Clean Heat:
Comfortable Homes, Affordable Future

A Vision for Vermont's Heating Future

VPIRG
VERMONT'S VOICE

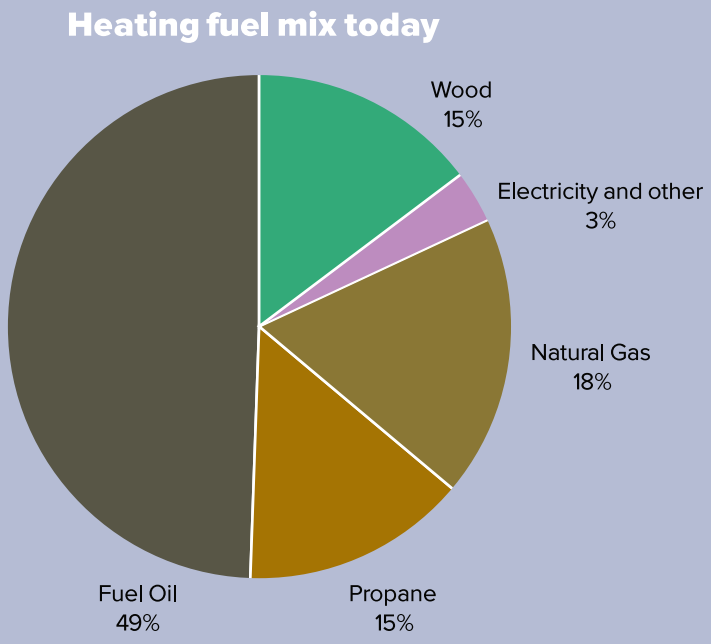
Vermont Public Interest Research
and Education Fund
Spring 2011

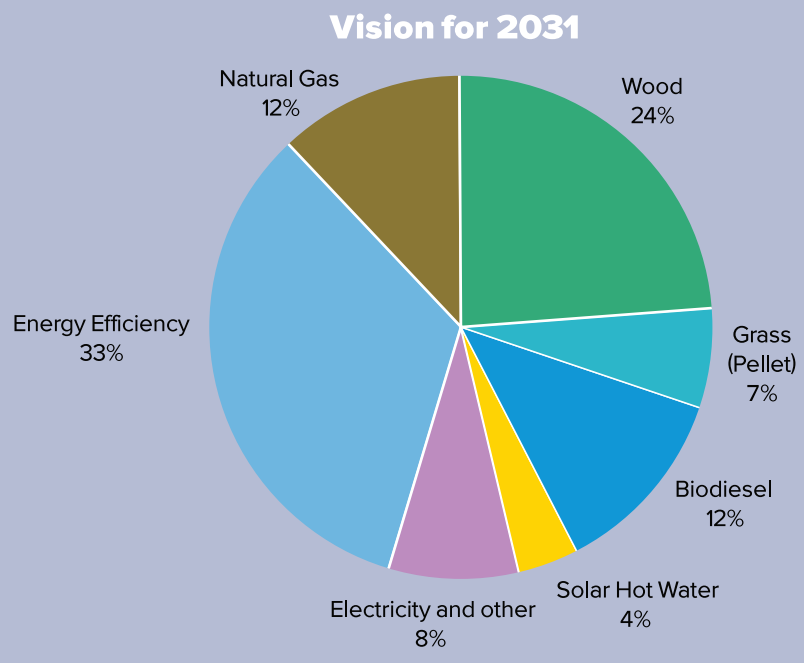
Clean Heat: A Vision for Vermont's Renewable Heating Future

Vermont has the opportunity to create a more affordable, cleaner heating future that will keep our energy dollars in-state. Vermont needs a diverse thermal portfolio based on a clean and reliable fuel mix that can serve as a hedge against the impacts of regular price spikes in fuel oil costs.

Thermal mix today

Currently, Vermont's thermal fuel supply is dominated by expensive and dirty sources. Over 80 percent of Vermonters heat their homes and fuel their farms and businesses with fossil fuels. Relying on these fuels has created unsustainable economic and environmental costs.





VPIRG's 2031 Clean Heat Future

Within the next 20 years, Vermont can meet almost 90 percent of its thermal needs through increased energy efficiency and Vermont-based renewable heating technology.

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Written by Clay Francis

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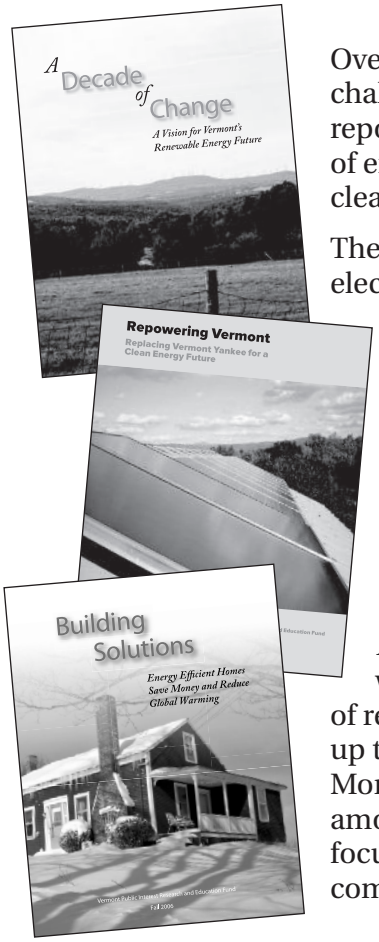


Over the past five years, VPIREF has released three major reports addressing the challenges and opportunities in determining Vermont's energy future. These reports provided insights into the economic challenges and environmental impacts of energy use in Vermont and identified solutions that could help Vermont build a clean energy future.

The 2006 report *Decade of Change* laid out a broad vision for building a renewable electricity portfolio for Vermont. In 2009, VPIREF released the follow-up, *Repowering Vermont: Replacing Vermont Yankee for a Clean Energy Future*. This report provided a more detailed roadmap for how Vermont can replace Vermont Yankee and meet 100 percent of the state's electricity needs through local renewable resources by 2032. *Repowering Vermont* also explains how Vermont can use renewable electricity sources to completely power the transportation sector.

In 2006, VPIREF also released *Building Solutions*, which addressed how Vermont could reduce its global warming pollution and save money by making our homes more energy efficient. This report, *Clean Heat: Comfortable Homes, Affordable Future*, builds on that theme by examining the energy fuel sources we use for heating. *Clean Heat* focuses on Vermont's thermal fuel mix, inclusive of residential, commercial and industrial uses. Residential fuel use, which makes up the majority of the thermal mix, is almost entirely for space and water heating. More than one-third of commercial use is also for heating; however, a significant amount of fuel is used for non-heating and process applications. This analysis focuses on thermal fuel use but also addresses non-thermal applications in the commercial and industrial sectors.

Executive Summary

Vermont's reliance on dirty fuels to heat our homes and run our businesses is economically and environmentally bankrupt. Every year, we send hundreds of millions of dollars to oil companies and foreign countries, which could otherwise stay in our local economy. Vermont needs a diverse thermal portfolio based on a clean and reliable fuel mix that can serve as a hedge against the impacts of regular price spikes in fuel oil costs. Building a clean heat future today that reduces our overall need for heating fuel and promotes the use of local, clean heating options from our farms and forests will strengthen Vermont's economy and environment while providing better price stability for consumers.

Over 80 percent of Vermonters heat their homes and businesses with fossil fuels like fuel oil, propane and natural gas. Prices for these fuels have more than doubled in the past decade. Vermont now spends nearly $1 billion to heat its homes and fuel its farms and businesses.[1] Our aging housing stock makes the problem even worse. About 50 percent of the state's homes pre-date any energy efficiency standards for buildings and require more fuel to heat.[2]

Using expensive, dirty fuels to heat our inefficient homes has created unsustainable economic and environmental costs. Continuing to rely on fossil fuels to heat our inefficient buildings will only worsen the financial burden we face in years to come. We cannot simply pass these costs on to the next generation.

Fortunately, Vermont has the basic ingredients that will help us reverse this trend of higher and higher energy costs. We have everything we need to make this transition a reality and we can look in-state to find it. Our world-renowned

expertise in energy efficiency will improve our buildings and reduce the amount of fuel we need. Vermont's farms and forests will then play the lead role in supplying the fuel that will keep us warm and move our economy forward.

Vermont's clean heat potential will not be realized overnight, but we can start today on a path toward a locally-fueled, more affordable heating future. Focusing on energy efficiency and moving to cleaner heating fuels will save Vermonters money and create thousands of in-state jobs. Energy efficiency upgrades alone will provide 3,600 jobs over the next twenty years.[3]

Clean Heat lays out a clear and achievable vision for a renewable and affordable heating future for Vermont. By 2031, Vermont could meet almost 90 percent of its heating and thermal fuel needs, including residential, commercial and industrial uses, with increases in energy efficiency and renewable heating technology. Here's how:

- Continued investment in energy efficiency will help our economy grow while reducing our overall demand for heating fuels. Performing energy efficiency upgrades to less than half of Vermont homes and buildings will reduce our demand by more than 33 percent.
- Vermont biomass in the form of cord wood, wood chips and wood pellets can provide 24 percent of our state's heating needs.
- Vermont biodiesel can meet 12 percent of our state's heating needs. Harvesting crops not used for food on three percent of our farmland would put farmers back to work and generate 3.2 million gallons of pure biodiesel. Algae-based biodiesel — the next wave of liquid renewable fuels — can produce 42 million gallons of biodiesel each year.
- Vermont electricity can power eight percent of our heating needs. Ground source heat pumps, the most efficient type of electric heater, are a proven technology for affordable space and water heating.
- Vermont grass pellets can provide seven percent of Vermont's heating needs. Converting 15,000 acres of unused farmland to grass for energy crops is an innovative way for Vermont farms to remain financially viable.
- Solar hot water can meet four percent of Vermont's heating needs. Solar hot water is one of the easiest and most affordable renewable technologies to install, and Vermont homes get enough sun to meet their hot water needs for almost the entire year.

Making this clean heating future a reality will require leadership from state officials actively encouraging energy efficiency and supporting clean local fuels. To realize this goal, Vermont should do the following:

- Support innovate financing mechanisms like the Property Assessed Clean Energy (PACE) program that encourage investment in energy efficiency and renewable heating technology.
- Accelerate upgrades of building efficiency standards.
- Implement time-of-purchase energy disclosure requirements that help Vermonters make smart energy choices.
- Expand funding for state energy efficiency programs to aggressively and effectively address all homes, regardless of heating fuel type or income level.
- Adopt a biofuel requirement starting with a five percent blend and ramp up to a 100 percent requirement.
- Implement a renewable heating standard for new buildings.
- Institute high quality standards for wood pellets.

Too Expensive to Continue

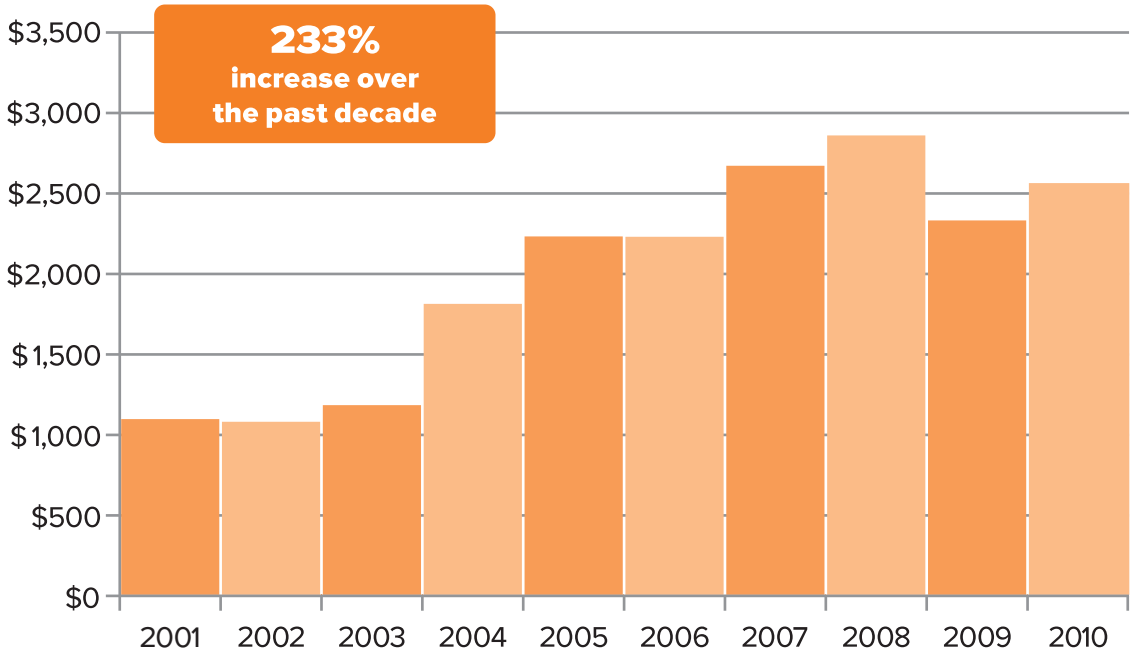
As the snow and temperatures start to fall every winter, Vermonters look to stay warm by turning on their furnace or boiler or putting another log in the wood stove. However, rising fuel costs have caused many families to question whether they can afford to heat their homes while still paying for food and other necessities. Fuel costs have more than doubled over the past ten years (see Figs. 1–3), and Vermonters now spend nearly $1 billion each year to heat their homes and offices and fuel their farms and businesses. This staggering number is about two-thirds of what the state pays for the entire education budget.

Vermonters now spend nearly $1 billion every year to heat their homes and offices and fuel their farms and businesses.

Heating is a significant cost for almost all households and businesses. Those Vermont families barely getting by now are the hardest hit because heating costs represent a larger portion of their budget. The average heating bill in Vermont is $2,600, up 12 percent from just one year ago, despite stagnant and decreasing salaries.[4] Fuel assistance programs do a critical job serving about 25,000 low-income homes, but as prices rise higher, more Vermonters need help making it through the winter. Fuel assistance alone is not a sustainable answer for Vermont's economy — neither is letting families go without heat in the coldest months of the year. To ensure that Vermonters stay healthy and warm, we must break this reliance on the fossil fuels with the highest prices.

This will not be easy considering that over half of Vermont homes and offices rely on fuel oil for heat, and another quarter use natural gas or propane. When fuel prices soared to nearly $5.00 per gallon in 2008, they did not stay there for long and came down significantly before the full force of the heating season was upon us. However, the price spike exposed significant weak-

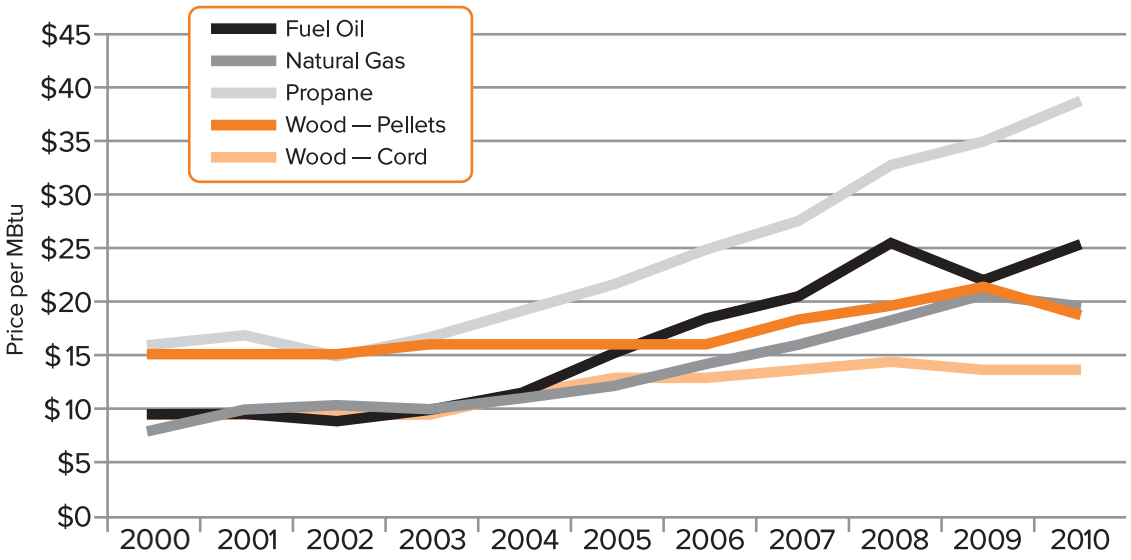
FIGURE 1: **Annual cost to heat your home with oil**



Source: U.S. Energy Information Administration and Vermont Department of Public Service Price reports

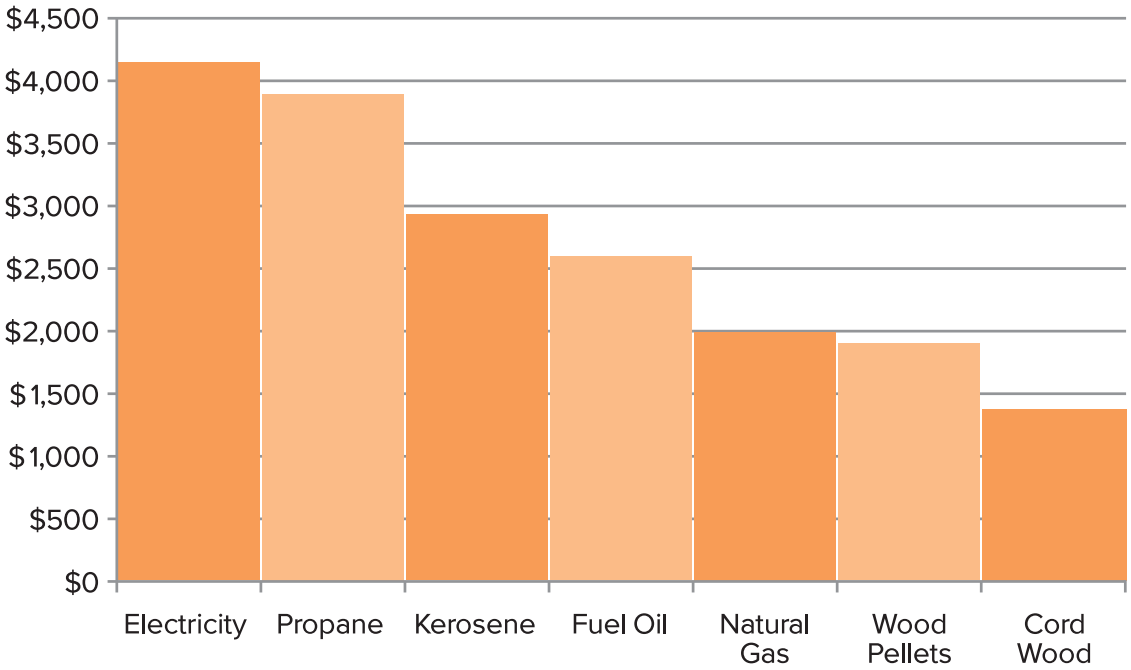
nesses in our ability to keep Vermonters warm and safe through the cold months when oil prices rise. There wasn't an affordable, quick fix at the ready to avoid a crisis. More systemic changes need to be implemented to help Vermonters reduce the amount of fuel they need and then switch to alternative fuels. We will have to invest some today to save a lot over the years to come. Otherwise, we will find ourselves wholly unprepared when prices reach $5.00 per gallon. Vermont cannot continue down this unsustainable path that puts families at risk.

FIGURE 2: **Fuel prices on the rise over the past decade**



Source: U.S. Energy Information Administration and Vermont Department of Public Service Price reports

FIGURE 3: **Annual cost to heat your home by fuel type**



Assumes total thermal demand is 100 MBtu

Source: Vermont Department of Public Service Price report, November 2010

Building Solutions that Work

The farmhouses large and small that dot Vermont's horizon are some of the most recognizable features of the Vermont landscape. These homes and the farms on which they sit are part of the state's identity and have been for many decades. They are also a big part of the problem: Vermont has the second oldest building stock in the nation. The one-third of homes built before 1950 have little or no insulation and are very expensive to heat. The rest of homes are not much better, with 65 percent built before 1980.[5] Moreover, the oldest homes, those that are the least efficient to heat, are most likely to use expensive fuel oil. As quaint and picturesque as these homes may be, the Vermonters that live in them need relief from high heating costs.

The basic ingredients to help reverse this trend of higher and higher energy costs can be found right here in Vermont. The solutions come from the earth, sun and soil. But to ensure our local, clean heating options can meet our needs, first we need to reduce the amount of fuel we require by making buildings as efficient as possible. Investing in better insulation and replacing old and inefficient heating equipment will reduce demand and save money. Vermont's farms and forests can then supply a large portion of the fuel we need to heat our homes. Employing sustainable forestry and farming methods to produce renewable heating fuels can provide a viable alternative for struggling farmers. Vermonters have the will and ingenuity to start this transition to a cleaner, more affordable future, and now is the time to make it a reality.

Economic Benefits

Creating a more affordable heating future starts with getting our fuel from within the state's borders. Right now, 80 cents of every dollar we spend on heating fuel leaves Vermont.[6] This means that each year, out of the $1 billion dollars we spend on heating and process fuel, $200 million supports Vermont businesses and $800 million is sent out of the Vermont economy to oil companies and foreign countries.

Imagine how many Vermonters could be put to work making our buildings more energy efficient or growing, harvesting and delivering local fuel with that $800 million.

Vermont sends $800 million annually to out-of-state and foreign oil companies that could instead go to support Vermont's renewable fuel businesses and efficiency investments.

Efficiency Vermont, the state's energy efficiency utility, has already proven that Vermonters can save money by investing in electric efficiency. The same holds true for investments in energy upgrades that improve insulation and heating equipment in our homes and businesses. For example, a home energy upgrade saving 40 percent on the typical energy bill would equate to $1,350 in savings each year.[7] Combining energy upgrades and renewable heating technology is an even faster way to save money. The same 40 percent energy upgrade combined with a solar hot water heater would save $2,131 each year.[8]

Moving to cleaner heating fuels will not only save Vermonters money, but it will also create hundreds of in-state jobs.[9] A typical building efficiency upgrade employs electricians, heating system technicians, weatherization technicians and a project manager (see Fig. 4). Supplying the clean heating fuel to this efficient home gives work to farmers, loggers and foresters that are cultivating and harvesting local fuels. Looking toward new fuels on the horizon, the Vermont Sustainable Jobs Fund is helping to fund University of Vermont researchers who are developing cutting edge technology that will transform algae into renewable, liquid heating and transportation fuels. Vermont is currently one of many states developing these technologies. Locating renewable heating manufacturing centers here could revive Vermont's factories, farms and forests at a time when they need it most.

An energy upgrade technician inspects the furnace and measures the efficiency and performance of a residential heating system.

FIGURE 4: **Typical energy upgrade**
This table is the typical labor and materials breakdown for an energy upgrade saving 40% on annual fuel bills. Eighty cents of every dollar spent on efficiency stays in our economy.

Putting Vermonters to work		
Job and hours	Energy Upgrade Technician	128
	Crew Chief	64
	Energy Analyst	12
	Heating System Technician	20
	Manager	2
	TOTAL	**226 hours**

Putting money in our economy	
Labor	$5,655
Overhead	$1,131
Materials	$12,000
TOTAL	**$18,786**

Source: Regulatory Assistance Project.
A Vermont Case Study and Roadmap to 2050.

Environmental Benefits

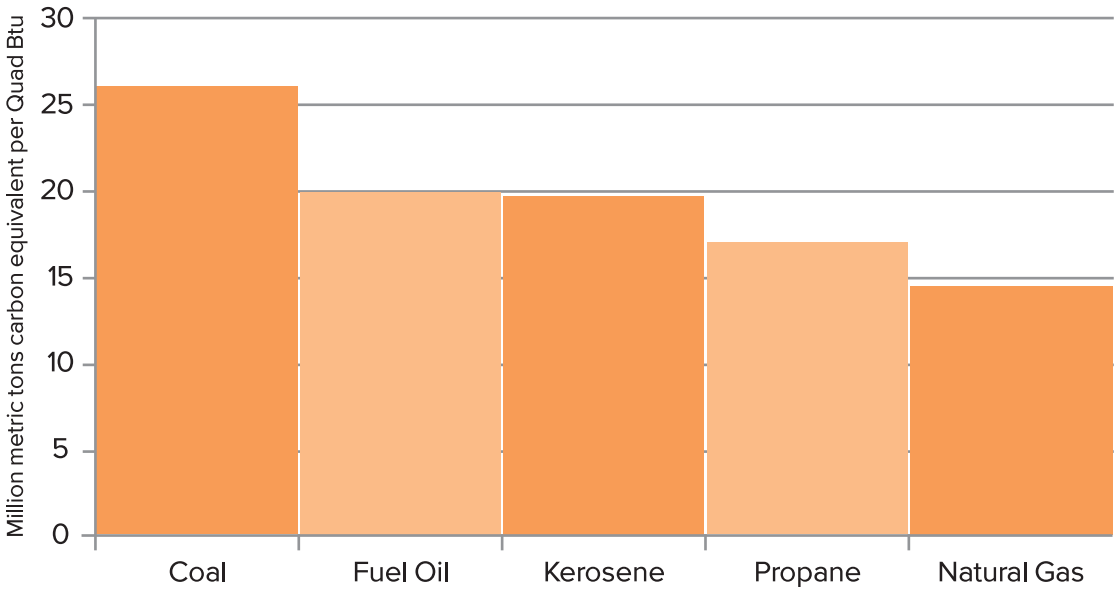
Human activity, primarily the burning of fossil fuels, is changing our climate. The evidence of that change is unequivocal. Devastating floods and droughts both ravaged the globe in 2010, a year that was one of the hottest years on record. Heat waves and extreme weather events have become even more intense in the past ten years, the hottest decade on record. The distinct seasons that define Vermont's year will blur together or disappear completely if we don't stop climate change. This is especially troubling considering that Vermonters who work on our farms, in our maple forests and at our ski resorts depend on the predictability of our climate to make a living. The future of Vermont's tourism-based economy depends on how we respond to this challenge.

Vermont's carbon dioxide emissions from home heating increased 29 percent from 1990 to 2000. The state must reverse this trend.[10]

To put us back on the right track, we must reduce the greenhouse gas emissions that are causing our planet to heat up. Nearly one-third of Vermont's greenhouse gases come from the dirty fossil fuels we use in the residential, commercial, and industrial sectors (see Fig. 5).[11] Fuel oil, the dirtiest liquid fuel for greenhouse gas emissions, is also the most widely used in Vermont homes. Reducing our heating demand through efficiency and using cleaner fuels to provide for the rest can help us avoid the worst impacts of climate change (see Fig. 6).

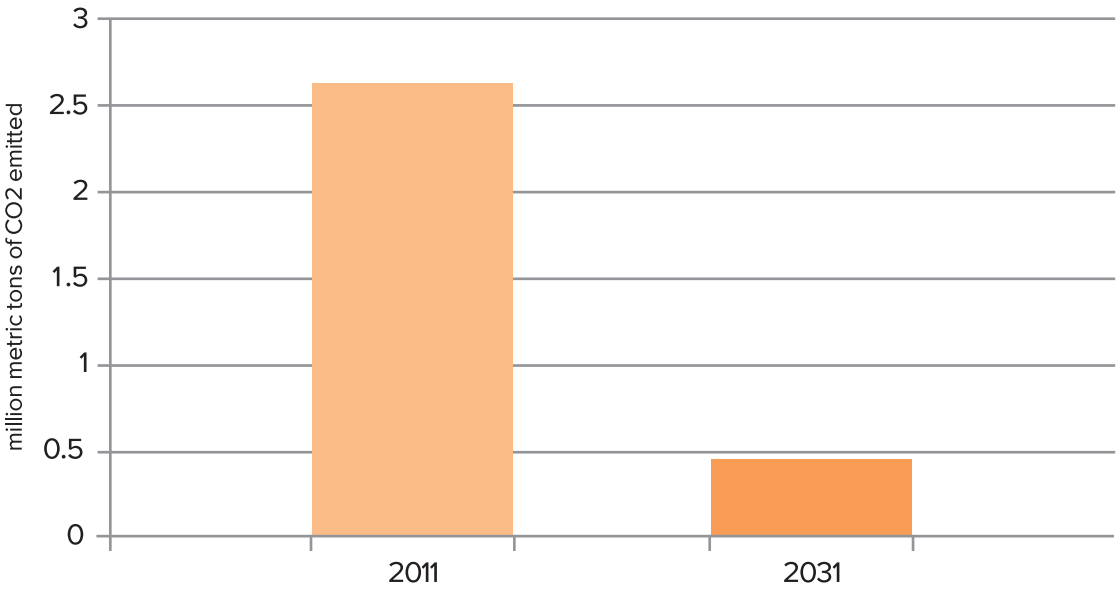
Making the transition to cleaner heating fuels has other environmental benefits as well. Renewable heating technologies like solar hot water heaters and ground source heat pumps do not emit dangerous pollutants like sulfur dioxide and nitrogen oxide. These pollutants, along with other particulate emissions that come from burning dirty fossil fuels, are responsible for increasing respiratory illnesses and hospitalizations for heart and lung diseases.[12] Additionally, modern stove and biomass boiler and furnace technologies can take wood from our forests and burn it cleaner and more efficiently than old fossil fuel or wood burning technology.

FIGURE 5: **Global warming pollution by fuel source**



Source: U.S. Department of Energy, Energy Information Administration, Documentation for Emissions of Greenhouse Gases

FIGURE 6: **Reducing GHG pollution by using clean heat 2011 and 2031**



Source: Final VT GHG Inventory and Reference Case Projections 1990–2030




Choosing Action

VPIRG member Paul Limberty has reason to care about Vermont's changing environment. Paul runs Dragonfly Sugarworks in Huntington, Vermont. A farmer and master sugarmaker, Paul's livelihood depends on the weather. So does the future he will leave for his five-year-old son Theo, who began sugaring at the tender age of 11 days.

"As we acknowledge climate change as the most pressing issue of our time and feel the wild swings in weather patterns, one might wonder why we got into a business that relies on predictable seasonal cycles. To us, committing to a form of small-scale agriculture that keeps the trees standing makes sense. Some estimates project that Vermont's sugar maples will have largely moved north by 2050. But we choose hope and action. For us, making sustainable choices means generating much of our electricity from the sun, heating our home with wood, having large gardens, and volunteering locally."

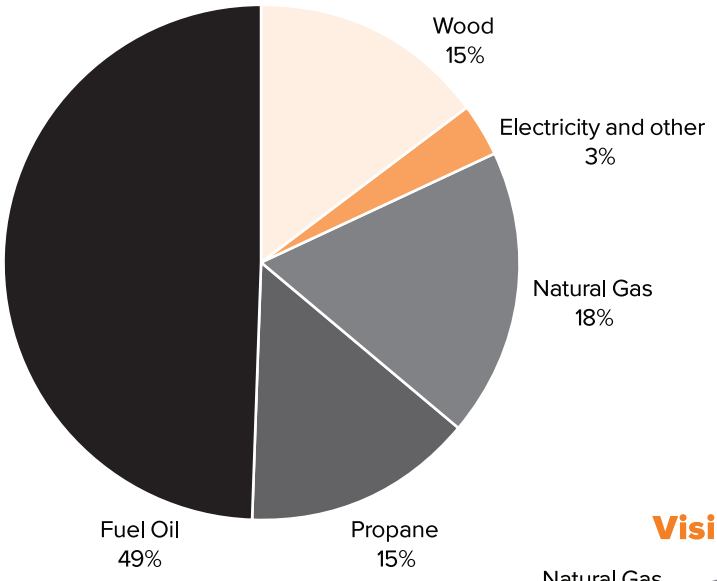
Paul's latest project: building a carbon negative greenhouse that will use the waste steam from his sugaring operation to heat the greenhouse for his farm's spring seedlings.

A Vision for the Future: Fuel Oil Free by 2031

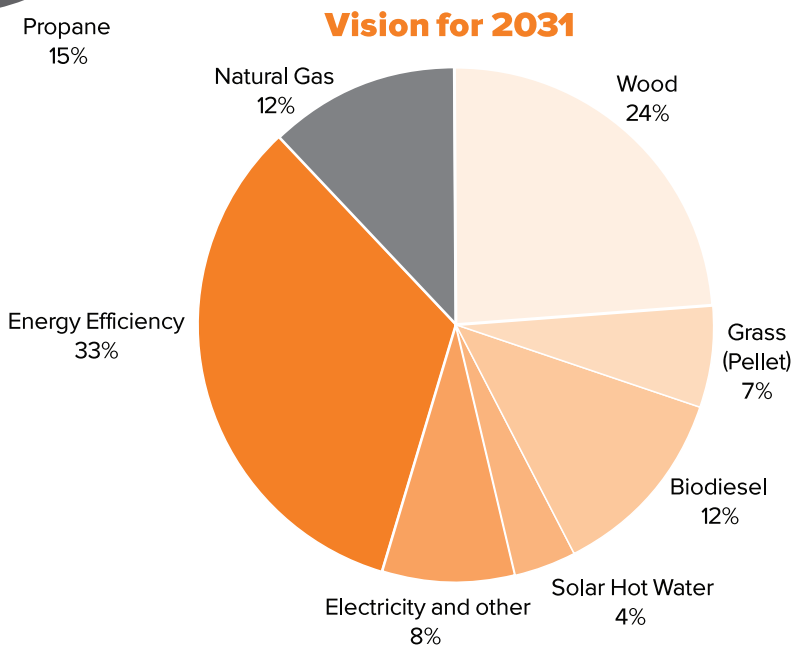
Vermont has the basic elements of a cleaner, more affordable heating future. Combining our world-renowned expertise in energy efficiency with cutting edge heating technology will enable Vermont to tackle this challenge. The path to a more sustainable future will not be easy, but Vermonters have shown over the years that their ingenuity and resilience can achieve extraordinary results.

VPIREF envisions a heating future for Vermont where efficiency and clean, local fuels satisfy our heating energy needs. We have analyzed the current availability of each fuel and the technology and equipment that will be needed to use those fuels moving forward. We have done so while also examining the job growth and the positive effect locally sourced heating fuels will have on Vermont's economy. Weather patterns and personal habits will also influence the amount of fuel that Vermonters use each year. The analysis that follows starts with Vermont's current building stock and assumes that our heating and other fuel needs in 2031 will be comparable to today.

Heating fuel mix today



Vision for 2031



Energy Efficiency and Conservation

Contributed savings by 2031:
16.4 trillion BTUs

Target percent of total fuel mix:
33 percent

Efficiency is the smartest investment Vermont can make for its clean and affordable heating future. Investing in efficiency is the least expensive and cleanest way to reduce our heating bills. We will need to invest $3.2 billion to reduce our fuel needs by one-third.[13] This investment will put Vermonters to work in tough economic times — 80 cents of every dollar we spend on efficiency stays in Vermont. We can build a better Vermont where families can afford to be comfortable in their homes, but we have to start with efficiency and we have to start now.

"Making our buildings more energy efficient is one of the fastest, easiest and cheapest ways to save money, combat pollution and create jobs right here in the United States of America. And that's what we're going to do."

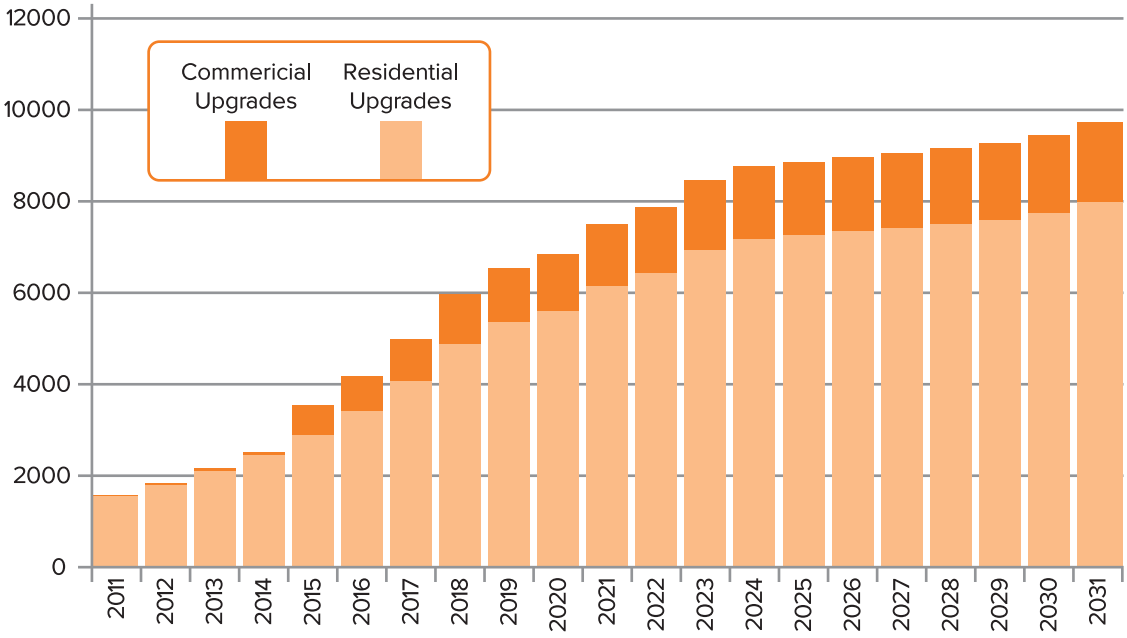
— President Obama, Feb. 2011

Vermont has a number of local renewable fuel sources that can provide affordable heat for our homes and offices. However, these resources are not without limit. We simply cannot harvest every tree or plow every field in the state for the sake of energy resources. Therefore, we must use efficiency to reduce the amount of energy we need for heating by one-third to ensure that Vermont's local resources can sustainably keep us warm.

To reach our clean heat potential and secure a more affordable energy future, we will have to perform energy upgrades to just over 45 percent of Vermont homes and buildings (see Fig. 7). We assume that initial upgrades will average 25 percent savings on energy use. As fuel costs rise, the average upgrade will generate 40 percent savings and eventually ramp up to 60 percent savings (see Fig. 8). Many homes that experience 25 percent savings in the next five to ten years will need additional upgrades over the twenty year timeline. This expensive step could be avoided by starting with more comprehensive upgrades today.[14]

Realizing a one-third reduction will allow us to be smart about the energy we do use and ensure that old buildings

FIGURE 7: **Number of energy upgrades recommended for each year**



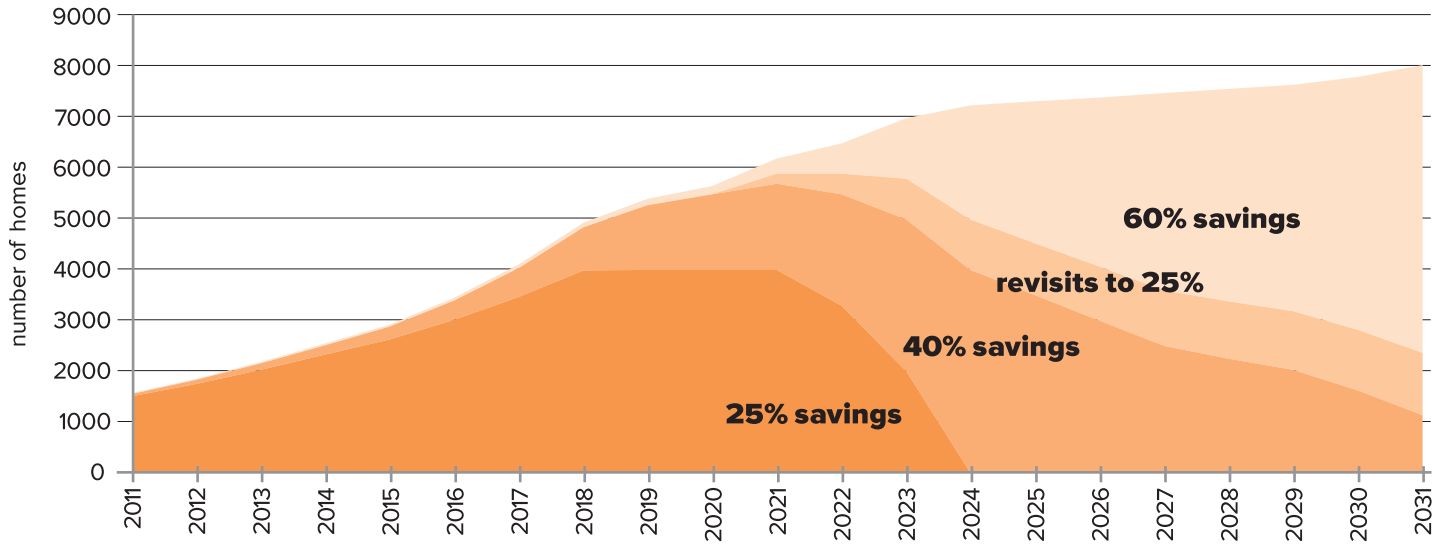
Source: Regulatory Assistance Project. *A Vermont Case Study and Roadmap to 2050.*

and heating equipment are not a drain on our economy. For example, the average fossil fuel furnace or boiler in basements across Vermont is about thirteen years old.[15] These systems were not intended to operate for more than twenty years. The need to replace old and inefficient heating equipment in the next decade presents Vermont with a window of opportunity to install more efficient ones without placing undue economic hardship on those that can least afford it.

Vermont is recognized across the nation as one of the most energy efficient states. Efficiency Vermont has led the way for electric efficiency and has saved Vermonters $643 million in electricity costs over the past ten years.[16] Their world-renowned expertise in electric efficiency can easily be translated to better buildings and reduced heating bills. Dozens of Vermont contractors and construction companies are already collaborating with Efficiency Vermont to help customers invest in energy upgrades that improve insulation, replace old heating equipment and ensure that our homes don't lose heat through leaky windows or doors. Upgrading 45 percent of our building stock will be a huge boon to these hard working Vermonters, providing an estimated 3,600 full-time jobs over the next twenty years.[17]

While icicles are an image of Vermont winters, they are also a sign of where inefficient homes are losing heat. Energy upgrades can help reduce that heat loss and energy waste.

FIGURE 8: **Annual number of home retrofits achieving a certain percentage of savings, 2010–2031**



Source: Regulatory Assistance Project. *A Vermont Case Study and Roadmap to 2050.*

Wood: Pellet, Chip and Cord

Resource contribution by 2031:
11.87 trillion BTUs

Target percent of total fuel mix:
24 percent

Vermont's forests represent one of the principal foundations of the state's economy. Our forests employ over 6,300 foresters, loggers and small business owners and provide an affordable source of heat for at least one-fifth of Vermont homes.[18] With forests covering 78 percent of Vermont's land area, the state is ideally positioned to make forest biomass an even larger part of its heating future.[19] Of course, while Vermont forests currently experience net growth every year, they are precious and not inexhaustible. We must balance the use of our wood resources with sustainable stewardship of our environment. Requiring foresters and loggers to employ sustainable harvesting techniques will ensure that our forests can continue to provide crucial habitat for wildlife, sequester carbon dioxide, and draw tourists to the state for years to come.

Each year, Vermont's forests add 10 million tons of new growth.[20] The good news is that right now, Vermont's forest growth-to-removal yield is 1.43 to 1, meaning that the forest adds about 43 percent more material than we are currently taking out each year.[21] This new biomass growth presents a tremendous source of local, renewable energy that can be used and harvested on a sustainable basis. Estimates from the Biomass Energy Resource Center state that Vermont can sustainably increase its harvest by 895,000 green tons of low-grade wood each year.[22] Combining only sixty percent of this new annual harvest with Vermont's current yield of about one million green tons for thermal uses could provide enough wood, wood pellets and wood chips to meet one-quarter of Vermont's heating needs and 38% of our needs after accounting for energy efficiency savings.[23]

The fuel coming from our forests and the technology that burns it is nothing like the old and dirty wood boiler from decades past. Modern processing techniques reuse by-products from the wood harvest like sawdust and wood chips by compressing them into wood pellets about an inch long and a quarter inch wide. A hopper located at your home can store enough pellets to last a month or more. A completely automated augur system loads the pellets into a

David Frank, owner of Sunwood Systems located in Waitsfield, with a clean burning, European wood pellet system at the East Montpelier Firehouse. Sunwood focuses on developing renewable heating systems that use energy from the sun and Vermont's forests.

furnace or boiler that is tied to your thermostat, just like an oil furnace or boiler would be. Sawmills also produce wood chips that are the trusted source of heat for 44 Vermont schools, numerous state buildings, three Vermont colleges and many industrial facilities. These schools and businesses use large boilers to burn the wood chips cleanly and efficiently and some have combined heat and power systems that provide both heat and electricity.

Vermont is making progress to lead the Northeast in the production and use of wood for fuel. For example, to ensure that Vermonters have access to the most efficient equipment, the Vermont Legislature passed a waiver in 2009 allowing the sale of European wood pellet heating systems, the most advanced in the market. Since these heating systems are not currently manufactured in the United States, Vermont has an opportunity to develop an industry that benefits the state's most rural areas. Besides creating a new wave of manufacturing jobs, responsibly increasing our biomass harvest for renewable energy would create more forestry jobs, support the forest products industry, and create a market for forest wood residues — a necessary component of sustainable forestry.[24]

Moving forward with a sustainable wood-for-fuel plan requires us to consider how Vermont can best use our renewable yet limited forest resource. Traditional wood-fueled electricity generation only uses about 25 percent of the energy embodied in the wood — the rest escapes as heat. On the other hand, combined heat and power projects can generate electricity and use the excess heat for industrial processes. These systems are 60 to 70 percent efficient. Burning wood strictly for heat is the most efficient application, using 70 to 80 percent of the energy embodied in the wood.[25] Vermonters have heated their homes in this way for many years, and continuing to use wood for heat is the most responsible way to use our forests.

Pellergy: Changing the way Vermont heats

Founded in 2006 and based in Barre, Vermont, Pellergy is the only company in the nation to manufacture and install a European-style pellet burner retrofit that can heat an entire home with a completely automated system. Pellergy can exchange an old oil burner with a new wood pellet burner without replacing the entire heating unit, so their installations are more affordable than a new system. They also specialize in bulk storage units so you don't have to haul bags of pellets. A local delivery company comes on a regular schedule and blows the wood pellets into your hopper or storage bin, similar to how fuel oil trucks refuel tanks now. The monthly savings on the typical heating bill can pay for this system in five to seven years.

PELLERGY

Sustainable Forestry

Managing our forests responsibly involves balancing the forest's overall health with our need to harvest the wood and wood products that fuel Vermont's economy. Sustainable forestry techniques that are ecologically, economically and socially responsible ensure that we don't sacrifice one of these needs to achieve the other. Sound forestry and logging techniques can even improve the health of our forests. Vermont's forests contain a diverse number and type of trees and habitats, so there is no one set of specific guidelines to manage every acre. However, there are several broad principles for forest health that foresters and loggers can apply to any land plot with woody biomass harvests.

Soil Productivity

Healthy soil with the right mix of nutrients produces healthy trees and forests. Increasing woody biomass harvests can strip nutrients out of the soil and prevent future generations of trees from regrowing. Whenever possible, foresters should leave the stumps and roots as intact as possible to minimize disturbance to the soil. Leaving other organic material such as tree tops and limbs to decay naturally also adds to the soil's productivity.[26]

Water Quality

The state's acceptable management practices for water quality should be the foundation for a forester's plan to maintain and improve water quality. Harvesting sites should include a buffer zone for nearby bodies of water to reduce erosion and water degradation. These sites should also minimize the landing size of the operation to the greatest extent possible.

Forest Biodiversity

A large component of forest health includes protecting the habitat for trees and other organisms that live in our forests. Harvesters should leave intact the forest floor, roots and stumps that are home to many animals. Additionally, leaving some live wildlife trees improves the chances that forest habitat will not be completely removed. Above all, loggers should involve a professional forester to devise a long-term plan for maintaining and improving forest biodiversity.[27]

Forest Guild Guidelines

The Forest Guild guidelines are widely recognized as the best in the world. Red Start Forestry, a Vermont forester, already implements these guidelines on the ground. Encouraging other Vermont foresters do the same should be a top priority to maintain our forest's health. The Biomass Energy Development Working Group, a committee established by the Vermont Legislature, has the opportunity to help make Vermont an exemplar of sustainable forestry by setting the state's harvesting guidelines. By adopting the Forest Guild's guidelines, the Working Group would ensure Vermont's forests are harvested with a focus on the long-term health of our environment. The Guild's basic guidelines for sustainable forestry and the complete list of recommendations can be found on their website www.forestguild.org.

Grass

Resource contribution by 2031:
3.24 trillion BTUs

Target percent of total fuel mix:
7 percent

Much like our abundant forests, farms will be an increasingly important piece of Vermont's energy future. As the number of working farms decreases across the state — Vermont has about 84,000 acres of idle cropland and a significant amount of marginal farmland not currently in production — farmers are looking for innovative ways to remain financially viable.[28] Dedicating underused crop and grasslands for energy crops is a great way to put farmers back to work and cultivate local, renewable energy sources. Farmers can even rely on the same growing techniques and harvesting equipment they already have. Grasses like switchgrass and reed canarygrass can be grown and harvested on these lands and later made into pellets to create a fuel source similar to wood pellets.

Dedicating underused crop and grasslands for energy crops is a great way to put farmers back to work and cultivate local, renewable energy sources.

Vermont farmers are ready to start growing grass for energy, but there are still some hurdles to overcome before grass pellets can be produced at a large scale for residential use. Grass pellets contain higher ash content than traditional wood pellets. This can cause residential stoves to clog and lose efficiency when burning grass instead of wood. On the other hand, industrial boilers and heating systems can be designed to overcome these challenges. Some larger boilers have adjustable pellet feed rates and emission control technology that allow for the use of pure grass pellets.[29]

The Vermont Grass Energy Partnership, a collaboration between the University of Vermont Extension, the Vermont Sustainable Jobs Fund and the Biomass Energy Resource Center, is working to build in-state capacity and a knowledge base at each step in the supply chain for converting grass to energy. Doing so will help to open new markets that will reduce the use of fuel oil for heating. The Partnership's work combined with farmers' ingenuity will help Vermont produce a local and affordable fuel that can heat our homes and businesses.

Since larger boilers are the most readily available technology for burning grass pellets, Vermont should look for grass energy to supply the commercial and industrial sectors first, while technological developments are made for smaller systems in the residential sector. Converting 15,000 acres of unused farmland to grass for energy crops over the next 10 to 12 years would produce enough fuel to meet about seven percent of Vermont's thermal needs, and ten percent of our needs after accounting for energy efficiency savings.[30]

Biodiesel

Resource contribution by 2031:
6.06 trillion BTUs

Target percent of total fuel mix:
12 percent

Vermont relies heavily on fuel oil to meet the majority of its thermal needs. Having a liquid fuel to meet that need would be helpful in the transition to cleaner heating fuels. Biodiesel, a fuel derived from animal fats or plant oils that can be made from crops grown in rotation with other small grains, is currently Vermont's best option for a locally-sourced, renewable liquid fuel. It can be used in almost all applications that require fuel oil and kerosene.

Canola, mustard, soybean and sunflower oils — all crops that can be grown in Vermont — are most commonly used to create biodiesel. Unlike corn-based ethanol, these oilseed crops do not compete with food crops and are easier to cultivate.

Like grass energy, biodiesel presents another opportunity for Vermont farmers to provide for Vermont's fuel needs. Most of the biodeisel produced from Vermont's oilseed crops will be used to power agricultural equipment. Farmers are already familiar with this fuel and have blended low concentrations of biodiesel with petrodiesel and fuel oil for many years without negatively affecting performance. Blends of 20 or 5 percent biodiesel — also known as B20 or B5 — contain 80 to 95 percent petrodiesel or heating oil and are the most common blends. These blends perform well for residential, commercial and industrial uses. Higher concentrations of biodiesel and even pure biodiesel, called B100, can also be used, though in some cases minor modifications to combustion systems are needed.

Oil from field crops can sustainably replace up to three percent of the state's distillate use and most of that amount will be absorbed by Vermont's agricultural sector.[31] However, new research into algae as a biodiesel feedstock indicates that microalgae grown in Vermont can produce significantly more gallons of oil per year than oilseed crops. Algae crops grown for this purpose — these are not the cyanobacteria harming Lake Champlain — are high in oil content and can produce the feedstock needed to create biodiesel. This technology is still in its beginning stages, but several Vermont companies and independent researchers at the University of Vermont are working to develop in-state capacity to grow the algae and produce fuel from its oil. The research and development taking place in Vermont and elsewhere around the world could bring algae-based biodiesel to commercial scale production in the next decade.

In the short-term, pure and higher concentrations of blended biodiesel are the best option for Vermont's agricultural sector and ski area equipment, construction and logging equipment, and other off-road industrial processes that require petroleum distillate fuels. As algae biodiesel becomes more readily available, homeowners and small business owners will be able to make the transition to biodiesel as well. About 40,000 acres, or three percent of Vermont's total farmland, would be needed to generate 3.2 million gallons of pure biodiesel. Algae harvested from 5,000 unit acres could provide over 42 million gallons of pure biodiesel per year. Combining these clean and local sources would meet just over 12 percent of Vermont's thermal energy needs and 18 percent after accounting for energy efficiency savings.

Solar Hot Water

Resource contribution by 2031:
1.85 trillion BTUs

Target percent of total fuel mix:
4 percent

Heating water is the second highest energy cost in most Vermont homes. About two-thirds of Vermont homes use fossil fuels to heat their hot water and the remainder use electricity. Using solar technology to heat water instead of these expensive fuels is a reliable and affordable alternative for all Vermonters. An average family of four using an electric hot water heater spends more than $600 each year for hot water. A solar hot water heater can eliminate 70 percent of that fuel bill.[32]

Solar hot water does not currently provide a sizable amount of Vermont's energy needs. However, due to its short payback time and proven reliability, this technology could easily generate four percent of our total heating needs, or six percent after accounting for efficiency savings. In 2010, there were about 30 new systems installed and another 84 in the installation process in homes, businesses, and schools across the state.

Sunward: Using the warmth of the sun

Vermont-based solar companies are leading the way for the solar hot water industry. For example, Sunward, located in Vergennes, Vermont, is a regional leader in solar hot water manufacturing and installation. The proven technology that fuels their systems has been around for 30 years. In a Sunward system, glass solar collectors placed on your roof gather heat from the sun's rays. The sun warms the non-toxic glycol inside tubes that are located in the collectors. The glycol then transfers the heat to a long string of copper pipes where water absorbs the heat. The hot water can be used immediately or stored in a storage tank similar in size to the electric or fuel water heater you already have. Sunward's systems also have a small built-in photovoltaic panel that provides the electricity for the system's only moving part: a pump that helps circulate the glycol.

SUNWARD™

Electricity and Ground Source Heat Pumps

Resource contribution by 2031:
4.2 trillion BTUs

Target percent of total fuel mix:
8 percent

Electricity is currently one of the most expensive ways Vermonters can heat their homes and businesses. Increasing the number of traditional electric space and water heaters should not be part of Vermont's transition to a more affordable heating future. However, emerging electric heating options hold the promise of more heat using less electricity. One option that can save money on annual heating bills is ground source heat pumps.

Ground source heat pumps are the most efficient electrically-powered heating systems because they rely on the earth's constant underground temperature to heat and cool. This system uses an electrically-driven pump to circulate water or an antifreeze solution through a network of underground pipes. In the winter, when the below-surface temperature is higher than outside temperatures, the water or antifreeze collects heat when passing through the buried pipes and carries that heat into the home. A heat exchanger concentrates the heat and then delivers the heat to the home. In the summer, the same fluid can work like an air conditioner by capturing the colder temperatures from below the surface. A ground source heat pump uses from one-half to two-thirds less energy than the traditional electric heater.

Even in Vermont's harsh winters, a ground source heat pump can meet all the hot water and space heating needs of a home or business at half the cost of an electric heater. At around $11,000 for installations in new construction, the initial investment for a ground source heat pump system is higher than a traditional electric heater. Nevertheless, annual savings on heating bills can pay for the system in as few as five to seven years. Ground source heat pumps are also guaranteed to last for 25 years for the indoor components and 50 years for the underground piping, so savings over the lifespan of the system can easily reach into the tens of thousands of dollars.

There are an estimated 200 ground source heat pumps installed in Vermont. There are 10 ground source heat pump installers in Vermont, so there is capacity to substantially increase the number of annual installations. New ground source heat pumps combined with current electric use for heating can meet eight percent of Vermont's future heating needs and 13 percent of our need after considering efficiency savings.

Natural Gas

Resource contribution by 2031:
5.97 trillion BTUs

Target percent of total fuel mix:
12 percent

Natural gas is not a renewable source of energy. Nor is it without its serious environmental drawbacks. One of the techniques that extracts natural gas, called hydraulic fracturing, pumps toxic chemicals underground that can contaminate our drinking water. Prices for natural gas are low today, but their rise is inevitable since reserves for all fossil fuels are limited. However, for now it is the least expensive and cleanest fossil fuel and as such, natural gas can serve as a bridge fuel to help to supply a portion of Vermont's energy over the next twenty years.

Natural gas use in Vermont is limited to Chittenden and Franklin counties, the only counties with access to the natural gas pipeline. About 40 percent of homes in Chittenden County and 20 percent in Franklin County — nearly 38,000 homes — rely on natural gas for heat. Natural gas is also an important process fuel for some industries located in these counties. To ensure that natural gas use does not increase, these homes will need to use efficiency to help reduce consumption by at least one-third. After this one-third reduction, natural gas could meet about 12 percent of Vermont's annual heating and thermal energy needs.

Vermont Gas Systems, the regulated utility that delivers natural gas in Vermont, has offered efficiency programs to both residential and commercial users since 1992. The gas utility's investments and collaboration with Efficiency Vermont have saved enough natural gas to serve almost all the company's residential customers for one year. Reducing the amount of natural gas we need will help create Vermont's cleaner and more affordable heating future. However, using only clean and local fuels for heat should be our long-term goal.

Policy Recommendations

Vermont has an incredible opportunity to invest locally and reduce fuel costs for homeowners, farmers and small businesses. A combination of increasing building efficiency and promoting local, renewable heating fuels will put Vermont on track to a cleaner, more affordable heating future. Making this transition will also create thousands of jobs for Vermonters. However, achieving this vision will not come easily.

Luckily, Vermont has a history of tackling tough challenges and developing solutions that protect our local economies and the health of our communities. Overcoming this particular challenge will require commitment and leadership from state officials and the willingness to adopt policies that will improve efficiency and support the use of cleaner, more affordable fuels. Vermont can and should continue to lead the nation as one of the most energy efficient states, and the following list of policies will be instrumental in making that a reality.

Financing Energy Efficiency and Renewable Heating

Financing for energy efficiency upgrades and renewable heating systems is an essential element of Vermont's efforts to move to a more sustainable heating future. Long-term financing can help homeowners and businesses pay for the cost of these improvements over time rather than all at once. Unfortunately, Vermont's current financing programs are often complicated and not always available to high-risk borrowers and rental property owners.

One innovate financing mechanism that could help Vermonters is called Property Assessed Clean Energy, or PACE. PACE helps Vermonters come up with the upfront money they need to make significant, money-saving energy renovations to their homes, businesses and farms. Property owners pay back the initial investment with their energy savings over time through a separate assessment on their property tax bill. Only the property owners who choose

to participate in the program will pay through a line item in their local tax bill. The PACE program also removes the uncertainty of recovering the cost of improvements if the property is sold. The financing, just like the energy savings, stays with the property and not with the person.

Forty communities have expressed an interest in PACE and are exploring the potential of implementing the program locally, but the current law prevents them from taking advantage of the program. Mortgage giants Fannie Mae and Freddie Mac have decided not to back PACE because the assessment takes senior status to home mortgages. Fixing this problem will allow Vermonters to invest in their homes, their local economies and our clean energy future.

Better Buildings

To improve the efficiency of new homes and buildings, Vermont should continue to adopt and upgrade the most stringent building codes. In 2009, Vermont pledged to adopt the residential standards outlined in the International Energy Conservation Code 2009 (IECC 2009) when it accepted funding from the American Reinvestment and Recovery Act (ARRA). The Department of Public Service must outline a plan for complete adoption and enforcement of these codes by September 2011. Enforcing these standards has created some difficulty for municipal and local governments, but meeting — and exceeding — the IECC 2009 standard is essential for Vermont's energy future.

While these standards are a good foundation, upgrading them on a regular basis is one of the least costly and most effective means of reducing high heating costs. Making new buildings as efficient as possible will reduce the need to retrofit them later at much greater cost. Vermont should aim to improve on the IECC 2009 standard by a minimum of 30 percent better than current practice in three years and 50 percent better in eight years.

Energy Disclosure Requirement

Annual fuel bills are an important consideration for Vermonters as they look to buy a home or rent an apartment. Everyone has a right to know how much and what kind of fuel a home uses before buying or renting. Time of sale energy disclosure requirements would require the homeowner to have an energy audit completed before selling. Buyers could then use that information to make smarter choices when making a final decision. Providing this information at the time of sale will also provide the buyer with the option of financing the cost of energy upgrades through the traditional home mortgage. The monthly savings from the upgrades will largely or entirely offset the incremental increase in the monthly mortgage payment.

Increase All Fuels Funding for Efficiency Vermont

As part of electric utility regulation, Vermont currently provides statewide energy efficiency services that are focused primarily on electricity. These services have provided significant levels of electric savings, but they do not do enough to reduce the amount of fuel that homes, businesses and farms use. Regulated utility efficiency programs, like those at Vermont Gas, can address fuel use for the small portion of homes and businesses that use natural gas. For the remaining majority, which uses non-regulated fuels like oil, propane and wood, current efficiency programs do not have enough funding to be helpful. Vermont's low-income Weatherization Assistance Program directly addresses efficiency for all fuel types, but only for a narrowly defined income-eligible population.

To help Vermonters address the problem of high fuel costs, Vermont should expand funding of efficiency programs to comprehensively address the opportunities to reduce fuel use in all homes and businesses, regardless of fuel type or homeowner income level. The energy efficiency utility, the state's five community-based, low-income weatherization providers and private sector energy and home performance contractors all have a role to play in this expansion. This collaboration will create green jobs and put many Vermonters to work.

Fuel Requirements

Vermont relies heavily on liquid fuels to meet the majority of its heating needs. Renewable liquid fuels made in Vermont can be substituted for many residential, commercial and industrial uses. According to the Vermont Agency of Natural Resources, blends up to 20 percent biodiesel (B20) are already safe and reliable for commercial and industrial boilers.[33] To encourage the adoption of Vermont-based biofuels in these sectors, Vermont should require that all heating oil sold in state contain a minimum of five percent biodiesel by 2013 and ramp up to a pure biodiesel requirement by 2031.

Renewable Heating Standard

To save money and help support the development of the renewable heating market, Vermont should require all new or renovated buildings to install renewable heating technology for space and water heating. The state should make an investment today in clean heating technology that will provide savings for many years to come. Additionally, a renewable heating standard for new construction would be a great foundation for an educational awareness campaign about the benefits of energy efficiency and renewable technologies.

Wood Pellet Fuel Standards

Ensuring that all wood pellets meet high quality standards is essential to their future success in Vermont's heating market. There is no quality standard for wood pellets made in Vermont — wood pellet providers are self-regulated — so homeowners and businesses have no guarantee that the pellets they buy will burn cleanly and efficiently. Austria was the first nation to adopt pellet standards and as a result of this standardization, the market for pellet fuels developed there at a booming rate. With pellet fuel standards in place, manufacturers can design better heating systems that are easy to use and require less maintenance. Vermont should adopt the equivalent of the European standard to support market development of the wood pellets and pellet heating systems.

Methodology

Our analysis focuses on Vermont's entire thermal fuel mix, including residential, commercial and industrial uses. Residential fuel use, which makes up the majority of the thermal mix, is almost entirely for space and water heating. More than one-third of commercial use is also for heating; however, a significant amount of fuel is used for non-heating and process applications. This analysis focuses on thermal fuel use but also addresses non-thermal applications in the commercial and industrial sectors.

We relied primarily on data and projections from the Vermont Department of Public Service (DPS) and the U.S. Energy Information Administration (EIA) to estimate past and present thermal fuel usage in Vermont. First, we converted total usage for each fuel type to British Thermal Units (Btus), the most useful common denominator for comparing fuels typically measured in different units. Commercial and industrial usage estimates are from the EIA, but residential usage data from EIA underestimates the amount of fuel Vermonters consumed. To calculate residential estimates, we used 2009 U.S. Census data to determine the number of homes that heat with a given fuel type. That number of homes was then multiplied by the average Btu usage per fuel consumed to determine annual estimates. Cost comparisons and efficiency factors for the different fuels come from Vermont Fuel Price Reports, published monthly by the DPS.

Future projections for efficiency savings were based on estimates from *A Vermont Case Study and Roadmap to 2050*. Our projection begins acquiring savings in 2011 and forecasts potential efficiency savings in the current building stock through 2031. Energy use in new buildings was not calculated in this analysis.

Potential capacity for grass, biodiesel, solar hot water and geothermal are based on a combination of information from renewable resource developers in Vermont and projections from the *Vermont 25 by '25 Initiative*. Biomass supply assumptions are based on the 2010 update of the Biomass Energy Resource Center's *Vermont Wood Fuel Supply Study. Biomass heating in Upper Austria: Green energy, green jobs*, a report from Upper Austria's energy agency, provided a foundation for the potential growth of the biomass heating market in Vermont.

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"Each of us has a part to play in a new future that will benefit all of us. As we recover from this recession, the transition to clean energy has the potential to grow our economy and create millions of jobs — but only if we accelerate that transition. Only if we seize the moment. And only if we rally together and act as one nation — workers and entrepreneurs, scientists and citizens, the public and private sectors."

— President Obama, June 2010

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