

A Resource Guide to In-State Hydropower Production

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Fairfax, VT – Hydro Facility Owned & Operated by CVPS



**Winooski, VT - Winooski One Hydro Electric
Facility**

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Introduction

Vermont is at a unique place in its energy history. For several years now, the state has enjoyed the energy security that the long-term contracts with Vermont Yankee and Hydro-Québec have provided. Indeed, as global warming and climate change move to the forefront of the public discussion, the state has come to realize that its unique energy portfolio is extraordinary in comparison to the rest of the United States.

Currently, coal is the principal source of electricity generation in the U.S., providing over 50 percent of the country's total power and disgorging billions of tons of carbon dioxide and other harmful toxins into the atmosphere annually.

In Vermont however, the story is vastly different. With clean hydro and nuclear providing two-thirds of Vermont's total power with negligible carbon emissions, the state has one of the cleanest energy portfolios in the country.

However, Vermont still faces energy challenges in the near-term. For one, the state's long-term contracts with Hydro-Québec and Vermont Yankee will begin to expire in 2012. Unless these contracts are renewed, the Green Mountain State will be forced to import expensive electricity from the grid that will almost surely come from fossil fuel fired power plants.

Positive steps to secure future contracts with Vermont Yankee and Hydro-Québec have already been taken, however Vermont must continue to broaden and diversify its current electricity portfolio by developing and incorporating more renewable energy sources into its mix, along with expanded energy efficiency programs.

When considering renewable sources like wind, biomass and hydro, the same question always persists: How much power can these sources really provide?

Currently, hydropower in Vermont meets anywhere from seven to ten percent of the state's electricity needs, depending on the year. Is that all Vermont can expect or is there room to further tap into this resource?

This issue brief seeks to answer these questions and provide some key facts surrounding the current use of hydropower, including the pros and cons associated with this resource and the potential for further hydro development in Vermont.

The Vermont Energy Partnership has developed this issue brief with the intent of helping to educate the public, policy-makers and the media about Vermont's energy challenges, now and in the future.

Hydropower Production Overview

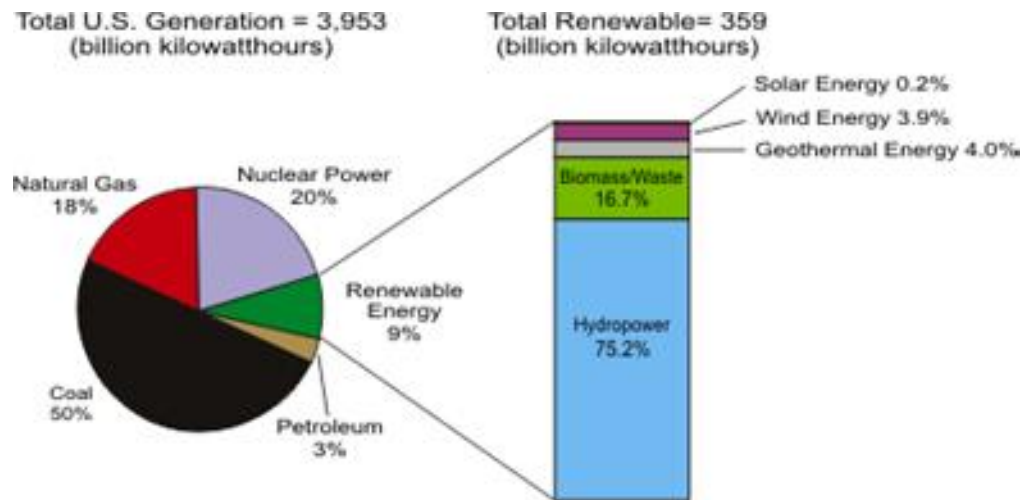
Worldwide hydropower production is expected to increase to meet demand. Currently, hydropower accounts for approximately 20 percent of the global electricity supply. Experts estimate that this percentage will remain constant in the near future, as new projects are brought online to meet increasing global electricity demands, which are projected to rise about 76 percent by 2020.¹

Over 500 hydroelectric projects with an estimated combined output of 152,900 megawatts (MW) of electricity are currently under development in 80 countries worldwide. This includes China's \$29 billion Three Gorges project, a massive dam on the Yangtze River capable of generating 18,200 megawatts from 26 generators, each roughly equal to a mid-sized nuclear reactor.²

Hydropower is the largest renewable electricity source in the world and the United States. Hydropower is the most significant source of renewable energy generation in the world, accounting for about 92 percent of all the renewable energy produced.³

In the United States, wind, biomass, hydro and solar combined meet about nine percent of electricity demands. The vast majority of this renewable power comes from hydro, which alone accounts for roughly seven percent of the nation's electricity portfolio, and makes up roughly 76 percent of all renewable electricity production in the U.S.⁴

Total U.S. Electricity Generation by Energy Source⁵



¹ Hydro Research Foundation, "Hydropower Internationally," <http://www.hydrofoundation.org/hydropower/international.html>

² *Ibid.*

³ *Ibid.*

⁴ U.S. Energy Information Agency, "Renewable Energy Trends 2005," http://www.eia.doe.gov/cneaf/solar_renewables/page/trends/rentrends.html

⁵ U.S. Energy Information Agency, "Renewable Energy Sources: A Consumer's Guide," <http://www.eia.doe.gov/ncic/brochure/renew05/renewable.html>

Hydropower production can fluctuate. With over half of U.S. hydropower produced in Washington, California and Oregon, any fluctuations in water levels caused by droughts can drastically affect hydro output. Between 1989 and 2005 hydro experienced low yields, which was directly attributed to droughts.⁶

While hydropower on average is responsible for about seven percent of the U.S. electricity supply, it can reach upwards of ten percent. That is enough power to supply electricity to “about 35 million residential customers in California, New York, Ohio, Pennsylvania and Texas.”⁷

⁶ U.S. Energy Information Agency, “Renewable Energy Sources: A Consumer’s Guide,” <http://www.eia.doe.gov/neic/brochure/renew05/renewable.html>

⁷ Hydro Research Foundation, “*Hydropower Today*,” <http://www.hydrofoundation.org/hydropower/index.html>

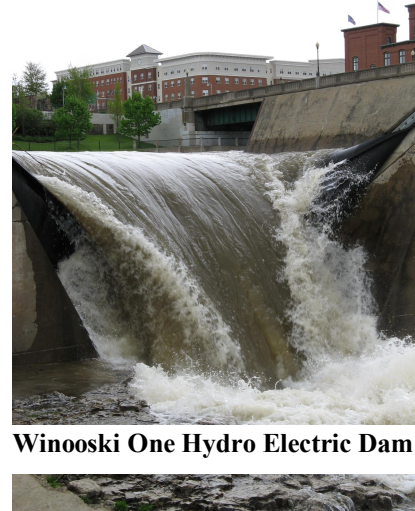
The History of Hydropower in Vermont and its Role Today

Vermont's history is closely tied to hydropower. In the 1700s hydropower played a critical role settling Vermont as people used rivers to power their saw and grist mills.⁸ Over time these hydro-mechanical sites turned to hydroelectric generation, which brought the first electricity to Vermonters,⁹ and became the bedrock of early industrial development in the state.¹⁰

By World War II hydropower was the primary source of electricity in Vermont,¹¹ however by the 1950s hydro dams were abandoned as more people switched to the then abundant and cheap power of fossil fuel.¹² It was not until the 1980s and 1990s that hydropower experienced a resurgence as many dams were rebuilt and brought back online. Today, it is common for utility companies to own and operate dams.

In Vermont, Central Vermont Public Service (CVPS) owns and operates 20 hydro facilities¹³ and GMP operates eight additional dams. Last year the dams owned by CVPS produced 237 million kilowatt hours of electricity, enough to supply 20 percent of the company's residential consumer demand.¹⁴ In 2006, GMP's dams also had a productive year, accounting for about 7.8 percent of the company's total electricity output. On average the dams contribute closer to four to five percent.¹⁵

Today, there are approximately 85 hydro electric facilities operating in Vermont and on waters bordering other states.¹⁶ These facilities play an important role in Vermont's electricity portfolio, supplying on average seven percent of Vermont's total electricity demand.¹⁷



Winooski One Hydro Electric Dam

⁸ VTEP interview with Jeff Wallin, July 31, 2007.

⁹ *Ibid.*

¹⁰ VTEP interview with John Warshow, August 13, 2007.

¹¹ *Ibid.*

¹² VTEP interview with Jeff Wallin, July 31, 2007.

¹³ Gordon Dritschilo, "Micro hydro makes small-town comeback," Times Argus, 5 August 2007.

¹⁴ *Ibid.*

¹⁵ Dotty Schnure, Green Mountain Power, July 27, 2007.

¹⁶ Vermont Agency of Natural Resources, Facilities Engineering Division, "Hydroelectric Power," <http://www.anr.state.vt.us/dec/FED/damsafety/hydropower.htm>

¹⁷ Vermont Department of Public Service, "Vermont Electric Plan 2005." January 19, 2005, p.9-2.

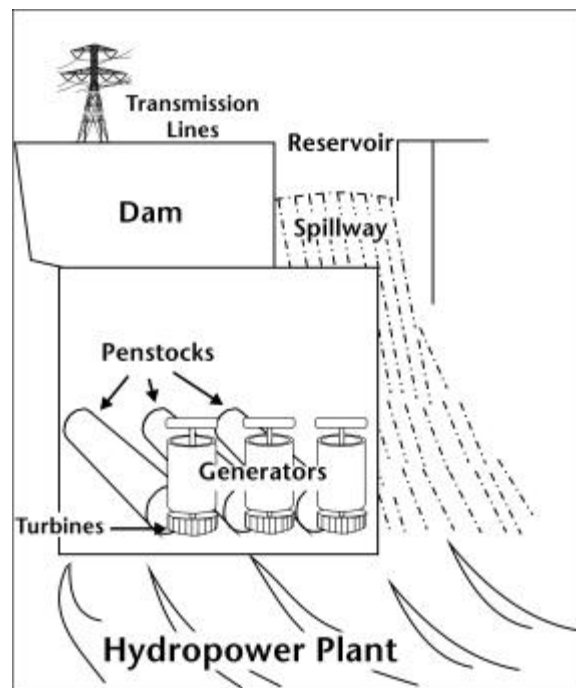
Types of Hydropower Used in Vermont

There are two main forms of hydropower production in Vermont: run-of-river, which uses the natural flow of water to generate power, and those that store or “pond” water behind a dam.

Run-of-river facilities rely on seasonal rainfall and snow pack from watersheds to produce power. Although there are times during the year where production is low (typically mid-July through September), river flow is relatively predictable.¹⁸ Run-of-river power is considered more environmentally friendly than other hydropower forms, as it does not require major changes to river flow or surrounding ecosystems.

The other type of facility in Vermont incorporates the pond method, where water is stored behind dams. Storing water behind a dam allows for control of the water flow and thus consistent electricity production. When demand for electricity is at peak levels, these facilities can increase electricity production, unlike run-of-river hydro generation. Consistency and control make the ponding method more lucrative;¹⁹ however, ponding can radically change or damage the river and surrounding environment.

Inside a Hydro Electric Facility²⁰



¹⁸ VTEP interview with Jeff Wallin, July 31, 2007.

¹⁹ Vermont Department of Public Service, “*Vermont Electric Plan 2005.*” January 19, 2005, p.4-2.

²⁰ U.S. Energy Information Agency, “Hydropower: Energy from Moving Water,”

<http://www.eia.doe.gov/kids/energyfacts/sources/renewable/water.html>

Benefits of Hydropower

Harnessing the power of water provides a number of environmental and economic benefits. Some of the major advantages of hydroelectricity include:

- ✓ Clean power – Since hydropower relies on water to generate electricity, it does not produce any harmful pollutants (like greenhouse gases) that fossil fuel sources like coal and natural gas do. The National Hydropower Association estimates that more than 160 million tons of carbon emissions were avoided in the U.S. in 2004 by the use of hydropower.²¹
- ✓ In-state power sources provide grid stability – In-state power sources tend to be more reliable and increase grid stability. This helps to reduce Vermont’s need to purchase power from other states on the spot market. In addition, ponding facilities can go from zero to maximum output as necessary. This is especially crucial during peak periods when electricity demand is at its highest.
- ✓ In-state power sources have economic benefits – In-state hydro facilities pay property taxes and provide local employment to Vermont communities. Estimates from 1997 indicate that hydropower stations paid more than \$11 million in property taxes and local payrolls for more than 100 Vermont cities and towns.²²
- ✓ Renewable energy source – The use of water to generate electricity is considered a renewable energy source, meaning that unlike limited sources such as coal or oil, hydropower will be available as long as there is water flow.
- ✓ Recreational uses – Many hydropower sites are open to the public for recreational usages such as boating, swimming, fishing, canoeing and kayaking.
- ✓ Hydro sites are widely dispersed – Hydro sites in Vermont are located throughout the state, which ensures that there will be some generation all the time.²³

²¹ National Hydropower Association, “HydroPOWER the power of moving water,” <http://www.hydro.org/hydrofacts/docs/climatefriendlycleanfactsheet.pdf>

²² Vermont Hydropower Coalition, “Your Guild to Public Access at Vermont Hydropower Sites,” 1997.

²³ VTEP interview with Jeff Wallin, July 31, 2007.

Drawbacks of Hydropower

While there are certain benefits to using hydropower for electricity production, like any power source, there are also drawbacks. Some of the problems associated with hydropower include:

- ✓ Environmental degradation – Dams alter the natural state of the river which can affect aquatic life and vegetation. Some forms of hydropower, such as ponding, have a greater negative impact on the environment than run-of-the river facilities and others.
- ✓ Many dams require license renewal – Many projects require a license renewal from the federal government in order to operate. These licenses can be granted for 30–50 years. The process can be quite lengthy as complex issues such as flow and water level management, wildlife, endangered species, recreation and cultural resources are considered.²⁴ Recent concerns around the environmental impact of some dams are expected to lead to certain restrictions, and in some cases, a switch from the ponding method to run-of-the river which will likely reduce output.²⁵
- ✓ Power can fluctuate – Although power output can be closely estimated, production does fluctuate yearly based on rain or snow fall. Droughts and other extreme weather changes have a major affect on the amount of electricity produced.
- ✓ Economic considerations – The power sold to utilities from in-state hydro facilities is around 13 cents/kilowatt hour (kwh). This is considerably higher than Vermont’s current long-term contracts with Vermont Yankee at 4 cents/kwh, and Hydro-Québec at 6.5 cents/kwh. As the Department of Public Service has pointed out these higher prices cause concern about the potential for higher electric rates.²⁶

²⁴ Vermont Agency of Natural Resources, Facilities Engineering Division, “*Hydroelectric Power,*” <http://www.anr.state.vt.us/dec/FED/damsafety/hydropower.htm>

²⁵ Vermont Department of Public Service, “*Vermont Electric Plan 2005.*” January 19, 2005, p.4-2.

²⁶ *Ibid.*

The Future of Hydropower in Vermont

Many agree that Vermont has already developed the vast majority of utility scale hydro sites.²⁷ John Warshow, a co-owner and operator of the Winooski One hydro dam, estimates that there may be another 20 megawatts of undeveloped hydro available, but considers this a high estimate.

There is also the expectation that hydropower will sustain its current role in Vermont's electric portfolio at about seven percent (and at times as much as ten percent depending on the year) as long as Vermont can keep its electricity demand low. The one exception is if environmental damage at some dams inhibits production levels, in which case Vermont may see a slight decrease in output from hydropower.²⁸

But there seems to be a renewed interest in developing smaller, micro-hydro sites to be used by towns and local residents. Micro-hydro is small-scale (limited capacity) with minimal impact on wildlife, fauna, fish and the river.

A number of towns such as Morrisville, Hardwick, Enosburg Falls and Swanton already have municipal hydro projects,²⁹ and others are moving forward.

One project is in Bennington where the town was recently awarded \$63,000 from the Vermont Department of Public Service's Clean Energy Development Fund to construct a hydro dam that would provide half the power needed to run the municipal water treatment plant.³⁰

Still other towns are conducting studies on the potential to host small, low-impact hydro dams. For example, the City of Barre is currently studying the feasibility of hydropower and the best method to finance its development.³¹ Green Mountain Power is assisting this study by providing \$15,000 in matching funds.

While these smaller hydro projects may reduce some electricity costs for the towns and reduce carbon emissions, as David O'Brien, Commissioner of the Vermont Public Service Department explained when commenting on the Barre project, "While these sources will not become a dominant part of our power mix, they certainly can play a contributing role."³²

²⁷ VTEP interview with John Warshow, August 13, 2007.

²⁸ *Ibid.*

²⁹ Gordon Dritschilo, "Micro hydro makes small-town comeback," Times Argus, 5 August 2007.

³⁰ Patrick McArdle, "Hydro plan gets a boost," Rutland Herald, 11 August 2007.

³¹ Green Mountain Power, "Green Mountain Power Provides Matching Funds to the City of Barre to Study Low-Impact "Micro Hydro" Generation," press statement, 27 April 2006.

³² *Ibid.*

Conclusion

Hydropower provides Vermont with a number of benefits including the diversification of our electricity portfolio and the mitigation of significant amounts of CO₂ and other harmful emissions.

As Vermont contends with a steady, one percent annual growth in energy demand and faces the expiration of its two long-term contracts with Vermont Yankee and Hydro-Québec, the state must make several significant energy planning decisions that will have lasting effects.

Will the Vermont Yankee license be renewed and will Vermont continue to purchase power from this base-load source? Will contracts with Hydro-Québec be renewed, and if so at what price and for how much electricity?

There is still much to be done if Vermont is to ensure that it remains a leader in clean energy generation well into the future. Ensuring that hydropower continues to play a role in Vermont's electricity portfolio will be important as Vermont considers how to achieve a diverse, reliable, clean, and affordable energy portfolio.