April 6, 2004

To: Energy Modeling and Analysis Subgroup and Economic Cost-Benefit Modeling and Analysis Subgroup, Regional Greenhouse Gas Initiative (RGGI)

RE: RGGI Modeling Guidelines & Preliminary Comments

Prepared and Supported by: Clean Water Action; Conservation Law Foundation; Environment Northeast; Mass Climate Action Network; National Association of State PIRGs; Natural Resources Defense Council; and Union of Concerned Scientists; with assistance from Synapse Energy Economics, Inc.

The following are initial thoughts on what we believe would represent sound principles and processes for the RGGI modeling work.

- The general principles guiding the modeling teams should be:

  - **Transparency**: publicly and openly present (i) the relationship between RGGI and the modelers, (ii) the assumptions and data and algorithms underlying the analyses and, of course, (iii) the conclusions;
  - **Accuracy**: select models and input data that are widely accepted by experts in the field and that are fully and publicly reviewed;
  - **Clarity**: develop a set of scenarios or sensitivities that attempt to bound future uncertainty associated with model inputs and assumptions and then present modeling results in a form that a wide range of non-experts will be able to understand; and
  - **Usefulness**: create modeling outputs that will provide usable guidance for decision makers in shaping concrete, implementable and replicable policies.

The following specific steps can ensure that the work overseen by these subgroups lives up to these fundamental values.

- The relationship with consultants and modelers should be clearly defined and publicly disclosed, with a copy of the contract made available for review, giving the public:
  - Clear understanding of the scope, schedule, and cost of that work; and
  - Clarity regarding what information is viewed as proprietary by the contractor or model developer, what will be shared with state agencies, and what will be available to all other parties.
- Public and stakeholder involvement and comments must be meaningful, including:
  - An opportunity to comment on the work plan of the modeling group well before it is finalized, that work plan should clearly describe what they are likely to model and where there will be opportunities for public comment and input during the modeling process;

- Full public release of the input data prior to the running of the reference case, giving stakeholders and the public a full opportunity to comment on the assumptions being used and to propose alternative data sources or assumptions;
- Full, timely, complete and meaningful opportunities for written comment by Stakeholders and the public at key moments, including when:
  - Initial inputs utilized in the modeling are identified,
  - Reference case results are compiled,
  - A draft list of "policy runs" and underlying assumptions for these runs has been developed,
  - Policy run results have been compiled, and
  - Draft and Final results of modeling are being reviewed.
- Full public disclosure of written comments received by the State Working Group with a clearly stated process for soliciting such input, posting received input on the website, and any response to input.
- Full public disclosure of underlying information, assumptions and analysis justifying all decisions, including model input and output files.
- We would like to see the modeling completed well in advance of the final discussion of the model rule.

Preliminary Comments on Electricity Sector Modeling

In addition to the modeling principles and guidelines outlined above, we have drafted a list of input assumptions and model results that we as a group would like to see and be able to comment on. The list of model assumptions or data sources is purely an outline at this point. We plan to provide input to the RGGI Electricity Sector Modeling Group on what data sources are most accurate, but wanted to provide this initial list and compare notes with the modelers and the subgroup to confirm that the list is complete. We will be working to provide specific recommendations on each input and our recommended data sources.

The table that follows is a list of the inputs and assumptions that we believe the modeling team will need to examine. It is followed by a list of model results that we believe it will be necessary to produce in order to fully inform policy makers and to complete the cost-benefit analysis. We will also develop a list of model runs that we think will be necessary to capture the potential outcomes of the RGGI cap & trade policy. We plan to submit our specific recommendations on inputs, results, and model runs to the modeling team in the next week to ten days.

We would appreciate any thoughts or feedback from the modeling team on this outline. Let us know if there are missing elements or categories that are unclear.

Regional Greenhouse Gas Initiative - Electricity Sector Modeling

Assumptions and Results - DRAFT OUTLINE

Assumes that the model being used is ICF's Integrated Planning Model

	IPM Default Assumption	Consensus Recommendation from Environmental Groups
Model Input Assumptions and Data Sources		
Model regions (spatial distribution / transmission)	TO BE DETAILED BY ICF	TO BE ADDED LATER
Model run year structure		
Existing Plant Characteristics		
Size, fuel(s), heat rate, emissions, etc		
Existing plant O&M costs		
Plant retirement or relicensing		
Treatment of distributed generation		
Transmission Characteristics		
Load projections		
Reserve Margins		
Existing air regulations		
Existing energy pricing or must run conditions		
Existing energy subsidies (PTC or others)		
Underlying market conditions (SMD, ISO load-response programs, etc)		
Energy Prices & Characteristics		
Coal (source, characteristics, and prices)		
Oil (characteristics and prices)		
Gas (prices and elasticity)		
Financing assumptions by technology		
Transmission upgrades & additions		
Location, size, timing		
Interconnection costs		
Plant Improvements		
Emissions controls (types and costs)		
Plant upgrades / uprates		
Re-powering or fuel switching		
New Build Characteristics (capital & O&M costs, capacity factors, interconnection, learning, & resource availability)		
Coal		
Oil		
Gas		
Nuclear		
Hydro		
Wind		
Landfill Gas		
Biomass		
Solar		
Fuel Cells		
Renewable Energy Constraints		
Long-term capital cost multipliers		
Short-term growth rate constraints		
Treatment of intermittent resources (wind & solar)		
Capacity credit for wind and solar		
Ancillary service costs for wind power		
Renewable energy facilities built to meet existing policies (e.g. state RPS and funds)		
Existing efficiency programs		
Demand response		
Curtailment / reduced elec. usage		
Price driven efficiency improvements		
Carbon offsets		
Characteristics (types, requirements)		
Price curve by type		
Allowances		
Auction v. allocation		
Fixed allocation versus output-based allocation		
Impact on new builds		
Impact on renewables		
Impact on efficiency programs		

Requested Model Results	
Base year - 2000 or 2001 (actual data is available)	
Annual data or every five years through 2025, if possible	
Results in as much detail as possible (output files)	
Generation by type. state, and region	
Capacity additions by type, state, and region	
Emissions (CO2, SO2, NOx, HG, Particulates, etc) by plant, type, state, and region	
Emissions (averages) allocated to states based on state demand	
Emission allowance prices	
Renewable energy certificate prices	
Renewable energy cost curves for 2004, 2010, and 2020	
Natural gas prices	
Electricity revenues by sector, state, and region	
Production costs by region and generation type	
Wholesale electricity prices by sector, state, and region	
Consumer electricity bills by sector, state, and region	
Leakage (imports and exports from the policy region)	
	Power / emissions flows
	New builds (coal) outside the region due to leakage
Identify and produce results to satisfy cost-benefit modeling needs (REMI)	

Preliminary Comments on Economic Cost-Benefit Modeling

We have attached a memo prepared by Synapse Energy Economics that discusses the use of the REMI model for cost-benefit analysis. It addresses the following questions:

1. Has there been previous REMI modeling of CO_2 regulations that our clients should become familiar with?
2. What's the best way to model the economic impacts of a CO2 cap in the Northeast with REMI? Things to make sure they include? Pitfalls to avoid?
3. What data needs to come out of the electric system modeling work to allow for good REMI modeling?

In addition, we wanted to raise some concerns about the way the modeling teams will address the allocation of allowances. The following are brief suggestions on the kinds of model runs and results it would be helpful to see.

Potential model runs to assess allowance allocation methods:

1. Free allocation of permits to power producers based on historical generation (looking at both input and output based allocation methods)
2. Auction of permits, with some assumption of how the money is then used
   a. Fully returned to the public on some basis, such as rebates (through the state, via utility bills, or other)
   b. General state funds/budget (used for: closing budget deficits, funding social programs that have been cut, funding energy efficiency and renewables programs, or other options)
3. Some combination of the two options above – for example 20% free allocation and 80% auction

It will also be important to look at socioeconomic impacts in terms of:

1. Gains/losses to generators of different types
2. Gains/losses to households at different levels of income and electricity consumption (possibly dividing population into quintiles or deciles)
3. Gains/losses to other businesses and institutional electricity customers

It would also be helpful to understand what portion of the total increase in electricity costs would be needed to compensate producers for increased compliance costs; and what portion of the price increase has the potential to raise profits under free allocation of permits, or could be available to mitigate the impacts of higher electricity prices on all electricity consumers.

In addition to consideration of the primary category of economic costs likely to result from RGGI implementation, i.e., energy price increases, RGGI policymakers should explicitly consider in their analysis other benefits of RGGI in addition to reductions in carbon emissions. These benefits include: improved ecosystem health, improved public health impacts, and reduced cost of SO_2 and NOx pollution programs (to the extent that these GHGs are reduced in tandem w/CO2). While many of these benefits are not traded in markets and are thus difficult to monetize, they can be identified and assessed qualitatively, and where possible, quantified. Economic analysis of RGGI would be incomplete without consideration of these co-benefits.

We look forward to continued discussion of the RGGI modeling process and assisting the modeling subgroups in any way we can. Feel free to contact us with any questions you may have on this material.

To: Geoff Keith, Marc Breslow, and other RGGI Clients

From: William Steinhurst

Date: April 1, 2004

Re: RGGI Socioeconomic Modeling

CC: Bruce Biewald

I have been asked to review the enclosed document and comment on it and three particular questions relating to modeling the socioeconomic impact of greenhouse gas (GHG) emission control scenarios. Those specific questions are:

1. Has there been previous REMI modeling of CO_2 regs that our clients should become familiar with?
2. What's the best way to model the economic impacts of a CO2 cap in the Northeast with REMI? Things to make sure they include? Pitfalls to avoid?
3. What data needs to come out of the electric system modeling work to allow for good REMI modeling?

I understand that these scenarios will be represented by electric system modeling with IPM to determine the resulting cost of power and that the REMI model will be used to estimate the macroeconomic and demographic consequences of those scenarios.

To begin with, it is worth noting that the REMI model is well suited to this purpose, because it has a very wide variety of options for representing the scenario concepts under consideration, including both changes in employment, expenditures, final and intermediate demands, fuel costs (although representing fuel cost changes in the residential sector is a bit tricky), and transfer payments. Depending on the number of sectors and geographic regions in the REMI model being used, location (state or county) specific and industry specific impacts may be represented. Unfortunately, I do not know what scenarios will are being considered and what version of the REMI model is available for use, so my comments here are necessarily somewhat general. With further information on these points, some conversation with those who will implement the REMI modeling, and perhaps with the vendor, I may be able to provide additional insight.

1. Studies of GHG scenarios with REMI

As for previous REMI modeling of CO_2 regulations, I know that the Vermont Department of Public Service conducted economic modeling of various energy policies, including some measures aimed at GHG reduction as part of its 1990s state energy plans. However, permit programs were not included; the measures were rather specific technology or tax policies.

Other GHG and air quality program analyses using REMI include:

- A West Virginia University study of the Kyoto Protocol and that state's economy
- Several studies of economic and demographic impacts of South Coast Air Quality Management District's Air Quality Management Plan
- Extensive use by U. S. EPA in studying economic impacts of policies (using a customized version of REMI)
- An academic study of the 1990 Clean Air Act on state economies
- An analysis of an emissions trading program on Los Angeles
- A study of voluntary programs and their impact the New Jersey economy

2. Best Approaches to Modeling GHG Scenarios with REMI

From the attached memo, it appears that the focus so far has been price effects and how they will flow through the regional economy. While it will be important to represent those price changes in REMI, that is not sufficient to accurately represent a scenario.

Each scenario, whether relying on permits or other policies, implicitly includes changes in the demand for final and intermediate inputs for electric generation and for each other sector in the economy. IPM will adjust in its dispatch of power plants the quantity and cost of each fuel, as well as the level of investment in power generation plant of various technologies and in various locations. Each of those investments will lead to a different geographic and technical patter of tax payments, O&M costs, employment, and so on. Those changes can probably be represented either in terms of changes in intermediate demand (in dollars) for the relevant goods and services in each region. These technological and geographic input trends are likely to be quite different from historical patterns of expenditure and investment due to the policy intervention itself, so simply shocking the price of power will cause the monetary flows to wind up in inappropriate locations.

Also very important is the possibility of scenarios that include policies that affect tax policy or promote efficiency, renewable generation or economic relief for consumers or selected industries. If, for example, permits are simply given away and competition for those permits sets prices for them that impacts electric power costs, it would be important to estimate and reflect in REMI the sectors of the economy that would garner that revenue and those that would bear the corresponding cost. If permits are sold, it is important to similarly reflect in the model the destination of those proceeds. If devoted to energy efficiency or new renewable generation, the resulting demand for specific goods and services should be represented. (Presumably, the reduced demand or increased supply form such programs would already have been reflected in IPM.) If they are devoted to tax relief or low income or industrial energy cost relief, that needs to be reflected, too.

I should also note that the likely geographic patter of changes in economic factor inputs and expenditures may be expected to be strongly dependent on geographic location. I would expect that considerable additional precision and plausibility would be obtained by using a REMI model with several subregions. REMI models may be configured with any number of regions, each made up of an arbitrary set of counties, states or both. If feasible, it could be worth considering a model with 8 or 9 regions. For example, one region for each state with Massachusetts divided into a metro-Boston region and a rest-of-state region and Connecticut divided into a southwest region and a rest of state region, should reasonably represent the geographic diversity of impacts on generation, price and investments in alternatives. Or a model that added to those regions a ninth region for New York State might help capture the economic impacts of extra-New England shifts in power purchases. Also, since electric energy intensity varies widely among sectors of the economy, a 53-sector REMI model should be considered. Additional sectors and regions add to the model's cost and the labor involved in running the model which must also be considered.

3. Data needed from IPM for REMI modeling

Most of the necessary data items are described generally above. However, specific data definitions would need to be defined in terms of the specific scenarios being represented. In general, the following would likely be needed for each year in the analysis and for each region in the model. Depending on the specific scenario, some items may not be needed.

a. Generation sector

   1. change in revenue due to sale of permits (if allocated)
   2. cost of permits purchased (over and above allocated permits if any)
   3. changes in fuel consumption by type (coal, gas, oil)
   4. changes in generating plant investment by technology
   5. changes in O&M cost and employment (job-year or wage bill)
   6. changes in tax payments (or change in net income)
   7. changes in imported or exported power, preferably by region affected

b. Commercial and Industrial sectors (by 2 digit SIC code if possible)

   1. change in price of electricity at retail

2. subsidies received, if any
3. change in demand for goods and services *as a vendor* due to energy efficiency programs OR change in employment for that reason
4. change in demand for electricity *as a consumer* due to energy efficiency programs
5. for sectors with significant fuel use, change in revenue due to sale of permits (if allocated)
6. for sectors with significant fuel use, cost of permits purchased (over and above allocated permits if any)

c. Residential sector

1. change in price of electricity at retail
2. subsidies received, if any
3. change in demand for electricity *as a consumer* due to energy efficiency programs

These suggestions are preliminary and generic because the relevant and most useful variables to use when representing a policy in REMI depend on the details of the program. Most economic shocks can be represented in several different ways in the model; the best way will depend on which can be most reasonably estimated from the available data.

It might worth mentioning a few words about the most appropriate indicators to use for summarizing the results of a REMI impact run. It is common to track gross state or regional product as a measure of impact on the economy. However, for policies specifically designed to reduce consumption without reducing amenity (e.g., demand side management programs), this is not a fully appropriate indicator. More appropriate would be employment and the construct of real disposable income *minus* expenditures on energy, either in aggregate or per capita.