the state. We do not go into this broader and complex topic here, but note it is an area of active interest in California, and if it is of interest to CT, it could be investigated further by NESCAUM. At this stage of inventory development and considering resource limits, however,

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[29] Strait R, Roe S, Lindquist H, Hsu Y. *Draft Vermont Greenhouse Gas Inventory and Reference Case Projections 1990-2030*. Center for Climate Strategies. May 2007.
[30] EPA. 2009. Resources for Inventory Development. EPA website. April 1, 2009. Available at http://www.epa.gov/climatechange/emissions/state_guidance.html (accessed June 5, 2009)
[31] ISO-New England. 2009. *Emissions Reports*. ISO-NE website. Available at http://www.iso-ne.com/genrtion_resrcs/reports/emission/index.html (accessed June 5, 2009)

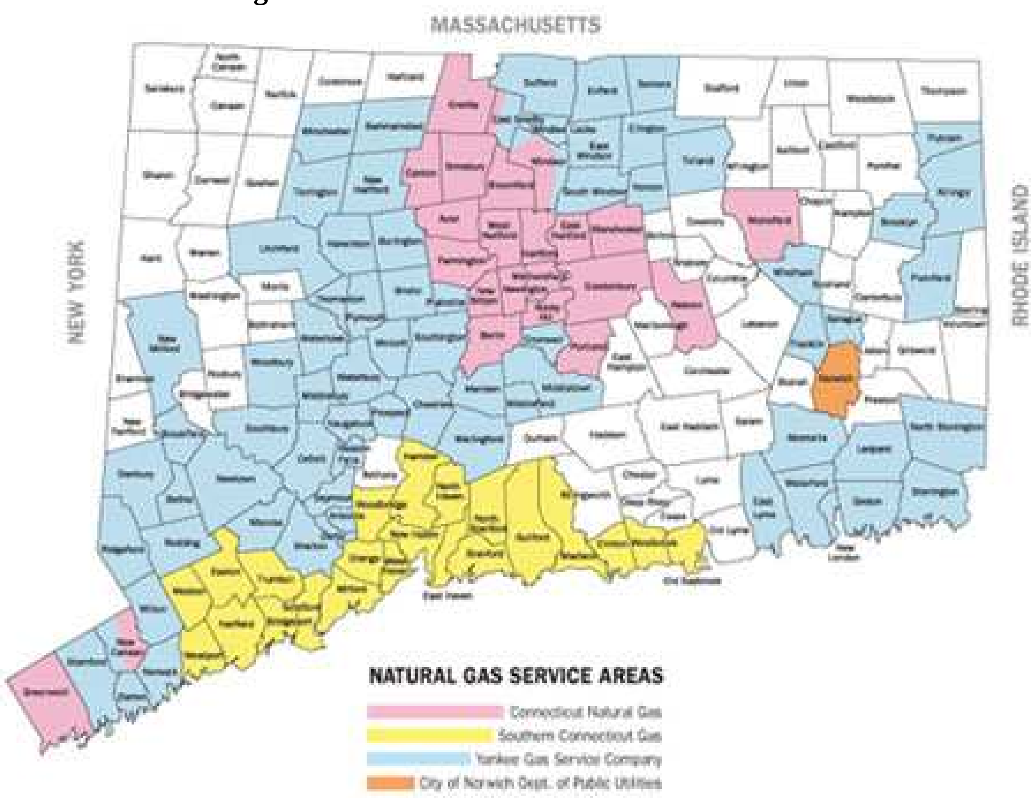
it is our recommendation to maintain "observer" status and follow what is happening in California as these concepts are further developed.

4. Connecticut Natural Gas Service Territories

Connecticut is currently served by four natural gas providers. These providers include: Connecticut Natural Gas, Southern Connecticut Gas, Yankee Gas Services, and the City of Norwich Department of Public Utilities. **Figure 1** below shows the geographic distribution of natural gas coverage, by provider. In terms of geographic coverage area, the largest provider is Yankee Gas Services. Southern Connecticut Gas and Connecticut Natural Gas have smaller coverage areas. The City of Norwich Dept. of Public Utilities is only in New London County.

The largest natural gas provider in terms of total customers is Connecticut Natural Gas, followed by Southern Connecticut Gas, Yankee Gas Services, and the City of Norwich. Many CT areas have no natural gas service. We assume that these are more rural areas with insufficient population density to make the infrastructure needed for natural gas service economically viable.

Figure 1. Connecticut Natural Gas Service Providers[32]



[32] Connecticut Natural Gas Corp. 2009. *Service Area*. CNG Corp. Available at http://www.cngcorp.com/OurCompany/ServiceArea/default.html (accessed June 5, 2009).

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MEMORANDUM

TO: Tracy Babbidge, Paul Farrell, CT DEP
FROM: Leah Weiss, Paul Miller
RE: *Information on New York State (NYS) Greenhouse Gas (GHG) Inventory*
DATE: June 10, 2009

1. *What is NY's base year for its GHG inventory?*

NYS DEC staff have been referencing 2005 as a base year, but in reality NY does not have a definitive base year, per se. It presents its climate data for the years 1990, 2000, and 2005, and has annual inventory data back to 1990. NY tries to track and update its inventory on an annual basis, but for forecasting purposes it publishes in five year increments.

The 1990 and 2005 inventories are very close, at 279 and 276 million short tons, respectively.

2. *How much of the NYS inventory is bottom-up versus top-down? How are power plant and transportation emissions calculated?*

NYS DEC staff have indicated that most of the inventory, roughly 90%, is top-down, and is based on U.S. DOE's Energy Information Administration (EIA) fuel use data, including the power and transportation sectors.

NY divides its inventory into two main categories: 1) Fuel Combustion and 2) Other Sources. Fuel combustion sources include electricity generation, transportation, residential, commercial, and industrial sectors.

For power plants, NY does not use power plant data from EPA's Clean Air Markets Division (CAMD) because NY ran into some issues with using those data, e.g., dual fuel facilities. In addition, the CAMD database does not cover units smaller than 25 MW. Therefore, the database does not include sources such as peaking units and small wood combustors.

NYS DEC does not include emissions associated with imported electricity, but it is considering including some data in future inventories.

For the transportation sector, NY has been using EIA data and calculating emissions based on total gasoline sales, and cross-checking the numbers against other data. Because it is nearly impossible to disaggregate the gasoline use data, and NY estimates that the top-down approach is underestimating transportation sector emissions by roughly 20%, NY is considering changing its methodology in future to vehicle miles traveled (VMT), a bottom-up approach. Previously, NY was reticent to use VMT projections for the GHG inventory because the VMT projections were not tracking well with the growth rate. More recently, however, that trend has changed, and NY now plans to adopt the VMT approach when EPA and states shift to the MOVES model. Note that even with the shift to MOVES, the data will have to be reconciled. NY will only be able to publish MOVES output for on-road vehicles, and will need data for the other mobile source categories. This process will be complex, as it is critical to ensure there is no double counting or category omissions.

3. *What is NY focusing on for the bottom up portion of its inventory, and what problems have been encountered in gathering the data?*

<u>Bottom up portion</u>
Approximately 30 million short tons comprise the "Other Sources" category, which covers sources such as agricultural animals and soils management, aluminum production, cement production, chemical manufacturing, crop waste combustion, iron and steel manufacturing, municipal waste and wastewater treatment facilities, natural gas leakages, and refrigerant substitutes. This category was compiled using a labor-intensive bottom-up approach primarily from EPA's EIIP Volumes VII, VIII, and X.

NY is looking to assess the EPA workbooks (since they have been recently updated) as well as other models (e.g., waste management models) for these categories, and will be scaling from the national numbers as appropriate.

It is a reflection of each agency's effort and past priorities as to what categories have been more researched and have useable data. Therefore, data in NY may not be available in another state.

<u>Problems encountered</u>
As NY collected data for the inventory, it identified several issues and quirks in the data. Issues to think about, particularly as most inventories are state-specific and focus primarily on fuel use, are how to deal with international or out-of-state products and avoid double counting and leakage. For example, in the aviation sector, the FAA publishes fuel use by flight type (including domestic and international flights) whereas NY wanted to collect data only on domestic flights with NY fuel use.

The issue of land use and carbon sinks has been challenging. NY felt the available federal data had too much uncertainty, so to date NY does not include sinks in its inventory. NY, however, plans to look at the sinks in future because: 1) they are a huge source of carbon that is important to track, and 2) EPA currently treats biomass as carbon neutral – a policy that is to be reexamined as biofuel policies are developed.

In the NY GHG inventory, all wood use (residential, commercial, industrial) and all biogenic sources, including biogenic waste, are considered carbon neutral. The exception is ethanol, which NY is treating as equal to gasoline in terms of GHG emissions given the uncertainties surrounding land use changes and ethanol production.