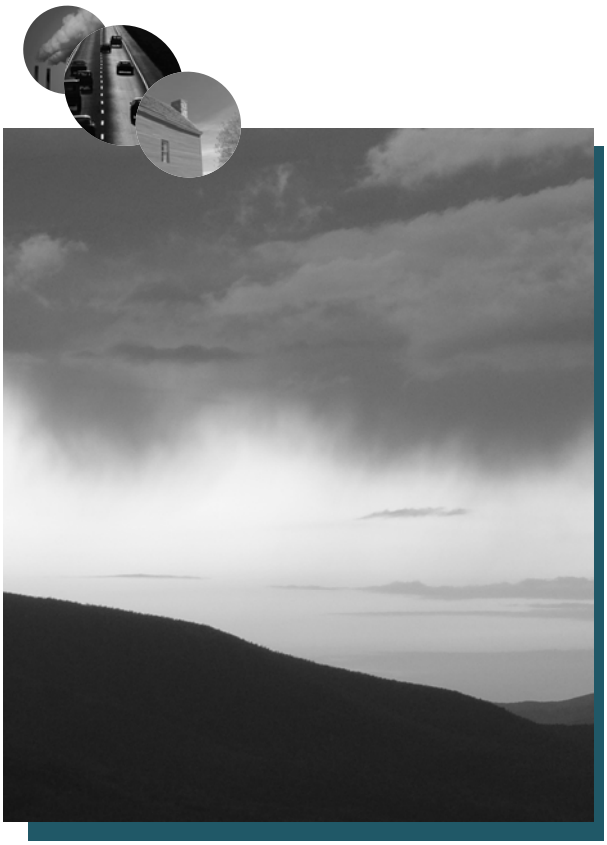

VERMONT

Greenhouse Gas Emissions Inventory Update 1990 – 2012

June 2015

VERMONT

Department of Environmental Conservation
Air Quality and Climate Division

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EMISSIONS SUMMARY

Vermont's statewide greenhouse gas (GHG) emissions exhibited a slight increase from 8.11 million metric tons CO2 equivalent (MMTCO2e) in 2011 to 8.27 MMTCO2e in 2012. This level is approximately 2% higher than 1990 levels.

Overall, emissions from most sectors declined slightly or remained nearly constant between 2011 and 2012. However, the consumption-based methodology used to quantify emissions from the electricity sector in this inventory indicates that emissions associated with this sector have been increasing over the past few years despite energy efficiency programs and an increase in in-state renewable energy generation. The increased emissions have been caused by a marked decrease in reliance on nuclear generation, a consequential increased reliance on higher GHG-emitting regional market power in Vermont's contracted electricity mix, and ongoing sales of Renewable Energy Certificates (RECs) to entities outside of Vermont. Selling the "renewable attributes" (RECs) separately from the renewably-generated electricity itself precludes taking credit in this inventory for the non-GHG emitting characteristics of that electricity.

The emissions estimates presented in this report were developed using methodologies consistent with the *Final Vermont Greenhouse Gas Inventory and Reference Case Projections, 1990-2030*[1] developed by the Center for Climate Strategies (CCS), the most current State Inventory Tool modules from the U.S. Environmental Protection Agency, and data available from a variety of in-state and national sources including the Vermont Department of Public Service, Vermont Agency of Transportation, Vermont Legislative Joint Fiscal Office (JFO), U.S. Department of Agriculture, U.S. Department of Energy, and others. Historical and updated GHG emissions data have been calculated and are summarized by sector in the tables and graphs that follow.[2]

This inventory provides a comprehensive GHG emissions update through calendar year 2012. Table 1 provides 2012 emissions estimates for sectors where data were available (black text). For sectors having no 2012 data available at the time of inventory preparation (grey text), this inventory assumes no change in the emissions value from 2011. These data will be revised, if necessary, in a future GHG emissions inventory update. Some data sources are available that can be used to infer calendar year 2013 GHG emissions from transportation and residential / commercial / industrial (RCI) fuel combustion. Based on these data, it is likely that transportation emissions for 2013 continued to decline, while RCI emissions likely increased slightly in response to a colder heating season. Overall, statewide emissions for 2013 are not expected to differ appreciably from 2012 levels.

[1] See http://www.anr.state.vt.us/anr/climatechange/Vermont_Emissions.html

[2] Primary author – J. Merrell, VT Air Quality and Climate Division (AQCD) – jeff.merrell@state.vt.us

Table 1. Vermont Historic GHG Emissions by Sector

Million Metric Tons CO_2 equivalent ($MMTCO_2e$)[3,4]

Sector	*Year*					
	1990	***2000***	***2005***	***2010***	***2011***	***2012***
Electricity Supply & Demand (consumption-based)	**1.09**	**0.44**	**0.64**	**0.43**	**0.44**	**0.92**
Coal	0	0	0	0	0	0
Natural Gas	0.047	0.018	0.003	0.005	0.005	0.001
Oil	0.014	0.058	0.011	0.042	0.042	0.014
Wood (CH_4 & N_2O)	0.003	0.009	0.009	0.014	0.012	0.012
Residual System Mix	1.03	0.35	0.62	0.37	0.38	0.89
Residential / Commercial / Industrial (RCI) Fuel Use	**2.43**	**2.88**	**2.98**	**2.53**	**2.53**	**2.29**
Coal	0.02	0.003	0.0003	-	-	-
Natural Gas	0.31	0.50	0.44	0.44	0.45	0.44
Oil, Propane & other petroleum	2.06	2.34	2.49	2.05	2.04	1.80
Wood (CH_4 & N_2O)	0.05	0.04	0.04	0.04	0.04	0.05
Transportation	**3.22**	**3.99**	**4.20**	**3.89**	**3.73**	**3.69**
Onroad Gasoline	2.64	3.20	3.29	2.90	2.77	2.70
Onroad Diesel	0.41	0.66	0.69	0.70	0.68	0.67
Jet Fuel & Aviation Gasoline	0.08	0.07	0.17	0.09	0.10	0.10
Rail / Ships / Boats / Other Nonroad	0.08	0.06	0.04	0.2	0.18	0.22
Fossil Fuel Industry [5]	**0.012**	**0.012**	**0.014**	**0.015**	**0.015**	**0.0027**
Natural Gas Distribution	0.011	0.011	0.013	0.014	0.014	0.0027
Natural Gas Transmission	0.0007	0.0008	0.0009	0.001	0.001	
Industrial Processes	**0.12**	**0.27**	**0.30**	**0.29**	**0.29**	**0.29**
ODS Substitutes	0	0.15	0.21	0.23	0.24	0.24
Electric Utilities (SF6)	0.05	0.03	0.02	0.02	0.01	0.01
Semiconductor Manufacturing (HFC, PFC & SF6)	0.07	0.06	0.03	0.01	0.01	0.01
Limestone & Dolomite Use	0	0.02	0.03	0.025	0.024	0.024
Soda Ash Use	0.006	0.006	0.005	0.004	0.004	0.004
Waste Management	**0.24**	**0.31**	**0.29**	**0.24**	**0.27**	**0.23**
Solid Waste	0.18	0.25	0.23	0.18	0.21	0.17
Wastewater	0.06	0.06	0.06	0.06	0.06	0.06
Agriculture	**1.0**	**0.96**	**0.92**	**0.84**	**0.84**	**0.84**
Enteric Fermentation	0.59	0.56	0.53	0.50	0.53	0.53
Manure Management	0.12	0.14	0.15	0.17	0.16	0.16
Agricultural Soils	0.29	0.26	0.24	0.17	0.15	0.15
TOTAL GROSS EMISSIONS	8.11	8.86	9.34	8. 23	8.11	8.27
Change relative to 1990	-	*+9%*	*+15%*	*+1.5%*	*0%*	*+2%*

[3] Note: Grey text for some emissions sectors for 2012 indicates that data are held constant from 2011 levels until actual data become available. As a result, the 2012 data are subject to change, and may be revised in the next inventory update.

[4] Totals may not sum exactly due to independent rounding.

[5] Source: US EPA FLIGHT Tool (http://ghgdata.epa.gov/ghgp/main.do). GHG Emissions data (transmission & distribution only) were reported by Vermont Gas Systems (VGS) in 2012. The data show that reported GHG emissions for 2012 were notably lower than this inventory's prior year estimates that were based on assumed national average transmission and distribution methane leakage rates.

Figure 1. Historical VT & US (1990-2012)[6] Gross GHG Emissions

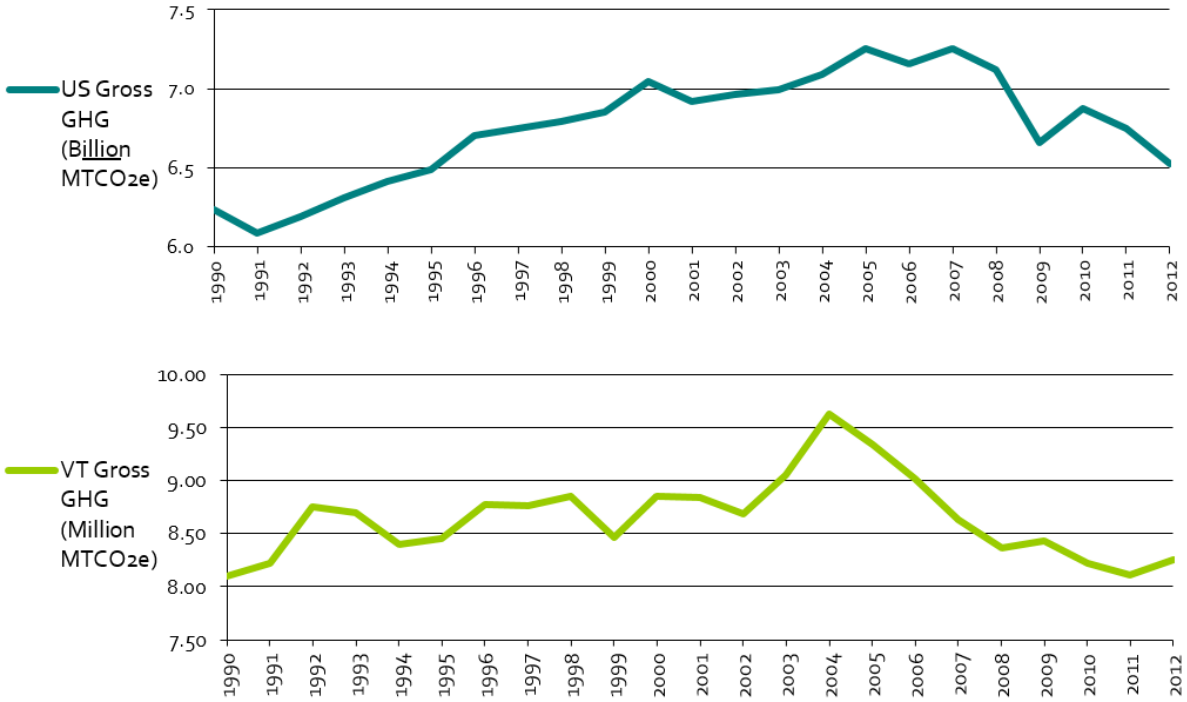
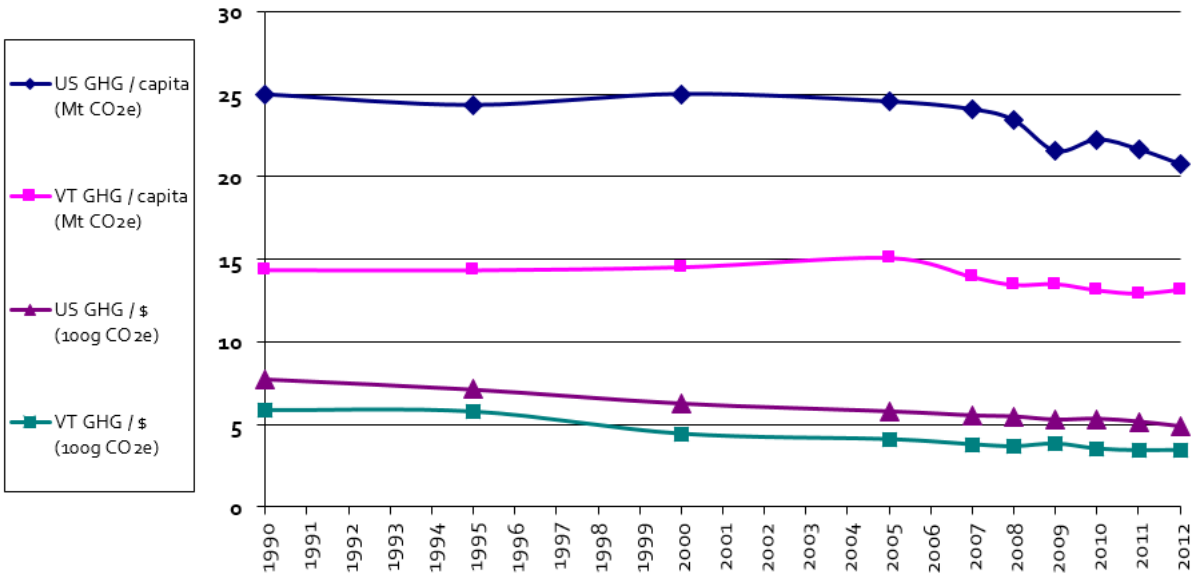


Figure 2. Historical VT & US Gross GHG Emissions per Capita[7] and per Unit Gross Product[8]



[6] US data source: US EPA - INVENTORY OF U.S. GREENHOUSE GAS EMISSIONS AND SINKS: 1990-2012, April 2014 - http://www.epa.gov/climatechange/ghgemissions/usinventoryreport.html

[7] Population data source: United States Census Bureau - http://quickfacts.census.gov/qfd/states/50000.html

[8] GDP data source: Bureau of Economic Analysis – US Dept. of Commerce - http://www.bea.gov/regional/index.htm

Figure 3. 2012 Gross GHG Emissions Percent Contribution by Sector, Vermont and the United States[9]

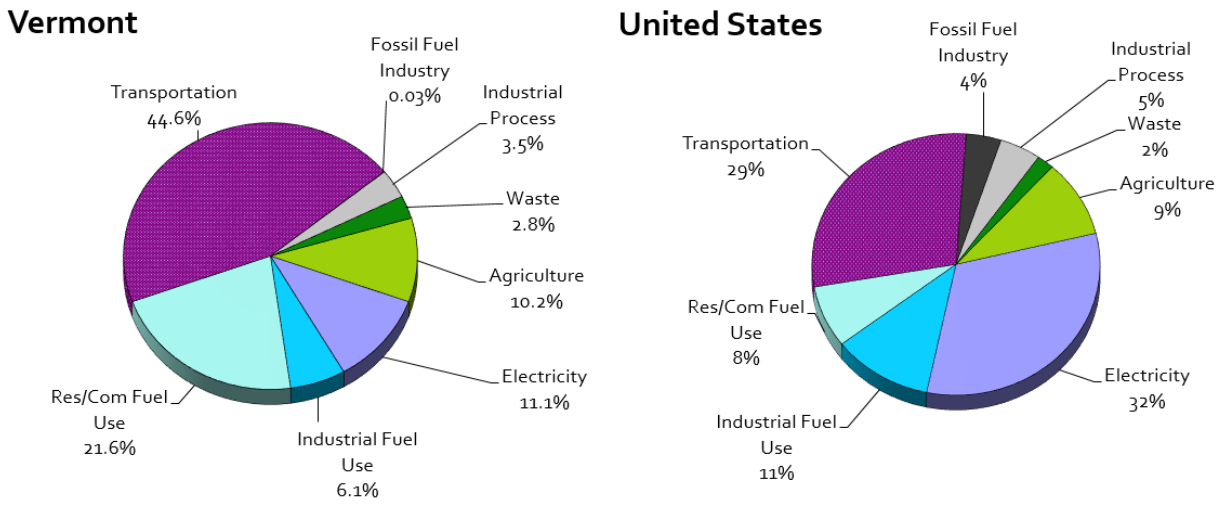
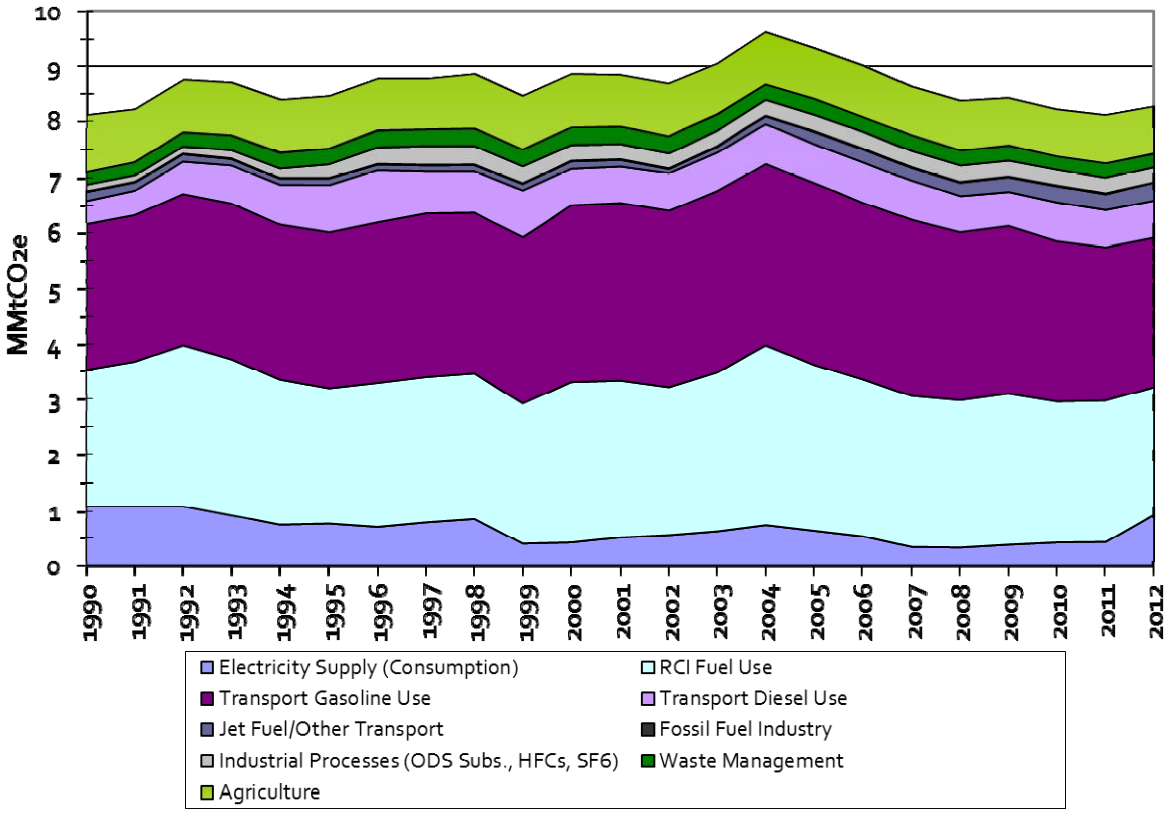


Figure 4. Total Vermont Gross GHG Emissions (1990-2012)



[9] US data source: US EPA - INVENTORY OF U.S. GREENHOUSE GAS EMISSIONS AND SINKS: 1990-2012, April 2014 - http://www.epa.gov/climatechange/ghgemissions/usinventoryreport.html

Figure 5. Vermont Gross GHG Emissions – Individual Sector Trends (1990-2012)

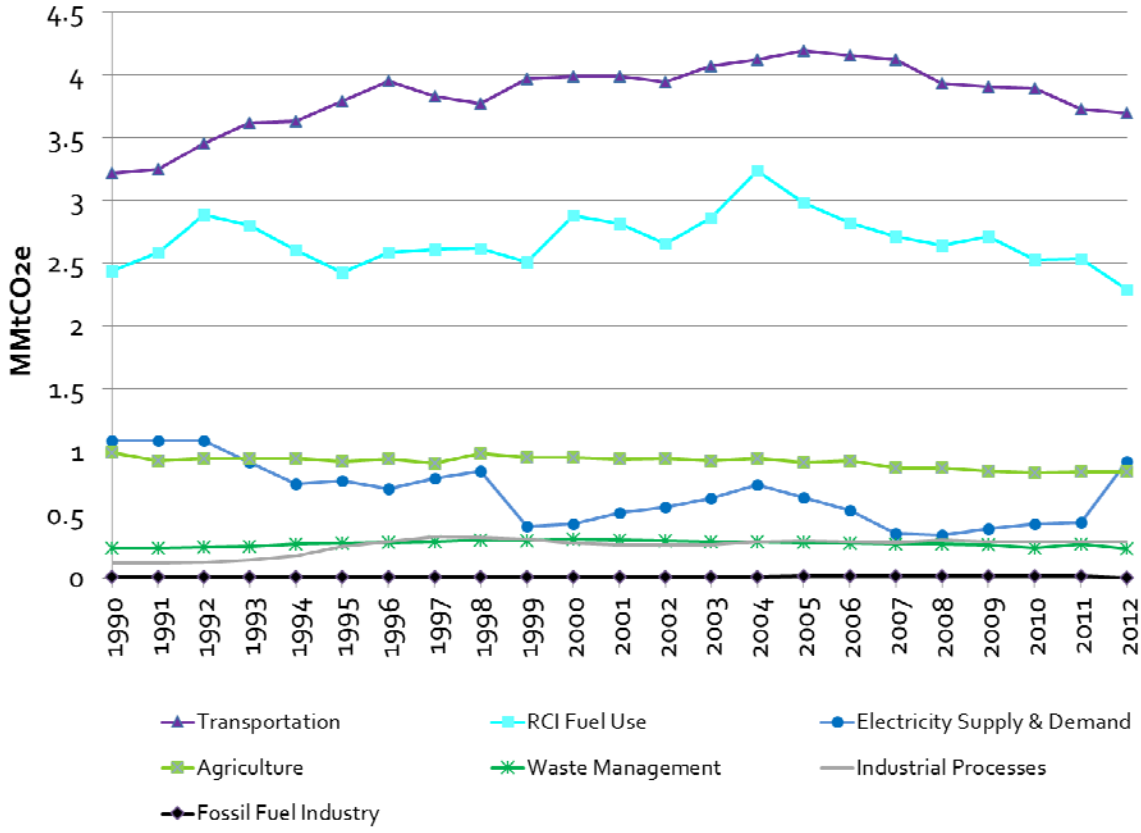
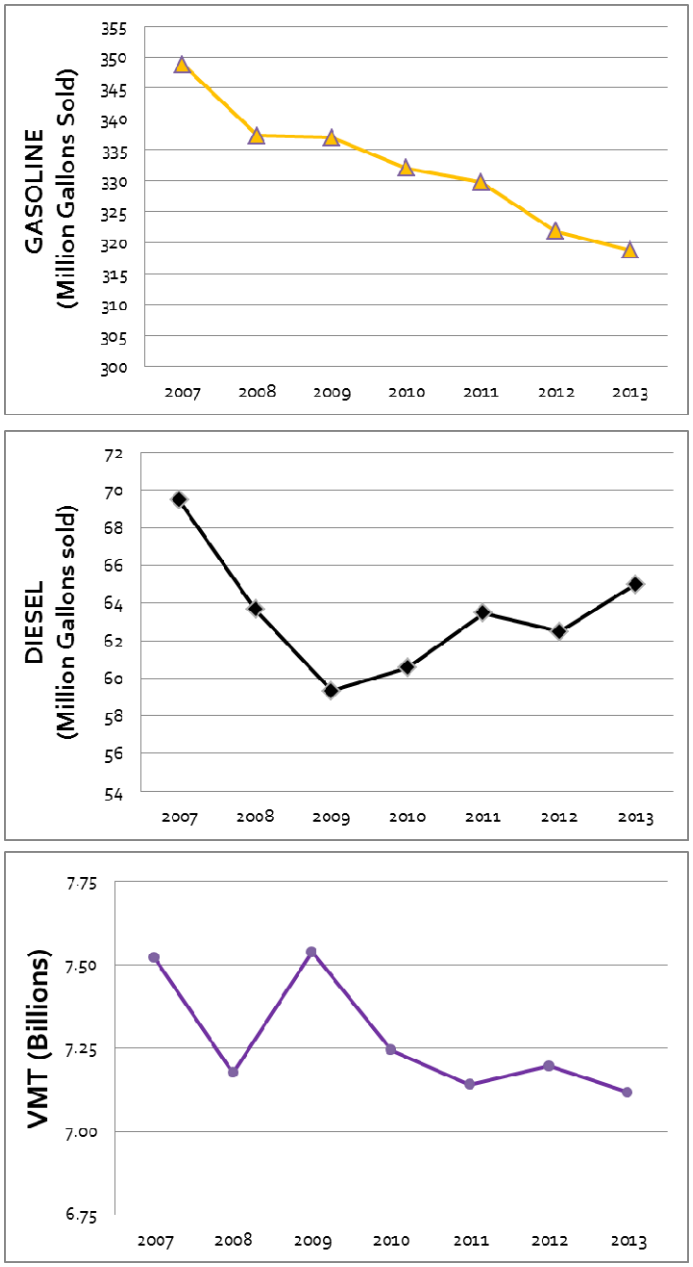


Figure 6. Vermont Transportation Indicator Trends[10]



Although a more thorough analysis to include all sectors and other GHGs such as methane (CH_4), nitrous oxide (N_2O), etc. will be performed for calendar year 2013 in the next GHG inventory update, a preliminary analysis is presented that considers only carbon dioxide (CO_2) emissions from the Transportation and RCI sectors.[11]

Statewide gasoline and diesel fuel sales data from the Legislative Joint Fiscal Office (JFO) indicate that gasoline sales continued to decline in 2013. Diesel fuel sales increased slightly from 2012 levels (see Figure 6). Vehicle Miles Traveled (VMT) data for 2013 from the Vermont Agency of Transportation (VTrans) indicate that statewide VMT did not change appreciably from the estimates presented in 2010 through 2012[12].

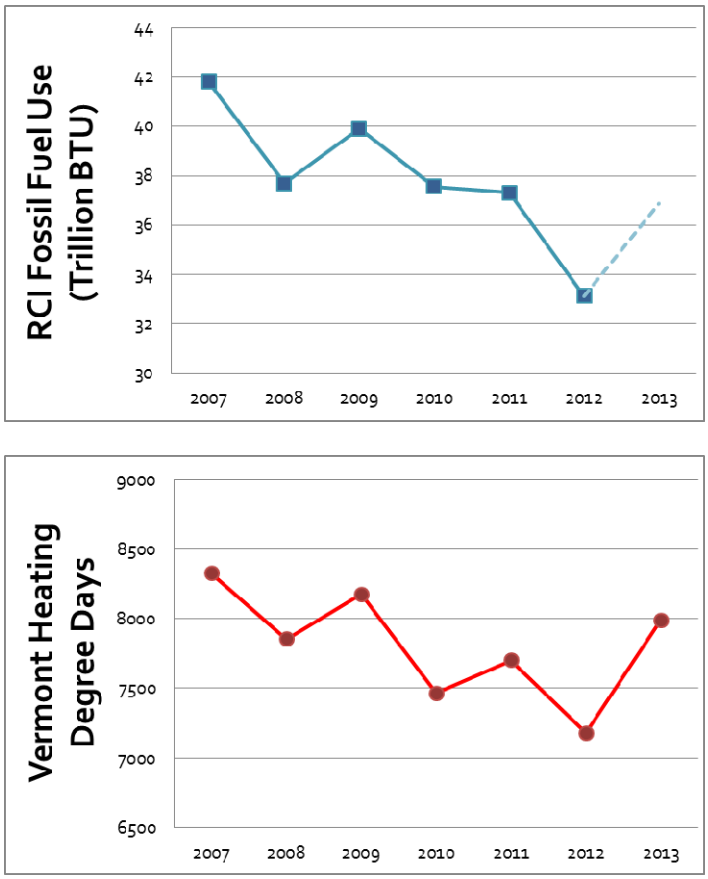
Transportation fuel sales data and VMT will not provide a comprehensive representation of actual transportation GHG emissions. Fuel sales are used in this analysis to provide a preliminary look ahead at the possible GHG emissions from the transportation sector. More accurate modeling will be done for this sector for 2013 when all the necessary data are available and processed.

[10] Gasoline and Diesel gallons sold data obtained from the Vermont Legislative Joint Fiscal Office http://www.leg.state.vt.us/jfo/transportation.aspx

[11] Estimates of CO_2 emissions were calculated using fuel-specific emission factors available from http://www.eia.gov/oiaf/1605/coefficients.html

[12] VMT data obtained from: http://vtransplanning.vermont.gov/sites/aot_policy/files/documents/highwayresearch/MI_VMT13.pdf

Figure 7. Vermont Residential / Commercial / Industrial (RCI) Fuel Use Indicator Trends[13]

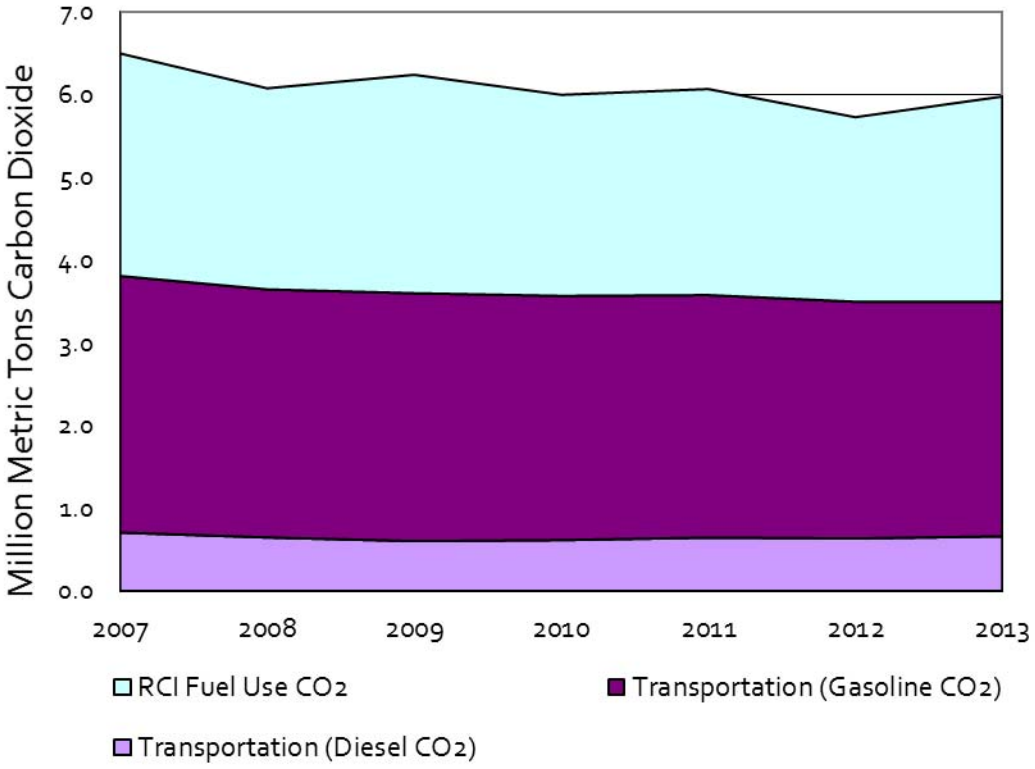


Fossil fuel consumption data for the Residential / Commercial / Industrial sectors in Vermont declined from 2011 to a level in 2012 slightly below what was predicted using annual Heating Degree Days (HDD) in the previous inventory update. The US Energy Information Administration data for RCI fuel consumption are not yet finalized for 2013. However, since much of the RCI fuel is consumed for space heating purposes, the data should correlate reasonably well with annual HDD data for Vermont which are available for 2013 (see Figure 7). Given the increase shown in the HDD data between 2012 and 2013, it is likely that 2013 RCI fuel consumption will be higher (shown by the dashed blue line in Figure 7) than 2012 levels.

[13] RCI Fuel consumption data obtained from the U.S. Energy Information Administration (EIA) – State Energy Data System (SEDS) http://www.eia.gov/state/seds/seds-data-fuel.cfm?sid=US.
Heating Degree Day data obtained from ftp://ftp.cpc.ncep.noaa.gov/htdocs/products/analysis_monitoring/cdus/degree_days/archives/Heating%20degree%20Days/monthly%20states/

A preliminary summary of CO_2 emissions from the Transportation and RCI sectors using these data indicates that the CO_2 emissions trend over the past several years continues to be relatively flat (Figure 8). Since Transportation and RCI are responsible for approximately 3/4 of total statewide GHG emissions, it is likely that the statewide total gross GHG emissions trend likely will also exhibit only minor changes through 2013.

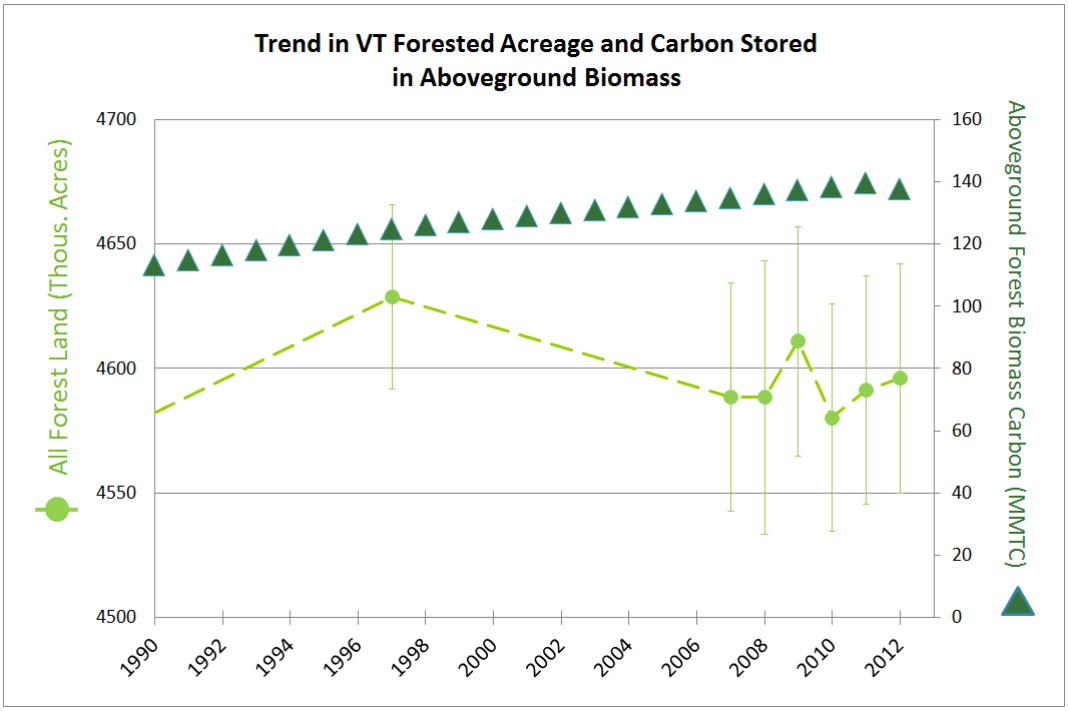
Figure 8. Estimated Carbon Dioxide (CO_2) emissions from Transportation and Residential / Commercial / Industrial Fuel consumption (2007-2013)



FORESTRY & LAND USE[14]

Recently updated data from the USDA Forest Service[15] indicate that Vermont's forests continue to serve the vital role of sequestering carbon. As shown in Figure 9 below, the total number of forested acres in Vermont has remained relatively constant over the past decade. In addition, the quantity of carbon that has been sequestered and stored as aboveground biomass (i.e., live trees) has shown a fairly steady increase over time with current levels reaching approximately 122% of 1990 levels.

Figure 9. Change in Aboveground C Stocks and Acreage of Vermont Forestland [16]



The USDA Forest Inventory and Analysis (FIA) Program made a substantive methodology change recently (2010) by transitioning away from using only computer model-based estimates of dead wood carbon, based on live tree carbon density, to estimates obtained using actual field observations of standing and downed dead wood[17]. The methodology change produces improved (and notably different) estimates of carbon stocks and flux, making direct comparison between the data for 2011 and 2012 with historical estimates challenging.

Until these data challenges are better resolved, Vermont may do well to focus its attention on tracking the parameters shown in Figure 9 above, especially since live tree measures are the largest above ground pool of carbon stock and flux. Vermont can maintain its rural, working landscape, enhance resilience of the landscape and its inhabitants to climate change, and help mitigate the ever-increasing concentrations of CO_2 in the atmosphere by increasing or (at minimum) maintaining the acreage of forest land, while simultaneously promoting healthy forests that represent a growing carbon sink.

[14] This section developed in collaboration with Sandy Wilmot (VT Dept. of Forests, Parks and Recreation).

[15] http://www.nrs.fs.fed.us/fia/data-tools/state-reports/VT/

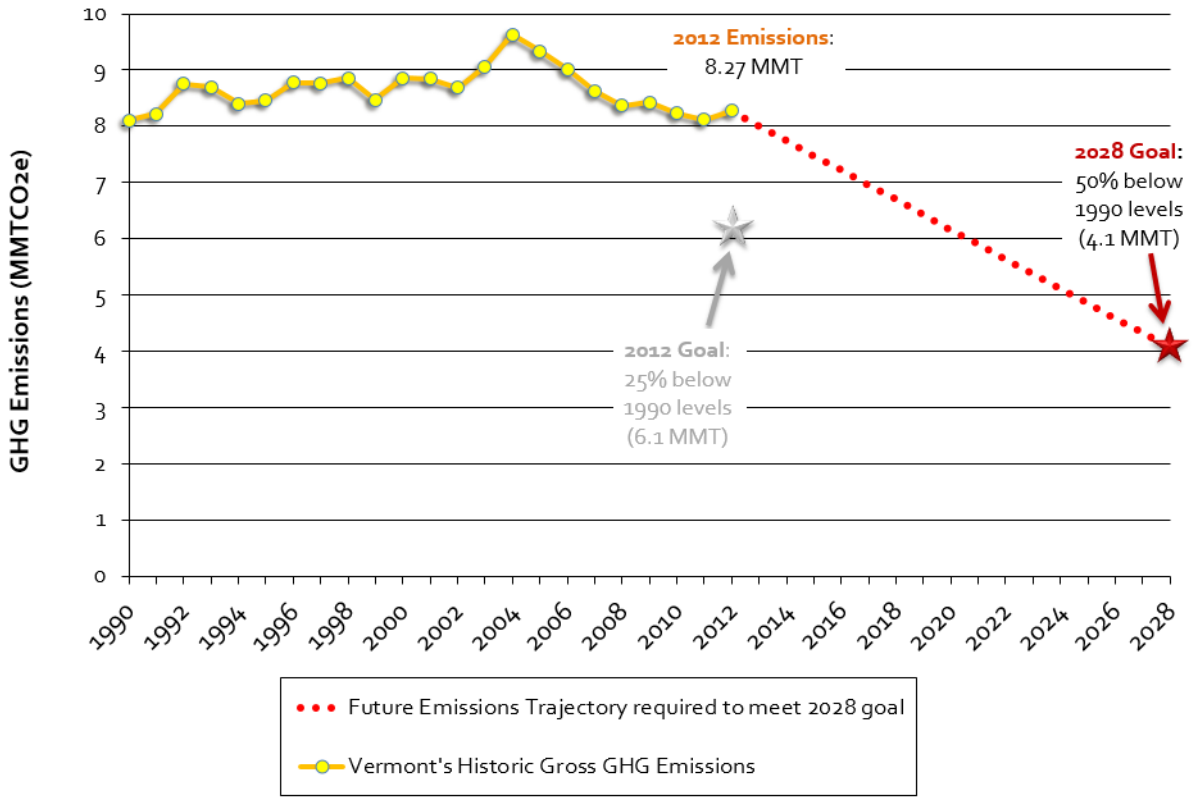
[16] Adapted from *Vermont's Forest Resources, 2012*: http://www.nrs.fs.fed.us/pubs/43901

[17] Grant Domke & Chris Woodall, (USDA-NRS-FIA), personal communications to S. Wilmot

CONCLUSIONS

Vermont did not achieve its 2012 goal of reducing GHG emissions to 25% below 1990 levels. It is clear that there is much work to do to reach the next goal on the horizon of reducing GHG emissions 50% below 1990 levels by 2028 as set forth by state statute (see Figure 10).[18]

Figure 10. Vermont GHG Emissions Relative to Reduction Goals



On December 5, 2014, the Vermont Public Service Department released the Total Energy Study[19] (TES) final report. This report lays out a framework of policy and technology pathways that are most likely to move the state towards success in achieving its GHG emissions goals, as well as the goal of 90% energy from renewable sources by 2050. As the TES doesn't recommend a specific path forward, it will be crucial to begin a broader conversation as to how we can best translate the results of the TES into real progress towards our state energy and GHG goals. In addition, we must continue to strongly promote other efforts at the state, regional, and national levels such as energy efficiency and weatherization enhancements, Vermont's continued commitment to the adoption of the California Zero Emission Vehicle (ZEV) requirements, participation in the Regional Greenhouse Gas Initiative (RGGI), and the federal government efforts to reduce GHG emissions and improve fuel economy for onroad vehicles and engines.

[18] See http://www.leg.state.vt.us/statutes/fullsection.cfm?Title=10&Chapter=023&Section=00578

[19] See http://publicservice.vermont.gov/publications/total_energy_study

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