# IPM Modeling of Electricity Sector Impacts of Regional Carbon Cap and Trade Program

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This paper was prepared by the RGGI Modeling Subgroup for discussion with the Stakeholders at the May 20 RGGI Stakeholder Group meeting in Boston. It includes 3 parts:

- Part A: Description of the IPM Modeling Process
- Part B: Proposal to Involve Stakeholders in the Modeling Process
- Part C: Some Key Questions for Stakeholder Group on Modeling the Benchmark (i.e. starting point) and Reference Policy Scenarios

There is also an appendix which describes the difference between sensitivity and scenario runs, and provides additional discussion on issues related to development of assumptions, the public review process, and treatment of proprietary information.

## Part A: Description of the IPM Modeling Process

The Contractor, ICF Consulting, Inc., shall perform the work described herein and provide the corresponding deliverables. The Contractor shall ensure that appropriate resources are allocated to the tasks specified herein so that the project deliverables are completed in accordance with the project schedule. It is recognized that completion of deliverables by the Contractor is dependent on the timely provision of scenario definitions, assumptions, and input data by the Regional Greenhouse Gas Initiative (RGGI) Staff Working Group and the RGGI Modeling Subgroup.

**Objectives:**

The objective of this project is to use the Integrated Planning Model (IPM), a proprietary model developed by ICF Consulting, Inc., to provide quantitative estimates of the impacts of a regional electricity sector carbon cap and trade program. The results will provide the quantitative foundation to support the Regional Greenhouse Gas Initiative (RGGI), a cooperative effort by northeastern and mid-Atlantic states to develop a specific proposal in the form of a Model Rule for a regional carbon cap and trade program for the electricity sector.

The impacts will be estimated by developing a Reference (or Baseline) Scenario which will show what the electricity sector is projected to look like without the proposed regional carbon policy, and comparing this to a series of scenarios that include a carbon cap and trade program in various forms under a range of assumptions and alternative designs. The potential impact of the carbon cap and trade policy will be estimated as the difference between the results of the Reference Scenario and the carbon cap and trade scenarios.

The results of the electricity sector modeling will also provide the primary input data for a separate macroeconomic model, which will be used to estimate the impact of a regional carbon cap on jobs, income, and gross state product.

**Project Scope–ICF General Tasks**

- Provide conceptual and technical guidance throughout process of developing definitions of scenarios and sensitivity runs, assumptions, and data input
- Perform model runs, compile, interpret, document, and present results
- Provide ad hoc spreadsheet analyses of impacts, by state and for the RGGI states as a group, on retail electricity rates and total electricity revenue
- Provide model assumptions and results to the RGGI Stakeholder Group for review and comment
- Make in-person presentations to the RGGI Staff Working Group and Stakeholder Group
- Prepare written draft and final reports, including full documentation of all results and complete model runs for all scenarios.

**Key Model Outputs** (to be provided for the RGGI region as a whole, for a region representing the rest of the U.S., and for each individual RGGI state)

- Carbon emissions
- Other Air Emissions
- Wholesale electricity prices
- Fuel use and diversity
- Imports and exports of electricity
- Compliance costs
- Cost and location of new resources
- Allowance trading costs

**Stages of Modeling–General**

The RGGI electricity sector modeling will be completed in the following four distinct stages.

1. Benchmark (i.e. starting point) and Reference Policy Scenarios (as defined below)
2. $CO_2$ Cap and Trade Level Scenarios
3. Policy, Structure, and Flexibility Scenarios
4. Model Rule Scenarios

## Description/Rationale for Each Stage of Modeling

Each stage may include multiple scenarios and sensitivity runs, as determined by the above steps, for variables such as higher gas prices, higher demand growth, technology cost and performance, transmission system changes, nuclear retirements, etc.

### *Stage 1 – Develop Benchmark and Reference Policy Scenarios*

The Benchmark Scenario will be the modeling starting point to show the electric system as it is projected to be without certain policies and/or regulations that may have been recently enacted or are believed to be imminent (*e.g.,* federal "3P", state Renewable Portfolio Standards (RPS), and SBC-funded energy efficiency and renewable energy programs in individual states). However, there may be considerable uncertainty about level of stringency, implementation schedules, funding levels, and/or effects on the electric system that could make for an uncertain and "mushy" baseline if we were to include them in it.

Some or all of these types of policies and/or regulations may therefore be included in the "Reference Policy Scenario" that is ultimately selected for the purpose of comparison to the various cap and trade policy scenarios to be developed later in Stages 2, 3 and 4. However, it is recognized that there is value in understanding the level of carbon emission reductions achieved through these regulations and programs and their relation to proposed cap levels, so it is important to estimate their impacts relative to the Benchmark Scenario separately and incrementally.

### *Stage 2 – $CO_2$ Cap and Trade Level Scenarios*

This stage will estimate the impact of specified levels of carbon caps, compared to a Reference Policy Scenario that is selected from Stage 1. These scenarios will model a straight carbon cap, such as X% below the 1990 level, with no flexibility or policy features (see Stage 3) added. This will enable us to understand the incremental impacts of such features or policies when they are added in Stage 3.

### *Stage 3 – Policy, Structure, and Flexibility Scenarios*

This stage will estimate the impact of features to be considered such as staged implementation, offset mechanisms, banking, safety valves, and alternative allocation or auction schemes. This stage will also estimate the impacts of combining a carbon cap and trade program with other policy actions, such as increased energy efficiency programs and an emissions portfolio standard.

### *Stage 4 – Model Rule Scenarios*

This stage will model the impacts of the proposed combination of carbon cap level, compliance schedule, flexibility features, and supporting policies that are expected to be written into the Model Rule. Multiple scenarios with sensitivities may be needed to indicate the range of impacts expected.

## Part B: Proposal to Involve Stakeholders in the Modeling Process

In each stage, the structure, rationale, assumptions, and input data for the scenario or group of scenarios will be developed by the RGGI Modeling Subgroup (comprised of designated members of the RGGI Staff Working Group), in consultation with ICF, with assistance by additional designated technical staff from each state, ISO staff, and other resources that may be consulted. RGGI Modeling Subgroup decisions about modeling and assumptions will be reviewed and approved by the RGGI Staff Working Group at critical points throughout the modeling process.

The general process steps below will be followed in each stage, to the extent practicable and within the constraints of financial resources, staff time, and the overall RGGI schedule:

1. Scenario definitions, data, and assumptions will be initially proposed by the RGGI Modeling Subgroup

2. Scenario definitions, data, and assumptions will be made available to stakeholders (at the level of detail that is judged by RGGI staff to be appropriate and practicable) for their review and comment. A Stakeholder Modeling Subgroup, consisting of members of the Stakeholder Group (or their designated technical staff), who have particular interest or expertise in modeling issues, will be formed. This Subgroup will have the opportunity to participate in discussion of modeling issues through conference calls with RGGI Modeling Subgroup at appropriate junctures.

3. Scenario assumptions, etc. will be modified, as deemed appropriate by the RGGI Modeling Subgroup and the RGGI Staff Working Group, prior to running of the model by ICF.

4. The model results from each stage will be made available to the entire Stakeholder Group prior to developing the scenario assumptions for the next stage.

5. ICF will rerun certain scenarios, or add scenarios or sensitivity runs, if deemed necessary and within budget and time constraints, prior to beginning the next stage, based on modifications requested by the RGGI Modeling Subgroup on behalf of the RGGI Staff Working Group and with input from stakeholders.

## Part C: Some Key Questions for Stakeholder Group on Modeling the Benchmark (i.e. starting point) and Reference Policy Scenarios

The benchmark and reference policy cases will serve as the baseline for the carbon cap and trade modeling. Numerous assumptions are to be made to formulate the benchmark and reference policy cases. At this juncture, the RGGI SWG seeks feedback on the following:

1. What demand forecasts should be used (e.g. EIA forecasts)?

2. What fuel price forecasts should be used ?

3. How should we deal with fact that some states' RPSs are final and in place (e.g., MA and CT), others are not final but likely imminent (e.g. NY), and other states are seriously considering adopting or modifying (e.g. RI and ME).

4. How should potential federal 3P legislation be treated?

5. What criteria should be used for including expected/planned new generation capacity (or other changes such as plant retirements) in these scenarios?

6. What transmission assumptions should be in the benchmark case?

## Appendix 1:
## *Scenario v. Sensitivity Runs*

In discussing the amount of effort required to analyze a model run, ICF generally distinguishes between *scenarios* and *sensitivity runs*. The differentiation between the two types of model runs depends largely on the variables being examined (*e.g.*, air regulations, technologies) and on the role the runs will play in the analysis. If runs differ in more than one respect (*e.g.,* by carbon regulation and gas price), the runs will be referred to as different *scenarios*. If, on the other hand, runs differ by only one parameter, such as gas price, the second run would be referred to as a *gas price sensitivity run* of the original *scenario*. An exception to this guideline might be several runs in which only the stringency of a particular air regulation (*e.g.,* a carbon cap) is changed. Even though only one variable is changed among the runs, it is likely that one or all of those runs will have further items changed in a later stage of the analysis and so they are referred to as *scenarios*. In other words, a run will be referred to as a *scenario* if it is likely to have *sensitivity runs* based on it. Generally, *sensitivity runs* are not based on other *sensitivity runs*.

A *scenario* generally refers to a specific view of the world, including specific air regulations facing the electric sector, the rate of technological advancement in new capacity and expectations of fuel markets. Changing specifications as air regulatory policies (*e.g.,* adding a new regulation) or technology assumptions (*e.g.,* making a new nuclear technology available to the market) will result in a change in that view and will therefore be new *scenarios*. Altering the expected gas price trajectory or limiting the penetration of a specific technology in the market, on the other hand, would likely be referred to as a *sensitivity run* to the original scenario.

In terms of effort and budget required to perform runs, scenarios generally require more effort and therefore cost more than sensitivity cases to run and analyze.

### ***Assumptions, ICF Public Review Process, and ICF Proprietary Information***

A significant amount of data is required to run an IPM® analysis. Most of that data will be made available for review (and possible modification) to the RGGI Modeling Subgroup and the Stakeholder Group. However, some data items as well as the IPM® modeling platform remain proprietary to ICF.

At the beginning of an IPM® project, ICF will provide NYSERDA and the RGGI Modeling Subgroup an Assumptions Document that details assumptions, and sometimes multiple alternatives for assumptions (*e.g.,* EIA and EPA data sets), that are likely to be critical to the outcome of the analysis. The NYSERDA Project Manager, the RGGI Modeling Subgroup, and the RGGI Staff Working Group will be asked to comment on and/or change those

assumptions prior to the start of modeling. Once they have been finalized, those assumptions are adopted by the client. The assumptions and the results of the study then become the responsibility of NYSERDA, the RGGI Modeling Subgroup, and the RGGI Staff Working Group. Those assumptions remain unchanged (*i.e.,* are "locked down") throughout the study except as specifically changed for an alternative *scenario* or *sensitivity run*. An Assumptions Document generally includes the following types of assumptions:

Model Structure and Market Assumptions

- Run years, or the years for which results will be provided
- Regional scope to be modeled in IPM® (*i.e.,* number and name/location of IPM® regions) and for each IPM® region being modeled:
  - Peak and load requirement forecast
  - Reserve margin requirement
- Transmission costs and capabilities among IPM® regions, including firmly planned expansion to existing capability
- Henry Hub natural gas price trajectory
- Natural gas seasonality and transportation adders
- Delivered oil, coal and other fuel prices to specific regions

Technology Assumptions

- Characteristics of new generating capacity and related items, including:
  - Capital, fixed and variable operating costs
  - Maximum annual capacity factor
  - Emission rates
  - Financing costs

- For renewable units specifically:
  - Operating subsidies (*e.g.,* Production Tax Credit)
  - Resource constraints
- Firmly planned capacity additions and pollution control installations
- Characteristics of pollution control and/or plant retrofits (*e.g.,* repowering or capacity uprates)
  - Capital, fixed and variable operating costs
  - Financing costs
  - Environmental performance (emission reduction factors, including co-benefits)

Policy Assumptions

- Current and proposed air regulations, including state, regional and national
- Current and proposed state and regional renewable portfolio standard (RPS) requirements

Depending on the analysis, other assumptions may also be provided or developed with the project participants in the assumptions development phase of the project, including energy efficiency options, demand response, and carbon offset potential.

Because IPM® models all generating units in the U.S. and Canada, cost and performance data for those units are maintained in the IPM® database. While unit-level data for IPM® is derived from public sources such as EIA and FERC, ICF does not generally provide unit-level assumptions from the IPM® database for broader public review. A significant amount of effort is required to pull unit-level information from the database and present it in a manner that would be suitable for review. Additionally, ICF has expended significant resources gathering and processing available data to arrive at the unit-level information stored in the IPM® database.

ICF can, however, provide the data for a specific set of units for review by the client or, at the RGGI Staff Working Group's discretion, specific associated parties. However, as stated above, providing and altering unit-level data is very time consuming and, given a limited project time and budget, would have to be done at the expense of other project items/analyses.

Some assumptions used for IPM® analyses are considered proprietary to ICF and cannot be released for review by the client. Coal supply curves, for example, used by IPM® to reflect the sensitivity of coal markets to changes in coal demand, have been developed internally by ICF and cannot be provided for review. Similarly, the specific algorithms that make up IPM® itself are considered proprietary and cannot be released for public review.