Repowering Vermont

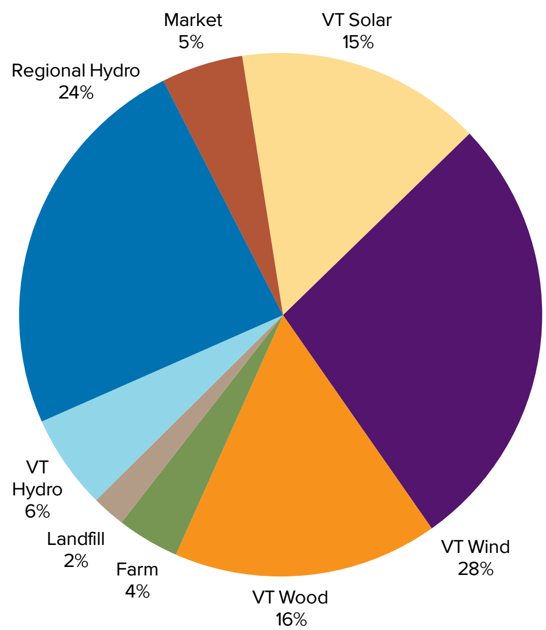
Replacing Vermont Yankee for a Clean Energy Future

Vermont Public Interest Research and Education Fund
Summer 2009

The choice to repower Vermont with local renewable energy resources or commit to an additional 20 years of Vermont Yankee will determine the legacy we leave future Vermonters. Local resources and the power Vermont purchases from regional hydroelectric facilities can meet all of our traditional electricity needs, power 100% of our transportation sector and still produce excess electricity. Vermont Yankee should be closed in 2012 and we should invest in an energy future that will protect our environment and promote a strong locally-based economy.

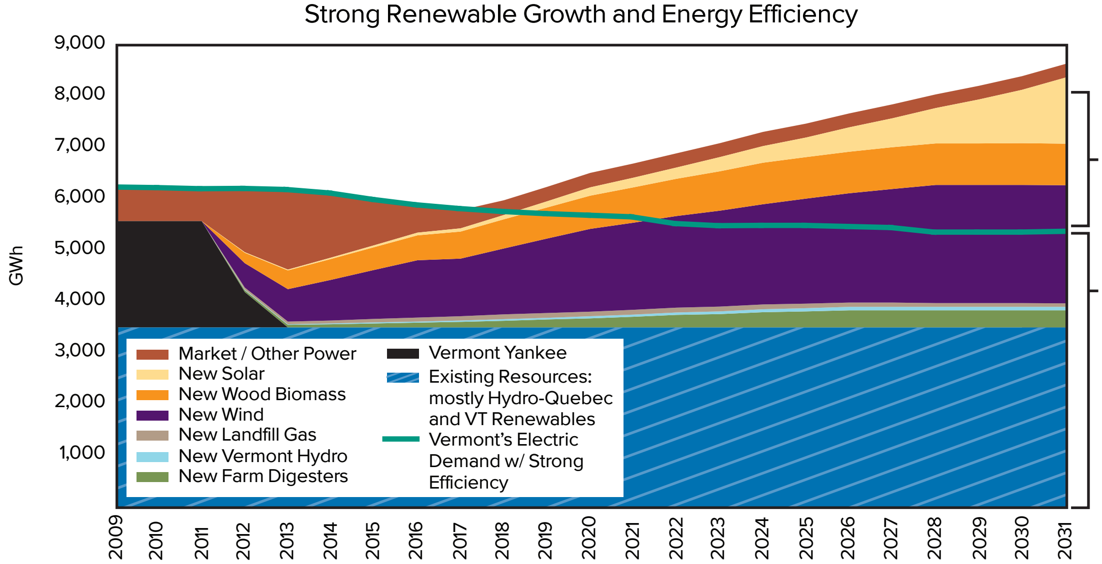
Repowering Vermont's Electricity and Transportation Sectors

2032 Electricity Supply: 8,400 GWh



Repowering Vermont without Vermont Yankee:

Strong Renewable Growth and Energy Efficiency



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VPIRG
VERMONT'S VOICE

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Written by James Moore

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The Vermont Public Interest Research and Education Fund (VPIREF) is Vermont's leading policy research and public education group. VPIREF's mission is to research and disseminate policy options, administrative strategies and business practices that promote and protect the health of Vermont's environment, people and locally-based economy. VPIREF was founded in 1975 as the research and educational outreach arm of the Vermont Public Interest Research Group (VPIRG). With cutting edge research and broad public education, VPIREF brings real solutions to Vermont's problems to the public, and teaches citizens to find their voice in public policy debates that shape the future of the green mountain state.

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Executive Summary

We are on the edge of making the biggest decision about Vermont's energy future in the past 40 years. The choice to repower Vermont with renewable energy resources or commit to an additional 20 years of Vermont Yankee will determine the legacy we leave future Vermonters.

Closing Vermont Yankee and moving forward with energy efficiency and local renewable energy would cost Vermonters 47–50% less, between 2012 and 2032, than relying on Vermont Yankee at predicted market prices. Replacing Vermont Yankee with local renewable energy resources would also add tens of millions of dollars to our state tax base and support the creation of hundreds if not thousands of new jobs.

The way that electricity is being produced, distributed and even used is undergoing monumental change. Wind power and solar power, which were once fringe energy sources, are now being talked about as mainstays of our energy future. Massive coal and nuclear plants are increasingly seen as symbols of the past and not compatible with a smart energy grid. Clean technology is moving fast to develop large scale energy storage and advanced batteries for plug-in hybrid and electric vehicles, and our traditionally slow-to-change utility industry is running to keep pace.

The old ways of generating electricity — oil, coal, and nuclear — have created unsustainable environmental and economic costs. Continued reliance on these old technologies will only worsen the situation we face in years to come and we cannot simply pass these costs on to the next generation.

Globally, our climate is in jeopardy from increased greenhouse gas pollution and collectively, Vermonters emit approximately 8,000,000 metric tons of global warming pollution every year.[1]

The Vermont Yankee nuclear reactor has generated more than 1 million pounds of radioactive waste which is stored on the banks of the Connecticut River and will remain radioactive for more than 100,000 years. It is estimated to cost millions of dollars every year to protect the waste[2] and it will cost an estimated $1 billion dollars to decontaminate and decommission the reactor site.[3]

All of the nuclear and fossil fuels used in Vermont are imported to the state. In an age of increasing supply constraints and market volatility, this is an untenable economic, political and social situation.

Repowering Vermont lays out two clear and achievable visions for replacing Vermont Yankee with local renewable resources. The first, moderate, scenario was designed to meet our traditional electricity demand and anticipates a slow transition to more electricity being used in our transportation sector. The second, strong renewable energy growth, scenario sought to identify how much renewable energy could be built in Vermont over the next two decades. The results exceeded all of our expectations. Vermont could meet well over 100% of its future electricity demand, including complete electrification of our transportation sector, with in-state generation and existing levels of regional hydroelectric power.

The resources outlined below would meet all of Vermont's traditional electricity needs, power 100% of our transportation sector, and produce some excess electricity:

- Continued investment in energy efficiency will allow our economy to grow while keeping our electricity demand from increasing. In 2008, Efficiency Vermont programs reduced our state demand for electricity by 2.5%. Over 150,000 megawatt hours were saved, reducing associated carbon dioxide emissions by 920,000 tons.
- Vermont wind farms can provide 28% of our state's electricity. Vermont has a

tremendous wind resource. Capturing only a fraction of that resource will provide a significant amount of affordable power to our utilities.

- Vermont biomass or wood-fired generation can provide 16 % of our state's electricity needs. Forests cover 80% of Vermont's land. Sustainably harvested biomass generation will support local forest-based economies while generating renewable electricity and heat.
- Vermont solar power can meet 15% of our state's electricity needs. Installing solar on just one in five homes over the next two decades will produce significant power when we need it the most — hot, sunny summer days. This will increase the reliability of our electric grid and decrease the need for additional transmission projects by using our existing distribution system more effectively.
- Vermont hydroelectric facilities can provide 6% of our state's electricity needs. Vermont utilities and independent dam owners can make moderate improvements to the existing dams in Vermont to make them run more efficiently, slightly increasing the total output from the dams.
- Vermont farm and landfill methane projects can provide 6% of Vermont's electricity needs. Converting farm waste into methane and non-polluting by-products will help reduce air and water pollution.

The type of future we create for ourselves and the next generation of Vermonters depends on the choices we make today. VPIRG is committed to making sure our future is based on a clean energy economy. Over the past few years we have witnessed an ever-increasing rate of renewable energy development in Vermont. Committing to 20 more years of Vermont Yankee could halt the progress we've made and will leave an even greater unsustainable legacy for the next generation.

Photo simulation of the Sheffield wind farm from Route 5 southbound in Barton, VT

Introduction

Health risks, a warming climate, degraded air quality, water pollution, radioactive waste, and an unstable economic future are but a few of the consequences our current reliance on nuclear power and fossil fuels has created. This reliance has forced Vermonters to export approximately $1.5 billion dollars from our local economy every year to purchase fossil fuels and nuclear power.[5] In contrast, relying on local renewable energy sources will protect our health and environment while bolstering the local economy.

Vermont's energy use can be divided into three main sectors: electricity, transportation, and heating. Our electricity usage accounts for 39% of our energy consumption; transportation accounts for 31%; and heating our homes and businesses accounts for the majority of the remaining 30%.[6]

Vermont Yankee, Entergy Corporation's nuclear power plant located in Vernon, Vermont, accounts for one third of the electricity portion of Vermont's energy usage, or just 13% of the state's total energy usage. However, the reactor is a high-profile and controversial part of our energy mix.

The reactor was designed to run until 2012 when its 40-year license to operate will expire. But despite the facts that there is no solution to the radioactive waste that has been generated and that the reactor experienced serious mechanical problems due to its age, its owners would like to run it until 2032, an additional 20 years.

Vermont legislators have the authority to require the plant to close as planned in 2012 and they may make that decision early in 2010. To prepare for this possibility Vermont's electric utilities have already lined up alternatives to replace any power they might currently be buying from Vermont Yankee.

If we are going to create an energy future for the next generation of Vermonters that does not worsen global warming or burden them with nuclear waste and the risk of a serious nuclear accident, we must take action today to repower Vermont.

Fortunately, Vermont is well-positioned to create an electricity portfolio that will be the envy of the nation and an example for other states to follow. Vermont has a wealth of clean energy resources that have yet to be utilized.

Energy goals committed to by the legislature and Governor Douglas have echoed those of President Obama — including the need to bring our electricity system into the 21st Century, create local green jobs, and push towards energy independence. The legislature and Governor also have committed Vermont to reducing Vermont's global warming pollution to 25% below 1990 emissions by 2012 and to 75% below 1990 by 2050.

These aggressive goals will require Vermont to build the local renewable generators capable of meeting our future energy needs and successfully integrate those resources through a smart electricity grid. It is this work that, over the next two decades, will be the foundation for a thriving clean energy economy in Vermont.

March 22, 2012, the Day After Vermont Yankee Closes

When Vermont Yankee ceases to operate on March 21st, 2012 your lights will not flicker and your next electric bill is not likely to be any different. Though Vermont Yankee sells power to Vermont's two largest utilities, Green Mountain Power (GMP) and Central Vermont Public Service (CVPS), most of Vermont's utilities do not currently buy any power from Vermont Yankee and will not be affected when it closes.

Over the past few years Vermont Yankee has shut down on a regular (and not so regular) basis for refueling, planned maintenance and unplanned maintenance due to accidents at the reactor.

In 2006, Vermont's electric distribution company, VELCO completed a thorough analysis of Vermont's transmission network. The report specifically addressed the possibility that Vermont Yankee does not receive a license renewal past 2012. The report found that:

> *Removing Vermont Yankee from service poses no significant reliability or distribution problems to Vermont's transmission network. While there are some minor negative consequences, all of these are addressed by upgrades and maintenance already under consideration by VELCO even if Vermont Yankee remains in service.*[7]

A report commissioned by the Vermont Department of Public Service found that Vermont's electricity grid would not be adversely affected by closing Vermont Yankee. The report stated:

> *The current transmission grid could effectively accommodate the import of replacement power into Vermont through the existing network to replace Vermont Yankee's generation. There are many potential partners who could contract with Vermont utilities for power, including renewable energy developers. Terms contained in contracts with power marketers or merchant plant developers, including renewable developers, would be based on prevailing market prices.*[8]

The price that Vermont Yankee is currently charging Vermont utilities is above the price Vermont utilities would have to pay if they were to just go to the New England electricity market. In fact, the average market price in each of the five months preceding the publication of this report was below the rate Vermont Yankee is charging.[9]

Replacement options:

The two Vermont Yankee replacement scenarios analyzed in this report demonstrate that all of Vermont Yankee's power could be replaced by local renewable energy sources by 2016. However, the four years from 2012–2016 remain in question. Below are three different ways to fill the short-term gap. All of the options will protect Vermonters from the economic and environmental risks associated with continued reliance on Vermont Yankee.

1. MIXED PORTFOLIO

The mixed portfolio option assumes that in 2012 the Vermont utilities that need additional power, will purchase from a mix of local renewable energy and other market generators to meet their short-term needs. The mixed portfolio option is the most likely short-term replacement option for Vermont Yankee. In fact, GMP, CVPS, and the Vermont Electric Cooperative have already issued a contingent request for proposal, planning for the closure of Vermont Yankee in 2012. It appears that at least Vermont's largest utility, CVPS, has already selected a replacement mix that includes wind power and other market purchases.

2. REGIONAL RENEWABLE ENERGY

New renewable energy providers are coming online across New England and New York. These power plants include everything from small scale farm methane systems to large scale wind farms and biomass facilities. The thousands of megawatts (MW) in the pipeline would easily replace the 200 MW that Vermont Yankee would likely supply to Vermont utilities in the future.

3. CANADIAN HYDRO AND WIND

In addition to renewable energy that is under development in the northeastern part of the US, our Canadian neighbors are developing wind and hydro power. They have expressed interest in selling to Vermont utilities and our utilities have expressed interest in buying additional power from them.

Vermont's Smart Grid: Moving Beyond Baseload

Our electricity grid has become stuck in the 1950's design and philosophy of energy generation and supply. In an age when the Internet, your office and your entire music collection fit in your pocket, it is amazing that so little has been done to bring the way we produce and distribute our electricity in to the 21st century. All indications are that this is about to change dramatically.

In 2008 the Vermont legislature took what will likely be a very important step forward towards making Vermont's local electricity grid compatible with a 100% renewable energy future. Enter the "smart grid". The Vermont legislature required that all Vermont electric utilities examine "smart metering" technology and the legislature also instructed the Public Service Board to require Vermont utilities to begin implementation of smart meters. In part because our utilities were already examining upgrading our electrical grid, we are now well-positioned to be one of a handful of states to receive potentially more than $100 million dollars in federal economic recovery monies to make Vermont a demonstration of how smart a smart grid can be.

There are many benefits to moving towards a smarter electricity grid including reduced utility costs, the ability to influence consumption through market price signals and increased reliability. However, the greatest benefit of a smart grid is that it will allow Vermont and the rest of the country to move away from reliance on large polluting "baseload" power plants and create a new clean energy future, based on local clean power producers.

Recently, the Chairman of the Federal Energy Regulatory Commission (FERC), Jon Wellinghoff, put out a vision of a renewable energy future. He stated, "I think baseload capacity is going to become an anachronism," noting that renewables like wind, solar and biomass will provide enough energy to meet baseload capacity and future energy demand. Mr. Wellinghoff further commented, "Baseload capacity really used to only mean in an economic dispatch, which you dispatch first, what would be the cheapest thing to do. Well, ultimately wind's going to be the cheapest thing to do, so you'll dispatch that first."[10]

The key to achieving a smart grid isn't just the type of meters that are installed in our homes and businesses or how well those meters communicate with our utility operators. It is how flexible our supply and demand can be. To ensure a reliable electricity grid our supply needs to always match our demand. The easier it is to adjust or shape our supply and demand to bring them into sync, the smarter our grid will be. Many small generators with smart energy storage technology spread over the entire region make for a more flexible, stronger and easier to shape grid than our traditional old power plants.

FERC Chairman Wellinghoff's comments suggest that continued reliance on facilities like Vermont Yankee will act as an impediment to a renewable energy future for Vermont:

> *So if you can shape your renewables, you don't need fossil fuel or nuclear plants to run all the time. And, in fact, most plants running all the time in your system are an impediment because they're very inflexible. You can't ramp up and ramp down a nuclear plant. And if you have instead the ability to ramp up and ramp down loads in ways that can shape the entire system, then the old concept of baseload becomes an anachronism.*[11]

It is time we move beyond the old concept of "baseload" power and move to a smarter grid that will help Vermont realize our clean energy future.

What is a Smart Grid?

Ask "what exactly is a smart grid?" and you will hear a variety of answers because there are different levels of just how smart our grid could be. On the really smart end of the spectrum, utilities will be able to ensure we always have enough electricity, delivered from thousands of small distributed renewable energy generators, by allowing them to adjust and balance supply and demand across the entire system. To adjust demand, a signal might be sent out to customers, who had agreed to participate, telling their air conditioners to cycle off for 20 minutes. To adjust supply, a signal might be sent telling the cow power farm that had been storing some of their biogas to burn a little more to generate electricity.

This type of smart grid will also enable an entire new generation of technologies that help Vermont homes and businesses better understand their use of electricity and how to reduce it. Home Area Network (HAN) and in-home display technologies will provide access to real-time and historic energy use data, enable customers to make choices about energy use based on dynamic price information and allow for control of "smart appliances" that can respond in a variety of ways to price signals.

In a more rudimentary form, a smart grid will simply consist of electricity meters that can automatically tell the utility how much power a customer has used via a digital signal sent over a phone or other communication line. This would allow the utilities to streamline billing processes and eliminate meter readers. The next step up is the installation of meters that allow customers to respond to hourly price fluctuations in the electricity market, presumably using less when each kilowatt hour of electricity is more expensive.

Electrifying Transportation in Vermont

The automotive industry has been reliant on the gasoline-powered internal combustion engine since the Model T revolutionized transportation in 1908. Today we understand that not only has this reliance prompted global warming, but it has also contributed to worldwide military turmoil and has huge economic consequences. Something has to change.

VPIRG's research found that local renewable energy resources have the potential to meet our current electricity needs and power every mile that is driven in Vermont on an annual basis.

According to the Vermont Agency of Transportation over 7,500 million vehicle miles are traveled in Vermont every year.[12] The associated emissions account for almost half of Vermont's global warming pollution.[13]

Our dependence on gasoline is also draining our bank accounts and hurting our local economy. In 2006 Vermonters spent $1.77 billion dollars on petroleum products, most of which was used to run our cars and trucks. The next highest usage was in heating our buildings. Collectively our spending on fossil fuels is more than $3,000 for every man, woman, and child in the state, every year and most of that money is flowing straight out of our local economy.[14]

Vermont's approach to addressing our transportation challenges should fundamentally be no different than our current approach to our electricity use. We should use as little as is needed, use cleaner fuels, and create a smart system that facilitates using less and cleaner fuels. When it comes to transportation there are multiple ways to use less. Options include not only technology-based solutions such as more efficient cars and trucks, but also carpooling, walking or biking. Less polluting fuels range from cleaner diesel to bio-fuels to electricity (depending on what fuel was used to generate the electricity).

On the national and international stage electricity is emerging as a fuel of choice to power our cars and trucks. In part this is because electric motors are approximately three times as efficient as gasoline-powered engines — 92% efficient compared to 30%.[15] Toyota, Ford, Dodge, Chevy, Nissan, Mitsubishi, Mini and Tesla are just some of the auto manufacturing names moving forward with plug-in hybrid electrics or straight electric vehicles. The models range from the sexy sports roadster to the light commercial truck and include sedans and SUV's in the middle.

A study done by the University of Vermont Transportation Center found that the current electric grid in Vermont could handle 200,000 vehicles plugged into the grid without affecting peak load under an optimal charging pattern.[16] When combined with driving habits that reduce the number of miles we travel, a smart grid and local renewable resources present a clean energy future that will keep billions of dollars each year in our local economy while reducing our environmental impact dramatically.

What Will it Take to Electrify our Transportation Future?

It will not happen overnight but the move to plug-in hybrid electric vehicles run by renewable energy is starting to take place. We are seeing more and more renewable energy projects come online in New England, creating a clean electricity supply for the hybrid electric vehicles that are starting to hit showrooms in 2010. Over the next 20 years Vermont will likely transition to rely on a combination of hybrid electric and electric vehicles. The strong

Benefits of an Electric Transportation Future

GLOBAL WARMING POLLUTION

Converting to electricity produced by local renewable resources would effectively cut Vermont's production of global warming pollution in half.

OUR LOCAL ECONOMY

Rather than export more than a $1.5 billion dollars every year from the Vermont economy to purchase fossil fuels, we could be producing our own energy from clean resources here in Vermont. This would put more Vermonters to work, support our local tax base and keep our dollars circulating locally.

SMART GRID STABILITY

With a smart grid, electric vehicles could be a tremendous asset. If our cars are plugged into the electricity grid (when we are not driving them) they can act as a battery back up for the grid. If electricity demand exceeds supply, then our cars could put a little electricity back into the grid and if electricity supply exceeds demand, then our cars could adsorb excess electricity. A clean energy future with lots of small renewable generators as a major contributor to the total supply mix works even better with electric vehicles integrated into the system.

LOCAL BIO-FUELS

Use of plug-in electric vehicles will reduce liquid fuel (gasoline and diesel) consumption dramatically. It then becomes possible that sustainable production of bio-fuels may be able to meet our reduced liquid fuel needs. This would allow Vermonters to take trips longer than 300 miles without using petroleum-based fuels or running into battery charge challenges.

The Tesla Model S

Most of the current electric vehicles are hybrids, which rely on gasoline to extend their range and ensure greater fuel availability. Many of these models are ready to go. Tesla is one of the numerous companies advancing “pure” electric vehicle technology, perhaps the next evolutionary step for automobiles. Their Model S sedan runs on a 100% electric motor. It gets up to 300 miles per charge and isn’t lacking in power.[18] It goes from zero to 60 in 5.6 seconds. Additionally, it takes around five minutes to install a new battery, about what it takes to fill up your car, hinting at the possibility that future filling stations will provide charged batteries rather petroleum. Over time we can expect the range and performance of electric vehicles to improve while the cost comes down.

renewable energy scenario analyzed in this report indicates that increased local renewable energy production can meet any anticipated increase in electricity demand due to electrification of our cars and trucks.

The math:

- Currently, pure electric and plug-in hybrids get approximately 3.5 miles / kWh charge[17]
- We collectively drive just over 7,500 million miles a year
- 7,500 million miles / 3.5 miles per kWh = 2,100 million kWh or 2,100 GWh to power all vehicle miles traveled in Vermont.

Vermont’s electricity demand (without transportation included) is projected to be between 5,300 GWh and 6,000 GWh/yr in 2032, depending on what level of energy efficiency is achieved. If Vermont builds local renewable energy we could meet all of our traditional electricity demand and anywhere from 17–147% of our transportation needs over the next two decades.

VPIRG’S Renewable Energy Scenarios	GWh Available for Transportation (after all other electricity needs are met)	% of Transportation Needs Met with Electricity
Strong Renewables / Strong Efficiency	3089	147%
Strong Renewables / Moderate Efficiency	2471	118%
Moderate Renewables / Strong Efficiency	975	46%
Moderate Renewables / Moderate Efficiency	357	17%

Vermont Yankee, an Unsustainable Legacy

The current economic turmoil in our country is the result of excessive risk taking and borrowing against our future — putting off until next month, next year or next decade, what should be paid for today. We are being asked by the corporate owners of Vermont Yankee to embrace an excessive risk, trust them, and pass on costs to future generations so that they can reap excessive profits today.

When will we learn from our past mistakes?

Continued reliance on Vermont Yankee past 2012 would mean counting on one of the oldest nuclear reactors in the nation to continue operating despite signs that it is falling apart. A serious accident at the reactor would render Vermont uninhabitable and even a minor accident at the reactor could ruin our economy.

Continued reliance on Vermont Yankee would mean asking the next generation to deal with and pay for 20 more years (~750,000 lbs) of high-level radioactive waste and countless tons of low-level radioactive waste. Continued reliance on Vermont Yankee would pass on to our children a reactor site that is even more intensely contaminated than it is today.

Vermont Yankee Reliability and Safety Problems

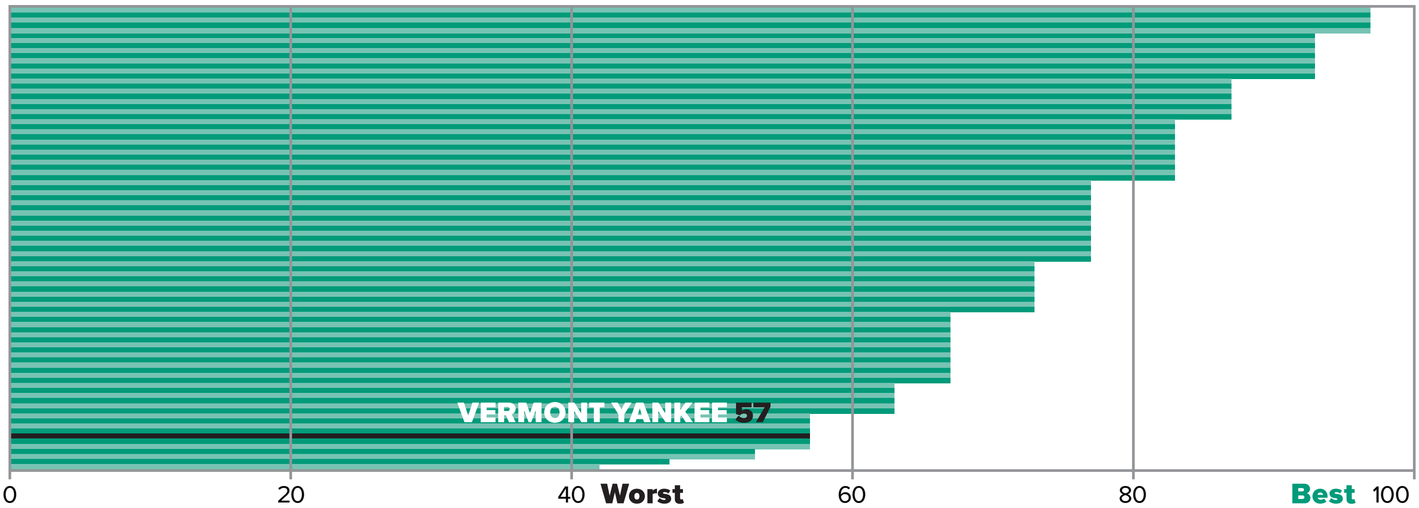
As Vermont Yankee's corporate owners near the decision point as to whether either the Vermont legislature or the Vermont Public Service Board will grant them permission to operate past their expected closure date in March 2012, one would think they would put their best foot forward. However, regular accidents, spikes in radiation release, bursting pipes, collapsing cooling towers and fires over the past few years instead indicate that not only is the plant showing its old age, but that its owners are cutting corners.

If this is the best Vermont Yankee's owners can do today, when they are under close scrutiny, what would we see if the plant were running for another 20 years without this intense level of oversight? Entergy, the plant's owners, have indicated that they will only make some repairs to the facility if they are granted permission to operate past 2012.[19] It seems that the company is attempting to minimize maintenance just in case they are not allowed to operate past 2012. They are willing to put all of us at risk rather than make necessary investments that they know should be made. If this is how they operate today, what kind of decisions would be made if the reactor were still running in 2020, 2025 or even 2030 when the owners know it will close in 2032 at the latest?

When the Vermont legislature asked for a reliability review of Vermont Yankee the results showed a plant with serious problems. The problems included, but were not limited to, the aging infrastructure of the plant and how the corporate management was running the reactor. The overall report on the plant revealed that Vermont Yankee was one of the worst reactors in the country according to the industry Equipment Reliability Index.

Equipment Reliability Performance Scores for all US Nuclear Reactors

Data From Nuclear Safety Associate's Reliabilty Assessment of Vermont Yankee, 2008



Problem areas at Vermont Yankee included but were not limited to:

1. POOR EQUIPMENT UPKEEP:
The Vermont Yankee Oversight Panel discovered that Vermont Yankee has an excessive backlog of both deferred maintenance and preventative maintenance. Vermont Yankee has a significant number of components that need repair compared to reactors that are considered good performers in terms of reliability.[20]

2. FAILURE TO FIX KNOWN PROBLEMS:
Corrective action requests are filed when problems at the reactor are identified that need to be addressed. While well run reactors have less than a handful of corrective actions in backlog, as of spring 2009 Vermont Yankee had 38.[21] It was also uncovered that contrary to industry standards Vermont Yankee removes items from their backlog list before they are actually fixed.[22]

3. POOR MANAGEMENT:
When it came to how Vermont Yankee was being run, the list of problems was long. The management at Vermont Yankee has failed to adequately emphasize worker performance, has failed to adopt industry equipment reliability best practices, has failed to provide adequate contractor oversight, and has failed to institutionalize a process that identifies and tracks needed improvements. It was also found that the majority of the procedures — basic operating instructions for the plants systems — failed to meet industry standards. This problem was exacerbated by the fact that Vermont Yankee has a less experienced workforce.[23]

4. OVERWORKED AND UNDERSTAFFED:
According to the oversight panel report there were about 40 unfilled positions at Vermont Yankee. Many of the most experienced workers are nearing retirement age and are being replaced by less experienced staff, and the staff that are there are often overworked. Some systems engineers are responsible for six systems when the industry norm is just two to four.

5. WEAK INSPECTIONS:
The oversight panel discovered that the collapse of the cooling tower in 2007 and subsequent leaks in 2008, as well as the fire in 2004 all could have been avoided had better inspections taken place or been paid attention to. Entergy employees were denied their requests for more time and money to assure more thorough inspections, the company's profits while lowering safety and reliability margins.[24]

Decommissioning Vermont Yankee in 2012

Generating electricity from a nuclear reactor produces large quantities of both high level and low level nuclear waste. The high level waste is mostly the used nuclear fuel. Everything from the reactor building to contaminated soil and even some water used in the facility is dangerous low level waste. All of this should be removed from the current Vermont Yankee site as part of the decommissioning process. Vermont Yankee's corporate owners, who have profited from the operation of the reactor, should be required to pay for the clean up.

Leading up to the sale of Vermont Yankee to Entergy in 2002, Vermont ratepayers put money into a clean-up fund for the facility. By 2002 there was $311 million in the decommissioning fund. Since 2002, Entergy has not put any money into the fund. Between 2002 and 2009 the estimated cost of cleaning up the reactor site increased from $633 to $987 million, meanwhile the amount of money available to complete the clean up only grew from $311 million to $385 million.

When Entergy bought the reactor they committed to all financial liability for the reactor clean up. In fact, in the negotiations prior to the sale, Entergy stated in a February 25, 2002 press release:

> *"Entergy will assume all financial and operational risks of increases in operating and fuel costs, decommissioning costs, used fuel costs, nuclear waste disposal costs, costs of any accidents at VY or other nuclear plants in the U.S., costs of premature shutdowns and extended outages. The day before the closing of the sale, the ratepayers have all the risk and the day after, Entergy has all the risk and the ratepayers have $180 million in purchase price plus $70 million in financial assurances."*[25]

Then on July 18, 2002 Entergy went so far as to say it was unfair for them to accept the risk of decommissioning if they couldn't also benefit if there was extra money left over after the reactor site was cleaned up.

> *"Entergy believes that it is fundamentally inequitable for it to bear all of the downside decommissioning fund risk without the potential to share in the upside if funding levels or actual decommissioning costs turn out better than expected."*[26]

There is a provision in the sale agreement that would guarantee Entergy some of the money if there was ever leftover funds after complete decommissioning.

However, when the Chief Financial Officer of Entergy Nuclear Operations testified in front of the Vermont House of Representative's Committee on Commerce in 2008, the responsibility for decommissioning appeared to have shifted.

> *"…today the responsibility for decommissioning Vermont Yankee is with its owner, and we've talked about its owner and I know you can think about that numerous ways but its owner is Entergy Nuclear Vermont Yankee. Its owner is not Entergy… So the responsibility to decommission it is Entergy Nuclear Vermont Yankee."*[27]

Entergy Nuclear Vermont Yankee (ENVY) is a limited liability corporation. Shortly after the sale to Entergy, Entergy shifted ownership to ENVY LLC.[28]

Vermont legislators and our governor should do everything within their power to hold Entergy to their initial commitment. Protecting Vermont ratepayers or taxpayers from paying to decommission Vermont Yankee is worth potentially hundreds of millions of dollars. Closing Vermont Yankee as scheduled in 2012 is the only way to avoid further costly contamination of the site.

(See page 16 for chart)

Economic Benefits of Replacing Vermont Yankee

Replacing Vermont Yankee with local renewable energy and energy efficiency is the responsible choice for Vermont's economic future. It is also the lowest cost option. Over the next twenty years, local renewable energy will cost Vermonters less, put more Vermonters to work, and provide more support for our local tax base.

Price stability and reliability are two important factors when it comes to protecting our economy moving forward. The recent series of failures and accidents at Vermont Yankee illustrates the plant's declining reliability, even before its expected 2012 closure date. If the plant won't be able to run reliably it will not be able to provide stable or reliable electricity even if contracts are signed with Vermont utilities.

Building our clean energy infrastructure today will create a new highly reliable, high-tech, electricity system which can offer fixed price stability.

Consumer Benefits of Replacing Vermont Yankee

Electricity prices in New England are expected to rise between 2012 and 2032 as electricity demand across the region increases and fossil fuels become less available and more expensive.[29] VPIRG's analysis found that relying on local renewable resources will cost Vermonters 47–50% less between 2012 and 2032 than relying on Vermont Yankee at market prices. If Vermont Yankee were to sign a contract with Vermont utilities that was guaranteed to be 20% less than predicted market rates the two renewable energy scenarios analyzed in this report would still be 35–40% less than Vermont Yankee.

VPIRG's moderate renewable energy scenario shows that combined energy efficiency and renewable energy development could deliver 1.5 times as much power as Vermont Yankee at 6.9 cents per kWh. VPIRG's strong renewable energy scenario shows that combined energy efficiency and local renewable energy development could deliver approximately twice as much power as Vermont Yankee at 7.8 cents per kWh.

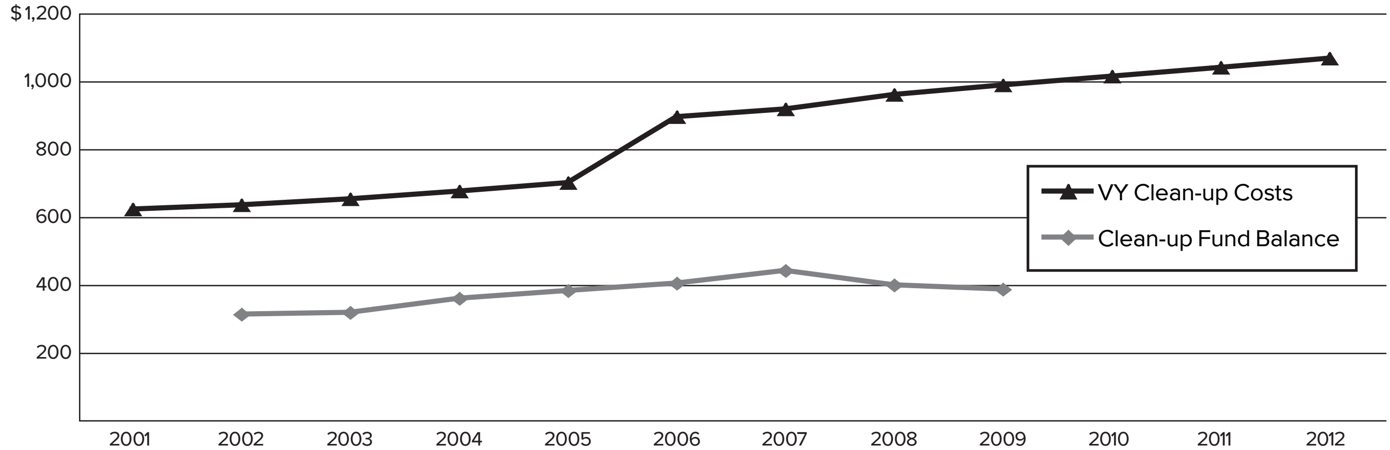
A report done for the Vermont Department of Public Service found that replacing Vermont Yankee with a mix of renewable energy resources would cost 7.3 cents per kWh.[30]

If Vermonters invest upfront in renewable resources the cost comes down even further. Once a renewable energy generator such as a wind farm, solar power facility, small hydroelectric generator or farm methane digester is built, it can deliver electricity at 1–3 cents per kWh because they have no fuel costs. This allows renewable energy producers to deliver very affordable electricity at stable rates.

If Vermont Yankee's owners offer a fixed price contract to Vermont utilities to calculate the real cost Vermonters would be forced to pay, there are a number of additional factors to consider:

- Vermonters may have to pay a significant portion of the $1 billion dollars needed to decommission the facility, including $4 million dollars a year to secure the radioactive waste that is left at the reactor after it closes[31]
- Vermont would receive $25–43 million dollars less in property taxes than if Vermont developed the moderate renewable energy or strong renewable energy scenarios outlined in this report
- Vermont would risk the possibility of an accident at Vermont Yankee which could ruin the Vermont economy and environment

Vermont Yankee Decommissioning Fund (Millions $)



Tax Benefits of Replacing Vermont Yankee

There are numerous economic reasons to replace Vermont Yankee with local renewable energy resources, not the least of which is the fact that local renewables will contribute more to our tax base than Vermont Yankee.

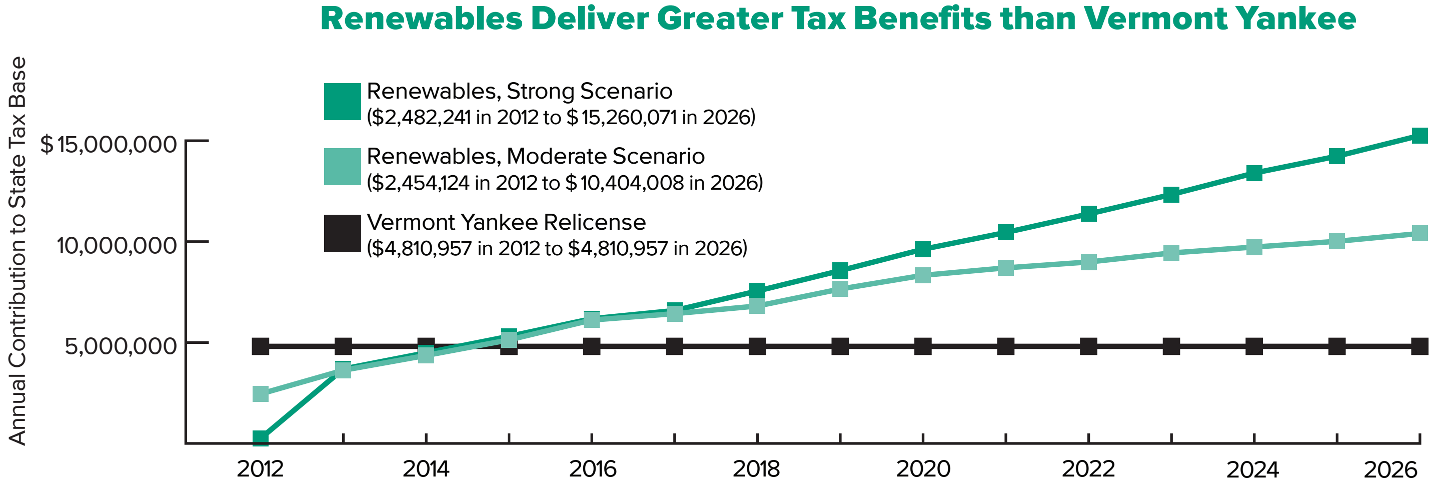
Vermont Yankee's corporate owners are not and have not been paying their fair share of taxes. A survey of all renewable electricity producers in Vermont showed that Vermont Yankee's owners are paying a property tax rate that is a fraction of what renewable energy providers are required to pay.[32] In 2008 the legislature passed a new law that would require new wind farms to pay $0.003 per kWh they produced, but the legislature left Vermont Yankee's rate at $0.001.

If we replace Vermont Yankee with local renewable energy resources, we will do more to support our local tax base and the state Education Fund.

Moderate growth in the local renewable energy sector would contribute 1.5 times as much in property taxes as Vermont Yankee, $75 million vs. $50 million from VY (2012 dollars). By 2032, the state would be receiving $13 million annually, nearly three times as much every year from renewables as would come from Vermont Yankee.

Strong growth in the local renewable energy sector would contribute nearly two times as much in property taxes as Vermont Yankee, $93 million vs. $50 million from VY (2012 dollars). By 2032 the state would be receiving $22 million annually, nearly 4.5 times as much as would come from Vermont Yankee.

Renewables Deliver Greater Tax Benefits than Vermont Yankee



Meeting Vermont's Future Needs

Vermont has tremendous resources to help us meet our future energy needs. From international expertise related to energy efficiency to cutting edge renewable energy companies and abundant renewable resources, we have the basic raw ingredients of a renewable energy future. When we combine these basic ingredients with the ingenuity Vermonters have shown over the years and our strong independent streak, Vermont is well-positioned to determine its own energy future.

Vermont can meet 100% of its electricity needs through a portfolio of Vermont-based renewables combined with the power we currently purchase from regional hydroelectric facilities.

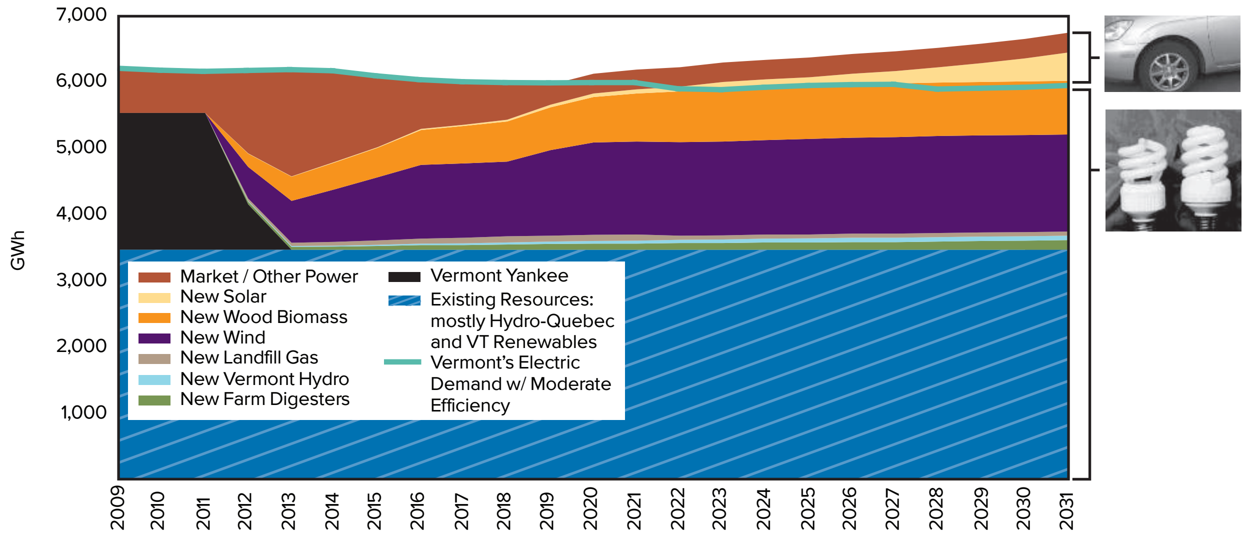
Vermont's current electricity mix is too reliant on too few sources. Vermont should seek to create a diverse electricity portfolio based on a reliable fuel mix that can serve as a hedge against the impacts of unprecedented price spikes in fuel costs and interruptions in our transmission system. Building a portfolio today that relies on clean local resources will not only strengthen our electricity grid but it will also provide better price stability for consumers.

VPIRG analyzed two scenarios for investing in Vermont's clean energy future. The first is a moderate growth scenario that has Vermont meeting all of its own needs with local renewables and regional hydroelectric power. Under the moderate scenario, by 2020 Vermont would have excess power generation that could be put towards electrifying our transportation sector or sold into the regional market to bring more money into the Vermont economy. The second scenario, a strong renewable growth plan, also has Vermont meeting all of its needs with local renewable resources and regional hydroelectric power. However, under the strong scenario, Vermont will produce both enough electricity to run our homes and businesses as well as our transportation sector.

Moderate Renewable Energy Growth Scenario

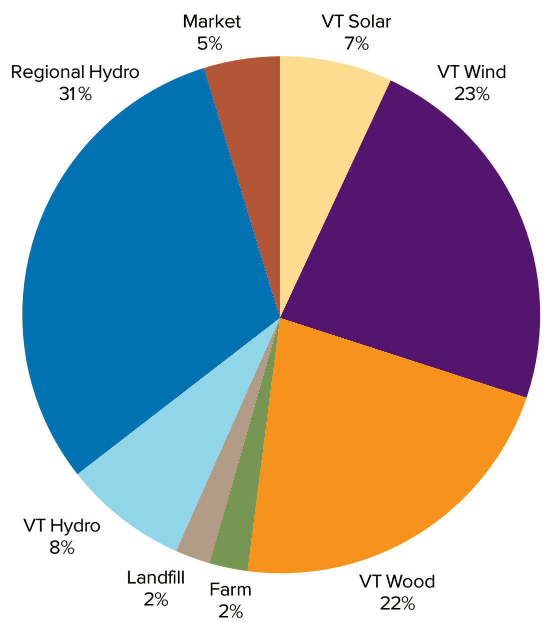
The graph below demonstrates how moderate growth in different types of renewable energy installations collectively will more than meet Vermont's electricity demand over the next twenty years.

Repowering Vermont without Vermont Yankee:
Moderate Renewable Energy Growth and Energy



To the right is a snapshot of what Vermont's electricity portfolio could look like in 2032 if we invest in a clean energy future based on local renewable resources.

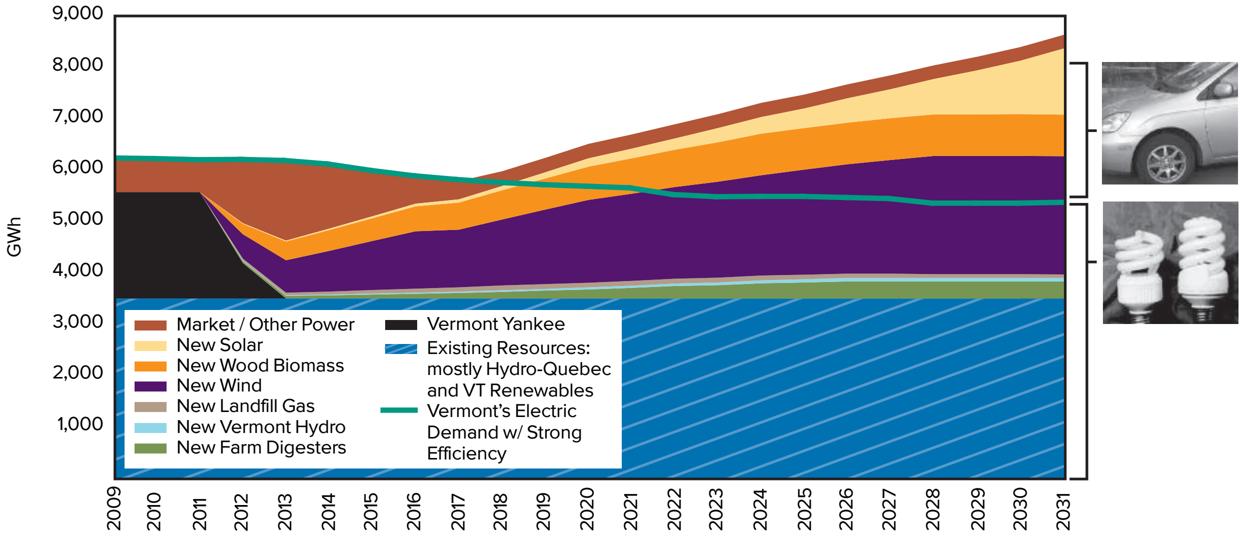
Repowering Vermont's Electricity Sector — Moderate
2032 Electricity Supply: 6,300 GWh



Strong Renewable Energy Growth Scenario

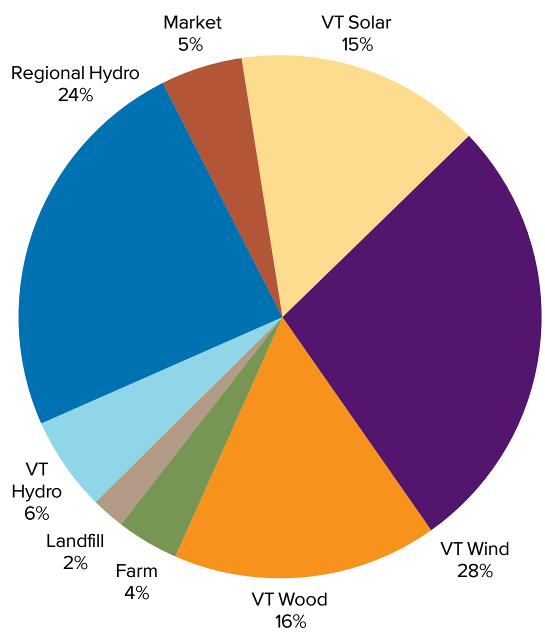
The graph below demonstrates how strong growth in different types of renewable energy installations collectively will more than meet Vermont's electricity demand and will produce enough local electricity to power Vermont's transportation sector over the next twenty years.

Repowering Vermont without Vermont Yankee:
Strong Renewable Growth and Energy Efficiency



If Vermont were to build enough local generation to power our homes, businesses and transportation sector we could cut our global warming pollution in half. To the right is a snapshot of what such an electricity portfolio could look like by 2032.

Repowering Vermont's Electricity and Transportation Sectors
2032 Electricity Supply: 8,400 GWh



Conservation and Efficiency

The foundation of a clean energy economy is built upon a commitment to energy conservation and efficiency. As Vermont moves forward with developing an electric plan, the first question to answer is how much electricity will the state need? DPS has projected that Vermont's electricity demand will grow at 1.5% per year, absent any investment in efficiency. In 2032, that would place demand at 27% more than we use today. But if we combine common sense conservation actions with investments in energy efficiency, we can instead bring down our electricity demand to 13% below current usage.

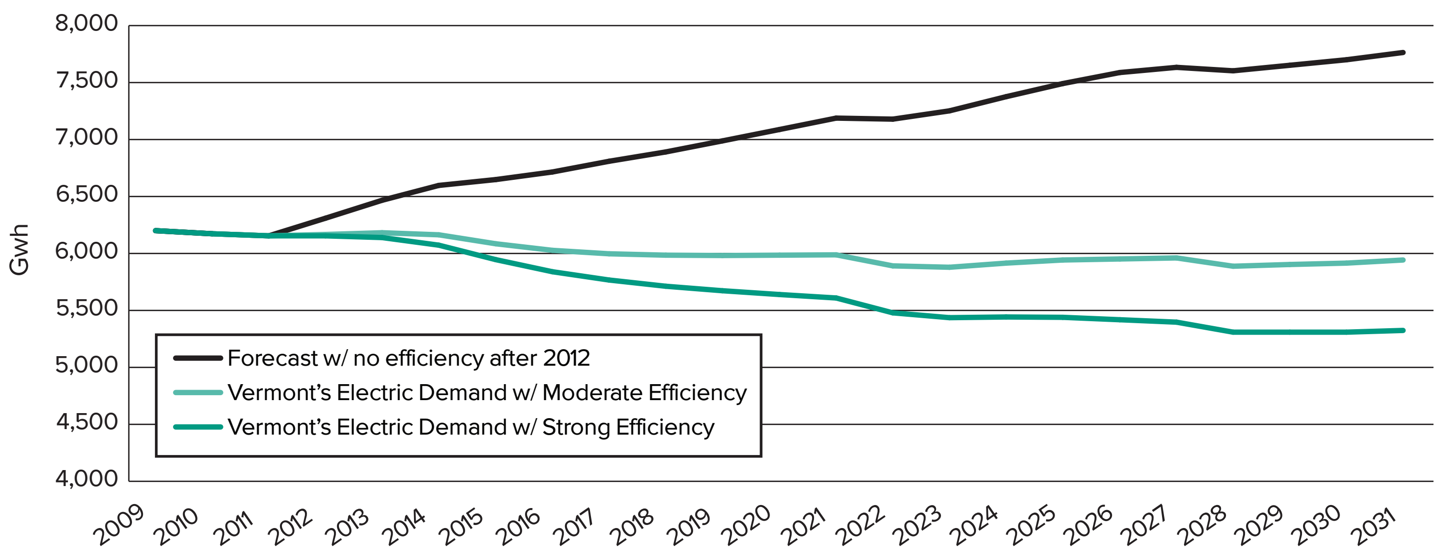
VPIRG analyzed two different energy efficiency investment scenarios. The first and more moderate scenario assumes that investments in energy efficiency are maintained at existing levels after 2012, adjusted for inflation. The second scenario assumes that Vermont continues to increase our energy efficiency investment on an annual basis in order to capture all cost-effective energy efficiency savings.

To minimize our need for electric generation, we should start by eliminating unnecessary and wasteful energy use, and then make sure we meet our remaining needs as efficiently as possible.

Using less energy does not require us to sit in the dark reading books by candle light. Rather, it means making common sense decisions such as turning the lights off in rooms that aren't being used, designing buildings to use more natural day lighting, and using efficient appliances, commercial motors and industrial systems.

Today, reducing our energy needs is easier than it ever has been, thanks to a broad range of energy conservation and efficiency technologies. For example, programmable thermostats can assure us that our homes stay warm in the winter and cool in the summer while not wasting electricity when people are away at work or school. Motion detection switches on lights automatically turn them off when they are not needed and energy-efficient lighting products can now replace virtually all incandescent

Vermont's Electricity Demand



lighting. Efficient technology options are also available for most appliances, home electronics, motors and industrial manufacturing equipment.

Those planning Vermont's energy future should consider energy efficiency to be an available resource that can be purchased just like power from a power plant. In fact, investing in efficiency is currently cheaper than purchasing electricity from almost any other source. In 2007 Vermont became the first state in the nation to gain more in efficiency savings than the state's projected increased demand, turning the state's year over year electricity demand negative. This trend was continued in 2008 with the 2.5% demand reduction more than offsetting the Department of Public Service's projected 1.42% increase.[33]

In 2008 the investments made by Vermonters through the efficiency utility delivered savings at an average of 2.5 cents per kWh, less than half the price that Vermont utilities would have had to pay for electricity supply had this energy not been saved.[34] Approximately 150,000 MWh were saved in 2008.[35] For a sense of scale, when measured by participation in the ISO-New England Forward Capacity Market auctions for future energy supply, efficiency is Vermont's third-largest "power plant", trailing only Vermont Yankee and the McNeil Generating Station in Burlington.

The efficiency utility works with Vermont homes and businesses to help them become more energy efficient through the use of products such as efficient lighting, refrigeration systems and manufacturing processes. It provides consumer information, technical expertise and financial incentives to encourage cost-effective energy efficiency. Two separate studies conducted for the Vermont Department of Public Service over the past seven years have shown that there continues to be tremendous potential to invest in additional efficiency measures that will deliver electricity savings to Vermonters at or below market prices. The first report, released in 2002, estimated that Vermont could meet 30% of its 2012 electricity demand through cost-effective efficiency.[36] The second report, released in 2006, estimated that Vermont could meet 19% of its 2016 electricity demand through cost-effective efficiency.[37]

In addition to being the lowest cost resource option for Vermont, efficiency is the cleanest and safest. Purchasing megawatt hours through efficiency allows us to avoid global warming pollution or other types of pollution associated with generating power. The energy saved by Efficiency Vermont in 2008 resulted in lifetime reductions of 920,000 tons of carbon dioxide, 400 tons of nitrogen oxides and 1,300 tons of sulfur dioxides. Unlike nuclear plants, efficiency investments are not vulnerable to terrorist attacks, and they reduce the need for massive power lines used to deliver electricity. Furthermore, efficiency investments create new jobs here in Vermont by stimulating innovative businesses in the retail, design, and specialized installation markets related to efficiency technology.

In 2008 the Vermont Public Service Board issued a ruling that energy efficiency investments made by Vermont's energy efficiency utility be increased to $41.5 million dollars annually. While this is a very significant investment it still represents a small fraction of the nearly $1 billion dollars that Vermonters spend to purchase electricity every year.

Vermont Wind Farms

Moderate Renewable Energy Growth

Installed Capacity: 496 MW
Total Energy Provided 2032: 1,463 GWh
Percent of 6,300 GWh: 25%
145 Turbines x 3 MW, 24 miles, less than 4% of Vermont's windy ridges

Strong Renewable Energy Growth

Installed Capacity: 766 MW
Total Energy Provided 2032: 2,305 GWh
Percent of 8,400 GWh: 28%
235 Turbines x 3 MW, 39 miles, just over 5% of Vermont's windy ridges

As global warming, air pollution and fossil fuel prices increase, VPIRG believes thoughtfully developed wind power is a critical source of renewable energy that must be developed in Vermont. Although there is a vocal minority in opposition to wind farms, Vermonters strongly support wind power and that support has been growing. In a statewide public engagement process the Vermont Department of Public Service found that 90% of Vermonters support a wind farm being built if they could see it from where they live.[38] In a separate poll, 81% of those surveyed said they would consider wind turbines on Vermont ridges beautiful or acceptable.[39]

Wind power development in New England has come a long way since Green Mountain Power's 6 MW Searsburg wind farm was built in 1997. At the time, it was the largest in the eastern half of the country. Today, in New York alone almost 1,300 MW of capacity has been built or is under construction.[40] Maine is making progress toward a goal of building 3,000 MW by 2020[41] and Massachusetts has set a goal of building 2,000 MW by 2020.[42]

A study conducted by Vermont Environmental Research Associates (VERA) found and mapped an astonishing 6,000 MW of potential wind resources in Vermont. VERA looked at two types of facilities: Class A turbine strings — large wind power installations sited on the windiest ridges and directly connected to the transmission system; and Class B turbine strings — smaller turbines that can either be connected to the sub-transmission system or directly to the distribution system.[43] If all of Vermont's wind resources were utilized it would provide three times Vermont's current annual electric demand. Since the VERA study was conducted in 2003, improvements in wind energy technology have made the 6,000 MW estimate conservative given Vermont's wind resource.

Turbines today can generate as much as 3 MW of power each — enough power to serve around 1,300 Vermont homes. In 2005, a proposal to build four 1.5 MW turbines on East Mountain was abandoned; today Vermont's municipal electric utilities are looking to install three 3MW turbines in the same location, reducing the number of turbines while increasing the energy output by 50% (the new turbines are taller).

Despite gubernatorial opposition to larger scale wind farm development in Vermont, we are starting to make real progress. Two wind farms totaling 70 MW of capacity have been granted approval by Vermont's Public Service Board and should start delivering power to Vermonters' homes and businesses within the next year or two. Projects already on the drawing board in Chittenden, Rutland and Orleans County represent an additional 130 MW.

Wind turbines come in many different sizes. VPIRG's moderate wind development scenario is based on 430 MW from larger scale wind farms and 66 MW from smaller community installations or wind turbines built at individual businesses and homes. VPIRG's strong renewable energy growth plan is based on 700 MW from larger scale wind farms and 66 MW from smaller turbines.

VPIRG's plans are based on large turbines having an average capacity of 3 MW. Some of the wind farms built in the next couple of years will use turbines that can produce only 2.5 MW, however, these will be balanced out by slightly higher capacity turbines being installed in the near future. Over the past ten years the standard capacity of wind turbines has increased from 0.75 MW to 2.5 MW.

Wind turbines are usually spaced out so that approximately six are sited per mile. To meet 25% percent of the state's electricity needs would therefore take about 29 miles of Vermont's ridges.

Building wind farms in Vermont will provide millions of dollars worth of new tax revenue for host towns and the state. Additionally, wind farms will provide a steady income stream to land owners as well as help to create Vermont-based jobs related to their construction, maintenance and operation. If developed by local municipalities, they have the potential to dramatically reduce local electricity costs and in some cases would provide a positive net income stream for the city or town.

It is not only reasonable, but prudent to presume that the wind will play a significant role in our clean energy future.

Wind Jobs in Vermont

In addition to the engineering, construction and maintenance jobs associated with every new wind farm built in Vermont, we have a number of growing businesses that are proving to be industry leaders.

Northern POWER SYSTEMS

Northern Power Systems was founded over 30 years ago in Vermont and is currently headquartered in Barre. The company designs and manufactures advanced, gearless wind turbines and its Northwind 100 is fast-becoming the industry leader in community-scale wind power. A 2.2 MW wind turbine is the final stages of design and will be available in early 2010. The company expects to double their workforce over the next year to 150 employees.

NRG SYSTEMS

NRG Systems was founded in 1982 in Hinesburg, Vermont and has grown to be a global leader in wind energy measurement and turbine control technology. As the wind industry has grown globally, NRG has continued to employ more and more Vermonters to keep pace. The company operates out of two state-of-the-art green manufacturing facilities in Hinesburg, VT.

EarthTurbines inc

Earth Turbines was founded in 2005 and is based out of Williston. As Vermont's only manufacturer of residential wind turbines and solar trackers, they design and install complete, grid-connected renewable energy systems while creating sustainable, well-paying jobs for Vermonters. By the end of 2009 Earth Turbines will employ 25 people.

Vermont Solar Power

Moderate Renewable Energy Growth

Installed Capacity: 245 MW
Total Energy Provided 2032: 430 GWh
Percent of 6,300 GWh: 7%

Strong Renewable Energy Growth

Installed Capacity: 734 MW
Total Energy Provided 2032: 1,290 GWh
Percent of 8,400 GWh: 15%

Directly harnessing the power of the sun to significantly help meet our power needs has been a laudable goal for decades. Today meeting that goal appears close to becoming a reality. Tremendous public and private investments have poured into solar technology research over the past decade leading to advances in available technology. These advances combined with increased production volume have led to an ever-decreasing cost per kWh for solar electric generated power. Costs have now decreased to the point where solar power can be competitive with some peak wholesale fossil fuel power rates during the summer. As additional capacity is installed, prices will continue to decrease, making solar power increasingly more affordable compared to a wider range of power sources. Existing federal and state incentives can make solar affordable and very close to (or below) utility power for residential applications depending upon financing and installation time.

Vermont has a rich history of hosting some of the nation's first solar electric companies. Today Vermont is home to dozens of solar power companies including groSolar, one of the nation's largest, and Alteris Renewables, one of the region's largest. The solar industry in Vermont has been growing fast, providing good jobs for engineers, electricians, contractors, sales associates and more.

One of the main differences between VPIRG's moderate and strong renewable energy growth scenarios is the amount of assumed solar installation. Both plans start conservatively with limited projected development in the next 10 years as the industry continues to expand significantly and prices are further reduced. This ramp up may happen faster depending upon federal policy. Between 2020 and 2032 we expect to see tremendous growth in the solar sector.

VPIRG's moderate growth scenario envisions up to 245 MW of solar capacity coming online between now and 2032. This would include nearly seven percent or one out of every 15 Vermont homes producing solar power in addition to small and larger scale commercial installations. The strong renewable energy growth scenario includes three times as much power coming from solar — 20% or one out of every 5 homes producing solar power, significant growth in commercial installations and some smaller scale solar plants.

One of the unique benefits of solar power is that it is produced in greatest quantities during hot summer days, a time when power demand across New England is highest. This also means it is produced when it is most expensive to buy power in the electricity market. Therefore, as we see significant amounts of solar energy installed in Vermont our utilities will be able to avoid some, or all, of their dirtiest and most expensive power purchases.

Today's best solar installations can convert 20% of the sun's energy that they receive directly into electricity. In calculating the solar potential in Vermont, VPIRG did not assume that this 20% capacity factor would increase, however, it is likely that it will as new technologies become cost competitive.

Solar thermal panels can reduce the amount of electricity, oil or other fossil fuel needed to provide hot water for a home or business. For each kW of solar hot water panels installed 3,120 kWh of electricity can be saved every year. Because in Vermont most domestic and commercial hot water is heated by fossil fuels and in order to err on the conservative side, both of the renewable energy growth scenarios analyzed by VPIRG assume no avoided electricity from solar hot water installations. This does not diminish the fact that solar hot water systems will allow many Vermonters to significantly reduce their fossil fuel or electricity consumption, saving money and reducing global warming pollution.

Additionally, Vermont is beginning to see the development of multi-megawatt solar photovoltaic (PV) plants. It is likely that Vermont will see a series of 1–3 MW solar PV plants, in the near future.

Vermont Wood Biomass

Moderate Renewable Energy Growth

Installed Capacity: 170 MW
Total Energy Provided 2032: 1,379 GWh
Percent of 6,300 GWh: 22%

Strong Renewable Energy Growth

Installed Capacity: 170 MW
Total Energy Provided 2032: 1,379 GWh
Percent of 8,400 GWh: 16%

With forests covering 80% of Vermont's land area and growing every year, the state is ideally positioned to make forest biomass a significant and sustainable part of its long-term energy strategy. However, our forests are precious and limited. They provide crucial habitat for wildlife, sequester carbon dioxide, provide heating fuel for many Vermont homes, businesses and schools and sustain Vermont's forest products industry.

Presently, Vermont's forest growth-to-removal yield is 3:1, meaning that the amount of wood in our forests is increasing three times faster than it is being harvested. The state adds 11 million tons of new growth each year. New biomass growth, plus the need to thin existing low-grade wood out of forests, presents a tremendous source of renewable energy based in Vermont that is available to be harvested on a sustainable basis.

The future of wood energy in Vermont belongs to more efficient, cleaner technologies that are becoming commercialy available — principally biomass gasification and combined heat and power (CHP). Traditional wood fueled electricity generation fails to capture more than two-thirds of the energy that is in the fuel (the same is true for all traditional large coal, oil, gas and nuclear power plants). However, combined heat and power projects capture the wasted energy in the form of heat that can be used in industrial processes or used to heat and cool buildings. Biomass gasification, rather than burning the wood, utilizes a technique that turns the wood into a natural gas which is then burned to power a turbine. This process reduces air pollution and increases efficiency nearly two fold. Biomass gasification also produces waste heat which can also be utilized.

Emerging technologies will allow smaller facilities to be located around the state, drawing wood resources from local forests rather than trucking wood over long distances and delivering local clean power and heat. In order to maximize our sustainable use of available biomass resources, all new power generation facilities should be sized based on how much heat can be utilized.

The local economic benefits of harvesting this biomass for renewable power will be realized in Vermont's most rural areas. These benefits include forestry jobs, support of the forest products industry and creation of markets for forest wood wastes — a necessary component of sustainable forestry. To the extent that biomass directly replaces fuels such as oil, coal and natural gas currently purchased from outside of Vermont, biomass will reduce the huge outflow of energy dollars from Vermont's state and local economies.

Vermont currently has two facilities that generate electricity from wood chips. The Ryegate plant has a rated capacity of 20.3 MW and the Burlington Electric Department's McNeil plant has a rated capacity of 53 MW.[44] Estimates are that at least 100 MW of new capacity could be developed while maintaining sustainable forestry practices. A 25 MW facility is already in the planning process in Springfield, VT.

Vermont has been a national leader in our sustainable use of biomass in numerous different applications. Today, at least 26 Vermont schools, numerous state buildings and industrial facilities use wood chip heating systems. In addition, Vermonters use wood biomass for residential cordwood, community and district heating, and steam production for dry kilns in the forest products industry.

Vermont Farm Biomass

Moderate Renewable Energy Growth

Installed Capacity: 20 MW
Total Energy Provided 2032: 49 GWh
Percent of 6,300 GWh: 2%

Strong Renewable Energy Growth

Installed Capacity: 45 MW
Total Energy Provided 2032: 335 GWh
Percent of 8,400 GWh: 4%

One of the most recent electricity success stories in Vermont has been the capture of methane from farms' manure, crops and food waste. When methane energy systems displace fossil fuels, the result is a net reduction in the buildup of global warming pollution in the atmosphere. Capturing methane provides additional environmental benefits by reducing water quality impacts of farm run-off. The systems also provide farmers with a stable additional income stream.

In late 2008, six Vermont dairy farms were producing electricity from cow manure and feeding it to the grid. At least a dozen more "cow-power" systems are in the planning stages.[45]

So far, cow power has been limited to farms with at least 500 cows for technical reasons. However, new technology is making it cost competitive for smaller farms to also install manure digesters. One Vermont company working to make technology work for smaller farms is Avatar Energy, based in South Burlington. In 2008, Avatar began marketing a manure-to-methane system geared to farms with as few as 100 cows and plans to begin bringing units online in 2009.

The Vermont Agency of Agriculture, Food and Markets has stated that a ten-fold increase in cow power within 10 years, from 1.5 megawatts to about 15 megawatts is possible. The state anticipates that twice that much power will be generated from crops and crop residues mixed in with cow power's traditional feedstock, manure.[46]

Vermont Hydroelectric Power

Moderate Renewable Energy Growth

Installed Capacity: 113 MW
Total Energy Provided 2032: 493 GWh
Percent of 6,300 GWh: 8%


Strong Renewable Energy Growth

Installed Capacity: 113 MW
Total Energy Provided 2032: 493 GWh
Percent of 8,400 GWh: 6%

Hydroelectricity produced in Vermont has long been a key part of Vermont's energy mix. Starting in the early 1900s, Vermonters tapped our rivers and streams to generate electricity, make flour and spin wool.

A portion of the state's hydroelectric facilities are owned by independent power producers. This power is delivered to Vermont utilities and the sale and purchase of the power is managed by Vermont Electric Power Producers, Inc (VEPPI).[47] The contracts for the power under which their production is now sold to Vermont utilities will expire before 2015. In most cases the dams should remain in production and whether through VEPPI or a different contract arrangement, that power (annual production of about 160 GWh) should continue to provide electricity to Vermont utilities.[48]

Vermont utilities own and manage additional dams that produce nearly 300 GWh of electricity. Of this total about 51 MW are run-of-the river basis, generating electricity from rivers as they flow. The remaining are able to store water behind a dam, allowing the electricity to be generated during periods of peak use.[49]

Currently the utility-owned dams provide the cheapest electricity in the state, generating electricity at two to three cents per kWh.[50] Utilities have been upgrading the dams' technology and this "repowering" will allow for an increased generating capacity in years to come.

New hydroelectric capacity estimates vary greatly, some noting as much as 174 MW.[51] VPIRG's moderate and strong renewable energy growth plans anticipate the 15 MW of additional capacity that has been identified by the Vermont 25 x 25 initiative in their preliminary findings.[52] VPIRG's conservative approach to additional hydroelectric generation is due to challenging wildlife issues and permitting hurdles for small scale, low-impact, hydro power.

Vermont Landfill Methane

Moderate Renewable Energy Growth

Installed Capacity: 19 MW
Total Energy Provided 2032: 150 GWh
Percent of 6,300 GWh: 2%


Strong Renewable Energy Growth (all electricity and 100% of transportation needs)

Installed Capacity: 19 MW
Total Energy Provided 2032: 150 GWh
Percent of 8,400 GWh: 2%

Washington Electric Co-op (WEC), a consumer-owned utility serving over 10,000 mostly residential accounts in Washington, Orange and Caledonia Counties, has had tremendous success in recovering methane gas from Vermont's largest landfill in Coventry, operated by New England Waste Services of Vermont. WEC's facility, presently producing over 7 MW, will reach its installed capacity of 8 MW over the next few years as gas volume at the landfill continues to grow.

The plant provides about two-thirds of WEC's total energy needs and is the largest contributor to the utility's supply.

Additionally, a landfill in Moretown recently came online with a 3.2 MW generator. Green Mountain Power has contracted for the power plant's output for the next 15 years. Vermont does not have other large landfills, however, there may be smaller landfills with limited additional capacity.

Regional Hydroelectric Power

Moderate Renewable Energy Growth

Total Energy Provided 2032: 1,930 GWh

Percent of 6,300 GWh: 31%

Strong Renewable Energy Growth

Total Energy Provided 2032: 2,030 GWh

Percent of 8,400 GWh: 24%

Hydroelectric power from outside of Vermont has long been a major component of Vermont's electricity mix. Vermont has a 35-year relationship with the utility Hydro-Quebec. There are many economic, social and physical relationships between Vermont and our northern neighbors that should allow for a continued strong relationship, including future electricity purchases.

In the early 1980s, Vermont negotiated a 150 MW power contract with Hydro-Quebec. A specially designed 200 MW substation was built so that Vermont could receive the Canadian power. Power flowing through this tie quickly became an essential part of Vermont's electricity mix and contributes to the reliability of Vermont's transmission grid. Vermont should seek a substantial, reliable amount of electricity, to utilize the 200 MW converter and provide electricity generation in the summer months when wind power is less available.

In addition to hydro-power from Canada, significant power is generated by dams on the Connecticut River which could be purchased by Vermont utilities. This output in combination with Hydro-Quebec power would provide a stable source of power to Vermont for many years.

VPIRG does not support Vermont increasing its reliance on Hydro-Quebec power. It is irresponsible for Vermont to export the environmental footprint associated with our electricity needs. The construction of new massive hydroelectric facilities in Quebec threatens to seriously damage entire watersheds through flooding and water diversion.

Both the moderate and strong renewable energy growth scenarios analyzed by this report assume approximately the same amount of power coming from regional hydroelectric facilities between now and 2032 as is currently being purchased from Hydro-Quebec.

Market Purchases

Moderate Renewable Energy Growth

Total Energy Provided 2032: 296 GWh

Percent of 6,300 GWh: 5%

Strong Renewable Energy Growth (all electricity and 100% of transportation needs)

Total Energy Provided 2032: 418 GWh

Percent of 8,400 GWh: 5%

The region's electricity is dominated by fossil fuels and nuclear power. If Vermont is going to create a clean electricity future, it is essential that it is not overly reliant on New England market purchases to meet its needs. However, the mix of power in the New England market is getting cleaner and the ability of market purchases to fill in when local resources are not able to meet our needs is valuable to Vermont utilities.

All utilities need to correlate the shape of their electricity portfolios to the pattern of usage in the state (electricity usage at different times of day, week, year). Market purchases can help meet this need. This happens now with Vermont utilities.

Vermont utilities currently purchase between 10–15% of the state's total load from market resources. Vermont utilities also currently own 15 dispatchable units with a combined installed capacity of over 150 MW. These generators are available to help stabilize the transmission system and meet local demand when other resources fall short. The units are mostly old diesel generators and their use should be minimized.

Conclusion and Recommendations

In our efforts to repower Vermont, we must address our future electricity supply options today. If our state relies on additional fossil fuels to meet its future electricity needs, our global warming pollution will increase dramatically. If we rely on Vermont Yankee we will be gambling with the future of the state and creating a toxic legacy for the next generation to pay for. At the same time, Vermont has a tremendous amount of untapped renewable resources that can be used to generate electricity. We have companies that are global leaders in developing wind, biomass and distributed generation technologies. Vermont has a history of tackling tough environmental challenges and developing solutions that protect our environment, economy and the health of our people.

To stop global warming, scientists are calling for a 75% reduction in pollution levels over the next 45 years. By the end of the next decade we must be polluting significantly less than we are today. The scale of our leader's response to this crisis must match the scope of the problem. Vermont must do its part and should set an example for other states to follow. The need to create a clean, safe and affordable electricity future points the way to several steps the state should take.

Recommendations

- **Retire Vermont Yankee** as scheduled in 2012. Vermont legislators should determine that continued operation of Vermont Yankee does not promote the general welfare of the state and therefore it should be closed on time.
- **Hold Entergy to their original commitment to fully decommission Vermont Yankee**. Vermont legislators and Governor Douglas should do everything in their power to protect Vermonters from any future costs associated with the clean-up of the Vermont Yankee reactor site.
- **Reduce Vermont's electricity demand** by funding Efficiency Vermont to capture all cost-effective efficiency savings.
- **Bring renewable energy to all Vermonters** by investing public dollars in local renewable resources that will deliver low-cost power to all Vermonters for decades to come.
- **Ensure price affordability and stability** by entering into long-term contracts for in-state renewable resources.
- **Promote local ownership of renewable resource generation** by helping interested municipalities to secure financing for renewable energy projects.
- **Plan for and build smart grid infrastructure** to maximize the integration of local renewable power and accommodate the electrification of our transportation sector.

The data presented in this report show that a clean, safe and affordable electricity future is possible. Now we must create it. To do so will require tremendous leadership on behalf of our elected officials and action by each and every Vermonter. Together, we can realize this vision for Vermont's renewable energy future.

Economic Analysis Methodology

The economics of the alternatives to Vermont Yankee were examined from the electric system perspective for the impacts to Vermont's electric bills. First, the present value of the costs to ratepayers from power supplied to Vermont by the relicensing of Vermont Yankee for another 20 years were calculated. Then the present value of the costs for the efficiency and renewable alternatives for supplying the same amount of power as Vermont Yankee were calculated and compared to the Vermont Yankee present value costs. The energy and capacity costs were calculated separately and added together for a total cost in each year.

The Vermont Yankee costs were assumed to be 20% less than market power costs. Market power costs were based on electric energy and capacity avoided costs developed by Synapse Energy Economics, Inc, and presented in the report Avoided Energy Supply Costs in New England, 2007 Final Report, August 10, 2007 (AESC 2007). These are the same avoided costs approved by the Vermont Public Service Board for use by the efficiency utility when examining efficiency alternatives. The AESC 2007 avoided costs are shown in the table to the left.

The economic analysis also estimated Vermont Yankee costs to Vermont assuming two levels of excess revenue sharing — 92% and 55%. Revenue sharing potentially occurs whenever the price that Vermont Yankee gets for selling its power exceeds the target price through the year 2021. The target price is assumed to be 6.1 cents/kWh in 2012 and escalated at 3.0% per year thereafter. The price that Vermont Yankee is expected to receive for selling its power was based on the projected market price (AESC 2007). The price that Vermont would pay for Vermont Yankee's power was assumed as 20% less than the market price and the price for power sold outside of Vermont was assumed to be equal to the market price.

The calculation of the costs for the alternative scenarios started with the efficiency savings and renewable installed capacity assumptions. The levelized costs per kWh for acquiring the efficiency savings and renewable power in each year were multiplied by the projected kWh resource to estimate the costs for efficiency and renewable alternatives in that year.

Where new efficiency and renewable resources were not enough to replace

Electric Avoided Supply Costs

(2009 dollars, without line losses)

	Winter Peak Energy	Winter Off-Peak Energy	Summer Peak Energy	Summer Off-Peak Energy	Summer Capacity
	$/kWh	$/kWh	$/kWh	$/kWh	$/kW—yr.
2012	0.1024	0.0758	0.1064	0.0742	132.9
2013	0.0982	0.0709	0.1054	0.0711	141.1
2014	0.1004	0.0713	0.1049	0.0714	141.1
2015	0.0987	0.0711	0.1058	0.0720	141.1
2016	0.0999	0.0730	0.1080	0.0751	141.1
2017	0.1044	0.0756	0.1100	0.0742	141.1
2018	0.1009	0.0737	0.1085	0.0755	141.1
2019	0.0995	0.0714	0.1099	0.0743	141.1
2020	0.1023	0.0743	0.1123	0.0748	141.1
2021	0.1052	0.0748	0.1157	0.0739	141.1
2022	0.1073	0.0760	0.1175	0.0761	141.1
2023	0.1089	0.0771	0.1193	0.0772	141.1
2024	0.1104	0.0783	0.1210	0.0783	141.1
2025	0.1121	0.0794	0.1227	0.0795	141.1
2026	0.1137	0.0805	0.1245	0.0806	141.1
2027	0.1153	0.0817	0.1263	0.0818	141.1
2028	0.1170	0.0829	0.1282	0.0830	141.1
2029	0.1187	0.0841	0.1300	0.0842	141.1
2030	0.1204	0.0853	0.1319	0.0854	141.1
2031	0.1222	0.0865	0.1338	0.0866	141.1

Vermont Yankee power for Vermont, the shortage was made up with purchases of market power. If the investments in new efficiency and renewable resources exceeded the Vermont Yankee power, then the excess was valued at market power rates and subtracted from the total costs. The levels of both energy and capacity were balanced and the respective costs assigned.

Efficiency

Two efficiency scenarios were developed — one moderate and the other more aggressive. Both efficiency scenarios begin acquiring savings in 2012 and project efficiency savings in addition to the currently planned efficiency from Efficiency Vermont (EVT) and Burlington Electric Department through the end of 2011.

The moderate efficiency scenario assumes that efficiency savings as a percentage of forecast MWh sales continues at the level currently projected for 2011. In other words, the efficiency savings added in 2012 were calculated as the projected 2011 efficiency savings times the percentage forecast growth in MWh requirements from 2011 to 2012. 2013 efficiency savings were calculated as the 2012 savings times the percentage forecast growth in MWh requirements from 2012 to 2013, and so on until 2031. The levelized cost ($/kWh) for the moderate efficiency scenario were assumed to be the same as currently planned for EVT in 2011, in real dollars. The total cost in each year increases at the same rate as the increase in MWh savings.

The strong efficiency scenario is based on efficiency savings projections in 2011 — made by VEIC as part of the Act 61 proceedings — with a hypothetical efficiency budget of $85 million (2008 dollars). Similar to the moderate efficiency scenario, the savings in future years increase at the same rate as forecasted load growth. The savings in 2012 were calculated as the projected 2011 efficiency savings times the percentage forecast growth in MWh requirements from 2011 to 2012. 2013 efficiency savings were calculated as the 2012 savings times the percentage forecast growth in MWh requirements from 2012 to 2013, and so on until 2031. The levelized cost ($/kWh) for the strong scenario was assumed to be the same as that estimated for 2011 with an efficiency budget of $85 million. The total cost in each year increases at the same rate as the increase in MWh savings.

Decay rates for efficiency savings for both scenarios were based on EVT historical measure life distribution. For example, the savings in year two after installation of the efficiency measures is reduced by the estimated percentage of measures with a one year measure life or less. The savings in year three is reduced by the estimated percentage of measures with a two year measure life or less, and so on.

Renewables

Assumptions for installed cost per kW, capacity factor, and lifetime came from a combination of renewable resource developers in Vermont and two reports. The referenced reports were:

Vermont Utilities Technical and Cost Issues of Generation Alternatives, *Phase One of a Two-Phase Report*, January 18, 2008, by Concentric Energy Advisors; and *Report to Vermont DPS on Vermont Yankee License Renewal, Chapter 12 Alternatives to Vermont Yankee*, by GDS Associates, Inc.

Other Assumptions Used

Future inflation was assumed at 2.6% per year after 2009. This is the inflation assumption developed by the DPS and currently used in the Vermont statewide screening tool for assessing efficiency measures.

A real discount rate of 5.7% was used for calculating the present value of costs and levelized costs for each resource. This was also developed by the DPS and currently used in the Vermont statewide screening tool.

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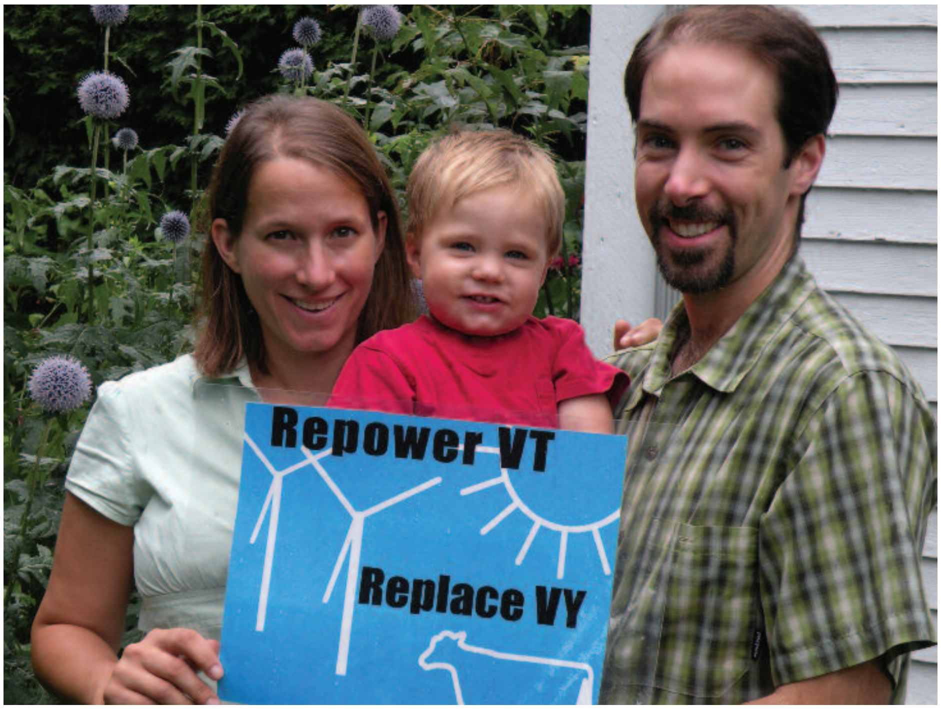

Dr. Elizabeth Hunt, Sam Moore, and Dr. Jess Moore of South Burlington, VT
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