MEMO

FROM: NHPUC Commissioner Clifton Below

TO: Scenario Matters, ISO-NE

RE: Comments on 6/18/2007 New England Electricity Scenario Analysis Draft Report

In general the report appears to be in very good shape. I have a number of suggested edits, both substantive and minor. Some are to help the less knowledgeable lay reader and some are just to make it read a bit easier from my point of view or style. For most edits I'll copy sections or sentences and mark them up.

p. 1, 2nd paragraph:

This situation is challenging for a number of reasons. Residents and businesses expect reliable power on demand and they want it ~~to be low cost~~ at reasonable and competitive prices. But New England has long been a region with high energy costs and some of the highest retail electricity prices in the nation, and policymakers are searching for ways to lower or at least stabilize electricity bills. At the same time, policymakers and consumers alike want the power sector to continue to make environmental progress, as witnessed by many New England states adopting air emission regulations stricter than required by the U.S. Environmental Agency (EPA) to limit sulfur dioxide (SO_2) and nitrogen oxides (NO_X)—which contribute to the formation of acid rain and smog, respectively—and carbon dioxide (CO_2), which has been linked to climate change. New England policymakers also want the region's electricity consumers to pursue energy efficiency ~~on a more aggressive schedule~~ to a greater extent than in the recent past. For reliability …

COMMENT: The report has a number of references to a goal of low cost electricity. I think that is an unrealistic expectation to suggest. Generally electricity prices are rising throughout the world and the days of "low cost" electricity are over most everywhere. Maybe residents and businesses would like low cost but what they really want, I suspect, is for our electricity prices to be in line with those in other regions, i.e., reasonable and competitive prices.

p. 1, last paragraph, 2nd sentence:

… Among them are ways to reduce demand, such as by increasing the use of more efficient appliances and equipment or by installing devices to cycle electric appliances on and off during peak hours or shift load off-peak.

p. 2, 3rd footnote (FN), last sentence:

Demand-side measures include the adoption of more energy-efficient building codes, the installation of highly efficient appliances (such as refrigerators or lighting), advanced cooling or heating technologies, electronic devices to cycle air conditioners on and off during day-time hours, and equipment to shift load to off-peak hours of demand.

p. 3, the 7 scenarios bullets: Style question: The 2nd bullet point has a period at end but the others do not. Conform?

p. 4, FN 9: There is a reference to the peak demand on 8/2/06 at 28,201 MW. This does not conform with the reference to the 28,021 MW figure cited on p. 16, neither of which conform with the official, after the fact, figure of 28,130 MW, which would seem to be the one to use.

p. 6, 1st bullet: "***However, it is difficult, if not impossible, to accurately predict today…***"

p. 6, last line: "… Energy Certificates, the effects of ~~any~~ new regulatory requirements, and other sources."

p. 6, FN 11:

A Renewable Energy Certificate represents the environmental attributes of one megawatt-hour of electricity from a certified renewable generation source for a specific state's Renewable Portfolio Standards (RPSs). Providers of renewable energy are credited with RECs, which are typically [or "usually"] sold or traded separately from the electric energy commodity (see Section 1.4 and Section 5.3.2).

COMMENT: I think the package of RP requirements is usually referred to as the portfolio standard, in the singular. Also, although RECs are usually sold separately from the energy commodity in New England, that is not always the practice in other regions and NH's RPS specifically allows the possibility that RECs can be procured in conjunction with PPAs for energy (and capacity).

p. 7, 2nd bullet:

New England's CO_2 emissions from the power sector vary considerably across the scenarios (and within some scenarios, depending on the assumptions about such variables as fuel prices, emission allowance costs, and unit retirements). The analyses indicate that for the different scenarios and sensitivity-analysis cases, meeting the region's CO_2 emissions targets under the Regional Greenhouse Gas Initiative (RGGI) will require some economic combination of adding substantial amounts of low- or zero-CO_2-emitting resources along with having affected power generators buy additional CO_2 emission allowances from sources outside the regionNew England, but within the RGGI region, relying on offsets in other sectors and redispatching the electric system, among other actions.[12] Adding more renewables with no- or low-CO_2 [conform with dash style above] emissions in areas far from load centers or importing more hydroelectric power will require the region to build substantially more transmission to move this power to the load centers.

COMMENT: the reference to "outside the region" is potentially misleading since there are no emission allowances to be had or acquired from outside of the RGGI region and cap. FN 12 references the northeast RGGI region.

p. 8, last sentence of 1st paragraph: "However, an expansion of the natural gas capacity would expose New England to potentially high prices and further additional [or "more"] fuel-diversity issues."

p. 9, 2nd paragraph:

Virtually all the new power plants added in the region since 2000 burn natural gas as their primary fuel and were planned and built when gas prices were forecast to remain relatively low. Since 20002, however, natural gas prices have doubled and are subject to considerable volatility, which has led to relatively high electricity prices for New England's consumers.

COMMENT: As written I found these 2 sentences to be contradictory and confusing. How could it be that prices have been subject to considerable volatility and doubling since 2000, but plants have been built since 2000 "when gas prices were forecast to remain" low? Maybe the first "since 2000" could be changed to an earlier year (1998 or 1999?), if true I think my suggested edits make it make more sense and are consistent with the data in FN 40, p. 19 that show prices going from $2.95 in 2002 to an estimated $6.42 in 2006.

p. 9, 3 paragraph, 1st sentence: "Most would agree that New England's future economic health depends on the region having a reliable, low reasonable cost[or "competitively priced"], and environmentally sound supply of electricity that can minimize variations in costs that result from changes in fuel prices or fuel availability."

COMMENT: See also my first comment. I wouldn't agree, and I hope most economists and policymakers wouldn't agree that our future economic health depends on having "low-cost" electricity, because that's not the case now and there is no realistic prospect for that in the foreseeable future. New England has long been at the end of the energy supply pipeline and has long had above average energy costs. Probably most would agree that our electricity costs need to be reasonable and not too far out of line with other regions and thus competitive, but we are never going to sell ourselves on having "low cost" electricity (compared with what?).

p. 10, after the 4th bullet add:

A lesser known but mature and commercially available demand-side resource is:

- Off-peak cooling (OPC) with thermal energy storage (TES) that can shift air conditioning and cooling loads from peak hours of electric demand to off-peak hours by using chiller equipment to store coolness in ice, chilled water or phase change materials for use when needed during peak hours.

COMMENT: I think it would be helpful to highlight this greatly underutilized (in New England) resource that is starting to be aggressively deployed in NYC and CA to shave peak demand, save big bucks, and significantly cut NOx and CO_2 emissions.

p. 10, last bullet:

Building new gas-fired, ~~and~~ coal, or nuclear power plants ~~and expanding generating capacity at nuclear stations~~

COMMENT: "expanding capacity at nuclear stations" is perhaps misleading in that it suggests that existing nuclear reactors could significantly increase their output when the real option is to build new nuclear power plants (albeit, perhaps at existing sites).

p. 11, Sec. 1.2, 1st line: " … a Steering Committee, which include~~s~~d …" It seems more like the past tense than the present since the Steering Committee is no longer active.

p. 11, After Footnotes 20 and 21: Perhaps add another footnote listing the actual Steering Committee members and their affiliation.

p. 12, 2nd paragraph, 2nd sentence: "A series of economic, reliability, and environmental, "outcome" metrics allow~~ed~~ for comparison~~ng~~ of the results of the different scenarios."

p. 12, last line just before Sec. 1.4: "This deliberately provides distinct and clear pictures of possible future states that can be compared readily, rather than realistic pictures of the future that would have had to have been carefully honed for a particular set of assumptions."

p. 13, 3rd bullet: "**Scenario #3—Expansion of Nuclear Capacity.** For this scenario, nuclear capacity is assumed to be expanded at or near existing nuclear stations.

P. 13, 4th and 5th bullets: **COMMENT:** Add a footnote to explain the basics of what a combined-cycle power plant is. For example: "FN 25 A combined-cycle facility produces electric power in two stages or cycles. The first stage runs a gas turbine and generator driven by the direct burn of gas, like a jet-engine. The second cycle uses the heat from the burning gas to make steam that drives a steam turbine and generator." You could also add an explanatory statement to the following effect: "Combined cycle power plants tend to have a higher capital cost per MW of capacity compared with single or simple cycle power plants such as combustion turbines, but are significantly more efficient in power output per unit of fuel burned."

p. 13, 6th bullet: "**Scenario #6—New Renewable Projects.** This scenario adds capacity from new renewable resources, such as those sources defined in the states' Renewable Portfolio Standards (RPSs).

p. 13, FN 25, 3rd sentence: "Vermont is pursuing an alternative approach and is requiring that renewable resources be used to serve all growth in that state's ~~energy use~~ electric load." [or "electricity use"]

p. 14, 7th bullet (from p. 13), last sentence: "… This scenario takes into consideration the different seasonal demand patterns experienced in Canada (winter peaking) and New England (summer peaking) and improves the use of planned hydroelectric and wind projects by increasing their capacity factor."

p. 15, FN 28: "The 35,000 MW level is based on a 50/50 summer-peak demand, which is expected to occur at a New England-wide average temperature of 90.4°F and has a 50% chance of being exceeded due to weather." [If that is true? If not what is the temperature assumption implicit in the 50/50 forecast?]

p. 16, §2.1.2, 2nd paragraph: 28,021 MW peak vs. 28,201, vs. 28,130 (see comment on p. 4, FN 9, above). See also 2006_smd_hourly.xls, available at: http://www.iso-ne.com/markets/hstdata/znl_info/hourly/index.html, which FN 34 could be changed to.

p. 16, FN32: I think this is the first reference to a CELT report. Perhaps spell out parenthetically "1999 CELT (Capacity, Energy, Loads, and Transmission) Report (Holyoke: ISO New England Inc., 1999) …"

p. 17, Figure 2-1: "**Source:** ISO New England, *2006 Regional System Plan* (RSP06), Figure 4.1."

p. 17, 2nd to last sentence: "The Scenario Analysis assumes that the 2,600 MW portfolio of technologies in the queue, which includes wind projects, biomass and landfill gas projects, hydro projects, fuel cell installations, gas-fired combustion turbines (peaking units) and combined-cycle facilities, and coal IGCC projects, represents a reasonable mix of possible future resources.

p. 21, 1st paragraph on Solar PV energy profiles: I strongly suggest adding a footnote to the following effect:

> FN 43 Some sources suggest that optimally oriented PV systems, at low levels of grid penetration of 2% or less of total capacity, could have effective capacity values as high as 50% to 65% at peak demand times in New England. See for example, Richard Perez, et al, *Update: Effective Load Carrying Capability of Photovoltaics in the United States.* National Renewal Energy Laboratory, June, 2006, available at http://www.nrel.gov/pv/pdfs/40068.pdf. See also Steven Letendre and Richard Perez, *Understanding The Benefits Of Dispersed Grid-Connected Photovoltaics: From Avoiding The Next Major Outage To Taming Wholesale Power Markets,* The Electricity Journal, Volume 19, Issue 6, July 2006, pages 64-72, describing PV availability during certain peak demand times in the PJM and NYISO systems from 55% to 80%. Available at http://www.asrc.cestm.albany.edu/perez/2006/letendre-perez-Elejrnl-06-06.pdf.

COMMENT: At least twice during stakeholder meetings I pointed out that some literature suggests higher capacity values for PVs during summer peaks. I also tried to point out possible limitations to the analysis used for the 40% estimate. I followed up on some of this with a couple of emails to 'scenariomatters@iso-ne.com' on 3/12/07, including copies of the two above referenced papers. In FN 23 you point out that "To reflect the often opposing information provided by stakeholders, the ISO also used ranges of information from the literature." When I pointed out why the 40% estimate might be low, I conceded that it was reasonable to use for purposes of the basic analysis but with some expectation that the higher estimates that exist in the literature would be disclosed to readers of the report, so that they could explore a range of assumptions, possibly in the spreadsheet tool. I'll explain again a couple of reasons why the 40% figure might be low. First, the analysis used assumes that peak demand hours are evenly distributed across the months of June through September. I'd submit there are as likely to be summer peak demand days in May (when solar insolation is higher) as in September. But more significantly, peak demand days are more highly correlated with sunny or at least hazy days when solar insolation is higher than average as with overcast or cloudy and rainy days when it is much lower than average. Summer peak demand is driven by air conditioning and cooling loads. High ambient temperatures (esp. coupled with high humidity) are two important drivers of air conditioning loads and are themselves correlated with sunnier days, but air conditioning loads are also driven by direct solar insolation, which drives up solar gain through building fenestration (both direct and from re-radiation from exterior objects) as well as direct heating of envelope surfaces and HVAC rooftop equipment, lowering its efficiency. Also, the hours chosen, 14-18, are slightly skewed toward later in the afternoon than actual 2006 peak hour data indicates (which includes as many 12 and 13 hours as 18 hours in the top 1,000 or 2,000 MW of peak demand, with an actual average earlier in the afternoon than assumed). The combination of these factors may result in a significant underestimate of actual potential PV contribution to the peak demand hours that it serves on the margin, especially at low levels of grid penetration. Thus I think it important to provide at least one reference to a credible source (such as the study funded by NREL) that suggests possible higher capacity values. Note that the estimated capacity values for northern New England, esp. VT and ME, in that study are much lower than for southern New England. This appears to be an artifact of the study analysis that considered state specific peak demand hours, where northern New England still has a significant number of winter hours in the overall peak demand hours used for the analysis.

p. 23, Table 2-2, the heading of the 6th column doesn't make sense: I think it really refers to "Generic Capital Costs (2006 $/kW)" or just plain "Capital Costs (2006 $/kW)." If is really is "Annual Capital Costs" then the figure should be "(2006 $/kW/year)."

Annual Capital Costs (2006 $/kW)

p. 26, Table 2-3: The reference to 170 lbs/MBtu of CO2 for Biomass might be footnoted that if fueled by sustainably harvested biomass then the CO2 emitted overtime would be balanced by the CO2 that is sequestered by growing the fuel, which is why it can be considered carbon neutral over time. Likewise the 0 emission rate of landfill gas might be footnoted to point out that there are actually CO2 emissions from burning landfill gas, but they are assumed to occur with or without electricity production, whether by flaring the gas or direct emission as more potent GHG from landfills.

p. 26, FN 56: "Additionally, the Conference of New England Governors and Eastern Canadian Premiers (NEGC/ECP) Climate Action Plan (August 2001) has broader goals for CO_2 emission reductions. This plan, adopted in 2001 by the NECG/ECP, includes a cross-sector goal of reducing all greenhouse gas emissions to 10% below 1990 levels by 2020, and longer term goal of ~~reductions of between 75% and 85%~~reducing "regional GHG emission sufficiently to eliminate any dangerous threat to the climate." That plan also presented …"

COMMENT: I think the above edit is a more accurate statement. The actual long term goal reads: "Reduce regional GHG emissions sufficiently to eliminate any dangerous threat to the climate; current science suggests this will require reductions of 75–85% below current levels." Noting that "current science suggests" is different than adopting that range of reduction as a goal per se. This is something some Governors or Premiers may be sensitive to.

p. 27, 1st ¶ after Table 2-4, 3rd sentence: "A sequestration operating cost of $25/ton of CO_2 was assumed for this case, for transportation, monitoring, and storage." [As opposed to a capital cost.]

p. 31, 2nd and 3rd to last bullets:

- For Scenario #2 alone, a sensitivity case was run that interchanged the levels of demand response and energy efficiency (Double DR and Double EE, respectively).
- A sensitivity case for Scenario #4 (coal IGCC) considered the implications of 90% carbon capture and sequestration by assuming increased capital and operating costs of $400/kW and $25/ton of CO_2, respectively~~associated with carbon sequestration~~.

p. 32: "Counting the seven core scenario runs for the common set of assumptions, the scenario analyses conducted ~~over~~ 52~~0~~ simulations, as shown in Table 3-1."

p. 38, 2nd paragraph, last sentence: "(A consumer's actual price of electricity includes electric energy, capacity, ancillary service, transmission, distribution, and other items, such as payments tied to credits for renewable energy sources~~,~~ and taxes, which appear on retail electricity bills.)"

p. 41, 2nd paragraph, 3rd sentence: "As shown previously in Figure 2-2(p. 18), this mix includes fast-start, gas-fired "peaking" (CT) units(57%); gas combined cycle plants (20%), renewable power plants (composed of biomass, landfill gas, wind, fuel cells, and hydro projects) (11%); and coal-fired IGCC capacity(12%)."

p. 42, next to last ¶: "All non-production-related costs are captured in the annual revenue requirements range of 15% to 25% of capital costs."

p. 43, 1st ¶, 3rd sentence: "The IGCC operating and capital cost and efficiency penalties associated with the carbon capture, are shown in Table 2-~~1~~2, (p. 23)." [Wrong reference.]

p. 46, last paragraph, next to last sentence: "Table 5-1summarizes the annual production and wholesale electric energy market costs and average clearing prices under the common set of assumptions and the double energy-efficiency case (termed "All EE" in the table)."

p.47, FN (d) to Table 5-1, 3rd sentence: "Scenario #2 (EE/DR) is assumed to supply 18 Million MWH of no-cost "energy," and the double energy-efficiency case ("All EE") is assumed to provide 36 million MWh of no-cost "energy," which is comparable to the nuclear and coal IGCC scenarios."

p. 50, add a possible FN at the end of the first paragraph under §5.1.3, to the following effect:

> "FNx But it does assume that each MWH of energy-efficiency is paid for at the market clearing price, as explained in footnote (d) to Table 5-1. To the extent that energy-efficiency might be realized for less than the clearing price, Figure 5-3 may overstate the cost of energy-efficiency scenarios to load-serving entities. See also footnote 80 below."

p. 51, 2nd paragraph:

> Although this analysis modeled demand-side resources the same way as supply-side resources, and energy efficiency and demand response were assumed to be "dispatched" to satisfy the same load level assumed in the other cases, in reality, energy efficiency and demand response actually reduce system load. Demand-side resources are not "dispatched" in the same way as power plants, and LSEs do not have to buy less electric energy than in the cases without demand-side resources. [I can't make sense of the prior sentence. Does it mean: "As modeled under EE/DR scenarios, although demand-side resources are not "dispatched" in the same way as power plants, LSEs were assumed to have purchased as much electric energy as in cases without demand-side resources."?]While this did not affect the production costs or clearing prices estimates in any hour (since the demand-resources were effectively bid in at zero cost), it did affect the total amount of electric energy LSEs were modeled to have purchased over the course of the year. Therefore, the cases that involve demand-side resources could be adjusted to reflect the lower amount of electric energy purchased compared with the cases that have not deployed any incremental energy efficiency, demand response, or a combination of both

p. 56, 2nd paragraph, end of 2nd line: "… only assuming no ~~$~~ revenue for capacity …"

p. 56, 4th paragraph, next to last sentence: "Additionally, they are expensive such that they may need financial subsidies for many applications."

p. 57, 1st paragraph under §5.2.1.1, next to last sentence: "In Scenario #2, demand response provides half of the capacity expansion, ~~which does not~~ but is not assumed to provide any significant amount of electric energy (and instead is assumed to be primarily peak shaving) and thus ~~causes~~ results in existing gas-fired generation to operate more often than in many other cases."

p. 57, last bullet, 2nd sentence: "This is in large part because, like under the common set of assumptions, demand response ~~does~~is not assumed to introduce much energy-producing capacity into the overall capacity expansion plan."

p. 58, third bullet, last sentence: "The use of peaking units to produce large quantities of electric energy, which they ~~were~~are not designed for, also increases electric energy prices."

p. 60, last sentence at very end of page continuing on to p. 61: "For example, approximately 18,100 MW of natural gas units with uninterruptible fuel supply[??] would need to be available to avoid the use of emergency procedures over the summer peak period."

p. 66, FN 82: "For example, New Hampshire, the last state in New England to establish an RPS~~s~~, has set the highest target among the six states: 25% by 2025 (which is exclusive of in-state large-scale hydro that currently generates the equivalent of about 10% or more of the electric sales in New Hampshire. …"

p. 67, Table 5-4: **Comment:** I think it would be helpful to explicitly state the assumptions on the acres/MWH of effective capacity (vs. nominal capacity – or perhaps both) for each renewable resources, esp. wind and solar, perhaps in a Table footnote.

p.67, the four bullets concerning gallons/minute: **Comment:** This needs just a bit more explanation. Are the totals for the various scenarios the average increase in cooling water (for all new capacity) expressed in gallons/minute for every minute of the year? If so, just say something like that. Perhaps state "gallons per minute" the first time you use it.

p. 68, last paragraph:

- ***The price for fossil fuels (natural gas and oil) is the most dominant factor affecting the costs and emissions for each of the scenarios.*** This can be seen in Figure 5-3 (p. 50) and Figure 5-10 (p. 65) for the LSE expense for wholesale electric energy and total CO_2 emissions, respectively. The absolute and relative levels of natural gas and oil prices tend to be the biggest factors affecting the amount of electricity produced by different technologies, total system wide expenditures on energy production, and the total amount of emissions produced by power plants. For example, the sensitivity case for which natural gas price doubled also showed increases in wholesale energy costs to LSEs by approximately 50% across all scenarios. This same sensitivity case increased system wide CO_2 emissions by more than 10 million tons for every scenario compared with the cases under the common set of assumptions. Fuel prices affect the energy mix, costs, and emission levels. If gas prices were to increase (relative to oil), then emissions would likely rise, as power plants will be burning more oil. …

p. 69, first bullet, last sentence: "… Therefore, to induce investment in these technologies and have them enter the market, some other means would need to be used to fill this revenue gap, such as through payments from the Forward Capacity Market, long-term purchased power agreements for energy and/or capacity, rate basing of capital costs, the provision of ancillary services, tax credits, the sale of emission allowances, Renewable Energy Certificates, the effects of any new regulatory requirement, and other sources."

COMMENT: PPAs and rate basing, though perhaps controversial, are among the range of policy options to address this issue that should be mentioned here. Also, check spacing between bullet points on this page (and elsewhere) for consistency.

p.72, next to last paragraph, right under §6.2, first sentence: "The Scenario Analysis initiative has been designed to provide the region with information about the implications of various choices for meeting consumers' future needs for reliable, ~~low-cost~~reasonably priced [or competitively priced], efficient, and environmentally sound supplies of electricity."

COMMENT: See my very first comment, page. 1.

p.73, 2nd paragraph under §6.3, 2nd sentence: "For example, the core scenarios ~~set out scenarios that~~ incorporate relatively homogeneous technology paths, adding 5,400 MW from a single type of technology."

p. 74, next to last sentence: "The spreadsheet will enable users to incorporate, for example, different cost assumptions with regard to the capital costs of particular technologies, the cost of transmission and distribution expansion for a particular scenario,~~,~~ and modification to other types of costs."

p. 75, 3rd and 4th references look like they are actually just one item with a paragraph return in the middle.

p. 76, 6th reference: "ISO New England. *NEPOOL Forecast Report of Capacity, Energy, Loads and Transmission*. (CELT) Holyoke: ISO New England Inc., April 1999."

Hopefully add one or both references mentioned in my suggested footnote for page 21 above.

Final generic comment: I personally prefer the general convention of providing two spaces after at the end of sentences instead of one, as I think it makes such a long document more readable, especially with 11 point font size, but this is just a style choice.

Overall, again, I think this is a very good product and hope my suggested edits are of some value and thank you for your consideration of them.