# Summary of *Vermont/New Hampshire Transmission System 2010 Needs Assessment*

**February 17, 2011**

## Introduction to this Summary

On a regular and ongoing basis, ISO New England (ISO-NE) assesses the ability and needs of the New England transmission system, both systemwide and in specific areas, to provide a reliable supply of electricity to the region's residents and businesses. ISO New England is responsible for conducting planning for the region's high-voltage transmission system, under authority conferred by the Federal Energy Regulatory Commission (FERC). The transmission system must meet mandatory reliability standards set by the North American Electric Reliability Corporation (NERC), the Northeast Power Coordinating Council (NPCC), ISO-NE, and the region's transmission owners.

ISO New England's initial Vermont Needs Assessment began in mid-2008. The preliminary results of the initial Vermont Needs Assessment were presented to ISO-NE's Planning Advisory Committee in February 2009. The initial study identified issues in neighboring states, so the study was revised to also include a broader look at New Hampshire and surrounding areas. The resulting Vermont/New Hampshire Transmission System 2010 Needs Assessment was conducted by a study team led by ISO-NE with representatives of Northeast Utilities (NU), Vermont Electric Power Company (VELCO), and National Grid (NGRID).

Given the level of transmission system detail contained in ISO-NE's reliability needs assessments, these reports are classified as Critical Energy Infrastructure Information (CEII), a federal designation intended to protect the security of the power system. These reports cannot be released to those without CEII clearance. ISO New England has prepared this summary to make the major findings of the Vermont/New Hampshire Transmission System 2010 Needs Assessment, a 100-page report completed and posted for stakeholder comment in February 2011, available to the general public.

This study identifies the areas of the system in Vermont and New Hampshire that potentially fail to meet mandatory federal and regional reliability standards. A second study is underway to identify potential regulated transmission solutions to address needs identified in this analysis, while a third will provide high-level information on nontransmission alternatives.

With no official request from Entergy to retire the Vermont Yankee nuclear power station, no official ruling from the federal government on Vermont Yankee's application for a license renewal, and no official ruling from Vermont's Public Service Board on the plant's application for a certificate of public good, the initial Vermont Needs Assessment did not assume for planning purposes that Vermont Yankee will retire in March 2012 when its current operating license is set to expire.[1] However, the ISO and Vermont transmission owners are preparing for the possibility that Vermont Yankee will not be in service past 2012. The initial needs assessment studied scenarios with Vermont Yankee out of service and the subsequent Vermont/New Hampshire Transmission System Needs Assessment simulated the performance of the system under conditions that include the permanent retirement of Vermont Yankee.

[1] According to a report by the Nuclear Regulatory Commission, all nuclear power plants that applied for relicensing and whose applications were completed and reviewed have been approved. See http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1850/sr1850_faq_lr.pdf.

## Study Assumptions

The Vermont/New Hampshire Transmission System Needs Assessment analyzed the performance of the power system in Vermont and New Hampshire using a model of New England's power system as it is expected to be in 2020. The study assumptions included the projected level of peak electrical demand in 2020, the existing and planned generation and demand-side resources expected to be in service in 2020, and the transmission system as it exists today plus any planned transmission upgrades expected to be in service by 2020. The forecasted peak load in 2020 is 33,560 megawatts (MW) under extreme weather conditions for the entire six-state region, compared with about 29,310 MW forecasted for 2010. Similarly, the forecasted peak for Vermont in 2020 is 1,255 MW compared with an all-time peak load of 1,102 MW experienced in 2006. For New Hampshire, the projected peak is 3,080 MW compared with an all-time peak load of 2,483 MW in 2006.

## Study Process

This comprehensive study employed an advanced power system analysis software tool that models how power flows from more than 350 generators over the 8,000 miles of high-voltage transmission lines in New England. Electricity travels at the speed of light and flows like water, following the path of least resistance. When a contingency occurs on the system—that is, if a power plant or other equipment trips off line or a high-voltage transmission line goes down—unwanted consequences can occur far from the source in a split second. This power system model shows how power will flow, where transmission facilities may be overloaded, and where voltage may surge or drop, when various combinations of outages are simulated. According to federal and regional transmission planning requirements, power system engineers must look at what happens when any one of thousands of contingencies occur, and then they must analyze how the system responds when these possible contingencies occur with a facility already out of service.

A total of 29 different generation dispatches were examined in this study. Each of the generation dispatches examines the system with a different combination of one or two critical generating plants unavailable. Many of these hypothetical dispatches reflect the possibility that Vermont Yankee may be retired in March 2012.

The study team then analyzed the results of 1,100 different contingencies on each of the 29 dispatch cases. A first contingency could be a high-voltage transmission line or a large transformer tripping out of service. After each of those first contingencies was modeled, adjustments to the power system model were made that reflect the measures that system operators would take in preparation for a second contingency. These actions could include the redispatch of fast-start units in Vermont and New Hampshire and adjustments to regulating transformers that can control the flow of power on a transmission line. To evaluate system needs at the next level of system stress, the study team looked at 443 second-contingency scenarios—each one representing a system element removed from service upon which each of the 1,100 first-contingency scenarios were applied. These multiple-contingency scenarios are rare, but the consequences can be significant, threatening the safe and reliable operation of the power system in New England and neighboring systems, such as New York and New Brunswick. In all, ISO-NE engineers and the study team evaluated over 500,000 different permutations of the power grid for the Vermont/New Hampshire Needs Assessment.

## Study Conclusions

The Vermont/New Hampshire Transmission System 2010 Needs Assessment found that by the year 2020, the Vermont and New Hampshire transmission systems will need additional resources, transmission system upgrades, or a combination of both to reliably serve the forecasted demand for electricity. These additional resources could include generation, demand resources, or voltage support. Under a variety of scenarios and demand levels, potential thermal overloads and voltage violations were observed in almost every area of Vermont and New Hampshire, with potential overloads and voltage violations also seen in north central and western Massachusetts.[2]

Many of these potential violations occur at current levels of demand. These issues exist with or without Vermont Yankee in service, but generally (but not always) tend to be more widespread and severe without Vermont Yankee. Under some circumstances, loss of load—that is, loss of electricity service—could occur in portions of Vermont and New Hampshire.

The analysis shows many potential violations in the following areas or under the following conditions:

- **Regional Issues**:
  - Contingencies that result in the loss of a major source of generation within New England could cause potential widespread thermal and voltage violations in the study area of Vermont and New Hampshire.
  - Under certain combinations of 345 kilovolt (kV) line outages, both Vermont and southwest New Hampshire would become disconnected from the rest of New England's 345 kV network. Thermal overloads would occur on 115 kV lines in New Hampshire and Vermont. Low-voltage conditions would occur in southwest New Hampshire and southern Vermont.
- **Vermont-Specific Issues**:
  - The Vermont transmission system requires additional local reactive support to help maintain voltage at stable levels.[3]
  - Following the outage of major 345 kV lines serving the area, the remaining 115 kV lines serving the state can become overloaded.
- **New Hampshire-Specific Issues**:
  - Many localized areas of the New Hampshire transmission system, from the Seacoast to northern New Hampshire, would experience potential low-voltage violations and potential thermal overloads on the remaining transmission lines after contingencies occur.

## Vermont Yankee's Role in the Regional System

Vermont Yankee, by virtue of its location on the region's power grid, as well as its ability to generate more than 600 MW of electricity, serves a significant amount of load in the region and helps to control voltage in New England. Vermont currently has 76 generators, most of which are small. After Vermont Yankee, the next largest generator is 52 MW.

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[2] *Thermal overloads* are caused when a transmission line is carrying significantly more electricity than it was designed to carry. When other lines go out of service, electricity in the system funnels into the remaining lines. At high levels, thermal overloads can damage the transmission line and associated equipment. *Voltage* can be compared to pressure in a water pipe—it's what moves the current of electrons or, in this analogy, it's like the water pressure that moves the current of water through the pipe. Low voltage can be caused by the loss of devices that control the "pressure," such as a generator. A large drop in voltage can dim lights and can also cause damage to electrical equipment. Severe voltage drops can lead to the loss of portions of the transmission system, potentially removing service to customers fed from the underlying distribution system.

[3] There are two kinds of power in an Alternating Current system: real power and reactive power. *Real power* does the work of running motors or lights, for instance. *Reactive power* is necessary to magnetize motors and other equipment so they start and operate. *Reactive power* must be maintained to ensure steady voltage on transmission lines. If power system equipment cannot get reactive power from nearby sources, it will pull it across transmission lines and destabilize the grid.

In some study scenarios, in particular, in second-contingency scenarios, the continued operation of Vermont Yankee is a significant benefit to the overall reliability of the power system. After certain contingencies, Vermont's 345 kV transmission system, as well as parts of southwestern New Hampshire, would be separated from the rest of New England's transmission grid. Under these circumstances, with Vermont Yankee retired, many thermal and voltage issues would arise; with Vermont Yankee on line, these violations are much less severe and in some cases, no longer exist.

## Upcoming Studies

Continuing its work with transmission owners that would be affected, including VELCO, Northeast Utilities, and National Grid, ISO New England hopes to complete the Vermont/New Hampshire Solution Study by the second quarter of 2011. The solution study will develop alternative transmission solutions that are then tested to determine their effectiveness. Solutions must be painstakingly designed to avoid adverse impacts on system reliability. Solution studies assess the transmission projects that will result in the most cost-effective solutions to meet the identified reliability needs.

Some transmission solutions under consideration that address long-term issues in Vermont and New Hampshire include a variety of possible 115 kV transmission line and substation upgrades; new 345 kV transmission lines into northern or eastern Vermont; a new transmission line within Vermont; and additional reactive support, which could be provided by capacitors and reactors, to help control and improve voltage performance.

Private developers also may opt to pursue new generation, increased energy efficiency, and new sources of imported power, all of which could help address system reliability issues. While the ISO's authority is confined to the identification and development of transmission solutions, at the request of stakeholders, ISO New England is conducting a high-level pilot study of nontransmission alternatives that could address the identified reliability needs in Vermont and New Hampshire. The results of that pilot study are expected by summer 2011.

For more information, please contact:

Ellen Foley
Corporate Communications
ISO New England Inc.
T. 413-535-4139

Marcia Blomberg
Corporate Communications
ISO New England Inc.
T. 413-540-4555