Synapse
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Cleaner Air, Fuel Diversity and High-Quality Jobs:

Reviewing Selected Potential Benefits of an RPS in New York State

Prepared by:
Geoff Keith, Bruce Biewald, David White,
Anna Sommer and Cliff Chen
Synapse Energy Economics
22 Pearl Street, Cambridge, MA 02139
www.synapse-energy.com
617-661-3248

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The Renewable Energy Technology and Environment Coalition (RETEC) includes the following organizations: American Lung Association of NY State, American Wind Energy Association, Citizens Advisory Panel, Community Energy, Inc., Fuel Cell Energy, Inc., Natural Resources Defense Council, New York Lawyers for the Public Interest, New York Public Interest Research Group, New York Renewable Energy Coalition, New York Solar Energy Industries Association, Pace Energy Project, Plug Power, Inc., Riverkeeper, Safe Alternatives for Energy Long Island, Scenic Hudson, Sierra Club Atlantic Chapter, Solar Energy Industries Association, Union of Concerned Scientists.

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Introduction

A Renewable Portfolio Standard (RPS) in New York State can be expected to result in benefits and incremental costs to New York consumers. Staff of the Department of Public Service (DPS) are preparing a modeling analysis of some potential RPS impacts. At the request of the Renewable Energy Technology and Environment Coalition ("RETEC"), Synapse Energy Economics has prepared this review of several kinds of benefits that would likely result from an RPS requiring 25 percent of the energy sold in New York to come from renewable energy sources by 2013. This review of benefits focuses on three categories of benefits that we do not expect the DPS analysis to examine:

- The environmental and human health benefits of reduced air emissions from fossil-fueled power plants due to an RPS,
- The fuel diversity and natural gas price benefits of an RPS, and
- Employment benefits within the renewable energy and high technology sectors due to an RPS.

We believe that these three categories represent considerable benefits of a New York State RPS. We have not quantified these benefits here for three reasons: first because the DPS modeling analysis has not yet been finalized; second, because we have not had time or sufficient resources to quantify these benefits accurately; and third, because their exact quantification is not necessary for the RPS implementation process currently under way in New York. This third point is critical. In making his decision to implement an RPS in New York, Governor Pataki clearly made a determination that the RPS policy would benefit New York. Thus, the goal of cost and benefit studies in the implementation proceeding need not be an aggregated cost-benefit analysis but instead should focus on identifying the various categories of costs and benefits and understanding how they function so that implementation can maximize benefits and minimize costs. Recognizing this, our analysis focuses equally on (a) explaining how the benefits we discuss come about and (b) summarizing other studies that have assessed the benefits of RPSs.

1. Environmental and Health Benefits of an RPS

The preliminary results of the DPS analysis indicate that substantial emission reductions would result from the proposed RPS. Across the three control areas modeled in detail (New York, New England and the PJM Interconnection), the DPS staff found NO_x benefits rising from roughly one thousand tons in 2006 to ten thousand tons 2013. Projected SO_2 reductions rise from roughly two tons in 2006 to 22 tons in 2013, and CO_2 reductions rise from roughly 690,000 tons in 2006 to 7.8 million tons in 2013. These figures are summarized in Table 1. As discussed further below, NO_x and SO_2 are under federal and state emissions caps and Governor Pataki has begun a process to control New York's emissions of greenhouse gases such as CO_2. In addition to the public health benefits of reducing these pollutants, the RPS should be an effective tool in reducing the cost of implementing these other policies. The RPS should reduce the cost of NO_x and

SO_2 credits and the cost to the state's electric generators of meeting the impending mercury cap. Also, should a CO_2 cap and trading system be developed, we expect that the RPS would reduce the cost of CO_2 credits as well.

Table 1. Emission Reductions Projected in the DPS's Preliminary Modeling

Pollutant	2006 Reductions	2009 Reductions	2013 Reductions
NO_x	1,000	3,000	10,000
SO_2	2,000	8,000	22,000
CO_2	687,000	2,325,000	7,782,000

While these projections are a good starting place for assessing the potential environmental and health benefits of an RPS, they do not include several important pollutants. The most important of these pollutants is particulate matter. From a human health perspective, particulate matter poses significant risks, especially to residents of densely populated areas, such as much of downstate New York, and it is critical that the benefits of reductions in fine particulate emissions be acknowledged in any discussion of RPS costs and benefits. Power generation also emits large quantities of hazardous air pollutants (also known as "air toxics"). Mercury emissions from coal-fired power plants are the greatest health threat, and an RPS in New York will reduce mercury emissions to the extent that it reduces coal-fired generation (through either displacement or co-firing with biomass). Below, we briefly describe each of these air pollutants and their environmental and public health effects. The goal is to assist Judge Stein, the Commission and the parties in understanding the likely public health and environmental benefits of adopting an RPS requirement

1.1 Particulate Matter

Particulate matter can contain many different chemicals or substances, and can vary greatly in size. The term "PM_{10}" refers to the fraction of particles less than 10 micrometers (µm) in diameter, roughly one-seventh the width of a human hair. Similarly, "$PM_{2.5}$" refers to particles less than 2.5 µm in diameter. A large body of work has been developed over the past several decades, documenting significant health impacts from exposure to PM_{10}.[1] However, over the past decade evidence has grown of even greater health risks from fine particulate pollution. Fine particles are believed to pose greater health risks than larger particles, because they are small enough to be inhaled deep into the lungs, while larger particles tend to be deposited in the upper airways. In fact, some scientists are beginning to discuss "ultrafine" particles, less than 0.1 µm in diameter, as potentially the most dangerous particles.[2]

[1] The information presented in Section 1 on health effects draws heavily from: Woolf, et. al., *Air Quality in Queens County: Opportunities for Cleaning Up the Air in Queens County and Neighboring Regions*, Synapse Energy Economics, May 2003. The health effects information in this report was researched and written by: Dr. Jonathan Levy, Patrick Kinney, Susan Greco and Kim Knowlton.

[2] Spengler J, Wilson R 1996. "Emissions, dispersion, and concentration of particles," in Wilson R and Spengler JD. (eds): *Particles in Our Air: Concentrations and Health Effects*, Harvard School of Public Health.

In response to the growing evidence of health impacts from fine particulates, EPA promulgated new ambient air standards for fine particulate matter in 1997. (Previously, only PM_{10} had been regulated.) Fine particulate levels in multiple counties of New York State commonly exceed these new standards, and bringing these areas into “attainment” will require the concerted efforts of many sectors.

Two of the most important fine particle types are secondary sulfate and nitrate particles. The term “secondary” refers to the fact that they are formed in the atmosphere, as the primary pollutants react with each other and naturally occurring substances. Sulfates are formed in the atmosphere when SO_2 gas reacts with ammonia gas, and nitrates form in reactions involving NO_x emissions. Sulfate formation tends to be quicker on hot and humid days and slower on cold days or at night. Thus, concentrations of sulfates are highest in the summer (both because of atmospheric conditions and because more electricity is generated in the summer). In contrast, nitrate formation is greatest in colder weather. On average, sulfates and nitrates together make up about half of ambient fine particulate matter in the Northeast.

Fine particulate matter can travel long distances in the atmosphere, meaning that power plants across a wide geographic area contribute to fine particulate pollution in New York State. However, the maximum pollutant concentrations from any given source are generally close to the source – anywhere from less than a mile to tens of miles, depending on the height of emission and the type of particulate matter.[3] Thus, New York residents will benefit more from reductions in fine particulate emissions at New York power plants than from reductions at plants in other upwind states.

A large body of scientific work documents a range of health impacts, including premature death, from short-term exposure to PM_{10}. A recent summary article found well over one hundred published studies, and the findings of these studies are extraordinarily consistent.[4] However, over the past decade several important studies have focused attention on fine particulates. Two of the most compelling studies are prospective cohort studies that control for potential confounding factors at the individual level, such as smoking, age and occupational exposure. These studies are known as the Six Cities study and the American Cancer Society study.[5] Though other cohort studies exist, these two

[3] Levy JI, Spengler JD 2002. Modeling the benefits of power plant emission controls in Massachusetts. J Air Waste Manage Assoc 52: 5-18. Levy JI, Spengler JD, Hlinka D, Sullivan D, Moon D 2002. Using CALPUFF to evaluate the impacts of power plant emissions in Illinois: Model sensitivity and implications. Atmos Environ 36: 1063-1075.

[4] Stieb DM, Judak S, Burnett RT 2002. *Meta-analysis of time-series studies of air pollution and mortality: Effects of gases and particles and the influence of cause of death, age, and season*. J Air Waste Manage Assoc 52: 470-484.

[5] Dockery DW, Pope CA III, Xu X, Spengler JD, Ware JH, Fay ME, Ferris BG Jr., Speizer FE 1993. *An association between air pollution and mortality in six U.S. cities*. New Eng J Med 329: 1753-1759.

Pope CA III, Thun MJ, Namboodiri MM, Dockery DW, Evans JS, Speizer FE, Heath CW Jr. 1995. *Particulate air pollution as a predictor of mortality in a prospective study of U.S. adults*. Amer J Respir Crit Care Med 151: 669-674.

studies are most often cited, primarily because they have undergone extensive scrutiny and re-analysis.

The Six Cities study followed a cohort of 8,111 white adults in six cities in the Eastern US for 15 to 17 years. After controlling for potential confounding factors, the study reported a significant association with mortality rates for three different measures of particulate matter (PM_{10}, $PM_{2.5}$, and sulfates). The risk of death was increased by 26 percent for an exposure difference of 18.6 microgram per cubic meter of $PM_{2.5}$ across the cities. This represents roughly a 1.3-percent increase in mortality for every microgram per cubic meter of annual average $PM_{2.5}$.[6]

The American Cancer Society study focused on a larger number of people (552,138 adults) and a broader geographic area (151 cities in all 50 states). The study population was drawn from a previously defined cohort being monitored for the development of cancer. The study found that a one microgram per cubic meter increase in annual average $PM_{2.5}$ concentrations was associated with a 0.6-percent increase in mortality rates. Significant effects were seen on both cardiopulmonary and lung cancer mortality.[7]

In 2000, the Health Effects Institute (HEI) released two much anticipated reports on the health effects of fine particulate matter: the *National Mortality, Morbidity and Air Pollution Study* and the *Particle Epidemiology Re-Analysis Project*.[8] Both studies strongly support the results of the Six Cities and American Cancer Society studies, and resolve some of the uncertainties identified in those studies (particularly with respect to the extent to which the health effects discussed in these studies could be attributed to other pollutants).

Although significant questions remain about exactly how different types of particulate matter affect human health and the factors that govern the susceptibility of different populations, the evidence for health effects of both PM_{10} and fine particulates is substantial. Very real and measurable health benefits will accrue to the citizens of New York if ambient fine particulate levels are lowered, and it is critical to factor these benefits into assessments of the proposed RPS.

1.2 Oxides of Nitrogen

Oxides of nitrogen (NO_x) are regulated as a criteria pollutant, because they have been shown to have both environmental and human health impacts. On the environmental side, NO_x combines with water in the atmosphere to form nitric acid, which contributes to

[6] Dockery et. Al., 1993.

[7] The original American Cancer Society Study is cited above (Pope, et. al. 1995). This article presents additional findings based on a longer follow-up period with participants. Pope CA III, Burnett RT, Thun MJ, Calle EE, Krewski D, Ito K, Thurston GD 2002. *Lung cancer, cardiopulmonary mortality, and long-term exposure to fine particulate air pollution*. JAMA 287:1132-1141.

[8] Health Effects Institute, *The National Morbidity, Mortality and Air Pollution Study*, July 2000. Health Effects Institute, *Reanalysis of the Harvard Six Cities Study and the American Cancer Society Study of Particulate Air Pollution and Morbidity*, July 2000.

the acidification of lakes and soils. On the public health side, NO_x is a precursor to both fine particulate matter and ground-level ozone, or "smog."

While SO_2 contributes more to acid deposition than NO_x, the contribution of NO_x is significant, and NO_x reductions in New York State will help to reduce acid deposition rates in the Northeast. Reductions in SO_2, achieved via the Acid Rain Program, have reduced acid deposition rates in the Northeast substantially, however, a growing body of data indicates that additional reductions are needed to protect fragile ecosystems, such as New York's Adirondack Mountains. (See discussion in Section 1.3, below.) A broad body of research supports the link between NO_x emissions and acid deposition, with the Chesapeake Bay being the area that has been studied most intensively.[9]

Emissions of NO_x are a major contributor to two of the most important airborne health threats in the world – ozone and fine particulates. Like nitrates and sulfates, ozone is a secondary pollutant. Ozone is formed most intensively during the summer months through reaction of NO_x, VOCs, and sunlight. The reaction is temperature dependent, and more ozone is formed from these precursors at higher temperatures. In New York, as for much of the East Coast, NO_x emissions have been regulated via a regional cap during the "ozone season," the period from May 1 through September 30 of each year. This is the period during which ozone formation causes the most significant air pollution problems and health impacts.

Ozone is a strong oxidant gas that, upon inhalation, causes damage to the sensitive cells deep within the lung. Ozone exposure has been associated with a variety of respiratory effects in both human chamber studies (in which human subjects are exposed to controlled levels of ozone) and epidemiological studies. These effects include pulmonary inflammation, decreases in lung function and the precipitation of asthma attacks.

Epidemiological studies have reported acute associations between ozone and a number of health outcomes, including respiratory symptoms, asthma exacerbations, emergency room visits, hospital admissions, and deaths. One recent article summarized this literature and provided estimates for three acute health outcomes that tend to contribute most to the total impacts of ozone – premature deaths, hospital admissions for respiratory causes, and days with minor restricted activities.[10] In addition, a growing body of research indicates that there are long-term health effects associated with chronic (as opposed to acute) exposure to ozone.

1.3 Sulfur Dioxide

Sulfur dioxide (SO_2) is a criteria pollutant and the major contributor to acid rain. SO_2 also contributes to respiratory illness, especially among children and the elderly and

[9] For more information on nitric acid deposition, see: US EPA, *Atmospheric Nitrogen Deposition Loadings to the Chesapeake Bay: An Initial Analysis of the Cost Effectiveness of Control Options*, November 1996, EPA 230-R-96-012.

[10] Levy JI, Carrothers TJ, Tuomisto J, Hammitt JK, Evans JS 2001a. *Assessing the public health benefits of reduced ozone concentrations*. Environ Health Perspect 109: 1215-1226.

results in visibility impairment through the formation of haze. SO_2 is emitted from fossil fuel generation when elemental sulfur is present in the fuel source. Because of the relatively high sulfur levels in coal, coal-fired power plants are responsible for the vast majority of electric utility SO_2 emissions. The electric generating sector is responsible for over 65 percent of US SO_2 emissions.[11]

Atmospheric SO_2 and NO_x interact with water vapor and other gases to form acidic solutions of sulfuric and nitric acid. Deposition of these acids, commonly known as acid rain, occurs when these acidic solutions (or their gaseous and particle-based counterparts) fall to the earth. Acid rain damages the natural environment by changing soil composition, acidifying lakes and streams, and harming forests and vegetation. The acidification of water bodies often results in their inability to support aquatic or plant life. Long-term exposure to acid rain poses a serious threat to the health and biodiversity of an ecosystem. Acid rain also accelerates the decay of buildings and monuments.

The EPA's Acid Rain program was established to achieve the SO_2 reduction goals of Title IV of the Clean Air Act. The program, which is currently in its second phase, utilizes market-based mechanisms such as emission allowance auctions and trading to obtain SO_2 emission reductions at over 2,000 fossil-fueled generating units across the country. As noted, the Acid Rain program has been successful, but additional reductions are necessary. A 1995 EPA study estimated that SO_2 and NO_x emissions need to be reduced another 40-50 percent beyond Clean Air Act requirements in order to protect sensitive ecosystems.[12]

The need for additional SO_2 emission reductions in New York State is particularly apparent. Because the surrounding soils of many water bodies in the Northeast lack the buffering capacity to neutralize acid rain, the region's lakes, ponds, and streams are especially sensitive to acid deposition. It has been estimated that 24 percent of Adirondack lakes are seriously acidic, and almost 50 percent are sensitive to acidic deposition. Acid rain is responsible for over 60 percent of the water quality impairments of surface waters in the state.[12]

In light of these impacts to New York waters, in 2002 Governor Pataki established some of the toughest regulations in the nation to reduce acid deposition in the State. The regulations, targeting emissions of SO_2 and NO_x, will require electric generators in New York State to reduce SO_2 emissions an additional 50 percent below levels allowed under the federal Acid Rain Program requirements. The regulations will also implement year-round reductions in NO_x emissions beginning October 1, 2004. The SO_2 reductions will be phased in over a three-year period beginning in January 2005. However, the New York Department of Environmental Conservation states in the rule promulgating these standards that, even after these regulations go into effect, Adirondack waters will still be at risk from acid rain. Thus, NO_x emission reductions from the RPS will continue to be important in combating this problem.

[11] See: US EPA, *Air Quality Where You Live,* available at http://www.epa.gov/air/urbanair/

[12] See: Governor Pataki's Environmental Press Release, *Governor Pataki Proposes Toughest Acid Rain Controls in the Nation,* February 14, 2002. Available at http://www.dec.state.ny.us/website/press/newrelgv.html.

1.4 Greenhouse Gases

Carbon dioxide (CO_2) is the most prevalent of the greenhouse gases – gases that are trapping heat in the earth's atmosphere and warming the earth's surface. Consequences of climate change include the spread of infectious diseases, an increase in the frequency and severity of extreme weather events, coastal zone flooding, loss of habitat, and agricultural disruption. Power generation is the largest U.S. source of CO_2, responsible for nearly 40 percent of total U.S. emissions.

In July 2003, the United Nations World Meteorological Organization (WMO) released a report stating that recent severe weather events including heat waves and severe storms are attributable to global warming.[13] This past May there were over 550 tornadoes in the U.S. alone, killing 41 people. The WMO notes that the number of such events have been increasing during the past several years.

Global climate models predict that worldwide daily mortality and morbidity due to extreme heat events could significantly increase in this century, especially among elderly poor who often have pre-existing health conditions and may lack air conditioning or access to air conditioned spaces. Other health impacts of climate change could include increased rates of secondary air pollutant formation (e.g., ground-level ozone and particulate matter), incidence of vector-borne and water-borne diseases and, as noted, increased frequency and severity of storms.[14]

In response to the risks of climate change, Governor Pataki's Greenhouse Gas Task Force recommended that the state adopt the goal of reducing GHG emissions five percent below 1990 levels by 2010 and 10 percent below 1990 levels by 2020. These targets were adopted in New York's 2002 State Energy Plan. Substantial CO_2 reductions will be needed from fossil-fired power plants in the state order to meet these targets. In April 2003, the Center for Clean Air Policy released the report, developed in collaboration with the New York Greenhouse Gas Task Force, *Recommendations to Governor Pataki for Reducing New York State Greenhouse Gas Emissions*. This report cited renewable energy, and an RPS in particular, as effective means of reducing CO_2 emissions from the electric power sector, and specifically recommended that New York adopt an RPS requirement.

1.5 Air Toxics

A wide variety of air pollutants have been classified as toxic; the US EPA maintains a list of 188 and is currently deciding which ones to regulate. (Until recently, lead was the only toxic air pollutant regulated.) Mercury is by far the most important air toxic in the electric power industry, due to the quantities in which it is emitted by coal-fired plants and its health impacts. However, fossil-fired power plants emit a range of toxic

[13] "Extreme weather set to increase" at http://www.news24.com/News24/Technology/News/0,,2-13-1443_1381680,00.html.

[14] *Climate Change and Public Health: Impact Assessment for the NYC Metropolitan* Region at http://metroeast_climate.ciesin.columbia.edu/health.html.

substances. Combustion of natural gas, for example, produces appreciable levels of formaldehyde, a product of incomplete methane oxidation, and plants burning residual oil often emit significant levels of nickel. Municipal solid waste incinerators, which burn about 40 percent fossil-fuel based products, produce a significant amount of mercury and are also a major source of dioxins. Dioxins have been demonstrated to be highly carcinogenetic, even in extremely small amounts. Though substances like these rank behind mercury in terms of the total health risks posed, reducing the levels at which they are emitted will provide benefits.

Fish consumption is the dominant exposure pathway for methylmercury, the form of mercury most dangerous to humans. As airborne mercury is deposited in lakes and rivers, it accumulates in sediments and in the tissues of certain species of fish. Populations that regularly consume local fish – generally lower income populations – and pregnant women and children are most at risk. Methylmercury is a developmental neurotoxin that damages the nervous systems of fetuses and children following a brief exposure period. Advisories warn citizens not to eat fish from specified lakes and rivers in over 40 US states, including New York.

In December of 2000 EPA issued a finding that the regulation of hazardous air pollutants, primarily mercury, from coal-fired power plants was "appropriate and necessary." Since that finding, the federal government has clearly been moving toward mercury regulations for power plants. A number of legislative proposals since 2000 have included mercury regulations, and, perhaps most tellingly, even the Bush Administration's Clear Skies proposal would set a national cap on mercury from coal-fired plants. Most of these federal proposals contemplate mercury reductions in the range of 70 to 90 percent.

Reducing mercury emissions from power plants with emission control technologies is a capital-intensive proposition. Flue gas desulfurization systems (FGD or "scrubbers') remove some mercury, and adding an activated carbon injection system to an FGD system enhances mercury removal considerably. However, co-firing coal plants with biomass, a technology likely to eligible to meet the RPS, also provides mercury reductions relative to baseline (all coal) firing. While co-firing is not likely to provide 70-percent mercury reductions from a given unit, it could be part of a company's overall compliance strategy. For example, a company might invest in controls or repower several units and co-fire several others to achieve 70 percent reductions overall. By providing additional value to the co-fired energy, an RPS would lower the cost of this compliance strategy to New York generating companies.

2. Fuel Diversity and Natural Gas Price Benefits of an RPS

While there has been much written about renewable power generation over the past decade, the impact this generation can have on natural gas supply, demand and prices has received little attention until recently. The recent interest in this dynamic stems primarily from increasing awareness of two important concerns. The first is gas price volatility, and the perception that long-term average gas prices are on the rise, and the second is increasing dependence on natural gas, especially in the northeastern United States, a region far removed from the major North American gas reserves.

Our discussion of the fuel diversity and price benefits of renewable energy in New York focuses on the following areas.

- A brief review of the economic theory behind the idea that new renewable generation can affect gas prices (Section 2.1);
- A review of recent gas price dynamics and the recent history of gas price forecasting (Section 2.2);
- A review of several studies that have projected the impact of an RPS on gas prices (Section 2.3); and
- An illustrative calculation to demonstrate how future gas prices could affect the premium required to bring new renewables online in New York (Section 2.4).

2.1 How Renewables Affect Natural Gas Demand and Prices

There are two important interactions between new renewable power generation and natural gas prices. One is the impact that new renewables can have on gas prices, and the other is the value that new renewables provide as a hedge against potential increases in gas prices.

First, additional renewable generation reduces demand for generation from other fuels, and a sufficient amount of renewable generation can be expected to lead to reductions in the prices of those fuels. The concept of fuel price reductions resulting from the substitution of other fuels is a basic economic concept, and the dynamic has been explored quantitatively in numerous energy modeling studies. In the Northeast, new renewable generation is likely to reduce the demand for gas most (i.e., more than it reduces demand for coal, oil or uranium), because gas-fired plants operate on the margin more than other types of plants. That is, when a new generator, such as a renewable unit, is added to a regional electric system, the additional energy provided tends to reduce the operation of the marginal plant(s) in that system most, and in the Northeast the marginal plant is often gas-fired.[15] New renewable generation also defers the addition of new plants (and in the Northeast, most new plants will be gas-fired for the foreseeable future). To the extent that new renewables decrease natural gas prices, these price reductions offset the incremental cost of adding renewables rather than other types of generation.

Second, renewable generating capacity provides a hedge against gas price increases. In the event that gas prices rise above forecasted levels, regions that have invested in renewable generating capacity rather than gas-fired capacity will be less exposed to additional costs. The hedging value of renewable generation is significant during short-term spikes in the price of gas, and it would be extremely large if gas prices rose and

[15] This concept of the displacement of marginal generation is supported by the results of numerous energy system modeling studies. The modeling performed by the DPS Staff in this proceeding indicates that new renewable generation in New York State would likely displace generation primarily from gas-fired and gas/oil fired units.

remained at high levels over a period of years. Further, this hedging value would be especially pronounced in New York and the other Northeastern states, where the vast majority of non-renewable plant additions are likely to be gas-fired.

Related to this second point is the fact that the gas prices assumed in an analysis of a proposed RPS play a significant role in determining the projected costs of the RPS. To the extent that gas prices turn out to be higher than the forecast used in the analysis, the market price of electricity will tend to be higher and the premium required to bring new renewables to market will be lower. Conversely, if gas prices are lower than forecasted, the renewable premium will be higher.

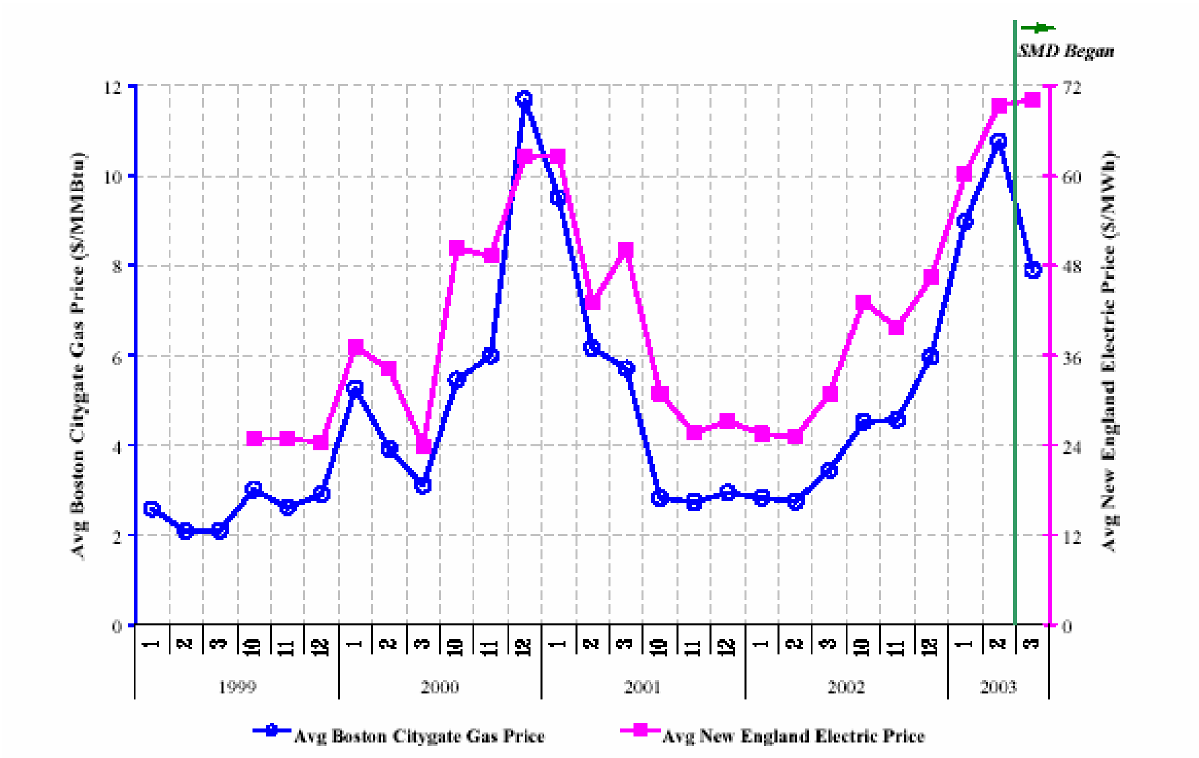
2.2 Natural Gas Prices – Volatility and Uncertainty

US natural gas prices have become much more volatile over the past several years, largely because (a) fast growing demand has outpaced production capacity and (b) the deregulation of the gas industry has made it much more sensitive to short-term price movement. During the past three years, spot market gas prices have risen to over $8.50 per mmBtu in January 2001, fallen to a low of just over $2.00 in October 2001, and climbed back to highs well over $8.50 in early 2003. In February 2003, the spot price at the Henry Hub in Louisiana rose to over $12.00 per mmBtu, and prices throughout 2003 have remained substantially higher than forecasted. Figure 1 shows monthly average gas prices for the winter months at the Boston citygate and the corresponding monthly average market-clearing price in ISO New England electricity (energy) markets. The correlation between gas and electricity prices is very strong, because gas-fired plants operate on the margin (i.e., are the price setters) in New England a large percentage of the time. This correlation is likely to be quite strong in New York as well, because gas-fired plants operate on the margin much of the time there too.

The Northeast is not unique in this respect. Because gas tends to be more expensive per unit of energy than other power generation fuels, it is the marginal fuel during a large number of hours in many US electricity control areas. Reflecting this reality, in July of 2003, the financial research group UBS Warburg projected that average US peak electricity prices would be 48-percent higher in 2003 than 2002 because of the "surge in natural gas prices."[16]

[16] Statements by Lawson Steele, head of global utilities research at Warburg, were quoted in the Utilities Monthly Report, July 2003.

Figure 1. Montly Average Gas Prices in Boston and Average New England Wholesale Electricity Rates[17]



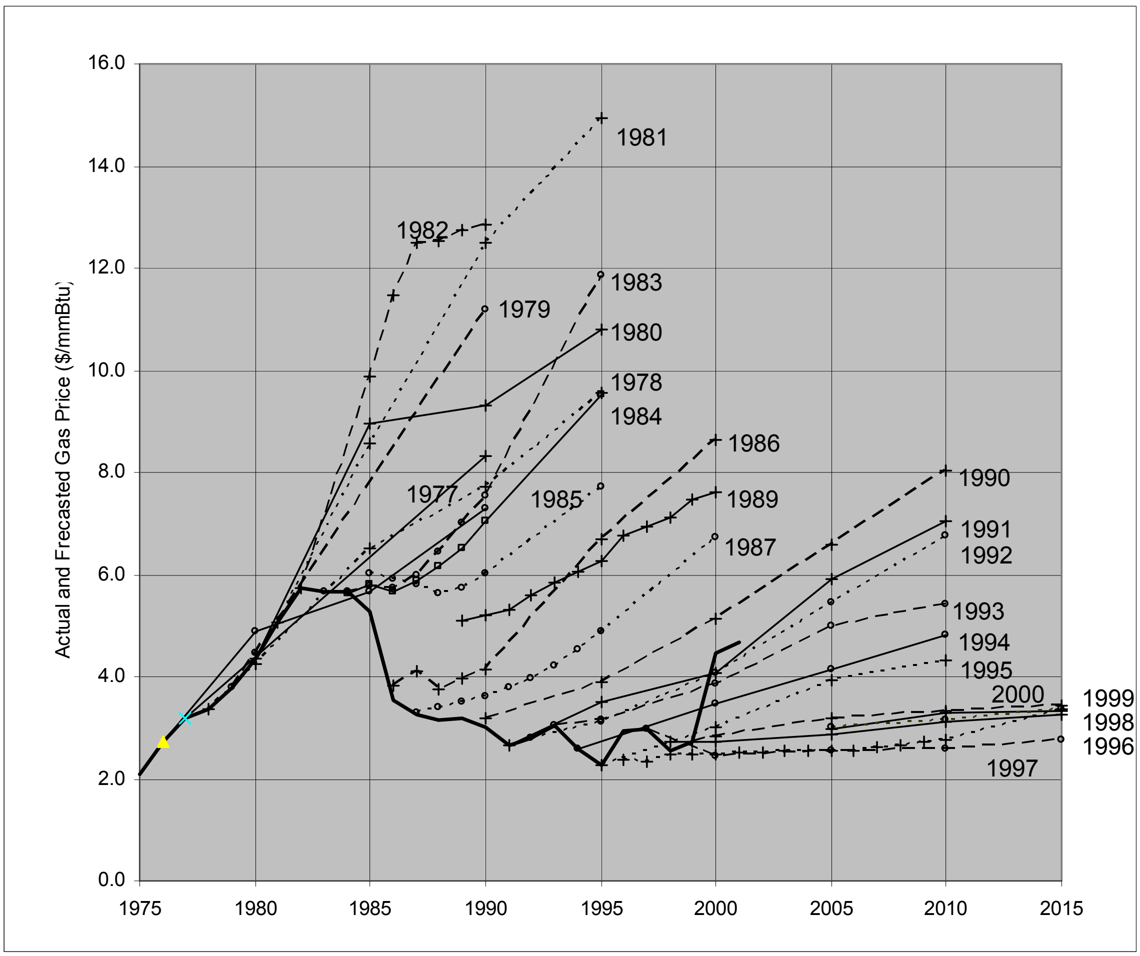
The electric power sector, like all sectors of the economy, is adjusting to the world of volatile gas prices with longer-term contracts and various kinds of financial hedging instruments. With these instruments, buyers essentially pay a premium to insulate themselves from price increases. The higher the premium paid, the more the buyer is insulated. As noted above, renewable power generation – much of it with zero fuel costs – can be seen as another way that buyers and sellers of electricity can insulate themselves from both short- and long-term increases in gas prices. In Section 2.4 we review one study that attempts to quantify the value of renewable energy as a hedge against volatile gas prices.

In addition to increased volatility, there has been increasing concern recently that we may be at the beginning of a protracted period of substantially higher average gas prices. During the summer of 2003, concerns over high gas prices have come from virtually every corner of the US economy, culminating in Federal Reserve Chairman Greenspan's comments before the Senate Committee on Energy and Natural Resources on June 10. Mr. Greenspan began this testimony by saying, "Today's tight natural gas markets have been a long time in coming, and distant futures prices suggest that we are not apt to return to earlier periods of relative abundance and low prices anytime soon."

[17] This figure is reproduced from: Levitan & Assocaites, *Natural Gas and Fuel Diversity Concerns in New England and the Boston Metropolitan Electric Load Pocket*, ISO New England, Inc., July 1, 2003, p. 61.

Exactly what gas prices will be in the future is extremely difficult to predict. While some analysts counter Mr. Greenspan's view, arguing that gas production will rapidly catch up with demand, the salient reality of today's gas markets is massive uncertainty. Reviewing gas price forecasts of the past three decades we find a startlingly poor track record. Future price forecasts have tended to predict the future in terms of the recent past, and whenever the future has not repeated that past, they have been wrong. Figure 2 below shows actual natural gas prices to electric utilities between 1975 and 2002 and the US Government forecasts made at different points during that period. The bold line shows the actual price, and the lighter lines coming off it at different points represent forecasts made by the US Energy Information Administration (EIA).

Figure 2. Actual Gas Prices and EIA Projections (1975 to 2000)



Given the difficulty of forecasting gas prices accurately, it is wise to consider several fundamental realities of natural gas use in the US.

First, there is a finite amount of natural gas in North America, and the marginal cost of recovering it is rising as reserves are depleted. A key focus of Mr. Greenspan's comments to the Senate committee was the smaller scale of gas markets compared to oil markets. Other than liquefied natural gas (LNG), North American consumers are dependent on gas that can be extracted in North America and delivered via pipeline. Currently LNG represents less than one percent of total gas consumption in the US, and that figure is not likely to grow rapidly due to extremely limited regasifiaction capacity (the ability to turn imported LNG back into gas). Currently, there are only four regasification facilities in the continental US, and only one in the Northeast (in Everett, Massachusetts). Many analysts believe that expanding regasification capacity in the US will be very difficult, due to the difficulty of permitting such facilities – a task that has become even more difficult since September 11.[18]

Thus, US consumers will be largely dependent on North American gas reserves, far smaller energy reserves than exist in the world oil market. A study on gas supply and prices commissioned by the New England Independent System Operator (ISO New England) summarized the long-term outlook as follows.

> Producers in the Gulf Coast and Western Canada, among others, are experiencing maturation of the traditional supply basins. In the major supply basins, depletion is accelerating as old reservoirs are replaced by less prolific reservoirs. Although North America's [gas] resource base remains immense, sustained production improvements will require massive investment by major energy producers, thus portending higher commodity prices, increased price volatility, and higher trading bandwidths than New England has witnessed in the last decade.[19]

The second fundamental reality of gas use is that natural gas is a "premium" fuel; it is clean, transportable via pipeline and high in energy content. Thus, it can be used in a wide variety of end uses, from residential heating to commercial heating and cooling and low-emission transportation. This means that the electric power industry will be increasingly competing for gas with a large number of other end users, many of whom will be willing to pay more for the fuel. Historically, the electric industry has not had to compete against many other end uses for its primary fuels (coal, residual oil, uranium and hydro energy).

Thus, regardless of what gas prices do over the next several years, the long-term outlook for gas in North America is that of a depleting resource in the face of fast growing demand from a variety of end users. In this context, the amount of gas-fired generating capacity to which the New York electric industry commits itself has very important implications for the State's economic future, and there are already signs that the Northeastern US is becoming precariously dependent on gas. ISO New England commissioned the study quoted above largely to explore the risks of increasing dependence on gas. Gas-fired power plants are expected to produce over 40 percent of New England's electricity in 2003, with that number projected to rise to 49 percent by 2010.[20] This is cause for substantial concern on the part of New England consumers, but it also means that soaring demand for gas in New England will exert upward pressure on gas prices in New York.

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[18] Petrie Parkman & Co., *The Promise/Disappointment of Liquified Natural Gas*, Petrie Parkman Petroleum Research, Vol XV, R70, July 10 2003.

[19] Levitan & Associates, p. v.

[20] Levitan & Associates, p. iv.

New York's electric industry is not yet as dependent on gas as New England's: in 2002, 24 percent of New York's electricity was generated from gas.[21] However this number will grow during the next several years, as roughly 3,660 MW of additional gas-fired capacity is brought online. Table 2 shows the new gas-fired power plants that are either under construction or very likely to be added during the next several years. This trend toward greater reliance on natural gas power plants has important environmental benefits. Adoption of an RPS, however, would provide critically needed fuel diversity to New York's power generation sector and hedge against natural gas price increases, while avoiding environmentally unsound and unsafe power sources such as nuclear power.

Table 2. New Gas-Fired Generating Capacity Added in New York Since 2002[22]

Plant	Unit	On-line Date	Capacity (MW)
Athens	CC Unit 1	2003	360
	CC Unit 2	2003	360
	CC Unit 3	2003	360
Bethlehem	CC Unit 1	2004	250
	CC Unit 2	2004	250
	CC Unit 3	2004	250
NYC CC	CC Unit 1	2006	500
Poletti	New CCCT	2005	500
Ravenswood	New CCCT	2003	250
East River	New CTs	2003	360
LIPA	New CTs	2003	220
Total			*3,660*

2.3 Studies Assessing the Relationship Between RPSs and Gas Prices

Two major studies have been performed recently that explore quantitatively the relationship between renewable energy and gas prices in the context of RPSs. One study, released in February of 2002 by the US EIA, assessed the impacts of a national RPS.[23] The second study, performed by Tellus Institute, examined the impacts of an RPS in

[21] US Energy Information Administration, Supplemental Tables to the *Annual Energy Outlook 2003*, Table 65.

[22] The project titled "NYC CC" represents the combined-cycle facility we assume will be constructed pursuant to Consolidated Edison's recent RFP for new capacity in New York City. The new capacity on Long Island (LIPA) includes one project in the Rockaways and one in Greenport as well as standby generation, "for use in emergencies and periods of extremely high demand" at Holtsville and Shoreham. See LIPA Press Release: *LIPA Projects Sufficient Electricity Supply to Meet "Normal" Summer Demand*, June 10, 2003.

[23] US Energy Information Administration, *Impacts of a 10-Percent Renewable Portfolio Standard*, February 2002, Report No. SR/OIA/2002-03.

Rhode Island. Only the Tellus study investigated the impact that higher-than-forecasted gas prices have on the premium required by renewable energy.

The American Council for an Energy Efficient Economy (ACEEE) is currently undertaking a study that will look directly at the impacts that increased use of renewables can have on natural gas prices, both nationally and within New York specifically. This analysis will be the first to capture fully the interactions between renewables, natural gas storage and local pipeline capacity, and natural gas prices on a location- and time-specific basis.[24] While the studies that we look at below show downward pressure on natural gas prices from increased use of renewables, it is reasonable to expect these impacts to be greater in the Northeast in general and within specific parts of the Northeast in particular. The Northeast has minimal local reserves, and location-specific costs are highly dependent on pipeline capacity and storage. The ACEEE study of the New York market will be available on September 2, and we recommend that it be reviewed carefully vis-à-vis designing an RPS for New York.

U.S. EIA Assessment of a National RPS

The EIA analysis focused on the RPS proposed in Senate Bill 1766 (the Energy Policy Act of 2002), but it also explored several sensitivities around key aspects of this RPS proposal. The RPS proposed in S. 1766 included the following provisions.

- The RPS would begin in 2003, with the required renewable share growing from 2.5 percent of national sales in 2005 to 10 percent in 2020. (The levels for 2003 and 2004 were to be set by the Secretary of Energy at levels under 2.5 percent.)
- Only energy from new renewable facilities (placed in service after January 1, 2002) would be eligible to meet the RPS.
- The qualifying technologies would be: hydropower, geothermal, biomass, solar, wind, ocean energy and landfill gas.
- The RPS would apply to all electricity marketers with retail sales of 500,000 MWh per year or more.
- A civil penalty of up to three cents per kWh would be assessed for each required renewable credit not submitted by an affected supplier.
- Qualifying renewable projects built on Indian land would receive two credits for each kWh generated, and
- The RPS would sunset (expire) at the end of the year 2020.

EIA used the National Energy Modeling System (NEMS) to simulate this RPS, with the *Annual Energy Outlook 2002* modeling runs serving as the reference case. Because NEMS is a multi-sector energy model, it captures fuel price impacts across all energy sectors (e.g., electric power, residential, commercial and industrial fuel use, transportation). Thus, it is an effective tool for assessing fuel price impacts of energy policy options.

[24] Personal Communication with Neal Elliot, ACEEE, July 24, 2003.

EIA examined the 10-percent RPS outlined in S. 1766 and also examined the impacts of a more aggressive RPS, which grew to 20 percent of retail sales in 2020. Other aspects of S. 1766 were not modeled (such as appliance and automobile efficiency standards) in order to focus on the impacts of the proposed RPS. EIA modeled the non-compliance penalty as an effective cap on the RPS credit price. That is, if the premium required by new renewable projects rose above three cents per kWh, retail suppliers were assumed to pay the non-compliance penalty.

To examine the impact of the sunset provision in S. 1766, EIA assessed a scenario in which the RPS expired in 2020, as proposed in the bill, and a scenario in which it did not expire. Changing this variable had a significant impact on the results. EIA projected that the RPS would not achieve the 10-percent energy goal if it expired in 2020 and that credit prices would rise to the noncompliance fee in the later years of the period. This was projected to occur because EIA assumed that, in the later years of the RPS, renewables developers would demand a much higher premium (because they could only count on credit revenue for a short time). EIA assumed that retail suppliers would pay the non-compliance fee (three cents per kWh) rather than the higher fees demanded by project developers. With suppliers paying the penalty rather than funding new renewable contracts, the RPS energy target is not met. However, when EIA modeled a scenario in which the RPS does not sunset in 2020, the 10-percent energy target was achieved and the credit price remained well below the noncompliance fee throughout the study period.

The EIA study projects that the S. 1766 RPS would have a significant effect on natural gas prices. In fact, the projected decrease in gas prices virtually offsets the incremental cost of the renewable energy in many of the years modeled. Specifically, EIA writes:

> In this analysis, the RPS is projected to lead to a fall in natural gas prices that just about offsets the higher cost of the new renewables. The retail price of electricity in the RPS 10 case [a 10-percent RPS in 2020] is only expected to be appreciably above the Reference case in the last few years of the projections, when the credit price is expected to reach three cents per kilowatt-hour (page 19).

As noted, EIA projects the renewable credit price to reach the compliance penalty in the later years of the program only when the RPS sunsets in 2020. In the scenario where the RPS continues after 2020, the renewable credit price remains well below the compliance penalty through the study period, and electricity prices are "not appreciably above the reference case" throughout the study period.

Table 3 below shows the impact of the RPS on gas and coal prices under a sunsetting RPS. Note that there are price reductions in all years assessed. Reductions are greatest in 2010, when gas prices are projected to fall by 4.6 percent with the RPS and coal prices are projected to fall by 3.2 percent. The impacts on gas and coal prices would be more pronounced under an RPS that did not sunset, because this RPS would provide more renewable energy.

Table 3. Projected Gas and Coal Prices Under a Sunsetting RPS

	2005		2010		2020	
	Reference	RPS	Reference	RPS	Reference	RPS
Nat. Gas Wellhead ($ per 000 CF)	2.66	2.64	2.85	2.72	3.26	3.14
% Impact of RPS	---	-0.8%	---	-4.6%	---	-3.7%
Coal Minemouth ($ per short ton)	14.99	14.84	14.11	13.66	12.79	12.72
% Impact of RPS	---	-1.0%	---	-3.2%	---	-0.6%

Prices are in constant 2000 dollars. See Table 3 in the EIA report.

Under an RPS that rises to 20 percent in 2020 gas price reductions are more pronounced. In 2010 gas prices are projected to be 6.3 percent below the reference case, and in 2020 they are 6.8 percent below the reference case. Moving to a 20-percent RPS is projected to provide little additional reduction in coal prices. (The 20-percent RPS modeled is assumed to sunset in 2020, and as in the 10-percent case, the RPS credit price reaches the noncompliance penalty in the later years.)

As discussed above, one would expect the reductions in gas prices caused by the RPS to have two effects: to reduce the renewable credit price and to reduce consumers' natural gas bills outside the electric industry. The results of the EIA study support this theory.

First, EIA projects that within the electric sector reduced gas prices would almost completely offset the cost of renewable credits. Table 4 shows EIA's projections of renewable credit prices and the national average (retail) electricity rates throughout the study period in the sunsetting scenario.

Table 4. Projected Renewable Credit Prices and Electric Rates Under a Sunsetting RPS

	2005		2010		2020	
	Reference	RPS	Reference	RPS	Reference	RPS
Renewable Credit Price (¢/kWh)	---	2.4	---	2.1		3.0
Average Retail Electric Rate (¢/kWh)	6.4	6.4	6.3	6.3	6.5	6.6

Prices are in constant 2000 cents. See Table 3 of the EIA report.

Note that the RPS has no effect on average retail rates to one decimal place in the years 2005 and 2010 and only a tenth of a cent impact in 2020. (EIA does not provide more precise numbers than those shown in Table 2.) While EIA does not show the same set of figures for the non-sunset scenario, they note that the credit price in 2020 would be 1.7 cents per kWh in that case rather than the 3.0 cents projected in the sunset scenario.[25] Thus, without the sunset clause, the reduction in gas prices would fully offset the cost premium of the new renewables throughout the study period.

Second, EIA projects substantial consumer savings outside the electric sector. In 2010 the national residential gas bill is $534 million lower (1 percent) with the RPS than in the reference case. The commercial gas bill is $387 million lower (2 percent) with the RPS,

[25] EIA, page 24.

and the industrial gas bill is $1.4 billion lower (4 percent). This amounts to a total annual savings of $2.3 billion outside of the electric sector.

Finally, note that this study was based on EIA's 2002 projections of gas prices, and the agency raised its gas price projections in the 2003 Annual Energy Outlook. This means that if EIA repeated this study using the 2003 gas price projections, the renewable credit price would be smaller and the gas price reductions provided by the RPS would be even more valuable.

Because the RPS assessed in this study is national in scope, the fuel price effects projected are likely to be greater than those of a state or regional RPS. However, bear in mind that the proposed New York RPS would bring the total percentage of US retail electricity sales subject to a formal RPS the range of 35 to 39 percent and the percentage subject to statewide goals or nonbinding targets to the range of 40 to 45 percent.[26] Table 5 below summarizes this information. Note that these numbers overstate slightly the amount of retail sales subject to these standards, because in some states certain customers or electric suppliers are exempt from the standard. In order to derive the precise numbers one would have to remove these customers' energy purchases from the totals. However, many of the states with RPS's (such as California and Massachusetts) are among the largest users of natural gas. Thus, the ideal measure would be the percentage of the electric sector's natural gas consumption that is under an RPS. For instance, while New York only represents about four percent of national retail electricity sales, it consumed six percent of the nation's natural gas in 2001.[27]

Table 5. 2001 US Retail Electricity Sales Subject to Renewables Policies

	Without New York RPS		With New York RPS	
	Retail Sales (TWh)	% of US Total	Retail Sales (TWh)	% of US Total
States with RPSs	1,172	35%	1,313	39%
States with Goals or Nonbinding Standards	1,378	41%	1,519	45%

We believe that the percentages in Table 5 represent levels that would exert downward pressure on gas prices. This conclusion is supported by modeling work performed by Tellus Institute for the State of Rhode Island, which projects small but significant gas price impacts from an RPS in that state.

[26] Thirteen states currently have renewable energy standards. The retail sales from these states in 2001 equaled 1,172 TWh, or 35 percent of total U.S. retail sales. Three other states (Hawaii, Illinois, and Minnesota) have statewide renewable energy goals that are either non-binding or do not stipulate compliance penalties. Including these states in the mix increases the sales to 1,378 TWh, or 41 percent of the U.S. total.

[27] New York State Energy Research and Development Authority, *Patterns and Trends; New York State Energy Profiles: 1997 – 2001*, NYSERDA, December 2002.

Tellus Institute Assessment of a Rhode Island RPS

In 2001 Tellus Institute modeled several different RPS scenarios for the Rhode Island Greenhouse Gas Collaborative.[28] Three different RPSs were modeled: one rising to 10 percent of sales in 2020; one rising to 15 percent and the third rising to 20 percent. All three RPSs began at three percent of sales in 2005. Two of these scenarios (the 15 and 20 percent RPSs) were also examined with gas prices both higher and lower than forecasted. Importantly, the RPSs were modeled under the assumption that suppliers in Rhode Island could purchase renewable credits from eligible projects in upwind New York State. Thus, the RPSs resulted in substantial development of renewable energy in New York. Like EIA, Tellus used the NEMS model in order to capture all fuel price feedbacks of the RPSs.

The Tellus study examined the effects of an RPS in Rhode Island as well as continued implementation of existing RPSs in Connecticut, Maine and Massachusetts. The total amount of new renewable generation provided relative to the reference case was 2,060,000 MWh in 2013, approximately 12 percent of the incremental renewable generation that would be provided by the proposed New York RPS (roughly 16,800,000). Nevertheless, Tellus found that the 15-percent Rhode Island RPS scenario resulted in discernable reductions in natural gas costs, relative to the reference case, both within and outside of the electric sector. As one would expect, projected gas price reductions were smaller under the 10-percent RPS and larger under the 20-percent RPS. In addition, Tellus found that higher-than-forecasted gas prices reduced the projected price and bill impacts of the RPSs.

The Tellus study projects that the average annual reduction in electric sector natural gas prices in New England during the period 2005 through 2010 would be $0.013 per mmBtu, or 0.36 percent.[29] The same figure for the period 2011 through 2020 is 0.018 per mmBtu, or 0.45 percent. The study also predicts gas price reductions – albeit smaller – to non-electric sector gas users in New England and to both electric and non-electric gas users in New York. Table 6 shows the annual savings achieved in New England and New York.

Table 6. Projected Annual Savings from Reduced Gas Prices Resulting from a Rhode Island RPS

	Electric Sector Savings (million $)		Non-Electric Sector Savings (million $)	
	2005-2010 Annual Avg.	2011-2020 Annual Avg.	2005-2010 Annual Avg.	2011-2020 Annual Avg.
New England Impacts	17.9	41.4	4.0	5.7
New York Impacts	16.9	35.1	15.7	17.1
Total Impacts	34.8	76.5	19.7	22.8

Figures are in constant 2000 dollars.

[28] Steve Bernow and Alison Bailie, *Rhode Island RPS Modeling*, Tellus Institute, January 24, 2002.

[29] All figures quoted from this study are in constant 2000 dollars.

In addition to these savings from lower gas prices, the Tellus study also predicts that higher assumed natural gas prices would reduce the incremental cost of the RPS in a small but appreciable way.[30]

A final factor to consider regarding both of these studies is that the NEMS, like most electric system simulation models, represents a "smoothed" or averaged view of the future. That is, models tend to represent long-term averages and not the extremes that can occur in volatile markets. In a volatile market, even small changes in demand can have significant price impacts. Thus even a modest amount of renewable energy in a mix could act to reduce the number and extent of fossil fuel price spikes.

2.4 How Gas Prices Affect the Cost and Value of Renewables

The studies above look at the impact of an RPS on gas prices, but they do not look at the effect that the price of gas has on the cost or the value of renewable energy. Here we look at this in two ways. First, we perform an illustrative calculation to show the likely relationship between the price of gas and the premium required to bring new renewables to market. Second, we review a study that estimates the value renewable energy provides as a hedge against gas price increases.

An Illustrative Calculation

A useful proxy for the long-term, market-clearing price of energy is the total cost of operating the plant type that can enter the market at lowest cost. In New York this is likely to be a combined cycle combustion turbine (CCCT) for baseload power for the foreseeable future. As shown in Table 7, EIA's *Annual Energy Outlook 2003* places the total costs of operating a CCCT in 2010 at 4.87 cents per kWh.[31] (All costs in this example are in 2001 dollars). The projected 2010 gas price on which these costs are based is $3.85 per mmBtu.[32]

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[30] Bernow and Bailie, p. 2.

[31] US Energy Information Administration, *Annual Energy Outlook, 2003*, DOE/EIA-0383(2003) p. 69. Note that this table shows fuel and variable O&M together as "variable" costs. We have separated these components for illustrative purposes, using the heat rate EIA assumes for a CCCT in 2010 (6,350 Btu/kWh).

[32] This figure is taken from Table 106 (Natural Gas Delivered Prices by End Use Sector and Census Division) in the supplemental tables to the AEO 2003. This gas price is for gas delivered to electric generators in the MidAtlantic US in the year 2010. This figure is quite similar to the forecast of the national average for electric generators in 2010 of $3.86.

Table 7. EIA Projection of the Cost Components of a CCCT in 2010

Cost Component	Cost (¢/kWh)
Capital	1.23
Fixed O&M	0.13
Fuel	2.45
Variable O&M	0.78
Transmission	0.28
Total	4.87

Costs are in 2001 dollars.

If the average electricity market-clearing price in 2010 is 4.87 cents per kWh, consistent with a new CCCT, and the marginal cost of the renewable generation necessary to meet an RPS in that year is 7.0 cents per kWh, then the market-clearing price for renewable credits would be roughly the difference, or 2.13 cents per kWh. (We choose this marginal cost of renewable energy for illustrative purposes only; it is not based on an analysis of the cost of renewable energy in New York State.)

Now, what happens to the renewable credit price if gas prices in 2010 turn out to be 20 or 40 percent higher than the forecasted $3.85 per mmBtu? As shown in Table 8, with gas 20 percent higher than the EIA forecast, the renewable credit price drops to 1.65 cents per kWh, and with gas 40 percent higher, it drops to 1.16 cents.

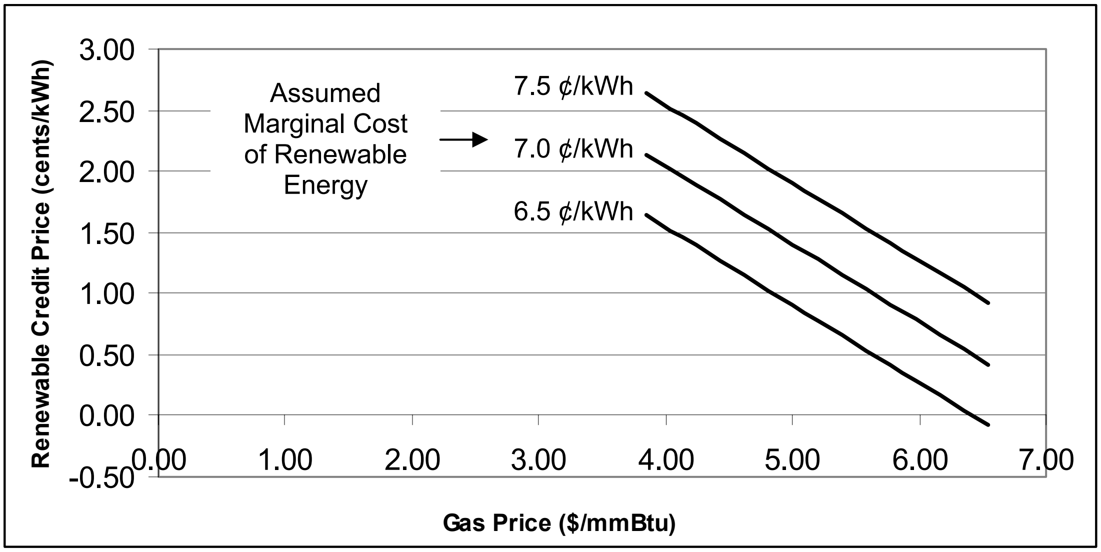
Table 8. Illustration of Gas Price Impacts on Renewable Credit Prices (¢/kWh)

	Gas at $3.85	Gas at $4.62	Gas at $5.39
Marginal Cost of Renewable Energy	7.00	7.00	7.00
Energy Market Price	4.87	5.35	5.84
Renewable Credit Price	2.13	1.65	1.16

Using the same cost assumption about the market price of electricity in 2010, Figure 3 illustrates the relationship between the price of gas and renewable credit prices, given different marginal prices of renewable energy (6.5, 7.0 and 7.5 cents per kWh). Note that this relationship has a strongly negative slope, meaning that relatively small increases in the price of gas result in significant reductions in renewable credit prices. For each gas price increase of $0.20 per mmBtu, renewable credit prices drop by roughly 13 cents per kWh. If the marginal cost of renewable energy is 6.5 cents per kWh, renewable credit prices are zero at a gas price of roughly $6.42 per mmBtu.

Note also that this relationship is independent of the cost of renewable energy. Rising gas prices have the same effect under all three different assumptions about the marginal cost of renewable energy. The relationship between gas prices and renewable credit prices is governed by the influence that gas has on the market price of electricity. In this example (based on the assumption that a new CCCT sets the long-term market price), gas costs make up just over 50 percent of the total cost of operating a new CCCT. If gas is more expensive than forecasted, it represents an even larger portion of this cost.

Figure 3. Gas Prices and Renewable Credit Prices in this Example



It is important to note that this is a highly simplified example, designed to illustrate these dynamics in general terms. Several factors could cause the price of renewable energy credits to be at levels other than the difference between the marginal cost of renewable energy and the market price of electricity. Examples of these factors include inefficiencies in the renewable credit market and rules regarding the banking of credits across accounting periods. This example does, however, show the importance of gas price assumptions in predicting the cost premium required by renewable resources.

Quantifying the Hedging Value of Renewable Energy

Another way to think about renewable energy in the context of volatile or rising gas prices is as a hedge against these prices. Lawrence Berkeley Laboratory (LBL) recently released a study that estimated the financial hedge value of renewables to be roughly 0.5 cents per kWh.[33] This estimate was derived by comparing the cost of financial hedges for gas prices with EIA forecasts of gas prices. For the financial hedge prices, the LBL study used gas "swap" prices available from Enron in 2001 and 2002. The swap prices were for 2-year, 5-year and 10-year periods.

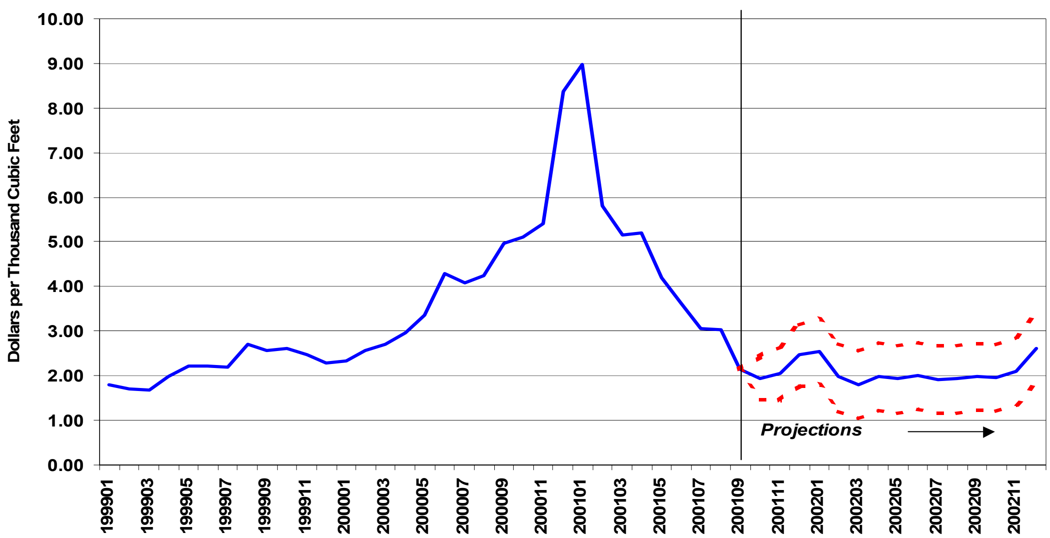
While LBL study is a good starting point for assessing willingness to pay for gas price hedging, it does not fully capture the value that new renewable energy provides in the context of today's gas and power markets. This is true for several reasons.

First, as discussed in Section 2, gas price forecasts have commonly been off the mark in the past – and not just by a few percent, but off by 50 and even 100 percent in the relatively short term. This includes both government forecasts and those of the financial

[33] Lawrence Berkeley Laboratory, *Quantifying the Value that Wind Power Provides As a Hedge Against Volatile Natural Gas Prices*, Mark Bolinger, Ryan Wiser, and William Golove, Environmental and Technologies Division, June 2002.

community. As one final example, consider Figure 4, a graph from an EIA presentation made in October, 2001. The graph shows the price spike of the 2000/2001 winter, and the presentation predicts that future "prices are expected to remain in the range seen in 1998 and 1999."[34] As discussed above, in the winter of 2002/2003 Henry Hub prices climbed to over 12.00 per mmBtu ($11.60 per MCF) and have remained over 5.00 per mmBtu ($4.83 per MCF) for much of 2003. It is unlikely that any hedging instruments were being offered in 2001 that would have protected a long-term buyer from these prices. Thus, it seems clear that gas markets to date have not been offering hedging instruments that reflect the market's true potential for price spikes.

Figure 4. Historical and EIA Predicted Gas Prices in September 2001



Second, the LBL gas price hedge value is based on *financial* hedges against high gas prices, not *physical* hedges. The important distinction here is that financial hedges tend to cover much shorter terms than physical hedges. (As noted, the hedge products used in the LBL study were for 2-year, 5-year and 10-year periods.) New renewable generating capacity represents a physical hedge, an asset with a lifetime of 20 to 40 years, and thus this capacity represents a much longer term hedge than the type of instruments reviewed in the LBL study. For example, it is highly unlikely that the hedging instruments on which the LBL hedge value is based reflect any risk of CO_2 regulation in the US. Over a three-to-five year time frame this may be an appropriate assumption, but when considering risk over the life of a new renewable generating facility, the potential for carbon regulation becomes much more real. Further, longer-term financial hedge products contain a certain amount of risk regarding the financial standing of the company providing the hedge. Over a longer period of time, there are greater chances of the hedge provider being unable to deliver on the product. For example, the long-term gas hedging products offered by Enron are now worth little.

[34] William Trapmann, *An Assessment of Recent Natural Gas Market Trends*, 62nd Conference on Glass Problems, October 17, 2001.

Third, the LBL gas price hedge value is derived from financial hedge products that are in part sold to regulated utilities. Electric utilities typically pass the costs of purchasing gas for their power plants on to their ratepayers. Thus, electric utilities (from the shareholders' perspective) face very little risk of future gas price volatility and uncertainty. Since they face so little long-term risk, it is unlikely that they would be willing to pay much to hedge against it. In addition, regulated utilities may be concerned that purchases of hedging "insurance" would be deemed by regulators to be imprudent, and cost recovery disallowed. Finally, utilities may be concerned about the risk that past and future restructuring efforts will erode their customer bases, making it more difficult to recover hedging costs from remaining customers. These could be some of the reasons why there are so few products on the market that provide electric utilities with long-term hedges against gas prices.

3. Employment Benefits of an RPS

The manufacture, construction and operation of renewable generating capacity often creates greater employment benefits in the Northeast than a comparable amount of fossil-fired capacity. This is because states like New York can be an attractive home for companies within the renewable energy industry, while New York consumers will always be paying companies in other regions for fossil fuels. Moreover, the jobs that renewable companies can bring to New York are attractive, high-tech jobs. This Section reviews the potential employment benefits, in the form of jobs with renewable energy companies, that RPSs can provide.[35]

The development of renewable energy in New York will bring jobs and property tax revenue to the state. It will create economic opportunities for construction firms, engineers, hotels and restaurants, consultants and many others, and the income and benefits of such projects will flow to many of the state's lowest income regions.

There have been several attempts at quantifying the economic development benefits resulting from clean energy development. Some of these, detailed in Section 3.1, are specific to New York and outline the benefits coming to the state and to local economies. Other analyses, described in Section 3.2, illustrate how large-scale clean energy developments have benefited the local economies of other states.

3.1 Employment Benefits for New York

New York businesses specializing in all kinds of renewable energy technologies can expect to gain from an RPS. There are over 130 businesses in the manufacturing and sales sectors of wind, solar, geothermal, hydro and fuel cells in the state.[36] Many more

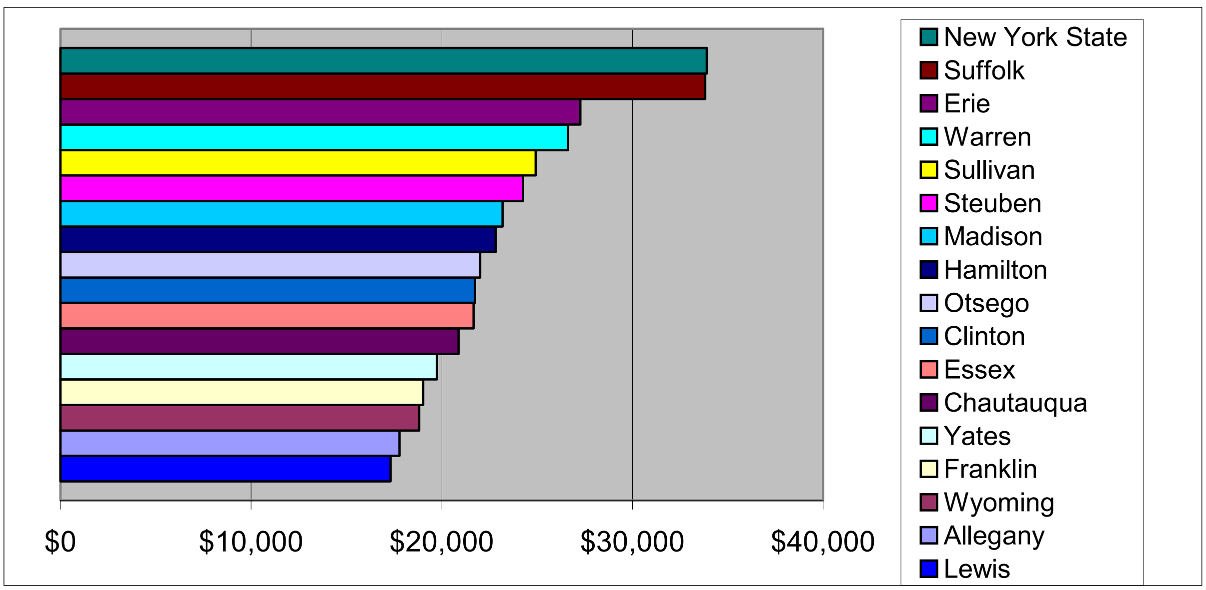
[35] It is important to note that a comprehensive economic analysis of an RPS would take into account many different types of employment dynamics. This Section focuses only on the potential for expanded employment opportunities with renewable energy manufacturers and developers.

[36] See: http://energy.sourceguides.com/businesses/byGeo/US/byS/NY/NY.shtml.

will be involved in site and feasibility analysis, construction and servicing. An RPS will create jobs in all regions of the state, from urban areas where PV panels will need to be serviced to rural areas where wind farms will require an operations and maintenance team. In general, these jobs will not be minimum wage jobs, but rather well-paid positions employing engineers, union laborers, technicians, electricians and other skilled laborers.

In New York, wind – which is likely to play a significant role in meeting the RPS requirements – will be a welcome economic opportunity for some of the counties with the lowest income. Figure 5 shows the per capita income in the counties with New York's best available onshore and offshore wind resources. Per capita income in many of these counties is well under the New York State average of $33,901.

Figure 5. Per Capita Income in New York's Windiest Counties[37]



The effects of an RPS on property values will also likely be positive. A Renewable Energy Policy Project (REPP) study found that property values have increased since the Fenner and Madison Windpower Projects in Madison County came online.[38] The study analyzed property sales data in the "view shed" around the projects and in a comparable community in the vicinity but outside of the view shed. The view shed is a five-mile radius around the project site. The literature, as well as field experience, suggests that housing values are not influenced by wind projects outside of this radius because of limited visibility. The results show that, within the Madison Project view shed, property values rose an average of $576.22 a month from January 1997 to January 2003 compared to $245.51 in the comparable community. In the Fenner view shed they rose an average

[37] See: http://www.nylovesbiz.com/nysdc/Personalincome/PCICounty.PDF

[38] *The Effect of Wind Development on Local Property Values* at http://www.repp.org/articles/static/1/binaries/wind_online_final.pdf.

of $368.47 a month during the same time period. The same comparable community was used in both analyses.

Using the National Renewable Energy Laboratory's (NREL) Wind Impact Model (WIM), we found that a generic 50 MW wind farm installed in New York would create over 95 jobs from direct, indirect and induced impacts during the construction period and over 20 permanent jobs following construction in the state alone. The model assumes that none of the generation equipment is procured in New York State, a conservative assumption given that there are component manufacturers located within New York. Total local spending for the project is projected to exceed $5,846,000 during construction and over $665,000 annually during the life of the project. Assuming that just six percent of the total equipment cost is spent locally increases the total local expenditure to $9,252,185. Table 9 summarizes the project's job and economic impacts under the more conservative assumptions.

Table 9. Expenditures and Job Creation for a 50 MW Wind Power Project in New York

	Construction Period	Operation Period
Jobs	96	22
Local Spending	$5,846,000	$665,000

The economic benefits of attracting new energy companies to New York are large. The fuel cell manufacturer Plug Power, for example, employs 300 individuals in New York, at average salaries exceeding $50,000. Since 1999, Plug Power has paid over $50,000,000 to suppliers located within New York State, and Plug Power employees have paid over $6,000,000 in state income taxes. Although Plug Power has benefited from active economic development support from the state, the vast majority of Plug Power's financial support has come from private investment that is funded through global financial markets.

3.2 Evidence from Other States

The development of wind projects has been a welcome investment in the farming regions of other states. Agricultural land is particularly well suited to wind development because it is clear of obstructions such as trees and buildings. In Iowa, the installation of a 240-MW wind farm brought $640,000 per year in lease payments to farmers, $2 million per year in property tax revenue, $5.5 million per year in operations and maintenance income and 40 long-term operation and maintenance jobs to the local area.[39] During the construction period, 200 jobs were added to the region. The jobs and other benefits created in other sectors and businesses (such as manufacturing) were not included in this assessment.

[39] See: Wind Powering America: http://www.eere.energy.gov/windpoweringamerica/pdfs/econ_clemmer.pdf

A study by Northwest Economic Associates for the National Wind Coordinating Committee examined the job and revenue impacts from three wind farms: Lake Benton I in Lincoln County, Minnesota; Vansycle Ridge in Morrow and Umatilla Counties, Oregon; and Delaware Mountain in Culberson County, Texas. Table 10 summarizes these impacts. Personal income and employment are both direct and indirect benefits generated by the project for the local economy. Local taxes are those paid by all beneficiaries of the project to local government or other entities. Landowner payments are net of taxes and represent the total amount paid annually to landowners on whose land the project is located. The small, natural resource-based nature of the economies in this study limited the number of jobs that could be created within the county.

Table 10. Employment, Tax and Revenue Impacts of Three Wind Projects[40]

	Lincoln County, Minnesota	Morrow and Umatilla Counties, Oregon	Culberson County, Texas
Installed Capacity	107.25 MW	25.08 MW	30 MW
Construction Employment	8	4	26
Construction Personal Income	$98,400	$105,400	$391,300
O&M Employment	31	6	11
O&M Personal Income	$909,200	$103,600	$346,100
Local Taxes Paid	$611,000	$242,000	$387,000
Landowner Payments	$501,000	$64,000	$51,000

The establishment of a Texas RPS has generated significant cash flow to school districts in the state. Table 11 lists the payments received by county in Texas. Pecos County tops the list with more than $4.8 million paid in 2002 alone.

[40] *Assessing the Economic Development Impacts of Wind Power* at http://www.nationalwind.org/pubs/economic/econ_final_report.pdf.

Table 11. Taxes Paid to School Districts by Texas Wind Projects[41]

County	Installed Wind Capacity (MW)	Assessed Value ($ million)	Tax Rate (%)	Tax Due in 2002
Pecos	412.7	297.1	1.62	$4,809,472
Upton	292.3	191.0	1.44	$2,750,400
Taylor	100.5	82.0	1.38	$1,131,324
Carson	80	57.5	1.49	$856,750
Crockett	61	47.5	1.33	$631,750
Nolan	49.5	37.6	1.58	$594,080
Culberson	65	34.9	1.55	$470,028
Howard	34.3	24.7	1.5	$370,656
Jeff Davis	6	4.3	1.5	$64,800
Hudspeth	1.3	1.0	1.5	$14,256
Total	**1,103**	**777.49**	**1.49**	**$11,693,516**

In comments filed regarding the Nevada RPS, the REPP used an in-house spreadsheet job calculator to estimate the RPS's job creation potential. The calculator, based upon a survey of companies within the renewables industry, projects the number of jobs created by a policy such as an RPS. It calculates the direct jobs resulting from increased wind, solar and biomass co-firing capacity. For the Nevada RPS, REPP projected about 4.7 jobs per MW of wind installed, 34.8 per MW of PV installed, and 1.6 per MW of biomass cofiring. Table 12 shows the breakdown of those jobs between manufacturing, installation and operations and maintenance.

Table 12. REPP Job Calculator Employment Rates in Nevada by Technology (jobs/MW)

Technology	Manufacturing	Installation	Operations and Maintenance
Wind	3	0.7	0.9
Solar PV	25	7	2.4
Biomass Cofiring*	n/a	n/a	3.9

*Using silvicultural wood only. Figure does not include O&M of the coal-fired plant, only the growth, harvesting, transport and preparation of biomass fuels.

The CALPIRG Charitable Trust has compared the number of jobs created by renewable energy to the number created by new gas-fired generating capacity.[42] This analysis concludes that building renewable generation rather than gas-fired generation creates more jobs: 70 percent more in the case of wind, twice as many for solar and 14.7 times as many for landfill gas. Table 13 presents the estimates from this study of the number of construction and permanent jobs created by various energy technologies.

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[41] Virtus Energy Research Associates, 2002.

[42] *Renewables Work: Job Growth from Renewable Energy Development in California*. at http://www.calpirg.org/reports/renewableswork.pdf.

Table 13. CALPIRG Employment Rates by Technology (jobs/MW)

Technology	Construction Employment	Operating Employment
Wind	2.57	0.20
Solar PV	7.14	0.12
Landfill/Digester Gas	3.71	2.28
Natural Gas	1.02	0.13

A Union of Concerned Scientists study also shows that wind projects create more jobs than natural gas or coal-fried plants. The study examined the benefits coming to Nebraska as a result of a 10-percent wind energy standard by 2012. By that year, assuming that 50 percent of the turbines are manufactured in-state, 1,000 jobs will be created. Assuming no in-state manufacturing, that figure goes down to approximately 750. Generating the same amount of electricity from natural gas and coal, on the other hand, is projected to create just 400 jobs.

A report by the Colorado Public Interest Research Group (CoPIRG) Foundation estimates the economic impacts resulting from 4,100 MW of wind installed by 2020 versus 2,400 MW (the capacity that would generate the equivalent number of Gigawatt hours) of natural gas. Wind development brings significantly more jobs, tax revenue and landowner payments, as well as saving billions of gallons of water. Table 14 summarizes the results of CoPIRG's report.

Table 14. Projected Economic Impacts from Two Generating Options[43]

	Total through 2012		Total through 2020	
	Wind	Natural Gas	Wind	Natural Gas
Electricity Generation	5,100 GWh	5,100 GWh	12,600 GWh	12,600 GWh
Capacity	1,800 MW	990 MW	4,100 MW	2,400 MW
One-Year Jobs				
Manufacturing	370	340	840	830
Installation	920	480	2,100	1,200
Supporting Areas	1,500	950	3,400	2,300
Long-Term Jobs				
O&M	260	40	590	100
Supporting Areas	300	120	680	290
Taxes Paid to Local Government	$74 million	$46 million	$230 million	$150 million
Royalties Paid to Landowners	$20 million	$0	$76 million	$0
Conserved Water (gallons)	6.8 billion	0	25 billion	0
Value of Rights to that Water	$47 million	0	$120 million	0

In summary, renewable energy creates new high paying jobs in a wide variety of industries. This includes direct jobs installing, operating and manufacturing renewable generating facilities and jobs at the facilities that manufacture and construct renewable generating equipment. It also includes indirect jobs in the industries that support these activities. Further, property tax revenue and landowner payments bring additional revenue into New York.

4. Conclusions

In sum, there is strong evidence for a number of important benefits from an RPS in New York. The key benefits we have explored here include environmental and public health benefits from reduced air emissions, fuel diversity and natural gas price reductions from additional renewable generation and employment benefits in New York's growing renewable energy sector. Regarding these three categories of benefits, we find the following.

- The emission reductions projected by the DPS modeling work will provide significant environmental and public health benefits, however reductions in fine particulates and air toxics (not assessed by the DPS) will provide substantial benefits that should be also recognized.

[43] http://www.environmentcolorado.org/reports/windenergy11_02.pdf.

- Natural gas prices have become much more volatile in the past several years, and there is a strong chance that they will be higher on average in the coming years than over the past decade. An aggressive RPS would provide much-needed fuel diversity to New York's power generation sector and would insulate the state's electricity users from potential increases – both short term and long term – in gas prices.
- A number of studies suggest that investments in renewable power generation result in more jobs, and better quality jobs, than investments in fossil-fueled generation. This is especially true in states like New York, which (a) do not have significant fossil-fuel resources and (b) are attractive homes for high-technology manufacturing companies.