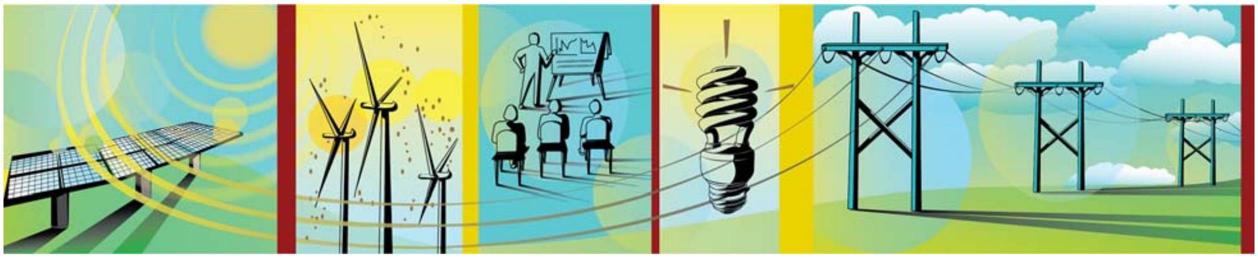

# 2009 Vermont Long-Range Transmission Plan

July 1, 2009

## Vermont Electric Power Company, Inc.

## VELCO

# Letter from VELCO CEO, John Donleavy

Dear Vermonter:

Electricity increasingly powers our lives. We depend on it. The backbone of the complicated machine that provides us reliable electric service is the transmission system. Vermont Electric Power Company (VELCO) constructs, owns and operates the state's transmission system and must ensure the integrity of this critical infrastructure. Our duty to ensure reliability requires us to identify potential transmission system problems early enough to fully consider solutions other than transmission, to share our findings, and incorporate the feedback of Vermonters.

This document is VELCO's 2009 Vermont Long–Range Transmission Plan. It looks out 20 years to identify potential reliability problems and their transmission solutions and serves as the first step for additional work to analyze Non-Transmission Alternatives (NTAs) such as local generation and energy efficiency. The Plan proposes 25 potential transmission solutions: six line reinforcements, with combined length of about 50 miles, and 19 substation projects. Total cost is an estimated 500 million to one billion dollars. The 20-year planning horizon affords ample time to examine NTAs that may make it possible to avoid or delay the need for some transmission reinforcement.

VELCO developed the draft Plan with the help and input of many stakeholders through a new collaborative planning process approved by Vermont's Public Service Board (PSB) in 2007. The PSB created what's called the Vermont System Planning Committee (VSPC). The VSPC, whose input helped shape the plan, consists of representatives from a broad cross section of interests including utilities, residential consumers, business consumers, and environmental protection.

In April and May, VELCO reached out to the public, aided by the Snelling Center for Government, through six public forums around Vermont and an on-line comment process. The input gathered through those means has been incorporate into this report by the addition of a new Section 2 that distills the public dialogue into 13 themes, and through other edits to the document.

One theme we heard clearly was the public's desire to see the whole picture of potential transmission projects; not just the reliability solutions that are the heart of this Plan. During the six months of public dialogue on the draft, so-called "economic transmission" projects that seek to bring renewable energy to market, and the potential that such projects would come through Vermont has emerged as a central transmission issue in the New England region. Our state lies between renewable energy sources on our borders and the customers who need them to our south. Interest in connecting customers with renewable energy is so strong companies other than VELCO may propose transmission projects for Vermont. Given the critical nature of this issue, the discussion of economic transmission's status has been expanded significantly, and VELCO expects to broaden a public discussion of the issue in the coming months.

VELCO's responsibility is to move power and maintain the integrity of the transmission grid. We embrace all options that ensure system reliability. We also know that public engagement works; this final 2009 Plan is stronger for the public dialogue that has taken place during the past six months. But it is just the first step. We now look forward to building on the Plan's foundation to address the individual reliability issues it identifies through collaboration with the utilities and the VSPC, and through public engagement.

Sincerely,

John J. Donleavy
President and Chief Executive Officer, VELCO

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THE FOLLOWING ATTACHMENTS ARE BOUND SEPARATELY FROM THE PLAN

Attachment 1 Comments of the Vermont System Planning Committee on the Technical Analysis
Attachment 2 Verbatim record of public comments
Attachment 3 Subsystem Assessment List

# 1 Overview

This document is the product of months of public input preceded by months of planning. This final version incorporates Vermont System Planning Committee (VSPC) and public input in several ways. Section 2 has been added to list and respond to the input received during public forums held in April and May. Minor changes have been made to the body of the document. A new Appendix 2 indexes the location of information required by Public Service Board (PSB) Docket 7081. New Attachments 1 and 2 contain a complete record of comments received from the VSPC and the public respectively. Finally, Attachment 3 lists the status of subtransmission system assessment.

Maintaining a reliable electric system involves careful long-range planning. Every three years VELCO, the owner and operator of Vermont's **transmission**[1] system, performs a detailed analysis that identifies reliability concerns and the transmission alternatives to address those concerns. The purpose of this Plan is to present the key findings from the most recent analysis and to put the findings in context.

VELCO's planning must balance three fundamental tensions. The first is the tension between state and federal regulations that are not completely complementary. Federal policy sets explicit, mandatory reliability criteria for transmission system design, while state policy is much less explicit and more diverse in its criteria for evaluating transmission upgrades against other alternatives. Second, state standards favor transparency and full public disclosure about transmission planning while federal rules governing **Critical Energy Infrastructure Information** treat detailed transmission planning data as sensitive information that must be protected to guard homeland security. Third, while the playing field is more level than in the past, regional treatment of transmission solutions and their alternatives, energy efficiency and **generation**, do not enjoy the same levels of cost support. The balance among these factors is addressed in various places throughout the Plan.

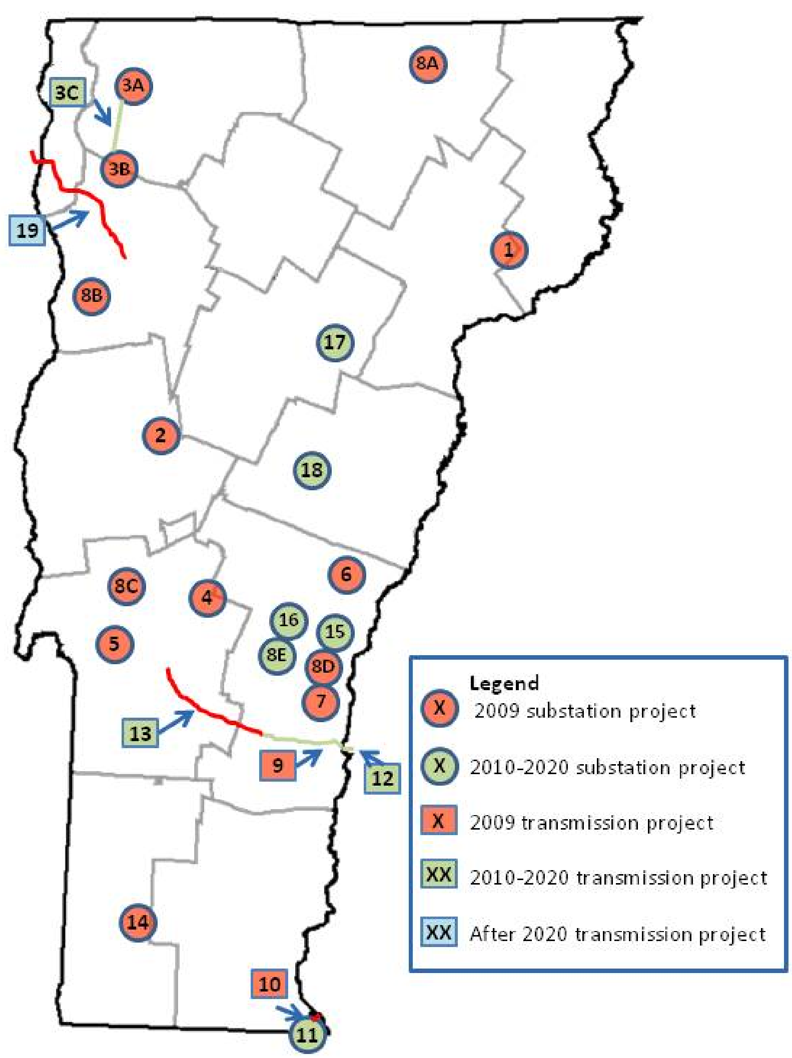
Since 2006, the last time a transmission analysis was published, there have been significant changes to the planning process. In a regulatory proceeding called Docket 7081, VELCO and other parties developed a new approach to engaging the public and other representatives in the planning process. Other modifications were made in how the analysis itself is conducted, such as incorporating mandatory national standards that became effective in 2007 and extending the planning horizon to 20 years.

One key assumption in the transmission analysis is that Vermont's peak electric **demand** will grow by 24 percent from 2008 to 2028, representing an annualized growth rate of 1.1 percent. Another major and perhaps more significant factor driving the need for new reinforcements to the transmission system is the mandatory national reliability standards imposed on the industry in 2007. These standards carry a fine of up to $1 million per day per violation for non-compliance. The standards require a transmission system capable of reliably transmitting **power** over a wide range of expected operating conditions, such as the loss of two major components of the system.

[1] Highlighted terms are included in the glossary at the back of the Plan. In the online version, these are hotlinks.

The 2009 analysis identified 23 transmission performance issues that require reinforcement to comply with reliability and planning standards. Twenty-five new **transmission system reinforcements** were identified to address the 23 identified **reliability deficiencies**. These reinforcements describe the potential transmission solutions to the identified deficiencies, should it be determined through the planning process that transmission is the best alternative.

Figure 1-1. Proposed transmission related project locations.




The numbers on the map in Figure 1-1 are keys to the locations, type and timing of the proposed reinforcements. (See pages 26-27, Figure 4-5, for descriptions of the numbered projects.) Of the 25 projects, six involve transmission lines, and the rest are substation related. The **substation** reinforcements involve the addition of equipment to existing facilities, and sometimes the expansion of existing facilities. Of the six transmission line projects, projects 3B and 19 involve new lines, whereas the other projects propose rebuilding existing lines to a higher capacity.

VELCO currently estimates the total cost of transmission solutions to all 23 issues will range from $512 million to $902 million at today's costs (2008 dollars). Based on VELCO's analysis, 14 reinforcements are needed as soon as practicably possible, representing about 38 percent of the proposed dollar investment total. One single reinforcement (number 19), also represents about 35 percent of the proposed total investment. That project is currently identified as being needed in 2021 for system reliability reasons but may be considered sooner to facilitate access to **renewable** resources in New York State among other factors. The remaining reinforcements are needed between 2010 and 2020, and represent about 27 percent of the proposed total investment.

In addition to performance issues on the transmission system, planners identified seventeen potential **subtransmission** performance issues when they applied a single explicit set of criteria for uniform examination of the 34,000 to 70,000 **kilovolt (kV)** part of Vermont's power system. (See Figure 4-2 for a list of the potential subtransmission performance issues planners identified.) The subtransmission facilities are for the most part owned and operated by Vermont's local **distribution utilities**. At this time federal standards do not apply to these areas, giving local utilities more flexibility concerning the reliability level to which the subtransmission system is designed when compared to transmission. Local distribution utilities determine what, if any, projects are required to address the potential reliability issues on the subtransmission system. However, given that the transmission and the subtransmission systems are parts of an interconnected, interdependent network and the reliability of one affects the reliability of the other, VELCO is required to understand how the subtransmission system will perform.

The transmission reinforcements identified in the 2009 Plan would address only the identified reliability concerns. The Plan does not include transmission projects that could be needed to accommodate the purchase and delivery of renewable generation, to replace resources that may retire, to facilitate the operation of the energy market, or as the result of large, localized increases in **load** due to potential development. It is possible that one or more transmission projects will be proposed for these reasons within the plan's horizon. For instance, two major energy sources that supply a large percentage of Vermont energy needs—Vermont Yankee and Hydro-Québec—may become unavailable within the next ten years. Replacing these resources may require transmission system reinforcement. If New England decides to access renewable resources from Canada or New York, transmission reinforcements may also be needed in Vermont.

During April and May of 2009, public meetings were held in locations around the state to gather input on the draft plan. The description, evaluation and outcomes of these meetings is available on the VELCO website at www.velco.com/publicoutreach. Next steps in the process will entail further study of transmission and **non-transmission alternatives (NTAs)** to the proposed transmission projects, where applicable. If a proposed transmission project is determined to be the best alternative, the project will undergo additional detailed study and extensive review. The planning process anticipates public input into each of these steps, as well as opportunities for public input when and if any project is ready for a permit application to the PSB.

# 2 Responses to Public Input on the Plan

VELCO conducted an extensive public engagement process to gather input on the 2009 Vermont Long-Range Transmission Plan—Public Review Draft.[2] From April 27 through May 19, VELCO hosted six public forums on the Plan in locations around the state, which were convened with the assistance of the Snelling Center for Government. In addition, VELCO solicited written comments through an interactive website created for the public engagement process (www.velco.com/publicoutreach) and through direct mail and email to more than 1,800 people and groups. Participants' comments[3] addressed three broad areas: (1) the content of the Plan; (2) information about local communities and projects happening at the local level; and (3) the outreach process itself. The following section summarizes and responds to the themes that emerged from the public comment process.

**Theme 1: The Long-Range Plan is too narrowly focused on reliability. It should consider the full spectrum of issues affecting Vermont's transmission system.**

Various participants expressed the concern that the Plan dealt only with reliability-based transmission needs when the current environment also includes increasing consideration of transmission to bring renewable power and other energy supplies to market, so-called "economic transmission."

The regulatory framework that requires VELCO to prepare this Plan—the Memorandum of Understanding and PSB order in Docket 7081—is focused on planning transmission for system reliability. Issues of system reliability must be addressed; VELCO's responsibility is to maintain a system that will meet federal and regional reliability standards. When this Plan was drafted, economic transmission had not yet taken on its current prominence. In recent months, activity at the regional and federal levels has made the issue significantly more pressing. For these reasons, the following discussion has been added to this final report.

Multiple proposals under consideration at the regional level provide evidence of the increased immediacy of economic transmission issues. Among these proposals are: a 1,200 MW direct current (DC) project proposed by Northeast Utilities, NStar, and Hydro-Québec; and a proposal to bring large amounts of renewable energy through Vermont to serve loads in New England (including Vermont) and the Mid-Atlantic, via a transmission line built by Northeast Utilities through a "New England Transmission Consortium."

In addition, the reliability project identified in this report as Priority 19 (Plattsburgh to Essex or "PV 20") has the potential to become an economic project in a more immediate time frame to serve both reliability needs and the demand for renewable power in Vermont and New England from wind and

[2] The Snelling Center for Government final report detailing the public outreach process is posted at http://www.velco.com/publicoutreach/Pages/default.aspx .

[3] A transcribed record of comments at the public forums, along with a compilation of written comments, is posted at http://www.velco.com/LongRange/Documents/2009planattach2.pdf.

other resources in upstate New York. These projects have emerged rapidly as a result of increasing federal, regional and state focus on carbon emission reduction. Consequently, it is likely that other regional proposals will join this list soon.

The discussion of regional needs for transmission on based solely on reliability is already underway. In April of 2009 the New England Independent System Operator (ISO-NE) stated that it had received six "Economic Study Requests" with the two top priorities both involving Vermont. The first of these, originating from the New England Governors, asks ISO-NE to "conduct studies of potential renewable generation in New England and the associated transmission infrastructure required to integrate them." ISO-NE's second priority is to study ways to "increase the power transfer capability from the New York to the New England system." This study came about in part by the New England Governors' request and in part by request of New England Transmission Development LLC, which is exploring options to bring renewable energy to New England from generation being proposed and built in New York.

Dynamics driving the interest in economic transmission routes in New England include a large power supply gap in southern New England; a gap in renewable power needed by 2025 to meet New England renewable energy portfolio standards; and a gap in the resources needed to comply with the Regional Greenhouse Gas Initiative 2025 limits on carbon dioxide emissions.

Many sources for new, renewable generation capacity and energy are located in Quebec and upstate New York, meaning that Vermont lies between the source of clean power and the customers who need it. These dynamics may mean that transmission proposals for lines in Vermont, whether upgrades or new transmission corridors, will be submitted for regulatory approval regionally and in Vermont, whether they are proposed by VELCO or other companies. VELCO and Vermont almost certainly face a decision to meet the need ourselves or to leave it to other transmission companies to own, build and operate transmission within the State. (Other companies can make proposals regardless of what action VELCO takes.)

The path of decision-making on economic projects has begun at the regional level, but will ultimately include the need for PSB approval of any new or upgraded lines. The speed and extent of the regional discussion has created the need to expand discussion of the issue in the present context, as well as beginning a separate process of public engagement with Vermonters in the months following the filing of this Plan.

**Theme 2: The Plan does not adequately take into account possible Vermont Yankee decommissioning.**

The 2009 analysis examined transmission system performance with Vermont Yankee out of service. The analysis assumed that, with Vermont Yankee decommissioned, the plant's output would be replaced from outside of the state of Vermont and, under this assumption, demonstrated that no new transmission facilities would be needed in Vermont if Vermont Yankee is decommissioned. The analysis indicated the potential need, absent Vermont Yankee, for additional transmission facilities in adjacent states.

**Theme 3: The Plan does not explain the consequences of the Hydro-Québec contract ending.**

The 2009 analysis examined transmission system performance with the Highgate DC converter offline, reflecting the conditions that would result from an end to Vermont importing Hydro-Québec power by its current route. The analysis, which assumed replacement power from sources outside Vermont, demonstrated approximately a 10-year acceleration of the need to carry out the upgrade designated Project 19 (Plattsburgh to Essex or the "PV 20"). Any change in assumptions regarding the Highgate DC converter's status or location of the energy replacement for the Hydro-Québec contract may impact the timing, scale and scope of Project 19.

**Theme 4: The Plan should more extensively address expected increases in energy efficiency.**

The forecast used by VELCO in its analysis was developed by a qualified third-party firm (Itron) during the first and second quarters of 2008. The forecast used available economic forecasting data, known changes in nationwide/statewide energy use—such as those from the Energy Independence and Security Act (EISA) of 2007—and efficiency trends in appliances. All of these factors were considered and included as input data for the forecast developed and supplied by Itron. By incorporating past peak demands, which include ten years of rate-payer funded energy efficiency efforts, as well as appliance efficiency trends, the forecast reflects some of the impact of in-state energy efficiency.

Prior to the next update of the Long-Range Transmission Plan, Efficiency Vermont will provide a 20-year forecast of the peak demand reductions from Vermont's expected energy efficiency efforts. VELCO will take this information into account when we develop the peak demand forecast for the next Plan to be published in 2012. In the meantime, the Plan has described the need for each reliability-driven upgrade in terms of both the year and the statewide peak demand load level at which it is needed. If the forecast expectations change, whatever the reason, the timing of the need for reliability-driven upgrades can be based upon these statewide load levels, rather than dates. (These "need" load levels are shown in Figure 4-5 on pages 26–27 and Figure 4-6 on page 28.)

The Plan provides a foundation for in-depth, project-by-project analysis by the affected utilities. These next steps provide the opportunity to further consider information from the first Forecast 20, to be published in 2009, as well as other emerging data that may not have been available at the time of the ITRON forecast.

**Theme 5: The forecast should incorporate decreases in demand driven by the economy.**

The forecast was developed in the spring of 2008 with economic forecast data from April of 2008. VELCO acknowledges that peak demand can be impacted by significant changes in the economy, with economic downturns potentially resulting in fewer commercial customers and heightened cost-sensitivity from residential customers. What is difficult to predict, though, is the exact impact of these concerns on the peak demand. New seasonal peaks have been established during recessions. As discussed in Theme 4 above, the "need" load levels can be used to determine the timing of the specific upgrades with revised forecasts that reflect more recent economic impact information. In addition, the three-year update cycle required by the planning process will mean that the forecast is updated in a relatively short time frame, allowing utilities to consider the measurable impacts of the current recession as early as 2011. Lastly, the process of reviewing each identified reliability issue in detail will enable utilities and stakeholders to update assumptions in relation to each potential project.

**Theme 6: The significant current efforts to implement “Smart Grid” should be taken into consideration in the Plan.**

The installation of additional information technology throughout grid operations, including advanced metering infrastructure, or “Smart Grid,” could have a significant impact on the transmission system, potentially changing how peak demand is manifest and controlled. Vermont and the nation are at the very beginning stages of implementing these technologies. Consequently, planners face major unknowns, such as when this infrastructure will be built, what will be built in Vermont, and how much it will impact peak demand. As soon as the specific details of Vermont’s Smart Grid adoption are known, VELCO will begin to incorporate Smart Grid’s impact into its planning and forecasting. In the meantime, the company remains actively engaged with Vermont’s distribution utilities, public officials and Congressional representatives in aggressively pursuing every reasonable Smart Grid opportunity.

**Theme 7: The Plan should include a variety of scenarios that show how the choices of Vermont and individual Vermonters could affect future transmission needs.**

VELCO heard this input in the public meetings and will likely adopt it in the process and format of future plans. In the current iteration, time does not permit drafting a full range of scenarios. However, the current Plan as drafted does permit the consideration of multiple scenarios for reliability-based upgrades. Specifically, by varying assumptions about when load levels that trigger the need for each project will be reached, it is possible to project various scenarios regarding peak demand and therefore project timing.

Some participants in the public input process were very concerned about power supply issues and wanted VELCO to provide scenarios that address the transmission impacts of various power supply decisions. VELCO is constrained in this regard. According to federal law, as a transmission-only company, VELCO cannot provide information to any electric market participant that may give that market participant an unfair advantage over another. In addition, distribution utilities, rather than VELCO, are responsible for power supply decisions. Consequently, information on power supply scenarios is not included in this version of the Plan beyond examining the consequences of Vermont Yankee being decommissioned and the Hydro-Québec contract expirating.

VELCO intends to explore the concept of scenario analysis for the next Plan by seeking input from the VSPC and other forums prior to the initial draft.

**Theme 8: The Plan adheres to the current planning requirements and standards, but fails to look at a broader vision of the future.**

Like any planning process, VELCO's transmission evaluation must rely on many foundational assumptions. One of these assumptions is that the current planning requirements and standards will continue for the period under evaluation. Any deviation from this practice would require an objective basis of support for the change.

At the same time, VELCO continues to take action in the broader arena that reflects the preferences of Vermont policy makers and citizens. For example, the legislature has directed Vermont utilities to advocate regionally for parity funding by ISO-NE of non-transmission alternatives. VELCO continues to actively pursue this action, along with other Vermont utilities, through the VSPC. Through this and other initiatives, the company seeks to integrate the larger policy context with the specific, technical task of assessing system reliability in the Long-Range Transmission Plan. These responses to public input, along with Section 4 of the Plan, attempt to incorporate the variety of issues that, while they are not precisely measurable at this time, are likely to influence the future of the transmission grid.

**Theme 9: Extensive local activity is underway to develop in-state renewable generation sources. This trend needs to be fully taken into account by the Plan. The Plan should provide for infrastructure that would allow Vermont to build significant in-state renewables, and import system power only when needed to balance the in-state resources.**

The current Plan in no way precludes the incorporation of in-state renewable and distributed generation. VELCO accounts for planned local renewables if they meet the standards applied to other power sources considered in the Plan. These power sources, if they are above 1 MW, need to file with ISO-NE for consideration or analysis. Many of these sources also will need to file with the Vermont PSB for permission to construct the facilities. Planners need the information generated by these regulatory processes to model the power sources and to know they have achieved a level of certainty warranting inclusion in our analysis.

The analysis for the Plan took into account in-state renewable power sources that are the subject of specific proposals under regional or state regulatory review. The new in-state sources analysed were: the Sheffield wind farm; the Coventry landfill generator; the VPPSA Swanton gas-turbines; and the Moretown landfill generator.

Smaller projects may not be reviewed by ISO-NE and may face different permitting requirements at the PSB. These smaller generators, while of potential consequence locally, are too small in scale to have a significant impact on the performance of the transmission grid, although they may have the net impact of reducing effective local load in future forecasts.

To serve as reliability resources, small-scale renewable resources must also demonstrate their ability to perform at peak demand levels. Some of the more common renewable energy supply sources, such as hydro and wind power, can have a limited ability to generate power during our periods of highest electric demand, summer peaks. For example, Vermont's installed hydro power plants typically produce 10 to 15 percent of their maximum output during periods of peak demand on the hottest summer days. As local renewable projects are permitted, they will be incorporated into the transmission reliability analysis taking these factors into account.

**Theme 10: Alternatives do not enjoy a level playing field with transmission in terms of funding.**

Alternatives to transmission, such as power plants or energy reduction programs (efficiency and demand response efforts), can and do receive regional funding, but not in the same manner as transmission upgrades. The difference is due to a number of factors, including regional tariff language and the deregulation of the power markets. While these facts do not affect the analysis of transmission system performance, they play a role in VELCO's activities at the regional level. As discussed in Theme 8 above, VELCO, along with the other Vermont utilities, continues to advocate at the regional level for parity treatment of non-transmission alternatives.

**Theme 11: The Plan should do more to take non-transmission alternatives into account.**

The Plan takes into account those non-transmission alternatives that have been publicly announced and can be accounted for with a known level of certainty in terms of modeling and representation. These include those power plants that have followed the process for consideration and analysis with ISO-NE and those plants with filings before the Vermont PSB. Forecast 20, the first long-range forecast of energy efficiency impacts, will not be available until July, 2009. As a result, the Plan's demand forecast accounts for energy efficiency based on historical information as described in Theme 4 above.

**Theme 12: We cannot afford to build everything that the Plan says is required.**

In developing the Plan, VELCO must identify system upgrades that will be needed to maintain reliability if demand grows as forecasted. In doing so, VELCO must comply with reliability standards and rules set at the federal and regional levels. Deferring or avoiding the costs of maintaining transmission reliability to meet these standards would require influencing one or more of the variables that underlie the current regulation of transmission reliability. Modifications to the applicable reliability rules and standards could result in fewer identified reliability issues, but would have to be addressed through changes in federal and regional rules and laws. Reductions in project costs associated with permitting and construction could be achieved at the state level, but might mean reducing the amount of public engagement and regulatory oversight Vermont has traditionally provided.

Ultimately, each project identified in the Plan must undergo project-specific planning, consideration of alternatives, public engagement and permitting. The process provides many opportunities for Vermont citizens and regulators to weigh the costs and benefits of addressing identified reliability issues through transmission or other alternatives. The Plan is the first of many steps.

**Theme 13: Feedback on the public engagement process.**

The format of the public forums on the Plan sought to maximize public dialogue and avoid a traditional public hearing approach or didactic presentations. The meetings included six information kiosks on relevant topics, such as the planning process, environmental aspects of transmission, electric system basics, and, of course, specifics of the Plan itself. After participants had a period of time to visit the kiosks of their choice and get answers to their questions, the Snelling Center convened facilitated groups at tables where participants' comments were gathered using small digital voice recorders.

At the first two sessions, participants conveyed their concern that they did not have an adequate grounding in the report on which to base their comments and suggested that VELCO add a brief overview of the Plan at the beginning of each session. This change was made beginning in the third session and proved positive.

Each session included significant efforts to gather feedback about the process. Feedback was generally positive, as indicated by the evaluations contained in the Snelling final report.[4] The key suggestions for improvement that VELCO will seek to incorporate into future efforts are listed below.

1. *Improve turnout by making clearer the relevance of transmission planning and related economic impacts to people's lives and businesses.*

2. *Ensure access to the Plan prior to the meetings so people are able to ask informed questions.* The project was designed to make the Plan available from Day One of the outreach process (April 2) in multiple formats via the project website. However, while the information was available, the invitation process did not contain a sufficiently clear "call to action" asking people to read the Plan before the meetings.

3. *Increase the readability of the content.* Based in part on the feedback of the VSPC, the original 200-page technical analysis was completely rewritten to a more readable 44-page public review draft. While VELCO received considerable positive feedback about the readability of the document, and its plain-English approach to technical subjects, there remains additional work that can be done in future plans to improve readability.

4. *Hold multiple small-group sessions so people can learn a little, then come back and ask questions. Do outreach as a two-stage process so people have a chance to get educated and then come back together to provide input.* VELCO is considering splitting the public outreach process into two phases for the next Plan update: a first phase prior to creating the draft, and a second phase to obtain input on the draft. We think this approach may help address several suggested areas for improvement.

5. *Distribute copies of the posters used at the kiosks. The information is a lot to absorb within the time of the session.* This will be added to future sessions.

6. *Provide a better summary pinpointing individual projects, including their timeline. Provide more information about local impacts, such as where clearing will be.* This aspect of the Plan will be strengthened in the format of future updates.

[4] The report is posted at http://www.velco.com/publicoutreach/Pages/default.aspx .

7. *Reach out to existing groups rather than asking them to come to you.* VELCO expects to better incorporate this approach into future input designs. However, the Vermont statute requiring the long-range planning process also requires VELCO to convene public input meetings, so convened forums will continue to serve as a component of the process, along with other tools.

8. *In going from the initial technical draft to the Public Review Draft, much of the analysis was determined to require protection due to its classification as Critical Energy Infrastructure Information. While the Public Review Draft is easier to read, a lot of information that was in the technical draft is no longer available. This diminishes the transparency of the process.* VELCO recognizes the tension between its federal obligations to protect Critical Energy Infrastructure Information and Vermont stakeholders' and regulators' expectations of transparency and public access. This is an emerging pressing issue throughout the region and the state as utilities grapple with federal rules and the implications for the state regulatory process become clearer. We hope and expect that shared assumptions about how to apply the CEII rules in the state context will be in place by the 2012 Plan. For the current plan, we note that much of the underlying technical analysis for the Plan is publicly available at http://www.velco.com/PublicOutreach/Pages/TechnicalAnalysis.aspx; those sections that are not publicly posted can be obtained by those with a demonstrated need through the Non-Disclosure Agreement process that is documented on the website.

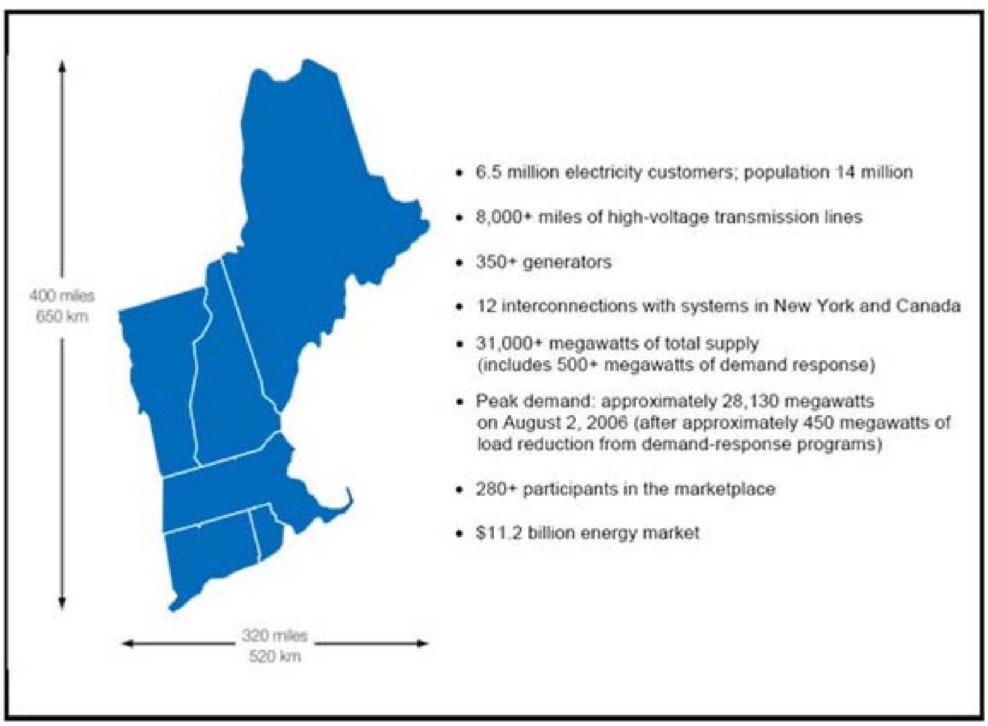
# 3 The Transmission Planning Process

## 3.1 New England Transmission System and Operations

Power systems have been called the most complex machines in the world because the electricity being made by power plants and delivered via the transmission and **distribution** wires must be in perfect balance with the electricity demanded by all customers at all times. Vermont's transmission system is interconnected with other utility transmission systems across New England, Canada and New York, which requires close coordination with these other states and regions to ensure that electricity is provided reliably and at an affordable cost.

ISO New England Inc. (ISO-NE) is an independent, non-profit organization that plans and operates New England's bulk electric system, administers the wholesale electricity markets and oversees regional system planning. ISO-NE ensures that individual utility companies plan for and operate the New England transmission system, or transmission "grid," in a way that assures the reliability of the entire New England system.

Figure 3-2. Key facts about New England electricity (source: ISO-NE).




*Note: "Participants" include power generation owners, marketers, transmission owners and other parties.*

ISO-NE reviews and decides to approve or not approve upgrades, modifications and additions to the New England transmission system, including Vermont. If a transmission project is deemed to provide reliability or economic benefit to New England, ISO-NE will categorize the project as a Regional Benefit Upgrade and the cost of that project will be shared throughout the New England states using a funding mechanism called **Pool Transmission Facilities** (**PTF**) funding. Most of the transmission reinforcement needs discussed in this Plan would likely be deemed by ISO-NE as benefitting all of New England. Vermont's share of any regionally funded transmission project, whether in or out of state, is approximately four percent of the cost, which reflects Vermont's percent share of New England electric load.

Regional sharing of funding for transmission projects has been present in New England for about a decade. Since 2008, through the creation of a regional energy market called the **forward capacity market**, developers of generation and energy efficiency are compensated through regional funding for their capacity to contribute to meeting the region's future electric demand. These energy supplies may reduce the need for building transmission. Since the funding mechanisms are not identical and complete parity has not yet been achieved, Vermont continues to advocate at the regional level for leveling the playing field between transmission and non-transmission resources.

The planning process discussed in this report is focused specifically and exclusively on the identification of issues and possible solutions to meet reliability standards. Transmission projects designed to meet other needs around New England, such as bringing renewable or low-cost power to customers, are under discussion around the region but will follow a different process.

Electric utilities generally interconnect within logical geographic regions, also called "power pools," that are sufficiently large to achieve reliability and economy-of-scale benefits. Although these power pools have ties with neighboring regions' power pools, they often directly generate most of the electricity consumed within their region. While this is the case for New England as a whole, for Vermont, these interconnections are even more critical. On a peak demand day in summer, Vermont may import between 75 percent and 90 percent of its electric demand via its transmission tie-lines with Vermont Yankee and Highgate, Canada, and the rest of New England—sources located at the edges or outside of Vermont. Vermont is therefore *highly* dependent upon the transmission network.

## 3.2 Key Transmission Planning and Operating Criteria

The 2003 **blackout** affecting 50 million people in the US and Canada led to more stringent requirements for transmission planning. The Federal Energy Policy Act of 2005 (the "Act") sought to prevent future large-scale blackouts and other electric reliability issues by making national reliability standards mandatory. Since June 4, 2007, users, owners and operators of transmission systems within the 48 contiguous states can be severely penalized for failing to comply with 83 electric reliability standards approved by the U.S. Federal Energy Regulatory Commission (FERC). Violation of any of the 83 standards is potentially subject to a penalty of up to $1 million per day.

If the transmission system fails, then large regions of the power system can experience a blackout. Achieving a high degree of reliability requires the system to have redundant features and excess capacity so that there is flexibility to reroute power due to equipment failures or when weather, accidents or other catastrophes cause a problem on the system.

Three out of the 83 national standards are particularly significant to planning for transmission system reliability. The first standard requires analyzing the transmission system using a scenario, called "N minus zero" (**N-0** ) where "N" represents normal operating conditions for a given set of system components. Electric systems contain thousands of pieces of critical equipment, such as **transformer**s, that will occasionally fail. To provide another layer of protection, utility planners must look at adding system backup, or robustness, to cover a second scenario called a "single **contingency** situation," such as the failure of a transformer or a lightning strike that causes the outage of a transmission line. These so-called single contingency scenarios are known as "N minus one" (**N-1**) conditions. The general philosophy is that no single failure of a piece of equipment connected to or comprising the transmission network should cause a large number of customers to lose power. Transmission designers further test the system design by looking at scenarios involving two or more equipment failures (known as "N minus one minus one" scenarios or "**N-1-1**").[5] To recognize the specific regional attributes of its transmission grid, ISO-NE has additional planning standards. For example, the system must be designed so that it can handle electric demand under extreme weather conditions (the so-called "**90/10 load**"), the outage of the two most critical generators, and limitations on the use of fossil fuel–fired peaking generation units. A detailed report of the exact modeling parameters used to create the transmission reinforcement plan is contained in VELCO's technical analysis.

By using these and other criteria to plan and design the generation and transmission system, transmission utilities seek to ensure that customers rarely lose power because of a problem in these parts of the system. Most customer outages are caused by a local problem on the distribution system such as a tree coming in contact with an overhead wire.

## 3.3 Electric Demand and Transmission Planning

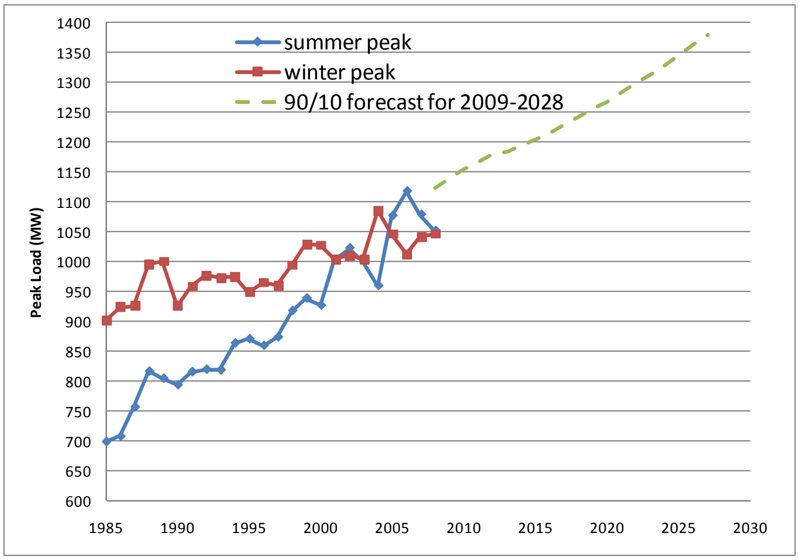
In years past, Vermont had its highest electrical demands in the winter. Those demands reached over 1000 **megawatts (MW)** in 1989. Actions taken by Vermont's regulators, utilities and customers resulted in a significant reduction of winter peak electric demand growth from the late 1980s to the present day. During the same period, steady peak demand growth occurred in the summer. In 1988, during a hot, humid summer, Vermont's peak demand was 815 MW, or barely 80 percent of the winter peak. By 2006, the summer peak demand had risen to 1118 MW, surpassing the winter peaks , due in part to an increased use of air conditioning over that time. The relatively mild summer in 2007 caused the winter and summer peak loads to almost equal. The overall trend has been one of increasing peak electric

[5] The "N-0," "N-1," and "N-1-1" scenarios are defined by national transmission planning standards TPL-001, TPL-002, and TPL-003, North American Electric Reliability Corporation, www.nerc.com.

demand. From 1991 to 2006, the non-weather-adjusted annualized electric peak demand growth averaged 1.2 percent per year. Meanwhile, summer peak demand growth from 1991 to 2006 averaged almost 2.2 percent per year. New transmission requirements are driven in part by the need to reliably serve this growing electric demand.

For transmission planning purposes, planners examine a range of forecasts. Vermont's analysis uses a forecast with a 90-percent probability (nine-out-of-ten chance) that the actual peak demand will be at or lower than the forecast. The so-called "90/10" forecast is used to ensure the transmission system is built to handle even low probability, but realistic, scenarios. For Vermont, the "90/10" forecast averages to about a 1.1 percent per year increase in summer peak demand. In 2018 and 2028, the planning load levels are 1275 and 1425 MW respectively.

Figure 3-3. Vermont peak demand: Actual from 1985 to 2008 and forecast through the 2028 planning horizon.




Source: Historical data from VELCO. 2009–2028 forecast is based on analysis from ITRON (an independent consulting firm) and represents a 90/10 forecast (90-percent chance the actual peak will be at or below the forecasted peak).

The way power flows within Vermont is not only impacted by the electric demand inside of Vermont but also across New England, Canada and other states. The New England load level for year 2018 was modeled at 33,200 MW, which also represents an estimated extreme weather 90/10 load and is based on the 2008 Capacity, Energy, Load, Transmission (CELT) Report issued by ISO-NE.

Developing a projection of future electric demands is a complex analysis. Historical usage, customer data, economic projections, appliance studies and efficiency measures are just some of the factors analysts examine when developing forecasts. The load forecast used for transmission planning purposes includes the effects of expected changes to energy efficiency due to new regulations, such as the increased use of compact fluorescent lighting in the near future. The load forecast also incorporates the effects of ongoing **demand-side management (DSM)** efforts because the historical data include the effects of past DSM. However, the effects of additional DSM due to increasing budgets for energy efficiency were not included in the load forecast. The load forecast also does not take into account recent macroeconomic events, such as the current economic downturn; however, the record of historical load data shows that prior recessions have had limited impact on long-term load growth.

Efficiency Vermont is the entity responsible for most energy efficiency, or DSM, programs in the state. They are currently preparing the first 20-year DSM forecast, which will be ready later in 2009 and will help inform future load forecasts. Any additional DSM efforts projected by that forecast can be accounted for by making a simple subtraction of the DSM impact from the load forecast.

Because of these and other uncertainties associated with forecasting electric demand, the need for transmission reinforcements is stated not only in terms of the year that each is estimated to be needed, but also by the level of electric demand in Vermont where a solution becomes necessary. The load level provides a triggering threshold, though the year in which it is reached may change from the predicted "year of need."

## 3.4 Vermont's Transmission Planning and Docket 7081 Process

VELCO is required to publish a Long-Range Transmission Plan that looks out 20 years and is updated every three years. That Plan analyzes the transmission system and serves as the foundation for a process that considers where transmission upgrades are needed and where alternatives can be employed. The intent of system planning is to assess the transmission system's needs over time as things such as peak load levels and generation resources change. In addition VELCO must comply with the previously mentioned planning requirements of ISO-NE and federal agencies such as the FERC.

The last Plan was produced in 2006. The transmission planning process and planning criteria have undergone substantial changes since 2006. These modifications include the mandatory national standards discussed above. In 2007 Vermont's PSB approved a new, collaboratively designed process that is defined in a in Docket 7081. The process is designed to facilitate full, fair and timely consideration of non-transmission alternatives to new transmission projects where such alternatives are cost-effective and meet design and reliability criteria. It accomplishes this goal through the VSPC, which increases collaboration among utilities, increases transparency of the process, and involves the public in decisions about alternatives. In addition, the new process extends the planning horizon from 10 to 20 years, which provides time to fully consider all alternatives.

Docket 7081 made major changes to Vermont's transmission planning process, including:

- **Creating the Vermont System Planning Committee.** The members of the VSPC include: representatives of each Vermont electric distribution and transmission utility and three public members who are appointed by the PSB to represent residential consumers, commercial and industrial consumers, and environmental protection advocates. In addition, three non-voting members participate in the VSPC, including the Department of Public Service (DPS), the Energy

Efficiency Utility (EEU) and the entity appointed to foster the development of renewable energy contracts, called the Sustainably Priced Energy Enterprise Development Facilitator (SPEED Facilitator). The VSPC meets quarterly to review utilities' analyses, planning and cost allocation proposals to address transmission system reliability deficiencies by local distribution utilities and VELCO. For more information visit www.vermontspc.com.

- **Increasing the planning horizon from 10 years to 20 years.** While state legislation mandates a 10-year planning horizon, it was recognized that a longer-term horizon of 20 years has value. It can take as long as 10 years to plan, approve, permit and construct a major transmission project. By expanding the planning horizon, the potential need for projects far into the future can be anticipated. Additionally, NTAs, such as energy efficiency or local generation, can be considered to avoid or defer the need for transmission reinforcements.

- **Identifying subtransmission system issues.** Potential inadequacies in Vermont's 34,000 to 70,000 volt systems are to be identified, but solutions to subtransmission issues will be the responsibility of local distribution utilities; therefore, the subtransmission solutions are not proposed in this analysis.

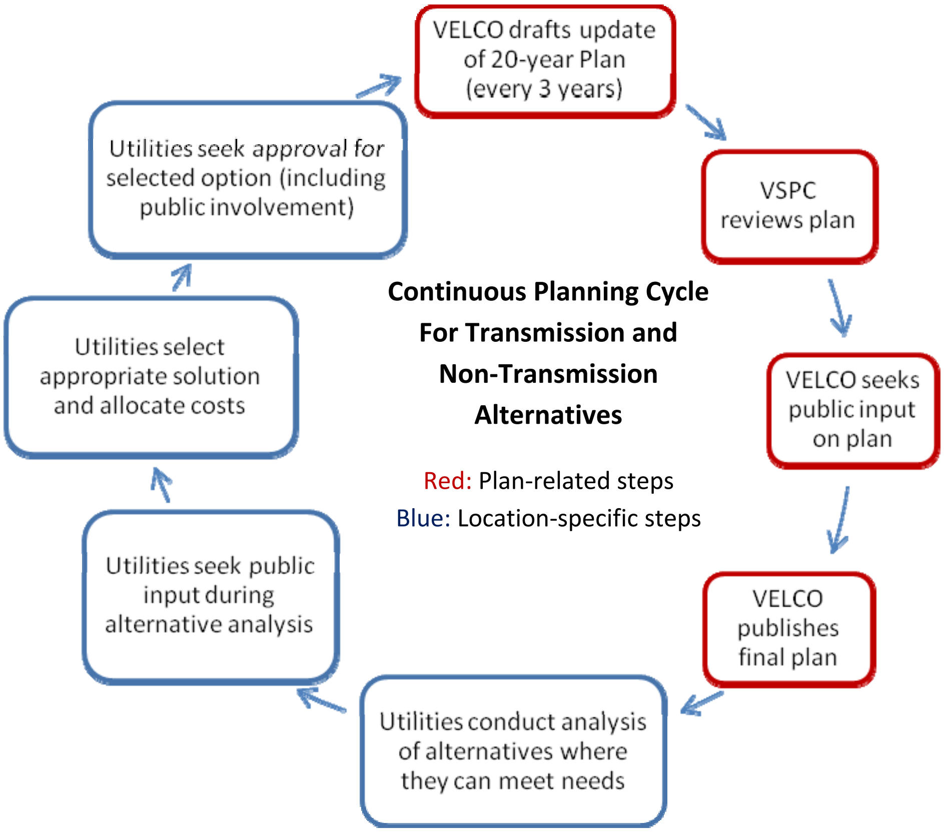
- **Formalizing the process of considering alternatives.** A formal and standard process is defined for evaluating whether alternatives to building transmission can solve each identified reliability deficiency. The process includes an "open door" for developers of potential alternatives to contact affected utilities and regulators to discuss possible NTAs. The process also includes a "market test," typically involving a solicitation for proposals to identify potential alternatives.

- **Assigning clear roles and steps.** Responsibility for moving the steps in the process forward is clearly assigned to a lead utility and **affected utilities**, who are identified through a formal process. Affected utilities are those whose systems cause, contribute to or would experience an impact from a reliability issue. The **lead distribution utility** is the utility selected by the affected utilities to facilitate decision-making and to lead the effort to conduct the analysis of alternative solutions.

- **Expanding public involvement in the planning process.** All VSPC meetings are open to the public and at least two public meetings are held in proximity to possible transmission solutions. In addition, the process includes requirements for a robust approach to public outreach in the development of Plan updates and as specific solutions are developed to each reliability issue.

An overview of Vermont's transmission planning process is provided in Figure 3-4. Publication of this document is the step, "VELCO publishes final plan."

Figure 3-4. Overview of Vermont's transmission planning process.




After filing of the final 2009 Plan, the VSPC process will proceed to its next step for each individual transmission performance issue. These next steps are complex and may take years to complete. The 2009 Plan includes a preliminary screening of each reliability deficiency to determine whether it passes a three-part test that has been approved by the PSB for this purpose. The screening makes a determination of whether alternatives to building transmission could be viable in each case. The screening is intended to include as many projects as possible, which, if they "screen in," move on to a full analysis of possible alternatives. The full non-transmission alternatives analysis then is the responsibility of the affected utility, guided by the lead utility.

For those projects that "screen out," and for those that are fully analyzed and it is determined that a transmission upgrade is the best alternative, the responsible companies—VELCO and/or one or more of the local utilities—will do the detailed planning for building the transmission upgrade. During this planning, the companies make extensive contact with local communities where the project will be built to provide information and gather input about how best to meet transmission system needs while recognizing local concerns.

Once transmission project planning is completed, the responsible companies file an application (called a "petition") with the PSB seeking approval to construct the project. Proposed projects must also be approved by ISO-NE, which generally looks at projects to ensure they will not harm other utilities in the region.

The Vermont approval process is referred to as the “Section 248 process” for the section of Title 30, Vermont Statutes, which lays out the requirements. The PSB is essentially a court, and the process for considering the petition is a formal one. During the process, the DPS acts as the public’s advocate before the PSB, and other individuals and groups may formally “intervene.” If and when the PSB grants approval, in the form of a Certificate of Public Good, the responsible company can begin construction, once it has all other required permits and approvals. The PSB publishes a Citizens’ Guide to the Section 248 Process, which provides a detailed description of the formal process.

The process from identification of the problem to implementation of a solution typically takes three to five years. During that time, the public will have at least three opportunities to provide input. As noted above, the first opportunity, in April and May 2009, was focused on this Plan. A second opportunity occurs when utilities are evaluating alternatives to building transmission to solve a particular reliability problem. Finally, when and if utilities are seeking PSB approval to implement a project, they will involve the public prior to making a formal request and the PSB will conduct local hearings in each affected county during its deliberation.

All of these activities are undertaken in parallel with VELCO’s responsibility to meet reliability criteria established on a nation-wide basis by entities such as the North American Electric Reliability Corporation, or regionally by groups such as the Northeast Power Coordinating Council and ISO-NE. ISO-NE has the responsibility for planning the interconnected transmission system in New England. Each year, ISO-NE examines system needs and publishes a Regional System Plan, which describes the collective transmission needs of the region in one document. VELCO assists ISO-NE by including Vermont’s transmission needs in this document. This report and others comprise the necessary documentation that ISO-NE and VELCO use to show planning compliance with current and forecasted system needs.

# 4 Reliability Issues and Solutions

## 4.1 Reliability Issues Identified

Figure 4-1 summarizes the transmission reliability issues identified as part of the 2009 planning process. These areas represent locations that require future transmission-related upgrades or alternatives, such as local generation or energy efficiency, to meet the reliability standards. The following table provides a brief description of each deficiency and its causes.

Figure 4-1. Identified transmission reliablity issues.

| Deficiency number | Name | Causes of Deficiency | Deficiencies |
|---|---|---|---|
| 1 | **Georgia–St. Albans** | * Loss of transmission line<br>* Loss of E. Fairfax transformer<br>* Loss of one or both St. Albans transformers | Low voltage, voltage instability, voltage collapse, thermal overloads |
| 2 | **Middlebury** | * Loss of Middlebury transformer or breaker failure | Low voltage, voltage collapse |
| 3 | **Blissville** | * Loss of Blissville transformer | Low voltage, voltage collapse, thermal overload |
| 4 | **Hartford–Chelsea** | * Loss of Hartford transformer or breaker failure | Low voltage, voltage collapse |
| 5 | **North Rutland** | * Loss of the North Rutland or Cold River transformers | Low voltage, voltage collapse, thermal overload |
| 6 | **Ascutney** | * Loss of Ascutney transformer | Low voltage, voltage collapse, thermal overload |
| 7 | **Bennington** | * Bennington breaker failure | Low voltage, voltage collapse |
| 8 | **Blissville–Ascutney** | * Various scenarios involving loss of transmission lines | Low voltage |
| 9 | **West Rutland–Coolidge** | * Light to moderate load levels | High voltage |
| 10 | **St. Johnsbury** | * Loss of St. Johnsbury transformer, aggravated when Highgate converter or Littleton autotransfomer is out of service<br>* Loss of transmission line | Low voltage, voltage collapse |
| 11 | **Vernon** | * Loss of Fitzwilliam transformer | Thermal overload |
| 12 | **Coolidge–Ascutney** | * Transmission line out of service | Thermal overload |
| 13 | **Ascutney–Ascutney Tap** | * New England power flows and New Hampshire load | Thermal overload |
| 14 | **Vernon** | * VY autotransfomer out of service | Thermal overload |
| 15 | **Coolidge–Cold River** | * Loss of transmission line | Low voltage, voltage collapse, thermal overload |
| 16 | **Coolidge** | * Loss of Coolidge transformer | Low voltage, voltage collapse, thermal overload |
| 17 | **Loop Flow** | * Increase in load and transmission outages. Note deficiency can be handled by operations at the subtransmission level. | Thermal overload |

| Deficiency number | Name | Causes of Deficiency | Deficiencies |
|---|---|---|---|
| 18 | **Subtransmission Voltage** | * Load level and loss of transmission lines/transformers. Note deficiency can be handled at the subtransmission level. | Low voltage |
| 19 | **Barre** | * Load level, loss of transformer | Low voltage, voltage collapse, thermal overload |
| 20 | **Vermont Yankee** | * VY removed from system. Note overloads occur in southwestern New Hampshire. Solution will need to be addressed at the regional/ISO-NE level. | Low voltage, voltage collapse, thermal overload |
| 21 | **Plattsburgh–Essex** | * Highgate converter removed and loss of transmission lines | Low voltage, voltage collapse, thermal overload |
| 22 | **Highgate** | * Highgate converter out of service and loss of transmission lines | Low voltage, voltage collapse, thermal overload |
| 23 | **2028** | * Year 2028 load levels, Highgate out of service, loss of transmission lines | Low voltage, voltage collapse, thermal overload |

The range of reliability performance issues documented in the 2009 technical analysis center on these causes:

- Heavy use of transmission facility may overload the equipment beyond its rating.
- A poorly supplied area may suffer **voltage** far below or above acceptable levels.
- **Voltage instability** may occur in areas with weak transmission networks.
- Extremely low voltage can lead to a **voltage collapse**, where the transmission system becomes unstable and sections automatically disconnect, potentially leading to widespread **blackout**.

These transmission system phenomena are examples of unacceptable system performance that must be resolved. The Plan describes proposed transmission reinforcements to address these unacceptable transmission performance issues.

On the subtransmission system, several potential reliability issues were also identified. The reliability of the subtransmission system can be improved by reinforcements made on the transmission system and vice versa; therefore, many of the subtransmission issues may be resolved by implementation of transmission solutions, and subtransmission fixes may sometimes resolve transmission system issues. The table in Figure 4-2 shows the reliability issues that would remain unresolved after implementation of the proposed transmission solutions shown in Figure 4-5. The table shows which part of the electric system is causing the reliability issue, i.e., transmission, subtransmission, or the failure of a transformer within a substation. The reliability impact of the equipment failure (or "contingency") is shown as either causing high or low voltage, or as a **thermal** issue in which equipment exceeds its rated temperature.

Figure 4-2 illustrates that there are five general subtransmission areas with potential reliability issues including Ascutney, Chelsea, Montpelier, Rutland, and St. Albans. At the subtransmission level there can be more flexibility concerning the reliability level to which the system is designed when compared to the transmission system because the subtransmission system is not currently subject to mandatory federal reliability standards. For example, it may be acceptable in the area to incur an infrequent power outage rather than to invest in infrastructure to eliminate the power outage risk. The affected utilities will determine what, if any, projects are required to address the potential reliability issues on the subtransmission system. The affected utilities have not yet submitted these evaluations.

Figure 4-2. Subtransmission potential reliability issues grouped by location (assuming proposed transmission projects are completed).[6]

| Location | Year Needed | "90/10" Load Forecast for Year | Contingency | Issue | VELCO Criteria Violations | Affected DUs | Lead DU |
|---|---|---|---|---|---|---|---|
| Ascutney | 2009 | 1141 MW | Subtransmission | Voltage | Low voltage & voltage collapse | CVPS | CVPS |
| Ascutney | 2010 | 1155 MW | Transfomer | Thermal | Ascutney–Lafayette | CVPS | CVPS |
| Ascutney | 2009 | 1141 MW | Transfomer | Thermal | North Springfield–Riverside | CVPS | CVPS |
| Ascutney | 2009 | 1141 MW | Transfomer | Voltage | Ascutney | CVPS | CVPS |
| Ascutney | 2009 | 1141 MW | Transmission | Voltage | Ascutney | CVPS, GMP, Ludlow | CVPS |
| Ascutney–Cold River | 2009 | 1141 MW | Transmission | Thermal | Wallingford–Cavendish | CVPS, Ludlow | CVPS |
| Chelsea | 2009 | 1141 MW | Transmission | Voltage | Chelsea | CVPS, WEC | CVPS |
| Chelsea–Hartford | 2013 | 1185 MW | Subtransmission | Voltage | Chelsea–Hartford | CVPS, GMP, WEC | CVPS |
| Montpelier | 2009 | 1141 MW | Subtransmission | Thermal | Berlin–Mountain View Tap–Montpelier | GMP, WEC | GMP |
| Montpelier | 2009 | 1141 MW | Transfomer | Thermal | Berlin–Mountain View–Montpelier | GMP, WEC | GMP |
| Montpelier | 2016 | 1215 MW | Transmission | Thermal | Berlin–Mountain View Tap–Montpelier | GMP, WEC | GMP |
| Rutland | 2009 | 1141 MW | Subtransmission | Thermal | North Rutland–East Rutland–South Rutland | CVPS | CVPS |
| Rutland | 2009 | 1141 MW | Transfomer | Thermal | North Rutland–South Rutland | CVPS | CVPS |
| Rutland–Cold River | 2009 | 1141 MW | Subtransmission | Voltage | Rutland–Cold River | CVPS | CVPS |
| St. Albans | 2009 | 1141 MW | Subtransmission | Thermal | Fairfax Falls–Milton | CVPS | CVPS |
| St. Albans | 2009 | 1141 MW | Subtransmission | Thermal | North St Albans–Nat Carbide | CVPS | CVPS |

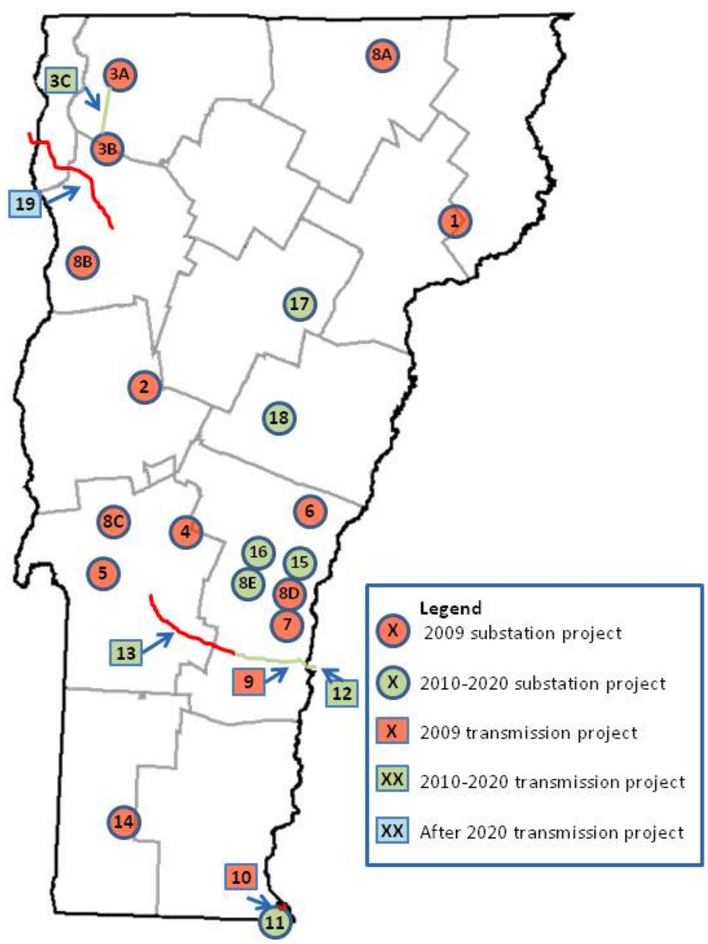
CVPS = Central Vermont Public Service, GMP = Green Mountain Power, WEC = Washington Electric Co-op

[6] These reliability issues were identified using a single, common set of screening criteria based upon single-outage performance at peak demand levels. These screening criteria may not be the subsystem planning criteria used by affected distribution utilities in their analyses.

## *4.2 Proposed Transmission Solutions*

Addressing transmission reliability deficiencies fall into two broad categories of transmission-related solutions: substation upgrades and transmission line reinforcements. Substation upgrades typically involve adding a transformer, the reconstruction of the substation to a redundant design such as a **ring bus** or **breaker-and-a-half**, and/or the installation of **capacitor**s and **reactor**s to improve system performance. Generally, substation projects have minimal impact on surrounding communities because substations are typically built on properties that are acres in size. The other category of reinforcement is transmission line–related. Transmission lines are sometimes rebuilt to increase their electricity carrying capacity. Transmission line rebuilds typically involve the replacement of existing poles (or towers) and wire within existing rights of way. Certain reliability issues require construction of entirely new high-voltage transmission lines, and may impact multiple surrounding communities.

Figure 4-3. Proposed transmission–related project locations.



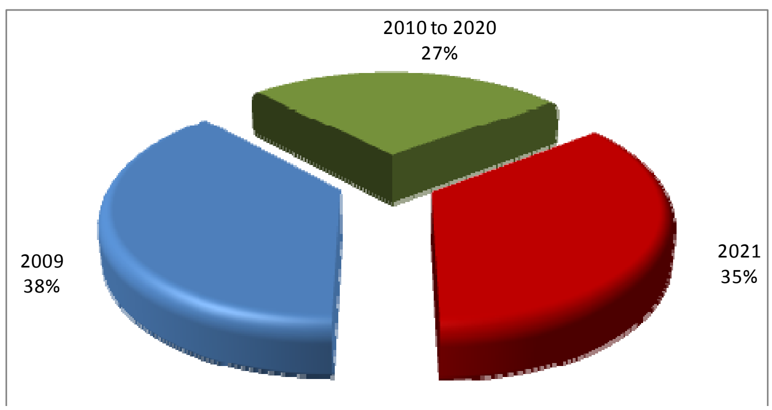

Planners have identified 25 potential transmission solutions that would enable Vermont to comply with the transmission planning standards. Figure 4-3 indicates the locations, type and timing of the proposed reinforcements shown in Figure 4-5.

Of the 25 projects identified, six involve transmission lines; the rest are substation related. Of the six transmission projects, two of the projects are new lines, the others propose rebuilding existing lines to a higher capacity. The two new transmission lines are projects 3B and 19 in northwestern Vermont. Project 3B is a proposed new transmission line that is needed before 2018. This 115-kV line would run from Georgia to St. Albans at a distance of about 10 miles. Project 19 is a 230-kV line that would run from Plattsburg to Essex at a distance of about 30 miles. In the "base plan," the timing of project 19 is scheduled for 2021 but may be needed by 2016. Project 19 may be undertaken sooner for reliability reasons or to facilitate access to renewable resources in New York State. Many of the listed projects are needed in 2009, based on existing loads and applicable reliability criteria. Most projects, however, will take several years to obtain the required approvals and to construct. The projects are therefore prioritized to help provide a sense of the order in which an application may need to be filed with the Board, the number of hours the criteria violation would exist, or the year in which the criteria violation occurs. All transmission reliability standards, however, must be met, so the prioritization should not be interpreted as indicating discretion on whether or not to address the problem.

Figure 4-5 provides more details about the transmission solutions. Planners were required to project the year each solution will be needed. Given the uncertainties associated with predicting future electric demand, planners also identified at what Vermont load level the projects become necessary. The load levels allow decision-makers and the public to evaluate these reliability issues in terms that can adjust to potential changes in the load forecast over time. Cost estimates in year 2008 dollars are illustrated and the figure indicates whether the project is a substation or transmission line modification. The deficiencies addressed by each individual project are listed. The description of the deficiency is available in Figure 4-1 according to the deficiency number listed. A brief description of the reinforcement, the distribution utilities that are impacted, and the local distribution utilities that will take the lead on coordinating the project are also provided in Figure 4-5.

The total cost for the proposed transmission projects is estimated in the range of $512 million to $902 million at today's costs (year 2008 dollars). As shown in Figure 4-4, many projects are needed as soon as is practicable (indicated by year 2009 projects); these projects represent 38 percent of the proposed dollar investment total. A single project (number 19) represents another 35 percent of the proposed total investment, but that project is currently identified as being needed in 2021 or sooner as already discussed. The remaining projects represent 27 percent of the proposed investment and are scattered between years 2010 and 2020.

Figure 4-4. Percentage of proposed investment by year(s).




*Note that most 2009 projects will take years to implement; however, the 2009 year does indicate they are needed as soon as is practicable.*

Figure 4-5. Proposed transmission project details (the cost estimates are in year 2008 millions of dollars).

| Priority number | Name | Year of Need | Load MW Needed | Low Cost | High Cost | Project Type | Defi-ciencies | Project | Affected DUs | Lead DU |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | **St. Johnsbury** | 2009 | 400 | $ 22 | $ 22 | Substation | 10 | Construct new ring substation at or near Lyndonville substation, install capacitor banks | CVPS, LED for station. CVPS, LED & VEC for capacitor banks | LED |
| 2 | **Middlebury** | 2009 | 700 | $ 10 | $ 20 | Substation | 2 | Install 2nd 115/46 kV transformer, rebuild to ring station. *(Note: CVPS is pursuing an alternative transmission solution to resolve this deficiency.)* | CVPS | CVPS |
| 3A | **St. Albans** | 2009 | 900 | $ 25 | $ 50 | Substation | 1 | Construct new ring station with two 115/34.5 kV transformers | CVPS, VEC | CVPS |
| 3B | **Georgia** | 2009 | 1100 | $ 20 | $ 40 | Substation | 1 | Rebuild to ring station | All Vermont DUs | CVPS |
| 3C | **Georgia–St. Albans** | 2018 | 1275 | $ 15 | $ 30 | Transmission | 1 | Construct new Georgia to St Albans 115 kV transmission line, under 10 miles. ***Needed before 2018.*** | All Vermont DUs | VEC |
| 4 | **South Rutland** | 2009 | 1000 | $ 15 | $ 30 | Substation | 5 | Construct new substation with a 115/46 kV transformer | CVPS | CVPS |
| 5 | **Blissville** | 2009 | 800 | $ 15 | $ 30 | Substation | 3 | Install 2nd 115/46 kV transformer, rebuild to ring station, install capacitor banks | CVPS | CVPS |
| 6 | **Hartford** | 2009 | 1000 | $ 15 | $ 30 | Substation | 4 | Install 2nd 115/46 kV transformer, rebuild to ring station | CVPS, GMP | CVPS |
| 7 | **Ascutney** | 2009 | <1170 | $ 14 | $ 28 | Substation | 6 | Rebuild to breaker-and-a-half station | All Vermont DUs, NU, NGRID | CVPS |
| 8A | **Newport** | 2009 | 1000 | $ 1 | $ 2 | Substation | 10 | Install capacitor banks | All Vermont DUs | VEC |
| 8B | **Queen City** | 2009 | <1170 | $ 2 | $ 4 | Substation | 8 | Install capacitor bank | All Vermont DUs, NGRID | GMP |
| 8C | **West Rutland** | 2009 | <1170 | $ 6 | $ 12 | Substation | 8, 9 | Install capacitor banks and shunt reactors | All Vermont DUs, NGRID | CVPS |
| 8D | **Ascutney** | 2009 | <1170 | $ 2 | $ 4 | Substation | 6 | Add capacitor banks | All Vermont DUs, NU, NGRID | CVPS |
| 8E | **Coolidge Reactor** | 2011 | 1200 | $ 4 | $ 8 | Substation | 9 | Install shunt reactor | All Vermont DUs, NU, NGRID, NY | CVPS |

| Priority number | Name | Year of Need | Load MW Needed | Low Cost | High Cost | Project Type | Defi-ciencies | Project | Affected DUs | Lead DU |
|---|---|---|---|---|---|---|---|---|---|---|
| 9 | **Coolidge–Ascutney** | 2009 | N/A | $ 25 | $ 50 | Transmission | 12 | Rebuild transmission line to higher rating, under 15 miles | All Vermont DUs, NU, NGRID | GMP |
| 10 | **Yankee–Vernon Rd** | 2009 | <1170 | $ 5 | $ 10 | Transmission | 11 | Rebuild line for higher rating, under 10 miles | All Vermont DUs, NU, NGRID | CVPS |
| 11 | **Vernon** | 2010 | 1185 | $ 15 | $ 30 | Substation | 14 | Install 2nd 345/115 kV transformer | All Vermont DUs, NU, NGRID | CVPS |
| 12 | **Ascutney–Ascutney Tap** | 2013 | 1210 | $ 5 | $ 10 | Transmission | 13 | Rebuild transmission line to higher rating, under 10 miles | All Vermont DUs, NU, NGRID | CVPS |
| 13 | **Coolidge–Cold River** | 2013 | 1210 | $ 35 | $ 70 | Transmission | 15 | Rebuild transmission line to higher rating, under 20 miles | All Vermont DUs, NY | CVPS |
| 14 | **Bennington** | 2009 | <1170 | $ 10 | $ 20 | Substation | 7 | Rebuild to ring substation, install capacitor banks | All Vermont DUs, NGRID | CVPS |
| 15 | **Ascutney Transformer** | 2013 | 1210 | $ 6 | $ 12 | Substation | 6 | Install 2nd 115/46kV transformer | CVPS, Ludlow for station | CVPS |
| 16 | **Coolidge Transformer** | 2016 | 1245 | $ 20 | $ 40 | Substation | 16 | Install 2nd 345/115 kV transformer | All Vermont DUs, NU, NGRID, NY | CVPS |
| 17 | **Barre** | 2018 | 1275 | $ 10 | $ 20 | Substation | 19 | Install 2nd 115/34.5 kV transformer and rebuild to ring station. ***2018 assumes there will be an upgrade to the 34.5 kV system*** | GMP, WEC | GMP |
| 18 | **Chelsea** | 2018 | 1275 | $ 15 | $ 30 | Substation | 4 | Install 2nd 115/46 kV transformer, rebuild to ring station | CVPS, WEC | CVPS |
| 19 | **Plattsburgh–Essex** | 2021 | N/A | $200 | $300 | Transmission | 21, 22, 23 | Construct new Plattsburgh to Essex 230 kV transmission line, parallel with existing 115 kV lines, under 30 miles, ***NOTE: timing may be 2016 or earlier depending on other possible scenarios*** | All Vermont DUs | GMP |
| | *TOTAL* | | | *$512* | *$902* | | | | | |

* R&J = Readsboro and Jacksonville

Figure 4-5 identifies the year of need, based on the load forecast, for the potential transmission solution to each identified reliability deficiency and concern. Figure 4-6 below shows the estimated year when each reinforcement may be in service. These dates consider the severity of need, the ability to mobilize resources to act, and the ability to construct multiple reinforcements simultaneously. The dates are estimates that will likely be revised as the planning process continues.

Many upgrades are shown in the Plan as being needed in 2009. Some of these were identified in the 2006 Plan and have not yet been constructed. Others are newly identified as a result of changes in reliability standards and rules. Although they are all needed at current load levels, it is obviously not feasible to construct them in 2009. The next steps following publication of the Plan are to complete further, issue-specific analysis, by VELCO in the case of bulk system issues, and in consultation with the affected distribution utilities in the case of predominantly bulk system issues. Based on those detailed analyses, VELCO will determine the sequence of steps toward project permitting. Where Figure 4-6 below shows 2012 or 2013 in-service dates, VELCO assumes analysis and regulatory action in 2009 or 2010, and construction in 2010 through 2012.

Figure 4-6. Estimated In-Service Year for Potential Reinforcements

| *Location* | *Load MW Needed* | *Priority* | *Estimated In-service Year* |
|---|---|---|---|
| St. Johnsbury | 400 | 1 | 2012 |
| Middlebury | 700 | 2 | 2013 |
| St. Albans | 900 | 3A | 2013 |
| Georgia | 1100 | 3B | 2012 |
| Georgia–St. Albans | 1275 | 3C | 2015 |
| South Rutland | 1000 | 4 | 2013 |
| Blissville | 800 | 5 | 2014 |
| Hartford | 1000 | 6 | 2015 |
| Ascutney | < 1170 | 7 | 2012 |
| Ascutney | < 1170 | 8A | 2012 |
| Newport | 1000 | 8B | 2015 |
| Queen City | < 1170 | 8C | 2013 |
| West Rutland | < 1170 | 8D | 2012 |
| Coolidge–Ascutney 115 kV K-31 line | VT load generally not relevant | 9 | 2013 |
| VY–Vernon Road 115 kV K-186 line | < 1170 NH and Brattleboro load mostly | 10 | 2014 |
| Vernon | 1185 | 11 | 2013 |
| Ascutney–Ascutney Tap 115kV K-149 line | 1210 | 12 | 2013 |
| Coolidge–Cold River 115 kV K-32 line | 1210 | 13 | 2013 |
| Bennington | 1170 | 14 | 2014 |
| Ascutney | 1210 | 15 | 2013 |
| Coolidge | 1245 | 16 for transformer | 2016 |
| Barre | 1275 | 17 | 2018 |
| Chelsea | 1275 | 18 | 2018 |
| Plattsburgh–Essex | N.A. | 19 | 2021 or earlier |

## 4.3 Non-Transmission Alternatives (NTAs)

For each proposed transmission project, planners performed a PSB-approved method of initial screening to determine whether or not an alternative can postpone a transmission solution. The results of the analyses are summarized in Figure 4-7, indicating proposed transmission projects 3B, 11, 12, 14, 15, 16, 17 and 18 require further study of alternatives to transmission. The lead distribution utility will be responsible for analyzing the alternatives to transmission using the process established in Docket 7081. For these projects, there is a possibility some or all of the proposed transmission solutions can be avoided or delayed with alternatives such as installing new generation to serve load or implementing additional energy efficiency to reduce demand.

Not all projects are good candidates to solve a reliability deficiency using an alternative to transmission. Examples of where **NTAs** are not technically feasible are where deficiencies are caused primarily by power flowing for the New England region or other states, or where it is not practical to use an alternative to achieve the required high level of demand reduction immediately. These were the two main reasons for the screening outcomes in Figure 4-7. Projects 1 and 2 have already undergone a more detailed NTA assessment, the results of which can be found at http://www.vermontspc.com/.

Figure 4-7. Screening for the potential to meet needs through alternatives to transmission. Shaded rows are projects with NTA possibilities.

| Priority number | Name | Year Needed | NTA |
|---|---|---|---|
| 1 | St. Johnsbury | 2009 | NO |
| 2 | Middlebury | 2009 | NO |
| 3A | St Albans | 2009 | NO |
| 3B | Georgia | 2009 | NO |
| 3C | Georgia–St. Albans | 2018 | YES |
| 4 | S Rutland | 2009 | NO |
| 5 | Blissville | 2009 | NO |
| 6 | Hartford | 2009 | NO |
| 7 | Ascutney (substation) | 2009 | NO |
| 8A | Newport (capacitors) | 2009 | NO |
| 8B | Queen City (capacitors) | 2009 | NO |
| 8C | W Rutland (capacitors/reactor) | 2009 | NO |
| 8D | Ascutney (capacitors) | 2009 | NO |
| 8E | Coolidge Reactor | 2011 | NO |
| 9 | Coolidge–Ascutney | 2009 | NO |
| 10 | Yankee– Vernon Rd | 2009 | NO |
| 11 | Vernon | 2010 | NO |
| 12 | Ascutney–Ascutney Tap | 2013 | YES |
| 13 | Coolidge–Cold River | 2013 | YES |
| 14 | Bennington | 2009 | NO |
| 15 | Ascutney (transformer) | 2013 | YES |
| 16 | Coolidge (transformer) | 2016 | YES |
| 17 | Barre | 2018 | YES |
| 18 | Chelsea | 2018 | YES |
| 19 | Plattsburgh–Essex | 2021 | YES |

For those reinforcements where the use of non-transmission alternatives (generation and/or demand reduction) may defer the need for transmission investment, Figure 4-8 indicates the rough magnitude of the alternatives that could potentially defer the transmission reinforcements five to ten years. These are preliminary screening estimates and will require more detailed examination later in the planning process based on the use of specific non-transmission alternatives. Given uncertainties in how alternatives may be used to address any given reliability issue, the table presents a range of values.

Figure 4-8. Rough magnitude for potential NTAs.

| Priority number | Name | Year Needed | Rough NTA magnitude |
|---|---|---|---|
| 3C | Georgia-St. Albans | 2018 | 20 to 50 MW |
| 12 | Ascutney-Ascutney Tap | 2013 | 20 to 50 MW |
| 13 | Coolidge-Cold River | 2013 | 50 to 100 MW |
| 15 | Ascutney Transformer | 2013 | 15 to 30 MW |
| 16 | Coolidge Transformer | 2016 | 30 to 60 MW |
| 17 | Barre | 2018 | 20 to 40 MW |
| 18 | Chelsea | 2018 | 15 to 30 MW |
| 19 | Plattsburgh-Essex | 2021 | 100 to 250 MW |

To be effective, the non-transmission alternatives must:

- **Be located in the deficiency area and in the "right" location.** For example, a generator may need to be two to ten times larger than the overload it is meant to correct, depending on the specific details of the network, because power flow from the generator leaves via all transmission elements, not just on the overloaded line or transformer. Also, typically the farther a single non-transmission resource is from the deficiency, the less its effectiveness. Therefore, an effective alternative will likely have to be larger the farther it is removed electrically from the problem.

- **Be present and in-service when the problem occurs.** The most significant challenge to deploying non-transmission alternatives is the need to be "on-line" when needed. A generator must be "on-line" and load in a demand response program must be "off line" when the transmission system deficiency arises for these resources to be effective alternatives to transmission reinforcement. In addition, the variations in system voltage, frequency and power flow experienced during the events or outages that cause the deficiency can cause protective devices to automatically disconnect local generation from the transmission system to avoid potential damage. This cannot occur if the generation is to be an alternative to a transmission reinforcement.

Some non-transmission alternatives may be effective for more than one deficiency. For example, a demand response program, or generator deployed on a subtransmission network may help address a deficiency that involves loss of the transformer connecting the subtransmission network to the transmission system, or loss of local portions of the transmission system.

Vermont distribution utilities are responsible for integrating consideration of non-transmission alternatives into the analysis of solutions to reliability deficiencies related to transmission facilities. The affected distribution utilities will supply the human and financial resources and information necessary to conduct or oversee the detailed analyses, including identification of alternatives, with respect to the reliability deficiencies identified in the plan. The affected utilities must identify a lead distribution utility that is responsible for ensuring that detailed non-transmission alternatives analyses are completed in a timely manner.

Each solution—transmission or non-transmission—faces potential obstacles to implementation. At this stage of the planning process, those obstacles are unknown for any specific reinforcement described in this Plan or any potential alternative. One challenge in implementing solutions is land availability and land use. Most infrastructure requires space. Some substation reinforcements may require additional land adjacent to existing substations. New line reinforcements may be constructed within existing rights of way or may require expanded rights of way. A new generator may require land to construct the facility or a substation to connect it to the transmission network. Resources—physical, human and financial—present additional challenges to any solutions.

# 5 Industry Dynamics

VELCO's obligation to create this Plan is founded in its responsibility for electric reliability planning for the state's transmission system. Although this is a technical task that uses a specific planning methodology discussed in Section 3 above, transmission planning takes place in a larger context of industry, economic, environmental and social issues that will influence decision-making. This section describes the larger context and, where appropriate, touches on its potential implications for transmission and alternatives. Among the contextual issues are:

- **Carbon dioxide regulations**—Several countries and states have enacted or are enacting limits on the total amount of carbon dioxide that may be emitted annually. Many states in the northeastern US (including Vermont) have begun a mandatory, market-based effort, called RGGI (Regional Greenhouse Gas Initiative), to reduce greenhouse gas emissions. Most analysts are expecting the United States to enact federal limits sometime in the next decade. These limits could financially disadvantage higher carbon emission plants such as coal compared to non-emitting sources such as nuclear or renewable energy resources.

- **Electric demand growth**—Electric demand has been increasing not only because of population and economic growth but also because of other factors such as increased use of air conditioning and high consumption electric devices, including plasma TVs and large refrigerators. Another unknown is the potential increased demand associated with commercialization of plug-in hybrid cars. It is not yet known how recent economic trends will affect demand. New infrastructure (transmission and generation) will likely be needed if electric demand continues to increase.

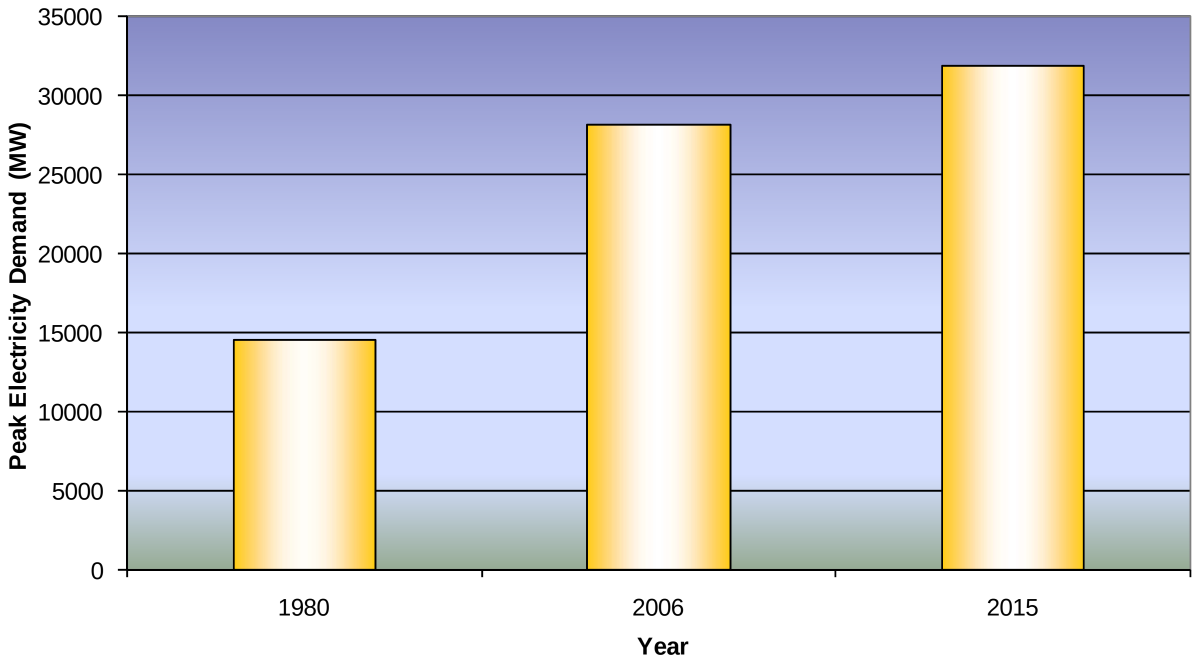
- **Fossil fuel costs**—Fossil fuel costs are volatile, especially natural gas. Prices have increased three to as much as ten times what they were in the 1990s.

- **Renewable portfolio standards (RPS)**—Many states, including most in New England, are enacting or have enacted renewable portfolio requirements. These requirements typically mandate that a certain percentage of a utility's generation capacity be from renewable energy sources such as solar, wind and biomass. The transmission system may need to be reinforced to accommodate this additional generation, depending on its size and location.

- **"Smart" technology investments**—New technologies are becoming commercially available to better operate the power system and provide customers with more information about their power usage, potentially leading to greater energy efficiency and demand reductions.

These and other factors impact the way utilities look at meeting growing customer demand. The power system must be designed to reliably and affordably serve the electric demand, especially the peak usage forecasted for current and future years. The demand for electricity at peak periods of usage has been growing in New England and is projected to continue to grow for the foreseeable future. In fact, the peak demand in 2006 was nearly twice the peak demand of 1980.

Figure 5-1. New England's peak electric consumption has nearly doubled since 1980 and is projected to grow to 32,000–34,000 MW by 2015 (source: ISO-NE).




Between 1980 and 2006, the population in New England increased from 14.5 million to 28.1 million and is expected to grow to nearly 32 million by 2015. By 2015 New England's peak electric demand per person is expected to be about 80 percent higher than what it was in 1980. This growth in peak demand per person is being driven by several factors such as economic growth and increased use of electric intensive appliances.

## 5.1 Demand and Usage Reduction

Reducing electric demand, especially during peak periods of usage, and reducing total electric usage are areas of increasing focus for utilities. Power systems must be designed to handle the maximum consumption (called the "peak demand") by customers. By reducing the growth in peak demand, investments in transmission, distribution and new electric facilities such as power plants may be deferred.

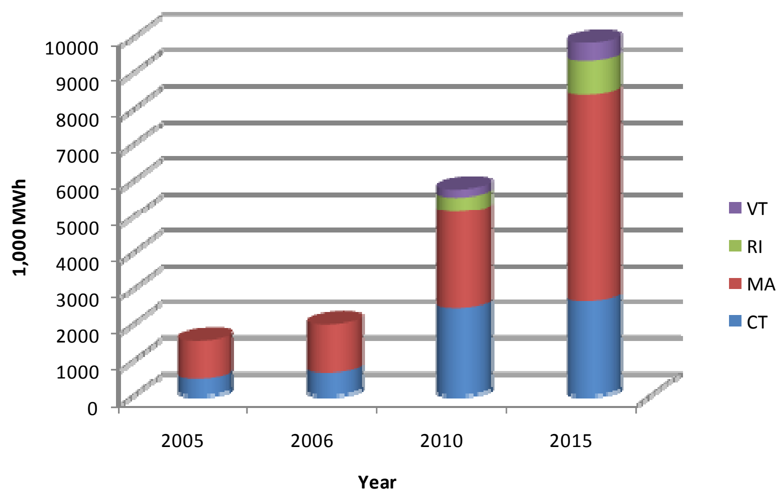
State energy policy, rising fossil fuel prices and more cost-effective, state-of-the-art technologies are spurring customers to monitor and control their energy consumption, and considerable investments are being made to develop and implement demand-reducing techniques. Vermont is a leader in the design and delivery of energy-efficiency, or DSM programs to its customers. In fact, according to DPS, Vermont's demand-reduction programs have lowered electric consumption by 460 giga-watt hours (GWh). This figure represents an eight-percent reduction in electric use and is nearly the equivalent electric usage of Vermont's third largest local distribution utility, Vermont Electric Cooperative (VEC).

Around New England, utilities supported by regulators and legislators also are working to keep demand in check by making significant investments in energy-reduction programs or DSM. According to ISO-NE, DSM and related programs are reducing New England's peak electricity demand by over 1,600 MW, one and a half times the peak electric demand of the entire state of Vermont. Without these programs New England's peak demand would be about six percent higher than it is today.

## 5.2 Renewable Energy Resources

Renewable energy resources such as wind, solar and biomass are seeing increased application for electric generation to help meet energy needs. The demand for these resources is increasing in part as a result of state policies. Vermont law includes a goal that 20 percent of its power come from renewable sources by 2017 and a program called the Sustainably Priced Energy Enterprise Program (SPEED) to help reach the goal. Connecticut, Maine, Massachusetts and Rhode Island have adopted Renewable Portfolio Standards (RPSs) that require a certain amount of generation to come from renewable sources. The ISO-NE is projecting that by 2015 nearly 10 million MWh of electricity, representing 6.5 percent of New England's electricity needs, will come from new renewable resources as a result of these state policies.

Figure 5-2. New England Renewable Portfolio Standards and Goals (source: ISO-NE).




*Note: Vermont has a statutory goal whereas the other states have renewable portfolio requirements.*

These policies are having an impact. According to March 2, 2009, testimony by the CEO of ISO-NE to the Federal Energy Regulatory Commission, 3400 megawatts of renewable projects are proposed in the ISO-NE region.

Unlike **baseload** generation, which can operate around the clock, solar and wind are intermittent resources. For example, when a cloud passes over a solar generator, or the wind is not blowing, the power system must have other "backup" generating resources available. The transmission system must be capable of moving both intermittent renewable and "backup" electricity from where it is made to where it is needed.

## *5.3 Conventional Generation*

Currently, Vermont customers receive substantial amounts of power under large contracts with both Entergy (Vermont Yankee) and Hydro-Québec in Canada. These two resources comprise nearly two-thirds of Vermont's energy supply commitments. In addition to these sources, Vermont utilities also purchase their energy from the wholesale New England power market ("system" power), and from gas, oil and other renewable electricity power producers. About 31 percent of Vermont's electric needs are met by importing power from Hydro-Québec in Canada and an additional nine percent (known as System A) comes from other New England states.

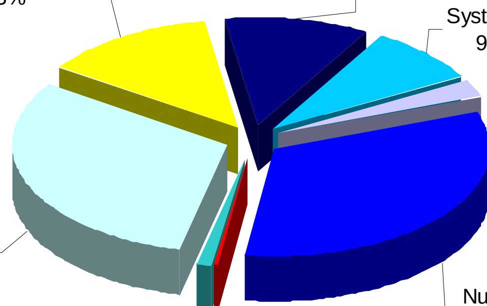
Figure 5-3. Vermont power plant examples and power generation resources.

Burlington, VT
Wood Plant
McNeil Station
Credit: Burlington Electric Dept.

Rutland, VT
Hydro Plant

Credit: CVPS

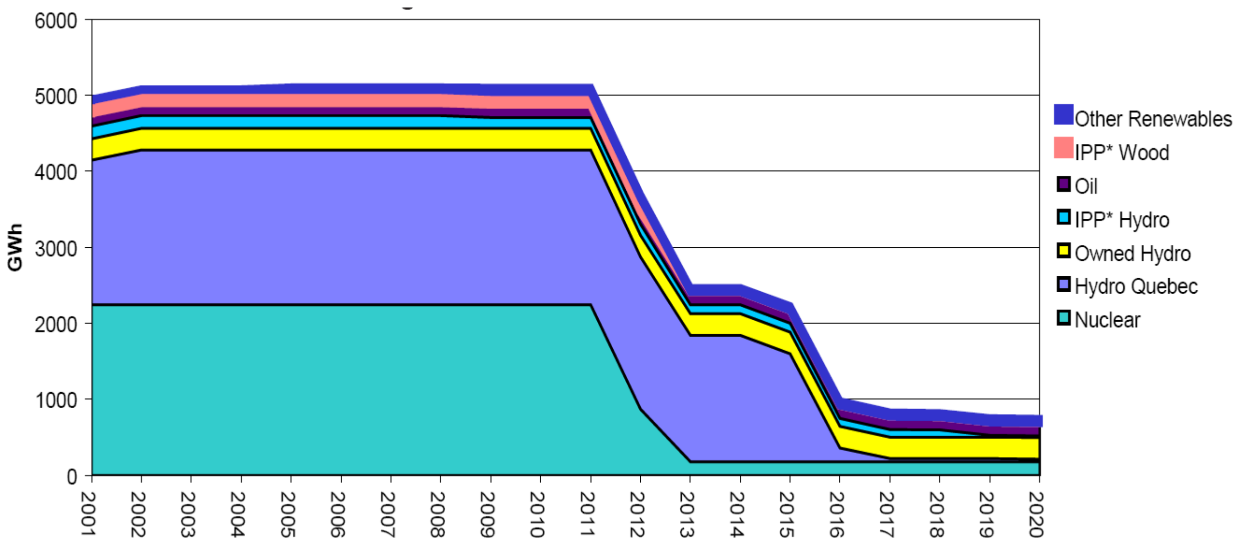
Brattleboro, VT
Nuclear Plant
Vermont Yankee
Credit: CVPS




*Source: VDPS. HQ = Hydro-Québec (Canada), System A = imports from New England states, and System B are renewable resources where Vermont utilities have sold the "Renewable Energy Credits."*

Because Vermont receives a substantial amount of power from Hydro-Québec through Highgate substation in northern Vermont and Vermont Yankee in southern Vermont, the impact of these resources on transmission must be carefully studied. In the "base case" for transmission planning purposes, planners assume that Vermont Yankee and Hydro-Québec continue to be available resources throughout the 20-year planning horizon. As indicated in Figure 5-4, however, the contracts for Vermont Yankee and Hydro-Québec expire over the 2011 to 2017 time period, so **sensitivity studies** are performed to assess the potential impact of these power generation resources on the transmission system in Vermont.

Figure 5-4. Vermont's contracted power supply (source: "VERMONT'S ENERGY FUTURE" document used for a Deliberative Polling Event held in Burlington Vermont on November 3–4, 2007).




In addition, other generation supply realities from Vermont's summer peak period are examined in the analyses. These include low local hydro power availability due to low water conditions that may occur during hot, dry summers.

## 5.4 Other Transmission Drivers

The transmission analysis performed by VELCO examines potential transmission system enhancements from a system-reliability perspective only. There are other potential driving factors for new or enhanced transmission facilities in New England. Some of those factors were described at the beginning of this section and in Section 2. Many of the potential renewable power sources in New England, such as wind power, may be located far from load centers in New England and far from the more robust and higher-capacity transmission corridors. In order to fully utilize these renewable resources, new and/or rebuilt transmission infrastructure may be necessary. Lack of transmission facilities will limit or preclude these renewable resources.

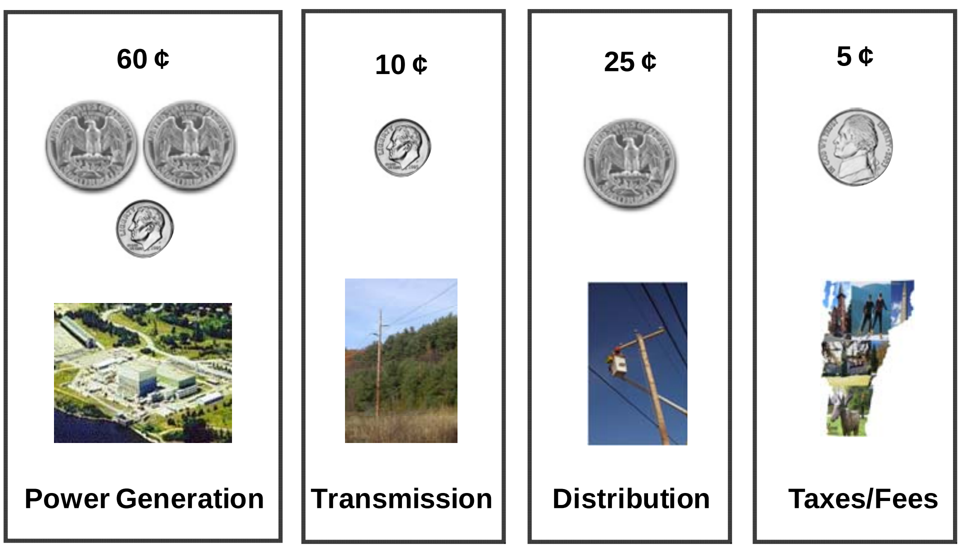
Yet another potential driving force for new transmission infrastructure in New England is economics. The fuel mix for new electric generation sources in New England is limited (due both to fuel/resource availability and greenhouse gas limitation policies). New transmission infrastructure may provide access to potentially lower-cost and renewable energy sources within or outside of New England. Projects are now before ISO-NE as proposed economic transmission upgrades and other projects are under consideration by market participants.

Any of these drivers may trigger potential new transmission projects in Vermont to connect renewable power resources, import power from neighboring regions to address Vermont's or the region's needs, or meet other emerging demands. When and if such proposals materialize, they will be reviewed within Vermont in terms of facility permitting and siting through processes that provide extensive opportunities for public input. Those proposals, since they are not driven by reliability, are not the focus of this Plan, because this document is focused on reliability issues. Nevertheless, these non-reliability-based transmission issues are clearly part of the current environment in Vermont and the region.

## 5.5 Funding of Transmission and Its Alternatives

Typically, around 60 cents of every dollar of an average electric bill goes to paying for power generation costs, including the cost of fuel. Transmission currently makes up around 10 cents for every dollar on the utility bill, distribution about 25 cents, and other charges including renewable and energy-efficiency programs make up the remainder of a bill (five cents). Planned projects around New England are expected to increase the cost of transmission in the next several years.

Figure 5-5. What a dollar of the utility bill pays for (representative).




While electric transmission is a relatively small portion of the cost in the electric business, a new major transmission project typically costs from tens to hundreds of millions of dollars. To minimize the impact on customer bills, the cost of transmission projects is recovered from customers over a long period (typically 30 to 40 years).

# Appendices

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**APPENDIX 4: LIST OF EXTERNAL WEBLINKS ...........................................................................................52**

# Appendix 1: Vermont System Planning Committee Comments

| REF # | COMMENTS ON LONG-RANGE TRANSMISSION PLAN—VSPC REVIEW DRAFT (LRTP) [7] | SOURCE OF COMMENT[8] | DISPOSITION OF COMMENT |
|---|---|---|---|
| 1 | Cross reference from LRTP to technical analysis. | 2/23/09 VSPC meeting | Relevant content moved into LRTP |
| 2 | Generic one-line drawings or skeletal drawing of Vermont system. | 2/23/09 VSPC meeting | Not adopted. LRTP edits have sought to make report more readable to a general audience. |
| 3 | Single glossary across the LRTP and technical analysis. | 2/23/09 VSPC meeting | Completed. |
| 4 | Request that VELCO show the draft of the report to the DUs before public release. | 2/23/09 VSPC meeting | Completed. |
| 5 | Footnote on the relationship between year of need and load to further emphasize that load level is the driver. | 2/23/09 VSPC meeting | Text added to clarify this point in Sections 2 and 3. |
| 6 | Summary is too long and doesn't get to the substance (the reliability deficiencies) until page 31. Sections 3, 4 & 5 are too long. Condense or make appendices. | 2/23/09 VSPC meeting | Report reorganized to address this point. |
| 7 | Page 2 and 31 maps should show the transmission lines as lines, not dots. | 2/23/09 VSPC meeting | Completed. |
| 8 | The report feels like it was written in 2007. Needs further updating to current conditions, such as slowed load growth, economy. | 2/23/09 VSPC meeting | Discussion added concerning how current economic trends relate to the planning process and the Plan. |
| 9 | More focus on Vermont, less on region. | 2/23/09 VSPC meeting | Completed. |
| 10 | Strengthen the idea of non-reliability transmission. Consider specific reference to proposed NU line. | 2/23/09 VSPC meeting | Expanded discussion of economic transmission added to Plan. No reference to any particular line. |
| 11 | On map of New England, unify Massachusetts so it doesn't look like three states. | 2/23/09 VSPC meeting | Completed. |

[7] Page numbers in comments refer to pagination in original VSPC review draft.
[8] Complete text of all VSPC comments is posted at http://www.velco.com/PublicOutreach/Pages/VSPCComments.aspx.

| REF # | COMMENTS ON LONG-RANGE TRANSMISSION PLAN— VSPC REVIEW DRAFT (LRTP) [7] | SOURCE OF COMMENT[8] | DISPOSITION OF COMMENT |
|---|---|---|---|
| 12 | Mention Non-Transmission Alternatives (NTAs) in the transmission planning section. | 2/23/09 VSPC meeting | Completed. |
| 13 | PTF: mention in the box on page 20 (the funding explanation). | 2/23/09 VSPC meeting | The box no longer exists. |
| 14 | Acknowledge in 4.2 that the 10 cents for transmission may (is likely to) change. | 2/23/09 VSPC meeting | Completed. |
| 15 | Be consistent about whether you call it a "plan" or something else. | 2/23/09 VSPC meeting | Completed. |
| 16 | Much of the document appears to be arguing for and defending transmission. While it is important to present information about where and when transmission may be needed, an equally important message is VELCO's intent to use the best and most current information in its analyses and to respond to changing demand and new technologies in a collaborative way that considers various options. [Full comment includes specific examples.] | Jenny Cole | Significant edits made that emphasize the Plan as the first step in the larger planning process of Docket 7081. |
| 17 | Pages 21-22: The amount of detail on funding may be more than needed. It has been pointed out that the shared funding favors transmission project construction. | Jenny Cole | Detail on funding significantly reduced and moved to Section 5. |
| 18 | Page 25-26: Consider adding a bullet describing VSPC's "open door policy." | Jenny Cole | Topic added to the fourth bullet in section 3.4. |
| 19 | Page 32, Figure 6-1 explanation: "Loss" may need further definition. Consider adding "Loss refers to____" | Jenny Cole | Added to glossary. |
| 20 | Page 34: "Project 3B is a proposed new transmission line that is needed before 2018. This 115-kV line would run from Georgia to St. Albans at a distance of fewer than 10 miles. Project 18 is a 230-kV line that would run from Plattsburg to Essex at a distance of fewer than 30 miles."The use of terms or phrases such as "fewer than" or "rebuilding existing lines" (which occurs earlier in the same paragraph) can give the impression that proposed projects are insignificant or have minimal impact, which may or not be the case. | Jenny Cole | Draft has been edited to remove subjective qualifiers wherever possible. |
| 21 | Public summary is a good idea. The summary is very readable. | CVPS | No action required. |
| 22 | Comment 1. Use of the word "project" implies we have chosen a solution and won't fully consider NTAs. Consider "reliability deficiencies" or "issues in need of final solutions." | CVPS | Substantial edits took this point into consideration throughout. |
| 23 | Comment 2. P 2. Subtransmission alleged criteria violations. Remove subtransmission system issue discussion or redraft to explain that VELCO and the distribution utilities are coordinating their planning efforts, but do not declare that a subsystem problem exists based on bulk transmission system study criteria. | CVPS | Did not use bulk transmission system criteria for analysis of subsystem issues. |

| REF # | COMMENTS ON LONG-RANGE TRANSMISSION PLAN— VSPC REVIEW DRAFT (LRTP) [7] | SOURCE OF COMMENT[8] | DISPOSITION OF COMMENT |
|---|---|---|---|
| 24 | Comment 3. Industry Dynamics. P 6. Section should be revised to better explain how industry dynamics affect Vermont decisions. E.g., SPEED vs. RPS; vertically integrated utilities vs.load-serving entities; supply mix low in GHG emissions. Better tailoring to Vermont will reduce misperception that LRTP serves interests of New England at expense of Vermont. | CVPS | Significant edits to this section sought to increase Vermont focus and decrease regional focus. |
| 25 | Comment 4. Power supply planning. P 9. How is this discussion relevant to the LRTP. DUs are responsible for power supply. Omit or explain the role of the DUs in power supply decisions. | CVPS | Power supply arises as a topic in discussion of transmission planning relative to the impacts of losing current supply from Vermont Yankee and Hydro-Québec. New England's supply mix remains a part of "Industry Dynamics, now Section 5, to provide context, but this section has been significantly shortened. |
| 26 | Comment 5. Role of EEU. P 9. Correct implication that DUs, rather than Energy Efficiency Utility, are responsible for Energy Efficiency in Vermont. | CVPS | Completed. |
| 27 | Comment 6. Renewables. P 10. Discussion of RPS requirements not relevant to Vermont. Redraft to better reflect Vermont situation rather than presenting regional focus where renewables don't play as great a role in current supply. | CVPS | Substantial edits took this point into consideration. |
| 28 | Comment 7. Conventional generation. P 11. Draft focuses on region not on Vermont. Redraft to focus on Vermont supply resource to avoid creating confusion in minds of Vermont consumers. | CVPS | Substantial edits took this point into consideration. |
| 29 | Comment 8. Identifying subtransmission deficiencies. P 24. Correct the draft to accurately reflect the respective roles of DU and VELCO under the 7081 MOU with respect to identifying reliability deficiencies in the subsystem. | CVPS | Substantial edits took this point into consideration throughout. |
| 30 | Comment 9. P 30. Revise the table to reflect prior comments regarding treatment of subsystem issues. | CVPS | Significant edits made to address concerns raised. |
| 31 | Comment 9. P 30. Continued. Rename Section 6 "reliability issues and solutions" | CVPS | Completed. |

| REF # | COMMENTS ON LONG-RANGE TRANSMISSION PLAN—VSPC REVIEW DRAFT (LRTP) [7] | SOURCE OF COMMENT[8] | DISPOSITION OF COMMENT |
|---|---|---|---|
| 32 | Comment 9. P 30. Continued. Revise intro to state: "Figure 6-1 summarizes potential ~~the~~ transmission reliability issues identified as part of the 2009 planning process. These areas represent locations that may require future transmission related upgrades or alternatives such as local generation or energy efficiency to meet the reliability standards. The following table provides a brief description of each issue based on the VELCO's application of the bulk system N-1-1 study criteria ~~deficiency~~." | CVPS | This specific language was not incorporated; however, significant changes were made to emphasize that the Plan is based on criteria VELCO is required to apply to the bulk system. Further changes were incorporated to clarify where the current Plan fits into the larger process of determining solutions. |
| 33 | Comment 9. P 30. Continued. Label the table "reliability issue number" not "deficiency number" and "reliability issues" not "deficiency causes." | CVPS | This suggested change has not been made. The Docket 7081 MOU requires VELCO to identify "reliability deficiencies." While this language has been significantly edited out of the report, in the context of what is now Figure 4-1, it is an accurate description of the data. |
| 34 | Comment 9. P 30. Continued. Expand the explanation for item 9. | CVPS | Completed. |
| 35 | Comment 9. P 30. Continued. Clarify the name for item 17. | CVPS | The name "loop flow" has been retained but more descriptive information has been added. |
| 36 | While the draft overview states that subtransmission issues can be resolved by transmission fixes, the opposite is also true. This should be reflected in the draft. | CVPS | Completed. |
| 37 | Delete the phrase "although the Vermont subtransmission system is designated as transmission with regards to FERC." | CVPS | Substantial edits addressed this point. |
| 38 | Comment 10. NTAs. P 36. Challenges accuracy of text regarding technical infeasibility of NTAs in projects 3A, 4, 5 and 6, and objects to use of 2009 loads in screening due to concerns with VELCO forecasts. More opportunity for consideration of NTAs than the report implies for these projects. Should be corrected in text. | CVPS | Edited to remove reference to these projects in illustrating technical infeasibility. |
| 39 | I think this has been very well done. I am delighted. Suggestion: glossary, angle: Don't we owe a bit of reference to alternating voltage/current? Everybody knows AC. How about: "Angle is used to measure the synchronism between different alternating quantities, such as voltage or current. It is often an important performance measure; it is measured in degrees." | Richard Suitor | Completed. |

# Appendix 2: Tracking of Docket 7081, Paragraph 28 Requirements For Long-Range Transmission Plan

| MOU ¶ | Requirement | Location in Plan |
|---|---|---|
| 28a | Identification of existing and potential Reliability Deficiencies by location within Vermont. | Fig. 4-1 |
| 28b | An estimate of the date, and identification of the local or regional load levels and other likely system conditions at which the identified Reliability Deficiency, in the absence of further action, occurred or likely would occur. | Fig. 4-5 |
| 28c | An identification of each Reliability Deficiency for which a Transmission solution is not planned and a statement of the reason(s) why a Transmission solution is not planned. | None |
| 28d | For each Reliability Deficiency for which a Transmission solution is planned, an action plan that: (i through v below are subsections of 28d) | |
| i | Describes the likely Transmission solution to the Reliability Deficiency. | Fig. 4-5 |
| ii | Identifies the projected date a Transmission solution would be placed into service, given the present maturity of the project and understanding of its specific components, and identifies any phasing of the project over time, if known. | Fig. 4-6 |
| iii | Estimates the likely costs of the Transmission solution. | Fig. 4-5 |
| iv | Identifies potential obstacles to the realization of the Transmission solution. | Page 31 |
| v | States the proposed prioritization, if any, of further analysis, decisions on solution selection, and implementation of a solution with respect to those Reliability Deficiencies, and the reason(s) for each priority assignment. | None[9] |
| 28e | The VSPC's preliminary determination of Affected Utilities under paragraph 14, above. | Fig. 4-6[10] |

[9] Priority order is documented in Fig. 4-6. Prioritization of further analysis will be completed in connection with the Project Priority List required under ¶ 51.
[10] Fig. 4-6 reflects the preliminary assignment of Affected Utilities for which no utility raised an objection during the VSPC review.

| MOU ¶ | Requirement | Location in Plan |
|---|---|---|
| 28f | The comments forwarded by the VSPC under paragraph 15, above, or a responsive statement delineating why VELCO disagrees with a particular comment. | Appendix 1 |
| 28g | The results of preliminary NTA Analyses conducted under paragraph 21 , above, and the delineation of reasons required by paragraph 23, above. [Bulk system deficiencies analyzed by VELCO.] | Fig. 4-7[11] |
| 28h | Subject to paragraph 27, the results of preliminary NTA Analyses conducted under paragraph 25, and the delineation of reasons required by paragraph 26, above. [Subsystem deficiencies analyzed by DUs.] | See p. 30. |
| 28i | Identification of the Lead DU assigned to oversee and coordinate the tasks necessary to complete Step 8. | Fig. 4-5 |
| 28j | For each Reliability Deficiency that is Bulk Transmission System or Predominantly Bulk System, or for which Preliminary NTA Analysis has been completed for the Subsystem in accordance with paragraphs 25 and 27, above, identification of the performance specifications for NTAs to achieve Equivalence. | Fig. 4-8 |
| 28k | For each Reliability Deficiency that is Subsystem or Predominantly Subsystem, and for which necessary decisions or analyses under Steps 1 through 3 are not complete, a statement of the forecasted date(s) by which each such necessary decision or analysis will be made or completed. | See Attachment 3 |

[11] The Plan provides general rather than project-specific rationales for those instances where a detailed NTA analysis is not recommended. The VSPC has adopted a procedure whereby the rationale for projects being "screened out" of full NTA analysis must be reviewed with the Committee in a workshop meeting. This review will take place during the summer of 2009, and will provide an opportunity to question the assumptions and conclusions in VELCO's preliminary screening. In the meantime, the summary reasons why NTAs may not be viable for a particular reliability issue are presented on pages 30-31 of the Plan.

# Appendix 3: Glossary

**90/10 Load**—An annual forecast of the state's peak electric ***demand*** (load) where there is a 10-percent chance that the actual system peak load will exceed the forecasted value in any given year or, stated another way, it is expected that on the average the forecast will be exceeded once every ten years.

**affected utility**—Affected utilities are those whose systems cause, contribute to or would experience an impact from a reliability issue.

**angle**—Used to measure the synchronism between different alternating quantities, such as voltage or current. It is often an important performance measure; it is measured in degrees.

**baseload**—A baseload power plant is an electric ***generation*** plant that is expected to operate in most hours of the year.

**blackout**—A total loss of power over an area; usually caused by the failure of electrical equipment on the power system.

**breaker-and-a-half**—A substation design that offers advantages such as ensuring that the failure of any one circuit breaker will not interrupt power for more than a brief time. The designs also allow parts of the substation to be de-energized for maintenance and repairs without causing a power interruption.

**brownout**—Abnormally low voltage that causes voltage-sensitive equipment such as computers, motors and certain types of lighting to have degraded or interrupted performance.

**bus—**Also referred to as a "node" or a "station" or a "substation." A common connection point for two or more electrical components, such as a transformer, a generator.

**capability**—The capacity of a piece of equipment to perform its intended function, such as carrying current for a conductor or transformer, or interrupting current for a switch or breaker, or supplying power for a generator. Certain pieces of equipment can have different capabilities based on certain factors, such as ambient conditions (temperature, wind) and the amount of time the equipment is expected to perform the intended function. Typically, a Normal rating or capability is nearly continuous, and an Emergency capability is a higher capability utilized during infrequent events for a short duration, typically twelve hours or less.

**capacitor**—A device that stores an electrical charge and is typically used to address low voltage issues on a power system.

**conductor**—Part of a ***transmission*** or ***distribution*** line that actually carries the electricity; in other words, the wire itself. The wire or conductor is just one part of a transmission line; other parts include the poles and the insulators from which the conductor is hung. A conductor must have enough capacity to carry the highest ***demand*** that it will experience, or it could overheat and fail.

**contingency**—An unplanned event creating an outage of a critical system component such as a ***transmission*** line, ***transformer***, or ***generator***.

**converge**—Power flow programs use an iterative mathematical process to solve for, or converge to, the solution of unknown system parameters, such as ***Voltage*** and ***Angle***. When the mathematics do not result in a solution, the iterative process has "failed to solve" or "failed to converge" to a solution. This result is an indication of voltage collapse or ***loss of load***.

**Critical Energy Infrastructure Information (CEII)**—Specific engineering, vulnerability, or detailed design information about proposed or existing infrastructure (physical or virtual) that: (1) relates details about the production, generation, transmission, or distribution of energy; (2) could be useful to a person planning an attack on critical infrastructure; (3) is exempt from mandatory disclosure under the Freedom of Information Act; and (4)gives strategic information beyond the location of the critical infrastructure.

**demand**—The amount of electricity being used at any given moment by a single customer, or by a group of customers. The *total* demand on a given system is the sum of all of the individual demands on that system occurring at the same moment. The *peak* demand is the highest demand occurring within a given span of time, usually a season or a year. The peak demand that a ***transmission*** or ***distribution*** system must carry sets the minimum requirement for its capacity (see also the definition for ***energy***).

**demand-side management (DSM)**—A set of measures utilized to reduce energy consumption. Energy conservation is one kind of DSM.

**dispatch**—As a verb: turning on or off, or setting the value or output of a generator, a **c*apacitor*** bank, ***reactor*** or ***transformer*** setting. As a noun: the state or status of these devices.

**distribution**—Distribution lines and distribution ***substations*** operate at lower ***voltage*** than the ***transmission*** systems that feed them. They carry electricity from the transmission system to local customers. When compared to transmission, distribution lines generally use shorter poles, have shorter wire spans between poles and are usually found alongside streets and roads, or buried beneath them. A typical distribution ***voltage*** would be 13.8-kV.

**distribution utility**—A utility in the state of Vermont that is responsible for owning, operating, and maintain the distribution part of the electric system within an area.

**easement**—A right to use another's land for a specific purpose, such as to cross the land with transmission lines.

**failed to converge**—See ***converge***.

**fault**—The failure of a line, ***transformer***, or other electrical component. Once such a component has failed (due to overheating, short-circuiting, physical breakage, or other trauma) it is automatically taken out of operation by a circuit breaker that quickly turns the component off. Once it has been "tripped off" it no longer poses a threat to human safety, but its loss may present a difficult burden to the remaining system (see also the definition of ***redundant*** below).

**forward capacity market**—A marketplace operated by ISO-NE using an auction system with a goal of purchasing sufficient power capacity for reliable system operation for a future year at competitive prices where all resources, both new and existing, can participate.

**generation or generator**—A device that converts mechanical ***power*** from an engine, a water wheel, a windmill, or other source, into electrical power.

**Inductor**—See ***reactor.***

**kilowatt-hour (kWh)**—One thousand watt-hours. A watt-hour is a measure of the amount of electric energy generated or consumed in a given period of time.

**kilovolt (kV)**—One thousand volts. Volts and kilovolts are measures of ***voltage***. **lead distribution utility** - A utility selected by the ***affected utilities*** to facilitate decision-making and to lead the effort to conduct the **NTA** analysis

**lead distribution utility**—A utility selected by the ***affected utilities*** to facilitate decision-making and to lead the effort to conduct ***NTA analysis***.

**load**—see ***demand***.

**load shedding**—Intentionally turning off power to a customer or group of customers, usually for reliability reasons such as to avoid a blackout or equipment damage.

**loss of load**—See ***blackout***

**megawatt (MW)**—One million watts. Watts and megawatts are measures of power. To put this in perspective, the peak power demand for the New England region is approaching 30,000 MW or 30,000,000,000 (thirty billion) watts.

**N-0** or **N-1** or **N-1-1**—The term N minus zero (or one or two) refers to the failure of important equipment. Although these terms sound complex, they are actually quite simple. "N" is the total number of components that the system relies on to operate properly. The number subtracted from N is the number of components that fail in a given scenario. Therefore, N-0 means that no components have failed and the system is in a normal condition. N-1 means that only one component has failed. N-1-1 means that two components have failed, which is generally worse than having only one fail (see also the definition of ***contingency*** above).

**non-transmission alternative (NTA)**—The use of a non-transmission solution such as local generation or energy efficiency to solve a transmission reliability deficiency.

**out of angle**—See ***phase shifter***.

**per unit (pu)**—The ratio of an actual or measured quantity to the base or reference value of the same quantity. For example, a 0.9 pu voltage on a 100 kV system represents a 90 kV measurement of the voltage.

**phase shifter**—Also referred to as a "phase shifting transformer" (PST) or "phase angle regulator" (PAR). A ***transformer*** that adjusts the ***angle*** between two ***buses*** in order to change the amount of power flowing between these buses. Some of these transformers are also able to adjust ***voltage***. These transformers have an ***angle capacity***, which states the extent to which the ***tansformer*** can adjust the ***angle*** between two ***buses***. When the ***angle capacity*** is reached before the desired flow can be achieved, it is stated that the transformer ran out of ***angle*** or that the ***angle capacity*** of the transformer is not sufficiently large.

**power**—The amount of electricity that is consumed ***(demand)*** or supplied at any given time.

**power factor**—A measure of the amount of reactive power (by-product of alternating current, i.e., AC) in relation to the real ***power*** (component of power that can heat).

**pool transmission facility or facilities (PTF)**—Generally speaking, any transmission facility operating at 69 kV or higher and connected to other transmission lines or transmission systems is considered a PTF. PTF falls under the authority of ISO New England and the construction of new PTF facilities is generally funded through the ISO on a load ratio share basis among its member utilities.

**reactive reinforcement**—Also referred to as "reactive compensation." The act of adding a ***capacitor*** bank or shunt ***reactor*** to increase or reduce ***voltage***.

**reactor**—A device that stores energy in the form of a magnetic field, and then uses this energy to induce current. Typically used to address high voltage issues on a power system.

**reliability deficiency**—An existing or projected future violation, before or after a contingency, of the applicable planning, design and/or operating criteria, with consideration given to the reliability and availability of the individual system elements.

**renewable power source—**Any power source that does not run on a finite fuel which will eventually run out, such as coal, oil, or natural gas. Renewable power sources include solar, wind and hydro generators, because sunlight, wind and running water will not run out. Generators that burn replaceable fuels also commonly qualify as renewable power sources. Examples include bio-diesel generators that run on crop-derived fuels and wood-burning generators.

**right of way (ROW)**—The long strip of property on which a ***transmission*** line is built. It may be owned by the utility or it may be an ***easement***.

**ring bus**—See ***breaker-and-a-half, bus, substation***.

**sensitivity studies**—A technique of analysis whereby different values of certain key variables such as the permanent loss of a generation or transmission resource are tested to see how sensitive study results are to possible change in assumptions.

**shoulder load**—A load level that is within some band width over and above 80% of the peak load level.

**steady state**—Refers to the period of time after all momentary network disturbances and automatic equipment adjustments have ended.

**substation**—A substation is a fenced-in area where several generators, ***transmission*** and/or ***distribution*** lines come together and are connected by various other equipment for purposes of switching, metering, or adjusting ***voltage*** by using ***transformers***.

**subtransmission**—Subtransmission lines are power lines that typically operate at a ***voltage*** of 34,000 to 70,000 volts and are generally below 100 kV.

**thermal**—Refers to the heating effects of current flow. Often used in conjunction with capability, impact, analysis.

**transformer**—A device that typically adjusts high-***voltage*** to a lower voltage. Different voltages are used because higher voltages are better for *moving* power over a long distance, but lower voltages are better for *using* electricity in machinery and appliances. Transformers are commonly described by the two (or more) voltages that they connect, such as “115/13.8-kV,” signifying a connection between 115-kV and 13.8-kV equipment or lines.

**transmission**—Transmission lines and transmission ***substations*** operate at high ***voltage*** and carry large amounts of electricity from centralized ***generation*** plants to lower voltage ***distribution*** lines and substations that supply local areas. Transmission lines use poles or structures, have long wire spans between poles and usually traverse fairly straight paths across large distances. Typical transmission ***voltages*** include 345-kV and 115 kV and generally all are above 100 kV.

**transmission system reinforcements**—Transmission line or substation equipment added to existing transmission infrastructure.

**voltage**—Voltage is much like water pressure in a system of pipes. If the pressure is too low, the pipes cannot carry enough water to satisfy the needs of those connected to them. If the voltage is too low, the electric system cannot carry enough electricity to satisfy the needs of those connected to it.

**voltage collapse** -A phenomenon whereby a series of events ultimately results in a blackout after a certain amount of time ranging from seconds to minutes.

**voltage instability**—A phenomenon whereby system operators cannot maintain acceptable system voltage given the tools at their disposal for a specific combination of load, generation and transmission. Voltage collapse may ensue.

# Appendix 4: List of External Weblinks

The electronic version of this document contains a number of clickable links to external websites. For those viewing the document in print, the web addresses for all links appear below.

**Description and Web Address**

VELCO site with detailed information about the Plan and related public input process: www.velco.com/publicoutreach

Vermont System Planning Committee: www.vermontspc.com

Technical analysis underlying this plan: www.velco.com/PublicOutreach/Pages/TechnicalAnalysis.aspx

*Note: Some sections of the technical analysis contain Critical Energy Infrastructure Information and must be requested from VELCO*

Planning standards

- TPL-001: www.nerc.com/files/TPL-001-0.pdf
- TPL-002: www.nerc.com/files/TPL-002-0.pdf
- TPL-003: www.nerc.com/files/TPL-003-0.pdf

North American Electric Reliability Corporation: www.nerc.com

2008 Capacity, Energy, Load, Transmission (CELT) Report: www.iso-ne.com/trans/celt/report/index.html

Information about Docket 7081: www.state.vt.us/psb/VSPC/main.htm

Approved form for preliminary non-transmission alternatives screening ("three-part test"):

www.vermontspc.com/VSPC%20Reports%20%20Correspondence/NTAscreeningtool-final.pdf

Citizens' Guide to the Section 248 Process: www.state.vt.us/psb/document/Citizens_Guide_to_248.pdf

North American Electric Reliability Corporation: www.nerc.com/

Northeast Power Coordinating Council: www.npcc.org/

Regional System Plan: www.nepool.com/trans/rsp/2008/index.html

Sustainably Priced Energy Enterprise Program (SPEED): vermontspeed.com/

Attachment 1 Comments of the Vermont System Planning Committee on the Technical Analysis
http://www.velco.com/PublicOutreach/Pages/VSPCComments.aspx

Attachment 2 Verbatim record of public comments
http://www.velco.com/PublicOutreach/Pages/Comments.aspx

Attachment 3 Subsystem Assessment List
http://www.velco.com/PublicOutreach/Pages/subsystem.aspx