Energy Efficiency's Role in a Carbon Cap-and-Trade System: Modeling Results from the Regional Greenhouse Gas Initiative

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Executive Summary

Background

This report summarizes the results of a ground-breaking effort to calculate the regional effects of increased energy efficiency investment in a carbon cap-and-trade policy framework. While it is generally accepted that energy efficiency reduces carbon emissions and can cut the cost of a carbon-reduction policy, there has been little quantitative analysis of specific levels of efficiency investment in a defined carbon policy context. Some climate policy analyses have projected negative economic impacts from carbon caps; however, they have generally not addressed energy efficiency explicitly as a resource in achieving climate goals. The analysis covered in this report is thus an important advance in the climate policy sphere: it is the most specific study yet conducted of energy efficiency's impacts on such important factors as allowance prices, energy prices, and economic growth.

This report focuses on the Regional Greenhouse Gas Initiative (RGGI), a nine-state effort to develop a regional carbon cap-and-trade system. At the invitation of New York Governor Pataki in 2003, the governors of Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New Jersey, and Delaware committed to developing a model carbon cap-and-trade rule for the region's power sector by 2005. A state agency working group, a stakeholder group, and other mechanisms were set up to develop the model rule. As a core part of the rule's development, the working group conducted extensive modeling of the regional power sector using ICF Consulting's *Integrated Planning Model* (IPM) linear programming model plus Regional Economic Models, Inc.'s (REMI) *20/20 Insight*™ regional economic model to assess RGGI's potential impacts. Part of the IPM and REMI modeling effort was dedicated to simulating the impact of accelerated energy efficiency deployment scenarios.

Methodology

The RGGI staff working group invited ACEEE to develop energy efficiency resource data as input for the IPM efficiency runs. ACEEE used a 2003 study of electric efficiency potential developed for the New York State Energy Research and Development Authority (NYSERDA) as the basis for this analysis. (ACEEE was a member of the analysis team that conducted the NYSERDA analysis.) This study provides a detailed assessment of the potential for electric end-use efficiency at a high level of sectoral disaggregation. These sectoral potential assessments were then benchmarked against sectoral electric consumption data from other RGGI states, and ACEEE characterized a set of efficiency resources in a format and at a level of aggregation suitable for use in the IPM.

The energy efficiency data showed significant economic potential, in the range of 20–30% of the reference forecast electricity demand. Of course, such savings cannot be achieved instantaneously; they must be realized over a period of years, at a rate constrained by such factors as public investment, market cycles, and delivery infrastructure. To test the effects of different levels of energy efficiency investment in the region, the IPM model was constrained in two ways: (1) assuming current levels of public spending on efficiency, and (2) assuming doubled public spending.

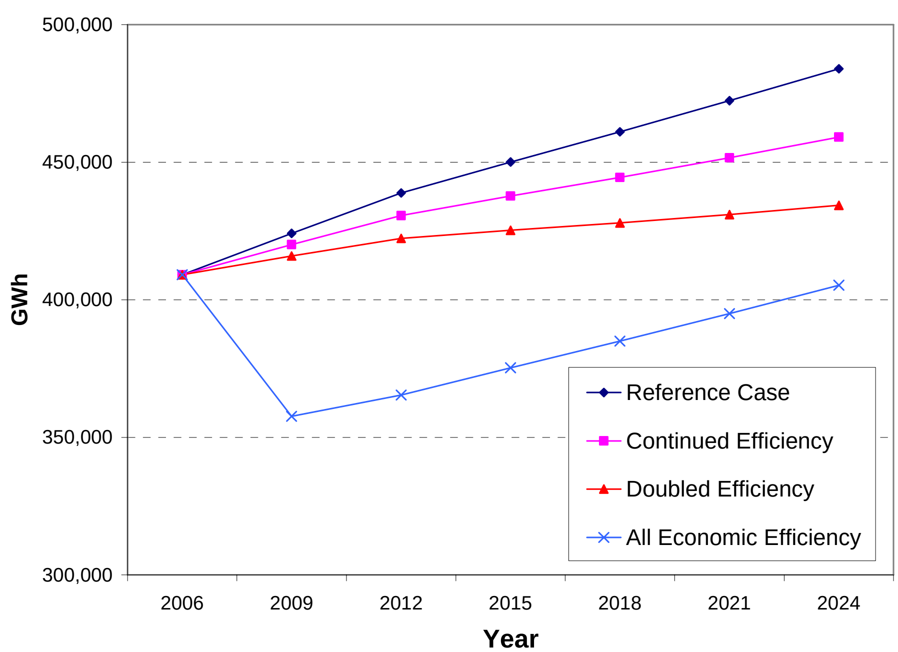
IPM selected energy efficiency as a resource among other available electricity resources, such as various types of fossil fuel, nuclear, and renewable generation technologies. As a linear programming optimization model, IPM selects the economically optimal mix of resources for each year in the study period. Based on the selected resource mix and a set of other assumptions and constraints, IPM projects total electricity capacity and generation, electricity prices, carbon emissions, carbon allowance prices, and regional power imports, among other factors.

Results

IPM's outputs showed that doubling the current level of energy efficiency spending in the RGGI region would have several very favorable effects on the carbon cap-and-trade system. It would reduce electricity load growth, future electricity prices, carbon emissions, carbon emission prices, and total energy bills for electricity customers of all types.

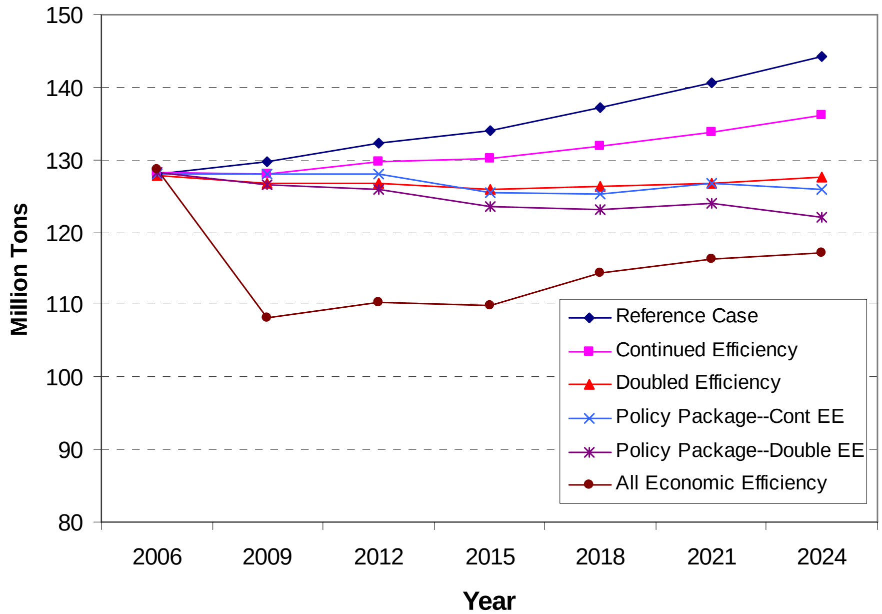
- **Electricity load growth—**Figure ES-1, which compares the reference case to cases with increased efficiency investment, shows that doubling efficiency would cut load growth by about two-thirds in 2024, from about 20% to about 6% above 2006 levels.

Figure ES-1. Electricity Generation



- **Generation capacity additions—**the doubled-efficiency scenario would reduce 2024 capacity additions by about 8,000 MW, or about 25% of the reference case forecast for new capacity.
- **Carbon emissions—**Figure ES-2, also comparing the reference case to increased-efficiency scenarios, shows that the efficiency scenario would keep carbon emissions virtually flat through 2024, compared to about 15% growth in the reference case.

Figure ES-2. CO_2 Emissions

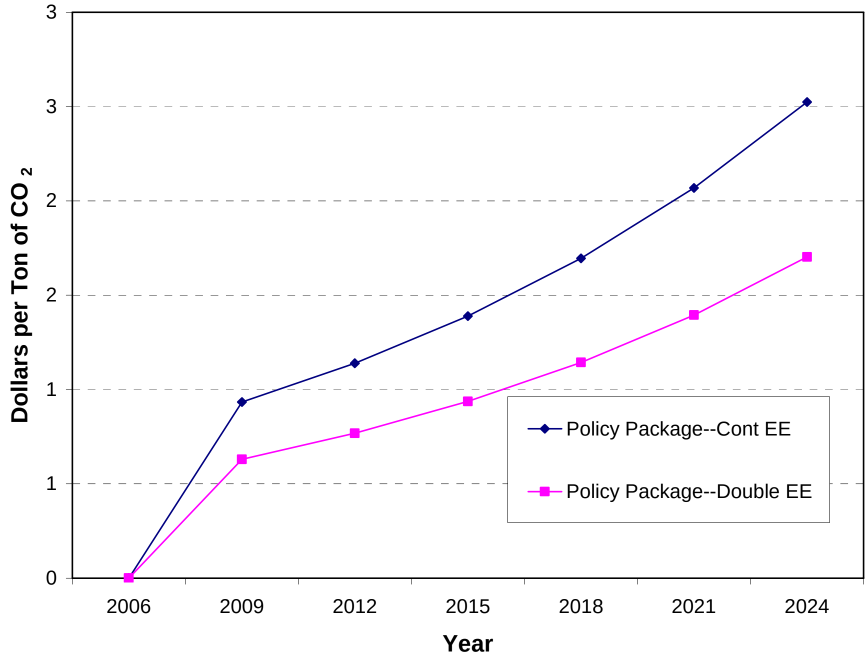


- **Energy prices—**doubling efficiency would reduce energy price growth to almost nothing; no significant prices impacts would occur until after 2020, when they would have less than a 1% impact on wholesale power market prices.
- **Carbon allowance prices—**Figure ES-3, which compares the RGGI policy scenario to one in which energy efficiency results are doubled, shows that allowance prices would also be substantially lower with increased energy efficiency investment, falling by about one-third to around $2/ton in 2024.
- **Power imports or "leakage"—**The IPM modeling process indicates that increased efficiency investment would substantially reduce power imports to levels lower than the reference case. While many factors affect leakage, efficiency can help reduce it, allaying one of the biggest concerns about RGGI, which was that the program might result in increased emissions from plants selling power into the region. Because of complexities related to the modeling process, we do not present quantitative data on leakage in this report, but nonetheless find enough indications from the modeling data to suggest that efficiency should be viewed as part of a leakage-reduction policy package.

The regional economic impacts, as projected by the REMI input-output model, also would show positive impacts from increased efficiency investment:

- **Consumer energy savings—**Analysis of energy savings from the IPM modeling results showed that under the doubled-efficiency scenario, 2021 household electricity bills would be an average of $109 lower than under the reference case.
- **Economic output—**Doubling efficiency would increase regional economic growth from almost no effect to 0.6% positive in 2021, relative to the reference case.

Figure ES-3. Carbon Allowance Prices



- **Personal income—**The doubled-efficiency scenario would increase personal income by almost 1% in 2021.
- **Employment—**The increased efficiency future would increase private-sector job growth by 0.8% in 2021.

Policy Implications

The RGGI modeling results show that an increased investment in energy efficiency results in the most positive set of economic impacts for the region. This puts a new premium on the value of stepping up public commitments to efficiency in the RGGI states. With strong efficiency programs and policies in place, the region could enhance economic growth while cutting carbon emissions. This is good news for consumers and policymakers. The question that logically follows is: How can the RGGI states realize these benefits?

It is often assumed that cap-and-trade systems will create emission-reduction markets that will naturally select the most cost-effective resource available to meet emission-reduction targets at least cost. However, energy efficiency, at least in the electric power sector, cannot participate directly as an emission-reduction measure in emissions trading markets. Because it is an "indirect" kind of emission-reduction measure, occurring not at the generation level but at customer facilities, there is no assurance that any marginal change in energy use will result in net emission reductions at the generation level for a given compliance period. The cap is on emissions and not on energy use, so if energy use is lower than expected, generators can adjust run times for various plants to marginally increase emissions up to the limits determined by emission allowances. For this reason, emissions traders have shied away from trading efficiency-based allowances or credits.

To overcome this inherent barrier to energy efficiency, policymakers must either: (1) carve out allowances from the cap specifically for efficiency-based emission reductions; or (2) pursue vigorous efficiency policies in parallel with the cap that will reduce the cost of meeting the carbon emissions targets. In the RGGI working group and stakeholder discussions, two major options have been discussed:

1. **A public-benefits allowance allocation**, in which a large fraction of carbon allowances would be allocated at the start of the program to public entities, which would then sell the allowances and use the proceeds to invest in public goods like energy efficiency. The RGGI Memorandum of Understanding (MOU) and draft Model Rule set a minimum public-benefits allocation of 25%. Some states are considering public-benefit allocations up to 100%.
2. **A parallel commitment to achieving energy savings targets in the power sector**. Almost all of the RGGI states have some kind of public spending program for efficiency, known generically as public benefits programs. However, these programs' impacts are driven primarily by limitations on spending levels, rather than by savings targets. Some states, including Connecticut and New Jersey, are developing quantitative targets as well as funding mechanisms. Known generically as Energy Efficiency Resource Standards (EERS), these mechanisms can be both simple and powerful ways to achieve desired results from efficiency programs.

The first option has the advantage of creating a defined pool of allowances, with monetary value, the proceeds from which can be used to increase energy efficiency investment. However, allowance prices are projected to be relatively low, in the range of $1–2/ton in most policy scenarios. Even if efficiency received all of the value of a 25% public benefit allocation, that would only create additional funding in the range of $50–185 million/year. Current spending in the region is about $600 million; so the direct allocation option seems unlikely to provide enough added funding to double efficiency resource results. States that allocate a higher fraction of allowances to public benefits would be able to spend more.

The second option may be more effective in achieving the doubled efficiency results that the model shows to be desirable. States have already tested the approach of setting energy savings targets, and state program experience shows that aggressive efficiency programs can cut historic electricity demand growth by at least half. However, setting these more ambitious targets would involve policy action outside the RGGI regulatory structure. Moreover, funding this significant new investment could be challenging, be it through expanded public benefits funding or other mechanisms such as EERS, building energy codes, or appliance/equipment standards. Some of RGGI states have already moved forward on some of these policies and can serve as models for other states.

ACEEE recommends that the RGGI states pursue both options: use public benefits allowance allocation funds to invest in added energy efficiency resources, while also setting EERS targets and other policies to guide all power-sector efficiency programs toward the economically optimal goal.

Introduction

Background

Energy efficiency is frequently acknowledged to be an important resource for reducing emissions of air pollutants and greenhouse gases (Vine 2003; Brown et al. 2001; Hanson and Laitner 2004). From federal and state regulatory approaches such as acid rain and smog reduction policies to voluntary programs such as the federal ENERGY STAR® program, energy efficiency's pollution prevention value has been widely accepted. For example, the New York Energy $mart^{SM} efficiency programs have documented emission reductions of 950 tons of nitrogen oxides (NOx), 1,700 tons of sulfur dioxide (SO_2), and 750,000 tons of carbon dioxide (CO_2) annually as of 2003 (Prindle 2005).

Despite the documented potential for energy efficiency investments to provide a significant reduction in energy-related air pollution and greenhouse gas emissions, it has proven difficult to implement programs that promote clean air and climate protection environmental goals. While states like New York and New Jersey, and some New England states have achieved significant emission reductions from energy efficiency policies and programs, securing adequate treatment of efficiency as a Clean Air Act compliance measure has been problematic, and gaining recognition of the market value of efficiency-driven emission reductions has been even more challenging. Because of fundamental market barriers and also design issues associated with cap-and-trade systems, efficiency's value is not inherently captured in such policies.

The Regional Greenhouse Gas Initiative (RGGI)

In 2003, nine Northeastern governors launched RGGI as the first attempt in the United States to establish a carbon cap-and-trade system. The RGGI effort followed on earlier efforts such as the New England Governors/Eastern Canadian Premiers 2001 Climate Action Plan, as well as the climate change policies of several of the RGGI states (the RGGI states are Connecticut, Delaware, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont). RGGI's development process is managed by a State Working Group (SWG) composed of representatives of energy and environmental agencies from the nine states (RGGI 2004). The process also includes a stakeholder group of interested and affected parties, including generators, public interest groups, customer groups, industry associations, and others. The state working group operates through subgroups, focusing on various issues such as modeling, greenhouse gas registry, offsets, and other issues. Subgroups of stakeholders participate in these subgroups as well.[1]

The RGGI SWG and stakeholders have conducted extensive analyses and discussions of the key issues in designing a carbon cap-and-trade system for the region's electric power sector. Chief among these issues are:

- **Setting the cap level**—The overall emissions budget in the MOU was negotiated based on a number of factors, but the basic goal was stabilization at current emission levels and

[1] More information on RGGI, including all of the documents and presentations developed for RGGI meetings, are available at www.rggi.org.

then a reduction to 10% below current levels. The 9-state RGGI budget in the MOU was approximately equivalent to 1990 emissions.

- **Limiting "leakage"—**Leakage means increased emissions outside the RGGI region, induced by the RGGI carbon cap. If the cap raises power prices in the RGGI region, outside generators may export more power into the region, increasing their emissions. However, the regional power markets are very dynamic (RGGI spans three interconnected power markets operated by separate transmission organizations), and RGGI adds only one modest variable to the mix. Other factors, including fuel price dynamics, transmission issues, and plant locations are likely to play much larger roles in power flow dynamics in the RGGI region.
- **Emission allowance allocation—**Because allowances carry financial value, there is great interest in how and to whom they are allocated. In the past, generators have typically received allowances for free, on a fuel-input basis that remains fixed over time. However, because awarding allowances on an energy-output, updating basis can encourage higher-efficiency generation, the RGGI process considered this issue carefully. Also, since RGGI is the first cap-and-trade system to be designed in a fully competitive wholesale power market context, analysis showed that many generators could receive financial windfalls from a carbon-cap program. This encouraged the SWG to allocate a minimum of 25% of allowances for public-purpose uses, including energy efficiency.
- **Defining "offsets"—**Offsets are greenhouse gas emission reductions, or greenhouse gas "sinks," from sources outside the capped emission sources. Offsets give generators flexibility in meeting the cap in the least expensive way. Increasing carbon sequestration through forestry and agriculture, reducing energy use in non-electric end-uses, and reducing methane emissions from landfills are examples of offsets considered for the RGGI programs. Specific offsets will be finally determined by individual states. Challenges in the process of defining allowable offsets include: "additionality," or ensuring that an offset will produce new emission reductions that would not otherwise have occurred; measurement and verification to ensure that estimated reductions are actually realized; and persistence, or assurance that emission reductions will last for the duration of the period for which they are credited.

Making these key decisions called for extensive computer modeling of the region's power sector. The modeling process, and energy efficiency's role in it, is discussed below.

Modeling Energy Efficiency in RGGI

The modeling subgroup was one of the most active in the first phase of RGGI activity. The modeling work used ICF Consulting's Integrated Planning Model (IPM)[2] (ICF 2006). IPM is an

[2] IPM provides integration of wholesale power, system reliability, environmental constraints, fuel choice, transmission, capacity expansion, and all key operational elements of generators on the power grid in a linear optimization framework. The model utilizes a Windows™-based database platform and interface that captures a detailed representation of every electric boiler and generator in the power market being modeled.

The fundamental logic behind the model determines the least-cost means of meeting electric generation energy and capacity requirements while complying with specified constraints, including air pollution regulations, transmission constraints, and plant-specific operational constraints. The versatility of IPM allows users to specify which constraints to exercise and populate IPM with their own datasets. Versions of IPM have been used to support the electric power generation model that characterizes the acquisition, operation, and retirement of resources to meet market demand for electric power. This model is used nationally by EPA for many of its air quality policy analyses, and is also widely used by states in their air quality and climate policy analysis, and utilities and utility regulators as a utility generation planning tool. IPM is a linear programming model designed to identify a least-cost mix of power generation resources, given basic inputs such as electricity demand, fuel prices, resource capital costs, emission constraints, and other factors.

IPM is comprised of several modules that reflect different elements of the electric power marketplace: a resource stock module that compiles available generation resources; a resource acquisition module that procures new generation assets to meet future market demands for power; and a dispatch module that selects which generation assets are operated to meet demand. IPM characterizes demand-side management (DSM) efforts as a static decrement on electric power demand, so is not capable of dynamically responding to changes in prices or allowing for energy efficiency resources to compete with generation on an economic basis.

The RGGI working group decided to include energy efficiency resources in its policy analysis scenarios using the RGGI model. ACEEE was invited to develop the necessary input data on energy efficiency resource potential for the RGGI region and to work with ICF to incorporate this potential into IPM. With support from the Energy Foundation, we developed a strategy to dynamically model energy efficiency in IPM and compile data in a format suitable for incorporation into IPM. Since the DSM module does not dynamically model energy efficiency, we proposed using the resource acquisition module as the vehicle to consider energy efficiency. Energy efficiency resources would be considered as an alternative to conventional generation technologies and would compete on a cost basis to meet future generation demands. This approach can be envisioned as a series of "virtual energy efficiency power plants" that compete with new natural gas and coal power plants to serve future load.

Our challenge was to characterize these energy efficiency resources. The primary data source we used was a 2003 efficiency potential study conducted for NYSERDA (NYSERDA 2003). The NYSERDA analysis was the most complete and detailed study available in the region and thus provided the fullest basis for this analysis. ACEEE was part of the analytical team for that study and so was able to straightforwardly manipulate the data sets into formats compatible with IPM input. We also checked the NYSERDA data against other potential studies conducted in the RGGI region in states like Connecticut, Massachusetts, and Vermont (NEEP 2004; ECMB 2004). We found that the potential data were very consistent across the various states, and thus felt confident in extending the NYSERDA data characterizations across the region. Studies from non-RGGI states provide comparable evidence for similar magnitudes of efficiency potential (Nadel, Shipley, and Elliott 2004; Laitner 2005).

Using the NYSERDA data sets, we characterized efficiency potential data for the residential, commercial, and industrial sectors in the form of generation resources. Because IPM calls for resource availability in peak and off-peak periods, we subdivided the residential and commercial resources into peak and off-peak categories. Each sector's potential was based on quantified

U.S. Environmental Protection Agency's (EPA) analyses of utility air emissions and the recent Federal Energy Regulatory Commission's (FERC) benefit-cost analysis of Regional Transmission Organizations (RTO).

savings from a wide range of efficiency technologies, including both economically viable technologies that are commercially available now and emerging technologies considered likely to be commercialized within the 20-year study horizon.

Defining Efficiency Potential

It is important to understand the multiple meanings that can be assigned to the general term "energy efficiency potential." Three types of potential calculations are generally accepted: technical, economic, and achievable potential.

Technical potential is based on engineering and technology assessment; for a given end-use, such as residential lighting or commercial air conditioning, it typically determines the differential between the average efficiency of equipment currently in place and the highest-efficiency equipment that is currently available. For future years, a projection is typically made for best-available efficiency in those years. Calculating technical potential then becomes a matter of determining the energy savings that would occur if best-available equipment instantaneously replaced all the existing equipment in the affected end-uses and applications. Market-based assessments usually come into play to estimate the total stock of equipment in place and the total volume of sales in the years involved in the study.

Economic potential is typically derived as a subset of technical potential. It is based on the calculation of the monetized costs and benefits of a given efficiency measure type, typically expressed on a Total Resource Cost (TRC) basis. TRC is the most commonly used economic cost-effectiveness test among state and utility program analysts. In simple terms, TRC compares the net present value (NPV) of the total costs and benefits of a given measure type or efficiency program. TRC analyses can express results in terms of net benefits, NPV of benefits minus NPV of costs, or a benefit-cost ratio (BCR), which is NPV benefits divided by NPV costs. In general economic analyses, the cost-effectiveness of efficiency measures and programs is determined simply by whether the measure/program produces positive net benefits, or whether its BCR is one or greater (CPUC 2001).

A third way of expressing TRC results is in terms of the levelized cost per saved unit of energy over the life of the measure, or cost of saved energy (CSE). CSE is often used in utility-sector program analysis, because it provides a convenient way to compare the cost of efficiency to the cost of supply-side resources. In the electricity sector, supply costs are expressed in cents per kilowatt-hour (kWh); CSE analysis for efficiency potential is accordingly expressed in the same terms. For the IPM model, we initially provided the efficiency potential data in CSE terms, because the model is designed to select resources on an average cost per kWh basis.

The final category of economic potential is **achievable potential**. Achievable potential is defined as the amount of efficiency resource that can be delivered in a given time period, given realistic assumptions about markets, program funding, and other constraints. While defining achievable potential is the least precise of the three types of potential analysis, it is important to conduct because failing to do so could produce unrealistic modeling results that could damage the credibility of this kind of analysis and of the perception of energy efficiency's deliverable resource potential. An economic potential study might, for example, show that 20–30% of the energy currently consumed in a given end-use could be saved through cost-effective measures. If the CSE of such a resource block is low enough, a model like IPM would select it all and "build" that much efficiency in as little as a single year. However, most observers would reject such a result, because it would be unrealistic to expect to retrofit or replace 100% of the energy-using equipment in a given end-use in such a short timeframe.

Achievable potential can be defined using both a technical and a temporal basis. Market experience has shown that markets, because of their various imperfections and barriers, and because of technical, legal, or other limitations in various buildings and other infrastructure, never realize 100% of the potential technology improvements identified in studies, regardless of timeframe (Brown 2001). And, even assuming optimum market response, there are limits on how much activity can be conducted in a given time period. For example, assume that a potential study shows that in a one-million-household market, the average household could accommodate six compact fluorescent light bulbs (CFLs). It would not be realistic to project that six million CFLs could be forced through such a modest-sized market in a single year. In such a case, program evaluation data and other market analyses would typically be used to establish a more realistic achievable potential estimate.

For the purposes of the RGGI IPM modeling analysis, our task was to develop aggregated estimates of the achievable levels of energy efficiency resources in major end-use sectors. We developed bins of "saved kWh" resources, with costs assigned to each bin. We also recommended methods for estimating resource deployment limits on an annual basis. The details of the data input structure are discussed below.

In the RGGI analysis, we reviewed potential studies conducted by states and utilities around the U.S.; these studies examined technical, economic, and achievable potential in various combinations (Nadel, Shipley, and Elliott 2004). Based on the data produced in these studies, we found that the average ratio of achievable to economic potential was about 0.67. That is, on average about two-thirds of the economic potential was deemed to be achievable. We used this number as a guideline by which to estimate achievable potential and thus calculated 67% of the economic potential as an estimate of achievable potential.

Constraining Efficiency Potential Within IPM

Applying these constructs to the RGGI IPM modeling process, it became apparent that while we had developed robust estimates of economic potential, it would also be necessary to constrain this potential within the model for each model run year, to establish a reasonable modeling proxy for achievable potential. Because energy efficiency resources are significantly cheaper than almost all conventional generation resources, IPM would chose all available energy efficiency. To address this issue, IPM allows the amount of any resource available in a year to be limited. To use this feature, however, it was necessary to define reasonable limits for a maximum amount of energy efficiency that could be acquired in a given model run year. To inform this decision process, we identified three ways to constrain the efficiency resource data within the model:

- **Straight-line diffusion.** This uses a very simplified version of a market diffusion model. It involves dividing the resource potential by the number of years in the study period and assuming that that fraction of the total resource potential is the maximum that would be achievable in a given year. For example, if the total potential is 100 million kWh, and the study period is 20 years, the assumption would be than no more than 5 million kWh is achievable in any given model year.

- **Percent of load growth.** Data is available (from states that have been aggressively pursuing energy efficiency over several years) on the net effect of these programs on total growth in electricity sales. This makes it possible to constrain the IPM data sets in terms of total impact on load growth. For example, if the reference case shows an average load growth of 1% per year, the model could constrain efficiency resources to reduce load growth by no more than 0.5% or 1% per year. Leading states are showing efficiency program impacts in that range.
- **Available funding.** The third constraint approach is to assume a maximum annual funding level available for efficiency programs and to then apply an average cost per first-year saved kWh to estimate the level of efficiency resource that could be "bought" by the assumed level of program funding. For example, if the maximum available funding is assumed to be $1 billion per year, and the average program cost per first-year saved kWh is 10 cents, the achievable potential would be capped at 10 billion kWh for that year.

ACEEE recommended that the RGGI working group use two methods to constrain IPM's ability to deploy efficiency resources: the diffusion approach and the available funding approach. After a series of consultations among working group members and stakeholders, the modeling subgroup staff decided to focus on available funding as the operant constraint. The details of this process are explained below.

Characterizing the IPM Efficiency Inputs

The NYSERDA study characterized the performance of individual efficiency technologies or grouped sets of technologies in detail. Because of the limitations of IPM, we had to significantly aggregate this data to fit within the model's calculation constraints. Thus, from hundreds of measure combinations, we developed a total of 15 "bins" of efficiency potential data. These were defined as residential peak, residential off-peak, commercial peak, commercial off-peak, and industrial, with three cost tiers within each end-use bin. So, for example, the model was able to select from low, medium, and high-cost resource bins in each of the five end-use categories. While this aggregation limited the "granularity" of the data, it was the maximum number of variables the model could handle, given that the resources also had to be allocated to 12 sub-regions within the RGGI region, and that the model calculates 6 run years. In total, the IPM model considered 1,080 combinations of energy efficiency potential data in this analysis (15 bins x 12 sub-regions x 6 years = 1,080 combinations).

The structure of the input data set is summarized in Table 1.

Table 1. Energy Efficiency Resource "Bins" for IPM Input

Customer Sector	Time Period	
	Peak	Off-Peak
Residential	High cost	High cost
	Medium cost	Medium cost
	Low cost	Low cost
Commercial	High cost	High cost
	Medium cost	Medium cost
	Low cost	Low cost
Industrial	High cost	High cost
	Medium cost	Medium cost
	Low cost	Low cost

IPM employs these data sets in its resource development module, which is its core operations center for selecting an optimal set of resources for a given model run year, based on the demand forecast and a set of assumptions about resource costs, fuel prices, financial parameters, and other factors. In the RGGI process, as with most analyses of this kind, IPM's operators first run a reference case. They then run a series of policy scenarios, based on various policy assumptions, and also run a number of sensitivity cases, based on alternative assumptions about key variables such as fuel prices.

Within this overall framework, it is instructive to view the energy efficiency potential data in relation to the reference case. Table 2 summarizes the IPM reference case demand forecast and the economic potential ACEEE developed for use as IPM inputs.

In Table 2, one can see that the economic potential ranges from 27% to 31% of the electric sales in the reference case forecast. These numbers are consistent with other recent assessments of efficiency potential (Nadel, Shipley, and Elliott 2004). One can also see that the total growth in electricity sales over the study period is 21%, with an average annual growth rate of just under 1%. Assuming that the economic potential study was to be constrained on a straight-line diffusion basis, i.e., about 5% per year, it would be possible to keep electricity sales virtually flat over the study period.

It is important to remember, however, that the model will select resource bins sequentially, taking the lowest-cost resources first. In some cases, it may not select the highest-cost bins of efficiency resources. So the table below serves only to define an upper boundary for the analysis.

Table 2. Total RGGI Regional Economic Efficiency Potential (GWh)

Year	Residential	Commercial	Industrial	Total	Sales (GWH)	% of Sales
2005	26,355	59,336	17,872	103,563	395,984	26.2%
2006	28,288	61,643	18,094	108,026	401,619	26.9%
2007	30,241	63,938	18,302	112,481	406,931	27.6%
2008	32,223	66,200	18,332	116,755	411,985	28.3%
2009	34,173	68,334	18,318	120,825	416,131	29.0%
2010	36,230	70,644	18,340	125,214	421,157	29.7%
2011	38,321	72,962	18,354	129,637	426,080	30.4%
2012	40,399	75,184	18,338	133,921	430,338	31.1%
2013	41,231	75,736	18,039	135,006	434,548	31.1%
2014	41,973	76,095	17,697	135,765	437,755	31.0%
2015	42,745	76,492	17,360	136,598	441,202	31.0%
2016	43,528	76,893	17,016	137,437	444,684	30.9%
2017	44,322	77,296	16,667	138,285	448,201	30.9%
2018	45,126	77,702	16,313	139,141	451,755	30.8%
2019	45,942	78,111	15,952	140,004	455,344	30.7%
2020	46,769	78,522	15,585	140,876	458,971	30.7%
2021	47,607	78,937	15,213	141,756	462,634	30.6%
2022	48,456	79,354	14,834	142,644	466,335	30.6%
2023	49,317	79,774	14,449	143,541	470,074	30.5%
2024	50,191	80,198	14,057	144,445	473,852	30.5%
2025	51,076	80,624	13,659	145,359	477,669	30.4%

IPM Modeling: Further Input Modifications

As mentioned above, the final decision was to constraint the level of efficiency resources for a given model run year on the basis of maximum available funding. This required an additional step: converting CSE data, on a levelized cost per lifetime kWh, into a first-year cost per saved kW. This amounted to estimating an imputed capacity cost for energy efficiency resources. Because it is designed to select from power generation resource options based on their combined capital and operating costs, the IPM model selects resources based on capacity (capital) costs plus fixed and variable operating and maintenance costs. To conform to this data convention, the energy efficiency data was revised accordingly. Working group staff imputed capacity costs for the efficiency resource data bins using both historical program results from RGGI states and average measure-life estimates. This imputed capacity cost was then converted to average cost per kWh by assuming zero operation and maintenance costs. This approach yielded per-kWh cost averages that were very close to those in the original data set; any small differences were estimated not to alter the model results significantly.

To complete the funding-constrained resource estimate for IPM input purposes, it was also necessary to establish an upper limit for available funding in the region. Currently, the nine RGGI states spend an average of about one and one-half mills ($0.0015) per kWh on public-benefits efficiency programs. The highest spending level is currently about 3 mills. Total dollar spending for the region is about $630 million[3] (RAP 2005). The working group established two levels of funding for the purpose of constraining efficiency resource availability within IPM: (1) continuing efficiency program results assuming maintenance of current spending levels; and (2) doubling current spending, with proportional results. The working group also allowed the model, in one run, to select all available economically cost-effective efficiency resources.

The modeling process as it unfolded was a multi-step effort. The initial IPM runs produced the energy efficiency resource acquisition levels as expected. However, to complete the model runs, it was necessary to assign capacity payments to each resource contributing to a given run. Because the efficiency resources were being funded externally, rather than through an ISO-operated power market, this created distortions in the capacity-payment outcomes. As a result, the modeling team undertook an additional step: they applied the efficiency resource amounts initially procured in the IPM resource module as exogenous variables, creating demand decrements that were then used as model inputs. This approach produced the same net effect on key IPM outputs, and it was necessary to conduct the initial runs to determine the economically achievable level of efficiency resources.

Regional Economic Modeling

The RGGI staff working group selected the Regional Economic Models, Inc.'s (REMI) 20/20 Insight™ model[4] to assess the impacts of the RGGI program on the nine-state region. REMI, an

[3] Data on current RGGI state spending and impacts were compiled from multiple sources by ACEEE staff in collaboration with the modeling team. Sources included state energy efficiency program evaluation reports and the Regulatory Assistance Project's assessment of energy efficiency and renewable energy program impacts in New England states (RAP 2005).

[4] REMI's 20/20 Insight™ is a model for fiscal and economic analysis at the local level. 20/20 Insight allows city, county, and municipal decision-makers to understand the total economic and fiscal effects of proposed policy changes, permits for housing or new business, and many other changes that will affect the local areas in question. 20/20 Insight incorporates a year-by-year forecast of local spending and projected revenues expressed in fiscal years, as well as a detailed population forecast by age and gender, and a complete economic forecast expressed in calendar years.

REMI designed 20/20 Insight to help county and municipal decision-makers answer such questions as:

- How much total revenue will be generated by a giant retailer opening a local store?
- How much will the town's expenditures on sewers, police, fire, and schools increase due to new proposed residential development?
- What are the total effects of increasing local property taxes?

input-output model based on matrix algebra like most mainstream economic policy models, has been widely used by state and other government agencies to simulate the economic effects of various policy regimes. Like IPM, REMI creates a reference case for the region, using current conditions and other known factors to generate a business-as-usual regional economic future. REMI, however, uses IPM's outputs to assess the economic impacts of different policy scenarios. Changes in energy prices, power sector inputs and outputs, and related variables are mapped into REMI's input formats.

For the IPM runs involving energy efficiency investments, working group staff mapped additional data into REMI's input formats. For example, increased investment in sectors stimulated by efficiency investments were mapped into specific REMI sector input vectors. Increased employment in sectors where efficiency investment created new jobs was also mapped into REMI, as were the effects of money saved on energy bills generating added spending in other sectors.

In this regard, REMI provides a more robust characterization of energy efficiency's economic impacts than do many other economic models. Some models treat energy efficiency impacts as simply a drop in energy sales, which shows up as an entirely negative economic impact, assuming that growth contracts in energy-sector revenues, investment, and employment. However, because efficiency generates capital investment and additional employment, and frees up dollars otherwise spent on energy bills, it can create economic benefits that more than outweigh any economic losses in energy supply sectors. In today's increasing national and global energy markets, the economic impacts of energy supply flow increasingly outside of state and regional economies. Efficiency investments, which tend to generate more local investment in retail, construction, services, and other sectors, can be a net economic winner for state and regional energy policymakers and consumers.

Description of the IPM Runs

The IPM modeling process explored increased energy efficiency investment scenarios in five different model runs (note that the RGGI draft model rule has modified some of the specifics assumed in these model runs):

1. **The RGGI "policy package" case**. The policy package included a phased-in carbon cap that begins to take effect in 2009, reaching maximum reductions by 2020. It allows regulated sources to utilize a limited number of emissions offsets.
2. **The package case with doubled efficiency**. This run simply doubled the assumed level of funding available for energy efficiency program support during the modeling period.
3. **The reference case with continued efficiency spending**. This run used all reference case assumptions, but assumed that current efficiency spending levels and program impacts continue through the modeling period.
4. **The reference case with doubled efficiency spending**. This run used the reference case assumptions, but allowed efficiency spending to double during the modeling period.

20/20 Insight™ is a fully customized product, incorporating county, city, or municipal fiscal data with the comprehensive power of REMI's economic and demographic forecast model. The simplified user interface provides access to necessary economic and fiscal variables in a clear, manageable system (REMI 2006).

5. **The reference case with all economic efficiency resources**. This run simply removed the annual funding constraint for efficiency programs and assumed that all cost-effective measures would be implemented.

Modeling Results

IPM Results

IPM produces copious results (ICF 2005), including generation capacity additions, electricity generation, fuel consumption for generation, carbon dioxide emissions, allowance prices, electricity prices (firm, energy only, and capacity only), and electric transmission data. We examined four key variables: generation, emissions, allowance prices, and electricity prices (firm). For these four key variables, we compared the impacts of various levels of efficiency resource acquisition to the reference case.

Generation. As one would expect, increased energy efficiency investment reduces forecast demand for electricity in the model and thus reduces projected electricity generation relative to the reference case. Figure 1 illustrates the relative impact of the various model run scenarios on electricity generation.

Figure 1. Electricity Generation

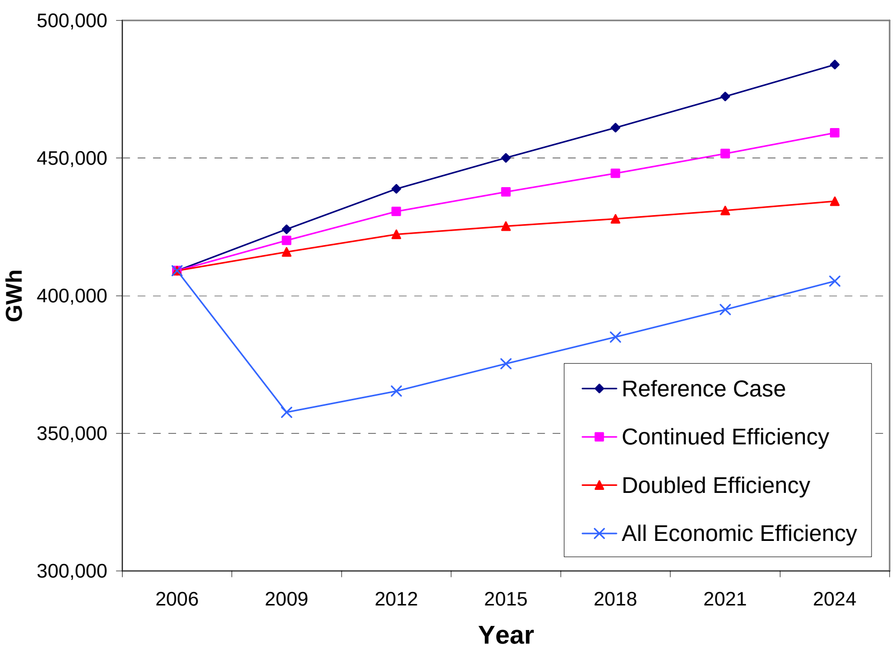


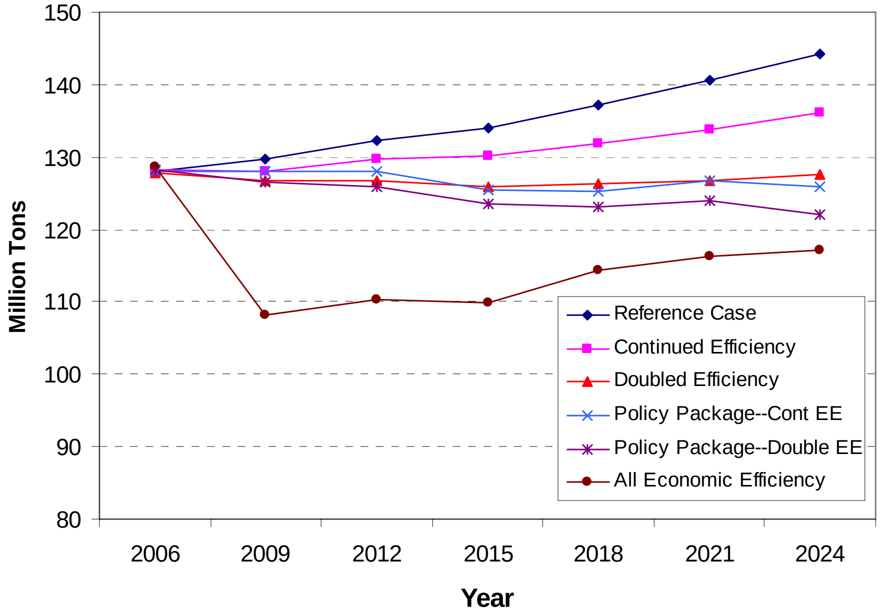
Figure 1 shows that efficiency investment can exert a strong influence on electricity generation growth. Simply continuing current spending levels would cut reference case load growth by 33% in 2024. Doubling efficiency investment would cut growth by 67%, and acquiring all cost-effective efficiency resources would actually reduce electricity use in 2024 by about 5% relative to current consumption levels. One must place a caveat, however, on the all-economic-efficiency case. Note that the model, unconstrained by spending limits, acquires a large amount of efficiency in the first model run year (2009), reducing total electricity use by about 12%. As noted earlier, this is an artifact of how we characterized energy efficiency within IPM. Without massive spending and other strong policy measures (or a major unforeseen economic setback), such a short-term decrease is improbable. However, a policy that called for acquisition of all cost-effective efficiency resources, if sustained over a 20-year period, could come close to the results shown in Figure 1 after about several years of cumulative impacts. In any case, this analysis shows that electricity consumption growth rates can be reduced significantly, and as the REMI economic modeling results will show later, reduced consumption can be achieved with positive economic impacts.

The energy savings produced by increased efficiency investment would also reduce future needs for electric generation capacity additions. The IPM reference case projects total capacity additions of 35,236 MW through 2024. The doubled-efficiency scenario would reduce capacity additions through 2024 to 27,388, a reduction of about 8,000 MW, or about 22% below the reference case. Given the challenges the RGGI region faces in siting new generation capacity, as reflected in the New England-Independent System Operator (NE-ISO)'s current Locational Installed Capacity program LICAP discussions, these capacity savings are significant far beyond the RGGI program's purposes.

Carbon emissions. Increased energy efficiency investment, as one would expect, can significantly reduce carbon emissions. This would be the case, unless generators adapt to reductions in forecast end-use electricity sales by modifying their power plant bid behavior and run times. Operating under a carbon emissions cap, generators know exactly how many emissions allowances they have to operate with in a given compliance period. If end-use electricity sales are lower than they had expected, this can give some generators the ability to run higher-emissions plants longer, depending on power market conditions, and thus to "make up" for reduced end-use electricity usage. This modeling process did not take such effects into account, because it is not possible to predict exactly how such plant operations shifts would unfold.

Figure 2 shows the impact on carbon emissions of various RGGI future scenarios. The top three lines show the emissions associated with the reference case, the reference case with continuation of current efficiency program results, and the reference case with a doubling of current efficiency results. The lower three lines show the RGGI basic policy package with continued efficiency, the package with doubled efficiency, and a reference case with all economic efficiency acquired. As noted above, the sharp reduction in the "all economic efficiency" line is somewhat artificial, in that it is based on an unconstrained model run. It is improbable that much energy use or carbon emission reductions could be achieved realistically in that short a timeframe.

Figure 2. CO_2 Emissions

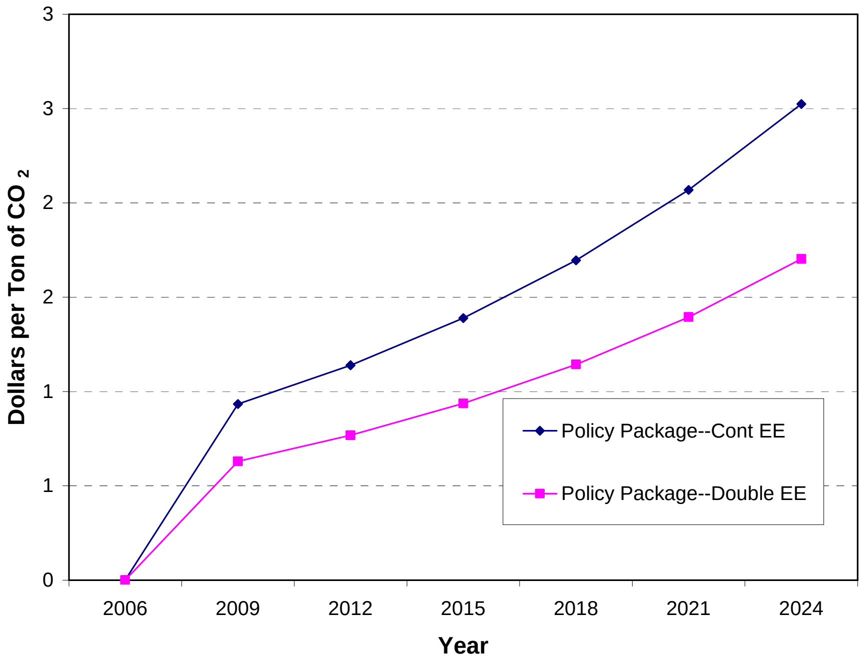


We also note that doubling current efficiency results achieves the same overall emissions impact as the RGGI policy package with continued efficiency results. This suggests that simply doubling efficiency commitments could potentially achieve the same emissions targets as the entire RGGI program, without imposing a carbon cap or the other policy instruments entailed in RGGI. We do not suggest that doubling efficiency investment should be a policy substitute for a carbon cap-and-trade program, but the analysis does show that a serious commitment to efficiency as a resource strategy could achieve comparable effects.

Allowance prices. The cost of carbon emissions allowances is a key concern for climate policies like RGGI. If carbon allowances cost too much, they can have negative economic consequences. Thus policymakers seek to keep allowance prices relatively low; in fact, the final RGGI Memorandum of Understanding sets "trigger prices" for carbon allowances that reflect this concern. Figure 3 shows the impact of two scenarios on carbon allowance prices: the RGGI policy package with continued efficiency investment, and the policy package with doubled efficiency investment.

Figure 3 shows that efficiency investment, and its effects on reducing energy usage and energy prices, can have a strong effect on keeping carbon allowance prices low. The RGGI package IPM run, which assumes continuation of current efficiency program results, showed carbon prices around \$3/ton of CO_2 in 2024, whereas the policy package run with doubled efficiency results reduces carbon prices by almost one-third. While much of this price-reduction effect comes from offsets that do not include energy efficiency, efficiency nonetheless had a large effect. The RGGI MOU trigger price for expanded use of emissions offsets is currently set at \$7.00 per ton, so the effects of efficiency can be important to keeping carbon prices well below such thresholds.

Figure 3. Carbon Allowance Prices



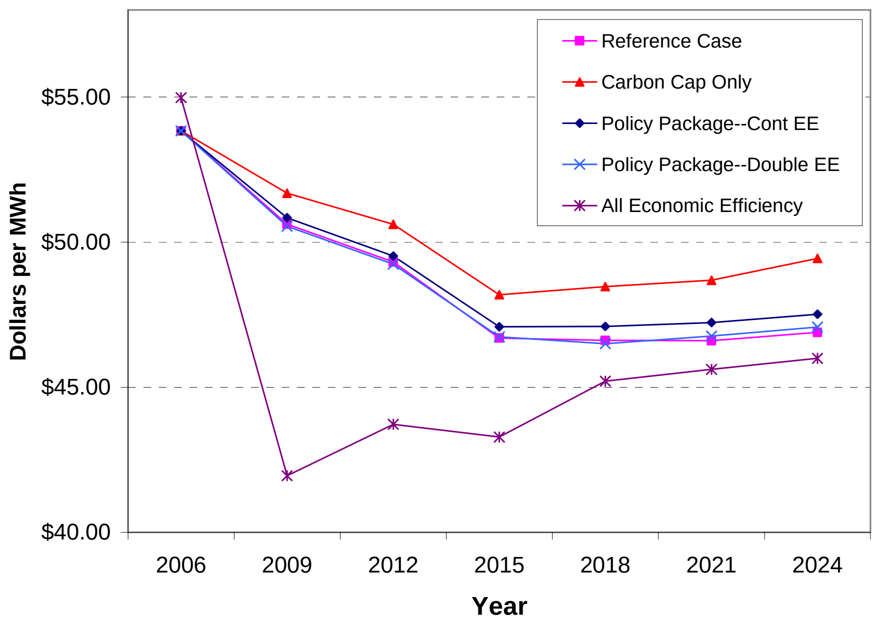
Energy prices. As with allowance prices, increased energy efficiency investment exerts downward pressure on wholesale power prices. The relative impact of all the RGGI policy runs on regional power prices was relatively small. As Figure 4 shows, the carbon-cap-only scenario had the greatest impact on power prices, which was only about 5% in 2024. Note that because the wholesale power price is only part of the net retail price to consumers, the energy bill impacts of these price effects would be reduced. The policy package runs track reference case electricity prices very closely: the package with continued efficiency investment increases wholesale prices just over 1% in 2024, and the doubled-efficiency package run shows less than a one-half of one percent price impact. It worth noting that the doubled-efficiency package scenario keeps energy prices virtually identical to reference case prices. This means that the RGGI program could be implemented, with a doubled commitment to efficiency investment, with virtually no impact on regional power prices.

Emissions "leakage." A significant concern for regional programs like RGGI is the issue of emissions leakage. Leakage refers to the risk of increased emissions from generators outside the RGGI states. These generators, responding to increased energy prices in the region, could increase their exports into the region's power grid through existing grid interconnections. These increased emissions in neighboring states have the effect of causing the RGGI program to "leak," in that the emission reductions realized in the region may be partially offset by emissions outside the region.

Minimizing leakage became an important concern during the MOU and model rule development process. Because leakage is determined by many factors, such as fuel price dynamics, transmission issues, and power plant siting decisions, the modeling of leakage in the RGGI process was necessarily less robust than for other issues. However, it is also clear that minimizing electricity prices in the region would be influential in limiting leakage and that increased investment in energy efficiency would bring down electricity price forecasts.

Therefore, the importance of energy efficiency to limiting leakage and thus to the success of a regional program like RGGI, cannot be overestimated.

Figure 4. Electricity Prices (Firm Power)



However, achieving a strong commitment to efficiency will require specific policy action, both within and in parallel to the RGGI model rule. Because of the indirect nature of efficiency's role as an emissions-reduction strategy, it will not automatically receive the needed investment within the design of a standard cap-and-trade program. It will need both direct emission allocations within the cap and additional policy commitments outside the cap, if efficiency's benefits are to be realized for the RGGI states. This issue is discussed in more detail in the policy implications section below.

REMI Results

REMI used IPM outputs, including changes in electricity prices and changes in capital investment in various energy technologies, plus other factors such as changes in labor demand in various economic sectors, to simulate the effects of the RGGI program on the regional economy.

REMI's overarching finding was that any of the various RGGI scenarios would have very small impacts on the regional economy. Most scenarios showed impacts of less than one-tenth of one percent on key indicators like gross regional product, personal income, and private sector employment. The largest impact shown in the REMI runs was a 0.15% increase in real personal income in 2021, for a scenario involving the RGGI policy package plus a U.S. federal and a Canadian carbon cap program, based on a high-emissions reference case.

The other major finding from the REMI modeling runs was that most RGGI scenarios showed positive economic impacts. Although some economic modeling analyses predict markedly negative economic impacts from carbon cap-and-trade programs, the REMI analysis showed small but positive impacts. While the possible reasons for the discrepancies among climate policy model results is properly the subject of another report, we suggest that the specific ways in which economic models treat (or fail to treat) energy efficiency investments and impacts is one of the more powerful explanatory factors in such discrepancies. Unless models fully characterize the net economic effects of efficiency investments, they are likely to overestimate the costs of climate policies that seek to use energy efficiency as an emission reduction measure.

Table 3 summarizes the main REMI outputs for three main scenarios (Petraglia 2005a):

- The RGGI policy package as described above
- The RGGI policy package with doubled energy efficiency investment
- The policy package plus U.S. federal and Canadian carbon cap-and-trade policies

Each of these scenarios was run against the standard RGGI reference case and against a high-emissions reference case, in which higher-than-forecast natural gas prices and other factors, such as allowing new coal builds in the RGGI region, would increase emissions relative to the reference case.

Table 3. Results of REMI Modeling Runs Impacts on Nine-State RGGI Region Percentage Changes from Reference Case

		2009	2015	2021
Standard Reference Case				
RGGI Policy Package	Gross Regional Product	0.01%	0.01%	0.01%
	Personal Income	0.00%	0.01%	0.02%
	Private Sector Jobs	0.01%	0.02%	0.02%
Policy Package with Doubled Efficiency	Gross Regional Product	0.04%	0.05%	0.06%
	Personal Income	0.01%	0.05%	0.09%
	Private Sector Jobs	0.05%	0.06%	0.08%
Policy Package with U.S and Canadian policies	Gross Regional Product	-0.04%	0.07%	0.08%
	Personal Income	-0.07%	0.12%	0.13%
	Private Sector Jobs	-0.04%	0.10%	0.09%
High-Emissions Reference Case				
RGGI Policy Package	Gross Regional Product	-0.01%	-0.05%	-0.07%
	Personal Income	-0.03%	-0.06%	-0.08%
	Private Sector Jobs	-0.01%	-0.04%	-0.05%
Policy Package with U.S and Canadian policies	Gross Regional Product	-0.03%	0.05%	0.10%
	Personal Income	-0.05%	0.10%	0.15%
	Private Sector Jobs	-0.02%	0.08%	0.11%

From an energy efficiency perspective, the most interesting comparison is between the policy package, which includes an assumed continuation of current levels of energy efficiency investment, and the policy package with doubled energy efficiency investment. While all these effects are relatively small, there is nonetheless a remarkable increase in the positive economic impacts that flow from increased efficiency investment. Doubling efficiency investment increased gross regional product as much as six fold and personal income and jobs by up to five fold.

One reason that efficiency investment boosts the regional economy is that it stimulates local enterprises and local investment more effectively than do many energy supply resource investments. Incremental increases in energy usage typically export most of the net increase in revenue outside the region, as national and global corporations typically dominate these industries. By contrast, increased sales of efficiency technologies create new revenues and new jobs in a range of regional economic sectors, including construction, retail, and services. The increased economic activity in these in-region sectors typically outweighs small decreases in energy revenues. Moreover, energy bill reductions free up personal income and business profit that are subsequently re-spent within the region, which compounds the in-region economic benefits from efficiency investments.

The RGGI modeling result also showed significant reductions in consumer energy bills. Staff used IPM projections of energy efficiency investment to estimate average consumer and business electricity bill impacts (Petraglia 2005b). While the IPM runs showed small increases in energy prices, the increased energy efficiency investment relative to the reference case reduces average energy bills. Table 4 shows the relative impact of the RGGI policy scenarios on consumer electricity bills.

Table 4. Impact of RGGI Program on Consumer Electricity Bills
(change in average household bills in dollars per year, compared to reference case)

	2015	2021
Standard Reference Case		
RGGI Policy Package	-$30.51	-$50.24
Policy Package with Doubled Efficiency	-$65.85	-$108.94
Policy Package with U.S and Canadian Policies	$2.26	-$12.04
High-Emissions Reference Case		
RGGI Policy Package	-$19.74	-$37.02
Policy Package with U.S and Canadian Policies	-$4.31	-$22.17

Table 4 shows that average consumer electricity bills could fall by more than $100 per year, if the RGGI states double their commitment to energy efficiency. In only one case do energy bills increase, and that is only about two dollars per household.

Viewing the IPM and REMI results as a whole, we find that energy efficiency can substantially reduce energy demand, carbon emissions, energy prices, and carbon allowance prices, and can also generate positive economic effects. These effects can play a key role in making the RGGI system work more effectively and at substantially lower cost. One of RGGI's challenges is to forestall potential "leakage," or increased emissions in nearby states from power plants that increase generation to sell into the RGGI region. While other factors, such as fuel prices, transmission capacity, and power plant location have strong effects on potential leakage, energy efficiency would help reduce leakage by keeping electricity prices lower than they would otherwise be. The modeling results show that efficiency, by reducing overall demand and average power market prices, would reduce the need and incentive for outside generators to sell into the RGGI power markets. In this respect, a robust efficiency policy can help assure RGGI's success.

We also note that that efficiency would reduce the average cost of electricity and natural gas in the region. Earlier ACEEE research (Elliott et al. 2003) showed that a level of efficiency resource acquisition comparable to that estimated in this analysis would reduce regional natural gas wholesale prices by 7–10%. Similar effects would be expected in wholesale electricity markets, especially since the majority of the gas savings in our 2003 analysis came from end-use electricity efficiency. Such energy price reductions not only reduce the overall impact on consumer bills and the regional economy, it also offsets the cost of acquiring the efficiency resource.

Implications of IPM and REMI Results: Within and Beyond the RGGI Model Rule

The IPM modeling process shows that a robust commitment to increasing energy efficiency investment in the region improves the fundamental viability of the RGGI cap-and-trade system by reducing leakage. (This finding comes in spite of the inherent limitations of the IPM model in addressing energy efficiency resources.) Energy efficiency also reduces the cost of the program substantially, to the point that net economic impacts are most positive with a doubled level of efficiency investment. These and other benefits should encourage policymakers to fully embrace a commitment to energy efficiency within the RGGI model rule.

However, building efficiency resource acquisition into a cap-and-trade system like RGGI is not straightforward. First, by its nature, a cap-and-trade system is not designed to require use of a particular resource solution. Markets are expected to bring forward the most cost-effective resource options. One might assume that efficiency, being relatively cost-effective, would leap to the fore as a primary resource option for generators affected by the rule. However, there are a number of obstacles to such an otherwise rational outcome:

- The way that emission allowances are allocated determines whether efficiency can be used to claim emission allowances. Because efficiency is an "indirect" emission reduction (i.e., it does not cut emissions directly at the power plant level but indirectly by reducing end-use energy consumption), it does not automatically ensure emission reductions. The cap is set on emissions, not on energy use. If a region's power use drops, generators can run higher-carbon plants longer or make other adjustments, such that emissions may not fall in proportion to the fall in energy use. This issue can be addressed by making direct allocations to efficiency at the time of allowance allocation, so that the efficiency-based allowances are subtracted from the total cap, but this must be done explicitly.
- Generators normally are disinclined to give up allowances. Even though analysis conducted for RGGI (Burtraw 2004) showed that the RGGI program would create windfall profits for generators and thus that giving up a substantial portion of allowances would not harm generators financially, generators still want to retain as much of the financial values of the allowances as possible. In this context, it is difficult to secure the large share of allowances for efficiency and other clean energy options sufficient to yield the level of benefits documented in the IPM analysis. In past cap-and-trade regimes, generators have received almost 100% of allowances, and they tend to exert strong claims on their right to allowances. Moreover, to the extent that a robust commitment to

efficiency reduces electricity sales, generators see efficiency as eroding their revenues and thus have a direct economic disincentive to support efficiency investments. This fundamental issue requires a strong policy commitment to balance generators' interests with public benefits.

- Efficiency is a distributed resource and as such requires broad-based aggregation strategies to harvest as a regional resource of significant magnitude. The RGGI region comprises states that have been among the leaders in developing effective statewide programs that effectively aggregate the efficiency resource from the myriad markets in which it is found. To tap these resources for RGGI's purposes, the model rule would have to find a way to mobilize these state programs, among other policy options, to deliver the level of efficiency resources needed to benefit the RGGI program. This could involve direct allowance allocation, auctioning allowances and using proceeds to acquire efficiency, or other options (discussed below).

  In past cap-and-trade programs, agencies have sometimes created "set-asides," small pools of allowances that can be claimed by providers of energy efficiency and other clean energy resources. However, set-asides have seen limited success. They are typically very small, in part because of generator resistance and in part because they have not been linked to large-scale aggregation programs. They require providers to go through administrative hoops to qualify for allowances. Typically, the allowance prices in the emissions trading markets have not been high enough to create enough value to motivate efficiency investments by themselves, so they have generally been under-subscribed.

To address these barriers, the RGGI states will need to take specific actions to realize the benefits of energy efficiency for the region, as shown in the IPM and REMI modeling analyses. We recommend two primary policy mechanisms toward this end:

1. Allocate substantial emission allowances to public goods purposes like energy efficiency. The RGGI Memorandum of Understanding calls on the states to allocate 25% of all allowances for public purposes. Energy efficiency, given its compelling benefits for the RGGI program and for the regional economy, should be a first priority for the use of such funds. However, our estimate is that even if the proceeds from selling a full 25% of allowances were dedicated to energy efficiency, IPM's low estimates for carbon allowance prices suggests that the resulting funds would not be nearly enough to double the efficiency results that the modeling analysis indicates would provide maximum total benefits.
2. Secure parallel policy commitments to increase energy efficiency resource acquisition. Since it is unlikely that a public purpose allowance allocation would be enough to support the needed level of efficiency investment, the RGGI states should make parallel commitments, outside the cap, designed to attain the goal of doubling efficiency results. A leading candidate for such parallel commitments is the Energy Efficiency Resource Standard approach, in which states set energy savings targets for their utilities or other efficiency providers. Texas included such a provision in its electricity restructuring law, and states like Connecticut, California, Illinois, and New Jersey are setting targets as well. States could also increase funding for public benefits efficiency programs, with or without the use of allowance sales proceeds. In assessing the levels of program

expenditures, states could incorporate the value of emission allowances when calculating the avoided costs used to assess the cost-effectiveness of efficiency resources.

The 25% public-purpose allocation in the RGGI MOU is an encouraging first step, and the MOU's language also calls on the RGGI states to pursue new energy efficiency commitments beyond the cap-and-trade system. The challenge now is for the individual states to implement the RGGI rule, while also pursuing key parallel commitments to efficiency. Regardless of the policy outcome, the IPM and REMI modeling process has made a very strong analytical case for energy efficiency as a cornerstone of climate policy, by showing the enormous benefits that energy efficiency can bring to a cap-and-trade system.

Conclusions

The RGGI modeling process created an opportunity to simulate the directionality and relative magnitude of the benefits that energy efficiency can contribute to a carbon cap-and-trade policy. By characterizing energy efficiency as a resource in IPM competing with conventional generation resources using robust energy efficiency potential data from RGGI state studies, ACEEE contributed a key element to the RGGI modeling process. For the first time, global warming policymakers have concrete analysis results with which to assess the value energy efficiency can bring to climate policy. Only time will tell the accuracy of the IPM and REMI analyses, but the modeling results strongly indicate that energy efficiency resources should be a cornerstone of a carbon emissions reduction policy.

The IPM results clearly document that a doubled commitment to energy efficiency produces the lowest emissions, carbon allowance prices, energy prices, and consumer energy bills of any policy scenario studied. The REMI modeling showed that not only would RGGI produce positive economic benefits for the region, but that a doubled commitment to efficiency produced the strongest economic benefits of any scenario. The REMI results serve to refute the argument that carbon emission reductions impose unacceptable economic costs.

Clearly, RGGI can be implemented with positive economic effects on the region, and energy efficiency is clearly a key to realizing these benefits. The challenge for the RGGI states going forward is to enact policy measures that fully tap these benefits. A substantial allowance allocation for public purposes like efficiency—at least 25%—would be a very helpful start. But to double the level of efficiency resources in the RGGI region, states will need to undertake parallel commitments beyond the RGGI rule. We suggest that energy efficiency resource standards (EERS) and public benefits programs, both of which already exist in RGGI states, are prime candidates for such policies. Building energy codes and appliance standards can also contribute in this regard.

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