Appendix 6

Center for Energy, Economic & Environmental Policy (CEEEP) of Rutgers University Microeconomic Impact of CO_2 Reductions in New Jersey

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Date: October 29, 2009

To: New Jersey Department of Environmental Protection

From: Center for Energy, Economics & Environmental Policy

Re: Microeconomic Impact of CO_2 Reduction in New Jersey

The New Jersey Department of Environmental Protection (DEP) has asked the Center for Energy, Economic and Environmental Policy (CEEEP) and the Rutgers Economic Advisory Service (R/ECON[TM]), both part of the Edward J. Bloustein School of Planning and Public Policy at Rutgers University, to analyze the economic impacts of the proposed Supporting Recommendations prepared in response to Governor Corzine's Executive Order 54 and the Global Warming Response Act (GWRA). Both organizations have previously worked together on behalf of the State to analyze the economic impacts of the State's Renewable Portfolio Standard (RPS), the Energy Master Plan (EMP), and the Low Emission Vehicle (LEV) program.

This memorandum identifies, describes and, where possible, quantifies the economic benefits of certain of the policies within the Supporting Recommendations including the benefits of avoiding damages associated with the emission of greenhouse gases and other co-benefits not related to greenhouse gases.[1] It is organized in the following sections. First, the costs and direct and co-benefits associated with greenhouse gas emission reduction policies are characterized. Next, a brief review of economic impact analyses of other jurisdictions' policies to reduce greenhouse gas emissions is presented. The third and fourth sections quantify, respectively, the direct greenhouse gas reduction benefits and non-greenhouse gas reduction co-benefits of the proposed Supporting Recommendations.

I. Identifying and Quantifying the Economic Impacts of Greenhouse Reduction Policies

The emission of greenhouse gases and their associated impact on global climate change presents policymakers with extensive technical, economic and policy challenges. Different greenhouse gas reduction measures have different costs. Some measures are economical; the adoption of such a measure should occur regardless of its greenhouse gas reduction benefits. Energy efficiency measures generally fall into this category because the energy savings are sufficient to more than pay for the cost of the measure. Any additional direct benefits, such as a reduction of greenhouse gases, would only make that measure even more cost-effective. In the work performed by the Center for Climate Strategies (CCS) on the Supporting Recommendations,

[1] In this memorandum, the term "co-benefits" refers to benefits of a particular measure other than those associated with reducing greenhouse gas emissions.

measures that are cost-effective are identified as having “negative” costs (reported per metric ton of equivalent CO_2), indicating that the measure’s benefits outweigh its cost.

Other measures have costs that exceed the narrowly defined economic benefits before their impact on greenhouse gas emissions and other co-benefits are accounted for. In the work performed by CCS, these measures are characterized as having a positive cost. The costs of the policy measures proposed in the Supporting Recommendations are not known with complete certainty. They are based upon engineering estimates performed prior to the implementation of the measures. Over time, as more experience is gained with individual measures, their actual costs may turn out to be different from their estimated costs. Since these measures would be implemented by the State of New Jersey, the costs associated with them would be borne by the State’s residents.

The benefits associated with the proposed measures in the Supporting Recommendations can be categorized in several ways. The most prominent category of benefit is the reduction in greenhouse gas emissions. Reduced emissions should translate into lower increases in global temperatures and should therefore lower the net economic and other costs associated with global climate change. Other benefits may also occur that are not related to global climate changes, such as reductions in other air emissions or improved flood control. In some cases the greenhouse gas reduction benefits and the non-greenhouse gas reduction benefits can be quantified, although the range of uncertainty around specific point estimates may be large. In other cases, it is not practical to provide any reasonable quantification of these two categories of benefits; nonetheless these unquantifiable benefits are real and should be considered a part of the economic impact analysis.

Table 1 summarizes the types of benefits associated with each major category of additional measures in the Supporting Recommendations.

Table 1: Direct and Co-Benefits Associated with Supporting Recommendations of the Supporting Recommendations

Category	Benefit	Benefit Type	Quantified/ Unquantified
All Categories	CO_2 Reduction	Direct	Quantified
	Sea Level Rise Abatement	Co-Benefit	Unquantified
	Job Creation	Co-Benefit	Unquantified
Green Buildings	Electricity Reduction	Direct and Co-Benefit	Quantified
	Natural Gas Reduction	Direct and Co-Benefit	Quantified
	Reduced SO_2 and NO_x	Co-Benefit	Quantified
Waste Management	Electricity Reduction	Direct and Co-Benefit	Quantified
	Reduced SO_2 and NO_x	Co-Benefit	Quantified
	Enhancement of Aesthetic and Property Values	Co-Benefit	Unquantified
Warming Gases from C&I Refrigeration and A/C	Indoor Air Quality	Co-benefit	Unquantified
Terrestrial Sequestration of Carbon	Reduction of Urban Heat Island Effect	Co-Benefit	Unquantified
	Stormwater Control	Co-Benefit	Unquantified
	Wildlife Protection	Co-Benefit	Unquantified
	Water Quality Protection	Co-Benefit	Unquantified
Transportation and Land Use	Gasoline Use Reduction	Direct and Co-Benefit	Quantified
	Renewable Energy Use	Direct and Co-Benefit	Quantified
	Reduced Dependence on Foreign Oil	Co-Benefit	Unquantified
	Improved Road Conditions	Co-Benefit	Unquantified
Electricity Generating Units	Reduced SO_2 and NO_x	Co-Benefit	Quantified

As a direct consequence of the greenhouse gas effect, the greenhouse gas reduction benefits occur throughout the world, although New Jersey is particularly affected by global climate change as discussed in the Supporting Recommendations. Moreover, the greenhouse gas reduction benefits due to the Supporting Recommendations depend on reductions in greenhouse gas emissions by other states and countries. The non-greenhouse gas reduction benefits accrue primarily, if not exclusively, to New Jersey. In many cases, the benefits, whether greenhouse gas related or not, are uncertain. In other words, wide variations exist among the various estimates of the economic benefits.

How should policymakers respond to the difficulties in both quantifying the costs and benefits associated with greenhouse gas reduction measures? Despite the relative uncertainties as to the timing and location of the costs and benefits, substantial actions taken immediately, such as those proposed in the Supporting Recommendations, are reasonable. Certainly, the above mentioned issues do not justify inaction or delay. Given the range in costs associated with various measures, it makes sense, as the State of New Jersey is doing, to pursue the most cost-effective measures first, subject to regulatory and legislative restrictions. It is also reasonable for the State to identify, characterize, and in some cases even pursue more expensive measures, even if in some cases those measures' costs exceed their expected benefits. As a matter of public policy, the State may decide that there are issues of equity that justify certain measures even if the strict economics relating to those measures do not. In addition, the State may be risk-averse and therefore willing to incur costs that avoid or limit the likelihood of extremely bad climate change outcomes even if the measures are not strictly justified on an economic basis. Finally, in identifying and characterizing measures based upon the best information available today, the State creates the flexibility to pursue these measures in the future when they may be more economical based upon new and better information.

II. Studies of Economic Impacts of Greenhouse Gas Reduction Policies from Jurisdictions Other Than New Jersey

Florida recently completed a statewide study of the impacts of the Florida Energy and Climate Change Action Plan on the State's economy.[2] The Florida Energy and Climate Change Action Plan designs policies and measures to mitigate the emissions of greenhouse gases. The report highlights 28 mitigation and sequestration strategies including energy supply and demand (Renewable Portfolio Standards, nuclear power and combined heat and power), transportation and land use (low greenhouse gas fuels and improving transportation system management), and agriculture, forestry and waste (forest retention and forest management for carbon sequestration). Most of the strategies discussed in the paper had positive macroeconomic impacts. Overall, the strategies are expected to increase the Gross State Product by about $33 billion (0.66%). The study also estimates that about 129,000 full time equivalent jobs (direct and indirect) will result from the mitigation strategies. This represents an increase of nearly one percent over baseline projections.

CCS summarized the results of a study designing a regional cap-and-trade system in Michigan.[3] For an economy-wide cap-and-trade system, the net impact on the economy will be positive, with a cost savings to the Michigan economy of $193 millionby 2020. Overall, the Midwestern Greenhouse Gas Reduction Accord States would save $3.6 billion by 2020.

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[2] Rose, A. and D. Wei, "The Economic Impact of The Florida Energy and Climate Change Action Plan on the State's Economy." The Center for Climate Strategies, May 15, 2009.
[3] Rose, A., D. Wei, J. Wennberg, and T. Peterson. "Climate change policy formation in Michigan: the case for integrated regional policies." Forthcoming in International Regional Science Review.

Many other states have recently assessed or are currently in the process of assessing the economic impacts of climate change policies. Ruth et al. present a case study of the potential economic and energy impacts on Maryland from its participation in the Regional Greenhouse Gas Initiative (RGGI).[4] RGGI is the first mandatory market-based effort in the United States to reduce greenhouse gases from the production of electricity. Ten Northeastern and Mid-Atlantic states have the goal of capping and then reducing CO_2 emissions from the power sector 10% by 2018.[5] Using three models, Haiku, JHU-OUTEC, and IMPLAN, the authors showed that there would be only a limited impact on the economy and electric power markets in Maryland. Specifically, RGGI participation lowered net electricity demand by between 1.5 percent in 2010 and nearly three percent in 2025, reduced investment in new generation capacity by nearly 45 percent by 2025, and had virtually no impact on retail electricity prices paid by ratepayers. In addition, the study showed that RGGI would not lead to significant retirement of existing electricity generation capacity. Total profits of existing generators would fall by 13 percent in 2010 and 12 percent in 2025, with coal-fired generators experiencing the largest drop. Some of the economic impacts included an overall electricity bill decrease of $100 million in 2010 and more than $200 million by 2025, with the average residential ratepayer seeing $22 in annual savings by 2010, and an overall positive impact on Gross State Product and job growth (0.1 percent, each).

Prindle et al. examined the regional effects of increased energy efficiency investment in the RGGI framework using the REMI model.[6] The REMI runs showed that RGGI would have a very small impact on the regional economy. In general, the impact was less than one-tenth of one percent for key indicators such as gross regional product, personal income and private sector employment. The authors also note that the REMI runs indicated small but positive individual economic impacts from RGGI. For example, average household electricity bills are expected to decrease by about $30 by 2015 and $50 by 2021.

ISO New England conducted its own analysis of RGGI impacts by surveying generators and stakeholders on likely compliance strategies and potential operating risks, and by using sensitivity analyses for those factors.[7] The analysis found that four New England states (Connecticut, Maine, New Hampshire, and Vermont) would be able to meet the New England RGGI cap through 2015 if the CO_2 allowance price is $5/ton or higher. New generating resources would need to have zero or low CO_2 emissions to maintain emissions below the cap

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[4] Ruth, M., S.A. Gabriel, K.L. Palmer, D. Burtraw, A. Paul, Y. Chen, B.F. Hobbs, D. Irani, J. Michael, and K.M. Ross, "Economic and Energy Impact from participation in the regional greenhouse gas initiative: a case study of the State of Maryland." Energy Policy, 36 (2008), 2279-2289.

[5] Information provided by Regional Greenhouse Gas Initiative website. Available at http://www.rggi.org/home

[6] Prindle, W.R. A.M. Shipley, and R.N. Elliott, "Energy Efficiency's role in a carbon cap-and-trade system: modeling results from the regional greenhouse gas initiative." American Council for an Energy-Efficient Economy, Report Number E064m May 2006.

[7] "ISO Evaluation of Regional Greenhouse Gas Initiative," Presentation from PAC Meeting, Sturbridge, MA, June 2006. http://www.masstech.org/renewableenergy/public_policy/DG/resources/2006-06-06_ISO-NE_study-of-RGGI.pdf

after 2015. Leakage from non-RGGI units will be a significant problem for remaining below the RGGI cap (3 million tons in 2015, allowance cost of $10/ton). The addition of Rhode Island and Massachusetts would cause CO_2 emissions to exceed the six-state cap of 55.8 million tons in 2010 at $5/ton and 2014 at $20/ton.

III. Estimate of the Global Climate Change-Related Direct Benefits from the Proposed Supporting Recommendations beyond the NJ EMP and LEV Standard

The supporting climate change policy recommendations that are quantified in this section are in addition to the policy options presented in the New Jersey Energy Master Plan (EMP) and New Jersey's Low Emission Vehicle program (LEV). The New Jersey EMP proposes policies that relate to energy efficiency, renewable energy, and the development of clean energy technologies. The New Jersey LEV or Clean Car Program implements the California Low Emission Vehicles (LEV) standard, which contains programs for vehicle emission standards, fleetwide emission requirements, and a Zero Emission Vehicle (ZEV) sales requirement.

Emission reductions of equivalent CO_2 can be quantified in dollars using estimates for the negative economic impact per ton of equivalent CO_2 emitted. One difficulty in this analysis is the wide range of estimates for the benefits per ton of equivalent CO_2 reduction. The Intergovernmental Panel on Climate Change (IPCC) produced a study based on a survey of 100 estimates of this parameter, with ranges from $3 to $95 per metric ton and a mean of $12 per metric ton.[8] These estimates were used in the modeling effort for the New Jersey Energy Master Plan (EMP) to estimate the monetary benefits of reducing CO_2 through the implementation of the EMP strategies.[9] The methodology and savings estimates used for the EMP are applied here to the supporting recommendations. When equivalent CO_2 reductions from reduced electricity usage are excluded, the supporting recommendations reduce equivalent CO_2 by 24.8 million metric tons in 2020 and by 138.8 million metric tons from 2009 to 2020. In the year 2020 alone, this translates into economic benefits of approximately $65 million as the low estimate, $260 million as a mean estimate, and $2.06 billion as a high estimate, in 2020 dollars. Table 2 lists the economic benefits of reduced equivalent CO_2 emissions from 2010 through 2020. The net present value of savings from 2009 to 2020 is $291 million as a low estimate, $1.16 billion as a mean estimate, and $9.22 billion as high estimate.[10] The economic benefits accrue to the global economy, not just New Jersey's economy, due to the nature of global warming.

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[8] Gilbert E. Metcalf, *A Proposal for a U.S. Carbon Tax Swap: An Equitable Tax Reform to Address Global Climate Change*, The Brookings Institution, Oct. 2007 citing the Intergovernmental Panel on Climate Change (IPCC), *Contribution of Working Group II to the Fourth Assessment Report*, Geneva, Switzerland, 2007.
[9] Center for Energy, Economic & Environmental Policy, *Modeling Report for the New Jersey Energy Master Plan*, Rutgers, The State University of New Jersey, October 2008, on behalf of the New Jersey Board of Public Utilities.
[10] Note: A real interest rate of 3% was used for all net present value calculations to match the interest rate used in the CCS report.

Table 2: Direct Economic Benefit of Reduced Equivalent CO_2 Emissions Beyond EMP and LEV Strategies

	CO2 Savings (Million Metric Tons)	Low Savings Estimate	Mean Savings Estimate	High Savings Estimate
2009	0.07	$ 195,990	$ 783,960	$ 6,206,347
2010	2.10	$ 6,298,173	$ 25,192,690	$ 199,442,133
2011	3.50	$ 10,502,646	$ 42,010,585	$ 332,583,800
2012	5.05	$ 15,138,492	$ 60,553,969	$ 479,385,587
2013	6.74	$ 20,212,821	$ 80,851,284	$ 640,072,664
2014	8.56	$ 25,690,380	$ 102,761,521	$ 813,528,709
2015	10.52	$ 31,557,506	$ 126,230,023	$ 999,321,017
2016	12.55	$ 37,651,907	$ 150,607,627	$ 1,192,310,381
2017	14.70	$ 44,088,069	$ 176,352,274	$ 1,396,122,170
2018	16.99	$ 50,970,102	$ 203,880,407	$ 1,614,053,219
2019	19.34	$ 58,025,053	$ 232,100,212	$ 1,837,460,013
2020	21.73	$ 65,204,178	$ 260,816,713	$ 2,064,798,979
	Total NPV	**$ 291,376,116**	**$ 1,165,504,464**	**$ 9,226,910,343**

IV. Estimate of the Non-Global Climate Change Related Benefits from the Proposed Supporting Recommendations beyond EMP and LEV Strategies

In addition to a reduction in equivalent CO_2, implementation of the supporting recommendations also reduces other air emissions that are detrimental to human health and the environment, mainly SO_2 and NO_x. SO_2 and NO_x are the principal pollutants that cause acid precipitation. The SO_2 and NO_x emission savings were determined by multiplying the electricity and natural gas savings for the supporting recommendations by emission factors in the New Jersey Protocols to Measure Resource Savings.[11] In order to monetize the benefits of emissions reduction, the reduced emissions were multiplied by forecasted emission permit prices.[12] On this basis, SO_2 savings account for $6.3 million and NO_x savings account for $10.5 million in 2020 alone. Table 3 shows the estimated economic benefits of reduced SO_2 and NO_x emissions from 2010 through 2020. The net present value in 2009 dollars of the estimated savings is $27.2 million for SO_2 and $47.6 million for NO_x.

[11] New Jersey Clean Energy Program. *Protocols to Measure Resource Savings*. December 2007. Available at www.njcleanenergy.com.

[12] SO_2 allowance prices were taken from the EPA Annual Auction Results. NO_x allowance prices were taken from the Chicago Climate Exchange.

Table 3: Economic Benefit of Reduced SO_2 and NO_x Emissions beyond EMP and LEV Strategies

	SO2 Savings	NOx Savings
2009	$ 72,918	$ 966,739
2010	$ 201,706	$ 1,584,292
2011	$ 578,075	$ 2,403,459
2012	$ 2,122,723	$ 3,408,449
2013	$ 2,818,313	$ 4,671,417
2014	$ 2,677,046	$ 3,076,158
2015	$ 2,413,479	$ 4,075,921
2016	$ 3,073,088	$ 5,173,853
2017	$ 3,793,812	$ 6,369,911
2018	$ 4,592,814	$ 7,690,765
2019	$ 5,432,086	$ 9,078,552
2020	$ 6,308,017	$ 10,528,854
Total NPV	**$ 27,203,370**	**$ 47,598,303**

Although the economic benefits from reduced emissions are significant, the economic benefits have a relatively minor impact on the overall state economy. In 2020, taking the mean equivalent CO_2 savings estimates combined with the SO_2 and NO_x benefits, the overall economic benefit is $308 million. When compared to the projected total Gross State Product in 2020 of $474 billion, emission savings benefits only account for approximately 0.06% of New Jersey's Gross State Product.[13] By comparison, the New Jersey EMP is projected to have a 0.1% impact on New Jersey's Gross State Product, and New Jersey's Renewable Portfolio Standard is projected to have a negligible impact on the growth of New Jersey's economy.[14]

The preservation of New Jersey's natural capital is another benefit of the supporting recommendations. Natural capital includes the natural assets that provide natural goods (commodities such as fish and timber), and those that provide ecosystem services. Ecosystem services include carbon sequestration, pest and disease control, and purification of water and air. The benefits of New Jersey's natural capital were quantified in a study performed by the New Jersey Department of Environmental Protection.[15] To monetize these benefits for the present study, dollar values per acre were multiplied by the number of acres saved by land type due to the supporting recommendation. In 2020, this translates in real dollars into approximately $5.7 million in natural goods benefits and $37 million in ecosystem services benefits. Table 4 shows the economic benefits of preserved natural capital from 2009 through 2020. The net present

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[13] Gross State Product projections provided by the July 2009 R/ECON™ Econometric Forecast.

[14] Center for Energy, Economic & Environmental Policy, *Economic Impact Analysis of New Jersey's Proposed 20% Renewable Portfolio Standard.* Rutgers, The State University of New Jersey, December 2004, On behalf of the New Jersey Board of Public Utilities.

[15] New Jersey Department of Environmental Protection. *Valuing New Jersey's Natural Capital*. April 2007. Available at http://www.state.nj.us/dep/dsr/naturalcap/.

value of savings from 2009 through 2020 is $148 million in natural goods benefits and $1.4 billion in ecosystem services benefits.[16]

Table 4: Economic Benefits of New Jersey's Natural Capital[17]

Year	Goods Benefits	Services Benefits	Total Benefits
2009	$ 25,393,568	$ 247,599,691	$ 272,993,259
2010	$ 25,393,568	$ 247,599,691	$ 272,993,259
2011	$ 25,393,568	$ 247,599,691	$ 272,993,259
2012	$ 25,393,568	$ 247,599,691	$ 272,993,259
2013	$ 25,393,568	$ 247,599,691	$ 272,993,259
2014	$ 5,203,825	$ 34,608,658	$ 39,812,483
2015	$ 5,203,825	$ 34,608,658	$ 39,812,483
2016	$ 5,203,825	$ 34,608,658	$ 39,812,483
2017	$ 5,203,825	$ 34,608,658	$ 39,812,483
2018	$ 5,203,825	$ 34,608,658	$ 39,812,483
2019	$ 5,203,825	$ 34,608,658	$ 39,812,483
2020	$ 5,203,825	$ 34,608,658	$ 39,812,483
Total NPV	**$ 148,589,868**	**$ 1,359,529,223**	**$ 1,508,119,091**

Each of the benefits discussed in the previous sections are additive, which means that the benefits from CO_2, SO_2, NO_x, and Natural Capital can be added together to determine the overall co-benefit economic impact. The cumulative effects of these co-benefits is almost $350 million in the year 2020 alone and lifetime benefits are $2.75 billion when using the mean estimate for CO_2 savings.

V. Other Non-Quantifiable Benefits

Even though there are many quantifiable benefits from the supporting recommendations, there are other benefits of implementing climate change policy options that cannot be economically quantified. One significant benefit is the reduced dependence on foreign oil. Other benefits that have not been quantified in this analysis include increased visibility due to the reduction of smog caused by SO_2 and NO_x, improved driving conditions due to transportation policy options, and the cultivation of new businesses and markets aimed at reducing greenhouse gas emissions.

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[16] Note: There is a sharp drop in benefits from 2013 to 2014, this is caused by the expiration of the RGGI 5-Year Investment Program.

[17] Note: CEEEP used acre savings estimates from William Mates of the NJ DEP.