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Compendium of Concerns
Regarding the Proposed Installation of a Scrubber at PSNH's Merrimack Station in Bow, New Hampshire

Prepared for the
Commercial Ratepayers Group

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(Revised January 5, 2009)

The discussion and costs reported herein reflect a brief initial assessment that should be improved with additional time and analytical resources; additional or more accurate information and/or suggestions for improvement are welcome. This assessment is intended simply to demonstrate that a thorough, comprehensive investigation of several significant, as-yet-unaddressed issues should be developed and carefully considered by policymakers before ratepayers are committed to the long-term costs and impacts likely to result from the installation of the scrubber at, and ongoing operation of, Merrimack Station.

Revision History

Original version released December 11, 2008.

Revision 2 released on December 19, 2008 included these changes:

1. Mercury control costs for activated carbon injection and TOXECON technology revised per Institute of Clean Air Companies (ICAC) January 3, 2005 comment letter in USEPA Docket ID No. OAR-2002-0056 and personal communication.
2. New section added on Jobs and Labor Opportunities Associated with Energy Alternatives (IV.F.).

Revision 3 released on January 5, 2009 included these changes:

1. References to (a) Center for American Progress / Political Economy Research Institute study and (b) Gittell Magnusson study on economic impacts of Regional Greenhouse Gas Initiative (RGGI) to New Hampshire added to Section IV.F. on Jobs and Labor Opportunities Associated with Energy Alternatives; section reordered.

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I. Overview

Reducing mercury emissions is important for both public health and the environment, and in 2006 the Legislature mandated that PSNH install wet flue gas desulphurization ("scrubber") technology at its coal-fired Merrimack Station in Bow to reduce mercury emissions by 80%. At the expected cost of $250 million and given what we knew then, that was the right decision. Much has changed, however, and this brief initial analysis indicates that PSNH's proposed installation of the scrubber and continued operation of Merrimack Station could leave ratepayers exposed to billions of dollars in potential additional costs for carbon, mercury, cooling water systems, fuel costs, construction cost increases, etc. – ***in addition to*** the now $457 million nominal cost of the scrubber project estimated by PSNH. Applying a simple ratio based on PSNH's indication that the scrubber project would cause a 0.33¢ per kWh rate impact, the table below shows that overall as-yet-unaccounted-for future rate impacts can be expected to be several times greater. Increasing fuel costs over time are not included in this table, and are likely to further exacerbate ratepayer impacts, particularly as compared to energy efficiency and some renewable energy alternatives.

	PSNH Calculation	High Cost Scenario	Low Cost Scenario
Scrubber Cost	$457,000,000	$457,000,000	$457,000,000
Additional Costs	$0	$2,482,325,815	$852,875,744
Total Costs	**$457,000,000**	**$2,939,325,815**	**$1,309,875,744**
Scrubber Rate Impact	0.33¢ per kWh	0.33¢ per kWh	0.33¢ per kWh
Additional Rate Impacts	n/a	1.79¢ per kWh	0.62¢ per kWh
Total Rate Impact	**0.33¢ per kWh**	**2.12¢ per kWh**	**0.95¢ per kWh**
Multiple of PSNH's Rate Impact Estimate	**n/a**	**6.4**	**2.9**

The magnitude of these potential costs associated with installing the scrubber and continuing to operate Merrimack Station for at least 15-20 more years require a thorough investigation by the NH Public Utilities Commission to determine whether PSNH's proposal represents the best path forward for ratepayers and for the state as a whole. At this time no analysis has been performed of PSNH's revised cost estimate (which increased the estimate from $250 million to $457 million).

> *"Prudent viewers can already see that within the next half dozen years, there are likely to be radical changes in construction costs, operating costs, expected sales-volumes, competitive alternatives and price resistance from smart or desperate customers. These concerns call into question whether large investments in coal-generation without carbon controls are reasonable in today's industry.... [These] are the concerns that investment analysts should address before, rather than after, commitments for investment in new coal-fired generation are made."*
>
> *(Michael Dworkin, former Chair of the Vermont Public Service Commission, and Director of the Institute for Energy and the Environment at Vermont Law School, 2008)*

II. Background

A. Merrimack Station is PSNH's prime base load plant (see http://www.psnh.com/AboutPSNH/CompanyProfile/Merrimack.asp):

1. 478 MW output
2. Supplies 189,000 residential, commercial and industrial customers; PSNH serves 490,000 total customers
3. Began commercial operation in 1968
4. Operates on two coal-fired steam turbines, and two combustion turbines utilized only during great power demands
5. Annual emissions (PSNH 2007 data, EPA EGrid 2005 and TRI 2006 data); other pollutants include Carbon Monoxide, Volatile Organic Compounds, Ammonia, Particulate Matter, and several toxic compounds:

Pollutant	Emissions	Units
Carbon Dioxide	3,726,216	Short Tons
GHGs Overall	3,398,027	Metric Tonnes CO_2 Equivalent
Sulfur Dioxide (SO_2)	36,504	Short Tons
Nitrogen Oxides (NOx)	3,219	Short Tons
Mercury Compounds	137.64	Pounds (2007 ISTEPS estimate)
Mercury	19.08	Pounds (2005 EGrid)

B. PSNH has announced that it expects to spend $457 million of ratepayers' money – an 83% increase over its original cost estimate of $250 million – to install a scrubber at its 40-year-old coal-fired Merrimack Station. Reducing mercury emissions is important for both public health and the environment. The scrubber installation was mandated by the Legislature in 2006 and would reduce mercury emissions by 80%. In 2006, at a $250 million cost and given what we knew then, that was the right decision. Now, amid an unprecedented global economic meltdown, increasing constraints on carbon dioxide emissions and a rapidly increasing array of alternatives, we should take a hard look to make sure this is still the right deal for ratepayers, New Hampshire and the environment. It all boils down to the question: Is this is a good investment? If PSNH's customers are going to invest nearly a half-billion dollars, should that investment be used to continue operating a 40-year old coal plant that will still emit mercury, carbon dioxide and other harmful air pollutants? That will still require substantial additional investment for environmental controls for both air and water pollution? Are there alternatives, and if so, shouldn't viable alternatives be assessed to better inform this important decision?

III. Concerns About Unexamined Costs and Risks of the Scrubber Installation

A. Control of Carbon Dioxide and Other Greenhouse Gas (GHG) Emissions

1. Urgent Need to Control GHG Emissions

   a. In order to avoid climate change impacts, Annex 1 (developed) countries must reduce GHG emissions by 25-40% by 2020. The technology for carbon capture and storage of emissions from coal fired power stations is not expected to be available on an economically viable commercial scale by 2020. (IPCC, 2007)

   b. Rather than declining, global GHG emissions are currently accelerating. The IPCC "worst case" development scenario reflects a lower-emissions path than we are actually experiencing. Further, where IPCC (2007) suggested that atmospheric concentrations of GHGs (CO2-equivalent) needed to remain at ~450 parts-per-million by volume (ppm) in order to avoid dangerous man-made interference with the climate system, several scientists now believe that the correct level is ~350 ppm – which is actually *below* current atmospheric concentrations of ~388 ppm.

   c. The New Hampshire Governor's Climate Change Task Force has set a goal of reducing CO_2 emissions by 75-80% by 2050. New Hampshire has also committed to the "25 x '25" vision, which aims to have America's farms, forests and ranches provide 25 percent of the total energy consumed in the United States by 2025. The New England Governors and Eastern Canadian Premiers committed in 2001 to reducing GHG emissions too 1990 levels by 2010, 10% below that level by 2020, and 75% below by 2050.

2. Coal Plant Proposals Must Consider Carbon Emissions

    a. On April 2, 2007, the US Supreme Court determined in *Massachusetts v. EPA* that carbon dioxide was a pollutant. Resulting uncertainty over future carbon regulations has contributed to coal power plant delays and cancellations across the country. Since late 2006, more than twenty proposed coal-fired power plants have been cancelled. More than three dozen others have been delayed. State regulatory commissions in Oregon, Florida, North Carolina, Oklahoma and Washington State have rejected proposed power plants. The State of Kansas has rejected permits for two 700 MW coal-fired power plants. (Synapse Energy Economics, AMP Report, 2008)

    b. The November 2008 decision by EPA's Environmental Appeals Board to remand a Deseret (Utah) power plant proposal could affect all plant modifications having CO_2 impacts, potentially including Merrimack Station's scrubber proposal. Costs associated with Best Available Control Technology (BACT) requirements for CO_2 have not been assessed and the administrative process for determining BACT could cause significant permitting delays.

3. Uncertainty About Future Federal Carbon Controls

    a. Substantial uncertainty currently exists about the nature and costs of future federal carbon controls on power plants, including the level of stringency, timing (when such a program will take effect), emissions allowance allocation and prices (e.g., the degree to which allowances are auctioned or allocated freely), and whether and to what degree emissions "offsets" are allowed.

    b. Offsets, if allowed by a federal carbon control program, would likely reflect energy and/or environmental improvements made elsewhere instead of in New Hampshire.

    c. President-Elect Obama has committed to embark on a path targeting nationwide GHG reductions to 1990 emission levels by 2020 and an 80% reduction by 2050.

4. Regional Greenhouse Gas Initiative (RGGI)

    a. PSNH is already subject to some degree of carbon regulation through NH's participation in the RGGI program. Under this program, PSNH's CO_2 emissions are capped (albeit at a reasonably high level) from 2009-2014, and from 2015-2018 the cap declines by 2.5% per year for an overall 10% nominal reduction by 2019.

    b. Most RGGI states have decided to auction 100% of allowances, so the costs for RGGI allowances going forward cannot be known. The initial auction in September 2008 cleared at $3.07/short ton. Credible sources (e.g., Innovest) estimate costs of $7.00/short ton as the program matures.

    c. Merrimack Station represents about 47.5% (2007) of total power sector CO_2 emissions in New Hampshire. PSNH has included $15.4 million in its proposed 2009 energy service rate to meet RGGI compliance costs.

    d. PSNH also appears to have already factored the costs of RGGI compliance into its calculations of the rate impacts of the scrubber. For example, in its September 2, 2008 filing spreadsheet, "Existing Plant with Capital Adds, Emissions Costs" for 2013 are listed as $32,414,996. This exceeds its previous NOx/SO_2 emissions costs (e.g., $22,920,000 in 2007) by approximately $10,000,000. This appears roughly consistent with Merrimack Station's annual emissions of CO_2 of 3.7 million short tons multiplied by the initial RGGI auction price of $3.07.

    e. It is not clear if or how PSNH may have factored in the fact that it could potentially receive an amount (the exact amount has not yet been determined by the New Hampshire Department of Environmental Services (NHDES)) of free CO_2 allowances under NH's RGGI implementation. This amount could range from 5 to 12 million tons, which would translate to between ~1.4–3.4 years of cost-free RGGI compliance. The more tons of allowances that NHDES grants to PSNH, the less its CO_2 emissions will be reduced. Over the long term, however, even the best-case scenario for PSNH (i.e., receiving 12 million allowances free from NHDES) makes little difference in this analysis. Against billions of dollars in carbon costs to ratepayers, this would reduce PSNH's costs by only ~$77,643,506 at $7.00 per short ton, or only ~$34,052,224 at $3.07 per short ton (2013 present values).

5. Carbon Capture and Storage (CCS) is Unlikely to Figure in Merrimack Station's Future
   a. Commercial scale CCS is unlikely to be available until the 2030 timeframe.
   b. CCS will result in significant energy penalties.
   c. Merrimack Station will likely be at the end of any CCS transportation and storage infrastructure development (e.g., CO_2 pipelines).
   d. McKinsey and Synapse both estimate that CCS would increase power costs by two-thirds or more.
6. Consideration of Adaptation Issues and Costs
   a. Public interest determinations approving increased GHG emissions are likely to lead to requirements for greater public and private expenditures for adaptation as the climate changes.
   b. The UK Stern Review suggested climate impacts will be ~5-10 times more costly to global GDP than mitigation costs.
   c. The Governor's Climate Change Task Force Report will include adaptation recommendations to mitigate the effects of climate change, continuing to operate coal-fired power plants will make such adaptation efforts more expensive over the long term.
7. Costs: RGGI is only a modest first step to reduce carbon emissions; far more stringent carbon controls are anticipated under a future federal program. Synapse expects that carbon allowance prices will range between $15-45 per metric tonne of CO_2 equivalent ($MTCO_2e$); Innovest's estimates are slightly higher. These values are consistent with prices already seen in the European Union Emissions Trading Scheme (EU ETS).

   A rough estimate of potential carbon control costs for Merrimack Station at these allowance prices is shown below.

Rough Present Value (PV) Cost Estimates for Carbon Allowances	
At 2013, for 2013-2030 period, discount rate of 5%, and 100% auctioning	
High Carbon Price - \$45/$MTCO_2e$	\$2,152,559,262
Medium Carbon Price - \$30/$MTCO_2e$	\$1,435,039,508
Low Carbon Price - \$15/$MTCO_2e$	\$717,519,754

Note: NPV would increase correspondingly with each year that Merrimack Station continues to operate after 2030.

B. Control of Mercury and Other Toxic and Acid Gas Emissions

1. Merrimack Station is at risk regarding EPA's upcoming determination of Maximum Achievable Control Technology (MACT) for mercury. New federal MACT mercury control requirements may be imposed on Merrimack Station that would be more stringent than the scrubber can deliver. Fortunately, other technology options now exist that would likely achieve greater mercury reductions at lower cost than the scrubber.
   a. In 2005 EPA issued the Clean Air Mercury Rule (CAMR) to cap and reduce mercury emissions from coal-fired power plants. Several environmental groups and states sued EPA arguing that CAMR did not comport with the Clean Air Act. In February 2008, the CAMR was remanded by the US District Court of Appeals and sent back to the EPA to be re-written. There is currently no federal mercury MACT emission regulation while the EPA re-writes the rule. Fourteen states have enacted their own mercury regulations for power plants. (ADA, http://www.adaes.com/faq/index.html#Mercury)
2. MACT for existing facilities is defined as the average of the best-performing 12% of plants. It is not clear at this time what EPA will determine the MACT performance level (in percent reduction) to be, but several ongoing legal proceedings seek to compel the imposition of mercury MACT emissions limits on coal-fired power plants.

3. The proposed scrubber technology is primarily designed to reduce sulfur dioxide emissions, but in concert with selective catalytic reduction (SCR) NOx-control systems (which Merrimack Station has), it promises to reduce mercury emissions by 80%. If EPA determines that MACT requires greater reductions than these combined systems can achieve (say, 90%), then ratepayers will be at risk to pay for additional required mercury control technology (e.g., activated carbon injection (ACI) or TOXECON II technologies).
4. It is not clear that the combination of SCR and scrubber technology captures elemental as well as oxidized captured mercury. Therefore, the plant may require further investments in additional technology, such as ACI or TOXECON II technology. Annual operating costs may also be higher to capture elemental mercury through the use of halogens or oxidizing agents.
5. Commercial availability of mercury-control technology is demonstrated by the fact that more than 100 full-scale activated carbon injection systems have been ordered by U.S. coal-fired power generators as of April 2008 (Institute of Clean Air Companies).
    a. These contracts include both new and retrofit installations and represent more than 44 gigawatts of coal-based electric generating capacity. About 33 gigawatts of existing electric generating capacity (about 10% of total U.S. coal-based capacity) will be retrofitted with ACI to control mercury emissions. This includes halogen-treated carbon systems that can capture elemental mercury. ACI systems have the potential to remove 70% or more of the mercury, and in some cases, 90% or greater mercury capture, at a cost that can dip below $10,000 per pound of mercury removed. (National Energy Technology Laboratory (NETL), http://www.netl.doe.gov/newsroom/features/06-2008.html)
6. Mercury is the hazardous air pollutant of greatest concern at this time, but other toxic and acid gas emissions from Merrimack Station may be subject to additional control technology requirements – and associated costs to ratepayers – in the future. Other toxics include hydrochloric and sulfuric acid, hydrogen fluoride, and barium, chromium, manganese, and vanadium compounds, among others.
7. Costs: Data on mercury control costs indicates that the cost of retrofitting mid-sized coal-fired power plants with ACI systems is relatively inexpensive, averaging approximately $1-5 million capital cost and roughly the same amount in annual operating costs. A newer technology pioneered by the Electric Power Research Institute (EPRI) called TOXECON II, is more costly in terms of capital, at approximately $8-25 million capital cost, but this process allows the fly ash to be sold for concrete without the need for a new fabric filter. As a result, plants equipped with TOXECON II will be able to avoid the loss of this revenue stream. The operating costs for TOXECON II are similar to those for ACI. (ICAC, 2005) Some data suggests parasitic load for these technologies are in the vicinity of 0.15 MW (Starns, 2008). Costs are likely to vary substantially based on site-specific space and configuration issues (e.g., hot side or cold side installation).

Rough Cost Estimates for Technology for Mercury MACT	
Capital Costs	$717,000 – $25,334,000
Operating Costs (per year)	$452,226 – $4,522,262

Present Value (PV) Cost Estimates for Mercury MACT	
At 2013, for 2013-2030 period, discount rate of 5%, capital + operating.	
High	$88,994,718
Low	$14,970,072

Note: NPV would increase correspondingly with each year that Merrimack Station continues to operate after 2030.

C. Cooling Water Systems

1. Merrimack Station discharges hot water into the Merrimack River, averaging around 50-55°F in mid-winter, 90-95°F in mid-summer, and occasionally reaching 100°F. Merrimack Station's federal National Pollutant Discharge Elimination System (NPDES) water discharge permit has expired and a renewal permit is pending at EPA. The plant could be required to convert to a closed-loop cooling system as have other fossil-fuel fired plants in the region. If the site's footprint allows, this would probably involve the construction and operation of one or more cooling towers, which would again involve capital costs for construction, annual operating costs, and parasitic load (i.e., electricity used to operate the pollution control technology).
   a. Almost all older power plants use once-through systems, which take water from a water body for cooling and then discharge the heated fluids back into the same body of water. Such systems have significant impacts on the local aquatic environments through the entrainment and entrapment of fish and fish larvae and through the heated water discharged at the end of the cooling cycle. In closed-cycle systems, cooling water is pumped through the plant's condenser and then through cooling towers. Closed-cycle systems use 95-98% less water than once-through systems. New power plants generally are required to have closed-cycle cooling systems, but many older plants still used once-through systems. When these plants' water permits are renewed, however, the issue arises of whether the plant's cooling system should be converted from a once-through to a closed system. Economic issues that should be evaluated regarding conversion from once-through to closed-cycle cooling systems include: (1) the estimated cost of making conversions to closed-cycle systems; (2) performance and cost penalties associated with operating closed-cycle cooling systems; (3) analysis of the impact of the proposed cooling system conversion on electric system reliability; and (4) the impact of converting to closed-cycle cooling systems on the expected profits of the plant's owner. (Synapse, http://www.synapse-energy.com/expertise/cap_powerplants.shtml)
2. Associated issues and concerns may include:
   a. NPDES permitting issues and delays (Merrimack Station's draft permit is now expected in mid-2009)
   b. Cost of conversion to a closed-cycle cooling system
   c. Energy penalty necessary to operate a closed-cycle system
   d. Consumptive water use
   e. Make-up; blowdown treatment and discharge
   f. Visible plumes, drift, particulate matter
   g. Noise pollution
   h. Site space, footprint, and separation distances
   i. Potential modifications to the condenser and other equipment (and the costs thereof)
   j. Other site-specific constraints, impacts, and costs
3. Costs: More research needs to be done to identify representative capital and operating costs associated with retrofitting mid-sized coal-fired power plants like Merrimack Station with closed-cycle cooling systems. Initial soundings suggest that these costs are likely to be in the range shown below. Costs are likely to vary substantially based on site-specific space and configuration issues. (Maulbetsch, 2003, 2006)

Rough Cost Estimates for Closed-Cycle Cooling System	
Capital Costs	$50,000,000–$100,000,000
Operating Costs (per year)	$5,000,000–$10,000,000

Rough Present Value (PV) Cost Estimates for Cooling System	
At 2013, for 2013-2030 period, discount rate of 5%, capital + operating.	
High	$240,771,835
Low	$120,385,918

Note: NPV would increase correspondingly with each year that Merrimack Station continues to operate after 2030.

D. Construction Costs and Delays

1. Construction and materials cost pressures are likely to bring delays and postponements

   a. Based on recent trends, it is reasonable to assume plant capital costs could be 20-40% higher than currently estimated costs. Analyzing such additional cost increases is justified, indeed necessary, in light of recent industry experience and the expectation that worldwide demand will continue to be a driving force for rising prices for the foreseeable future. (Synapse, *Don't Get Burned, 2008*)

   b. The cost of new power plant construction in North America increased 27% in 12 months and 19% in the most recent six months, a level 130% higher than in 2000. A power plant that cost $1 billion in 2000 would, on average, cost $2.31 billion today. The latest increases have been driven by high activity levels globally with continued tightness in the equipment and engineering markets, as well as historically high levels for raw materials. Excluding nuclear plants, costs have risen 79 percent since 2000. (IHS/CERA, 2/14/08, http://energy.ihs.com/News/Press-Releases/2008/North-American-Power-Generation-Construction-Costs-Rise-27-Percent-in-12-Months-to-New-High-IHS-CERA.htm)

   c. In addition to regulatory and stakeholder opposition, rising construction costs continue to derail the construction of new coal-fired power plants throughout the US. Potential delays coupled with increasing costs of construction will likely result in significant upward adjustments in cost projections. This will ultimately result in increased electricity rates. In Nevada, the cost of Sierra Pacific Resources' proposed 1,500 MW Ely Energy Center has increased by more than 30% from $3.8 billion to $5 billion since it was first announced in 2006. In 2007, Duke Energy's proposal to build two 800 MW coal-fired generating units was reduced to one unit as a result of the North Carolina Utilities Commission's concern over the need for new capacity in light of rising construction costs and available alternatives. These two cases exemplify a national trend that has resulted from rapid increases in the cost of material inputs throughout the last several years. (Innovest, Sunflower Holcomb report, 2008, http://blog.climateandenergy.org/2008/03/25/news-update-new-report-on-sunflower-concludes-that-proposed-coal-plants-would-commit-western-kansas-ratepayers-to-decades-of-high-electricity-prices/)

2. Annual economic growth in China and India is now likely to dip from ~12% and 9% respectively, but still maintain 5-8% growth, keeping steel, concrete, etc. supplies under pressure (*The Economist*, 11/21/08)

   a. USDOE's Energy Information Agency's Annual Energy Outlook for 2008 anticipates 4-5% energy growth in China and India through 2015. (http://www.eia.doe.gov/oiaf/ieo/appi.html)

3. Risks that were once borne by contractors are being shifted to plant owners

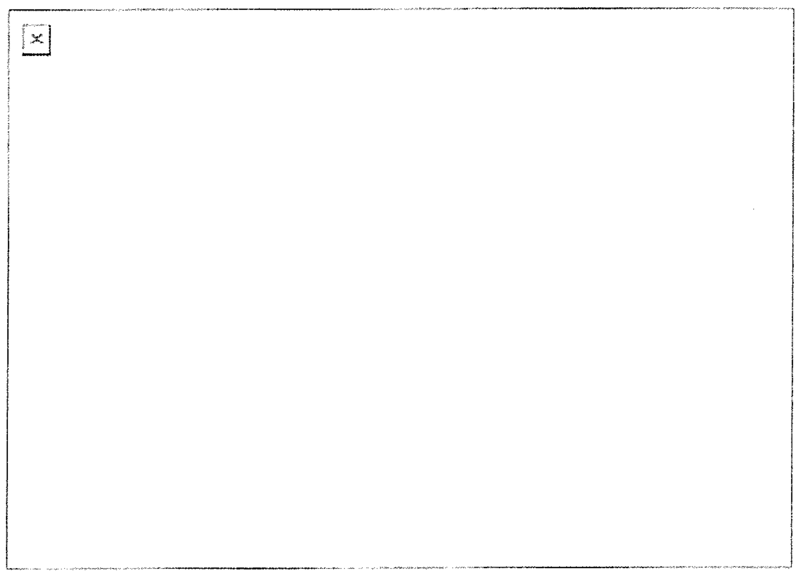
   a. In the past, major Engineering, Procurement and Construction (EPC) contractors were willing to enter into fixed price contracts for new power plants. As a result, the contractors bore the risks that actual materials, equipment and component prices would be higher than estimated. Recent experience at a number of power plant construction projects shows that the major EPC contractors are no longer willing to enter into fixed price contracts. Construction project contracts now often shift the risks of higher commodities, equipment and/or labor costs to plant owners and investors. (Synapse, *Don't Get Burned, 2008*)

4. Costs: Costs associated with construction and delay are not calculable empirically in advance, but sensitivity assessments concerning construction costs, delays, and ratepayer impacts should be conducted and/or made available.

E. Fuel Costs and Issues

1. Aside from carbon, mercury, cooling system, and construction cost issues, the ongoing operation of Merrimack Station obviously requires ongoing outlays to purchase coal for fuel. As shown below, between now and 2030, these purchases represent a significant financial commitment from ratepayers. While such costs are mandatory for any combustion-based generation, they may not be necessary to the extent that electricity demand can be satisfied through energy efficiency and demand-side management measures and/or some renewable energy resources.

2. PSNH spends approximately $150 million per year for coal burned at Merrimack Station.
3. Recent trends in coal price and quality reinforce the importance of a thorough investigation into the ultimate costs of proceeding with the scrubber installation and continued operation of Merrimack Station. Prices for thermal coal have more than doubled over the last year – from ~$50-55/ton to ~$100-135/ton (Macquarie Bank, Reuters) and the current economic downturn is unlikely to affect this trend over the long term.
4. There is some evidence that "peak coal" (akin to M. King Hubbert's "peak oil") may be on the foreseeable horizon. Although not yet widely recognized, there is increasing evidence that economically recoverable coal reserves have been dramatically overstated. Some analysts project that global coal production will peak in the 2030-2040 timeframe.
    a. It is not possible to confirm the often-quoted assertion that there is a sufficient supply for the next 250 years. Present estimates of coal reserves are based upon methods that have not been reviewed or revised since their inception in 1974, and much of the input data were compiled in the early 1970s. Recent programs to assess reserves in limited areas using updated methods indicate that only a small fraction of previously estimated reserves are actually minable reserves. (National Academy of Sciences, 2007)
    b. The world could run out of economically recoverable reserves of coal much earlier than widely anticipated. ... Coal might not be so abundant, widely available and reliable as an energy source in the future. (Institute for Energy, The Future of Coal, Report to the European Commission, March 2007)



    c. Projections of US domestic coal production are similar to the global picture.
    d. Potential impact to NH ratepayers: Greater global competition for coal will maintain or increase coal prices, increasing fuel costs passed on to ratepayers.
    e. Price impacts of global demand are already evident: As noted above, thermal coal prices have more than doubled from last year, from ~$50-55/ton to ~$100-135/ton (Macquarie Bank, Reuters).
5. Fuel quality: The average heat content of coal appears to be declining
    a. In 1955 the average heat value was 30.2 MJ/kg; in 1976 this had declined to 27 MJ/kg. The trend continues from 1980 to present. Today the average heat value of American coal is only around 20.5 MJ/kg. The total decline in heating value is more than 30% since 1955. A part of this can be explained by the increasing amount of lignite and subbituminous coal since the 1970s. But even within each coal class the quality is declining. (from Heinberg, referencing Hook, Zittel, Schindler, Aleklett, Energy Policy, 2008)
    b. Potential impact to NH ratepayers: Higher future coal costs for equal heat value, or less generation for the fuel cost projected.
6. Merrimack Station is at the end of the fuel transport supply chain

a. Transportation can be up to 70% of the delivered cost of coal, and rail bottlenecks may be a significant factor in future supply. (Heinberg, 2008)

b. Potential impact to NH ratepayers: Higher delivered fuel costs for equal heat value in the future as transportation costs increase, perhaps disproportionately due to accompanying increases in transportation fuel costs.

7. Issues regarding PSNH's September 2, 2008 fuel cost assumptions:

   a. PSNH assumed a fuel cost of $4.82/MMBTU escalating at 2.5% per year. This cost escalation is certainly not consistent with recent coal price increases, which doubled over the last year.

   b. PSNH's overall projected fuel costs reflect an ~34% increase 2007-2008; run level through 2012; and then escalate at 2.5% per year through 2028. This cost scenario is not likely, given the above supply constraints. The economic downtown may temper recent price fuel price increases, but this is not likely over the longer term of Merrimack Station's continued operation. A thorough investigation should thus include reasonable fuel price sensitivity analyses to better assess fuel cost risks to ratepayers.

   c. In addition, PSNH currently purchases most of its coal for Merrimack Station from Venezuela, which means that its supply is also subject to geopolitical risks.

   d. In today's marketplace, coal no longer necessarily wins economically. If coal stays at $100-150 per ton and if natural gas remains as low as it is or continues to fall in price, a lot of utilities will look at gas instead. (Buchsbaum, EnergyBiz, 2008).

8. Costs: Coal costs over the remaining life of Merrimack Station will represent a substantial financial commitment from ratepayers, especially in the face of increasing global demand. Such costs may not be necessary to the extent that electricity demand could be satisfied through energy efficiency measures and/or some renewable energy resources.

   The table below illustrates the present value of these costs assuming varying degrees of coal price escalation. Note that even the "High" scenario below reflects price increases far below those recently experienced in global coal markets.

Rough Present Value (PV) Cost Estimates for Coal Purchases	
At 2013, for 2013-2030 period, discount rate of 5%, $150 million per year.	
High – 10% per year	$3,930,781,449
Medium – 5% per year	$2,571,428,571
Low – 2.5% per year (PSNH, 9/2/08)	$2,111,577,529

Note: NPV would increase correspondingly with each year that Merrimack Station continues to operate after 2030.

F. Financial Issues

1. Financing terms and rates are uncertain due to the current credit crunch; this could have greater-than-anticipated impacts on financing costs.

   a. PSNH's September 2, 2008 report indicates that 52.8% of the scrubber installation will be financed with debt; no interest rate is specified.

2. Under the 2006 law (RSA 125-O:18), the cost of the scrubber must be recovered in PSNH's default energy service charges (i.e., they cannot be "socialized" over a broader ratepayer base or in other sales). This could increase the risk of a "death spiral" dynamic if current customers choose alternative energy providers and could disadvantage small businesses that may be unable to cost-effectively switch providers.

3. Under NH law, capital investment in pollution control equipment is not subject to property taxes. The scrubber investment would be the dominant factor in Merrimack Station's net book value (e.g., by a factor of ~7 in 2013).

4. PSNH must seek future regulatory approval to finance the project, which will entail a review at the PUC of its use of the funds. This could potentially cause delays later in the process if a full investigation is not done now.

G. Recovery of Lost Generation Output

1. It is not clear if or to what extent the PSNH's cost estimates incorporate the cost of the scrubber's own electricity consumption. This energy penalty represents additional net cost that will be incurred by ratepayers, and it merits additional clarity.
2. Modifications have already taken place to recover net power output that will be lost to the scrubber (i.e., its "parasitic load" or "energy penalty"). These modifications to the plant are the subject of another PUC docket. Additional modifications for this purpose may also be planned or proposed.
3. If additional net power output recovery modifications are not necessary, why is the scrubber's cost ($457 million) unusually high compared to many scrubber installations?

H. Other Issues

1. Sulfur Dioxide Emissions
   a. With the installation of the scrubber (which is principally designed to reduce SO2 emissions and incidentally captures mercury as well), PSNH's SO2 emissions would drop dramatically. Correspondingly, its compliance costs under Title IV of the federal Clean Air Act (i.e., the federal Acid Rain program) would decline.
   b. PSNH appears to have already factored these reduced Acid Rain compliance costs into its calculations of the rate impacts of the scrubber. For example, in its September 2, 2008 filing spreadsheet, "Scrubber Only Incremental Costs" for 2013 are listed as -$29,775,129 (i.e., a savings of this amount). PSNH's spreadsheet characterizes these savings as varying between $22.8-30.5 million until 2017, when they stabilize at ~$20 million and then escalate at 2.5% per year. None of these figures, however, have been reviewed by the PUC or any other party.

I. Summary Table of Rough Cost Estimates of Potential Impacts

1. Overall Costs: A rough estimate of readily available potential cost impacts – ***in addition to PSNH's estimate of $457 million*** – concerning proposed and potential changes at Merrimack Station is shown below. Note that this estimate does not include costs associated with construction or for fuel for the remaining life of the plant, costs which have escalated dramatically in recent years.

Rough Estimates of Overall Present Value Costs		
At 2013, for the period 2013-2030, discount rate 5% capital + operating.		
Description	High	Low
Carbon Allowances	$2,152,559,262	$717,519,754
Mercury (to meet MACT)	$88,994,718	$14,970,072
Closed-Cycle Cooling System	$240,771,835	$120,385,918
Total	**$2,482,325,815**	**$852,875,744**

Note: NPV values will increase correspondingly with each year that Merrimack Station operates beyond 2030.

2. Rough Estimate of Effect on Energy Service Rates: Using a simple ratio comparing the above totals to PSNH's indication that the $457 million scrubber installation produces a 0.33¢/kWh rate impact, the following table estimates the overall future rate impacts that can be expected:

	PSNH Calculation	**High Cost Scenario**	**Low Cost Scenario**
Scrubber Cost	$457,000,000	$457,000,000	$457,000,000
Additional Costs	$0	$2,482,325,815	$852,875,744
Total Costs	$457,000,000	**$2,939,325,815**	**$1,309,875,744**

Scrubber Rate Impact	0.33¢ per kWh	0.33¢ per kWh	0.33¢ per kWh
Additional Rate Impacts	n/a	1.79¢ per kWh	0.62¢ per kWh
Total Rate Impact	**0.33¢ per kWh**	**2.12¢ per kWh**	**0.95¢ per kWh**
Multiple of PSNH's Rate Impact Estimate	n/a	6.4	2.9

J. Examples of Studies Needed Before Construction of the Scrubber Should be Approved

1. Comprehensive cost/risk assessment of carbon and mercury liabilities, and perhaps other hazardous air pollutants.
2. Assessment NPDES permitting issues, cooling system issues and costs, other associated costs, constraints (e.g., space) and risks of further delay.
3. Thorough assessment of power flow analysis and other ISO-NE transmission grid issues to investigate potential transmission and distribution (T&D) impacts, ISO impacts, capacity and capacity payments impacts, etc. (Initial inquiries suggest that such a study is likely to cost ~$200,000-250,000.)
4. Comparisons of the cost and reliability impacts of energy efficiency, renewable energy, distributed generation, and new, cleaner energy generation.
5. Assessment of rate and revenue impacts on viability if customers depart PSNH for other suppliers. Under the 2006 mercury law, all costs of the scrubber project will be recovered through energy service rates, so customers who leave its energy service will not pay those costs. (RSA 125-O:28)
6. Increasing emphasis on energy efficiency in residential, commercial, industrial and institutional buildings and processes is likely to moderate future demand growth projections. Already there is strong anecdotal evidence that demand for electricity is falling measurably (see for example http://online.wsj.com/article/SB122722654497346099.html), though it is not clear how much of this is a long-term trend or due to the current economic turmoil. PSNH is estimating that its sales will decline by ~3% in 2009. The likely depth, breadth, and longevity of these factors – notably with respect to ratepayer impacts of existing fixed costs and proposed new capital investments (e.g., the scrubber) – need to be carefully considered.

IV. Consideration of Alternative Energy Paths

A. Numerous studies and analyses (e.g., McKinsey & Company, the American Council for an Energy Efficient Economy (ACEEE), the Center for Climate Strategies, etc.) indicate that significant opportunities for energy demand reduction and associated savings exist today. In addition, less costly energy supply approaches may exist, particularly in terms of avoiding a long-term commitment to coal-fired generation with its high environmental and economic risks and impacts. A thorough investigation should be conducted to determine if any of the alternatives below – or others – represent better paths to protect PSNH ratepayers and New Hampshire's quality of life.

1. Step up energy efficiency programs, resulting in reduced electricity demand and lower consumer energy costs. Efficiency is, by far, New Hampshire's largest and least costly "source" of energy.
2. Pursue distributed generation such as wind and solar electric generators or new, hyper-efficient oil, gas, or wood pellet-fired combined heat and generating units installed at homes and businesses. This could also reduce the need for future power transmission and distribution capacity.
3. Pursue "smart grid" and smart metering technology. A recent smart grid test in Washington State reduced home energy consumption by at least 10%. The low-cost,

wireless ZigBee open communications standard for smart appliances, meters, etc for homes, businesses, and utilities is now in place. Pacific Gas and Electric of California will install up to 3.3 million GE smart meters for some of its customers. The provinces of Victoria, Australia and Ontario, Canada now require installation of smart meters for all energy users. National Grid recently announced its intention to launch trials of this technology.

4. Require or incent PSNH to enter into medium- and long-term purchased power contracts from clean, renewable energy sources. New England now has sufficient surplus natural gas and renewables capacity that the decommissioning of Merrimack Station could be accommodated.
5. Allow PSNH to build renewables plant under regulated rates. (This option is strongly opposed by renewables developers.)
6. Purchase power from under-utilized natural gas fired plants, which emit no mercury and far less CO_2 per kWh than coal. The nearby 750 MW Granite Ridge gas-fired power plant is apparently for sale by a group of post-bankruptcy note holders who now control it. That plant could be shifted from peaking to baseload service during a transition period between Merrimack Station's closure and the availability of even lower emission, lower-cost options. (The higher cost of gas must be factored into a ratepayer analysis, however recent fuel pricing trends suggest that natural gas generation has become competitive with coal-fired power plants.)
7. Enhance transmission capacity to permit delivery of increased generation from clean sources in New Hampshire's North County. An estimated 400 MW of additional New Hampshire wind and biomass generating resources could be unlocked by added transmission capacity. (The NH PUC held its first meeting on August 21, 2008 to try to develop a plan for the expansion of transmission capacity in the North Country as established by Senate Bill 383.)
8. Enhance transmission capacity to allow delivery of available Canadian renewable power. (This is opposed by some environmentalists and by those who wish to preserve the economic benefits of renewables development within the state.)
9. Pursue utility-scale combined heat and power (CHP) generation, such as that proposed in Berlin-Gorham.
10. Adopt a new regulatory framework as an alternative to rate-of-return regulation, allowing PSNH to profit from efficiency programs, smart grid/metering, effective long term purchased power contracts, etc.
11. Other approaches or combinations of alternatives that a comprehensive investigation may show feasible.

B. Energy Efficiency (EE) and Renewable Energy (RE) Examples (ACEEE; Center for Climate Strategies; similar assessments exist for 20+ states)

1. Florida
    a. Implementing 11 specific EE/RE policies could reduce projected future electricity use by ~29% in the next 15 years and reduce peak electricity demand by ~32%.
    b. This would reduce consumer energy costs by $28 billion compared to constructing new power plants.
    c. This would result in the creation of 14,000 new jobs in Florida, roughly equivalent to nearly 100 new manufacturing plants relocating to the state.
    d. This would reduce CO_2 emissions over 37 million tons in 2023 and other pollutants similarly.
2. Texas
    a. Implementing 9 specific EE/RE policies could reduce projected future electricity use by ~22% in the next 15 years and reduce peak electricity demand by ~33%.
    b. This would reduce consumer energy costs by $73 billion over 15 years (~4.5 cents/kWh levelized cost).

c. This would result in a net employment increase of about 38,300 jobs, roughly equivalent to the employment that would be supported by the construction and operation of 300 small manufacturing plants.

d. Air emissions from power plants would be reduced by 20–22% by 2023.

C. The NH Public Utilities Commission has commissioned a study on the remaining energy efficiency potential in the state. The final report is expected this month.

D. Natural Gas

1. At what point is natural gas more competitive? Some sources suggest that we are already at or near that point.

E. Governor's Climate Change Task Force

1. The Governor's Climate Change Task Force may make additional recommendations that bear on this issue.

F. Jobs and Labor Opportunities Associated with Energy Alternatives

1. PSNH's September 2, 2008 filing with the NHPUC indicates that the scrubber installation will take four years to complete, and that at its peak, the project will require the efforts of more than 300 union craft workers in addition to engineering and management support services. It is not clear from PSNH's filing precisely how many full-time-equivalent (FTE) jobs these efforts will actually represent or for how long.

2. University of New Hampshire Prof. Ross Gittell and research scientist Matt Magnusson recently completed a study on "green jobs" in the state – *New Hampshire's Green Economy: Current Employment and Future Opportunities.* They divided "green jobs" into five categories, two of which were energy efficiency and renewable energy. Their research indicates that New Hampshire now has ~17,000 green jobs, but only about 4,600 (26%) in energy efficiency and just 200 (1%) in renewable energy. Gittell's & Magnusson's work indicates ***significant future job growth opportunity if New Hampshire focuses on the green economy, including job growth in traditional industries such as construction and real estate***.

3. In a separate analysis of the economic impacts of the Regional Greenhouse Gas Initiative (RGGI), Gittell and Magnusson (January 2008) corroborate the economic and employment opportunity that energy efficiency can provide for New Hampshire. Their assessment, *Economic Impact in New Hampshire of the Regional Greenhouse Gas Initiative (RGGI): An Independent Assessment*, indicates that if allowance revenues were used for energy efficiency, the overall economic affect would be to increase the state's employment by ***815 jobs*** and its economy by $63 million (or 0.06% of total annual gross state product).

4. University of Massachusetts-Amherst researchers have calculated that a $100 billion national program to create good jobs and start building a low-carbon economy could create 2 million new jobs in two years (Robert Pollin et al, Center for American Progress (CAP) and Political Economy Research Institute (PERI), Green Recovery, September 2008). About ***40% of this job gain would occur in the construction industry*** as a result of the program's focus on six green infrastructure investment priorities. Disaggregated to the state level based on population and gross domestic product, ***New Hampshire's share would be $432 million. Net job creation in the state would be 9,245 jobs***. And at this time, a much larger federal stimulus and recovery funding program is being considered (e.g., $1 trillion), so resulting job growth could be much larger as well.

5. Over the last 35 years, California has reduced its per capita energy requirements to 40% below the national average through energy efficiency policies. University of California–Berkeley researcher David Roland-Holst examined household reductions in per capita electricity demand over the period 1972–2006 in order to answer the question "Given California's economic structure, how would employment growth have proceeded in the

absence of household energy efficiency?" (*Energy Efficiency, Innovation and Job Creation in California, October 2008*)

Roland-Holst's core findings include:

a. Energy efficiency measures have enabled California households to redirect their expenditure toward other goods and services, ***creating about 1.5 million FTE jobs*** with a total payroll of over $45 billion, driven by well-documented household energy savings of $56 billion from 1972-2006.

b. As a result of energy efficiency, California reduced its energy import dependence, and directed a greater percentage of its consumption to in-state, employment-intensive goods and services, whose supply chains also largely reside within the state, creating a "multiplier" effect of job generation.

c. The same efficiency measures resulted in slower growth in energy supply chains, including oil, gas, and electric power. For every new job foregone in these sectors, however, more than 50 new jobs have been created across the state's diverse economy.

d. Sectoral examination of these results indicates that job creation is in less energy intensive services and other categories, further compounding California's aggregate efficiency improvements and facilitating the economy's transition to a low carbon future.

6. Expanding the use of renewable energy is not only good for energy self-sufficiency and the environment; it also has a significant positive impact on employment. This is the conclusion of 13 independent reports and studies analyzed by UC-Berkeley researchers Daniel Kammen, Kamal Kapadia and Matthias Fripp. Their study, *Putting Renewables to Work: How Many Jobs Can the Clean Energy Industry Generate?* (April 2004) assessed the economic and employment impacts of the clean energy industry in the United States and Europe. Key findings include:

a. Across a broad range of scenarios, the ***renewable energy sector generates more jobs than the fossil fuel-based energy sector*** per unit of energy delivered. (See tables below.)

b. The employment rate in fossil fuel-related industries has been declining steadily for reasons that have little to do with environmental regulation.

c. Supporting renewables within a comprehensive and coordinated energy policy that also supports energy efficiency and sustainable transportation will yield far greater employment benefits than supporting one or two of these sectors separately.

d. Generating local employment through the deployment of local and sustainable energy technologies is an important and underutilized way to enhance national security and international stability.

7. In a September 2008 study, *Green Jobs: Towards Decent Work in a Sustainable, Low-Carbon World*, the United Nations Environment Program (UNEP) concluded that:
   a. Along with expanding investment flows and growing production capacities, ***employment in renewable energy is growing at a rapid pace***, and this growth seems likely to accelerate in the years ahead.
   b. ***Compared to fossil-fuel power plants, renewable energy generates more jobs per unit of installed capacity, per unit of power generated and per dollar invested.***
   c. Overall, the number of people presently employed in the renewable energy sector runs to about 2.3 million. Given the gaps in employment information, this is no doubt a conservative figure. (See UNEP Table ES-1 below.)
   d. Additionally, many studies have begun to assess the number of potential jobs that would be created through energy-efficiency measures including investment, standards, and mandates. UNEP Table ES-2 below highlights some of these job predictions.

8. In a September 2000 study entitled *Working for the Environment: A Growing Source of Jobs* (Renner, Working Paper #152), the Worldwatch Institute concluded from numerous studies that ***wind power compares favorably in its job-creating capacity with coal- and nuclear-generated electricity.*** In Germany, although wind energy contributed a still minuscule 1.2% of total electricity generation in 1998, it provided some 15,000 jobs in manufacturing, installing, and operating wind machines. In comparison, nuclear power had 33% of the electricity market but supported a relatively meager 38,000 jobs; coal-generated power had a 26 percent market share and gave rise to 80,000 jobs. Given the rapid expansion of wind power in Germany, wind will likely overtake nuclear power as a source of jobs in 2000.

9. The ***United Steel Workers (USW) and the Communications Workers of America (CWA)*** have partnered with the Sierra Club and the Natural Resources Defense Council (NRDC) to create the BlueGreen Alliance, a strategic partnership between labor unions and environmental organizations to recognize and expand the job-creating potential of the green economy.

10. The ***Building and Construction Trades Department of the AFL-CIO, the Industrial Union Council (AFL-CIO), the International Brotherhood of Boilermakers, the United Association of Plumbers and Pipefitters***, and the Environmental Defense Fund sponsored a November 2008 study by Duke University researchers, *Manufacturing Climate Solutions: Carbon-Reducing Technologies and U.S. Jobs.* The report indicates that U.S. manufacturing is poised to grow in a low-carbon economy. The sponsors explicitly state that the demand for climate solutions ***will create—very directly—manifold job opportunities in many sectors, from core industries such as renewable and energy efficiency businesses to traditional areas such as construction trades, pipefitting and electrical jobs***. They also note the vast supporting cast of industries that make up the supply chain for low carbon end products, citing the example of rising demand for wind turbines: That's good for turbine manufacturers, but the economic benefits don't stop there: A wind turbine contains 8,000 parts, so demand for each one of these parts is rising, too. Following the "value chain" for low carbon technologies reveals that they have vast potential to grow sectors of our economy that aren't traditionally associated with environmental protection.

11. A report released by the U.S. Conference of Mayors in October 2008, *U.S. Metro Economies: Current and Potential Green Jobs in the U.S. Economy,* says the U.S. economy currently has more than 750,000 green jobs, and that number is projected to grow five-fold in the next three decades.
    a. ***Green jobs in the Manchester-Nashua area are projected to grow from 486 in 2006 to 3,843 in 2038***
    b. Green jobs in the Boston-Cambridge-Quincy-Southern New Hampshire area (MA-NH Metropolitan Statistical Area) are projected to grow from 19,799 in 2006 to 156,660 in

2038.

12. Numerous other studies and reports document and/or forecast substantial job growth through alternative energy supply options and increasing efficiency in energy use.

V. Process and Framing Questions, Concerns, and Issues

1. Ratepayer-funded electric generation through regulated monopolies like PSNH is a creation of statute, so it is incumbent upon the legislature and the NHPUC to protect the ratepayers' interests – including consideration of the scrubber and increasing operating costs for Merrimack Station.
2. The recommendations of the Governor's Climate Change Task Force, and other state emission reduction commitments, should be taken into consideration.
3. Merrimack Station's CO_2 emissions exceed the entire emissions of Nepal or the Congo, and are almost 60% higher than those of Iceland or Mozambique.
4. The situation we face with Merrimack Station is analogous to the "repair-or-replace" decision we face regarding an automobile at "trade-in" time.

VI. Conclusion

At this time, no analysis has been performed of PSNH's revised cost estimate for installing scrubber technology at Merrimack Station in Bow, which increased the estimate from $250 million to $457 million since 2006, nor has any consideration been given to the anticipated additional costs estimated above. The magnitude of the potential costs associated with installing the scrubber and continuing to operate Merrimack Station for at least 15-20 more years requires a thorough investigation by the NH Public Utilities Commission to determine whether PSNH's plan represents the best path forward for ratepayers and for the State of New Hampshire as a whole.

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