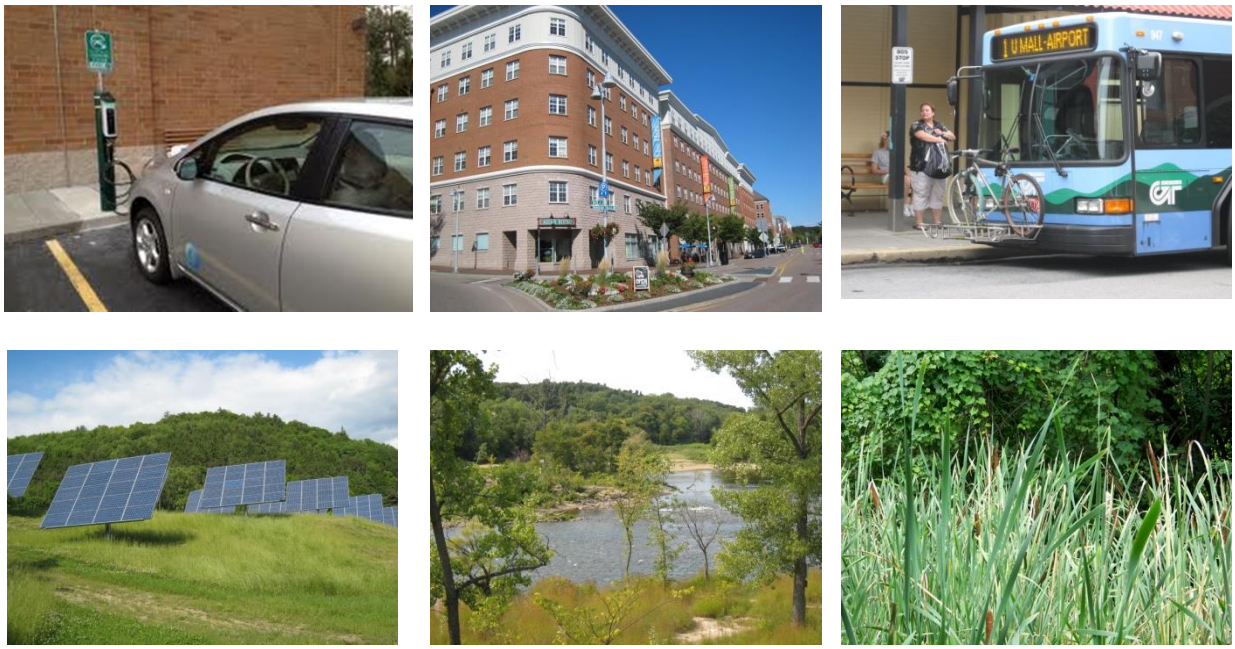
CREATING A CLIMATE FOR RESILIENCE:

Chittenden County Regional Climate Action Guide



May 2014

Chittenden County Regional Planning Commission

CHITTENDEN COUNTY RPC
Communities Planning Together

Executive Summary

Chittenden County's climate is already changing. Winters are warmer and summers are hotter. Lake Champlain freezes over later and less frequently, and the growing season lasts longer. While it is unknown exactly how future climate trends will specifically affect Chittenden County, precipitation throughout the northeast -- defined as the region stretching from New Jersey and Pennsylvania north to Maine, New Hampshire and Vermont -- is projected to increase as much as 10 percent over the century.

Winter precipitation amounts are predicted to grow at higher rates than summer. While 14 of the last 20 Chittenden County winters, including seven of the last 10, have seen above average snowfall, scientists predict a greater proportion of winter precipitation throughout the northeast region will fall as rain in the future instead of snow. Vermont can expect heavier rain and snowstorms, particularly in winter and spring. Even this far north, summers will likely have more than 15 days per year over 90°F by the 2050s under a global scenario modeled for continued high emissions of heat-trapping gases.

Scientists overwhelmingly agree that changes in climate worldwide are a result of human activities, mainly the burning of fossil fuels. Climate model forecasts for the Northeast US predict that during this century temperatures will continue to increase, as will extreme heat days and heat waves. More precipitation and extreme precipitation events are expected to increase, although short-term summer droughts may also become more frequent. These current and predicted changes in climate will have broad impacts on our region's environmental quality, natural communities, public health, built environment and local economy.

The regional greenhouse gas emissions inventory determined that 1,193,000 metric tons of carbon dioxide equivalents were generated in Chittenden County in 2010. This amount is approximately 16% of the state's 2011 greenhouse gas emissions. Transportation accounts for 48% of county emissions; heating fuels account for 38%.

The purpose of this Climate Action Guide is to establish a common understanding of the regional issues associated with climate change, identify priority regional strategies and actions, and provide guidance for municipalities, employers, and individual actions. The focus of this plan is on both reducing the ways we contribute to climate change (climate mitigation) and to adapt in ways that make us more resilient to a changing climate (climate adaptation).

The Chittenden County ECOS Plan establishes the following **regional climate change goal**:

> *Reduce greenhouse gas emissions contributing to climate change and adapt to become more resilient to a changing climate*.

With this goal as a foundation, and with relevant state and local goals in mind, this Climate Action Guide and the ECOS Plan recommend the following **regional climate target.**

- Reduce regional greenhouse gas emissions 50% from 2010 levels by 2028.

The Climate Action Guide also recommends a target to

- Promote the conservation of existing vegetative landscapes within the County and increase vegetation in areas where appropriate to maintain carbon sequestration levels of wetlands, forests, other natural areas, and agricultural lands.

Based on the greenhouse gas emissions inventory and the impacts associated with climate change, this Climate Action Guide identifies the **priority strategies and associated regional actions to be done by CCRPC and its regional partners**. These strategies and actions address both climate mitigation and climate adaptation. **Priority Strategy 1** - Reduce greenhouse gas emissions from transportation/land use.

1.1 Implement policies that promote investment in transportation options that reduce emissions.
1.2 Enhance transportation systems management (TSM) techniques to improve the safety and efficiency of existing roadway networks.
1.3 Implement employer trip reduction programs and other transportation demand management programs.
1.4 Increase transit service area, frequency and hours to make transit competitive with driving.
1.5 Invest in transit passenger facilities and technology to make transit more appealing to existing and future riders.
1.6 Locate and develop Park and Ride facilities to promote transit use and ridesharing.
1.7 Fund construction, operation and maintenance of facilities that support bicycles and pedestrians.
1.8 Promote development of infrastructure for electric vehicle charging.
1.9 Work with municipalities to update local zoning regulations to allow for and encourage compact development that support alternative transportation modes.

Priority Strategy 2 - Reduce greenhouse gas emissions from heating.

2.1 Implement policies that support reduction of fossil-fuel energy and greenhouse gases from heating.

Priority Strategy 3 - Maintain vegetative landscapes to support carbon sequestration.

3.1 Implement policies that support, protect and conserve forests, wetlands and agricultural lands.
3.2 Implement programs to increase urban forest canopy.

Priority Strategy 4 - Protect river corridors in order to reduce flood and fluvial erosion impacts.

4.1 Assess and protect river corridors.
4.2 Promote on-site stormwater management, low impact development techniques and stormwater management techniques.

Priority Strategy 5 - Be prepared for climate-related emergencies.

5.1 Prepare and maintain plans for emergency operations, emergency response, business continuity and business recovery.
5.2 Provide Incident Command System training for local officials.
5.3 Prepare, implement and update hazard mitigation plans.

Priority Strategy 6 - Be prepared for climate-related health impacts.

6.1 Plan for extreme heat events and the health impacts of extreme weather events.
6.2 Raise awareness of vector-borne illnesses.

Recommendations on additional actions that may be done by individuals, employers and municipalities are included as Appendices.

Monitoring of progress in implementing this guide will be done under the broader sustainability monitoring and reporting of the ECOS Annual Report.

The appendices include the greenhouse gas emissions inventory, guides for municipalities, employers and individuals.

The climate science in this guide is citing 2014 National Climate Assessment. The principal conclusions from this document are as follows (Melillo et al. 2014):

- Global climate is changing and this is apparent across the United States in a wide range of observations. The global warming of the past 50 years is primarily due to human activities, predominantly the burning of fossil fuels.
- Some extreme weather and climate events have increased in recent decades, and new and stronger evidence confirms that some of these increases are related to human activities.
- Human-induced climate change is projected to continue, and it will accelerate significantly if global emissions of heat-trapping gases continue to increase.
- Impacts related to climate change are already evident in many sectors and are expected to become increasingly disruptive across the nation throughout this century and beyond.
- Climate change threatens human health and well-being in many ways, including through more extreme weather events and wildfire, decreased air quality, and diseases transmitted by insects, food, and water.
- Infrastructure is being damaged by sea level rise, heavy downpours, and extreme heat; damages are projected to increase with continued climate change.
- Water quality and water supply reliability are jeopardized by climate change in a variety of ways that affect ecosystems and livelihoods.
- Climate disruptions to agriculture have been increasing and are projected to become more severe over this century.
- Ecosystems and the benefits they provide to society are being affected by climate change. The capacity of ecosystems to buffer the impacts of extreme events like fires, floods, and severe storms is being overwhelmed.
- Planning for adaptation (to address and prepare for impacts) and mitigation (to reduce future climate change, for example by cutting emissions) is becoming more widespread, but current implementation efforts are insufficient to avoid increasingly negative social, environmental, and economic consequences.

Acknowledgments

This regional climate action Guide was prepared by the Chittenden County Regional Planning Commission (CCRPC). CCRPC is the regional and transportation planning organization for Chittenden County, Vermont.

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Julie Potter, former Senior Planner, was the Project Manager and principal author of this guide. Melanie Needle, Senior Planner, was the Project Manager for the greenhouse gas emissions inventory and authored the appendices. Charlie Baker, CCRPC Executive Director and Michele Boomhower, CCRPC Assistant/MPO Director provided overall direction.

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CCRPC staff received invaluable assistance and advice from the Climate Action Plan Advisory Committee and the Greenhouse Gas Emissions Inventory Technical Advisory Committee. The Advisory Committees were comprised of local and state experts on various aspects of local government, natural resources, energy, transportation, land use, public health, and business. Their input is greatly appreciated.

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Meredith Birkett – Chittenden County Transportation Authority
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Introduction and Background

Purpose of this Climate Action Guide

Every Vermonter knows that weather is changeable; if you don't like the weather, wait a bit. Climate – the long-term, prevailing weather patterns – goes through slow, long-term cycles of change. However, climate scientists around the world have noted that climate patterns are changing more quickly and in ways that will significantly impact our lives. How should we respond to these changes?

As the organization responsible for regional land use and transportation planning for Chittenden County, the Chittenden County Regional Planning Commission (CCRPC) is in the business of working with our communities and others to identify how we can collectively address regional needs and plan for the future. Addressing the regional issues associated with a changing climate is beyond the ability of any one local or regional entity and requires a cooperative and coordinated approach.

The purpose of this Climate Action Guide is to establish a common understanding of the regional issues associated with climate change, establish goals and priorities that are most appropriate for our region, and identify actions to address the regional priorities. The focus of this guide is on both reducing the ways we contribute to climate change (climate mitigation) and to adapt in ways that make us more resilient to a changing climate (climate adaptation). This guide is not a policy document and is not to be used in the review of local and ACT 250 development applications but is intended to support interested municipalities in developing policy and regulations to address climate change.

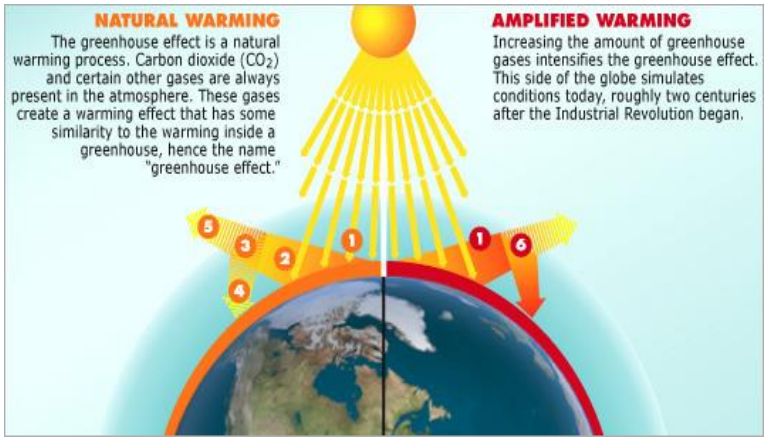
Given CCRPC's role, this guide has been developed in four parts. The first describes why climate change is a significant issue for our region. The second part presents regional goals and priority strategies based on how climate change is and will affect our region. The third part presents actions that CCRPC and regional partners can take to implement the priority strategies. CCRPC has responsibility for encouraging communities, employers and individuals to undertake suggested strategies and actions, but it cannot force them to do so. Therefore, the Appendices contain the fourth part of the guide, in the form of guidance on actions that others – individuals, employers and municipalities – may take to address the priority climate strategies.

Consequently, the strategies and actions in the guide itself are intended for implementation by CCRPC and other regional entities we work closely with. Suggestions for municipalities, employers and individuals are in the Climate Action Guides in the Appendices.

Understanding Climate Change

Our climate is affected by complex interactions between the atmosphere, oceans, landforms and ecosystems. Heat from the sun warms the oceans and land, which absorbs most of the heat and radiates some back into the atmosphere. In turn, the atmosphere traps the radiated heat – much the way glass traps heat in a greenhouse (Figure 1). Certain atmospheric gases are particularly effective in trapping the sun's heat; these gases are known as greenhouse gases (GHGs).

Figure 1 - Greenhouse Effect



Source: Marian Koshland Science Museum, National Academy of Sciences[1]

1. Sunlight brings energy into the climate system; most of it is absorbed by the oceans and land.

THE GREENHOUSE EFFECT:

2. Heat (infrared energy) radiates outward from the warmed surface of the Earth.
3. Some of the infrared energy is absorbed by greenhouse gases in the atmosphere, which re-emit the energy in all directions.

   Some of the infrared energy further warms the Earth.

   Some of the infrared energy is emitted into space.

AMPLIFIED GREENHOUSE EFFECT:

5. Higher concentrations of CO_2 and other "greenhouse" gases trap more infrared energy in the atmosphere than occurs naturally. The additional heat further
6. warms the atmosphere and Earth's surface.

Although water vapor is the most prevalent greenhouse gas in our atmosphere, water moves fairly easily from vapor to liquid and back again, and its concentration in the atmosphere is largely a function of air temperature. This is not the case for persistent greenhouse gases identified below.

The most common persistent greenhouse gases are carbon dioxide (found in the air we exhale), methane (the major component of natural gas) and nitrous oxide. Figure 2 shows the major greenhouse gases. Different greenhouse gases trap heat to different degrees – some are more potent than others. The degree to which greenhouse gases trap heat is called the global warming potential (GWP), which is expressed as a multiple of the heat-trapping potential of carbon dioxide. To provide a common scale for measuring different greenhouse gases, emissions are typically expressed as carbon dioxide equivalents (CO_2e).

Figure 2 – Major Greenhouse Gases

Greenhouse Gas	Greenhouse Warming Potential
Carbon dioxide (CO_2)	1
Methane (CH_4)	21
Nitrous oxide (N_2O)	310
Sulfur hexafluoride (SF_6)	23,900

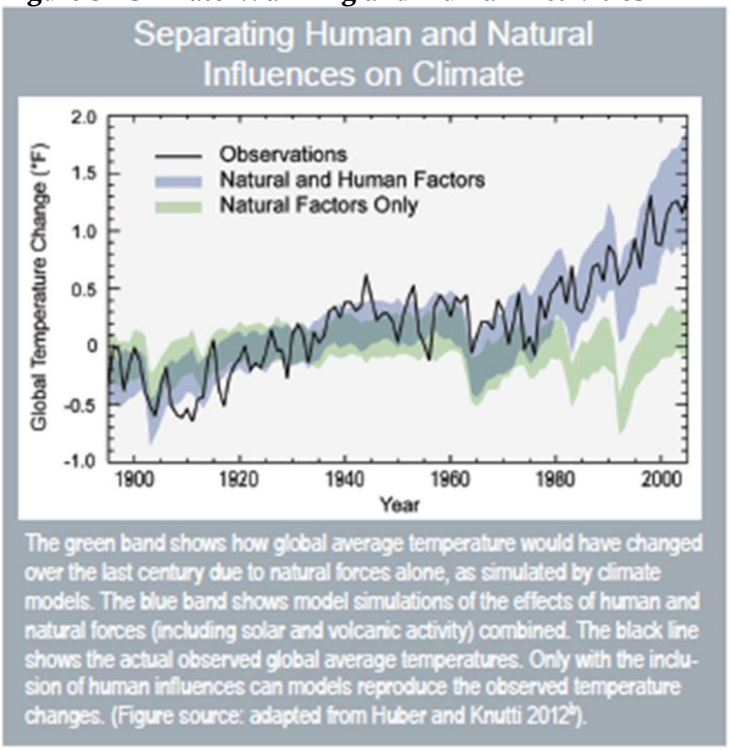
Source: Intergovernmental Panel on Climate Change[2]

Climate scientists have observed that our climate has changed since 1900, with the most dramatic changes occurring since 1970. The United Nation's Intergovernmental Panel on Climate Change observed:

Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased.[3]

An overwhelming 97% of climate scientists agree that increases in greenhouse gases in the atmosphere are due to human activities and are responsible for observed climate changes. Climate modeling of historical data supports the position that observed temperature increases are caused by human activities (Figure 3).

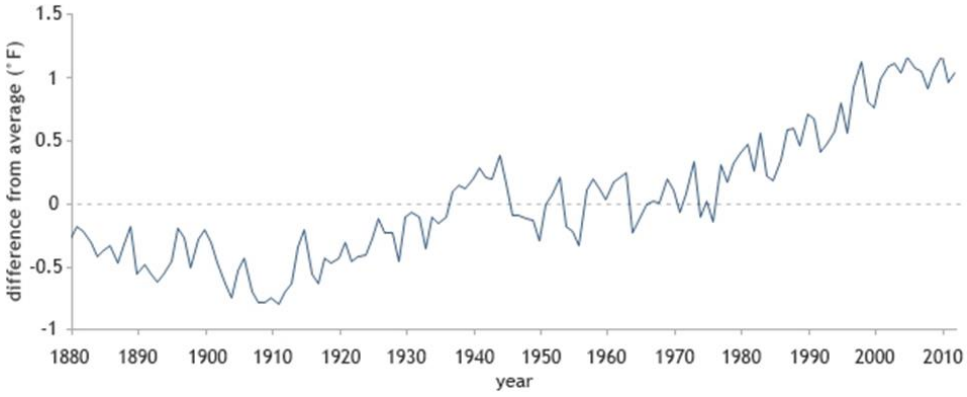
Figure 3- Climate Warming and Human Activities



Source: May 2014 U.S. National Climate Assessment

Climate change is a long-term process; it takes a while for the climate to respond and change over a century or more is what defines "global warming". Figure 4 shows that starting in the 1970's global average temperature increased. Yet in 2000, the earth's surface temperature stopped rising. The most likely explanation for this cycle is a shift in ocean circulation patterns that moved excess heat into the deep ocean.[4] The changes that we are seeing today are the result of many decades of greenhouse gas emissions. Climate models predict that even if global greenhouse gas emissions were to be cut by 50% today, we would still see significant changes to our climate during this century – but these changes would be much less drastic than the changes that will occur if greenhouse gas emissions continue at their current rate.

Figure 4 – Earth's Surface Temperature Anomalies



Source: National Oceanic and Atmospheric Administration

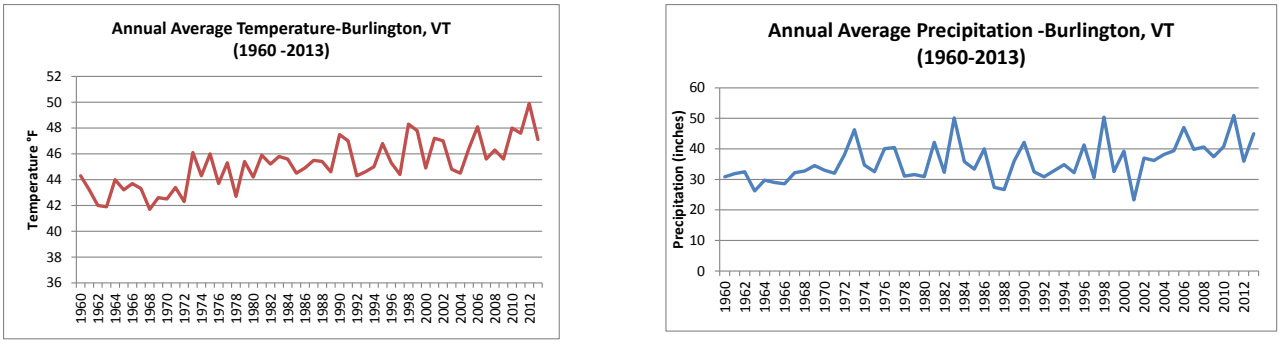
Climate Change and Chittenden County

The 2012 report by the Chittenden County Regional Planning Commission, Chittenden County Climate Change Trends and Impacts[5], describes recent changes to our climate and what further changes are predicted for our region. These changes are briefly summarized here.

Historical temperatures and precipitation records indicate that Chittenden County's climate is already changing (Figure 4). Temperature records show a warming trend, with warmer winters and hotter summers. While there are no Chittenden County specific predictions for the future, scientists predict temperatures throughout the northeast -- defined as the region stretching from New Jersey and Pennsylvania north to Maine, New Hampshire and Vermont -- will increase another two-to-eight degrees Fahrenheit by mid-century. The number of extreme heat days throughout the northeast with temperatures over 90 degrees is expected to increase. Even this far north, summers will likely have more than 15 days per year over 90°F by the 2050s under a global scenario modeled for continued high emissions of heat-trapping gases.

As for precipitation, we get more than we used to, with predictions calling for the northeast to receive an additional 10-percent by century's end. Warmer temperatures are predicted to cause a greater proportion of winter precipitation throughout the northeast to fall as rain instead of snow. To date, however, Chittenden County, even though Burlington has experienced warmer winters than in the past, has experienced strong snowfall as 14 of the last 20 winters, including seven of the last 10, have seen above average totals. Despite the predicted increase in precipitation, scientists believe the northeast may experience more short-term droughts during the summer punctuated by more intense rain events[6].

Figure 5 –Increases in Average Annual Temperature and Precipitation



Source: National Weather Service

Despite the predicted increase in precipitation, scientists believe the northeast may experience more short-term droughts during the summer punctuated by more intense rain events. With warmer and wetter conditions predicted by climate models, Chittenden County's climate will become more like the current climate in the Mid-Atlantic. These conditions will have multiple impacts on our region.

- Environmental Quality - Summer air quality will deteriorate, as warmer temperatures promote the formation of smog. More intense rainfall will increase storm water runoff and the potential for flooding. Increased rain and runoff will wash pollutants into our waterways, and warmer waters will encourage growth of bacteria and blue-green algae.

- Natural Communities - Cold-water aquatic species, such as brook trout, will struggle to survive in warmer waters and in competition with species better able to adapt to warmer temperatures. Our forests will change: maple, beech and birch trees will gradually be replaced by oak and hickory trees that are better acclimated to warmer, wetter conditions. Invasive species, like the hemlock wooly adelgid, will further affect change in forest composition.
- Public Health - Warmer temperatures also enable the spread of insect-borne diseases, such as West Nile virus and Lyme disease. Air pollution and higher pollen production will increase problems for people with allergies, chronic respiratory diseases and asthma. High temperatures and heat waves will increase the risk of heat stress for vulnerable populations, especially for the growing number of elderly.
- Built Environment - Flooding will put homes, businesses and public infrastructure in flood-prone areas at risk. Although warmer winters will require less fuel for heating, hotter summers will increase electricity demands for cooling.
- Local Economy - Warmer temperatures will hurt maple sugar makers. Farmers can expect declining yields for cool-weather crops, and depressed milk production from heat-stressed dairy cows. Tourism will be impacted by less-colorful foliage seasons and unpredictable snowfall.

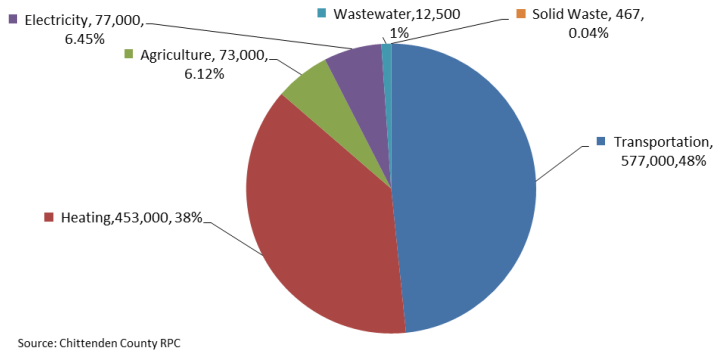
Regional Greenhouse Gas Emissions Inventory

As part of this climate action guide, Chittenden County Regional Planning Commission developed a county-wide inventory of 2010 greenhouse gas emissions. This followed the methodology of emission inventories conducted in other regions. (See Appendix B for more detailed information on the inventory methodology.)

The results of the regional emissions inventory show that 1,193,000 metric tons of carbon dioxide equivalents ($MTCO_2e$) were generated in Chittenden County in 2010 (Figure 66). This amount is approximately 16% of the state's 2011 greenhouse gas emissions.[7] Two sources account for almost 90% of all the greenhouse gases emitted in the county: transportation (48%) and heating fuels (38%).

These results make sense. Vermont is a rural state and, even in more urbanized Chittenden County, people drive a lot. Chittenden County has a cool climate, and people and businesses need heat during long, cold winters. The electrical grid in the Northeast relies less on coal- and oil-fired power plants and more on electricity from nuclear and hydropower which don't emit as much greenhouse gases. We recycle much of our solid waste; 53% of municipal solid waste and construction debris was diverted from landfills in 2010. Non-recycled waste is sent to Moretown and Coventry landfills where methane is collected and controlled.

Figure 6– 2010 Greenhouse Gas Emissions, Chittenden County



Comparatively speaking the quantity of ghg emissions for Chittenden County align with the ghg emissions of Tompkins County, NY. Tompkins County, NY is of similar size and has a similar mix of rural and urban land uses. Tompkins County has a population of 101,564 and comprises the Ithaca metropolitan area

which is comparable to the City of Burlington and surrounding area. In 2008, the emission inventory for the Tompkins County community yielded 1,172,000 metric tons of carbon dioxide equivalents ($MTCO_2e$)[8]. In Tomkins County, transportation is also the highest contributor of emissions.

Trees and soils are able to take carbon out of the atmosphere and store it – a process called carbon sequestration. By removing carbon from the atmosphere, carbon sequestration offsets greenhouse gas emissions. Based on research at the University of Vermont[9], the 2001 annual carbon sequestration rate for Chittenden County was 760,000 MTCO2e. This is about 64% of the current greenhouse gas emissions rate. Forests account for the largest amount of carbon sequestration in Chittenden County because approximately 60% of the county is forested. However, green spaces in urban areas have a high rate of carbon sequestration in both soils and biomass, and emergent herbaceous wetlands have the highest carbon sequestration rate of all.

By identifying the amounts and activities that generate greenhouse gases, the regional emissions inventory helps with identifying the types of actions that have the greatest potential to significantly reduce the region's emissions.

Figure 7 – 2010 Greenhouse Gas Emissions from Heating Fuels

	Residential		Commercial & Industrial	
Fuel Type	**$MTCO_2e$**	**%**	**$MTCO_2e$**	**%**
Natural gas	142,924	56.6%	195,326	97.4%
Oil	92,364	36.6%	3,704	1.8%
Propane	8,810	3.5%	1,364	0.7%
Kerosene	7,732	3.1%	61	.03%
Wood	697	.28%	112	.1%
Total	*252,528*	*100%*	*200,567*	*100%*

A closer look at the heating fuels emissions data (Figure 6) shows that total heating emissions are divided between residential users (21%) and commercial/industrial users (17%). Natural gas is already the dominant heating fuel in Chittenden County, so shifting more users to this less-emitting fuel will not greatly reduce heating emissions by itself. Consequently, it will be important to focus strategies to reduce heating emissions on thermal efficiency and weatherization for existing and new buildings.

Because transportation comprises such a large proportion of the total emissions, strategies that reduce the number of vehicle miles traveled (VMT), increase the fuel efficiency of vehicles driven, and shift to low or zero-emission fuels will be critical to emissions reduction.

Responding to Climate Change: Mitigation and Adaptation

There are two types of actions that can be taken to respond to climate change:

- Climate mitigation refers to actions that are taken to reduce the speed and amount of climate change. Mitigation measures involve reducing greenhouse gas emissions or increasing the removal of carbon dioxide from the atmosphere. By reducing the net addition of greenhouse gases to the atmosphere, mitigation measures will help to reduce climate change impacts in the long term. Curbing climate change requires planet-wide actions to reduce greenhouse gas emissions. People *everywhere* will need to be involved.
- Climate adaptation refers to actions that are taken at the regional or local level to reduce adverse impacts from climate change, or to take advantage of beneficial impacts. The ability to cope with, and recover from, the effects of climate change is also called resiliency. Depending on the impact being considered, adaptation options may include policies, operations or infrastructure. Using the example of flood-related impacts, adaptation options might include:
  - Protect whatever makes us resilient and helps us recover quickly from the impact (e.g., protect wetlands that absorb floodwater),
  - Protect from the impact (e.g., floodproofing buildings),
  - Accommodate the impact (e.g., replace undersized culverts with larger ones),
  - Retreat from the impact (e.g., prevent new development in flood hazard areas).

This same approach can be used to consider adaptation options for other climate change impacts, such as impacts to the built environment or to public health.

Some climate change strategies are either mitigation strategies or adaptation strategies, however some strategies have both mitigation and adaptation benefits. For example, protecting wetlands along rivers helps maintain or increase carbon sequestration (a mitigation strategy) as well as helping slow down and absorb river flooding (an adaptation strategy). Additionally, many climate mitigation strategies help communities become more adaptive and resilient overall. For example, energy efficiency projects and distributed renewable energy projects help improve the stability and resilience of our energy supply systems. Similarly, increasing bicycle, pedestrian, ride-share and public transportation options makes us less dependent on single-occupancy vehicles and more resilient when gasoline prices increase rapidly.

Local and regional climate mitigation efforts are our contribution to the global cause, but will not be enough to halt climate change for our region. Cumulative global greenhouse gas emissions are currently on an increasing trajectory. Even with aggressive reduction in greenhouse gas emissions, we will still need to deal with the impacts of a changing climate.

The climate mitigation strategies and actions in this guide include climate mitigation actions that will reduce greenhouse gases but also have other important benefits, including strengthening the ability of our communities to be more resilient. This guide also includes climate adaptation strategies to help our region cope with the inevitable impact of climate change.

Regional Climate Action Goals and Targets

Relevant State and Local Climate Action Goals and Targets

In establishing regional climate action goals for Chittenden County, it is helpful to consider existing climate goals – and climate-related goals – at the state and local level. Goals identify where you want to go and are typically general statements about expectations for a program, project or activity. Targets provide a goal post – a measurable destination to be accomplished by a certain time. Measuring your progress towards the goal allows you to know whether your efforts are being effective and to identify how much more needs to be accomplished.

State of Vermont

In 2006, the Vermont legislature established aggressive state-wide targets for reducing greenhouse gas emissions:

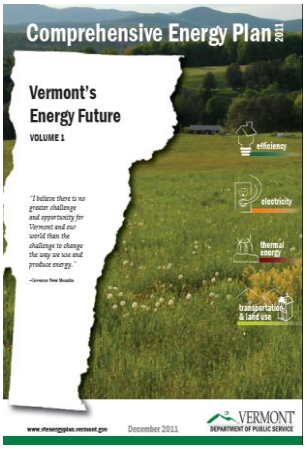
- 25% reduction from the 1990 emissions baseline of 8.11 $MMTCO_2e$ by 2012;
- 50% reduction from the 1990 emissions baseline by 2028; and
- if practicable using reasonable efforts, 75% reduction from the
- 1990 baseline by 2050.[10]

The December 2013 update of the Vermont greenhouse gas emissions inventory identifies the state's 2011 emissions are about equal to 1990 levels, about 8.11 $MMCO_2$. This represents a decline in statewide emissions starting in 2005 and a return to 1990 levels. For the state to meet the targets for reducing ghg emissions, emissions must be reduced by 50% from this level in order to meet the 2028 target. Given that Chittenden County contributes about 16% of the state's greenhouse gas emissions, the region would need to similarly halve its emissions in order for the state to reach its goals.

The state has also established some relevant energy-related goals and targets. In 2007, the Vermont legislature established aggressive state-wide targets for building energy consumption:

- Substantially improve the energy fitness of 20% of the state's housing stock (60,000 units) by 2017 and improve 25% of housing (80,000 units) by 2020;
- Reduce annual residential fuel needs and fuel bills by an average 25%;
- Reduce total fossil fuel consumption across all buildings by 0.5% per year, leading to reductions of 6% annually by 2017 and 10% annually by 2025;
- Save $1.5 billion on fuel bills through improvements installed between 2008 and 2017; and

- Increase weatherization services to low income Vermonters by expanding the number of units weatherized, or the scope of services provided, or both, as revenue becomes available in the home weatherization assistance trust fund[11].



Statewide, 18,000 homes were retrofitted between 2008 and 2013.[12] The pace of retrofitting needs to significantly increase for the retrofit goal to be met.

Vermont's 2011 Comprehensive Energy Plan includes a relevant renewable energy goal:

- Obtain 90% of the state's total energy from renewable sources by 2050.[13]

In 2011, 23% of the state's energy came from renewable sources, so this energy target is a significant increase.

City of Burlington

At the local level, Burlington has a long history of climate action planning. In 1998, the Burlington City Council adopted a resolution setting a goal to reduce greenhouse gas emissions 10% below 1990 levels. After completing a greenhouse gas emissions inventory for a 1997 baseline year, Burlington adopted a climate action plan establishing a goal of reducing greenhouse gas emissions 10% below 1997 levels by 2005. Burlington updated its greenhouse gas emissions inventory for 2007 and 2010. In 2014, the City revised the Climate Action Plan to include targets that require the leveling off emissions by 2016 and bring them back to 2010 levels by 2025.

Burlington's 2010 greenhouse gas emissions inventory found that city-wide emissions (including the airport) increased 7% between 2007 and 2010; emissions from transportation increased 22% during this period.[14] Because it is a regional employment center, many of the vehicle trips generating greenhouse gas emissions in Burlington are due to employees who live in the County (or beyond) and commute into the city. For Burlington to achieve significant transportation emissions reductions, a regional approach to transportation emission reductions is needed.

Both the state's and Burlington's targets address climate mitigation – that is, they both focus on reducing greenhouse gas emissions. Neither sets specific targets related to carbon sequestration. Neither Vermont nor Burlington has formally adopted climate adaptation goals or targets.

Climate mitigation planning has been a focus area longer than climate adaptation, so there are fewer examples of climate adaptation plans, goals or targets. Additionally, climate adaptation doesn't have a single, common framework for measuring progress the way that climate mitigation does, so setting adaptation goals and targets is challenging. Climate adaptation goals typically address the concerns and impacts of climate change, such as flooding, extreme heat events, habitat change, etc. Climate adaptation targets tend to be developed for specific adaptation strategies and actions.

Keene, NH is a leader in local climate adaptation planning; Keene's adaptation goals and targets are tied to their priority strategies and actions.[15]

Chittenden County Regional Planning Commission

Chittenden County Regional Planning Commission, in conjunction with GBIC and 60+ municipal and organizational partners approved the 2013 Chittenden County ECOS Plan, which is the new regional plan. The ECOS Plan establishes the following goal addressing both climate mitigation and climate adaptation: This Climate Action Guide accepts this regional climate change goal.

Climate Change Goal: Reduce greenhouse gas emissions contributing to climate change and adapt to become more resilient to a changing climate.

With the climate change goal as a foundation, and with the relevant state and local goals and targets in mind, this Climate Action Guide and the ECOS Plan establish a climate mitigation target related to ghg emissions.

Climate Action Target 1: Reduce regional greenhouse gas emissions 50% from 2010 levels by 2028.

This target is consistent with the state's mid-term 2028 emission target. Given that Chittenden County accounts for almost 1/6 of all Vermont greenhouse gas emissions, Vermont will not be able to achieve its target unless Chittenden County makes an equivalent reduction.

This is an aggressive target. Achieving it requires substantial efforts to improve energy efficiency and conservation and adopt cleaner fuels – particularly in the areas of transportation and heating.

Forecasting future greenhouse gas emissions is challenging due to the lack of historic emissions data, economic uncertainties, population growth, and other factors. The Chittenden County Regional Planning Commission has not attempted detailed future emission forecasting. It should be noted, however, that several recent federal and state initiatives will help with progress towards this target:

- One-time federal Energy Efficiency and Conservation Block Grant funds (2009-2012) have helped many schools and municipalities improve their energy efficiency.
- Federal vehicle fuel efficiency standards for new passenger vehicles are increasing to an average 34.1 mpg in 2016, with a fuel efficiency standard of 54.5 mpg currently planned for 2025. As people and businesses replace existing vehicles with new vehicles, the overall efficiency of vehicles on the road will increase.
- The Drive Electric Vermont initiative is working to enable widespread adoption of electric vehicles, including vehicle and infrastructure availability.
- Vermont, which has long been a leader in electricity energy efficiency programs, has begun funding thermal and process energy efficiency programs through Efficiency Vermont.
- Efficiency Vermont's Home Energy Challenge is a marketing program to encourage homeowners to weatherize their homes to reduce home heating fuel and emissions. The goal for this program is weatherize 3% of homes in each town by 2013. 10 municipalities in Chittenden County have signed up to participate.

Reducing greenhouse gas emissions is one aspect of climate mitigation; carbon sequestration is another. This Climate Action Guide establishes the following carbon sequestration target.

Climate Action Target 2: Promote the conservation of existing vegetative landscapes within the County and increase vegetation in areas where appropriate to maintain carbon sequestration levels of wetland, forest, other natural areas, and agricultural lands.

Maintaining forests, wetlands, agricultural lands and vegetated spaces in developed areas is important for ensuring current and future carbon sequestration. In 2001, approximately 95% of the county's area was vegetated – an amount that was essentially unchanged in 2006. As growth continues to occur in Chittenden County, it will be important to protect forests, wetlands and agricultural lands, as well as maintaining vegetation in new development. Wetland protection is especially important because wetland ecosystems store larger quantities of carbon than other natural land cover types. Compact development patterns, urban trees and low-impact development techniques can be used to establish and maintain urban vegetated spaces. Maintaining vegetative landscapes concurrent with achieving the emissions reduction target will help Chittenden County become a "carbon sink," absorbing more carbon than it emits. This target is intended to help us monitor the amount of vegetated land lost over time and educate decision makers on the critical role vegetation plays in mitigating ghg emissions. It is not intended to prevent development from occurring.

Because of the multiple aspects of climate impacts – precipitation, heat, flooding, air and water quality, natural habitats, public health, local economy, etc. – it is impossible to identify just one or two targets that adequately embody the breadth of desired adaptation outcomes. Consequently, this Climate Action Guide does not propose broad adaptation targets. Instead, this guide recommends that climate adaptation strategy implementation include strategy-specific targets and monitoring to measure progress in achieving the strategies' objectives.

Priority Strategies: What Matters Most

When faced with many needs and opportunities but limited time and money, organizations and individuals set priorities based on what is most important and feasible within a reasonable timeframe.

The priority strategies identified by this Climate Action Guide are based on the clearly defined issues and impacts associated with climate change for our region. These strategies are considered to be the most important for our region, and they guide the selection of the specific climate actions identified in this guide. Because of the different issues involved, different priorities are needed for climate mitigation and climate adaptation.

Priority Strategies for Climate Mitigation

Reducing our region's contribution to climate change means that we must significantly reduce the amount of greenhouse gases emitted in the county and we must maintain vegetated landscapes that can sequester and store carbon. Although all strategies that help reduce greenhouse gas emissions are useful, the greenhouse gas emissions inventory clearly identifies that two sectors are responsible for almost 90% of the county's emissions. Transportation is the top emitter, accounting for 48% of regional emissions. Heating is second, with 38% of regional emissions. Major emission reductions in these two areas must be accomplished in order for the regional emissions reduction target to be achieved.

- **Priority Strategy 1** – Reduce greenhouse gas emissions from transportation/land use.

Emissions from transportation are a function of the types of vehicles we use, the transportation fuels we use, the fuel efficiency of our vehicles, the development density of our built environment, and our transportation behavioral choices. Reducing transportation emissions requires a variety of approaches to address each of these areas.

- **Priority Strategy 2** – Reduce greenhouse gas emissions from heating.

Reducing emissions from heating requires improvements in thermal energy efficiency. Vermont has state-wide energy standards for new residential and commercial buildings, so new buildings should be more energy efficient than older buildings. Because so many of the region's buildings predate these standards, the focus should be on improving the energy efficiency of existing buildings.

- **Priority Strategy 3** – Maintain vegetative landscapes to support carbon sequestration.

Maintaining vegetated landscapes – forests, wetlands, agricultural lands and urban trees and vegetation – is important for continued carbon sequestration. Vegetated landscapes also help with climate adaptation by absorbing precipitation, reducing stormwater runoff, maintaining natural habitats, and reducing the urban heat island effect.

Priority Strategies for Climate Adaptation

Some climate change impacts are being experienced now: heavy rain events, flooding damage to buildings and roads, blue-green algae blooms, initial encroachment of some pests and diseases previously deterred by cold winters. The 2011 Spring flood and Tropical Storm Irene demonstrated how damaging floods can be. The following regional climate adaptation priority strategies have

been selected based on the need to prevent and respond to flooding, and to be prepared for an expected increase in climate-related health impacts.

- **Priority Strategy 4** – Protect river corridors in order to reduce flood and fluvial erosion impacts.

With increasing heavy precipitation events, our streams, rivers and lakes will flood more frequently. We can't stop the flooding, but we can take steps to reduce the impacts of floods on people, buildings, bridges and roads.

- **Priority Strategy 5** – Be prepared for climate-related emergencies.

Emergency preparedness and response plans and operations continuity plans can limit the scale of disaster impacts and increase the ability of a community to maintain basic functions and recover quickly.

- **Priority Strategy 6** – Be prepared for climate-related health impacts.

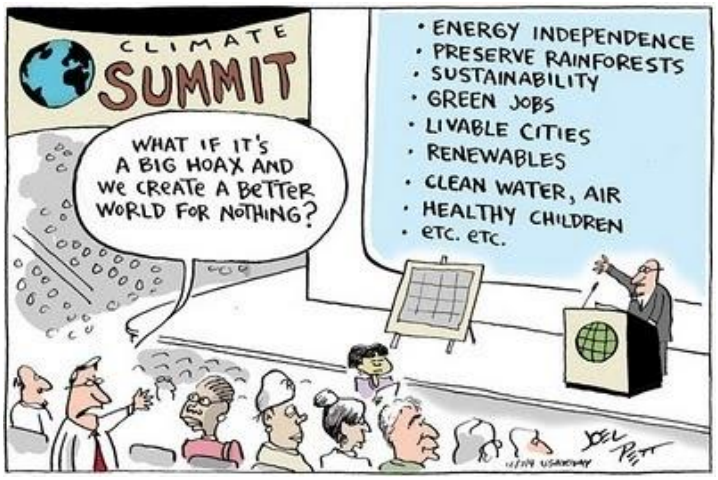
As our climate changes, new impacts are likely to become important: high heat events, heat stress for people and livestock, decreasing summertime air quality, increasing allergies and asthma, new vector-borne diseases. Monitoring and information will be important to reducing the severity of climate-related health impacts.

Other new impacts may become more important over time: changes in the growing season, loss of predictable snow cover, changes in natural communities. Our climate adaptation priority strategies may need to change in the future to address these new impacts.

Regional Climate Actions and Implementation

Approximately 100 potential actions were identified and evaluated in the process of developing this Climate Action Guide. These potential actions are identified in Appendix F. About 60% of the actions address climate mitigation and about 40% address climate adaptation. Actions were grouped by topic (natural systems, transportation, land use, water and waste, energy, agriculture and forestry, health and food, education and outreach, public safety and hazard mitigation). Actions were also grouped by the best level of implementation (regional, municipal, employers, or individual).

The purpose of a climate action guide is to make a commitment to take action. This guide focuses on regional actions that the Chittenden County Regional Planning Commission can commit to implement on its own or with partners. Because of the other benefits associated with these actions, implementing these actions have little downside. In fact, many of these actions already have efforts underway precisely because they have energy, transportation, air quality, natural resource, and/or public health and safety benefits. For similar reasons, these actions also reinforce the actions in the ECOS Plan. Continued effort is needed to fully implement these actions.



The mechanism for the Chittenden County Regional Planning Commission to implement projects is through including projects into the organization's annual work plan (formally, the Unified Planning Work Program, or UPWP).

The Regional Planning Commission has no authority to direct other organizations, municipalities, employers or individuals to take specific actions – it can only provide guidance and assistance. Therefore, actions to address the priority strategies which would be implemented at other levels are discussed in the guides in the appendices.

1. Actions to Reduce Greenhouse Gas Emissions from Transportation/Land Use

The following regional actions are important to reducing the amount of fossil fuel energy consumed and greenhouse gases emitted by transportation.

1.1. Implement policies that promote investment in transportation options that reduce emissions.

Increase focus on transportation investments and service expansions on projects and strategies contributing to greenhouse gas emission reductions and enhancing resilience to climate change. Approaches include: incorporate emissions reduction and resiliency into transportation evaluation criteria; give increased investment priority for transportation projects that reduce emissions and enhance resiliency, include greenhouse gas emission reduction target in the long-range Metropolitan Transportation Plan section of the ECOS Plan.
Lead Partners: CCRPC, VTrans.
Critical Partners: Municipalities.

Implementation Status: The ECOS Project Evaluation Criteria used by CCRPC to evaluate projects for the Transportation Implementation Plan include emissions reduction and adaptation strategies. The transportation focal areas identified for targeted impact in the ECOS Plan (sections 3.2.2.4 iii, 3.2.2.6.a-c) are all investments important to reducing transportation greenhouse gas emissions.

1.2. Enhance transportation systems management (TSM) techniques to improve the safety and efficiency of existing roadway networks.

Optimizing traffic flow allows traffic to move more steadily along roadways and through intersections decreasing time spent idling or accelerating and reducing vehicle emissions. TSM programs include Intelligent Transportation Systems (ITS) projects; intersection improvements, traffic calming and traffic signal optimization; projects that improve bicycle, pedestrian and transit safety and efficiency. Projects that improve efficiency can preclude or postpone capacity expansion projects.
Lead Partners: CCRPC, VTrans.
Critical Partners: Municipalities.

Implementation Status: A TSM and ITS task (2.3.10) are included in CCRPC's FY 2014 UPWP. ITS is specifically identified in section 3.2.2.6.c.ii in the ECOS Plan as an action that invests in the metropolitan transportation network.

1.3. Implement employer trip reduction programs and other transportation demand management (TDM) programs.

Employers, acting alone or collectively, can provide a variety of strategies and benefits to reduce drive-alone commuting. Comprehensive programs offering multiple options and incentives are more effective at reducing commute trips than implementing components separately. Municipalities can encourage employers to participate in GO!

Chittenden County and consider joining Campus Area Transportation Management Association (CATMA) to offer trip reduction programs to employees.
Lead Partners: Go! Chittenden County, CCRPC, CATMA, CCTA.
Critical Partners: Employers, Municipalities.
Implementation Status: *TDM task (2.3.3 and 2.3.3.1-2.3.3.2) are included in CCRPC's FY2014 UPWP. TDM is specifically* identified in sections 3.2.2.6.a, 3.2.2.6.c.ii, & 3.2.2.6.c.iii in the ECOS Plan as one of the actions for investing in the metropolitan transportation network.

1.4. Increase transit service area, frequency and hours to make transit competitive with driving.

Fifteen-minute service is considered a key threshold to making transit competitive with driving. Adding evening and Sunday service on the four major corridors into Burlington would generate additional ridership. Improvements along existing railroad tracks to provide passenger rail service and new bus routes would expand transit service to new areas in the future .
Lead Partners: CCTA.
Critical Partners: CCRPC, VTrans, Municipalities.
Implementation Status: CCRPC's FY 2014 UPWP Task 2.3.4.1 describes that CCTA is the lead agency for conducting market research and outreach for new service development. Increasing investment in transit service is specifically identified in section 3.2.2.6.i of the ECOS Plan.

1.5. Invest in transit passenger facilities and technology to make transit more appealing to existing and future riders.

CCTA riders have requested further investment in passenger facilities (bus shelters, benches, bike racks) and new technology (real-time passenger information, Wi-Fi and trip planning software).

Lead Partners: CCTA.
Critical Partners: CCRPC, VTrans, Municipalities.
Implementation Status: Tasks 2.3.4.2-2.3.4.4 in CCRPC's FY2014 UPWP are related to improving transit facilities and information about transit service.

1.6 Locate and develop Park and Ride facilities to promote transit use and ridesharing.

Park and ride facilities reduce highway traffic, congestion, worksite parking demand and can help support transit service. Amenities can enhance the security and usability of a park and ride facility. Facilities should be appropriately sized and phased, based on location, potential for transit and potential future usage.
Lead Partners: CCRPC, Municipalities.
Critical Partners: VTrans, CCTA
Implementation Status: *Planning for park and rides is included in the Intermodal Transportation Planning task (2.3.9) in CCRPC's* FY2014 UPWP. Park and ride facilities are identified within the Metropolitan Transportation Plan Investments action in section 3.2.2.6. of the ECOS Plan.

1.7. Fund construction, operation and maintenance of facilities that support bicycles and pedestrians.

A variety of facilities can support bicycle and pedestrian transportation: Complete streets programs can include sidewalks, bicycle lanes and crosswalks; off-road multi-use paths; and amenities such as bicycle parking, shade trees and benches. Roadway design checklists can include measures of bicycle and pedestrian accommodation. Cost effectiveness of some bicycle and pedestrian facilities is higher in urban and suburban areas, compared to rural areas.

Lead Partners: CCRPC, VTrans, Municipalities.
Critical Partners: CCTA.
Implementation Status: Regional Pedestrian/bicycle transportation planning is included as a task (2.3.7) in CCRPC's FY2014 UPWP. Expanding walking and biking infrastructure is specifically identified within the Metropolitan Transportation Plan Investments action of the ECOS Plan found in section 3.2.2.6.v.

1.8. Promote development of infrastructure for electric vehicle charging.

Electric vehicles produce fewer greenhouse gas emissions, particularly in regions with high renewable in the electric portfolio. Charging stations facilitate adoption for fleet and commuter use. Use stakeholder collaboration to develop a strategy to promote the use of plug-in electric vehicles in the region. Objectives should include: identify locations where infrastructure is needed; support regional efforts to establish a framework for siting/locating public electric vehicle charging stations; prioritize solar changing options to maximize mitigation benefits; streamline permitting processes associated with charging equipment to encourage installation; coordinate monetary and non-monetary incentives available to the general public and organizations purchasing electric vehicles; address issues related to siting criteria and increased electric demand effects on the electric grid.

Lead Partners: Drive Electric Vermont, VEIC, CCRPC, VTrans, Utilities.
Critical Partners: Municipalities.
Implementation Status: CCRPC is participating in a regional collaboration lead by VEIC to promote electric vehicle infrastructure. A completed scoping study with identified preferred locations for electric vehicle charging stations is a task (3.3.11) in the CCRPC's FY2014 UPWP. Developing a network of electric vehicle charging stations is specifically identified within the Metropolitan Transportation Plan Investments action in section 3.2.2.6.vi of the ECOS Plan.

1.9. Encourage municipalities to update local zoning regulations to allow for compact development that supports alternative transportation modes.

Research suggests that vehicle miles traveled and CO_2 decline as site density increases and the mix of jobs, housing, and retail uses becomes more balanced[16]. Many municipalities in Chittenden County currently have zoning regulations that allow for compact mixed-use higher density centers and infill development. Municipalities should continue to update their comprehensive town plans and zoning regulations to encourage development patterns that result in less energy use and greenhouse gas reductions. Form-based code, transit oriented development, reduced parking standards and waivers, density bonuses for energy efficient buildings, smaller/attached units, and brownfield redevelopment are some of the tools available to local governments to mitigate climate change.

Lead Partners: Municipalities
Critical Partners: CCRPC, ACCD
Implementation Status: CCRPC regularly conducts formal reviews of municipal plans for conformance with State requirements. CCRPC also provides municipalities with enhanced consultation services to amend their zoning regulations. In FY 2014, CCRPC will be assisting multiple municipalities with developing form based codes and transit oriented design. Investing in areas planned for growth is a major tenet of the ECOS Plan and is specifically identified in section 3.2.2.

2. Actions to Reduce Greenhouse Gas Emissions from Heating

The following regional action is important to reducing the amount of fossil fuel energy consumed and greenhouse gases emitted by thermal energy use.

2.1. Implement policies that support reduction of fossil-fuel energy and greenhouse gases from heating.

Efficient heating equipment and weatherized buildings use less energy for heating and cooling. CCRPC can include thermal energy efficiency in the Regional Plan and work with partners to promote thermal energy efficiency and retrofits of existing buildings.
Lead Partners: CCRPC, Efficiency Vermont, Utilities.
Critical Partners: CVOEO, Building owners, Municipalities.
Implementation Status: Promoting thermal energy efficiency is included as an action in the ECOS Plan (sections 3.2.2.4.a, 3.2.2.4.b.i-ii). CCRPC is assisting Efficiency Vermont to promote residential weatherization retrofits, as part of task 2.2.1 in CCRPC's FY2014 UPWP.

3. Actions to Maintain Vegetative Landscapes that Support Carbon Sequestration

The following regional actions are important for protecting and maintaining vegetative landscapes:

3.1. Implement policies that support protect and conserve forests, wetlands and agricultural lands.

Forests, wetlands and agricultural lands sequester carbon in biomass and soil and act as a sink for reducing emissions Enhancing sinks by avoiding the conversion of forests, wetlands, and agricultural lands to development is a key action to mitigating ghg emissions generated from existing developed areas. These lands also provide open space important for natural stormwater management, flood mitigation, and natural habitats. CCRPC can include land conservation in the Regional Plan and work with partners to promote forest, wetlands and agricultural lands protection and conservation.

Lead Partners: CCRPC, State and local land trusts.
Critical Partners: VHCB, Property owners, Municipalities.

Implementation Status: Habitat preservation and working lands implementation are included as actions (3.2.4.1a-b) in the ECOS Plan as well as tasks (4.1.1 and 4.1.2) in the FY2014 UPWP.

3.2. Implement programs to increase urban forest canopy.

Urban forests sequester carbon in biomass and soils. They also aid in the interception, detention and filtration of rainwater and stormwater runoff. Other valuable functions include modifying temperatures over pavement and rooftops, improve microclimates at street level, and filter out air and water pollutants. CCRPC can characterize regional urban forest cover and assist municipalities in establishing urban forest cover goals.

Lead Partners: CCRPC, Municipalities.
Critical Partners: VT Urban and Community Forestry Council, VT Dept. of Forests, Parks and Recreation
Implementation Status: Promotion of vegetative landscaping in urban areas is included as an action in the ECOS Plan and can be found in sections 3.2.4.1a-b, 3.2.4.2a-c.

4. Actions to Protect River Corridors in Order to Reduce Flood and Fluvial Erosion Hazards

The following regional actions are important for protecting river corridors:

4.1. Assess and protect river corridors.

Substantial flood damages and costs can be avoided by limiting development in river corridors and allowing rivers to meander naturally and proper sizing and placement of culverts and bridges. River corridor protection projects can help spread, slow and store floodwaters and sediment. River corridor protection mechanisms include outright purchase, purchase of development rights, easement acquisition, and regulatory policies. River corridor protection helps maintain habitat connectivity. Many towns in Chittenden County have done some level of FEH assessment and mapping; some have incorporated river corridor protection into zoning.

Lead Partners: VT ANR, VTRANS CCRPC, Municipalities.
Critical Partners: Watershed associations, Property owners.

Implementation Status: River hazard protection is included as an action (3.2.3.1a-d) in the ECOS Plan. Through grants from VT ANR, CCRPC has previously conducted stream geomorphic assessments (SGA) throughout the county. Tasks to evaluate SGA software updates (3.1.3) and review municipal water quality protection elements (3.1.2) are included in CCRPC's FY2014 UPWP.

4.2. Promote on-site stormwater management, low impact development techniques and natural stormwater management techniques.

A variety of vegetative approaches (rain gardens, vegetated swales, wetlands, green roofs) can be used for on-site stormwater management. These techniques also provide urban vegetative cover for carbon sequestration and storage. CCRPC can work with partners to promote adoption of these techniques.

Lead Partners: CCRPC, Chittenden County RSEP.
Critical Partners: Winooski NRCD, Municipalities, Homeowners, VT ANR

Implementation Status: Promotion of vegetative landscaping in urban areas is included as an action in the ECOS Plan and can found in section 3.2.3.1a-d. The Chittenden County Stream Team, administered by CCRPC for eight municipalities, engages citizens to implement projects to reduce non-point source pollution and stormwater reduction (CCRPC FY2014 task 3.2.2.3). On behalf of VAPDA, CCRPC will work with municipalities to encourage low impact development and develop a Vermont Green Infrastructure Toolkit.

5. Actions to Prepare for Climate-Related Emergencies

The following regional actions are important to prepare for climate-related emergencies:

5.1 Prepare and maintain plans for emergency operations, emergency response, business continuity and business recovery.

Emergency plans are critical for emergency preparedness, response and recovery. Municipalities and organizations should maintain current plans that are relevant for a variety of emergencies, including flooding and other climate-related emergencies. Consideration should be given to

emergency shelters, alternative routes and evacuation plans. CCRPC can provide technical assistance to municipalities in preparing and maintaining these plans.
Lead Partners: CCRPC, VT DEM, Municipalities.
Critical Partners: LEPC#1.
Implementation Status: Promotion of vegetative landscaping in urban areas is included as action 3.2.4 in the ECOS Plan.

5.2 Provide Incident Command System training for local officials.

Incident Command System (ICS) is the approach used in Vermont to manage emergency situations. ICS helps officials effectively manage emergency situations such as natural disasters, transportation incidents, and other serious incidents. Effective emergency response and management are important components of disaster response and recover, thus improving community resiliency in the face of a disaster. Homeland Security and Vermont Emergency Management coordinate with the regional planning commissions to provide ICS training at different levels for local officials, staff and emergency management personnel. CCRPC can provide technical assistance to municipalities in preparing and maintaining these plans.
Lead Partners: CCRPC, VT DEM, Municipalities.
Critical Partners: LEPC#1, Emergency response agencies.
Implementation Status: Working with Vermont Emergency Management to provide training on the Incident Command System for local officials is included as a task (5.2.1) in CCRPC's FY2014 UPWP.

5.3 Prepare, implement and update hazard mitigation plans.

Hazard mitigation plans evaluate a variety of hazards and identify actions to reduce the impacts of major hazards. Flooding is identified as a major hazard in the Chittenden County Multi-Jurisdictional All Hazards Mitigation Plan, including the municipal annexes. Climate change will affect the hazards communities will need to address. CCRPC can continue to assist municipalities in preparing, implementing and upgrading these plans.
Lead Partners: CCRPC, VT DEM, Municipalities.
Critical Partners: FEMA, LEPC#1.
Implementation Status: Working with communities in developing and enhancing their Hazard Mitigation Plans is included as a task (3.1.2) in CCRPC's FY2014 UPWP.

6. Actions to Prepare for Climate-Related Health Impacts

The following regional strategies and actions are important to prepare for climate-related health impacts:

6.1. Plan for extreme heat events and health impacts of extreme weather events.

Extreme heat events and the frequency of extreme precipitation events are forecasted to increase. The elderly, very young and persons with chronic diseases are particularly susceptible to these changes. Heat waves can lead to heat stroke, dehydration, and even death.

Extreme precipitation events can indirectly threaten human health by reducing the availability fresh food and water if areas become inaccessible because of flooded roads. Heavy rainfall or flooding can increase water-borne parasite found in drinking water, damage water treatment facilities, and may contaminate bodies of water used for recreation. Communication and health care services can be interrupted as well and access to emergency or critical health care could be limited. Additionally, extreme weather events can contribute to mental health impacts such as post-traumatic stress disorder.

Education and warning systems about heat stress and precautionary actions can be developed to help prevent heat stress, water-borne illnesses, and possible death. Emergency plans should be updated to include strategies for extreme heat response and evacuation procedures for areas prone to flooding. Increased heavy precipitation events expected with climate change justify reviewing whether water and wastewater facilities are adequately protected. Strategies may include providing cooling shelters for vulnerable populations

Lead Partners: VT Dept. of Health, CCRPC, Municipalities.
Critical Partners: VT DEM, Red Cross, LEPC#1.
Implementation Status: Monitoring and addressing health and safety impacts of climate change in emergency preparedness plans is included as action 3.2.5 in the ECOS Plan. The VT Department of Health was recently awarded a four-year CDC Climate-Ready States and Cities Initiative grant to investigate aspects of how climate change might impact human health in Vermont, including extreme weather events, vector-borne diseases, water quality and food systems. CCRPC should seek opportunities to assist and partner with VT Dept. of Health with regional implementation.

6.2. Raise awareness of vector-borne illnesses.

A warmer climate may allow currently-uncommon vector-borne diseases (such as Lyme disease, West Nile virus and Eastern Equine Encephalitis) to move into our region. Education programs to raise awareness among medical professionals and the public will enable avoidance practices and faster recognition and treatment.

Lead Partners: VT Dept. of Health, CCRPC.
Critical Partners: LEPC#1.

Implementation Status: Monitoring and addressing health and safety impacts of climate change in emergency preparedness plans is included as action 3.2.5 in the ECOS Plan. The VT Department of Health was recently awarded a four-year CDC Climate-Ready States and Cities Initiative grant to investigate aspects of how climate change might impact human health in Vermont, including extreme weather events, vector-borne diseases, water quality and food systems. CCRPC should seek opportunities to assist and partner with VT Dept. of Health with regional implementation.

Monitoring Implementation Progress

Monitoring is critically important for:

- Providing feedback on whether we are achieving our targets, and
- Ensuring accountability for implementing the recommended actions.

Monitoring progress towards achieving climate action targets is accomplished through the ECOS Annual Report that is updated and prepared annually. Including these climate indicators in the ECOS indicator framework will ensure that climate change continues to be a sustainability issue throughout the life of the ECOS Plan. For climate change, community-scale indicators can be used to measure the overall status of climate mitigation and climate adaptation efforts. Specifically:

- Greenhouse gas emissions inventory measures the amount of emissions from various sources,
- Percent of vegetative land cover (including wetlands and planted agricultural lands) measures the amount of land able to sequester carbon,
- Number of major disaster declarations measures the impact of natural disasters on our region,
- Annual cases of Lyme disease measures the incidence of this key climate-related disease among Chittenden County residents,
- Annual hospitalizations related to heat stress measures the impact of heat stress on Chittenden County residents,
- Vehicles mile traveled per capita measures how much people are driving.

Updating these climate indicators depends on the availability of underlying data prepared by other organizations. For example, the disaster declarations and health-related indicators are available annually. Similarly, greenhouse gas emissions from electricity usage can be calculated annually because Efficiency Vermont releases annual electricity usage data annually. Similarly, CCRPC measures vehicle miles traveled (VMT) per capita annually, so greenhouse gas emissions from transportation can be calculated annually. However, calculating the amount of vegetative landscape or greenhouse gas emissions from agriculture can only be done every five years when national land cover data and agricultural census data are updated and released by federal agencies. Consequently, some climate indicator components can be updated annually and used as interim indicators, but others will be updated based on the release schedule of the underlying data sets.

Monitoring progress in implementing the recommended actions depends on the specific action. This is especially true for the climate adaption actions, for which there is no overall adaptation target. Each action should be designed to include performance measures that indicate both progress and effectiveness of implementation.

End Notes

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[16] Reid Ewing, et al. Growing Cooler. Washington D.C. the Urban Land Institute. 2008.

Appendix A – How This Guide Was Developed

This Climate Action Guide is a product of a multi-year air quality, energy and climate change program by the Chittenden County Regional Planning Commission (CCRPC). In 2010, CCRPC published *Keeping Our Air Clean: Local and Regional Strategies to Improve Air Quality in Chittenden County*. In preparing this report, it became apparent that strategies important to maintaining air quality are closely related to energy and climate change issues. One of the three priority regional strategies recommended by this study was to develop and implement a regional climate action guide.

During 2010 and 2011, CCRPC researched climate change greenhouse gas inventories and climate action plans. CCRPC also contracted with TranSystems/E.H. Pechan & Associates to prepare *Climate/Energy/Air Quality Planning Best Practices Review and Summary* (January 2012). In April 2012, CCRPC published *Chittenden County Climate Change Trends and Impacts*, a review of existing literature on climate change and how it is expected to impact our region.

In 2012, CCRPC assembled two advisory committees: one to advise and assist with the preparation of a regional greenhouse gas emissions inventory and another to advise to assist with development of this Climate Action Guide. Members of the advisory committees were selected to represent a range of municipal perspectives (e.g., Selectboard, public works, planning, energy committee), regional perspectives (e.g., CCRPC board members, regional economic development, regional public transportation, regional solid waste management), a range of local employers with an interest in energy and climate change (e.g., utility, manufacturing, university), non-profits with energy and climate change expertise, and staff from several state agencies involved in energy and climate initiatives. Several members of the committees have experience in preparing emissions inventories and climate action plans for their own organizations. (See the Acknowledgements for identification of the committee members.) The committees met monthly throughout 2012.

Staff from CCRPC prepared materials for consideration and review by the advisory committees, and revised materials based on committee feedback. Staff also worked to coordinate development of the climate action guide with the concurrent development by CCRPC and numerous partners of the ECOS Plan (the new regional sustainability plan). Climate issues, indicators, priorities, strategies and actions have been coordinated between this guide and the ECOS Plan to ensure consistency. Because of the importance of including climate in the ECOS Plan and ensuring coordination between the two documents, the schedule and timeframe for developing this climate action guide was driven by the schedule for the ECOS Plan and the federal grant supporting the regional sustainability planning effort.

Appendix B-Greenhouse Gas Inventory

Introduction

Chittenden County Regional Planning Commission (CCRPC) conducted a Greenhouse Gas (GHG) Emissions Inventory as a component of the Chittenden County Climate Action Guide. The purpose of the inventory is to develop energy and GHG emissions data at both the municipal and county level to support the CCRPC's climate action planning process, as well as provide a resource for municipalities to understand the source and quantity of the emissions that occur within or relate to their jurisdictional area.

The inventory provides an accounting of the primary contributors of GHG emissions within Chittenden County and its municipalities for the base year of 2010. Certain data necessary to measure GHG emissions may deviate from this base year due to data availability.

Technical Oversight

The CCRPC Greenhouse Gas Emissions Inventory Technical Advisory Committee (TAC) provided significant oversight to the regional inventory process. The TAC advised staff on issues related to the development of the regional greenhouse gas emissions inventory. The membership consisted of persons with experience in emissions inventories or access to key data inputs. The TAC consisted of representatives from Vermont Department of Environmental Conservation, Vermont Department of Forest, Parks, and Recreation, Vermont Department of Agricultural (invited), Vermont Agency of Transportation (invited), Federal Highway Administration (invited), Vermont Energy Investment Corporation (VEIC), City of Burlington, City of South Burlington, Chittenden County Transit Authority, IBM, Vermont Gas, Burlington Electric Department, Essex Junction Wastewater Treatment Plant, The University of Vermont, Office of Sustainability, and Burlington International Airport (invited). Staff also relied on regional agencies as resources for key data inputs, particularly Chittenden Solid Waste District. Sam Swanson[1] from the South Burlington Energy Committee contributed a significant amount of time to this project. He worked closely with Green Mountain Power, Burlington Electric Department, and Vermont Electricity Coop to derive a custom emission factor that best represents each company's power portfolio.

Inventory Overview

The GHG emissions inventory is an accounting of human activities in Chittenden County that cause the release of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) into the atmosphere. These gases are known as greenhouse gases and contribute to the warming of the atmosphere. Each of these gases traps heat at different rates.

The focus of the inventory was to estimate the emissions from electricity use, thermal energy use, wastewater treatment, solid waste decomposition, agriculture, and transportation. In addition, CCRPC relied on research conducted at the University of Vermont to understand the rate at which trees and soils absorb carbon dioxide from the

[1] Sam Swanson, a member of the South Burlington Energy Committee, is a Senior Policy Advisor at the Pace University Energy & Climate Center.

atmosphere and store it. This process is known as carbon sequestration.

Many local greenhouse gas emission inventories identify the emissions from a specific organization, such as an individual business, school, or municipal operations. Other emission inventories look more broadly at an entire community. The Chittenden County Greenhouse Gas Emissions Inventory takes a community-wide approach for the entire county, with a breakdown by municipality. Emissions are categorized by source (i.e., electricity, transportation) and by sector (i.e. , residential, commercial). The goal of the regional inventory is to provide each municipality in Chittenden County with a profile of the emissions that are emitted as a result of activities that occur in their town.

Inventory Standards and Methodology

The following principles, taken from ICLEI's Local Government Operation Protocol serve as a general guide to emissions accounting and reporting and were frequently referenced at key decision points when developing the inventory. They are:

- **Relevance:** The greenhouse gas inventory should appropriately reflect the greenhouse gas emissions of the entity and should be organized to reflect the areas over which local governments exert control and hold responsibility in order to serve the decision-making needs of users.
- **Completeness:** All greenhouse gas emission sources and emissions-causing activities within the chosen inventory boundary should be accounted for. Any specific exclusion should be justified and disclosed.
- **Consistency:** Consistent methodologies should be used in the identification of boundaries, analysis of data and quantification of emissions to enable meaningful trend analysis over time, demonstration of reductions, and comparisons of emissions. Any changes to the data, inventory boundary, methods, or any relevant factors in subsequent inventories should be disclosed.
- **Transparency:** All relevant issues should be addressed and documented in a factual and coherent manner to provide a trail for future review and replication. All relevant data sources and assumptions should be disclosed, along with specific descriptions of methodologies and data sources used.
- **Accuracy:** The quantification of greenhouse gas emissions should not be systematically over or under the actual emissions. Accuracy should be sufficient to enable users to make decisions with reasonable assurance as to the integrity of the reported information.

CCRPC's inventory primarily utilizes the formulas for estimating GHG emissions included in ICLEI's Local Government Operations Protocol Version 1.1 (LGOP). Although the protocol focuses on the quantification of GHG emissions across a government's operations the methodologies do translate to the county and municipal levels. When appropriate to more accurately reflect local conditions or when available data required it, other approaches were used or referenced. The methodology for estimating emissions from solid waste was derived from the Clean Air Cool Planet's Campus Carbon. The U.S. Environmental Protection Agency (EPA)'s State Inventory Tool (SIT) was used to calculated GHG emissions from the agricultural sector. Additionally, CCRPC relied on EPA's Mobile Vehicle Emissions Simulator (MOVES) for estimating emissions

from the transportation sector. During the development of this inventory, ICLEI released a draft of the Global Protocol for Community-Scale GHG Emissions. CCRPC followed the recommendation from this protocol for deriving local emissions factors for the electricity consumed in the region. The specific methodology for determining the electricity emission factors was developed initially by Spring Hill Solutions, Inc.[2] and adapted after consulting with representatives of each of the four utilities that serve Chittenden County. More specific information about data inputs and the methodology used in each sector is discussed in subsequent sections of this document.

Summary of Emissions

Within Chittenden County, emissions of greenhouse gases totaled 1.19 million metric tons of carbon dioxide equivalent ($MMTCO_2$ e) in 2010. These emissions are summarized in Table 1. When compared with the amount of carbon sequestered by soil and vegetation, Chittenden County is a net source of GHG emissions, as the soil and biomass uptake 0.760 $MMTCO_2$ e. Transportation emissions from on-road gas and diesel consumption account for the largest share of ghg gas emissions in the County, 48%. Emissions from natural gas consumption for residential and commercial uses account for the second greatest share, 28%. Petroleum consumption for heating (fuel oil, propane and kerosene) comprises 10% of total emissions. Agriculture emissions from animal populations and crop yields contribute 6% of the total emissions. Electricity consumption accounts for7% of total emissions.

Wastewater management accounts for about 1% of emissions. The burning of wood for a heat source contributes about a half of a percent to the County's total emissions.

Table 1. Summary of Chittenden County GHG Emissions (MMTCO2 e), 2010

Source	Chittenden County	Percent of Total
Agriculture	0.073	6%
Electricity	0.077	7%
On road Gasoline/Diesel	0.58	48%
Solid Waste	0.0005	.04%
Wastewater	0.0125	1%
Natural Gas	0.34	28%
Petroleum	0.11	10%
Wood[3] (CH_4 & N_20)	0.001	.07%
Total Emissions	1.19	100%
Carbon Sequestration[4]	0.76	

[2] Spring Hill Solutions, Inc is a Chittenden County consulting firm that specializes in developing energy and climate change plans for business and government.

[3] This does not include the actual CO_2 emissions from wood combustion for reasons explained in the Wood subsection below.

[4] Carbon sequestration is discussed separately because CO_2 is removed from the atmosphere from vegetation.

Figure 2 Chittenden County Inventory, 2010

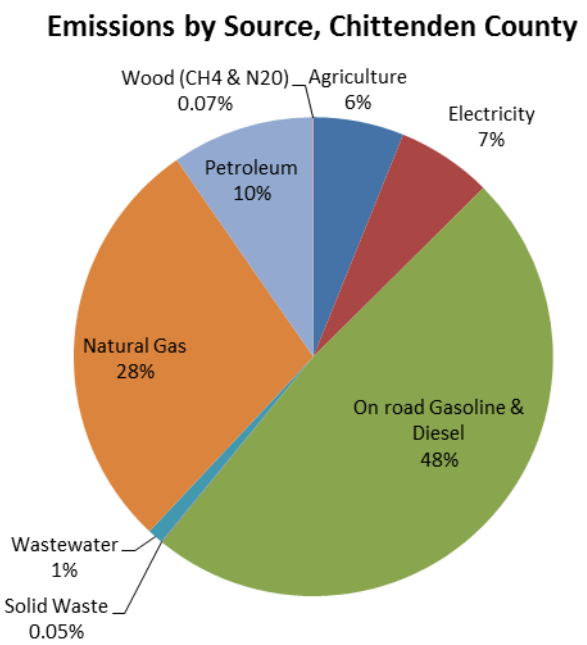
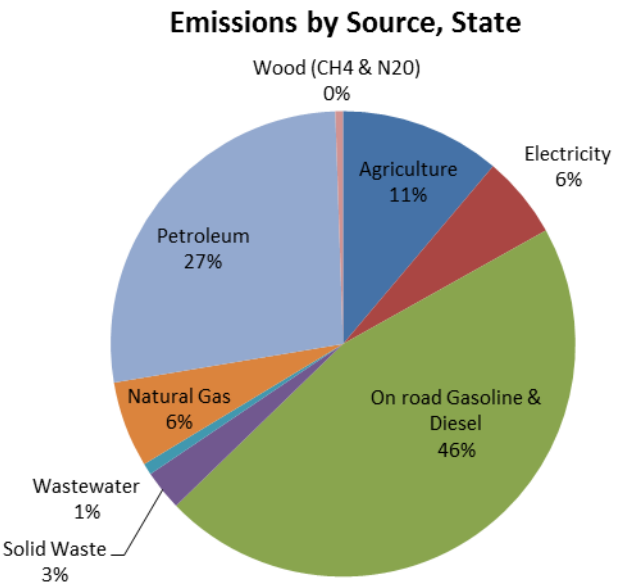


Figure 1 State of Vermont Inventory, 2011



As seen from the comparison of Figure 1 to Figure 2 below, Chittenden County shares a similar break down of emissions by source as the State with a few differences. Although, CCRPC's inventory does not directly compare to the state inventory because state-wide GHG emissions calculations were done with the EPA State Inventory Tool (SIT)[5] and other sources of data, it is still informative to understand how Chittenden County's overall emissions relate to the state's emissions. Additionally, various sectors that do contribute to the State's emissions are intentionally left out of Figure 2 to make the State inventory more relatable to the Chittenden County inventory.

Chittenden County

Chittenden County's emissions from natural gas account for a greater share of total emissions than the State's because a majority of Vermont Gas System's service area is in Chittenden County. Furthermore, petroleum emissions account for a smaller share of Chittenden County emissions because many residences and businesses have replaced petroleum fuel sources with natural gas. Agricultural emissions account for a bigger share statewide than in Chittenden County's due to relatively low number of farms in Chittenden County as compared to the State. Emissions from solid waste in Chittenden County in comparison to the State are surprisingly lower given that Chittenden County has a quarter of the state's population. It can be surmised that emissions from the solid waste generated in Chittenden County could be lower than the rest of the State because of Chittenden Solid Waste District's recycling program.

[5] US Environmental Protection Agency State and Local Climate and Energy Program. State Inventory and Projection Tool. See http://www.epa.gov/statelocalclimate/resources/tool.html

Explanation of Data Allocation

The regional inventory reports ghg emissions data at the county and municipal levels for four categories (stationary uses, transportation, waste management, and agriculture). The data contained in the regional inventory is as complete and consistent as available sources allow, and any changes or assumptions are documented. Table 2 provides a summary of data available for developing the baseline energy and emissions inventory. As shown in the table, there are a mixture of top-down and bottom up methods for quantifying energy consumption at the municipal and county levels. For example, electricity consumption is reported by Town. Thus, the town-level emissions from electricity consumption are rolled up to report a regional total. For estimating delivered fuel consumption, total usage by town is not directly available. In this case, state level consumption was disaggregated to each municipality based on Chittenden County's proportion of delivered fuel use by type and each Town's proportion of non-natural gas customers.

Table 2. Inventory Sectors and Data Availability

Source	Data Geography	Data Source
Electricity	19 Towns	Efficiency Vermont
Natural Gas	12 Towns	Vermont Gas
Delivered Fuels & Wood	State	Energy Information Agency, American Community Survey, VT Department of Labor
Transportation	Municipal, County	Chittenden County Regional Transportation Model and EPA MOVES model
Wastewater Treatment Plant	12 Facilities	Wastewater treatment facilities, U.S. Census, CCRPC
Solid Waste	County	Chittenden Solid Waste District, U.S. Census
Agriculture	County	U.S. Agricultural Census
Carbon Sequestration	County	University of Vermont

Building Energy Use

Energy consumption for heating, cooling, and lighting buildings in both the residential and commercial sectors result in two types of emissions: direct emissions and indirect emissions. Direct emissions include emissions from the combustion of natural gas, kerosene, propane, and heating oil within a furnace or any other fixed or stationary equipment that combusts fuels containing carbon. Typically stationary direct emissions are linked to heating buildings.

Indirect emissions refer to the emissions produced outside of the municipality or county's boundary to produce electricity. Indirect emissions occur at the facility where the electricity is generated but a portion of that electricity is purchased for use in either the town or the County. As a result a portion of the emissions generated are accounted for at either the municipal or county level.

The data collected for calculating emissions in the building energy use category consist of electricity, natural gas fuel oil, kerosene, and propane usage in the residential and commercial/industrial sectors.

Heating (Direct Emissions)

Residential and Commercial buildings are heated with natural gas, oil, kerosene, wood, or propane. Table 3 shows a breakdown of the emissions from each of these energy sources by commercial and residential use.

Table 3. Direct GHG Emissions from Heating

Source	Residential (mmtCo2e)	% of total	Commercial (mmtCo2e)	% of total
Natural Gas	142,924	57%	195,326	97%
Oil	92,364	37%	3,704	2%
Propane	8,810	3%	1,364	0.7%
Kerosene	7,731	3%	61	0.0%
Wood	698	0.3%	112	0.1%
Total	252,529	100%	200,567	100%

Natural Gas

The natural gas usage data were provided by VEIC from Vermont Gas by municipality for the residential and commercial/industrial sectors for the year 2010. Twelve towns in Chittenden County are part of the Vermont Gas Systems service area (Burlington, South Burlington, Colchester, Shelburne, Williston, Winooski, Essex, Essex Junction, Jericho, Hinesburg, Milton, and Underhill). GHG emissions from the combustion of natural gas were estimated by applying the emission coefficients from the LGOP Table G.1 and G.3 to the natural gas consumption data.

Emissions from natural gas combustion for both the residential and commercial sectors make up approximately 0.34 $MMTCO_2e$ or about 28% of Chittenden County's total emissions. Residential natural gas consumption contributes 42% of total natural gas useage. By contrast, commercial natural gas consumption is 57% of total natural gas usage.

Delivered Fuels (fuel oil, kerosene, and propane)

Heating oil, kerosene, and propane are all delivered unregulated fuels. Unlike natural gas data, delivered fuel consumption was not readily available at the county or municipal level. For heating oil, kerosene, and propane consumption, data was collected from the Energy Information Administration (EIA) for the residential and commercial/industrial sectors for the year 2009. Using year 2009 data is a departure from the inventory base year of 2010 but 2010 data was not available at the time of this inventory. These data from EIA are only available at the state level. Disaggregating to the County for the commercial/industrial sector was done according to percent of employees in Chittenden County as compared to Vermont. The Vermont Department of Labor's 2010 annual average of employment from the Quarterly Census of Employment and Wages program was the source data for employment counts at the municipal level. Commercial consumption of delivered fuels in municipalities that have access to natural gas was assumed to be zero because natural gas is significantly cheaper than delivered fuels. While this may not be fully accurate, it appears more reasonable than to assume that the commercial sector uses delivered fuels at the same rate as natural gas in towns where natural gas is readily available.

For the residential sector, disaggregation was done by multiplying the state consumption by each Town's proportion of non-natural gas customer's to the total number of households in Vermont for each municipality in Chittenden County. The source data for households was the American Community Survey Estimates (2006-2009). However for kerosene, a different approach was used because kerosene is usually found in mobile home heating systems as opposed to all housing types. So the percent of mobile home in Chittenden county relative to the state was applied that value to estimate kerosene consumptions. The emission factors for delivered fuels are based on the Table G.1 and Table G.3 of the LGOP.

VEIC was the lead consultant on disaggregating EIA data to the county and municipal levels. Please see the Chittenden County ECOS Plan Energy Analysis Appendix B for the specific energy consumption data (http://ecosproject.com/analysis).

Overall, emissions from delivered fuel consumption consist of 10% of total county emissions or 0.12 mmtCO_2e. Residential consumption contributes far more emissions than commercial consumption of delivered fuels at 90% versus 10%.

Wood

The consumption data for wood came from EIA at the state level and was disaggregated using a top-down approach to the municipalities. The statewide consumption of wood was multiplied by each town's proportion of non-natural gas customer's to the total number of households or employment in Vermont. When measuring the emissions from the combustion of wood, only methane and nitrous oxide emissions are reported as part of the direct emissions. Consistent with most greenhouse gas accounting methodologies, carbon dioxide emissions from burning wood are not considered in the same category of direct emissions from the burning of fossil fuels because the carbon originates from living materials and will be taken up by vegetation through carbon sequestration.

Electricity (Indirect Emissions)

This inventory estimates GHG emissions associated with electricity consumption by multiplying each utility's total electricity sales for Chittenden County municipalities (i.e., customer electric usage) by an estimate of the annual average emission rate for carbon dioxide, methane, and nitrous oxide.

Three different electric utilities serve Chittenden County: Green Mountain Power (includes legacy Central Vermont Public Service), Vermont Electric Co-Op, and Burlington Electric Department. It has been observed that each of these electricity utilities strives to generate and purchase electricity from clean non –emitting sources like hydro, wind, and solar power.

Chittenden County electricity usage data were provided by VEIC/Efficiency Vermont for each Chittenden County municipality for the year 2010. Efficiency Vermont receives customer electric usage results from the state's utilities. The electricity data is presented in two component sectors, i.e., residential and commercial/industrial.

The inventory estimates electricity CO_2 emissions using two different methods:

1. by applying the average annual emission rate for the New England regional electricity grid, and
2. by estimating the average annual emission rate for the electric supply sources of each electric utility serving Chittenden County.

The TAC recommended that this analysis report both the regional grid and the utility specific emission rates to communicate clearly the benefits Vermont utilities obtain by acquiring low emission supply sources and to indicate the significant potential impact when local utilities purchase electricity from grid sources to serve the varying needs of local electricity consumers. The inventory uses the utility specific annual emission estimates for CO_2 to calculate the electricity use related emissions included in this Chittenden County inventory.

Grid based emission estimates: The average annual emission rate for the New England regional electricity grid is obtained from EPA's Emissions & Generation Resource Integrated Database (eGRID[6]) The eGRID provides annual average emission rates for the six state New England Power Control Area (identified as the NEWE eGRID subregion). Applying this emission rate to total electricity use in Chittenden County would ignore the benefit Chittenden County gets from the decisions local utilities have made to acquire low emission supplies. The eGRID average 2009 emission rate for the New England region is 728.41 lb CO_2 /MWh), 5 times greater than the utility with the lowest emission rate in Chittenden County. Table 4, lists the emission factor for eGRID and for the individual utilities that serve the region.

Utility supply based emission estimates: The average annual emission rate for the electric supply sources of each electric utility serving Chittenden County is obtained using utility supplied information describing each utility's 2009 electricity supply sources and estimates of the associated CO_2 emission rates for each source.

[6] US Environmental Protection Agency Clean Energy Program. Information available on the Internet at: http://www.epa.gov/cleanenergy/energy-resources/egrid/index.html

Each utility's average annual emission rate, expressed in pounds CO_2 per kWh, is a composite of the average emission rates for its electricity supply sources that include a combination of individual generators and purchases from several different market suppliers that include the New England regional power grid, HydroQuebec, and the New York Power Authority. Each utility's average annual CO_2 emission rate has been applied to the 2010 annual electricity sales of that utility to its customers in Chittenden County, producing estimates of the total CO_2 emissions for the County and each County municipality.

As seen in Table 4, using the utility specific emission factors electricity contributes only 6 % of the County's emissions. The ghg emissions associated with Chittenden County electricity consumption would be about five times greater if Chittenden County utilities obtained their electricity supplies from the same mix of sources that serve the overall New England region.

It is important to realize that although total annual emissions are significantly reduced by the contract decisions of Vermont's utilities, short term variations in electricity consumption, especially during summer peak load periods, can produce disproportionately large changes in emissions. These disproportionately large impacts of changes in electricity consumption during peak loads occur because Vermont's utilities depend on the interconnected regional grid to supply local needs on a short term basis. This very important when considering action plans to meet climate goals.

As seen in Table 4, if this inventory used the grid emission factor electricity would make up 34% of the County's emissions.

Table 4. Emission Rates

Source	lbs/kWh
eGrid	.728
Green Mountain Power	.142
Burlington Electric Department	.203
Vermont Electric Co-op	.212

Table 5. Total Emissions from Electricity Consumption

Source	Total Emissions (MMTO2 e)	Percent of County
Grid Emissions	.40	34%
Chittenden County Emissions	.076	6%

Waste

Solid Waste

GHG emissions from solid waste disposal were accounted for using a top down approach because data on municipal solid waste tonnage is not available. Chittenden Solid Waste District (CSWD) provided 2010 solid waste tonnage for the Chittenden County. To disaggregate solid waste tonnage, the County total was divided by each municipality's proportionate share of the County's population. In other words, each municipality's solid waste tonnage is proportional to the municipality's share of the County's total population. The 2010 Census was the source for population data.

To estimate the GHG emissions from solid waste, an emission factor that accounts for landfilled waste with methane recovery and electric generation was applied to the solid waste tonnage amounts for each municipality. The landfilled waste emission factor came from Clean Air-Cool Planet's Campus Carbon Calculator (version 6.75). The factor was appropriate because the landfills where Chittenden County's waste is sent produce electricity from the recovered landfill gas and any excess gas not able to be used is combusted in a flare.

Although this inventory measures and reports GHG emissions from solid waste for each municipality, the emissions from solid waste do not occur with Chittenden County's borders. All of the solid waste generated in Chittenden County is transported to landfills outside the County in Moretown, VT and Coventry, VT.

Wastewater Treatment

Jim Jutras, Superintendent and Chelsea Mandigo, Environmental Technician from the Essex Junction Wastewater Treatment Plan prepared the estimate of GHG emissions from wastewater treatment. ICELI's methodology from the LGO protocol was utilized for measuring GHG emissions associated with wastewater treatment. ICELI's protocol formulas are based on processes that occur in a warmer climate which requires nitrification of waste water throughout the year. Given that Vermont has a colder climate nitrification is only needed 6 months out of the year. Therefore, nitrification calculations within the protocol were modified to account for seasonal changes in treatment. GHG emissions (methane and nitrous oxide) from wastewater treatment were calculated using emission coefficients and formulas from the LGO 1.1. Emissions included stationary emissions from incomplete combustion of digester gas, process emissions from treatment lagoons, tertiary treatment and effluent discharge, and fugitive emissions from septic systems.

The protocol was applied to each of the 12 wastewater treatment plants in the County plus those areas that rely on on-site septic systems. Municipalities that have wastewater treatment are Burlington, Shelburne, Richmond, Essex Junction, Town of Essex, Williston, South Burlington, Richmond, Hinesburg, Milton, and Winooski. Portions of these municipalities and other towns (Bolton, Buel's Gore, Charlotte, Huntington, Jericho, Underhill, St. George, and Westford) treat waste water with on-site septic systems.

The data for calculating emissions in the Wastewater Treatment category consist of:

- Amount of digester gas combusted in centralized treatment plant
- Measured fraction of methane in biogas
- Populations served by centralized treatment plants
- Nitrogen load of centralized treatment plants
- Populations served by septic systems

Digester gas, biogas, and nitrogen load are all values that remain constant throughout the protocol. Other custom terms were collected from the individual plants operators. Populations served by centralized treatment plants and population served by septic systems are inputs to the protocol and were based on U.S. Census 2010 population if the entire municipality is served by waste water treatment. If the town was only partially

served by a centralized treatment plant or portions of the town relied on septic systems the population was derived from CCRPC's Housing Database, U.S. Census Average Household Size, and mapped boundaries of sewer service areas.

Table 6. Emissions from Waste

Source	Emissions $MMTO_2$ e	Percent of County
Solid Waste	.000567	.04%
Wastewater	.0125	1%

Agriculture

Agricultural practices are a source of GHG emissions because of enteric fermentation, manure management, plant residues, and fertilizer application. The EPA's State Inventory Tool (SIT) Agriculture Module along with the 2007 U.S. Agricultural Census Data on animal population, crop yields, and acres of farms treated by fertilizer were used to estimate methane and nitrous oxide from agriculture. The SIT is designed to calculate agricultural emissions at the state level. However, it was utilized for this inventory with county data due to the absence of another suitable protocol. Municipal level data is not available from the U.S. Agricultural Census. Therefore, GHG emissions are only reported for Chittenden County.

The quantity of fertilizer within Chittenden County was the only derived input that needed to be derived from other data sources. It was derived from the total fertilizer use in Vermont reported in the module from the Association of American Plant Food Control Officials and The Fertilizer Institute. Then the proportion of acres treated was determined from the Agricultural Census for Chittenden County and applied to the quantity of fertilizer used in the State.

As seen in table 6, the greatest source of agricultural emissions comes from agricultural soils. Agricultural solids yield higher emissions than from enteric fermentation and manure management because crop production is more prominent in the County than large dairy farms. According to the 2007 Ag Census, there were 225 crop farms and only 81 cattle farms. Large dairy farms are a significant source of manure and enteric fermentation. Enteric fermentation it the digestion process of cattle that produces methane gas.

Table 7. Agricultural Emissions

Source	Total Emissions $MMTO_2$ e	Percent of County
Enteric Fermentation	.016	1.3%
Manure Management	.004	.33%
Ag Soils	.054	4.5%
Total	**.073**	**6%**

Transportation

On-Road

CCRPC uses EPA's Motor Vehicle Emission Simulator (MOVES - http://www.epa.gov/otaq/models/moves/index.htm) model in conjunction with the RPC's regional transportation model (http://www.ccrpcvt.org/transportation/model/) to quantify transportation emissions in Chittenden County using a bottom-up approach. Emissions are estimated for each

municipality and then summarized to the county level.

MOVES has the capability to estimate GHG emissions of CO_2, methane (CH_4), and nitrous oxide (N_2O) from highway vehicles using gasoline or diesel. This includes gasoline blends, such as various levels of ethanol, and biodiesel. GHG emissions can be calculated based on the actual fuel consumed under the local driving conditions (speeds and types of roads), the vehicle fleet (age of vehicles), and a variety of other local input data specific to Chittenden County.

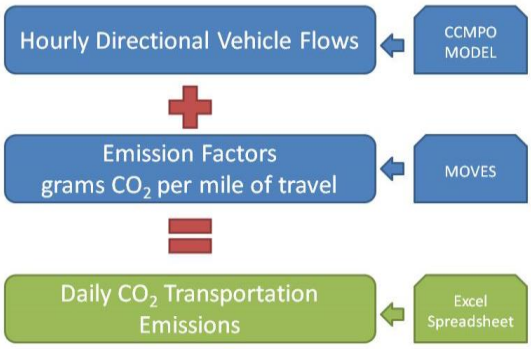


Figure 3 - Transportation GHG Emissions Methodology

Some of the advantages of using MOVES and the regional transportation model over other approaches include:

- The ability to estimate CO_2, CH_4, and N_2O emissions simultaneously from the same activity data (as well as ozone precursors and other criteria pollutants, if needed);
- Emissions represent Chittenden County specific inputs on Vehicle Miles of Travel (VMT) and the vehicle population;
- Since the type of travel (speed distribution, road types, driving cycles) in an area will impact fuel economy, MOVES emissions will be more representative than allocating Vermont total fuel use to Chittenden County;
- Many mitigation strategies can also be modeled with MOVES, providing a consistent approach estimating emissions for inventories, forecasts, and mitigation measures. In addition, emissions can be output by vehicle type, to allow for the development of focused mitigation strategies.

The use of the regional transportation model and MOVES enabled both the calculation of direct emissions and consumption emissions from travel on roadways. Direct emissions quantify the vehicle miles traveled within a municipality's borders irrespective of the origin and destination. For example, a municipality that contains the Interstate without an interstate exist is associated with the emissions generated on the portion of the Interstate within its borders regardless of the destination. By contrast, the consumption assignment of emissions from vehicles miles traveled assigns half of emissions to the origin and half of the emissions to the destination. For example, the emissions generated on the Interstate in Bolton are not assigned to Bolton. Instead they are assigned to the destination and origin of that vehicle.

The total Chittenden County direct emissions from transportation is 0.58 $MMTCO_2e$ or 48% of the County's total emissions. CCRPC is working on investigating the validity of the consumption emissions calculations and updates of this inventory may have a revised estimate for 2010 consumption emissions. Due to the uncertainty of the consumption emission estimates, this inventory utilizes the county total for direct emissions and each municipality's proportionate share of the consumption emissions is used to disaggregate out the emissions for each municipality.

Table 8. Transportation Emissions from On-Road and Diesel Usage

Source	Total Emissions $MMTCO_2e$	Percent of County
Direct	.58	48%

Off-Road

Vehicles operating at various types of off-road sites like the Burlington International Airport, CSWD facility, and construction sites are not included in this inventory due to inconsistent data availability. However, the City of Burlington's Climate Action Plan does measure emissions from the Airport's vehicle fleet.

Carbon Sequestration

Chittenden County consists of land cover that ranges from developed to forest. The soils and biomass that make up these different types of land cover sequester or capture and store carbon. Long term storage and uptake of carbon also known as carbon sequestration removes the amount of carbon in the atmosphere emitted by anthropogenic sources. The quantification of the rate of carbon sequestration is important because it helps stakeholders to understand that the County emits more carbon than its land cover stores.

This inventory uses the research of Anna M. Mika et. al. at the University of Vermont to measure the county's total annual sequestration. The Multi-Resolution Land Characteristics Consortium's (MRLC) 2001 National Land Cover Database (NLCD) was used to determine the amount of acreage in each land cover type. The land cover types from the NLCD were then assigned to the land cover classifications used by the Intergovernmental Panel on Climate Change (IPCC) to measure the sequestration rates. Additionally, the U.S. Department of Agriculture (USDA) Forest Service's Carbon On Line Estimator-EZ (COLE-EZ) and the 2006 Chittenden County Forest Inventory and Analysis was used to better estimate the carbon stocks and rates of specific forest types and ages.

Under the land cover conditions in 2001, Chittenden County's soils and biomass take up 7.6 $MMTCO_2e$. Since this research was completed 2006 NLCD became available. CCRPC has not had the resources to update the sequestration analysis, although it intends to do so in the future. Furthermore, the change in vegetated land cover types is nominal as it decreased from 95% in 2001 to 94.8% in 2006.

REFERENCES

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Municipal Inventory GHG Emissions (mtCo2e)

Town	Natural Gas		Delivered Fuels		Wood (CH4 & N2O)		Electricity		Waste		Transportation	Agriculture	Total	Share of Emissions
	Residential	Commercial	Residential	Commercial	Residentia	Commercial	Residential	Commercial	Solid Waste	Wastewater				
Bolton	-	-	2,522	116	15	-	225	127	4	266	6,291		9,566	1%
Buels Gore	-	-	20	-	0	-	1	-	0	7	104		133	0%
Burlington	49,068	72,135	12,203	-	81	-	8,083	24,732	154	120	99,246		265,822	22%
Charlotte	-	-	7,046	1,103	47	25	719	145	14	907	11,218		21,224	2%
Colchester	13,659	18,762	14,032	-	81	-	2,414	3,045	62	3,044	60,255		115,354	10%
Essex	10,203	-	3,669	-	24	-	1,260	1,891	37	1,261	48,715		67,060	6%
Essex Junction	13,127	45,259	6,063	-	42	-	1,487	1,341	34	64	18,724		86,140	7%
Hinesburg	658	178	6,254	20	39	-	921	312	16	1,029	19,198		28,626	2%
Huntington	-	-	3,501	403	22	9	371	34	7	446	8,752		13,544	1%
Jericho	2,468	235	4,823	-	33	-	1,082	441	18	1,040	18,003		28,144	2%
Milton	5,959	3,591	10,222	-	63	-	2,274	1,322	37	1,420	49,281		74,168	6%
Richmond	-	-	7,577	3,008	46	68	794	287	15	649	16,738		29,181	2%
Shelburne	6,811	3,551	5,210	-	33	-	1,165	1,212	26	280	23,500		41,787	4%
South Burlington	24,023	29,868	8,539	-	59	-	2,440	6,199	65	106	99,506		170,804	14%
St. George	-	-	1,608	78	8	2	3,099	756	2	149	1,342		7,043	1%
Underhill	381	10	4,103	5	28	-	768	91	11	681	11,709		17,787	1%
Westford	-	-	3,334	400	22	9	532	48	7	436	8,481		13,270	1%
Williston	8,013	16,803	5,883	-	37	-	1,508	3,669	32	557	60,051		96,553	8%
Winooski	8,555	4,935	2,767	-	19	-	781	1,254	26	20	15,813		34,170	3%
County	142,924	195,326	109,376	5,132	698	112	29,925	46,905	567	12,482	576,929	73,000	1,193,376	100%

Appendix C – Individual Climate Action Guide

Individual Strategies to Reduce GHG Emissions

Although we may not think much about it, each of us makes dozens of choices each day that contribute to ghg emissions that are emitted into the earth's atmosphere. We produce ghg emissions when we drive to work, school, and shopping. The activities we do in our homes also produce ghg emissions through heating, solid waste, and electricity use. Together these activities make up a person's carbon footprint. A carbon footprint is the total amount of ghg emissions caused by that person. This appendix addresses strategies that can be implemented by individuals to reduce ghg emissions and improve the environment in Chittenden County.

Individual behaviors and choices, such as where we live and how we commute to work, cannot be legislated. Consequently, it is important that people understand the connection between their choices and climate change, and voluntarily adopt individual strategies to reduce the amount of carbon dioxide that is warming our planet.

Individuals may not be able to adopt all of the strategies described in this appendix; however, most people will find many strategies that they can do. Choosing the most appropriate and effective individual strategies to reduce ghg emissions depends on each individual's circumstances. Some strategies require changing behaviors and practices, others require an investment in new materials or equipment. Many offer substantial cost savings through reduced energy use and reduced operational costs. Some even save time and can improve an individual's' quality of life.

The first group of individual strategies deals with transportation, because this is the largest source of ghg emissions in Chittenden County. The second group of individual strategies addresses ghg emissions from our homes, such as space heating.

1. Individual actions to reduce ghg emissions from transportation

1.1 Drive Less: Make a personal choice to drive less, using transportation options (e.g. walk, bicycle, transit, ride share, telecommute)

The average Vermonter drives 17,000 miles annually. With a little planning this could easily be reduced 10% or more, resulting in lower costs, less wear and tear on the car, and fewer emissions. Participating in the annual Way to Go Week is an easy and fun introduction to using these transportation alternatives.[7]

- Walk or bike to your destination. Walking and bicycling do not emit any ghg emissions. This is a low cost way for you and the environment to improve.

- Take transit if available. Even if just once or twice per week, taking transit will save money and reduce traffic congestion and ghg emissions.
- Ride share or car pool. Sharing a ride also saves money and reduces ghg emissions. 1200 lbs. of CO2 could be saved by sharing a ride to work just once a week.[8] Go! Chittenden County can help you find a carpool partner or van pool. Local programs may also be an available resource: Hinesburg Rides, a program of the Hinesburg Community Resource Center, offers a web-based ride-sharing program.
- Telecommute. If your job allows it, working from home just one day a week for a year could save 1,000 miles on your vehicle. This translates into over 30 hours a year of time saved by not commuting, over $500 savings in total driving costs, and significant air emission reductions.
- Join a car share program. Car share programs allow individuals and businesses to have the benefits of a car for transportation, without having to own a car. The car share program owns and maintains a fleet of cars. Car share members reserve a car and pay based on how much they drive. Car share members tend to drive much less than car owners; some studies show that car share members cut their driving in half. Members of car share programs tend to walk, bike and take transit more – using a car only when it is really needed. Car sharing saves money by providing mobility without the costs of purchasing, maintaining and insuring a car yourself. In the Burlington area, CarShare Vermont provides car sharing services to members.[9] Zipcar is a national organization providing car-sharing services at Middlebury College, Vermont Law School and Dartmouth College.

- Walk, bike or bus to school. Children can help parents drive less by walking, bicycling or taking the school bus to school. Fifty years ago, 70% of children in Chittenden County walked or biked to school; today about 13% walk or bike to school. Working with Local Motion, 26 elementary and middle schools in 11 Chittenden County towns are participating in Safe Routes

[7] Way to Go. Accessed June 1, 2009 at: http://www.waytogovt.org

[8] Hinesburg Rides. Accessed February 2, 2013 at: www.hinesburgrides

[9] CarShare Vermont. Accessed June 1, 2009 at: http://www.carsharevt.org

to School programs.[10] Safe Routes to School uses a team approach to identify safe, fun ways for children to walk and bicycle to school. Even if children walk or bicycle to school only a few days a week in good weather, they will help save gasoline, stay healthy, and improve the environment.

Resources: Safe Routes to School, Carshare Vermont, Go! Chittenden County, CCTA, Way to Go

1.2 Fuel Efficient Driving Practices: Adopt "eco-driving" techniques to improve vehicle gas mileage and fuel efficiency and reduce emissions.

Studies indicate that altering your driving style can improve fuel economy. Generally, improving vehicle fuel economy also reduces ghg emissions. There are a variety of simple techniques that drivers can use to improve their fuel economy and reduce air emissions. Collectively, these techniques are sometimes referred to as "Eco-Driving." Moderate use of Eco-driving techniques can improve fuel economy 10-15%; full application of Eco-driving techniques can improve fuel economy even more.

- Avoid rapid starts and stops. A few seconds of high-powered driving can use as much gas as driving for several minutes at more measured speeds.
- Coast to slow down or stop. This requires anticipating traffic conditions, but saves on fuel and brake wear. It takes 20% more fuel to accelerate from a full stop than from 5 miles per hour.
- Maintain a steady speed. Anticipate traffic flow and traffic signals to keep your car running efficiently and avoid red lights when traffic lights are synchronized.
- Drive slower. Fuel economy usually decreases rapidly at speeds above 60 miles per hour (mph); every 5 mph you drive over 60 mph is like paying an extra $0.24 per gallon for gasoline. Most vehicles get their best gas mileage at speeds between 30 and 55 miles per hour. Driving within this optimal range will increase fuel economy 10-15%.
- Avoid idling. Idling gets 0 mpg, and can use more than a half-gallon of fuel for every hour spent idling. Turn off the engine for stops anticipated to be more than 60 seconds (e.g., picking up a child from school, waiting in a drive through).
- Drive your car to warm it up. Today's cars generally need only 30 seconds to be ready to drive, and the car will reach an optimum operating temperature much faster when driving, rather than idling.
- Combine errands and trips. Cars emit more pollutants when the engine is cold than when the engine is warmed up. Grouping trips together, or "trip-chaining," will save both fuel and time and will reduce air emissions. Driving to a central location and walking to complete multiple errands will save even more gas and increase physical activity too.
- Use the air conditioner selectively. Air conditioning can reduce mileage by as much as 20%. Minimizing use of the air conditioner will reduce the load on the engine, decreasing fuel consumption and air emissions. Park in the shade to shield the vehicle interior from the sun. Open the windows when getting into a hot car to blow out

[10] Local Motion. *Safe Routes to School*. Accessed February 2, 2013 at: http://www.localmotion.org/programs/safe-routes-to-school/

the hot air. At speeds less than 40 mph, keep the windows open when you drive. Over 40 mph, close the windows to reduce aerodynamic drag and use the vents, or use the air conditioner and recycle the inside air to avoid drawing in hot air from the outside that has to be cooled.

- Travel light. An extra 100 pounds in the trunk reduces fuel economy by up to 2%. A loaded roof rack or carrier can decrease fuel economy by 5% because of the weight and aerodynamic drag. Remove luggage racks, roof-top carriers and ski racks when not needed.
- Avoid evaporation when refueling. In hot weather, fuel your car in the cooler morning or evening hours. This reduces the amount of fuel lost to evaporation during filling. Stop refueling when the gas nozzle clicks off. This avoids gas spillage and evaporation. It also avoids exposure to benzene. Close the gas cap tightly to prevent evaporation from the fuel tank; many gas caps click to let you know when they are closed properly.

Resources: ECOdriving

1.3 Vehicle Maintenance: Maintain vehicles to improve gas mileage and fuel efficiency and to reduce emissions.

A well-maintained vehicle produces 20% less ozone-related emissions, lengthens the life of the vehicle, and can save the average driver over $300 per year on gas.

- Change the oil. Regular oil changes can increase gas mileage and reduce emissions. Use the manufacturer's recommended grade of motor oil to increase fuel economy by 1-2%.
- Replace dirty air filters. Replacing a clogged air filter can increase fuel economy by 10%.
- Tune up your car. Regular tune ups can increase fuel efficiency by 4%.
- Check your tire pressure. Properly inflated tires can improve gas mileage by 3%. Check tires monthly, or when there is a sudden temperature change of more than 10° F. When time to replace, consider getting low rolling-resistance tires. These cost more than traditional tire replacements, but reducing rolling resistance by 10% can improve gas mileage by 1-2% for most passenger vehicles.

Resources: Fuel Economy

1.4 Purchase Low or No Emissions Vehicle: Choose the lowest polluting vehicle or vehicle with zero emissions that meets your needs.

The least polluting vehicle is the one you don't own or drive. If the transportation alternatives in Strategy 1 are not enough for you to go without owning a car, then choose the lowest-polluting vehicle that meets your needs.

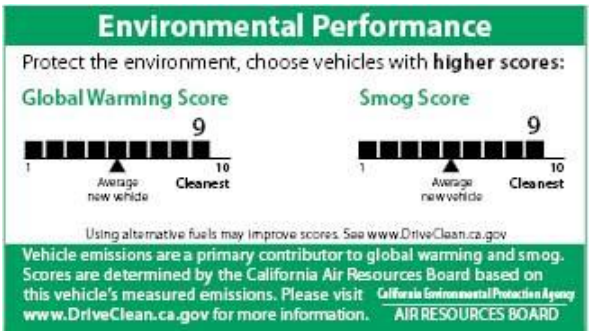
Vermont has adopted the California standards for vehicle emissions. This means that new vehicles sold by dealers must meet the same emission requirements as new vehicles in California. Vehicles are classified by the emission limit standards that they meet. From low to lowest emissions, these categories are:

- **LEV** – Low Emission Vehicle
- **ULEV** – Ultra Low Emission Vehicle
- **SULEV** – Super Ultra Low Emission Vehicle
- **PZEV** – Partial Zero Emission Vehicle
- **ZEV** – Zero Emission Vehicle

Both vehicle technology and fuels influence the amount of ghg emissions from cars:

- Newer gasoline-fueled vehicles include many cleaner models. Generally, cleaner gas-fueled vehicles have fewer cylinders, multiple catalysts, oxygen sensors, and exhaust gas recirculation systems.
- Flex-fueled vehicles can burn E85 ethanol fuel as well as gasoline. Emissions from burning E85 are similar to gasoline-powered vehicles.
- Diesel-fueled vehicles have traditionally been a major source of particulate pollution. The introduction of low-sulfur diesel fuel has allowed for the development of better diesel-engine control systems to reduce emissions. Emissions from diesel-fueled vehicles still have room for improvement. Biodiesel fuels generate lower emissions of many air pollutants, but emissions of nitrogen oxides, which contribute to ozone pollution, may actually increase.
- Compressed natural gas vehicles have low air emissions, but are limited by the availability of fueling stations. Compressed natural gas vehicles are increasingly being used for public transit buses and business fleets that have their own fueling stations.
- Hybrid electric vehicles have fewer emissions than comparable conventional vehicles because an electric motor is used in combination with the gasoline motor. Depending on the type of hybrid technology, some hybrids have fewer emissions than other types of hybrid vehicles.
- Electric vehicles have very few ghg emissions; about 10 different car makers offer an electric vehicle.

California is a leader in cleaner vehicle technology. Their Drive Clean website (www.driveclean.ca.gov) has good information on emissions from different vehicle types and models. The Green Vehicle Guide website (www.epa.gov/greenvehicles) can help you identify the emissions level of most vehicle makes and models, as well identify the lowest emitting vehicles by size class and model year. New vehicle emission control information can also be found on a label under the hood.



Starting in 2010, all new vehicles sold in Vermont will have an Environmental Performance Label (Figure 2-2) that shows a global warming score and a smog score. This label will help consumers know which vehicles are the most efficient and least polluting. Generally, vehicles with the lowest air emissions are also more fuel efficient. Choosing a less polluting vehicle will also help drivers save money on gas.

Resources: DOE Car Guide, Drive Electric Vermont

1.5 Encourage your employer to install an EV charge Station

As the popularity of owning an EV increases, EV owners will need charging stations at their workplace to supplement home charging. Consider asking your employer to support your ability to become an EV owner. Access to charging stations at work is especially important in the colder

winter months in Vermont. EVS have an internal heater that prevents the Li-ion battery from freezing. This internal heater does operate off of the car's Li-ion battery. To maintain a charge during sub-zero temperatures, an EV needs to be plugged in. Thus, the availability of a charging station at one's workplace makes it easier for more people to own EVS and maintain an adequate charge throughout the day.

Resources: Chargepoint

2. Individual actions to reduce ghg emissions from activities you do in your home.

2.1 Choose a Walkable Neighborhood: Choose to live in a neighborhood that is close to work, has sidewalks, is safe to bike, near shops and services, and has transit.

One easy way to drive less is to live in a neighborhood where it is convenient to drive less. When looking for a place to live, let your real estate agent know you prefer an accessible community. Consider choosing a home in a community that is close to work and has sidewalks, good conditions for bicycling, nearby shops and community services, and transit service. These features promote fewer and shorter automobile trips.

Resources: Land Use as a Climate Strategy

2.2 Retrofit Your Home: Retrofit your home to reduce electricity and thermal energy use.

With our cold winters, it is not surprising that residential energy use is a close second to transportation energy use in Vermont. Burning fuel to heat homes – whether oil, natural gas or wood – generates ghg emissions that contribute to the warming of our climate. Actions that improve a home's energy efficiency will reduce ghg emissions and help save money.

- Conduct a home energy audit. An energy audit typically evaluates building tightness, insulation effectiveness, heating system, lighting, appliances and windows. The audit will provide advice on ways to lower your energy bills. Audits can assist in prioritizing energy-saving home improvements and help accessing financing for those improvements. Efficiency Vermont, Vermont Gas Systems and Burlington Electric Department can provide information about energy audits and help identify qualified energy audit contractors.
- Weatherize or seal air leaks and insulate your attic, walls, and basement to reduce heat losses. Close the damper when not using the fireplace.
- Lower the thermostat in winter. Dress warmly and lower the thermostat. Open the curtains during the day to let in the sun's warmth, and close them at night to help keep in the heat. Install a programmable thermostat and use the automatic set back to reduce the temperature when sleeping or not at home.
- Conduct regular heating system maintenance. Changing the air filter regularly helps the heating and cooling system run more efficiently. Regular maintenance according to the manufacturer's recommendations will also help keep the system operate more efficiently.

- Consider upgrading to a more efficient system. The energy savings from upgrading to a more efficient heating system will help pay for the additional cost. For homes heating with wood, new EPA-certified wood stoves and fireplace inserts are more efficient and produce much lower air emissions. Vermont has proposed regulations requiring new outdoor wood boilers to meet the same particulate emission limits as in neighboring states.[11]
- Choose lighting and appliances that use less energy and are ENERGY STAR rated. Compact Fluorescent Light bulbs (CFLs) and light-emitting diodes use less energy and last longer than traditional incandescent light bulbs. All major appliance brands offer energy efficient models that are right for your home and help you to save energy and money.

Resources: Efficiency Vermont, Home Performance with Energy Star

2.3 Meet or Exceed Energy Building Code Standards: Meet or exceed state energy efficiency building code standards for new construction and major renovations.

The state of Vermont has a residential building energy code that applies to new homes and renovations to existing homes. Compliance to date has been largely voluntary as resources for enforcement is limited. During the planning phase for your new home or your renovation project of your existing home, consult the Vermont Residential Building Energy Code Handbook for performance requirements and enroll in Efficient Vermont's Energy Code Plus service to have an energy consultant assigned to your project.

Resources: Energy Code Plus, Energy Code Handbook

2.4 Expand Recycling: Increase the types and quantity of materials that are recycled in your home

Reducing the quantity of materials being landfilled reduces future landfill methane emission potential, while recycling reduces emission associated with raw material mining and product manufacturing. Use of waste materials as a fuel source can reduce emissions by offsetting fossil-based energy sources. Emissions from long-haul transportation to landfills may be replaced by emissions from long-haul transportation to recycling processors. Local recycling adds jobs and helps diversify the local economy.

2.5 Switch to Biomass and Biofuels: If suitable, switch to biomass-based heating equipment and fuels, including wood or crop based solid fuels such as chips and pellets, as well as blended liquid bio fuels.

You can heat your home without heating the planet. To reduce the amount of ghg emissions your home produces from combustion of fossil fuels for heating, consider switching to biomass based heating equipment or installing a supplemental woodstove. A Vermont home switched from oil-

burning heaters to a clean-burning wood-pellet stove would save about 575 gallons of oil yearly, which is the equivalent of 79 million British thermal units or Btu[12].

- Biofuels are made from new and used vegetable oils or animal fats. Biofuels are biodegradable, nontoxic and renewable. Combustion of biofuels results in far fewer ghg emissions than petroleum based home heating fuels. Most often, biodiesel can be used in your existing furnace that uses No. 2 heating oil.
- Wood-burning Appliances- There are several types of wood-burning appliances that a homeowner can choose from to use as a primary heat source or as supplemental heat. A variety of wood stoves are available and today's wood stoves are safer, more efficient, and produce almost no smoke as compared to their older counterparts.

Resources: Vermont Bioenergy Initiative, Wood-burning Appliances

2.6 Implement On-Site Renewable Energy Applications: Implement on-site renewable energy application.

For every kilowatt-hour (kWh) of electricity we avoid using prevents more than 1 ½ pounds of carbon dioxide from being released into the atmosphere- and saves money. Installing on-site renewable energy equipment in the home can reduce or prevent electricity usage. Also, use of distributed generation from multiple renewable sources reduces vulnerability to widespread power grid outages and fluctuations in electricity rates. A direct way to use renewable energy in the home is to install renewable energy generating like solar panels or wind turbines. These systems can provide the homeowner a substantial pay-back as households see a reduction in electricity bills because they are generating enough power for their home as well as an excess amount that they can sell to their utility company. This is referred to as net metering.

- Solar Panels typically make up a photovoltaic system and can be installed on the roof tops of homes to generate and supply electricity. Solar panels convert light energy from the sun to generate electricity, which is used to power a variety of household appliances. There are no ghg emissions in the generation of solar power, so this is a good option for a household that wants to reduce their carbon footprint.
- Solar Hot Water systems used in residential heating systems include storage tanks and solar collectors. There are two types of system: active, which have pumps and controls, and passive, which don't.
- Ground Source Heating is a central heating and/or cooling systems that pumps heat to or from the ground. The temperature of the earth about 10 feet down is a constant 54 degrees. In the winter the air is cooler than the ground below the surface so water is circulated underground via pipes to be heated and then a heat pump heats the air some more and then

[12] Meigs, James, "The Case for Biomass.", Popular Mechanics Mar. 2014: p.66. Print

the heat is circulated into the house. In the summer, the heat from the house is circulated underground to be cooled and then it re-circulated back into the house.

- Small Wind Turbines are generally available for the residential scale and range in height from 7 to 25 feet and produce electricity at a rate of 300 to 10,000 watts. Wind turbines can be used to move a mass or air to produce electricity. The electricity produced from wind turbines is clean and renewable.

Resources: Wind Energy, Solar Power, Geothermal Heat

2.7 Support Local Agriculture: Support Local Agriculture to adapt or become more resilient to climate change (climate adaptation)

As the climate changes individuals will need to adapt or become more resilient in order to remain healthy and thrive. Many of our activities of daily living may need to change as a result of global changing climate. A really crucial aspect of our way of life that may be impacted is our food supply as our current food system may be disrupted because of storm damage to road infrastructure and pest outbreaks. An example of this occurred during Hurricane Sandy in 2012. Thousands of truckloads of food headed for stores in the Northeast were stuck in warehouses as dangerous road conditions made deliveries difficult immediately after the storm. Local agriculture decreases the dependency on food coming from far distances and will enable people and communities to be more "self-sufficient" if a particular delivery network or product is impacted by storms or other climate factors. An individual can support local food through a variety of programs.

- Farmers Markets are held in many communities from spring to fall and include fresh produce, cheese, eggs, and other food products. Supporting growers who participate in these markets will help to further agriculture and make Chittenden County less dependent on outside sources for food.
- Community Support Agriculture or CSA's are a great way to buy local, seasonal food from a farmer. The CSA is a model where a farmer offers shares to the public for a certain amount of money during the growing season and in return each person receives an allotment of produce every week.
- Community Gardens are plots of land often rented or community owned that give people space to grow their own vegetables. This model works well in urban areas where land availability is limited.

Resources: Local Agriculture, Resilient Life

Conclusions

In order to reduce individual ghg emissions and become resilient, individual strategies should:

- Address the most significant contributor to emissions. In Chittenden County, on-road vehicles are the top source of ghg emissions, so strategies that reduce vehicle miles traveled will have the greatest regional benefit. Other significant sources of emissions include fossil fuel combustion for heating and non-road equipment (such as lawnmowers, snowmobiles, all-terrain vehicles, boats and personal watercraft). Individual efforts to reduce emissions from these sources will have more impact on Chittenden County's overall emissions than efforts that focus on less important sources.
- Address behaviors, as well as technologies, to reduce air emissions. Strategies that depend on individual behaviors or choices to reduce emission will be more successful if they also offer other benefits, such as saving money, increased convenience, or personal fitness and health benefits. These additional benefits will make it easier to sustain new behaviors that mitigate ghg emissions.

The 10 Percent Challenge program has a residential emission calculator for carbon dioxide that shows how the everyday activities of individuals add up, and offers practical suggestions on how to reduce emissions. These practical suggestions relate to the priority strategies in this guide.

Some of the strategies identified in this chapter can be implemented by individuals quickly, with immediate benefits. If sustained, these strategies will yield benefits long-term as well. Other strategies have longer lead times, or the opportunity to implement them occurs infrequently.

Appendix D – Employer Climate Action Guide

Whether in the public sector or the private sector, employers contribute greenhouse gas (ghg) emissions through daily operations and employee commutes. Fuel consumption for space and process heating also result in the release of ghg emissions. Employees driving to work alone generate more emissions than employees who share rides, take transit or walk or bicycle to work.

Employer strategies to reduce their ghg emissions can benefit the employer as well as the environment by:

- Lowering operating costs from increased energy efficiency and the reduced need for workplace parking spaces.
- Increasing worker productivity resulting from strategies that increase work-life flexibility;
- Improving employee recruitment and retention through alternate commute benefits;
- Providing tax-free commute benefits for employees;
- Improving public reputation and image for reducing ghg emissions, reducing roadway congestion and conserving energy.

Employers may not be able to adopt all of the strategies described in this appendix however; most workplaces will find many strategies that they can implement. The first group of employer strategies deals with transportation which is the the largest source of ghg emissions in the County. According to the Chittenden County Greenhouse Gas Inventory in 2010 transportation contributed to 48% of emissions. The second group of employer strategies addresses emissions from operations within the building such as space heating and electricity use. Although emissions from commercial electricity usage is 4% of total County emissions there are still opportunities to make buildings and processes that use electricity more efficient. Emissions from commercial use of fossil fuels for heating contribute 16% of overall emissions in the County. Employers can take action on weatherizing and upgrading heating equipment to bring this number down.

Transportation/Land Use

Action 1-Employer Trip Reduction Programs

Promote and provide alternatives to driving alone.

Chittenden County is often described as the economic engine of Vermont. In 2010, 32% of all jobs in the state were located in the County[8]. As shown in Figure 1, 72% of employees working in the County drive alone to work. Tail-pipe emissions and the number of vehicles miles traveled (VMT) would be substantially reduced if many of the drive alone commuters chose a different way to get to work.

Studies of alternative commuting options have found that providing enhanced commute

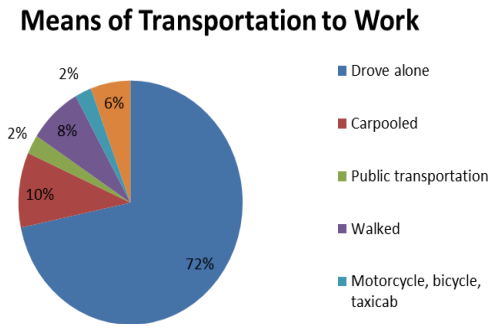


Figure 1

alternatives (such as vanpools) can reduce vehicle trips by about 8.5%. Providing financial incentives and disincentives (such as transit subsidies and parking pricing) can reduce vehicle trips 16.4%. Combining enhanced alternatives with financial incentives and disincentives have been shown to be the most effective way of reducing vehicle trips (24.5%).[9]

The 2011 Chittenden County Transportation Survey revealed that the incentive to encourage alternative transportation model that gets the most support among residents is helping organizers and offer services, benefits, and incentive to employees.

Employers play an important role in how people commute to work by educating employees and promoting commuting alternatives to change employee commuting behavior. Go Chittenden County!, CarShare Vermont , The Campus Area Transportation Management Association, Go Vermont, and Hinesburg Rides are transportation management programs that encourage ride-sharing, transit, and biking/walking.

Go Chittenden County is a network of the County's transportation service providers, advocates, and employers working together to make it easier to get around using other modes of transportation. Employers can work directly with Go Chittenden County! to customize a transportation program that matches their needs. Local Motion, CCTA, GoVermont, CarShare VT, CATMA, and CCRPC are currently partnering on the Go Chittenden County Initiative.

The Campus Area Transportation Management Association's (CATMA's) program helps campus-area and state employees in Burlington reduce the number of cars on the road, relieve parking pressures, and improve the health and productivity of its employees. CATMA services for member employees include the emergency ride home program, access to a network of employee transportation coordinators, and other educational and awareness events related to biking and walking.

Hinesburg Rides includes an Employer Partner Transportation Program that works with local employers to coordinate low-cost commuting options such as vans,

carpooling and bus services. NRG Systems in Hinesburg is a key partner in this program.

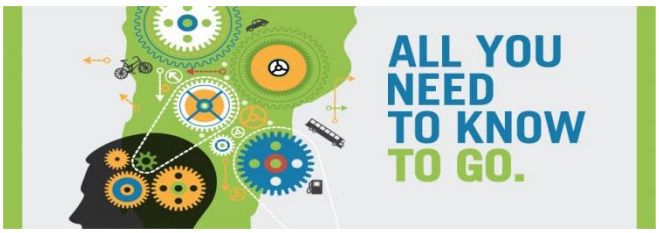
Go Vermont! supports employers who are looking for ways to reduce their ghg emissions and alleviate parking issues. Free employer services include education to employees about alternative transportation, van pool matching, a guaranteed ride home, and other benefits.

CarShare Vermont is a car sharing network of vehicles in Burlington, VT. CarShare helps businesses to meet their travel needs, address parking issues, and save money on mileage reimbursements or renting cars.

Other more general actions for trip reduction are:

- Encourage employees to use public transit to get to work. If public transit is available, employers can encourage its use by offering transit discounts or passes, providing a guaranteed ride home, and working with CCTA to provide a convenient bus stop and shelter. Chittenden County Transportation Authority's (CCTA) Smart Business Program assists employers with promoting employee transit use.

- Encourage employees to walk or bicycle to work. Providing shower facilities and covered bicycle parking can make this a more attractive commuting option for employees. In addition to the climate benefits, walking and bicycling to work can be promoted for their substantial employee health and fitness benefits. IBM has a summer bicycling program. CATMA provides walk and bike incentives for employees of its members. City Market provides fringe benefits for bicyclists. CCRPC provides bike racks and shower facilities.



- Encourage employee telecommuting. Many employers allow employees to work from home one or more days a week, if compatible with their job responsibilities.

- Offer alternate work schedule options. Alternate work schedules allow employees to work the standard number of weekly hours in fewer days, which reduces the number of days employees commute to work. Common alternate work schedules include 9 hour days (with a day off every other week) and 10 hour days (with a day off every week).

- Provide transportation fringe benefits that offer incentives to not drive alone to work. Employers can offer transportation benefits in addition to compensation, as tax-free benefits, or both. The Internal Revenue Service allows employers to offer transportation benefits that are relatively simple to administer and are tax free to the employee.[10] Benefits might include transit or van-pool subsidies, or flexible transportation benefits that cover more commute expenses for alternate commuters than for drive-alone commuters. In areas where parking is limited or expensive, benefits might include paying employees who don't use parking spaces (a parking "cash-out") instead of offering a parking subsidy, or not offering free parking if transit is available. Chittenden Bank provides employees a subsidy to park at a satellite lot and ride the bus to the office. City Market in Burlington is one of the first companies to provide a pre-tax benefit for bicycling to work.

Employers can also offer non-monetary "smart commute" incentives. CATMA has

monthly drawings for registered alternate commuters.

Action 2- Locational Efficiency

Locate your business within existing centers that contain a mix of residential and commercial development.

According to the Chittenden County ECOS Housing Analysis Report, more than 11% of Chittenden County residents commute 25 or more miles to work. Additionally, a vast majority of Chittenden County's residents pay more than 45% of their income for the combined cost of housing and transportation. Long commute times in and out of the County for employment place pressure on transportation infrastructure and contribute negatively to the environment. Additionally, the cost of housing was regarded by 83% of employers as a serious problem for economic development. National research and local studies recommend that a concentrated mixed land use pattern is the key to mitigating climate change and could alleviate affordability and transportation issues. Futhermore, the 2011 Chittenden County Transportation survey indicates that 91% would walk to work, school, or shopping or other activities if they were close enough.

Location efficient development consists of a combination of housing and commercial uses in a compact area that makes it easy to get around without a car and is designed to maximize housing and transportation affordability. The 2013 Chittenden County ECOS Plan recommends focusing new development in areas planned for growth. These areas planned for growth are divided into 6 planning areas. The planning areas where employment is located in close proximity to housing are Center, Metro, and Village Planning Areas.

Resources: **The ECOS Plan, Walkscore.com, Abogo**

Partner with housing advocates to create housing options near employment centers

Partnerships between employers and the housing community is an effective tool to increase housing near employment centers and also minimizes ghg emissions from employee commutes. Employer assisted housing programs help employees to purchase homes through financing or rental assistance near their workplace. Employer assisted housing programs can increase the amount of affordable housing near employment centers through creative partnerships between major employers and municipalities.

Resources: **Policy Link Employer Assisted Housing**

Action 3- Transportation Fleet Management

Implement fleet policies to reduce energy consumption, costs, and expand alternative fuel options for fleets.

Private and public sector employers may lease or own many types of vehicles, including car fleets, trucks and construction equipment. Several approaches can be used to reduce emissions from employer vehicles:

- Include no or low-pollutant emissions in vehicle selection criteria. This may include fuel-efficient vehicles, vehicles running on clean fuels (e.g., electric, compressed natural gas), and trucks and

construction equipment with new or retrofitted diesel engines.

- Alternative fuels diversify power sources for transportation, and can help reduce ghg emissions through energy efficiency, conservation and cleaner fuels. Although not a renewable fuel source, compressed natural gas (CNG) is cleaner and has lower greenhouse gas emissions than petroleum fuel, and is a realistic option for fleet vehicles.
- Retrofit diesel engines in trucks and construction equipment. The Northeast Diesel Collaborative provides information about diesel retrofitting and clean diesel technologies.[11]
- Provide proper maintenance to help keep vehicles operating more efficiently, including maintaining the appropriate tire pressure.

Resources: NE Diesel Collaborative, Clean Cities Blog, EPA

Action 4- Fuel Efficient Driving Practices

Adopt "eco-driving" techniques for fleet drives to improve vehicle gas mileage and reduce emissions.

- Driving behaviors - such as irregular driving speed, idling, and "jackrabbit starts" can significantly affect fuel efficiency and vehicle emissions. By driving in more careful and environmentally responsible way fleet drivers can be safe and cut tailpipe emissions while saving gas. An education and incentive program to encourage eco-driving will define what is expected of the driver and includes rewards for those who achieve the fuel efficiency standards. Monitoring and compliance is also important to enforcing the eco-driving policy. A fuel card that provides information about driving behavior is one way to track whether drivers are respecting the policy.
- **Resources:** EPA

Action 5-Rail Freight

Use rail for freight shipments when practical.

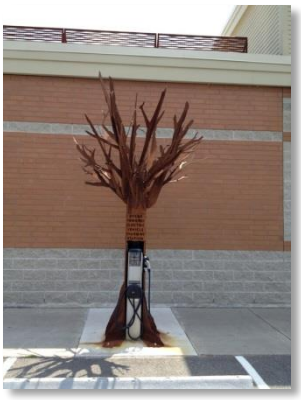
Rail freight is often the mode of choice for shipping large or heavy goods. Goods shipped by rail in Vermont include farm products, food products, lumber, petroleum, pulp and paper and minerals. Rail freight is four times more fuel efficient than trucks: a gallon of diesel fuel can move a ton of freight 457 miles by rail.[12] This fuel efficiency makes rail freight a good economic choice and a good environmental choice. US EPA estimates that a locomotive emits only a third of the nitrogen oxides and particulate matter than a typical truck. Rail freight indirectly improves air quality by reducing highway congestion. One box car can carry the load of about three trucks; one train load hauls the same amount of freight as 500 trucks. Less congestion on our highways means that other highway vehicles can operate at more fuel-efficient speeds. Some areas of Chittenden County are not served by rail, and rail shipment is not the best choice for all goods. However, when rail shipments make good business sense they will also help mitigate climate change.

Resources: CCRPC Freight Planning

Action 6- Electric Vehicles

Provide electric vehicle (EV) charging services for employees.

Offering electric vehicle charging stations can incite EV owners to choose one business with charging capabilities over another that does not offer charging infrastructure. EV charging spots are typically located closest to the entrance of a business or within a downtown which is seen as priority parking for EV owners who are looking to charge their vehicle. As EV adoption increases more EV owners will be looking to "top off" while they shop, get a meal out, or park for the day at their job. Attracting EV drivers offers a business a competitive advantage as shoppers may spend more time in the store to allow for adequate charging. This could translate into increased dollars spent.



Saint Michael's College in Colchester and Healthy Living in South Burlington have both partnered with Green Mountain Power to provide public electric vehicle charging stations.

Additionally, many companies are installing charging stations for their employees and visitors to establish themselves as environmentally sustainable places to work and do business with.

Resources: Drive Electric VT

Action 7-Idling Reduction

Implement policies and practices to reduce vehicle idling.

Idling vehicles emit pollutants, even when they are not moving. Idling increases engine wear, contributes to vehicle air-pollutant emissions, and can impair indoor air quality if exhaust from idling vehicles is pulled into building air intakes. Numerous strategies can be used to reduce idling, including behavior change practices (e.g., anti-idling policies, incentives for drivers to not idle, contracts with outsourced transporters) and technology-based approaches (e.g., automatic engine shutdown, direct-fired heaters, and auxiliary power units for heating and air conditioning). Many of these practices are relatively low-cost, or have a quick payback through operating cost savings. US EPA's SmartWay Transport Partnership[19] provides information, tools and recognition to participating transport employers. Green Mountain Coffee Roasters, a SmartWay partner since 2005, has successfully implemented idling reduction strategies that save money as well as reduce air emissions.

Resources: Idle-Free VT

Building Operations

Action 1-Renewable Energy and Efficiency

Implement on-site renewable energy applications and make energy efficient improvement

All business have heating, cooling, and lighting needs for the buildings that they own and or occupy regardless of the use or type of business. There are so many ways to save money on energy bills and reduce emissions. Converting to renewable energy sources for heating and electricity is a way to both save money and generate credits from the electricity produced on-site. The following suggestions are more applicable to businesses or property management companies that own the buildings.

- **Lighting-** The less is more approach to lighting applies to efficient lighting design to both interior and exterior lighting. A lighting designer who specializes in energy efficiency can offer valuable advice on light levels, maximum visibility, glare, technology color, and controls. Lighting is most efficient when it is not in use. Automating the right amount of light

when needed is key to correctly illuminating a workspace.

- **Heating, Cooling, and Ventilation (HVAC)-** The cost of running an HVAC system makes up a large part of businesses operating expenses. Modern HVAC equipment uses far less energy than equipment from just 10 years ago. Businesses can save money and increase workplace comfort by choosing ENERGY STAR models for their heating and cooling purposes.

- **Building Performance-** Quality insulation and air sealing will ensure that companies maintain comfortable indoor temperatures and minimize heat loss during the winter or keep spaces cooler in the summer. Investing in comprehensive weatherization improvements is a sound investment to protect the building from moisture or mold issues**.**

- **Solar Energy-** Solar energy can help companies lower operating costs and increase profits. Solar energy costs are rapidly falling and making solar more appealing for electricity generation than buying electricity from a local utility. In June 2013, Governor Shumlin signed into law new financing options through the Vermont Economic Development Authority for projects that help meet the state's goal of 90% renewable by 2050.

- **Biofuels-** Businesses can consider switching to biomass fuels for heating and biofuels for vehicles. Locally-sourced biomass and biofuels support local agriculture and forestry while meeting energy objectives, and are a renewable resource.

- **Monitor Efficiency-** Regular monitoring through automated controls is critical for ensuring that heating/cooling systems and other mechanical systems are operating correctly and efficiently. Trained staff that understand how to adjust controls for maximize efficiency is also part of building monitoring and efficiency. For a building that houses multiple businesses it is important for all tenants to have their own electric and gas meters to allow them to monitor their energy and ultimately conserve their energy use.

- **Green Roofs-** Green roofs is a system of interlocking grids that contain drainage layers, filter cloth, growing media and plants that can be installed on top of a building. Green roofs keep buildings cool through evapotranspiration and can also

manage storm water by absorbing it and letting it evaporate naturally.

Resources: [Efficiency Vermont](), [EPA,]()

The Burlington International Airport features a green roof with alpine vegetation on the roof of the parking garage.

Action 2- Meet State Energy Codes

Meet or exceed state energy efficiency buildings code standards for new construction of major renovations

The state has commercial building energy standards for commercial construction. As of July 2013, new commercial construction must comply with the code in order to receive a certificate of occupancy. The general requirements of this code include thermal envelope insulation, ventilation and combustion safety, windows, lighting, air leakage, and HVAC equipment. Compliance with state energy codes will reduce energy use thereby reducing ghg emissions.

Resources: [VT Commercial Building Energy Code]()

Business Operations

Businesses the rent or lease space may not have direct control over major building operations but they can manage when computers are shutdown and other opportunities for engaging in green initiatives in the workplace.

Action 1- Generate less office waste

Simple day-to-day practices can dramatically reduce product consumption, waste, and increase recycling management, which reduces ghg emissions throughout the product life cycle:

- Print hard copies only when necessary
- Set all printers to double-sided as default
- Reuse paper printed on one side for in-house draft printing
- Cut one-sided scrap into quarters for note pads
- Provide reusable cups/mugs, dishes and flatware in lunchrooms
- Reuse file folders and shipping and packaging materials
- Require environmental purchasing practices for buying products that reduce toxicity, increase energy efficiency, and/or reduce ghg emissions in one or more phases of the product's life cycle.

Action 2- Expand recycling programs and implement workplace composting.

Recycling and composting reduces the quantity of materials being landfilled which in turn reduces future landfill methane emission potential. Recycling also reduces emissions associated with raw material mining and product manufacturing.

Recycling is mandatory for all businesses in Chittenden County. Food scrap diversion from landfills will become mandatory starting with the largest generators in 2014. The Chittenden Solid Waste District (CSWD) provides comprehensive waste reduction assistance and advice for all Chittenden County businesses

Resources: [Chittenden Solid Waste District]()

Action 3- Launch a Green Business Challenge

Engage stakeholders and employees in a campaign to improve energy efficiency conserve water, and reduce waste.

Launching a Green Business Challenge program can be a way to raise awareness and move people to action to reduce the amount of ghg emissions related to the activities in an office, store, or industry.

- **Address energy use-** Use various software tool to quantify how "green" is your business. Create an energy profile of how much energy your business uses for HVAC, water heating, lighting, cooking and refrigeration, office equipment, computers.
- **Set an energy use reduction goal-** Identify the most intensive use of energy in your business and set a target to reduce the energy use for that process or piece of equipment. Implement strategies to help everyone in the business contribute to reaching the overall target.
- **Make Improvements to the Efficiency of the Lighting-** Ambient office lighting can consume a great amount of energy. Install programmable switches to turn lights on using a timer to decrease the amount of time lights are on overnight. Install occupancy sensors to turn lights on only when the room is being used.
- **Reduce plug loads for office equipment-** Refrigerators, printers, fax machines, and computers, can be adjusted to use less energy. Adjust the refrigerator temperature down to between 38 and 41 degrees and the freezer temperature between 10 and 20 degrees. Utilize advanced power strips on vending machines and other common equipment that can be turned off at night by a switch. Set computers to enter standby mode after no more than 15 minutes of being idle. Initiate a power down policy to encourage employees to turn their computers off at night.

Resources: EPA, ICLEI Green Business Challenge

Action 4-Support Local Agriculture

Join a food hub that delivers local food to the workplace.

Local food systems decrease reliance on centralized food systems, where concentrated food production and distribution locations may be vulnerable to climate disruptions such as storm damage, pest outbreaks, etc. Supporting local agriculture also reduces travel time of food thereby reducing ghg emissions. Providing employees the opportunity to participate in a workplace local food hub supports local growers, provides employees with fresh food, and can potentially reduce the number of trips to the grocery store.

Resources: Local Grower's Guide

Conclusion

Lessons learned here and elsewhere indicate that to achieve meaningful reductions in ghg emissions, employers should:

- Educate stakeholders and employees about potential workplace savings in energy
- Address the most important emission sources. In Chittenden County, on-road vehicles are the top source of ghg emissions.
- Address behaviors, as well as technology, to reduce ghg emissions. Employee choices about how to get to work can impact emissions as much as, or more than, their vehicle's fuel economy. Changing commuter behaviors can have a positive effect on employees and save both employers and commuters money.

Some actions can be implemented by employers quickly, with immediate benefits. If sustained, these change swill yield benefits long-term as well. Other actions have longer lead times, or the opportunity to implement them occurs infrequently. Any action to reduce ghg emissions is a move in the right

direction as climate change is an ever important issue in all our lives and in the workplace.

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[1]Vermont Dept. of Labor, 2012 Economic and Demographic Profile Series. Accessed July 9, 2013 at: http://www.vtlmi.info/profile2012.pdf

[2] US Federal Highway Administration. Commuter Choice Primer: An Employer's Guide to Implementing Effective Commuter Choice Programs. FHWA-OP-03-007. Accessed May 12, 2009 at: http://www.itsdocs.fhwa.dot.gov/JPODOCS/REPTS_PR/13669.html

3 Internal Revenue Service. January 11, 2001. Qualified Transportation Fringe Benefits Final Rule 66 Federal Register 2241. Accessed May 19, 2009 at: http://www.nctr.usf.edu/clearinghouse/pdf/irs_finalrule_01-11-01.pdf

4 Northeast Diesel Collaborative. Accessed May 19, 2009 at: www http://www.northeastdiesel.org/

5 Association of American Railroads. Environment. Accessed January 25, 2010 at: http://www.aar.org/Environment/Environment.aspx

Appendix E – Municipal Climate Action Guide

Municipalities influence climate change through both operations and policies that contribute to greenhouse gas emissions. Municipalities also affect the impacts of climate change through policies that prepare for and reduce climate impacts on people and property. This guide identifies productive climate actions that municipalities can take to help Chittenden County achieve its climate change goal.

> ***Climate Change Goal: Reduce greenhouse gas emissions contributing to climate change and adapt to become more resilient to a changing climate.***

The actions identified in this guide are based on research done by the Chittenden County Regional Planning Commission (CCRPC) in preparation of the regional climate action guide. These actions include both **climate mitigation** (reducing greenhouse gas emissions) and **climate adaptation** (reducing the adverse impact of climate change). The actions focus on the priority strategies identified in the regional climate action guide as being most important for Chittenden County municipalities. Actions generally fall into the categories of transportation, forest, energy efficiency, agriculture, renewable energy, solid waste, and wastewater. Within those categories specific resources and examples of action steps are included and the responsible entities within the municipal government are identified.

CCRPC intends for this guide to be a helpful resource, not a mandate. Municipalities may not be able to undertake all of the actions in this guide, however most communities may find many actions that they can implement. Many of the actions identified here may support goals set forth in the energy element of the municipal plan. Climate action at the municipal level is a joint-effort that involves staff, volunteer boards, and local residents. Municipalities may choose to take the recommendations of this guide to develop their own unique climate action guide that meets the needs of their community.

Many of the actions and specifics identified in this guide are also identified in the Vermont Natural Resources Council's (VNRC) Energy Planning and Implementation Guidebook for Vermont Communities. This guidebook is a relevant and current compilation of the implementation steps a municipality can do for climate mitigation. As such, CCRPC's goal with this appendix is to provide its member municipalities with the best resources that are most applicable to them so that they will succeed in reducing ghg emissions. CCRPC has provided links to the most pertinent information in the guidebook as it relates to the priority strategies, as well as other programs and entities. The guidebook can be read in its entirety either online at the VNRC website or at your town office.

VNRC has also prepared a Resilient Communities Scorecard. The *Scorecard* encourages communities to evaluate and think about its resiliency in regards to climate change and other challenges like budget constraints, development pressure, energy independence, and protection of natural resources. It has a checklist of thought-provoking questions that allow a community to measure their resiliency in terms of vibrant communities, public engagement, and energy efficiency. This valuable resource can be accessed here. Any community interested in climate mitigation, adaptation, and community resiliency is encouraged to use the *Scorecard* as a "jumping off point" to prioritize the actions listed in this guide.

Climate Mitigation Actions

Land-use/Transportation

The Chittenden County Greenhouse Gas Emissions Inventory identified that transportation is the largest regional source of greenhouse gases. Actions to reduce transportation emissions will have the greatest effect in reducing overall regional greenhouse gas emissions. CCRPC has identified the following strategies as being the most effective for municipalities to implement to reduce emissions from transportation. Additionally, the transportation tools and strategies section of VNRC's guide on page 48 includes a list of the programs and actions that a municipality can take to reduce ghg emissions from driving.

Action 1: Update Local Town Plans to include energy use and ghg data in the energy element.

All municipal plans are required to have to an energy section in their town plan. The energy section must include an analysis of energy resources, needs, scarcities, costs, and problems within the municipality. The ghg inventory developed for this guide and for the ECOS Plan contains available data and information related to energy supply and ghg emissions. Including energy and ghg information in the town plan is a necessary first step to understanding the most important action for promoting energy conservation and efficiency.

Resources: Chittenden County Climate Action Guide

Responsible Entity: Planning Commission, Energy Committees

Action 2: Update Local Zoning Regulations to Encourage Development that Reduces GHG Emissions and Increases Energy Conservation

Local development regulations impact energy consumption, greenhouse gas emissions and climate resiliency by specifying the density and the location of new development. Cities and towns should focus development along transit corridors and in town and village centers to maximize the effectiveness of transit (see CCTA Transit Development Plan Chapter 5). Bylaws and subdivision regulations can address energy efficiency in transportation and building energy use through a variety of tools that spur increases in density, access to transit, and encourage builders to construct homes that use very low energy for space heating and electricity. Compact, mixed-use development, infill and brownfields redevelopment and transit-oriented development substantially reduce vehicle miles traveled and require less energy to heat/cool. Consequently, greenhouse gas emissions are reduced.

- Transit Oriented Development (TOD) is an area that combines residential and commercial uses to maximize access to public transit and other modes of transportation (i.e. walking, biking). A TOD neighborhood has a center of highest density surrounding the transit stop and becomes gradually less dense further away from the center. The higher density development enables residents to use other modes of transportation, thereby reducing automobile use and reducing tail-pipe emissions.
- Form Based Code is an alternative to traditional zoning. It aims to regulate the shape of the built environment rather than the just the use. Form based code aims to shape the urban environment so that it is appealing and the streetscape becomes part of the community. It typically yields attractive building forms that are at least two stories and are sited along streetscapes with integrated walking, biking, and connectivity.
- Density Bonuses can be integrated into local zoning regulations to encourage developers to build energy efficient buildings, to use renewable energy resources, and to build along transit corridors. Together more density, energy efficiency, renewables, and access to

transit can reduce the overall ghg emissions of new development. The Town of Hinesburg offers developers density bonuses in exchange for the development of energy efficient homes in some of their zoning district. Hinesburg also requires that new residential homes be built in compliance with the State's Residential Building Energy Code.

Resources: Form-Based Codes Institute, Transit Oriented Design, CCTA Transit Development Plan, Town of Hinesburg

Responsible Entity: Planning and Zoning Department, Planning Commission, Legislative Body

Action 3: Become an Electric Vehicle Ready Town

Plug-in hybrids and all-electric vehicles are becoming part of our everyday lives and are gaining in popularity throughout Vermont. As of October 2013, 48% of Vermont communities have electric vehicles (EVs) and 510 total plug-in vehicles have been registered[13]. Projections for EV adoption state that by 2023 approximately 5,800 EVs will be registered in Vermont, requiring 70 charging stations in Chittenden County[14]. Additionally, Vermont is part of the commitment with other northeast states to put more than three million electric vehicles on the road by 2025.

As more people begin to drive EVs, communities should discuss what is necessary to get ready for meeting the changing needs of its residents, employees, and visitors. It is imperative that communities begin to plan for the deployment of electric vehicles and the necessary supporting infrastructure of charging stations. A variety of tools are available for EV-ready planning. These include zoning, parking ordinances, permitting and inspection, and partnership and procurement. A town interested in becoming EV read could look at how their town's zoning regulations would treat the installation of EV charging infrastructure. In development, is a guidebook for Vermont Communities to increase the awareness and adoption of EVs. Recommendations for streamlining the permitting process for installing EV charging stations will be included.

Resource: Creating EV-Ready Towns and Cities, Drive Electric VT

Responsible Entities: Planning and Zoning, Energy Committees, Town Administration

Action 4: Employer Trip Reduction Programs: Promote and provide alternatives for employees driving to work alone

American Community Survey data indicate that about 71% of employees in Chittenden County drive to work alone.[15] As employers, municipalities have an opportunity to encourage their employees to use alternatives to driving to work alone. Greenhouse gas emissions would substantially be reduced if many of the drive-alone commuters chose a different way to get to work. Municipalities can also work with employers with in their town to encourage them to reduce drive-alone commute trips.

Transportation demand management (TDM) is a term used to describe strategies that reduce commute trips. TDM reduces workplace parking needs and roadway congestion, as well as reducing greenhouse gases. Employers play an important role in TDM by educating employees and promoting commuting alternatives to change employee commuting behavior. Studies of alternative commuting options have found that providing

[13] DRIVE ELECTRIC VERMONT

14 CCRPC, Electric Vehicle Charging Equipment Infrastrcuture Planning 2013-2023

[15] American Community Survey data- 1 year estimate for 2012.

enhanced commute alternatives (such as vanpools) can reduce vehicle trips by about 8%. Providing financial incentives and disincentives (such as transit subsidies and parking pricing, respectively) can reduce vehicle trips by 16%. Combining enhanced alternatives with financial incentives and disincentives have been shown to be the most effective way of reducing vehicle trips (24 %).[16]

- Encourage employees to share rides to work and provide reserved parking for car and van pools. Go Vermont and Go Chittenden County can help with ride matching services. Go Vermont can help van pools obtain a van, insurance, vehicle maintenance and fare collections.
- Encourage employees to use public transit to get to work. If public transit is available, municipalities and employers can encourage its use by offering employees transit discounts or passes, providing a guaranteed ride home and working with CCTA to provide a convenient bus stop and shelter.
- Encourage employees to walk or bicycle to work. Providing shower facilities and covered bicycle parking can make this a more attractive commuting option for employees. In addition to climate benefits, walking and bicycling to work can be promoted for their substantial employee health and fitness benefits which can lead to long-term health insurance cost savings for the employer.

Resources: Go! Chittenden County, Campus Area Transportation Management Association, Go Vermont, Transportation Demand Management

Responsible Entity: Town Administration Office, Local Employers

Action 5: Transportation Investment Priorities: Implement policies that shift funding away from roads and highways to alternative transportation

Focus transportation investments and service expansions on projects and strategies that reduce greenhouse gas emissions and enhance resilience to climate change. Transportation funding sources come from a variety of programs mostly focusing on particular modes or facilities. However, virtually all federal programs are flexible and funding for transportation options like transit, biking and walking, are eligible. State transportation funds have some flexibility, as well. Additionally, Federal Congestion Mitigation and Air Quality (CMAQ) funds can be used for projects such as transit, walk/bike, car-sharing and others that improve air quality and reduce congestion.

- Town Plan - Identify goals and objectives in the municipal plan that reinforce the desired achievement of emission reductions and enhanced resilience to climate change, give higher investment priority to transportation projects that will reduce emissions and enhance resiliency and adaptability to climate change; incorporate emissions reduction and climate resiliency and adaptation into budgeting and evaluating for transportation projects.
- CCRPC Sidewalk Program is offered annually to member municipalities to improve and expand the region's sidewalk infrastructure. The purposes/goals of the CCRPC sidewalk program are: 1) to provide communities access to federal implementation funds to improve their public sidewalk systems, 2) to advance the development of an integrated sidewalk system using accepted standards and guidelines, and 3) to encourage connections between neighborhoods, schools, parks, town centers and linkages

[16] US Federal Highway Administration (2003). Commuter Choice Primer: An Employer's Guide to Implementing Effective Commuter Choice Programs.

to other public spaces for the benefit of the non-motorized traveler. While this regional program will assist municipalities with sidewalk construction, other sources through VTrans – Transportation Alternatives and Bicycle & Pedestrian programs – can also be utilized for the planning, design and construction of sidewalks and paths. The CCRPC program is intended to provide a supplement to these programs.[17]

- Support Local Transit Funding/Join CCTA- In all communities seeking transit service, the community will need to provide local funds to cover at least 20% of the operating cost of service. Communities should also work with CCTA to determine whether becoming a CCTA member community is appropriate.

Resources: CCRPC Bike/Ped. Information, CCTA Charter

Responsible Entity: Highway/Public Works Department, Town Administration

Action 6: Bring car-share programs to your community

CarShare Vermont is a network of vehicles parked in convenient spots in and around Burlington and Winooski that can be used by the hour or day through a member subscription. CarShare Vermont is implementing a neighborhood-based social marketing program and assessing the viability of expansion into new communities. Car-sharing programs require a critical mass of users, and are therefore more viable in urban rather than rural areas. However, peer-to-peer car sharing networks may be a better fit for lower density communities as these networks allow for sharing of private vehicles.

Resources: CarShare Vermont, Communities Tackling Vermont's Energy Challenge, Hinesburg Rides, Peer-to-peer Carsharing

Responsible Entity: Town Administration

Action 7: Implement fleet policies to reduce energy consumption, costs and greenhouse gas emissions.

A municipal fleet is diverse, with many types of equipment serving multiple functions. Because use of gasoline and diesel in municipal fleet operations are a source of emissions, municipalities have an opportunity to implement fleet greening policies within all departments to reduce emissions through choosing to upgrade with efficient and cleaner vehicles and instituting policies that minimize vehicle trips. If implemented wisely, the adoption of a comprehensive green fleet policy[18] will result in significant cost savings on fuel purchases and a reduction in pollution.

- Downsize Vehicles -Match duty requirements of staff to the smallest possible vehicle for the task. Also smaller vehicles should be substituted for larger vehicles by phasing them in as new vehicles are purchased or by selling larger vehicles.
- Incorporate Efficiency into Bid Specifications -Include specifications in the bid process to purchase the smallest and most efficient vehicle needed for a task. The cost of fuel should also be weighted heavily so that fuel savings over the life of the vehicle are taken into account.
- Eliminate Fleet Vehicles- Analyze operational needs and eliminate excess vehicles. Eliminate a fleet vehicle and purchase bicycles. Encourage employees to use bicycles for local trips. Another tactic is to join a car-sharing program like Car Share VT to take the place of fleet vehicles.

[17] CCRPC Sidewalk Grant Application

[18] ICLEI's Cities for Climate Protection Campaign, *Adopt a Comprehensive Fleet Policy*

- Use Transit, Walk, or Telecommute It is not always necessary to drive to a meeting. Encourage employees to use transit, a bicycle, or walk to a meeting. Widely available technology enables high-quality video and audio conferencing to eliminate the need to attend meetings in person. Incentives to encourage the reduction of vehicle trips include providing transit passes or a rewards program for walking or biking.
- Optimize Vehicle Use Schedule travel efficiently and conduct route optimizations so that multiple tasks can be accomplished in one trip. Encourage staff to share vehicles for all or part of a trip during the work day. Implement software to optimize fleet vehicle routes.
- Maximize Efficiency Ensure that regular maintenance is performed on vehicles. Oil should be changed regularly and tires should be kept at the correct pressure at all times. Establish a no-idling policy.
- Buy Vehicles that Run on Alternative Fuels Purchase hybrid electric medium and heavy duty trucks or ones that run on cleaner fuels or on compressed natural gas (CHG), liquid natural gas (LNG), propane (LPG), and biodiesel fuel.

Resources: Green Your Fleet, Communities Tackling Vermont's Energy Challenge, Colchester High School's Eco-Driving Program pg. 34, IDLE-FREE VT

Responsible Entity: Highway/Public Works Department, Town Administration

Action 8: Enhance Transportation Systems Management (TSM) techniques to improve the safety and efficiency of existing roadway networks

TSM programs include Intelligent Transportation Systems (ITS) projects, intersection improvements (such as roundabouts), traffic calming and traffic signal optimizations. Optimizing traffic flow allows traffic to move more efficiently along roadways and through intersections, decreasing time spent idling or accelerating and thus reducing emissions from vehicles. Projects that improve safety and efficiency for bicycles and pedestrians remove barriers to bike/ped transportation. Projects that prioritize signals for transit or provide real-time information on bus location improve the efficiency and competitiveness of transit. Projects that improve efficiency will preclude (or postpone) capacity expansion projects.

Resources: CCRPC ITS

Responsible Entity: Highway/Public Works Department, Town Administration

Action 9: Increase transit service area, frequency and hours to make transit more competitive with driving

More frequent transit service is the most effective way to increase bus ridership and discourage people from using their cars. Fifteen-minute service is considered a key threshold to making transit competitive with driving. According to CCTA's Transit Development Plan Needs Analysis, establishing 15-minute peak service on all four of the major corridors into Burlington (North Ave., VT15/Colchester Ave, US2/Williston Rd and US7/Shelburne Rd) is likely to be the most cost-effective investment in new service that CCTA can make. Adding evening and Sunday service on the 4 major corridors would generate additional ridership. Route expansion into new areas can also increase the number of riders the transit system carries and potentially reduce vehicle trips. Service expansions generally require additional local funding. Municipalities should work with CCTA to identify service ideas and costs.

Resources: CCTA

Responsible Entity Selectboard, City Council

Action 10: Invest in transit passenger facilities and technology to make transit more appealing to existing and future riders.

One way to reduce emissions from vehicles is to make transit services more easily accessible.

Chittenden County Transportation Authority (CCTA) provides bus service to the Chittenden County municipalities of Burlington, Colchester, Jericho, Essex, Hinesburg, South Burlington, Shelburne, Williston, Winooski, and Milton. The Link Express bus to Montpelier also stops in Richmond, the Middlebury Link Express bus stops in Charlotte, and the St. Albans Link Express bus stops in Colchester.

Respondents to a recent CCTA survey and participants in public outreach requested further investment in shelters, benches, bike racks and other passenger facilities, as well as new technology such as real-time passenger information, Wi-Fi on buses, and trip planning software. CCTA has installed bus shelters in many locations and continues to expand this program. CCTA is planning a downtown transit center to include a climate-controlled waiting area. Wi-Fi is available on Link Express buses. CCTA has proposed investments in bike racks, solar-powered shelter lighting, and real-time bus information.

Resources: CCTA

Responsible Entity: CCTA

Action 11: Locate and develop Park and Ride facilities to promote transit use and ridesharing

Park and ride facilities reduce highway traffic congestion and worksite parking demand. Park and ride facilities can help support transit service. Amenities such as bicycle and pedestrian access, lights, shade, shelters, bicycle parking and real time boarding information, enhance the security and usability of a park and ride facility. Park and ride facilities should be appropriately sized or phased, based on location, potential for transit, and potential future usage. Towns can encourage "pocket park & rides" using existing lots by making commuter parking a permitted use in existing parking lots or offering parking minimum waivers for spaces devoted to commuter parking.

Resources: CCRPC Park & Ride Information, CCTA

Responsible Entity: Planning and Zoning Department

Action 12: Fund construction, operation and maintenance of facilities that support pedestrians

A variety of facility types can support pedestrians. Complete streets programs include sidewalks and crosswalks in street construction, reconstruction and maintenance. Pedestrian facilities are important for enabling passengers to access transit. Off-road multi-use paths can provide a safe place for pedestrian transportation. Pedestrian amenities, such as shade trees and benches, make walking more attractive. Prioritize implementation of planned pedestrian networks. Evaluate whether these facilities are connected locally and regionally to major employment, education and recreation centers. Implement a roadway design project checklist that includes measures of pedestrian accommodation. Cost effectiveness of some pedestrian facilities is higher in urban and suburban areas, compared to rural areas.

Resources: CCRPC Bicycle/Pedestrian Information

Responsible Entity: Highway/Public Works Department, Town Administration, Planning and Zoning Department

Action 13: Fund construction, operation and maintenance of facilities that support bicyclists

A variety of facilities can support bicyclists. Complete streets programs include bicycle lanes or other infrastructure in street construction, reconstruction and maintenance. Off-road multi-use paths can provide a safe place for bicycle transportation. Interconnected, regional networks of bicycle facilities are particularly important for facilitating bicycling as a viable method of transportation. Safe and secure bicycle parking can be made available at municipal

facilities and bus stops. Prioritize implementation of planned bicycle networks. Evaluate whether these facilities are connected locally and regionally to major employment, education and recreation centers. Implement a roadway design project checklist that includes measures of bicycle accommodation. Cost effectiveness of some bicycle facilities is higher in urban and suburban areas, compared to rural areas.

Resources: CCRPC Bicycle/Pedestrian Information

Responsible Entity: Highway/Public Works Department, Town Administration, Planning and Zoning Department

Action 14: Implement policies to reduce parking demand and increase efficient use of parking facilities

Managing the type and number of parking lots can reduce pavement space and vehicle use. To use parking more efficiently, reduce minimum off-street parking space requirements in municipal zoning regulations, encourage shared parking and remote parking.

Resources: EPA

Responsible Entity: Planning and Zoning Department, Planning Commission, Legislative Body

Heating and Electricity

Action 1: Promote renewable energy development that works in harmony with community goals for land use

Renewable energy is energy that comes from resources that are replenished and do not produce ghg emissions when converted to energy. Renewable energy typically comes from sunlight, wind, and geothermal heat. There are many ways for a municipality to further development of renewable energy generation in their towns.

- Identify and map areas where the municipality would like to promote or discourage commercial renewable projects (such as wind, solar or biomass) based on community goals and natural resource considerations; and incorporate this information into the Town Plan.
- Implement on-site renewable energy in municipal buildings (i.e. solar array installation on community property).
- Include policies within the Town Plan that supports renewable energy development, and data that tracks how much community-owned renewables contribute to local electricity and heating needs.
- Include solar standards in building and site development standards (for example, solar access/site orientation, plumbing for solar thermal, and roof load capacity), and amend zoning to enable and promote solar energy installations.
- Locally owned, distributed renewable energy projects may also insulate a community from the effects of power outages and fluctuations, if they are designed to do so.

Responsible Entity: Planning and Zoning Department, Planning Commission and Legislative Body

Resources: Vermont Renewable Energy Atlas, Southern Windsor County Regional Planning Commission Model Energy Policies and Standards, Rocky Mountain Land Use Institute's Sustainable Community Development Code Framework, Solar Powering Your Community: A Guide for Local Governments

Action 2: Municipal Lighting Energy Efficiency Retrofit

- Conduct audits of indoor and outdoor lighting to determine if the bulbs are efficient and if the lighting is necessary.
- Install energy efficient lights within municipal buildings and parking lots.
- Work with utilities to install energy efficient lights in streetlights and traffic lights.

Resources: Efficiency Vermont's "*Improving Efficiency in Municipal Street and Public Space Lighting*"

Responsible Entity: Building and Grounds Department, Highway Department, Town Administrator's Office

Action 3: Implement energy and water conservation and efficiency improvements at treatment and distribution facilities

Energy costs can account for 30% of total operation and maintenance costs of water treatment plants. Energy efficiency programs can reduce GHGs by reducing consumption of electricity to run pumps, fans and other electrical equipment. The installation of variable frequency drive (VFD) pumps on wells and other appropriate infrastructure is one example of an action that can be taken to save money and energy.

Methane produced on site at wastewater treatment plants can be used to generate electricity to power wastewater treatment equipment. Additionally, leak detection programs implemented by water suppliers can identify where water loss is creating unnecessary water and electrical demand, thereby saving money and energy on the direct costs of pumping and treatment, but also regaining system capacity to serve new users or postponing expensive studies and upgrades.

Resources: Essex Junction Case Study

Responsible Entity: Wastewater Department, Water Department

Action 4: If suitable, switch to biomass-based heating equipment and fuels, including wood- or crop-based solid fuels such as chips and pellets, as well as blended liquid biofuels

Businesses, towns, school districts and individuals can consider switching to biomass fuels for heating and biofuels for vehicles. Locally-sourced biomass and biofuels support local agriculture and forestry while meeting energy objectives, and are a renewable resource. Combustion of biomass and liquid biofuels (e.g., bio-diesel) converts carbon captured by plants from the atmosphere into energy fuels, rather than replacing fossil carbon use. Because these biological fuels don't add "new" carbon into the atmosphere, they are sometimes considered "carbon neutral."

Action 5: Provide financial incentives for renewable energy applications, thermal efficiency improvements, and electricity efficiency

Financial incentives can make energy efficiency improvements more attainable and attractive for businesses and residents. The Property Assessed Clean Energy (PACE) Program is a way for municipalities to make a commitment to helping residents finance renewable energy or efficiency projects. A community must formally adopt the PACE program for a resident to take advantage of the financing options that PACE offers. PACE allows homeowners to borrow money from a lending institution to pay for energy improvements and then payback the cost over time at a low interest rate. The funds are paid back through an assessment of the improved property and remains with the property as a lien until the assessment is repaid in full.

Existing efficiency programs from Efficiency Vermont, Burlington Electric and VT Gas are also available.

Resources: PACE, VT Gas Systems, Burlington Electric Department, Green Mountain Power, Vermont Electric CO-OP

Action 6: Utilize demand side management and energy efficiency measures to reduce energy use, particularly during peak periods

Demand side management measures reduce electricity usage and or timing of energy use. Shifting energy use away from peak periods can mitigate the need to run less efficient and higher greenhouse gas emitting power plants. Lower peak demand can improve air quality for the region. Possible measures include:

support fair and reasonable rate designs and incentives that encourage customers to reduce overall electricity consumption as well as during peak demand periods; install smart grid meters, time of use rates, participate in peak demand reduction programs and undertake peak demand reduction measures at local government facilities and large employers; provide information and resources about peak demand and climate change as well as environmental and monetary costs associated with peak electricity demand. Education is an integral component of most demand side management programs.

Resources: Efficiency Vermont, VT Gas Systems, Burlington Electric Department, Green Mountain Power, Vermont Electric CO-OP

Action 7: Meet or exceed state energy efficiency building standards for new construction and major renovations

The State of Vermont has an energy building code, the VT-Residential and Commercial Building Energy Standard (RBES/CBES). All new residential and commercial buildings as well as renovations to existing structures that reveal internal wall cavities must comply. Effective July 1, 2013 for towns with a certificate of occupancy (C/O) process will require that a completed energy certificate be filed in the land recourds before a C/O will be issues. More energy efficient buildings use less energy for lighting, heating and cooling, thereby reducing ghg emissions.

- Efficiency Vermont offers homebuilders and commercial project teams technical assistance on meeting and exceeding RBES/CBES requirements.
- Provide relevant language on the town website to raise awareness about the energy code.
- Incorporate RBES, CBES and above-Code into building permit process or fees. The simple inclusion of acknowledging that the energy code requirements have been met can have a positive effect by reinforcing the expectation of compliance. Towns can also consider modest financial benefits linked to higher levels of efficiency. For example, a town could enact a tiered permit fee structure, where building to higher efficiency levels results in a lower permit fee.
- Adopt a Stretch Code. A state stretch code is envisions to be developed by 2014. At that time, it will become an option for municipalities to adopt.

Resource: Efficiency Vermont Code Assistance, Residential Building Energy Standards, Commercial Building Energy Standards

Responsible Entity: Zoning Administrator, Planning and Zoning Department, Planning Commission, Legislative Body

Action 8: Require energy efficient retrofit in existing building stock at time of sale

To improve the thermal efficiency of commercial and residential buildings in a municipality, a municipality could implement a time of sale energy retrofit ordinance. Time of sale retrofits target older buildings, particularly multi-family housing, that aren't being reached by voluntary incentive programs. Building energy retrofits offer multiple benefits that include saving money on utility bills, improved safety and maintenance, and comfort. Additionally, the money saved from doing energy improvements gets recirculated into the community instead of being exported out of the region. In 1997, the Burlington City Council passed the Minimum Rental Housing Energy Efficiency Standards Ordinance to improve rental dwellings within the City. The ordinance is applied upon transfer of a rental property at the time of sale. The seller and buyer negotiate who is

responsible for the compliance with the program[19].

- Cost Caps-Improvements- Improvement must not exceed 3% of the contract sale price. The seller must make improvements that have a simple payback of seven years or less. Simple payback is the cost of doing the measure divided by the calculated yearly energy savings.

- Conduct and Energy Audit- An evaluation of the air leakage in the building, the effectiveness of the insulation (if any), heating system, lighting, appliances, and windows. The audit will help to prioritize energy efficiency improvements and should be done by a certified contractor.

- Type of Improvements- Insulation to exterior walls, attics, box sills (where the building sits on the foundation), unheated crawl spaces, electric water heaters, heating and cooling ducts. Windows and doors should be double-paned or provided with storm windows and functional weather stripping. Large gaps and holes that allow heat to escape or cold to enter the building must be sealed.

Resources: Burlington Electric Department, Green Mountain Power, Vermont Electric CO-OP

Action 9: Promote Energy Efficient Programs and Emissions Reductions Campaigns

Community campaigns educate and motivate people and organizations to take action. Approaches such as community contests among residents and challenges with other towns can be effective. Energy efficiency programs are only effective if people and businesses know about and use them. Social media is useful in getting the message out to everyday people. Other effective programs are door-to-door campaigns, phone –a-thons, and energy parties. Efficiency Vermont, CarShare, Drive Electric Vermont, and municipalities are offering "challenges" to reduce ghg emissions in 2013.

- VERMONTIVATE! is a sustainability game that brings fun to tackling climate change. Players can participate in a wide variety of challenges that range from education to implementation. Many of the challenges align with the actions in this guide.
- Home Energy Challenge is a town level competition to encourage residents to weatherize their homes. The goal of this challenge is to increase thermal efficiency in the homes of many Vermonters and reduce the amount of natural gas and delivered fuels used for home heating.

Resources: Vermont Home Energy Challenge, VERMONTIVATE

Responsible Entity: Energy Committee, Conservation Commission, Planning and Zoning Department

Solid Waste

Action 1: Increase the types and quantity of materials that are recycled or composted.

Recycling and composting reduced the quantity of materials destined for the landfill and reduces the amount of methane emission produced from the decomposition of waste (methane is a ghg). Recycling also reduces emissions associated with raw material mining and product manufacturing. All businesses including municipalities contract with private haulers for recycling pick up. To encourage municipal employees to recycle

[19] City of Burlington's Minimum Rental Housing Time of Sale Energy Efficiency Standards Ordinance

more materials and compost food scraps take advantage of CSWD's free bins, signage and stickers to suit the town office's needs.

Resources: EPA, CSWD

Action 2: Consolidate Trash and Recycling Collection Routes

Consolidating collection would reduce duplicate transportation emissions by multiple haulers. CSWD completed an analysis of environmental and economic impacts.

Resources: Analysis of Consolidated Collection Systems, CSWD

Action 3: Implement financial incentives to reduce waste, such as pay-as-you-throw or unit pricing.

Recently enacted state legislation requires municipalities to implement variable rates for landfill material generated by residential customers by 2015. This is currently in place at all CSWD drop-off centers and, to a limited degree, by some haulers. Variable pricing is an incentive for reducing the amount of solid waste that end up in the trash can and ultimately in the landfill. Those who generate less waste pay less.

Resources: Act 148: Universal and Recycling Composting Law

Vegetative Landscapes

Action 1: Preserve forests and reduce clearing and conversion of forests to non-forest cover

Forest preservation is a key climate mitigation strategy because of the significant amounts of carbon aboveground in wood and belowground in roots and soils. Forests reduce greenhouse gas emissions through the process of sequestering carbon. Developed areas contain lower amounts of biomass and its associated carbon, and sequester less carbon than forested areas. Forest preservation also avoids substantial releases of stored carbon from biomass and soil decomposition when land is developed.

Forests help maintain air and water quality, and provide an adaptation benefit by absorbing precipitation and reducing stormwater runoff. Municipal land use plans, policies, and zoning regulations are the tools that a town can use to preserve forest lands.

- Conservation Districts typically encompasses a large area that contains forested lands or other fragile environments and is intended to limit or prevent the development and loss of these areas. The adoption of a conservation district to preserve forest lands would work well in the eastern part of Chittenden County as a majority of these areas are still forested.

- Overlay Districts can be adopted by a municipality that takes precedence over the underlying zoning districts. A municipality can adopt a forest preservation overlay district to restrict development in forested areas to ensure forest vegetation is maintained. An overlay district may work well to prevent further forest fragmentation of smaller forested areas, particularly in more suburban parts of Chittenden County.
- Subdivision Regulations address the pattern of development on a parcel and a municipality can include standards in their subdivision regulations to adequately protect forested lands on a parcel.
- Conditional Use review procedures within zoning can add specific criteria defined by a municipality. In the case of forest lands, a municipality can define whether a development is going to have an "undue adverse affect" on forested lands.
- Site Plan Review can be used to minimize a developments impact on forest lands. For example, bylaws could delineate areas where substantial development of the land is prohibited because of vital forested habitat.
- Transfers of Development Rights allow land owners to transfer the development rights of their property to areas that are planned for more intense development,

thereby protecting their land from development.

- The state's Use Value Appraisal Program (also known as "current use") enables landowners have large tracts of forested land to have their land taxed on its current use as opposed to its fair market (development) value. This results in significant tax savings and enables these properties to be kept as a forested use.
- Conservation Easements are very important for permanent conservation of forested lands. A conservation easement identifies the purpose for which the land is being conserved. The types of uses permitted on the land are established within the easement. A person who receives the easement is referred to as the grantee and is responsible for the overseeing the conditions of the easement.

Resources: Vermont Land Use Implementation Manual, Climate Change and Forests, Urban and Community Forestry, Community Planning Toolbox, Use Value Appraisal Program

Action 2: Preserve open space and agricultural land

Preservation of agricultural lands can mitigate ghg emissions through the storage of carbon below ground in soils and in above ground vegetation. Additionally, maintaining land in agriculture prevents development on these lands that could otherwise be developed and become a source of a significant amount of carbon emissions from transportation and building energy use. Agricultural lands can also provide area to grow crops for biofuels. Municipal land use plans, policies, and zoning regulations are the tools that a town can use to preserve agricultural lands.

- Transfer of Development Rights allow land owners to transfer the development rights of their property to areas that are planned for more intense development, thereby protecting their land from development.
- The state's Use Value Appraisal Program (also known as "current use") enables landowners who farm to have their land taxed on its current use as opposed to its value for agriculture, rather than its fair market (development) value. This results in significant tax savings and enables these properties to be kept as an agricultural use.
- Conservation Easements are very important for permanent conservation of forested lands. A conservation easement identifies the purpose for which the land is being conserved. The types of uses permitted on the land are established within the easement. A person who receives the easement is referred to as the grantee and is responsible for the overseeing the conditions of the easement.

Resources: Vermont Bio Energy Initiative, The Vermont Working Landscape Partnership, Use Value Appraisal Program

Action 3: Maintain current levels of vegetation in the built environment through a tree ordinance and green roofs

Urban vegetation plays an important role in climate mitigation through carbon sequestration and in climate adaptation by acting as natural shading and cooling to reduce energy use for air conditioning during hotter months that we will experience as the climate changes. Urban forests modify temperatures over pavement and rooftops, filter air and water-borne pollutants and improve microclimates at street level. Urban forests also aid in the interception, detention, suspension and filtration of rainwater and subsequent stormwater runoff. Rooftop gardens or green roofs can also be installed on buildings to provide shade and keep buildings cooler in the summer and warmer in the winter. Remote sensing and GIS tools are effective techniques for understanding forest cover loss.

Resources: USDA, Branch out Burlington, Winooski Valley Park District, Vermont Division of Forestry Urban Forestry Program

Responsible Entity: Planning and Zoning Department, Conservation Commission

Climate Adaptation Actions

Municipalities are already being challenged by climate change. Some impacts are being felt now: heavy rain events, flooding damage to buildings and roads, blue-green algae blooms, initial encroachment of some pests and diseases previously deterred by cold winters. The 2011 Spring flood and Tropical Storm Irene demonstrated how damaging floods can be. The following municipal climate adaptation priority strategies have been selected based on the need to prevent and respond to flooding, and to be prepared for an expected increase in climate-related health impacts.

Natural Environment

Action 1: Support Local Agriculture

Local food systems should decrease reliance on centralized food systems, where concentrated food production and distribution locations may be vulnerable to climate disruptions such as storm damage, pest outbreaks, etc. Programs to support local sustainable agriculture might include farm-to-school and farm-to-table food purchase programs, direct-to-consumer markets (farmers markets, farm markets, farmstands), municipal plans and development regulations that encourage value-added farm products. Additional, an increase in agricultural land locally can increase the amount of sequestered carbon in soil. However, organic and inorganic fertilizer application can result in N_2O greenhouse gas emissions.

Resources: Vermont Agency on Agriculture, Farm to Plate Strategic Plan

Responsible Entity: School Districts, Health Department, Town Administration

Action 2: Adopt practices to help town forests adapt to predicted changes in climate

Forests play an important role in climate mitigation by reducing the amount of carbon dioxide in the atmosphere through photosynthesis. As the climate changes, forests will need to adapt to predicted changes in temperature, rainfall events, and insect pests. Approaches include promoting diverse species and sizes within woodlots and promoting diversity of forest ages across landscapes. Increase forest fire awareness and protection. Prevent or reduce forest invaders**.**

Resources: Vermont Division of Forestry Climate Change and Forests

Responsible Entity: Conservation Commission, Parks and Recreation Department

Action 3: Maintain or restore habitat connectivity

Climate change will affect location suitability for natural communities. Habitat connectivity will allow animal and plant species to migrate to more suitable locations (e.g., upslope, higher latitudes). Protecting critical habitat locations and wildlife linkages from development is vital for wildlife species that could be endangered by a changing climate. Reducing development pressures within the rural landscapes of Chittenden County can be accomplished through allowing higher density in villages and growth centers and adopting conversation districts in areas that are primarily forested or open.

Resources: Uplands Project, Chittenden County Science to Action, Vermont Land Trust, Trust for Public Land

Increased Predicted Precipitation

Climate change predications support a 10% increase in precipitation. To protect the water quality of our lakes and streams and personal property, municipalities should evaluate and increase their storm water infrastructure capacity through green infrastructure practices and river corridor protection. Traditional storm water systems are designed to move runoff quickly to rivers and streams. During a significant rainfall event these systems can become overwhelmed and increase peak flows which increase the risks of flooding and erosion of stream banks and loss of homes and other property within the river corridor. Green infrastructure promotes on site water infiltration and slows the flow of storm-water into lakes and rivers. Whereas, river corridor protection establishes that development should be limited along stream banks to allow the river the meander naturally during flood events.

Action 1: Implement Green Infrastructure Principles into the built environment

Green infrastructure uses vegetation and soil to manage rainwater where it falls via interconnected systems of open spaces and natural areas that increase the infiltration of rainwater into the ground. Common practices include bioswales, permeable pavement, tree planting, green roofs, bioretention & infiltration. Currently, Vermont's RPCs are working with VANR to develop a Vermont Green Infrastructure Toolkit to educate municipal staff and officials on ways to incorporate green infrastructure and other low impact development mechanisms into their land use regulations. After completion, the Toolkit will be available at ANR's Green Infrastructure webpage located at here.

Resources: EPA, Vermont Planning Information Center

Responsible Entity: Planning and Zoning Department, Public Works Department

Action 2: Protect River Corridors and Limit Development in Vulnerable Areas

Flood losses in Vermont are caused by either inundation or fluvial erosion hazards. Fluvial erosion hazards (FEH) are a more common public safety risk and causes more private property loss than inundation hazards. Fluvial erosion can be either gradual changes in stream bank stability or sudden river course changes during significant flood events. Substantial flood damages and costs can be avoided by limiting development in river corridors and allowing rivers to meander naturally. River corridor protection projects can help spread, slow and store floodwaters and sediment. River corridor protection mechanisms include outright purchase, purchase of development rights/easement acquisition, and zoning overlay districts. River corridor protection also helps maintain habitat connectivity. Many towns in Chittenden County have done some level of FEH assessment and mapping; some have incorporated into zoning.

- Adopt a Fluvial Erosion Hazard (FEH) or other river corridor or floodplain protection by-law that meets or exceeds the Vermont Agency of Natural Resources FEH model regulations.

Resources: VT DEC, ANR Flood Resilience

Responsible Entity: Planning and Zoning Department

Action 3: Increase the protection of wetlands

Develop a wetlands management strategy that includes the identification of and recommendation to preserve key wetland areas in your town that will reduce the impact of a flooding event. Healthy wetlands sequester and store carbon, so wetland protection is an effective climate mitigation strategy as well.

Resources: VT DEC Wetlands Section

Responsible Entity: Planning and Zoning Department

Action 4: Assess culverts for geomorphic capacity and aquatic organism passage.

Culverts allow transportation routes to cross over waterways. They convey storm water under a road and also allow (or block) passage for aquatic organisms and wildlife. Increasing size and design of culverts can improve both functions. Inventorying and assessing culverts is the first step in identifying which culverts need replacement. CCRPC can offer municipalities' technical assistance to inventory the status and location of culverts in their town.

Resources: VTRANS

Responsible Entity: Public Works Department

Action 5: Develop or advocate for modified or new design standards for transportation infrastructure located in identified vulnerable areas

Transportation infrastructure design standards should be updated to reflect best practice for adaptation and resiliency. Standards might address asphalt and concrete composition, gravel roads, bridge design, elevation, and stormwater management. Materials should be resilient to temperature extremes and increased freeze-thaw cycles. Elevations and designs should account for greater flooding. Designs should effectively drain and manage stormwater.

Resource: Town Road & Bridge Standards, Handbook for Local Officials, Agency of Transportation

Responsible Entity: Highway Department

Action 6: Develop and apply a planning process to improve the resiliency of the transportation system.

Transportation resiliency is a key step to adapting to the impacts of climate change. Ensuring that basic mobility and access is maintained during extreme weather and disasters, especially floods and heat waves is necessary for ensure the safety of the public. The planning process should integrate transportation planning, river corridor management, and temperature stress considerations. Major steps should include identification of transportation infrastructure vulnerable to flooding and erosion, alternative and emergency routes, infrastructure and equipment vulnerable to heat and freeze/thaw stress, assessment of risk, identification and evaluation of impact-reduction strategies, and development of implementation plans.

Resources: VTrans Climate Change Adaption White Paper, Washington State Department of Transportation Climate Impacts Vulnerability Assessment

Responsible Entity: Public Works Department, Town Administration, Emergency Management Coordinator

Action 7: Flood proof or relocate water supply and wastewater treatment infrastructure in high-risk floodplains

Facilities located near streams and lakes may be subject to flooding or erosion that may disrupt operations or damage facilities. Water supply and wastewater facilities are typically designed with the 100 yr. flood in mind, however, increased heavy precipitation events expected with climate change justify reviewing whether facilities are adequately protected.

Resources:

Responsible Entity: Public Works Department, Town Administration

Climate-Related Emergencies

Acton 1: Develop/evaluate extreme heat response plans

More frequent heat events are predicted for Vermont and are a common cause of weather related deaths. Preparing for hot weather before it happens can keep people safer during these occurrences. Developing a plan to mitigate the effects of extreme heat events involve targeted strategies and messages for the most vulnerable populations. Extreme heat strategies may include providing cooling shelters for vulnerable populations, activate telephone heat hotlines, and inspect cooling systems.

Resources: Center for Disease Control, Vermont Department of Health

Responsible Entity: Emergency Management Director

Action 2: Incorporate climate change adaptation into the regional and local hazard mitigation plans to reduce long-term risk to human life and property from disasters

The Chittenden County Multi-Jurisdictional All-Hazards Mitigation Plan (AHMP) was first adopted in 2005. Working with municipalities and other entities, CCRPC completed comprehensive updates to the plan in 2008-2011 for the County section and the municipal annexes. These updates comply with federal rules and guidance for hazard mitigation planning. Each municipality then adopted the county-wide plan and the relevant municipal annex. CCRPC submitted the plans with adoption documentation to FEMA and VEM, and on August 8, 2011, the plans for 17 county municipalities went into effect. FEMA requires that the AHMP be updated and adapted every 5 years.

Resource: CCRPC AHMP

Responsible Entity: CCRPC and Municipalities

Action 3: Provide Incident Command System training for elected and appointed officials.

Incident Command System (ICS) is the approach used in Vermont and many other locations to manage emergency situations. ICS helps officials effectively manage emergency situations such as natural disasters, transportation incidents, and other serious incidents. Homeland Security and Vermont Emergency Management coordinate with the regional planning commissions to provide ICS training at different levels for local elected and appointed officials, staff and emergency management personnel. Effective emergency response and management are important components of disaster response and recovery, thus improving community resiliency in the face of a disaster.

Resource: FEMA ICS Resource Center

Responsible Entity: Local Emergency Planning Committee and Municipalities

Action 4: Identify alternate routes and modes for goods transport and evacuation efforts during emergencies.

Extreme weather of flood events may block key transportation routes and/or require area evacuation. Identification of alternative routes will help with goods movement or evacuation efforts during emergencies.

Resource: VTrans

Responsible Entity: Emergency Management Director, Town Administration

Conclusion

Municipalities are already doing many of the strategies presented in this guide. This guide asks that municipalities to consider placing a greater emphasis on the strategies because they do help the town to reduce ghg emissions and adapt to a changing climate. Opportunities exist for the all entities within municipal government to incorporate the items identifies here into their own planning, regulator, and budgetary frameworks. These include comprehensive plans, capital budgets, zoning bylaws and subdivision regulations, permitting process, redevelopment plans, transportation improvement programs, and open space programs, and mutual aid agreements.

CCRPC intends this guide to be helpful advice, not a mandate. Municipalities may not be able to adopt all of the actions in this guide, however, most communities may find many actions that they can implement.