The Climate Connection

The Vermont Agency of Natural Resources - Climate Change Team Newsletter

Backed by Deb Markowitz, ANR Secretary, the climate change team is working to facilitate enhancements to existing programs in order to promote sustainability, reduce greenhouse gas emissions, improve waste reduction, implement adaption and mitigation methods, provide education and outreach and advance related economic opportunities.

In This Issue...

ANR's Climate

A brief update on what the Agency has been working on

The Climate Cabinet – Established in May, this group will ensure coordination of climate change efforts across state government. Read the executive order and press release.

Energy Planning – The ANR Climate Change Team and Agency managers discussed the Comprehensive Energy Planning (CEP) Effort, a project which seeks to expand Vermont's use of renewable energy to become largely self-sufficient by 2030. www.vtenergyplan.vermont.gov

Adaptation – The Adaptation White Papers are out! See **Adapting to Climate Change in Vermont** on page 4. The Climate Change team also issued a request for proposals to perform a statewide vulnerability assessment. See the RFP page for details (proposals due July 29).

Forestry – The US Forest Service announced a competitive grant award to advance climate change adaptation strategies for forests. The goals of this effort include identifying species and landscapes most vulnerable to climate changes and developing Vermont-appropriate adaptation strategies.

Now on Twitter! Follow us @VTClimateChange to find out more.

Navy Shower
Reduce your shower length from 10 minutes (25 gallons) to 3 minutes (turning the water off while sudsing up) and save 18 gallons of water daily!

Were last winter's snowstorms the result of climate change?

Scientists predicted increased snowfall/precipitation for Vermont - *By Gwen Dunnington VTANR*

Photo: Courtesy of Burlington Free Press

The 2010-2011 winter was one of the snowiest on record for Vermont. The state saw its biggest snowfall in the last forty years (128.4 inches), unusually long periods of very cold temperatures, and its biggest March storm on record (NOAA). Vermont was not alone, either. In less than a month between December and January, six snowstorms walloped the Northeast, causing record-breaking snowfalls in Massachusetts, New York, and Connecticut and leading to headlines such as "Snoverdose" and "Enough!" from newspapers across the country. On January 11, 2011, snow was present in 49 of the 50 states, leaving only Florida free of ice and snowbanks. In short, after this winter, it sure doesn't seem like we should be too worried about global warming.

In actuality, though, more snowstorms and more winter precipitation are exactly what scientists have predicted in the Northeast as a result of climate change (Betts, 2011). This seems counter-intuitive; how could global warming be causing more snowstorms?

Well firstly, it is by definition impossible to tie a specific weather event, like the thundersnow storm we saw in Burlington in January, to climate change. So it would be inaccurate to say, for instance, that "the January thundersnow storm of 2011 was caused by climate change." But more frequent extreme weather events will, over time, change the "average" of the weather conditions expected in a certain region. This average is what we know as climate.

Secondly, increasing temperatures worldwide mean warmer air temperatures worldwide, and warmer air can hold more water than colder air. This means that in a warmer world, there will be more water vapor available overhead to fall down as rain, snow, sleet, or hail. Because of this, climate scien-

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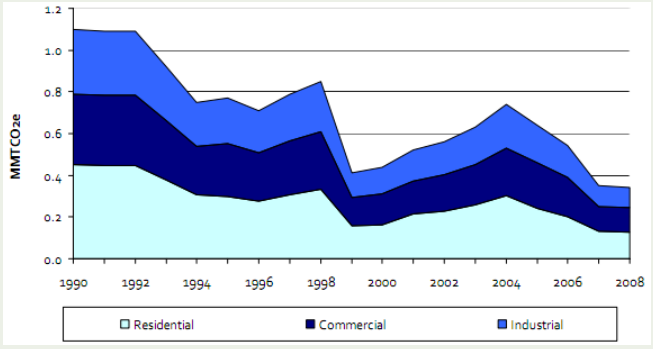
tists have predicted changes in the Northeast to include increased winter precipitation, more wet snow and freezing rain, and more frequent violent storm events (Betts, 2011; CDEP, 2009; MDEP, 2009; Stager & Thill, 2010).

Vermont's Smart Grid

How the smart grid will fundamentally change how we use electricity - *By Alex Geller VTANR*

Power grid, smart meter, electric car, smart grid, smart appliance? What do these terms mean? Why are they important? And how is this going to affect me? Since the electric light bulb's introduction in the 1870's, public utilities have formed across the country for the purpose of supporting networks of power lines that meet the electricity demands of residential, commercial and industrial consumers. At one end of the line sits a generator, or power plant, and at the other end, the consumer. This basic layout has remained unchanged for more than 100 years. Although this system is relatively tried and true, modern pressures such as climate change and unsustainable pricing for energy have inspired a movement that trades dirty power production, like burning fossil fuels, for clean and renewable power, like solar and wind. We have also begun to aggressively tackle how we use this energy in the form of implementing efficient lighting, bolstering insulation, and engineering more efficient design. Proof that these efforts are making a difference can be found in the Vermont Greenhouse Gas Emissions Inventory Update 1990 - 2008.



Historical VT electricity GHG emissions by sector VT GHG Inventory Update 1990 – 2008 Source: VTANR

Although we have seen a reduction in our Greenhouse Gas (GHG) emissions, adoption of renewable energy is slow and improving efficiency is a tedious and costly endeavor. However, a solution to these deterrents can be found with what is called a "smart grid". The smart grid can be thought of not as a technology that directly reduces emissions, but as a catalyst that will bring a paradigm shift in energy usage. This shift facilitates both increased benefits for renewable technologies and even greater gains in efficiency spread out across the entire electricity sector. Eventually this shift may also aid in the replacement of our fossil fuel based transportation infrastructure with electricity that is created in your neighborhood.

Digital smart meter (left) as compared to a traditional analog meter (right) Source: www.CaliforniaPhoton.com

In 2009, 20 Vermont electric utilities came together to apply for a US Department of Energy Grant that would provide a large portion of the funding ($69 million) to retrofit every household in Vermont with a smart meter. What differentiates this meter from your old, analog meter is the interval between readings. With analog meters, an electric utility worker will visit your house about once a month and read the meter to calculate your consumption over the past 30 days. Although you pay a constant rate for electricity, the utility buys power from many different sources of generation, and those prices can fluctuate by the minute. In order to determine how much you owe, the utility does its best to calculate the average cost of electricity over a long period of time (subject to the Public Service Board's approval). This rate assumes that your consumption can only be checked once a month, meaning that you cannot take advantage of electricity when it is inexpensive and plentiful. With a smart meter, your consumption can be tracked every 15 seconds, allowing for the utility to charge customers the real-time costs. Simultaneously, the utility can provide your household with information that includes both the rate and the duration for which that certain rate will last, allowing for households to plan their energy consumption as economically as possible.

GE's Nucleus Home Energy Management System can control Brillion compatible appliances from your computer or you smartphone. Source: www.GEAppliances.com

Smart grid technology provides real-time market rates, giving the consumer a choice of how and when to consume energy. The immediate advantage of this can be realized by delaying the use of power intensive appliances, such as water heaters and laundry dryers/washers, to the evening when demand for power from the utility is low and therefore so is the price. Eventually, appliances will communicate with your utility, and can be set to turn on when the price for electricity has reached a certain threshold that is set by the consumer. In fact, the General Electric Company is poised to introduce their BrillionTM line of appliances that do exactly this by the end of 2011.

Building on the idea of smart appliances, electric vehicles will also take advantage of this variable price structure due to the fact that they recharge throughout the nighttime hours. This is particularly attractive because 47% of Vermont's GHG emissions are emitted from the transportation sector (Merrell, 2010). There is also one other dis-

Computer

Turn off the monitor if you aren't going to use your PC for 20 minutes or more, and turn off the CPU and monitor if you're not going to use your PC in the next 2 hours. Though there is a small surge in energy when a computer starts up, this small amount of energy is still less than the energy used when a computer is running for long periods of time. *(U.S. Dept. of Energy)*

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tinct advantage of implementing an electric vehicle infrastructure. Currently when electricity demand peaks in the summer, the utilities need to meet that demand with additional generation to avoid brownouts and blackouts. This is accomplished with diesel and natural gas generators, known as peak load generators, which are both expensive to operate and dirty. A technology that is currently in development involves electric plug-in vehicles that are connected to the grid. These vehicles are able to discharge energy when the grid is under peak load, thereby avoiding the need to operate peak load generators, while compensating the owner of the vehicle with a premium for that service. This same principle of variable rate consumption can also be applied to production. Brownouts usually occur during the warm summer days in which people are relying heavily on A/C to combat the summer heat. Coincidentally, solar power produces the most energy on sunny days. Therefore, when demand is high enough to cause brownouts, clean, plentiful and cheap energy like solar, is of great value to the utilities in order to suppress the cost of electricity and avoid outages. With the implementation of smart meters, combined with residential scale photovoltaic panels for private homes, the utilities will be able to pay homeowners a premium for the energy they produce while also avoiding reliance on peak load generators.

The Chevrolet Volt is a plug-in electric vehicle with a conventional engine designed to extend the range of first generation lithium ion automotive battery. Source: www.CleanMPG.com

There are many other benefits of smart grid technology, only a few of which are described in this article. Vermont has a reputation for being a leader in curbing our energy and carbon footprint. Efficiency Vermont was the first rate-payer funded public energy efficiency utility in the country, and Vermonters emit roughly 40% less CO2 per capita than the average American due in part to efficiency programs and the current low-carbon profile of the electricity mix used in Vermont (Merrell, 2010). Smart meters have already been distributed to nearly 75% of Vermont Electric Cooperatives customers (Keese, 2009) and other utilities are hard at work with their respective roll-out plans. The vast majority of Vermont households will have smart meters by the end of 2013, allowing for Vermont to be the first smart grid state in the country. To find out when you can expect your smart meter, contact your local electric utility.

1. Hines, P., June 11, 2011, "Why should Burlingtonians invest in Smart Grid technology?" http://www.cems.uvm.edu/~phines/Smart_Grid_Letter.pdf (June 15, 2011).
2. Merrell, J. et al, September 2010, "Vermont Greenhouse Gas Emissions Inventory Update 1990 – 2008" http://www.anr.state.vt.us/anr/climatechange/Vermont_Emissions.html (June 15, 2011).
3. Keese, S., April 2009, "Vermont's utilities consider developing "smart grid"" http://www.vpr.net/news_detail/84785 (June 16, 2011)

Laundry

Wash your clothes at 86°F or lower. On average, this will use 40% less energy than hotter settings. Better yet, dry your clothes on a line for an all-time emissions low! *(Tesco)*

Adapting to Climate Change in Vermont

An Introduction to the Adaptation White Papers - *By Gwen Dunnington VTANR*

Vermont's climate has been changing rapidly in the past fifty years in response to increasing global temperatures. Atmospheric CO2 is now more than 30% above its highest value in the past million years, and it continues to increase in concentration every year. Reducing those emissions remains the most urgent task at hand if we are to avoid the most catastrophic effects of a changing climate.

Unfortunately, greenhouse gases (GHGs) like CO2 and methane remain in the atmosphere for a long time, so even if we stop driving, stop flying, stop heating our houses, stop emitting everything tomorrow, the climate will continue to warm for several decades before natural cycles can restore GHG levels to "normal." In the meantime, we must continue to make substantial reductions in our GHG emissions, but natural resource managers and state agencies must also begin to pursue adaptation strategies to deal with the changes that are already inevitable.

Agriculture	Fish and Wildlife
Water Resources	Transportation
Public Health	Recreation
Public Safety	Forestry

Vermont can expect to see a wide variety of effects as a result of climate change, and an adaptation plan is needed to protect the most vulnerable resources, areas, and sectors in the state. In the fall of 2010, the Agency of Natural Resources asked divisions and departments throughout state government to draft short adaptation white papers in the following sectors:

The white papers provide a brief overview of: 1. the challenges facing each of the different sectors of Vermont, 2. what programs are already in place to address those challenges, and 3. what areas are the most vulnerable to the impacts of climate change. This collaborative effort will help inform a more technical vulnerability assessment and state-wide adaptation plan in the near future.

Check out the Adaptation White Papers to learn what changes are coming our way, and how the State of Vermont will adapt to a changing climate.

http://www.anr.state.vt.us/anr/climatechange/Adaptation.html

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What Warmer Waters Mean for Vermont's Aquatic Critters

A look at the implications a changing climate has on Vermont's Aquatic Organisms - *By Jeremy Deeds VTANR*

Vermont is well-known for its cold, clear mountain streams which support a diversity of wildlife within its channel and along its banks. To aquatic organisms, the critters that spend their lives in these waters, the temperature of the water is crucial; water temperature regulates the metabolism, growth, development, reproduction and food availability of most aquatic insects and fish. Water temperature also determines how much oxygen the water can hold (The colder the water, the more oxygen is available for the animals that live there), and for many species of insects and fish, the amount of oxygen in the water is the most important habitat requirement.

Figure 1: Native Brook Trout

Animals that live in colder waters are more susceptible to changes in temperature, because these animals have adapted to particularly stable temperature conditions. For example, brook trout, one of Vermont's most prized native sport fish, live in a very narrow temperature range. The optimal range for brook trout lies between 55°F and 60°F, though they can survive in waters from freezing (32°F) to about 65°F. They cannot tolerate exposure to warmer waters, and will die after only a few hours in 75°F water (VT Fish & Wildlife). Even more susceptible than brook trout to changes in water temperatures are aquatic insects (such as mayflies, stoneflies and caddis flies) which constitute a large base of the food chain in lakes and streams. Mayflies and stoneflies – general indicators of good water quality – are particularly sensitive, as water temperatures of 68°F can be lethal to most species in these groups.

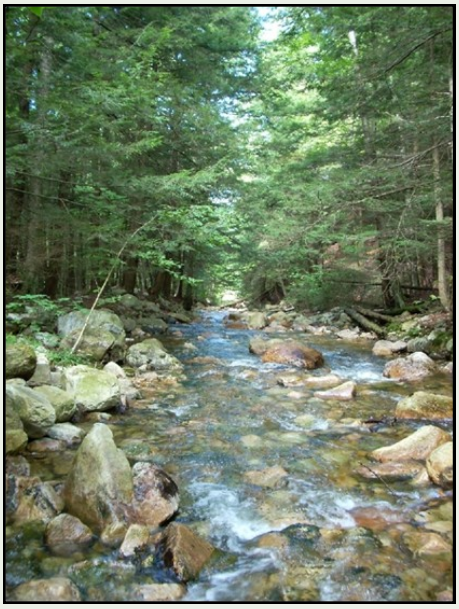

Figure 2: Headwater Stream (Fayville Branch in the Battenkill Watershed)

Most Vermont rivers and streams average about 53-59°F during the summer months, with our colder headwater streams roughly 50-52°F and our warmer rivers between 60-68°F. Warm-water habitats usually hold a lower number of species of insects and fish, since there are fewer species that are adapted to live in these warmer waters and lower oxygen levels. Warmer waters can also support the growth of plants and algae, as well as microbial organisms like cyanobacteria (blue-green algae) that are potentially harmful humans and animals.

Projections on the degree of water warming due to climate change vary, but it is agreed that higher water temperatures present a significant threat to coldwater fisheries in northern waters (Schindler, 2001). The predicted effects of climate change include not only warmer surface waters, but also warmer groundwater, more intense storm events, and seasonal droughts. Low flows in the summertime due to seasonal droughts will likely contribute to rising water temperatures and lower oxygen levels. These effects would significantly alter aquatic habitat for Vermont's most sensitive aquatic species, which have evolved to live in a very narrow range of water temperatures. The warming of Vermont's waterways may result in a loss of our native species and a northward expansion of species that are better adapted to live in warmer waters.

Water temperatures can rise for many reasons, not just climate change. Riparian buffers of native vegetation along the banks of lakes, rivers and streams – especially headwater streams – help to keep the water cool by providing shade and also filtering pollutants out of stormwater runoff. You can read more about how the Vermont Water Quality Division is managing thermal stress in the new Water Quality Management Strategy.

For more information about aquatic life and water temperature, see:
http://www.vtfishandwildlife.com or http://www.vtwaterquality.org/swms.html

1. Schindler D.W. 2001. The cumulative effects of climate warming and other human stresses on Canadian freshwaters in the new millennium. *Canadian Journal of Fisheries and Aquatic Sciences*. Vol. 58, No. 1, pp. 18-29(12)

More Citizen Science

Maple Sugaring Season Getting Shorter -
by Jeff Merrell VTANR

In the first issue of *The Climate Connection* newsletter, we explored how lake ice-out data shared by Vermonters are helping us to understand the more local impacts of global climate change. The volunteers' data showed that most lakes and ponds in Vermont are trending towards an earlier "ice-out", with 2010 generally showing the earliest ice melt on record. Scientific researchers in Vermont are finding similar trends with other climate change indicator data (for example, see Dr. Alan Betts' work at http://alanbetts.com/understanding-climate-change/topic/vermont-climate-change-indicators/).

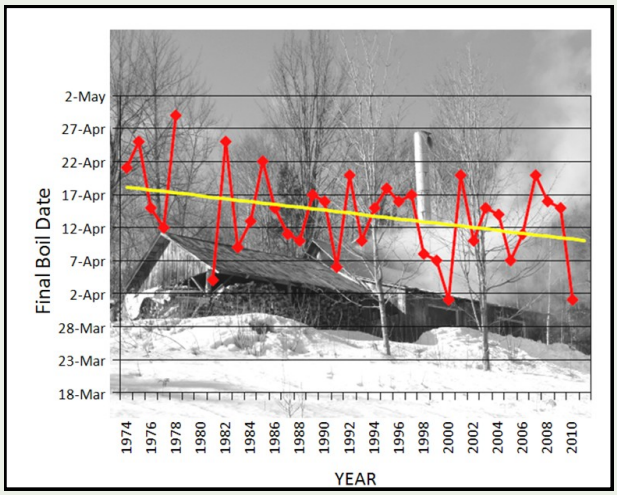

Figure 1: Kirby Mountain VT - Maple Sugaring Final Boil Date Source: Wood Family Maple

Recently, Wood Family Maple was kind enough to share maple sugaring records showing the "final boil date" at their sugarhouse from 1974 through 2010 (Figure 1 - *graph courtesy of P. Hamelin*). The trend in this dataset is strikingly similar to the lake ice-out data we presented in the previous newsletter (Figure 2). Despite annual variability in the weather, snow cover, etc., the average sugaring season at Kirby Mountain is now ending about a week sooner than it did in 1974. Similar results were found from the Proctor Maple Research Center's compilation of Vermont records showing the sugaring season beginning 8 days earlier, and ending 11 days earlier than 40 years ago (*T. Perkins, pers. comm. to S. Wilmot*). Each of these clues collected from our own backyards around the state (earlier lake ice-out, shorter maple sugaring season, longer growing season, earlier lilac leaf-out, etc.) paint a clear picture that Vermont's climate is changing in ways that are consistent with the expectations of climate scientists. It is also likely that there are many other unexamined climate clues out there that have a very similar story to tell.

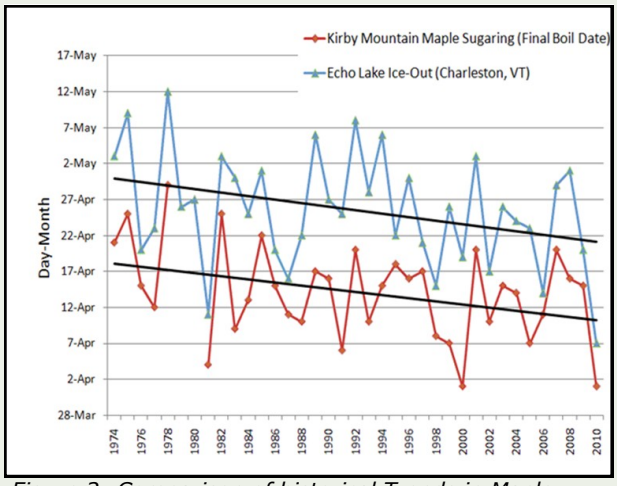

Figure 2: Comparison of historical Trends in Maple Sugaring Final Boil Date (Kirby Mountain, VT) and Ice-Out at Echo Lake (Charleston, VT)

If you think you might have some useful "climate change indicator" records that you're willing to share, please contact Jeff Merrell (jeff.merrell@state.vt.us) or Gwen Dunnington (gwen.dunnington@state.vt.us). Also, to all the "Citizen Scientists" who have shared their data already … **THANK YOU! … and please continue to send us your data each year** so we can update the graphs and better understand these important climate change indicator trends!

Thank you for reading the Vermont Agency of Natural Resources Climate Change Newsletter, The Climate Connection! This is only the second issue, but the response thus far appears to be very positive. If you have input, ideas or feedback on either the newsletter or website content for the climate change team, please feel free to email us at ClimateChangeInfo@state.vt.us. If you would like to subscribe and receive future newsletters, please sign up here: http://www.anr.state.vt.us/anr/climatechange/Newsletter.html

Thank you and get ready for our next issue in Fall of 2011!

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