CLEANER AIR THROUGH ENERGY EFFICIENCY: ANALYSIS AND RECOMMENDATIONS FOR MULTI-POLLUTANT CAP-AND-TRADE POLICIES

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EXECUTIVE SUMMARY

Background and Approach

Energy efficiency is frequently acknowledged to be an important resource for reducing emissions of air pollutants and greenhouse gases. 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℠ 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.

Yet realizing a significant measure of efficiency's potential contribution to clean air and climate protection environmental goals has not proven easy. While states like California and New York 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. With a number of multi-pollutant, cap-and-trade-oriented clean air and climate protection policies under development, the time is ripe to revisit energy efficiency's role in such policies, with the goal of defining the best paths to realizing efficiency's potential contribution.

Toward this end, ACEEE conducted a study designed to assess the potential contribution energy efficiency can make to attaining environmental goals through multi-pollutant, cap-and-trade policies. Beyond estimating the emission reduction potential and economic benefits efficiency can offer, we also explored in-depth the key policy framework and regulatory design issues that must be addressed if efficiency is to play a significant role in these policies. In addition, we estimated the potential value that efficiency-based emission reduction policies can offer to key private sector actors, including energy service companies (ESCOs), large industrial companies, and electric utilities. Based on our findings, we make specific recommendations for the design of cap-and-trade systems that will be necessary to realize the emission reduction benefits energy efficiency can offer.

For this study, we drew on the experience gleaned from including energy efficiency as a compliance option in existing U.S. air pollution policies such as the Title IV sulfur dioxide/acid rain program and the nitrogen oxides state implementation plan (SIP). We also drew from ongoing policy development processes such at EPA's Clean Air Interstate Rule (CAIR) and the nine-state Regional Greenhouse Gas Initiative in the Northeast.

The first major component of the study was an assessment of achievable energy efficiency resources in the residential, commercial, and industrial sectors, focusing primarily on electricity end-use efficiency. We developed an efficiency investment scenario based on the best available analyses of efficiency potential in these sectors. We applied these energy efficiency potential estimates to a baseline electricity demand forecast to derive energy savings projections. Using a set of emission factors, we then calculated the emission reductions that would be realized through the pollution prevention effects of the energy savings. Also, by comparing the costs of achieving the energy savings with the costs of conventional "smokestack" technologies to achieve comparable emission reductions, we assessed efficiency's costs relative to conventional methods.

We then subjected the efficiency investment scenario to a macroeconomic analysis to assess its broader economic impacts, including its effects on employment and gross domestic product (GDP) in various sectors of the economy. We used the IMPLAN input-output modeling system for this analysis.

Based on our initial finding that efficiency requires explicit treatment to be effectively included in cap-and-trade systems, we then defined and discussed the key issues involved in designing cap-and-trade-based policies aimed at criterion air pollutants or greenhouse gases or both. We covered issues such as:

- Setting the cap and timetable,
- Designing the emission allocation system,
- Options for mechanisms to include efficiency-based allowances,
- Determining allowance values,
- Entities eligible to provide efficiency-based allowances,
- Aggregation issues,
- Eligibility periods, and
- Monitoring and verification issues.

To provide additional insight into the players that might become involved in providing efficiency resources in a cap-and-trade framework, we developed case studies based on discussions with major ESCOs, major energy-intensive industrial firms, and a large vertically integrated electric utility. In these case studies we explored the issues that could attract or repel these key players from becoming actively engaged in cap-and-trade programs.

Summary of Key Findings

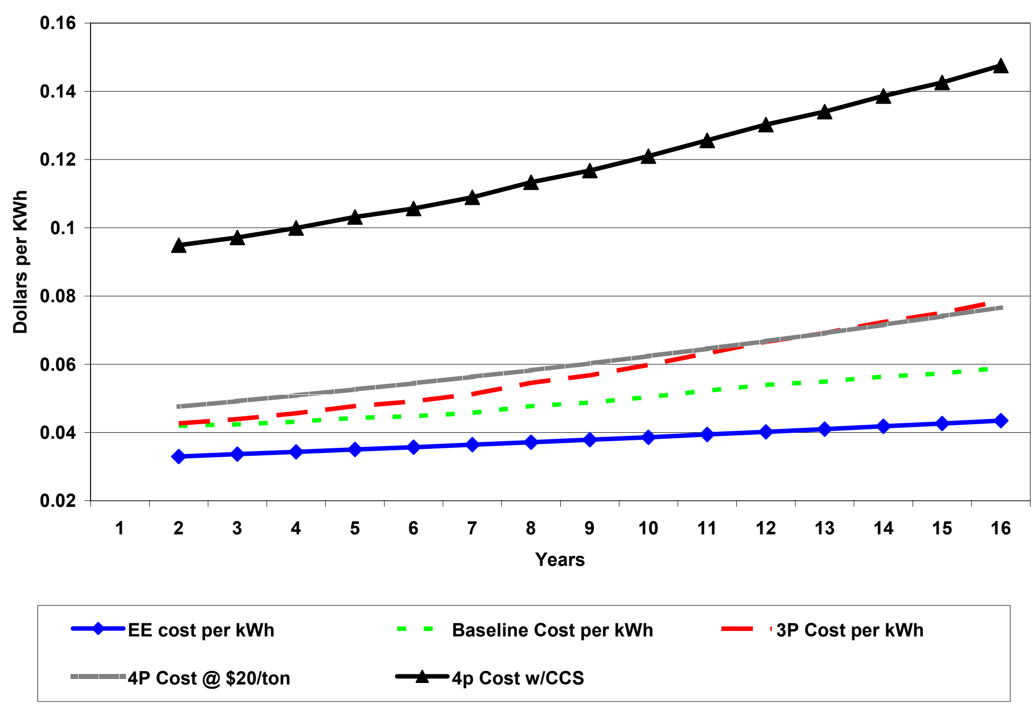
Our findings fall into three main categories: emissions impacts and costs, macroeconomic impacts, and policy findings.

Emissions Impacts and Costs

Our first major finding is that energy efficiency investments can make a significant contribution towards meeting national emission reduction goals. For example, the Clear Skies legislation proposed by President Bush and introduced in Congress calls for an 8-million-ton-per-year reduction in SO_2 emissions by 2018. The efficiency scenario could achieve about 35% of this target. Another example is that the Kyoto Protocol set a U.S. emissions target of 1,256 million metric tons of carbon by 2012; the current reference case forecast from the U.S. Energy Information Administration is for U.S. carbon emissions to be 1,856 million metric tons in 2012, and 2049 in 2020. The efficiency scenario in our analysis shows carbon emission reductions of 117 million tons in 2020. If the 1,256 million tonne target was re-set for 2020, the efficiency scenario would achieve 14% of the required carbon emission reductions.

Second, energy efficiency investments are a very productive and cost-effective emissions reduction strategy, costing substantially less than conventional pollution control technology. Unlike smokestack control technologies, the efficiency investments are cost-effective on their own economic grounds, as they cost less per kilowatt-hour (kWh) than the average cost to generate that kWh. So the true economic cost of the efficiency resource is actually negative. The efficiency investment scenario costs an average $0.033/ kWh of energy saved (including program costs), whereas the average generation cost from the baseline forecast is $0.043. The 4-P conventional "smokestack" control technologies (for carbon dioxide [based on carbon capture and sequestration], sulfur dioxide, oxides of nitrogen, and mercury) would more than double the baseline kWh generation cost, and the 3-P control scenario (for sulfur dioxide, oxides of nitrogen, and mercury) would add a small amount to the baseline generation cost. Assuming a $20/ton carbon permit price as a proxy for carbon control costs, we also calculated a lower-cost 4-P cost scenario. Figure ES-1 illustrates the comparative cost of energy for the efficiency scenario vs. the baseline forecast and the 3-P and 4-P scenarios.

Figure ES-1. Comparative Cost of Efficiency and Control Technologies Assuming a 2% Inflation Rate



While on a strictly first-cost basis, efficiency costs less than 4-P control technology and more than 3-P control technologies, the net lifetime cost of the efficiency investments on a cost-per-kWh basis is lower than the conventional control investment options. Because efficiency investments are more than offset by energy cost savings and also generate broader economic benefits, they are justified on a broader economic basis. Policy analysis in this arena should thus view efficiency investments on a broader basis, not just within the narrow confines of a comparative capital cost analysis.

These results show that energy efficiency is a cost-effective approach to meeting emissions targets. One reason for this is that efficiency achieves emission reductions through a single technology at the end-use. By contrast, realizing multi-pollutant emission reductions at the smokestack may require multiple technologies, some of which may have limiting or even counter-productive effects on emissions reductions for other pollutants. For example, flue-gas scrubbing technologies, because they typically consume energy, increase total energy consumption at the power plant, which typically increases carbon emissions.

Another reason that energy efficiency is a cost-effective emission reduction strategy is that, because of the losses built into conventional fossil fuel power generation and transmission, and distribution systems, saving a unit of end-use electricity saves multiple units of primary energy input into the power system. The average thermal efficiency of the U.S. power plant fleet is about 35% and is further reduced by transmission and distribution losses in the range of 7–10%. At power system peak demand hours, which is when emission reductions from pollutants like NOx are most critical, thermal efficiencies in marginal generating units can fall below 20%, and T&D losses can rise as high as 30%.

Macroeconomic Impacts

Using the IMPLAN input-output model in an analysis conducted by MRG Associates, we projected the employment and GDP impacts of the efficiency investment scenario compared to a baseline forecast for the years 2010, 2015, and 2020. The results are summarized in Table ES-1.

Table ES-1. National Macroeconomic Impacts of the Efficiency Investment Scenario Compared to Baseline Forecast

Year	Net Jobs Gain (job years)	Change in Wage and Salary Compensation (Million 2001 $)	Change in GDP (Million 2001 $)
2010	112,000	$2,831	($286)
2015	264,100	$7,252	($101)
2020	405,500	$11,961	$84

Notes: Dollar figures are in millions of 2001 dollars, while employment reflects the actual job total. These calculations are based upon the analysis by MRG & Associates, March 2004, using ACEEE's estimated reductions in energy use and air emissions below the baseline forecasted values.

Table ES-1 shows that the efficiency scenario creates over 400,000 new jobs and adds $12 billion in wages in the year 2020. GDP also increases slightly in 2020, by $84 million. There are slight negative GDP impacts in the intermediate years (less than 1/100th of 1%), which may be due to reduced capital investment in the energy supply sectors. However, even with these slight negative GDP numbers, jobs and wages are up substantially, and increased worker compensation is several times larger than the small GNP drop. Thus the efficiency investment scenario is an economic winner.

The analysis showed, not surprisingly, that employment increased relative to the baseline in some sectors, notably retail trade, services, and construction, and decreased relative to the baseline in energy supply sectors such as mining and utilities. It is important to note that these job increases and decreases are relative to baseline growth, not to current employment levels. In other words, there will not likely be mass layoffs in the supply sectors as a result of the efficiency scenario; these sectors will simply grow more slowly than in the baseline forecast, while other, more labor-intensive sectors will more than make up the difference through increased growth.

Policy Findings

The first finding in our policy assessment is that energy efficiency requires explicit policy treatment to be an effective emission reduction method in a cap-and-trade framework. Some economists argue that because cap-and-trade systems typically increase energy prices, those price increases are sufficient to drive the economically efficient level of efficiency investment via market forces. However, decades of falling energy intensities in the end-use sectors have reduced the effect of price signals as a market force, because energy is an increasingly small fraction of the cost of most economic activities. In addition, a number of market barriers serve to further blunt the effect of market forces that would otherwise drive energy efficiency investments. For example, because builders seek to minimize design and construction costs and do not see the benefits of reduced energy bills, new buildings are typically less efficient than they could be. Effective policy instruments can reduce these barriers very cost-effectively, at much lower cost to the economy than forcing energy prices to rise to needlessly high levels. Such policies can thus provide a lower-cost path for efficiency to make a substantial contribution to emission reduction goals.

Moreover, cap-and-trade systems are limited by their design in the ability to encourage the most cost-effective levels of efficiency investment. In this sense, policymakers should pursue energy efficiency on multiple fronts, both within and outside the cap-and-trade framework, to yield the lowest-cost mix of energy and environmental policies. Within the cap-and-trade framework, efficiency faces a number of limiting forces:

- Power generators, in negotiating program design and emission allowance allocation methods, tend to oppose explicit encouragement of end-use efficiency, since they would lose the marginal revenue from the affected electricity sales, and since demand reductions tend to reduce wholesale market clearing prices.

- Efficiency resource providers face added transaction costs in developing and aggregating efficiency projects on a scale and in a timeframe acceptable to the cap-and-trade system. Allowance prices are often too small to drive efficiency investments by themselves, which tend to limit the success of the current set-aside approach.

- There is also a potential "double-counting" issue that arises in emissions trading and offsets markets, as "indirect" emission reductions achieved by end-users could be double-counted as "direct" emission reductions at the smokestack. Traders are thus reluctant to buy such indirect emission allowances unless they are explicitly accounted for in the allocation system.

For these reasons, cap-and-trade systems must be designed to reduce these disincentives if efficiency is to compete fairly with other emission reduction options.

In designing cap-and-trade systems to realize the benefits efficiency can offer, we find that the following issues must be addressed:

- **Setting the cap and timetable.** This is essentially a political issue, but should be informed by robust analysis. Defining efficiency's potential and building it into the analysis used to assess potential cap and timetable targets is a key part of the process. Many of the models used to assess resources employed to meet caps or to project economic impacts of caps and timetables rely solely on price elasticities as a proxy for efficiency (and conservation) potential. This approach typically underestimates efficiency resources; efficiency should, rather, be built into the model as a defined resource, not as a derived effect driven only by prices. Many modeling approaches also assume that efficiency can be obtained only at a net cost to the economy; this is demonstrably false, as studies consistently show that cost-effective efficiency scenarios provide net economic benefits. If efficiency is explicitly included in modeling methods as a direct resource rather than a secondary effect, and if efficiency's net economic benefits are recognized, it is often possible to set more aggressive emission reduction targets.

  One way to view energy efficiency in relation to cap-and-trade regimes is in fact to pursue efficiency policies in parallel with, but not within, the cap itself. Member states implementing the current European Union Emissions Trading System are generally taking this approach. In this approach, governments use energy efficiency analysis and policy mechanisms to set a reduced baseline emissions level and a more aggressive emission reduction target, and also to reduce the overall cost of meeting the cap. Efficiency is thereafter used primarily as an offset mechanism, from sources outside the cap. Efficiency investments in developing countries, for example, can be used as emission offsets in the European Union system.

- **Designing the emission allowance allocation system.** Several issues affect efficiency in this context:

  - **Input- vs. output-based allocation.** While past allocation systems have awarded allowances based on historical fuel input, to encourage efficiency and clean power sources it is important to base allocations on emissions per unit of electricity output or on emissions avoided through reduced energy consumption. Output-based allocation is essential to encourage efficiency and other low-emission technologies in the generation sector and is also the only effective way to award allowances to non-emitting resources like efficiency.

- **Auctioned vs. "free" allocation.** The no-cost or "free" allocation approach presumes that the value of the allowances should accrue to emitters. The auction approach assumes that allowances are a public good for which emitters should pay. This approach can serve as an alternative to direct allocation of allowances to non-emitting sources like efficiency; by capturing part of the value of the allowance pool, auctions can generate funds for "clean" sources without directly awarding them allowances. In the past, most allowances have been awarded at no cost, though there is precedent, as in the Title IV SO_2 program, for auctioning at least a fraction of allowances. Auctioning can help make prices more transparent and can produce revenues to fund a range of public goods resources, including efficiency, renewable energy, customer rate relief, and smokestack emissions technology deployment. However, this approach departs somewhat from "pure" auction theory, in that the providers of efficiency resources do not need allowances in order to operate, so they would not be included in a pure auction framework. This is another example of the need to expand the framework for cap-and-trade mechanisms, in order to affect the least expensive solutions and to balance broader policy considerations.

- **One-time vs. updated allocation.** The one-time approach is usually referred to as historical allocation. Affected sources are awarded allowances once, at the beginning of the cap period, and those allocations do not change. Special set-asides must be created if new sources are to be allowed into the cap. Under the updated approach, there is an initial allocation, which is periodically updated, both to include new entrants and to reflect changes in emissions patterns within the cap. Updating tends to reward cleaner and more efficient generators, especially when combined with an output-based approach.

- **Allocation to generation vs. allocation to load.** Past practice has allocated allowances to generators as they are the primary sources of emissions. However, some argue that allocation to customers, or "loads," is more appropriate as they drive the electricity demand that creates emissions. An allocation-to-load approach assigns emissions content to units of energy consumption and requires load-serving entities to acquire allowances in proportion to the size of their loads. Allowing distribution utilities and other load-serving entities to act as proxies for loads could facilitate increased use of energy efficiency as an allowance option, because many distribution utilities are active in customer efficiency programs and could deliver these resources cost-effectively.

- **Options for engaging efficiency resources, within and outside the cap.** The crux of the policy challenge in this project was to define effective mechanisms for engaging efficiency resources in the context of a cap-and-trade system. We identified two principal options for allocations within the cap and two options for applying energy efficiency policies in parallel with the cap.

Options within the cap:

- **Create a set-aside allowance pool.** This option is based on the set-aside approach used in the federal SO_2 and NOx programs. It allows a fixed limit of allowances to be earned through efficiency; efficiency providers must document their savings according to program rules in order to be awarded allowances. While this option recognizes efficiency as a valid resource and creates opportunities for efficiency initiatives, it faces obstacles, such as high transaction costs and allowance values that are often too low to drive efficiency investments. This approach has had limited success in allocation systems where it has been tried.

- **Create direct allocations to efficiency resources.** This option would award allowances to providers of efficiency resources. This would occur within an output-based, updating allocation system at the outset of the cap program, so as to avoid double-counting issues. Efficiency providers could then sell their allowances, use the proceeds to invest in further efficiency gains, and acquire additional allowances at the next updating period. The initial allowances would be determined through evaluation of providers' proven energy savings. This option overcomes the major barriers to efficiency in cap-and-trade systems, including high transaction costs and limited allowance values.

Options outside the cap:

- **Pursue efficiency policies in parallel with the cap.** This approach, which can be followed in concert with either of the other two, focuses primarily on using efficiency policies to reduce baseline emissions and reduce cap levels. It does not try to create efficiency-based allowances within the cap itself. The advantage of this approach is that it is not hobbled by the structural limits of cap-and-trade systems as discussed earlier. However, where cap-and-trade systems are seen as the primary if not the only policy solution, efficiency risks being left out of the policy mix or at least being relegated to a supporting role that does not tap its full potential. We recommend policymakers take a "both-and" approach in this regard: pursue basic efficiency policies on their own merits and also seek to use efficiency to best advantage within cap-and-trade systems.

  We also observe that it may be preferable to make initial allocations to public entities or their designees. States, and their administrative agents such as utilities and ESCOs, have been shown to be the most effective resource providers over two decades of program experience. They thus operate the most reliable and cost-effective channels for delivering efficiency resources. Moreover, public entities are more likely (and may in some states be mandated) to channel the proceeds from allowance sales into future efficiency resource acquisition efforts. Public entities could then assign allowances to other organizations, such as utilities or ESCOs, through regulatory or contractual arrangements. This would allow a range of entities to participate in the process.

- **Auction allowances and use proceeds for efficiency. C**ap-and-trade policymakers could also use allowance auctions to generate funds for efficiency programs. Auctioning a fraction of allowances at market value, or selling all allowances at a fixed, low level, could produce funds needed to support substantial efficiency investments. This would lower the cost of complying with the cap, without interjecting efficiency into the emission allowance system.

  The direct allocation option and the auction approach could be viewed as having similar effects. Both would result in the sale of allowances and (assuming allocations went to public entities) both could generate significant funds for new efficiency resource investments. The difference would be that under the direct allocation approach, efficiency-based allowances would be explicitly included within the cap.

  We recommend the direct allocation option as the most effective way to realize efficiency's benefits within a cap-and-trade system. An auction approach could also be pursued, as an alternative or as a complementary approach; however, auction proceeds would have to be dedicated to specific purposes such as energy efficiency. Otherwise, no net new investment in efficiency would necessarily occur. We also recommend pursuing parallel efficiency policies and using them to reduce baseline and capped emissions levels.

  We do not recommend set-asides for efficiency as a primary approach. The concept of the set-aside arose from the recognition that efficiency requires explicit treatment; however, given set-asides' barriers and limited success, it appears that direct allocations, complemented by auctions and parallel policies, are needed to tap efficiency resources more effectively.

- **Determining the basis for allowance values.** Efficiency allowances can be either assigned a set average value or can be valued based on their specific load-shape and emissions impacts. Once the basis is defined, market forces would then set the monetary value. In recent years, advanced analytical approaches have improved the ability to custom-calculate the emissions impacts of specific kinds of efficiency resources. Standard average values may be preferred in trading markets to maintain simplicity and price transparency. However, in some states or regions, or for specific pollutants, the custom valuation approach could increase efficiency's value in the market. Program administrators should thus seek to preserve the flexibility to value efficiency-based allowances on a specific as well as on an average basis.

- **Entities eligible to provide efficiency-based allowances.** The general presumption in cap-and-trade systems is that directly-affected emissions sources such as power generators should be the primary entities entitled to receive and required to surrender allowances. However, efficiency-based allowances should be awarded to the entities that are directly involved in efficiency markets and thus are most capable of delivering efficiency resources cost-effectively. We recommend that the primary entities receiving efficiency allowances be state governments and that states be allowed to assign allowances to designated providers operating under their jurisdiction. These "secondary" or designated providers could include distribution utilities, ESCOs, product manufacturers, and end-use customers. This approach has several advantages: it builds on the successful track record of many states; it maximizes the potential size of the efficiency-based allowance pool; and it would be the most likely to channel funds from allowance sales back into energy efficiency and other public benefit programs.

- **Aggregation issues**. Because most efficiency resources come in small increments relative to the minimum size of allowances that can be effectively traded in an emissions market, it is important that cap-and-trade systems be designed to permit and facilitate aggregation of multiple projects, programs, and other sources of efficiency resources. Allocation allowances to states, with assignment at states' discretion, would be an efficient way to achieve that sort of aggregation. State-level aggregation would ultimately create the largest and broadest set of opportunities for increased efficiency investment.

- **Eligibility and banking periods.** This issue involves setting a base year that both encourages and rewards (or at minimum does not penalize) "early action" on the part of those who have been proactive in energy efficiency initiatives, while also designing the cap-and-trade system to maximize net new emission reductions going forward. We suggest a reasonable compromise can be reached that encourages early action to "bank" emissions reductions for future use, while achieving the bulk of net reductions through new activity.

- **Measurement and verification issues.** Because energy efficiency is an indirect source of emission reductions, it cannot be directly metered as are power generation and emissions from typical directly affected sources, which usually use continuous emissions monitoring technology. Measurement and verification (M&V) methods are thus needed to ensure that the emissions reductions from efficiency investments are real, accurate, and reliable over time. Fortunately, robust M&V methods have been developed over the last two decades in the energy efficiency field and are being included in consensus protocols for greenhouse gas emissions. These protocols provide a firm basis for effectively including efficiency resources in cap-and-trade systems.

Implications for Efficiency Providers

This study includes case study reviews of the potential impact of including energy efficiency in multi-pollutant cap-and-trade systems on providers of efficiency resources, including private ESCOs, larger energy users, and utilities. The case studies review the past experience of representative companies with energy efficiency in clean air policy framework.

For individual efficiency providers such as ESCOs and industrial customers, the value of emission allowances has to date been low in relation to the total financial value of energy efficiency investments. The case studies indicate that, even with carbon allowances valued at \$20/ton and NOx allowances valued at \$1,500/ton, allowances values add less than 10% to the financial value of an efficiency project investment. Such small increments of value, in and of themselves, are unlikely to drive major new efficiency investments. This implies that the traditional set-aside approaches to including efficiency in cap-and-trade systems may not be effective, because allowances values may not be high enough to motivate substantial new efficiency investment.

For utilities with active energy efficiency programs, there appears to be greater potential for efficiency to play a large role in clean air compliance regimes. This is partly due to utilities' role as aggregators of efficiency investment, which allows them to develop large blocks of efficiency-based allowances. It also stems from utilities' role as program administrators under many state-mandated efficiency programs. Finally, to the extent that utilities are also affected sources in a cap-and-trade system, they made be motivated to use efficiency resources as low-cost compliance options.

These observations based on our case studies support the core recommendations of the report: to use energy efficiency most effectively in a cap-and-trade framework, allowances must be allocated directly to efficiency resource providers. Merely allowing private entities to apply for allowances through set-asides will not create sufficient incentives to drive substantial new efficiency investment.

However, we also recommend that allocations go initially to public entities or their designees. While this might appear to deprive individual businesses of their "rights" to direct allowances, it is likely to generate more efficiency investment and greater financial benefits for private entities. If allocations are made on a "public benefit" basis to public entities, based on sound analysis, allocations are likely to be larger overall. And if public entities are responsible (and accountable) for the effective delivery of efficiency resources, there is likely to be greater confidence among policymakers that the system will not be abused. It is also likely that public entities will either assign allowances to private entities for program delivery or will use funds generated by allowance sales to launch new programs, which will likely create new business opportunities for the private sector.

Conclusions

This project has shown that efficiency can make a major contribution to emission reduction goals for multiple pollutants. It has also shown that efficiency can achieve emissions reductions at lower average cost than conventional smokestack emission reduction technologies. Moreover, a reasonable efficiency investment scenario would provide significant net benefits to the U.S. economy, creating over 400,000 new jobs by 2020.

From a policy perspective, efficiency has generally been acknowledged for its emissions reduction value. At the same time, policy approaches based on conventional economic theory have been inadequate to realize the level of energy efficiency investment that is economically justified and technically feasible. Declining energy intensity, a host of market barriers, and inherent barriers within cap-and-trade systems all serve to limit efficiency's potential contribution to air quality and climate protection goals.

Efficiency thus requires explicit treatment in emissions cap-and-trade systems. After reviewing the pertinent issues and a range of options for including efficiency in such systems, we recommend that efficiency resources receive direct emissions allowance allocations in the cap-and-trade design. States would be the primary recipients of efficiency-based allowances and would be able to assign them to various providers of efficiency services within their jurisdictions.

This direct allocation approach is the option best able to overcome the fundamental barriers to efficiency-based allowances in cap-and-trade systems. We also suggest that allowance auctions, with the proceeds used for efficiency investments and other emissions reducing resources, could be used as a complementary or alternative approach. In addition, we recommend that policymakers also pursue energy efficiency policies and programs in parallel with cap-and-trade systems, as this approach permits more aggressive emission reduction targets to be set and helps reduce the cost of meeting these targets.

The high transaction costs of assembling efficiency resources for participation in emission reduction programs, plus the limited value of emission allowances to efficiency providers, among other barriers, would otherwise severely limit efficiency's ultimate contribution to reaching environmental goals at minimum costs. Our assessment is that direct allocations to efficiency resources, complemented with auctions and parallel policies, will result in lower total costs of meeting emissions caps and will thus make the economic effects of cap-and-trade systems much more favorable. The long-term result would be a cleaner environment and a stronger economy.

INTRODUCTION AND RESEARCH OBJECTIVES

Federal clean air policies have undergone fundamental changes since first enacted in the 1960s and 1970s. They have moved away from strict "command-and-control" regulation that placed uniform, prescriptive emissions control requirements on each individual source toward more flexible, market-based mechanisms. The most common market-based approach to meeting air quality standards has become the "cap-and-trade" system, in which an overall target and timetable is set for a given pollutant, and pollutant emitters are given broad flexibility to meet these targets. Rather than requiring each source to meet a specified emission rate or use a specific abatement technology, cap-and-trade systems allow emitters to trade emission rights in a market-based system.

Along these lines, the first national "cap-and-trade" approach to clean air policy was established in Title IV of the Clean Air Act Amendments of 1990 for sulfur dioxide emissions from electric utility generation plants. This created a national system of tradable permits—called "allowances"—that were required to be acquired and surrendered by SO_2 emission sources included in the system.

Cap-and-trade systems are designed to encourage flexibility in the methods used to reduce emissions, and energy efficiency has long been seen as an emission reduction strategy. It is broadly accepted that pollution prevention, that is, reducing the emissions associated with energy generation by reducing end-use energy consumption, is a cost-effective way to help attain air quality standards. Accordingly, the 1990 Clean Air Act Amendments that created the Title IV SO_2 cap-and-trade system included provisions to award allowances to qualified energy efficiency and renewable energy projects. The legislation created a separate "set-aside" pool of allowances that could only be awarded to such projects. While this provision had limited success, it still established an important precedent in explicitly crediting energy efficiency and renewable energy projects for their air emissions reduction effects.[1] EPA regulations for attaining air quality standards for NOx have also included energy efficiency as an allowable emission reduction method.

While the energy efficiency and renewable energy provisions of Title IV and NOx regulations produced limited impacts, the overall SO_2 cap-and-trade system created has been very successful. Emissions have been reduced according to the targets established at costs significantly lower than likely would have occurred under a "command-and-control" approach. Title IV's success has shaped a variety of legislative proposals before the U.S. Congress, which call for the creation of "multi-pollutant" cap-and-trade systems to address major air pollutants. Some of the proposals call for such an approach to three types of airborne emissions—NOx, mercury, and SO_2. Other proposals would add carbon dioxide (a major greenhouse gas) to these three criteria pollutants.

Improved levels of energy efficiency in the economy clearly can reduce air emissions by reducing the amount of fossil fuel burned to produce electricity. However, little analysis has been conducted to assess the overall potential for emission reductions from achievable levels

[1] See York (2003) for a review of this policy and its impacts.

of energy efficiency. Moreover, the early experience of including energy efficiency in cap-and-trade systems has indicated a number of barriers and other issues that must be addressed if efficiency's full contribution is to be realized.

In this report we examine these issues and assess the potential contribution energy efficiency can make to national emission reductions of four pollutants, estimating emission reduction and costs over a 15-year timeframe. We project the economic impacts of the investments needed to realize these efficiency gains. We then define a policy framework that would give efficiency effective access to emission reduction allowances. We also include selected case studies of key actors that could play important roles in bringing energy efficiency into a cap-and-trade system.

ECONOMIC ANALYSIS OF ENERGY EFFICIENCY'S CONTRIBUTION TO REDUCING MULTI-POLLUTANT EMISSIONS

A primary objective of this project is to quantify the benefits, costs, and broader economic impacts of increased investment in energy efficiency as a means to comply with possible new multi-pollutant air regulations. In this section we present two related quantitative analyses that we performed to address these issues:

- A benefit-cost analysis of using energy efficiency to reduce multi-pollutant air emissions. This analysis examines the magnitude and cost of the energy efficiency resource that reasonably could be captured in key end-use sectors that have the greatest impact on power plant emissions. While we focus primarily on electrical end-use efficiency as an indirect emission reduction strategy, we also examine improved efficiency in large industrial boilers for its direct emission reduction approach. We then estimate the associated emissions reductions possible through greater investments in energy efficiency.

- A macroeconomic analysis that calculates the broader impacts on the economy that would result from these targeted increased investments in energy efficiency. This macroeconomic analysis uses the results of the benefit-cost analysis as part of its input.

Benefit-Cost Analysis of Electrical End-Use Efficiency

To determine the potential emissions reductions impacts of end-use electrical efficiency improvements, we first obtained a baseline assessment of current and future electricity consumption. The electricity consumption baseline used was developed by Energy and Environmental Analysis Inc. (2003), a leading credible source of energy market information. The baseline electricity forecast is displayed in Table 1.

We then projected a best-available estimate of achievable, cost-effective electric energy efficiency potential, drawing on existing research in the three major end-use sectors: residential, commercial, and industrial. The principal source for the energy efficiency potential estimate for this study was ACEEE's previously published analysis of the potential natural gas price impacts of energy efficiency (Elliott et al. 2003). We also benchmarked our estimates against several other studies (Nadel, Shipley, and Elliott 2004); this exercise showed our estimates to be relatively conservative with respect to the range established by other researchers. The median achievable potential estimate of the electricity end-use studies we reviewed was 24%; our estimate is about 14%, which is toward the lower end of the range. These findings are consistent with other major studies of energy efficiency potential, such as the U.S. Department of Energy's *Scenarios for a Clean Energy Future* (IWG 2000) and the *Energy Innovations* study (ASE et al. 1997).

The achievable electric efficiency potential estimates in our 2003 analysis were based on an aggressive policy scenario designed to achieve accelerated results in a 1–5 year timeframe. For the 15-year timeframe of this study, we projected a somewhat more moderate rate of efficiency investment and savings realization. We compared this "efficiency investment scenario" to the baseline scenario to define the potential contribution that energy efficiency could make to reducing air pollution and greenhouse gas emissions on a national basis. The net benefits and costs derived from this analysis then served as inputs to the macroeconomic impacts analysis described in the "Macroeconomic Impact Analysis" section. The costs of the efficiency resources are presented here as levelized total resource costs. That is, we have averaged the cost of efficiency investments over the study period and have included all costs of procuring the resource, including total capital costs and public program costs.

The total benefits and costs of the efficiency investment scenario are shown in Table 1. The costs by sector for realizing these energy efficiency gains are as follows, expressed as a levelized average cost per saved kilowatt-hour (Elliott et al. 2003) in Table 2.

These costs include both the direct end-user capital and program administrative costs of realizing the savings.

After we developed electricity savings estimates, we calculated air emissions savings associated with the avoided electricity generation, based on the avoided electric utility emissions rates from the EGRID database (EPA 2000). We also obtained estimates of the costs of conventional "smokestack" or "back-end" emission control technologies most typically applied in current power generation systems (EPA 2000). These numbers are shown in Table 3.

Based on these values, we applied the costs of applying smokestack emissions controls that would have otherwise been necessary to achieve the same emissions reductions realized by the efficiency investment scenario. Table 4 shows the resulting costs of smokestack technologies through 2020.

Table 1. Baseline Forecast, Energy Savings, and Costs for the Efficiency Investment Scenario

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
EEA Base Case Consumption (Million kWh)	3,682,068	3,755,507	3,840,307	3,905,004	3,980,988	4,057,876	4,146,973	4,214,234	4,293,626	4,373,857	4,467,154	4,536,773	4,619,413	4,702,875	4,800,151
Efficiency Savings Potential (Percent)	0.94%	1.88%	2.82%	3.76%	4.70%	5.64%	6.58%	7.52%	8.46%	9.40%	10.34%	11.28%	12.22%	13.16%	14.10%
Efficiency Savings Potential (Million kWh)	34,611	70,604	108,297	146,828	187,106	228,864	272,871	316,910	363,241	411,143	461,904	511,748	564,492	618,898	676,821
Cost of Energy Efficiency (Million $)	1,141	2,328	3,570	4,841	6,169	7,545	8,996	10,448	11,975	13,555	15,228	16,872	18,610	20,404	22,314

Table 2. Cost of Saved Energy in the Efficiency Investment Scenario

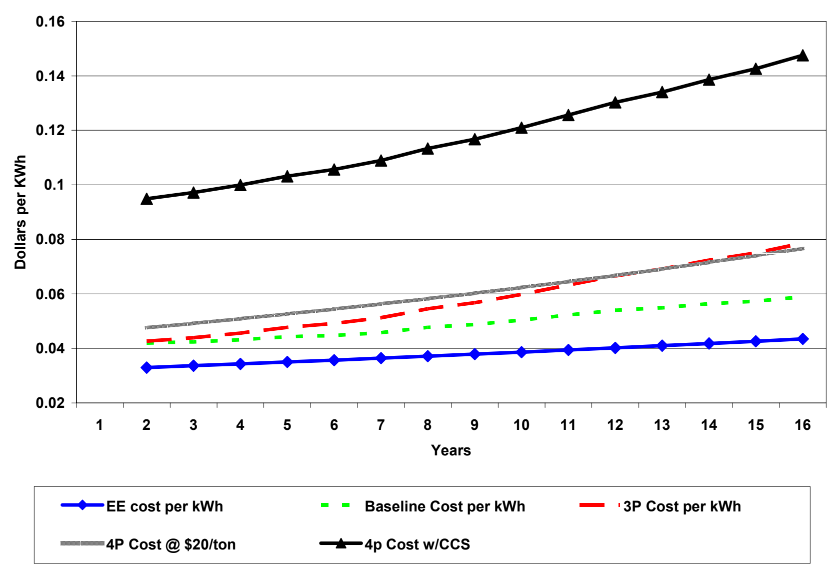
Sector	Cost ($/kWh saved)
Residential	$0.051
Commercial	$0.029
Industrial	$0.0184
Weighted cost of savings from all sectors	$0.0267

Table 3. Smokestack Emission Control Technology Cost Estimates

Pollutant	CO_2	SO_2	NO_x	Hg
Utility Emissions Rates (lb/MWh) (output)	1392.49	6.04	2.96	0.0272
Cost of "Smokestack" Control	$75/ton (carbon sequestration) $20/ton (nominal carbon allowance price	$150/ton	$1250/ton	$40,000/lb
Cost of "Smokestack Control"	$0.0522/kWh	$0.00045/kWh	$0.00185/kWh	$0.00054/kWh
Total Cost of Controls (4-P: CO_2, SO_2, NOx, Hg)	$0.0551/kWh (with CO_2 sequestration)			
Total Cost of Controls (3-P: SO_2, NOx, Hg)	$0.0028/kWh			

Figure 1 compares the cost of saved energy under the efficiency investment scenario with the baseline generation cost and the cost of generation with 3-P and 4-P control technologies. Efficiency costs less on average than baseline power generation, while the pollution control technologies increase energy costs. Taking efficiency's net economic benefits into account in this way, it becomes clearer that efficiency can reduce the total cost of compliance under a multi-pollutant regulatory system, while providing net monetary benefits to the economy as a whole.

Figure 1. Comparative Cost of Efficiency and Control Technologies



Source: ACEEE analysis (see text). Assumes a 2% inflation rate.

Table 4. Costs of Smokestack-Based Emission Reductions

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
CO2 Reduction (Million lbs)	48,196	98,315	150,802	204,457	260,544	318,691	379,970	441,295	505,809	572,512	643,196	712,604	786,050	861,810	942,467
Cost of CO2 reduction (at $20/ton carbon price)	482	983	1,508	2,045	2,605	3,187	3,800	4,413	5,058	5,725	6,432	7,126	7,860	8,618	9,425
Cost of CO2 Reduction (Through Sequestration) (Million $)	1,807	3,687	5,655	7,667	9,770	11,951	14,249	16,549	18,968	21,469	24,120	26,723	29,477	32,318	35,343
SO2 Reduction (Million lbs)	291.1	593.8	910.8	1,234.9	1,573.7	1,924.9	2,295.0	2,665.4	3,055.1	3,458.0	3,884.9	4,304.1	4,747.7	5,205.3	5,692.5
Cost of SO2 Reduction (Through Back-End Control) (Million $)	22	45	68	93	118	144	172	200	229	259	291	323	356	390	427
NOx Reduction (Million lbs)	0.86	1.76	2.70	3.66	4.66	5.70	6.79	7.89	9.04	10.24	11.50	12.74	14.05	15.41	16.85
Cost of NOx Reduction (Through Back-End Control) (Million $)	0.5	1.1	1.7	2.3	2.9	3.6	4.2	4.9	5.7	6.4	7.2	8.0	8.8	9.6	10.5
Hg Reduction (Million lbs)	0.00002	0.00005	0.00007	0.00010	0.00013	0.00015	0.00018	0.00021	0.00025	0.00028	0.00031	0.00035	0.00038	0.00042	0.00046
Cost of Hg Reduction (Through Back-End Control) (Million $)	0.9	1.9	2.9	4.0	5.1	6.2	7.4	8.6	9.8	11.1	12.5	13.9	15.3	16.8	18.3

Looking at this issue from a first cost basis alone, efficiency-based reductions cost substantially less than smokestack technologies for a 4-P scenario, while in the 3-P scenario, the initial costs of smokestack controls are generally lower. This does not mean, however, that efficiency cannot contribute to the attainment of 3-P emission reduction goals. Efficiency policies can be undertaken for multiple reasons, such as electric system reliability, reducing customer bills, and moderating price volatility, while also contributing to emission reductions in a multi-pollutant system. In a cap-and-trade context, efficiency can reduce the cost of compliance while providing a range of other benefits to energy systems and the wider economy.

This point illustrates the larger need to assess energy efficiency resources in an integrated energy and environmental policy framework. Viewing efficiency through the narrow aperture of a specific pollutant-reduction system restricts the value that efficiency is able to offer. This suggests that efficiency is a unique type of resource that requires a unique form of treatment in emission reduction policies.

Assessment of Industrial Boiler Efficiency Potential

While the majority of emission reduction potential is available through energy efficiency in electrical end uses, we also estimated the savings available through energy efficiency improvements in the large industrial boiler fleet. Since large industrial boilers (defined as 50,000 MMBtu/hr or larger) represent a significant source of air emissions, we determined that the efficiency potential of this market segment should be included in the analysis. Large industrial boilers account for approximately 80% of all boiler emissions.

Based on the *1998 Manufacturing Energy Consumption Survey* (EIA 2001*)*, we assumed an existing boiler fleet efficiency of 65%. Current boiler efficiency technology and operating practice indicates that this average efficiency could be cost-effectively increased to 70% on average. We thus calculated the potential energy savings from increasing the efficiency of the fleet from 65 to 70%. The gross savings potential is displayed in Table 5.

Table 5. Cumulative Boiler Savings and Investments

Fuel Type	10^{12} Btus Saved
No. 6 Resid Oil	17.6
No. 2 Distillate Oil	2.7
Natural Gas	181.3
LPG (butane)	4.5
Coal (Bituminous)	144.4
Total—trillion Btu saved	350.4
Total cumulative investment	$1.64 billion

Emissions rates for industrial boilers were estimated from EPA's allowable emissions rates for industrial boilers (EPA 2000). The potential reduction in air emissions is displayed in Table 6.

Table 6. Emission Reductions from Boiler Efficiency Investment

Savings (lbs)	SO_2	NO_x	CO_2
No. 6 Resid Oil	18,843,677	5,641,101	3,000,585,480
No. 2 Distillate Oil	913,163	465,306	432,346,939
Natural Gas	106,639	49,764,706	21,327,731,092
LPG (butane)	748	970,226	660,677,618
Coal	235,125,000	113,437,500	31,143,750,000
Total (lbs)	255,000,000	170,000,000	56,600,000,000

The boiler-related emission reductions in Table 6 suggest that while boiler efficiency is a specialized category, it represents enough efficiency and emission reduction potential to be included in future multi-pollutant emission programs as an eligible resource. It also suggests that if a multi-pollutant program offers an "opt-in" provision for industrial facilities, there may be enough emission reductions available through boiler efficiency that industrial corporations may be motivated to pursue this efficiency option.

Summarizing the findings from our efficiency investment scenario analysis, the data in Figures 1–2 and Tables 1–6 suggest several key points.

Energy efficiency can make a significant contribution towards meeting national emission reduction goals. For example, the Clear Skies legislation proposed by President Bush and pending in Congress calls for an 8-million-ton-per-year reduction in sulfur dioxide emissions by 2018. The efficiency scenario, by saving 2.35 million tons of SO_2 in 2018, would achieve about 35% of this target. Another example is that the Kyoto Protocol set a U.S. emissions target of 1,256 million metric tons of carbon by 2012; the current reference case forecast from the U.S. Energy Information Administration is for U.S. carbon emissions to be 1,856 million metric tons in 2012 and 2049 in 2020. The efficiency scenario in our analysis shows carbon emission reductions of 117 million tons in 2020. If the 1,256 million tonne target was re-set for 2020, the efficiency scenario would achieve 14% of the required carbon emission reductions.

Efficiency costs less than conventional pollution control technology in terms of the net cost of compliance. Efficiency typically costs less than baseline energy generation costs, yielding net savings to the economy. Smokestack controls, on the other hand, add net costs. The relative price of energy is thus higher under smokestack control technology scenarios.

Efficiency's investment costs can be higher than those for 3-P control technology. However, efficiency offers net economic benefits that are not recognized in a first cost comparison, so the net cost of compliance through efficiency can be lower overall than through smokestack technologies. Moreover, since efficiency policies can be justified for other reasons beyond direct economic benefits, they can still contribute to 3-P emission reduction goals, and their 3-P emission reduction benefits should be included in efficiency policy analyses.

Energy efficiency can thus be a very cost-effective approach to meeting multi-pollutant air quality and climate change mitigation goals. One reason for this is that efficiency achieves emission reductions through a single technology at the end-use. By contrast, realizing multi-pollutant emission reductions at the smokestack may require multiple technologies, some of which may have limiting or even counterproductive effects on emissions of other pollutants.

Another reason that energy efficiency is a cost-effective emission reduction strategy is that saving a unit of end-use electricity saves multiple units of primary energy input into the power system because of the losses built into conventional fossil fuel power generation and transmission and distribution systems. The average thermal efficiency of the U.S. power plant fleet is about 35% and is further reduced by transmission and distribution losses in the range of 10%. At power system peak demand hours, which is when emission reductions are most critical, thermal efficiencies in marginal generating units can fall below 20% and T&D losses can rise as high as 30%. While our analysis does not attempt to capture these temporal effects, they do serve to increase the value of efficiency resources in pollution reduction policy regimes.

MACROECONOMIC IMPACT ANALYSIS

Having determined the emissions impacts and costs of achievable energy efficiency investments, we then modeled the macroeconomic impacts that would result from such an energy efficiency investment scenario. We designed the analysis to project the *net effect* of employment and other economic changes. To do this, we first examined all changes in business and consumer expenditures, both positive and negative, that result from the efficiency scenario. We used an input-output modeling approach, sometimes called multiplier analysis, to calculate these effects.

It is important to note that the net economic effects estimated in this analysis are all relative to the baseline scenario. That means that changes in GDP, employment, and worker compensation are compared to the business-as-usual forecast, not to current levels. In other words, if the analysis projects a net decrease in employment in a given sector, this means that sector will grow more slowly than it would in the baseline scenario. It does not mean that jobs or GDP will be lost compared to current levels; if economic growth continues, all sectors may experience increases in employment and GDP.

Background on the Input-Output Analysis Approach

Input-output models initially were developed to trace supply linkages among sectors of the economy. For the efficiency scenario developed in this analysis, the model tracks expenditures on high-efficiency equipment, processes, products, and services that reduce energy consumption and air emissions. It also analyzes how these expenditures benefit not only the manufacturers (creating jobs and income) but also the parts and materials suppliers and other businesses supplying inputs to those manufacturers.

Because some sectors of the economy are more labor-intensive than others, expenditures in different sectors support different levels of total employment. In general, energy-producing sectors such as mining and power generation support fewer jobs per dollar of investment than do the sectors that receive investments in end-use efficiency, such as product manufacturing, construction, and retail trade. Table 7 compares the total number of jobs in the major sectors of the U.S. economy that are directly and indirectly supported for each one million dollars of expenditures made by consumers and businesses. To capture the full economic impacts of the investments in energy efficiency technologies, three separate effects (direct, indirect, and induced) must be examined for each change in expenditure.[2]

- **Direct effect**s refer to the on-site or immediate effects created by an expenditure. In the case of installing the energy efficiency upgrades in a manufacturing plant, the direct effect would be the on-site capital expenditures plus the wages of the electrical or special trade contractors hired to carry out the work.

- **Indirect effects** refer to the increase in economic activity that occurs when a contractor or vendor receives payment for goods or services delivered and then pays others, which in turn increases demand for their businesses. It includes, to continue the industrial example, the equipment manufacturer or wholesaler who provides the new equipment, the installation contractor, the banker who finances the contractor, and the building owner where the contractor maintains its offices, among others.

- **Induced effects** derive from the change in wealth that the energy efficiency investments create. Businesses and households that install efficiency measures are able to meet their power, heating, cooling, and lighting needs at a lower total cost. This lower cost of doing business and operating households, plus the added income from workers directly and indirectly supported by the efficiency investments, makes greater wealth available for firms and families to spend or invest in the economy.

The sum of these three effects yields the total economic impact that results from a given expenditure. However, since household spending is included as part of the final demand changes in the analysis, we have limited our analysis to the direct and indirect effects only. This conservative approach will tend to understate the net effect of the efficiency scenario (Miller and Blair 1985).

Table 7 provides employment multipliers for key sectors such as agriculture, construction, manufacturing, utility services, wholesale and retail trade, services, and government. For purposes of this study, a job is defined as sufficient wages to employ one person full-time for one year. Because the efficiency scenario tends to reduce job creation in the less labor-intensive energy supply sectors and increase job creation in the more labor-intensive sectors, the macroeconomic analysis shows significant net job growth from the efficiency investment scenario.

[2] In this study we have adapted data from the 2001 IMPLAN model for the analysis. See, for example, Minnesota IMPLAN Group (1999). Table 7 presents what are referred to as Type I multipliers, incorporating only the direct and indirect effects of an expenditure. Adding the induced effect would generate what are known as Type II multipliers.

Table 7. United States Multipliers for Selected Economic Sectors

Sector	Employment Multipliers (Jobs per $1 Million of Expenditures)
Electric Utilities	5.6
Natural Gas Utilities	6.9
Oil Refining	7.5
Oil and Gas Mining	9.7
Coal Mining	9.9
Finance	10.5
Motor Vehicles	10.5
Primary Metals	10.9
Other Mining	11.0
Other Manufacturing	11.3
Insurance/Real Estate	11.5
Wholesale Trade	11.7
Durable Metals	11.9
Transportation, Communication & Utilities	12.4
Food	14.9
Construction	18.6
Services	18.6
Government	19.2
Agriculture	24.1
Retail Trade	25.1

Source: Adapted from the 2001 IMPLAN database for the United States. The employment multipliers represent the direct and indirect jobs supported by a one-million-dollar expenditure for the goods and/or services purchased from a given sector.

Description of the Macroeconomic Analysis

The emission reduction and cost data from the efficiency investment scenario were used to estimate three sets of impacts for the benchmark years of 2010, 2015, and 2020. The first of the three impacts is the net contribution to GDP measured in millions of 2001 dollars. In other words, once the gains and losses are sorted out, the analysis provides the net benefits in terms of the nation’s overall economy. The second impact is the net gain to the nation's wage and salary compensation, also measured in millions of 2001 dollars. The final category of impact is the contribution to the nation's employment base as measured by full-time jobs equivalent.

The analysis reflects net incremental impacts for each of the benchmark years. In other words, the changes in energy expenditures brought about by investments in energy efficiency technologies were matched with their appropriate multipliers. These negative and positive changes were summed to generate a net result shown in the tables that follow. We made several modifications to this technique, however (Geller, DeCicco, and Laitner 1992). Several other studies support the use of this approach (Bailie et al. 2001; Barrett et al. 2002; Laitner, Bernow, and DeCicco 1998).

First, we assumed that only 90% of the efficiency investments would be spent within the United States.

Second, an adjustment was made in the employment impacts to account for changes in labor productivity in the sectors analyzed. As outlined by the Bureau of Labor Statistics (2004) in "Table IV–1: Employment and Output by Industry 1992, 2002, and Projected 2012," productivity rates are expected to vary widely among sectors, ranging from a 0.1% annual productivity gain in the mining sectors (other than coal, oil, and gas) to a 4.2% annual productivity gain in manufacturing sectors To illustrate the impact of productivity gains, let us assume a labor productivity increase of 1% per year in the services sector. This means, for example, that a one-million dollar expenditure in the year 2020 will support only 86% of the number of jobs as in 2006.[3]

Third, we assumed that approximately 80% of the investment upgrades would be financed by bank loans that carry an average 10% nominal interest rate over a five-year period. To limit the scope of the analysis, however, no parameters were established to account for any changes in interest rates as less capital-intensive technologies (i.e., efficiency investments) are substituted for conventional supply strategies, or in labor participation rates, all of which might affect overall spending patterns.

While the first cost premiums associated with the efficiency investments might be expected to drive up the level of borrowing (in the short term) and therefore drive up interest rates, this upward pressure would be offset to some degree by the investment avoided in new power plant capacity, exploratory well drilling, and new pipelines. Similarly, while an increase in demand for labor would tend to increase the overall level of wages (and thus lessen economic activity), the modest job impacts are small compared to the current level of unemployment. Hence the effect would be negligible.

Fourth, it was assumed that a program and marketing expenditure would be required to promote market penetration of the efficiency improvements.

It is also important to note that the analysis does not account for the full effects of the efficiency investments in two other key respects: (1) energy bill savings beyond 2020 are not incorporated in the analysis; and (2) the analysis does not incorporate other productivity benefits likely to stem from the efficiency investments. These other productivity benefits can be substantial, especially in the industrial sector. Industrial investments that increase energy efficiency often result in achieving other economic goals such as improved product quality, lower capital and operating costs, increased employee productivity, or capturing specialized product markets (Laitner 1995; OTA 1993, Romm 1994). To the extent these "co-benefits" are realized in addition to the energy savings, the economic impacts would be amplified beyond those reported here. Added to the earlier conservatism of excluded induced effects, excluding these two effects substantially understates the macroeconomic benefits of the efficiency investment scenario.

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[3]. The calculation is $1/(1.01)^{15} * 100$, which equals 1/1.161 * 100, or 86%.

Results of the Macroeconomic Analysis

This section summarizes the net national impacts of the efficiency investment scenario for the selected benchmark years as well as a detailed accounting for the 20 sectors analyzed in 2020. Table 8 provides the summary of the economic impacts for the benchmark years 2010, 2015, and 2020.

Table 8. Impact of the Efficiency Investment Scenario

Year	Net Jobs Gain	Change in Wage and Salary Compensation (Million 2001 $)	Change in Gross Domestic Product (GDP) (Million 2001 $)
2010	112,000	$2,831	($286)
2015	264,100	$7,252	($101)
2020	405,500	$11,961	$84

Notes: Dollar figures are in millions of 2001 dollars, while employment reflects the actual job total. These calculations are based upon the analysis by MRG & Associates, March 2004, using ACEEE's estimated reductions in energy use and air emissions below the baseline forecasted values.

Several aspects of Table 8 are worth noting. First, the numbers represent the net gain or loss in jobs, compensation, and GDP in each of the three benchmark years. Second, it should be noted that the impacts are largely positive. By the year 2020, all the impacts are positive, reaching a net total of 405,500 jobs, $11,961 million in wage and salary compensation, and $84 million in GDP (both in 2001 dollars).

Another noteworthy result is the drop in GDP for each of the first two years reviewed. This apparent contradiction (i.e., a rise in jobs and earnings with a decline in GDP) is the result of several different influences at work in the economy. First, in the earlier benchmark years many of the initial outlays for energy efficiency investments have not fully paid for themselves in energy bill savings. This delayed effect tends to modestly dampen short-term GDP growth. At the same time, due to the capital-intensive nature of the electric utility industry, as the revenues of electric utilities grow more slowly under an accelerated efficiency scenario, the growth rate of capital investment also decreases (i.e., fewer new power plants are built). (The absolute size of this dampening effect on GDP, however, is very small: less than $300 million in a $10 trillion-plus economy, or a few hundredths of 1% of GDP.)

Wage and salary compensation is a major element of GDP, constituting about 60% of total GDP. Thus, while overall GDP can decline or rise slightly, wage and salary compensation can rise significantly as labor payments are substituted for investment capital in the larger economy. New electric plants are displaced by more cost-effective efficiency investments that are more labor intensive. Thus, while the efficiency scenario may show a nominal net reduction in GDP in the short term, it does so by shifting investment among sectors such that net jobs are created. In this sense the average worker fares better under the efficiency scenario in all benchmark years.

The employment impacts start modestly in 2010 with net employment gains of 112,000 jobs, then climb to a net gain of 264,100 in 2015, and reach 405,500 in 2020. If we think of these net job gains as created by the start-up of a series of small manufacturing plants, we then can say that the efficiency investment scenario would produce new employment equivalent to the jobs supported by about 2,700 new manufacturing plants opening by 2020.[4]

Another way to look at the jobs issue is to assess how the efficiency investment scenario would change the unemployment rate. In March 2004, the United States' unemployment rate was estimated at 5.7%.[5] If that holds steady through the year 2020, when total non-farm employment is projected to rise to just under 160.4 million jobs,[6] then the number of persons unemployed would be just under 9.7 million. Adding another 405,500 jobs to the nation's economy would be sufficient to lower the average unemployment rate 4.2%, from 5.7% to 5.5%.

Table 9 provides a more detailed look at employment, compensation, and GDP impacts, showing how each of the 20 major economic sectors are affected in the year 2020 by the efficiency investment scenario. The sectors are ranked according to projected job growth, beginning with those that have the largest employment gains.

It should be noted that the results in this table are not intended to be precise forecasts but rather approximate estimates of overall impact. Indeed, while the aggregate totals offer reasonable insights into the benefits of energy efficiency and reduced air emissions, some of the individual sectors show impacts that are sufficiently small that the results may swing one way or the other depending upon even modest changes in the assumptions. This caveat applies to all macroeconomic analysis, especially over such a long timeframe.

[4] This estimate is based on the net gain of 405,500 jobs in the United States. It assumes a small manufacturing plant would employ 50 persons directly. For each job in the manufacturing plant, a total of 3 (2 additional) jobs would be supported in the economy for a total impact of 150 jobs. Therefore, each 150 jobs created by the Clean Air scenario is equivalent to the output of one small manufacturing plant. Dividing the total jobs created by 150 suggests approximately 2,700 (405,500/150) small manufacturing plants equivalent within the economy.
[5] The unemployment statistics for March 2004 (the most recent available) were downloaded from the Bureau of Labor Statistics (2004).
[6] This estimate for total U.S. non-farm employment is derived from the U.S. total civilian labor force projected to be 170.1 million persons in 2020. See ftp://ftp.bls.gov/pub/special.requests/ep/labor.force/clfa1050.txt.

Table 9. Macroeconomic Impacts of the Efficiency Investment Scenario by Sector in 2020

Sectors	Jobs	Wage and Salary Compensation (Million$)	GDP (Million$)
Services	180,000	$6,391	$10,038
Retail Trade	80,000	$2,312	$3,429
Government	70,800	$3,289	$3,807
Construction	53,900	$1,823	$2,183
Other Manufacturing	24,600	$2,246	$3,687
Insurance/Real Estate	13,400	$424	$1,569
Agriculture	11,500	$153	$471
Finance	11,200	$887	$1,777
Durable Metals	11,200	$737	$1,175
Wholesale Trade	9,300	$795	$1,459
Food	6,300	$286	$588
Transportation, Communication & Utilities	6,300	$393	$743
Primary Metals	4,000	$283	$359
Other Mining	2,400	$120	$220
Motor Vehicles	600	$78	$137
Oil Refining	0	$3	$9
Natural Gas Utilities	(500)	($65)	($208)
Oil and Gas Mining	(5,200	($344)	($1,004)
Coal Mining	(8,300)	($669)	($1,458)
Electric Utilities	(65,900)	($7,181)	($28,897)
Total	405,500	$11,961	$84

Notes: The numbers in parentheses reflect lower growth levels in that sector as a result of the efficiency investment scenario. Jobs refer to the net jobs in each sector, compared to the baseline scenario. Compensation refers to the net gain in wage and salary income by sector. GDP refers to the net gain or loss in Gross Domestic Product created in each sector. All dollar values are in millions of 2001 dollars. Totals may not equal the sum of components (as shown) due to independent rounding.

Table 9 shows two big "winners" under the efficiency investment scenario. These are the service sectors (180,000 jobs) and retail trade (80,000 jobs), largely for two reasons. First, they benefit from the actual investments in energy efficiency programs and technologies made in the year 2020. Second, they benefit from the higher level of goods and services sold as ratepayers and businesses respend their energy bill savings elsewhere in the economy.

These job gains are closely followed by the gains in the government sector (70,800) and those in the construction sector (53,900). The gains in the government sector also result from the respending of energy bill savings by ratepayers and businesses and the additional earnings throughout the economy. The construction sector is a winner primarily because it is the industry that benefits most directly as special trade contractors and others are hired to install the new technologies and make the efficiency upgrades.

Consistent with reduced growth in energy consumption and utility revenues, the energy industries (electric utilities, coal mining, oil and gas mining, and natural gas utilities) incur overall losses in jobs, compensation, and GDP. But this result must be tempered somewhat as the industries themselves are undergoing internal restructuring. For example, as the electric utilities engage in more energy efficiency services and other alternative energy investment activities, they will undoubtedly employ more people from the construction, business services, and engineering sectors. Hence the negative employment impacts should not necessarily be seen as job losses; rather they might be more appropriately seen as a redistribution of jobs in the overall economy and future occupational tradeoffs.

We note, once again, that these nominal "job loss" effects are experienced as reduced growth rates, not in absolute reductions in employment. They reflect differences between the baseline scenario and the efficiency investment scenario. They suggest that fewer people will be hired in the production sectors and more in other sectors. Assuming underlying economic growth is in the forecast range, no current employees are likely to be "laid off" by these effects. For the economy as a whole, the efficiency investment scenario produces significant gains in both employment and wage and salary compensation, and a drop in the unemployment rate.

POLICY ISSUES AND PROPOSED REGULATORY FRAMEWORK

The quantitative analyses presented in the previous section demonstrate the substantial potential benefits of using energy efficiency to achieve both economic and environmental objectives. They show that efficiency can achieve up to 40% of the emission reductions proposed under current legislative approaches, at lower cost than many traditional "smokestack" controls. The question then becomes: what policy issues must be addressed, and what regulatory framework is needed, to realize these documented benefits?

Policy Issues that Affect Efficiency's Participation in Cap-and-Trade Systems

Why is policy intervention needed to increase efficiency beyond the levels that market forces would produce? Some economists argue that efficiency needs no special policy treatment to be included in cap-and-trade systems, on the assertion that increased energy prices driven by the cap will drive optimal levels of efficiency investment. However, 30 years' experience in energy policymaking has shown that markets substantially under-value efficiency without policies to correct market barriers and failures. In addition to numerous market-specific barriers to efficiency investment (such as lack of information, access to capital, builder-buyer, and landlord-tenant barriers), there is a more general economic force that tends to reduce market response to price signals: the shrinking energy intensity that has occurred in many sectors of the economy in recent decades.

Falling intensity means that energy costs as a percentage of the total cost of an economic activity are dropping. This tends to make energy consumption less and less responsive to energy prices. While there are exceptions for energy-intensive industrial sectors where energy prices regularly drive business decisions, for the economy as a whole falling energy intensity reduces market responsiveness to price signals. As energy becomes a smaller and smaller fraction of business costs, homeownership costs, and personal income, firms and households are less and less motivated to change behavior or technologies when energy prices rise. Moreover, since the incremental monetary benefits to the investor from emissions reductions are relatively small compared to the total cost of efficiency investments, the market-based response to the value of efficiency-based emission allowances is likely to be small. Efficiency investment by firms and individuals driven solely by price signals is thus likely to decline, rather than increase, relative to its value to the economy and to the environment.

An additional factor that has tended to limit energy efficiency investment is a persistent pattern of volatility in energy prices. One of the by-products of deregulation in the energy production sector has been increasingly large and unpredictable swings in energy prices. In the 1970s and 1980s, during the initial energy crises, energy price increases were forecast to be continuous and steady. Many efficiency projects were financed based on heroic assumptions about future price increases. When fossil fuel prices fell in 1986, many projects foundered and several energy service companies went out of business. This experience, reinforced by continuing patterns of price volatility, has made customers and energy service providers alike warier about efficiency investments. The result is that many worthy energy projects, especially those with longer-term paybacks, are not undertaken.

Shrinking energy intensities and volatility-driven risk aversion would be rational economic outcomes of declining energy intensity and price volatility, but for two key factors: (1) the environmental costs of energy use, especially in terms of air pollution and climate change, continue to be large regardless of these economic conditions; and (2) the size of the efficiency resource continues to grow with technology evolution as underinvestment continues (Laitner 1995). The result is a paradox: as the economy becomes less motivated by market forces to invest in efficiency, the need for and the size of the efficiency resource continues to grow. The only way to resolve this paradox is through policy intervention: targeted measures that “mine” the efficiency resource for its total economic and environmental value.

Some economists might also say that cap-and-trade systems bypass these economic barriers to efficiency investment by their very design, since emitters can choose any means of reducing emissions that is technically sound and economically competitive. In theory, if efficiency is a least-cost emission reduction method, it should be selected by emitters. However, efficiency’s participation in cap-and-trade schemes is hobbled by several additional barriers:

- **Generator disincentives**. Because energy efficiency reduces power sales, generators generally tend to oppose large commitments to efficiency because of the foregone revenue from such “lost” sales. Aggressive efficiency policies have shown the potential for significantly reducing energy consumption forecasts; consideration of such prospects in the design of a cap-and-trade system would likely engender opposition from generator interests. Though we have shown in our analysis that efficiency can be obtained at lower cost than many smokestack abatement technologies, the generator would have to absorb the lost revenues from efficiency gains at end-use customers, in addition to the market price of the efficiency-based allowances. While a given generator might not directly lose sales in cap-and-trade systems spanning multiple power markets, and while efficiency's benefits in reducing costs of compliance may offset perceived "lost revenue" effects, generators are still likely to oppose significant commitments to efficiency in cap-and-trade systems.

- **Transaction costs**. Efficiency is a distributed resource; it exists at thousands, even millions, of individual points of energy use. Developing and then bundling individual energy efficiency investments into packages large enough to offer significant blocks of emission reductions can incur prohibitive transaction costs if undertaken solely on an entrepreneurial basis. Because efficiency cannot be easily "metered" as can smokestack technologies at power plants with continuous emissions monitoring systems (CEMS), rules for "additionality,"[7] monitoring, and verification will add costs to efficiency investments.

- **Allowance values**. The dollar value of allowances traded under the most likely cap-and-trade schemes for the near future is too small, by itself, to drive energy efficiency investments. Allowance values are not likely to be high enough to cover a large enough fraction of the basic economic costs, let alone the added transaction costs, of investing in and bundling energy efficiency measures. This implies that without explicit policy treatment, market signals from emission allowance markets will not be strong enough to motivate significant investments in energy efficiency through conventional approaches such as set-asides.

- **Accounting issues**. Energy efficiency investments (within the geographic area covered by the cap) result in indirect emission reductions, that is, their emission reductions occur back at the power plant, not directly at the site of the efficiency investment. Efficiency-based allowances thus require specific accounting treatment to avoid potential double-counting of allowances. This is because the cap is set on emissions, not on energy use. If an energy efficiency investment reduces electricity use, emissions will not automatically fall for the compliance period, because emitters may increase run times for higher-emitting plants or take other measures to increase emissions up to the allowed cap level. Emission allowances awarded to energy efficiency providers thus must be accounted for directly. Allowances awarded to efficiency must be subtracted from the total allowance pool. This can be done by using an output-based allocation approach, awarding allowances directly to efficiency providers.

  This problem does not apply to efficiency investments that occur outside the geographic scope of the cap, or in sectors not covered by the cap. This makes efficiency investments of this type eligible for offsets, as long as they pass tests for additionality and use accepted verification protocols.

[7] Additionality refers to the fact that some efficiency investments would occur through market forces without the stimulus created by the emissions reduction policy. To be credited as an emissions allowance, an efficiency resource must be determined to be "additional," that is, market forces would not have caused the investment to be made.

These factors lead to the conclusion that cap-and-trade frameworks, if they are to reap the multiple benefits of the energy efficiency resource, must include specific policy interventions that help overcome the market barriers and other obstacles to efficiency investment in this context.

Regulatory Framework and Recommended Approaches

In this section we present a framework for creating a system for granting emissions reductions credits in multi-pollutant cap-and-trade systems for energy efficiency projects, policies, and other measures. The objective of such a system would be to enable multi-pollutant policies to realize the full benefits of energy efficiency in attaining air quality and climate protection goals. These benefits include lowering the total societal costs of compliance, increasing overall levels of emission reduction, and increasing the broader economic benefits of efficiency investments to the U.S. economy.

We develop our assessment of cap-and-trade design issues from an energy efficiency perspective in the context of the following issues:

- Setting the cap and timetable
- Allowance allocation issues
  - Input versus output-based allocations
  - Free allocations vs. auctions
  - One-time vs. updating allocations
  - Allocation to generation vs. allocation to "load"
- Options for efficiency-based allocations
  - Set-aside pools
  - Direct allocations
  - Using allowance auction proceeds
  - Pursuing parallel policies
- Determining efficiency-based allowance values
- Entities eligible for efficiency-based allowances
- Emissions offsets issues
- Aggregation of efficiency measures and projects
- Eligibility period
- Monitoring and verification

The following sections address these issues and include ACEEE recommendations on key points.

Setting the Cap and Timetable

Determining the level and timing of emission reduction targets is a key first step in any cap-and-trade system. While there is an analytical element in setting caps and timetables, the actually setting of the targets and timetable is largely a political decision, based on the perceived costs and benefits to various parties. It is thus important to conduct robust analysis that fairly represents the likely costs and benefits of energy efficiency among other facets of a proposed cap-and-trade system.

Since energy efficiency is often the lowest cost approach to reducing emissions, it is important to determine efficiency's potential contribution to meeting emissions targets. Otherwise, the costs of meeting the emissions targets will likely be overstated. Therefore, the first analysis that should be conducted in setting the cap and timetable is an assessment of the impact of energy efficiency investments on energy and emissions forecasts. A scenario that harvests the achievable efficiency potential should be modeled to project its effects on reducing reference forecasts for energy use and emissions. This information will help policymakers set the most aggressive cap level attainable at acceptable costs. A model for this approach is the modeling process used by the nine-state Regional Greenhouse Gas Initiative now underway in the Northeast. A major first step in the process is regional power sector modeling of a series of future scenarios. These scenarios include one or more where the model (in this case, the ICF Integrated Planning Model, or IPM) explicitly includes a set of efficiency resources in its optimization routine. The analysis thus "builds" energy efficiency resources in the same context it builds various power generation options. This produces specific forecasts of the cost-effective levels of energy efficiency that can be deployed under the RGGI framework. These forecasts can then be used to set efficiency allocations within the RGGI allocation system. This effort could be a model for future cap-and-trade policies.

To help assess the costs and benefits of the cap and timetable, robust economic modeling should follow the efficiency impacts analysis. This modeling process should properly capture the benefits as well as the costs of energy efficiency. Some recent modeling analyses conducted on carbon cap-and-trade policies have failed to properly account for the economic effects of efficiency investments. For example, they have failed to account for any of the economic benefits efficiency provides, modeling only costs. In other cases, they have overestimated the costs of efficiency.

Some analyses have used a general equilibrium modeling approach in which the current deployment of technology in the economy is considered optimal, and any change in technology investment necessarily imposes costs on the economy. As we have pointed out, a realistic assessment would recognize that a range of market barriers distorts technology investments, and that policies that reduce these barriers can shift technology investment in ways that create net benefits for the economy. The latter approach is a fairer and more robust way to treat energy efficiency investments in such modeling exercises.

Moreover, some analyses have inaccurately characterized the way that efficiency can occur in a cap-and-trade system by assuming that the only way that efficiency occurs is through market responses to higher energy prices driven by the cost of allowances. As we pointed out earlier, falling energy intensity and other barriers limit market response to price increases. This causes the models used in such approaches to drive allowance and energy prices to very high levels. Such high energy prices necessarily lead to very negative overall economic impacts. However, there are other, lower cost ways to harvest efficiency resources, without driving allowance and energy prices needlessly high. Such policy approaches, with appropriate costs and benefits, should be included in economic analyses of proposed caps and timetables.

The RGGI modeling process is employing a robust economic modeling approach along the lines recommended above and serves as an example for future cap-and-trade policy analysis. Using the REMI model, a credible input-output model, the RGGI process fully estimates the benefits and costs of efficiency investments, using IPM model outputs as a source for its inputs.

Allowance Allocation Issues

A second key element of cap-and-trade systems is the mechanism used to create and allocate emission allowances to entities included in the system. Because emission allowances will acquire monetary value once the cap takes effect, the details of allocation methods become enormously important to ensure that a desirable mix of compliance options is enabled, to balance the equity concerns of affected stakeholders, and to make certain an economically efficient market is created.

Input-based vs. output-based allocations. An important decision in designing the allocation rules is whether to award allowances on an "input" or an "output" basis. Input-based allocation awards allowances based on historical fuel input to the power plant or other affected source (e.g., industrial boiler). Output-based allocation uses formulae that normalize emissions based on units of usable energy produced, such as per kilowatt-hour or per thousand pounds of steam. Output-based allocation, because it rewards higher efficiency power generation, is fundamental to encouraging more efficient, cleaner generation and industrial facilities in a cap-and-trade system. Input-based allocation disproportionately awards allowances to less efficient and more polluting technologies and facilities. To encourage higher efficiency and less polluting technologies such as combined heat and power (CHP) and renewables, output-based allocation is an essential element of allocation rules. In addition, output-based allocations address some fairness issues regarding sources that have already invested in clean and efficient technologies.

Output-based allocation is the appropriate basis for awarding direct allowances to energy efficiency resource providers. Efficiency has no direct fuel "input," and it would thus be awkward to award allowances to efficiency on an input basis. How end-use efficiency would be affected by input- versus output-based allocations depends on other aspects of the allocation design. If, for example, efficiency is given a direct allocation of allowances under an output-based system, it would be an advantage in that "negawatt-hours", since they prevent emissions, have no emissions associated with each unit of savings. The efficiency provider thus does not need to keep allowances in proportion to its emissions and can sell them in the emissions trading market

Auctioned vs. "free" allocations. A fundamental decision in allowance allocation is whether to award allowances for free, based on historical emission patterns, or to require affected sources to purchase allowances in a public auction. The free approach was used under Title

IV SO_2 program. Affected sources received allowances for free according to formulae based on historical emissions and fuel inputs.

Under the auction approach, the administrator would hold auctions to sell allowances. Affected sources would have to procure allowances as needed for their operation. An underlying principle of the auction approach is that the quality of the atmosphere and its effect on public health and welfare are public goods, and that private parties should pay accordingly for the right to emit pollutants. Auctions also allow early price discovery for allowances, helping affected sources to more quickly find the least cost compliance options, which could make early market operations more efficient and thus reduce the overall cost of compliance.

Auctions can create windfalls for generators whose output is able to be sold at increased market prices, such that net revenue exceeds the auctioned allowance price. This phenomenon can also occur more generally, as a function of the emissions cap's effect on raising average wholesale electricity prices. Generators whose cost of compliance is lower than average price increases are net gainers under the cap-and-trade system. These phenomena justify the use of auction proceeds to serve various public purposes, including:

- Paying for the administrative costs of the program;
- Providing energy bill credits to customers by flowing the revenue back to customers;
- Supporting investments in energy efficiency and renewable energy;
- Funding ameliorative efforts for the impacts of air pollution, such as public health programs;
- Funding worker transition programs for industries affected by program impacts; and
- Co-funding projects to upgrade "dirty" plants.

The free and auction approaches are not mutually exclusive and can be combined. The administrator could allocate a certain share of the allowances to affected sources at no cost and then auction a certain share. Such a mixed approach could generate revenue to increase the net benefits of the program by investing in public goods, such as overcoming market and policy barriers to energy efficiency and renewable energy. This kind of mixed approach also may have the advantage of being more readily accepted politically. Experience with cap-and-trade systems suggests that auctioning 100% of allowances may be politically difficult to achieve, while auctions of smaller percentages of allowances are more readily accepted. Such partial auctions would still have the advantages of creating early price discovery and generating revenue for public goods, but would limit the financial impact on major emitters.

Deciding on the portion of allowances to be auctioned is both an analytical and a political process. Robust modeling of the size of the efficiency resource is a key analytical step in defining the potential size of an efficiency-based allowance auction. From a political perspective, generation-owning stakeholders are likely to oppose a large portion of allowances going to auction. To strike a reasonable balance, policymakers need solid data on the size, cost, and other attributes of the efficiency resource.

One-time vs. updating allocation. One-time allocations use historical data to set allowances, and the allocation of allowances then remains fixed in perpetuity. Updating allocation approaches, on the other hand, review emitters' data at specified intervals and reallocate allowances accordingly. Updating allows, among other things, for the inclusion of new sources in the cap. Otherwise, the initial allocation must set aside an allowance reserve to permit new sources to operate. Updating also encourages advances in low-emitting and non-emitting resources by rewarding them periodically with increased allowances.

Allocation to generation vs. allocation to load. It is generally assumed that emission allocations flow to generators—the direct emissions sources. However, some have argued that allocations could also be made initially to the customers or "loads" that created the demand for the energy whose conversion created the emissions. This concept is consistent with the view that air quality is a public good and that allowances thus belong to the public. As practical matter, allocation to load is difficult to administer, because of the sheer number of "loads" involved. One way to address this problem would be to use the "load-serving entities" (LSEs) that serve customers at the distribution level as proxy entities for allocation to load. These are typically either regulated distribution utilities or unregulated retail electricity providers. It is argued that LSEs, because they serve customers directly, are in a better position than generators, many of whom are unregulated and have no retail customer contact, to develop efficiency programs under a cap-and-trade system. However, there are political problems with the allocation to load approach, particularly that generators are opposed to losing the monetary value of allowances. There are also administrative issues, especially with unregulated retail suppliers whose program delivery capability and longevity in the marketplace may be limited. Nonetheless, the allocation to load concept raises important issues, including the fact that distribution utilities are major providers of energy efficiency programs in many states and would thus be worthy of inclusion in cap-and-trade systems designed to encourage efficiency.

This allocation-to-load issue is related to the policy concept that electric distribution utilities have a responsibility to limit the pollutant or greenhouse gas content of their retail sales of electricity. It also calls for an expanded discussion of the mechanics of emission reductions, allowance allocations, and dollar flows in a load-based allocation scheme. These issues are beyond the scope of this report, but bear further discussion.

We recommend that regardless of the disposition of the larger allocation to load issue, the concept of awarding efficiency-based allowance allocations through load-serving entities and other organizations that administer efficiency programs is a worthy one and should be considered as an allowance allocation method in cap-and-trade systems.

Options for engaging efficiency in relation to the cap. This discussion assumes that either (1) efficiency-based allowances would be awarded within the cap according to protocols and procedures developed by the cap-and-trade system administrator, or (2) policymakers would engage efficiency resources in a coordinated fashion, but without creating specific efficiency-based allowances.

We define two principal options for allocating allowances to efficiency providers, and two options for pursuing efficiency in relation to the cap-and-trade system without making direct allocations. The two options within the cap are:

(1) Create a set-aside pool. This option would create a set-aside pool of allowances. Such set-aside pools have been used nationally for the Title IV SO_2 allowance trading system and by state NOx trading systems in the Northeast (including the states of Massachusetts, New Jersey, and New York). The relative success of this approach as used for Title IV and NOx allowances is mixed, with a relatively small share of allowances from the set-aside pool actually awarded for qualified energy efficiency projects (York 2003).

The pros of this approach include:

- It creates a specific set of allowances that can only be earned by implementing energy efficiency measures and achieving quantifiable and verifiable energy savings.

- The size of the set-aside pool can be set based on analysis of energy efficiency potential and can thus help "jump start" this aspect of the overall allowance market.

- The value of allowances in the emissions trading market would create an added economic incentive for efficiency investments.

The cons of this approach include:

- Experience with set-asides for energy efficiency and renewable energy in Title IV indicates they did not work as well as planned.[8] A combination of factors, including low allowance prices and limiting eligibility to utilities (Vine 2003), led to this set-aside not realizing its objectives and potential; it's not clear whether the same factors might similarly affect a multi-pollutant set-aside pool of allowances.

- The monetary value of allowances in emissions markets today and for the near future may be too low to drive efficiency investment by themselves. So while the set-aside would create a necessary conduit for efficiency, it would not be sufficient to ensure the investment occurs.

- Transaction costs create added barriers to efficiency. Efficiency resource providers would need to pay not only the project development costs, but also the administrative costs of qualifying for allowances, and may also have to pay to aggregate projects /measures to sufficient size to meet minimum allowance levels.

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[8] The Conservation and Renewable Energy Reserve (CRER) provision has been only partially successful. According to Walke (2003), EPA reported that 47,493 allowances—approximately 16% of the total reserve of 300,000—had been awarded through April 2003. Of the total CRER allowances that have been awarded, 36,360 have been for conservation measures and 11,133 have been for renewable energy generation. This means that about 252,500 CRER allowances were left unused—at an approximate value of $150/allowance, this amounts to about $38 million in value left "unclaimed." For more on CRER see http://www.epa.gov/airmarkets/arp/crer/factsheet.html.

While it is possible that changes in the design of the set-aside could have improved participation in the SO_2 or NOx programs, our assessment of the inherent limitations of this approach suggests that it would be insufficient to tap a significant portion of the potential emission reductions that efficiency can offer.

(2) Directly allocate efficiency-based allowances to designated providers. This option would take a more direct approach to harnessing energy efficiency to help achieve clean air objectives. Entities defined as efficiency resource providers, such as state agencies, utilities, or energy service companies, would be allocated allowances directly, based on either historical energy savings or on quantified prospective savings. This should occur on an output-based, updating allocation basis.

The pros of this approach include:

- This approach would come closest to producing an economically optimal level of efficiency-based emission reductions, resulting in faster and less costly compliance with the cap. The allocation could be based on robust modeling analysis of achievable levels of efficiency.

- As illustrated in the previous section, the increased energy efficiency investment would generate substantial new economic benefits, creating new jobs in sectors related to the manufacture, sales, installation, and maintenance of efficiency measures.

- As with set-asides, the sale of efficiency-based allowances would create a new source of revenue for efficiency investments. However, in the direct allocation approach the transaction costs of acquiring allowances could be reduced, especially if allowances are awarded to public entities or their designates. Also, if direct allocations go to public entities, there is a greater likelihood that proceeds of allowance sales will be channeled into supporting new efficiency investments.

The cons of this approach include:

- As with set-asides, there is likely to be opposition from generation owners who are reluctant to give up allowances. This could serve to keep the level of direct allocations small, limiting the ability to tap the full efficiency potential.

- This approach could be viewed as running counter to the unfettered free-market approach intended for emissions trading. It may thus encounter opposition from those committed to completely open emissions trading markets.

While this approach has not been used within a cap-and-trade system to date, the state of Texas has used energy efficiency mandates as part of its "state implementation plan" (SIP), required by federal clean air regulations for NOx reduction. Senate Bill 5, also know as the *Texas Emissions Reductions Plan,* requires all political sub-divisions in 38 Texas counties to (1) implement all cost-effective energy efficiency measures, (2) establish a goal to reduce electricity consumption by 5% each year for 5 years, and (3) report efforts and progress annually. The Texas SIP also contains a credit of 0.5 tons/day NOx emissions reductions for enacting a building code that includes specific energy efficiency requirements for new construction. While there are some differences between the NOx/SIP program and multi-pollutant cap-and-trade systems,[9] this Texas example shows that energy efficiency can be used effectively in an emission allowance framework.

Options for pursuing efficiency in relation to the cap, but without explicitly creating efficiency-based allowances, include:

(1) Institute efficiency policies in parallel with the cap. Policymakers can use efficiency policies to reduce baseline energy emission forecasts, cap levels, and compliance timetables. They can also be used to reduce the cost of compliance and lessen the overall economic impact of the cap. Several European Union member states are taking this approach in relation to the EU cap-and-trade system under the Kyoto Protocol. Policies in this category can include building energy codes, appliance efficiency standards, public benefits energy efficiency programs, tax incentives, efficiency performance standards for utilities that set specific targets for energy savings, and utility regulatory reforms that encourage utilities to support energy efficiency investments.

Pros of this approach include:

- It can allows a wider pursuit of efficiency policies, without the constraints imposed by the cap-and-trade system.

- It is not exclusive to allocating allowances to efficiency. A cap-and-trade system could make some allocations to efficiency, while policymakers pursue a wider range of efficiency options outside the cap.

- It avoids the competition for allowances that would occur under a direct-allocation approach.

Cons of this approach include:

- It does not create new funding support for efficiency. An advantage of including efficiency in the cap is that efficiency would gain the value of allowances sold in the emissions trading market.

- It does not apply the mandatory cap and timetable requirements to efficiency policies. It may thus be more difficult to achieve desired levels of efficiency investment without the hard-wired compliance mechanisms of the cap.

[9] The principal difference is that the federal requirements for SIPs place emissions reductions requirements on individual states, not individual "affected sources," as would be the case for multi-pollutant cap-and-trade systems as discussed in this report. However, even in cap-and-trade systems, states may have considerable flexibility in allocating allowances within their borders, as is the case in the proposed EPA Clean Air Interstate Rule. The model cap-and-trade system for carbon being developed for the Regional Greenhouse Gas Initiative in nine northeast states may also allow states to set their own allowance allocations within the overall cap.

(2) Auction allowances and use proceeds to support efficiency investments. This approach would, at the initiation of the cap-and-trade system, auction a fraction of allowances at market prices, or sell all allowances at a fixed (low) price, and use the proceeds to support efficiency policies and programs in parallel with the cap.

The pros of this approach include:

- It provides a funding stream for efficiency investments, while avoiding controversy over which entities are eligible for allowances.

- It affords policymakers maximum flexibility in applying the proceeds of the auction to a range of policies and programs.

The cons of this approach include:

- It raises the risk of diversion of funds from auction proceeds to unrelated uses. Jurisdictions receiving auction proceeds may experience pressure to divert funds to various purposes, from deficit reduction to utility rate reduction or road construction.

Recommendation. Each of these four approaches to including efficiency-based allowances within a national cap-and-trade system would be viable. We recommend direct allocation to energy efficiency resource providers as the most promising approach.

The direct allocation approach is the method that best addresses the market and policy barriers to efficiency investment in cap-and-trade systems. It best addresses the overall market barriers to efficiency investment and also addresses the issues related to generator disincentives, low allowance values, transaction costs, and double-counting that were discussed earlier.

The allowance auction approach could also serve many of the same purposes as the direct-allocation approach, if stipulations could be made that the proceeds of the auction be applied to the appropriate energy and environmental policy objectives.

We also recommend that, however efficiency is treated within the cap-and-trade system, policymakers rigorously pursue efficiency policies and programs in parallel with the cap. These can be used to help define appropriate baseline and cap levels, and can serve to reduce the cost of compliance.

Our review and analysis of the set-aside provisions under the Title IV and NOx programs leads us to recommend the set-aside option as a second-tier approach. While some of its problems might be resolved to improve the relative success of set-asides, we find that there are still fundamental structural problems with this approach. While energy efficiency has been shown to be a very cost-competitive option for meeting emission reduction requirements, experience from Title IV and some state NOx programs suggests that this option might well go under-utilized. The comparatively low expected market value of allowances and the added transaction costs to efficiency resource providers are likely to limit participation in such set-asides.

Determining the Emissions Value of Efficiency-Based Allowances

However efficiency-based allowances are created, it is important that the formulae used to determine the number of allowances earned be based on the amount of equivalent generation offset (at the generation level). For example, a 10 MWh savings at the customer level would generate allowances at least equal to the equivalent generation that it offsets (i.e., 10 MWh plus some factor for transmission and distribution losses). Determining what generation is "offset" in this manner is a potentially difficult issue, as this is a temporal and locational function of the type of generation affected by the energy savings. While significant advances have been made through modeling approaches used in such states as Texas, Wisconsin, and the Ozone Transport Commission states, further work is still needed to define nationally applicable methods. The principal choices are to (1) use a single, uniform value across the nation, or (2) use regional, state, or project-specific values based on regional/state fuel mixes, emissions factors, and load shapes.

The principal advantages of a single, uniform national value are simplicity, transparency, and fairness. Since an objective of a national cap-and-trade system is to create a uniform national market for allowances, using a single, uniform offset value better suits this objective. Energy efficiency improvements made anywhere in the country would earn emission reduction credits equally. Title IV of the Clean Air Act Amendments used such a single, uniform formula for determining the number of allowances earned for qualified energy efficiency improvements and programs, as well as renewable energy projects (one allowance was earned for every 500 MWh of qualified efficiency savings or renewable energy generation). Administratively, this is much easier than the alternatives—determining and awarding different allowance allocations according to state, regional, or project-specific differences. The disadvantage is that such a single uniform rate of award doesn't recognize the significant state and regional variations in fuel mix or the different emission reduction values of different efficiency measures. For example, the emissions impact of a saved kilowatt-hour in the hydro-dominated Northwest is significantly different than a saved kilowatt-hour in the coal-dominated Midwest. For another example, an efficiency program that reduces consumption primarily during summer peak hours tends to reduce NOx emissions at a higher rate per kWh than a program that saves energy during off-peak or winter hours.

The advantages and disadvantages of using formulae based on state or regional differences are the flip sides of applying a single, uniform national value. A regional/state or project approach would more accurately capture true emissions impacts. However, with this increased accuracy would come increased administrative costs and complexity. It also would place different values on the same amount of energy savings achieved through energy efficiency for different regions of the country. Some might see this as inequitable and contrary to the objective of a national cap-and-trade system. This might also make trading markets harder to operate, to the extent that it makes allowance prices more contingent on such factors and thus less transparent to the market.

However efficiency-based allowances are earned and awarded, the market will determine their value, and in turn, the explicit environmental value of energy efficiency investments in national cap-and-trade systems. As other sections document, this added environmental value alone may not be enough to trigger energy efficiency investments, but its marginal value might well help tip the scales in favor of many projects whose financial performance needs improvement.

Entities Eligible for Efficiency-Based Allowances

Creating energy efficiency-based allowances requires defining the entities that are eligible to receive allowances. Leaving eligibility completely open runs the risk of creating heavy administrative burdens, including assessing additionality and verifying savings from a large number of small providers. And as described earlier, many potential providers are not sufficiently motivated by the financial benefits of emissions allowances to become active participants in a cap-and-trade system. Wide-open eligibility also invites potential gaming and other forms of abuse.

For these reasons, an allowance allocation system needs to identify the entities eligible for allowances. Such entities (referred to generically in this report as efficiency resource providers) could include:

- energy end-users,
- manufacturers, distributors, and retailers,
- energy service companies, and
- energy program administrators, such as utilities, state governments, non-government organizations and private contractors.

A variety of resource providers can participate directly in a set-aside program, if they are sufficiently motivated given limited financial incentives and willing to go through the administrative processes needed to qualify. Experience shows that set-asides have been under-used for these and other reasons. Our recommended approach, however, would allocate allowances directly to efficiency resource providers. The effectiveness of this approach depends on the sale of these allowances and the application of the proceeds to future efficiency investments.

An open-eligibility method of allowance allocation in this context might be unworkable. A multitude of providers, offering small and diverse blocks of energy savings, could scatter allowances in such small units that they might not be tradable and would not assure that private entities would not simply pocket allowance values. To ensure that allowance sales operate efficiently in the emissions trading market and that the proceeds of allowance sales are applied appropriately to future efficiency investments, allocation to public entities or their designates would be more effective. This approach could be designed to ensure that allowance sale proceeds are appropriately used and also that a variety of resource providers be engaged in the use of these funds.

For example, a state agency could be designated as the official recipient of efficiency-based allowances. However, the allocation rules could also allow the agency to designate efficiency resource providers, including energy users, energy service companies, efficiency product manufacturers and trade allies, and utilities that administer efficiency programs. The state agency would receive its allocation of allowances, assign them in blocks, by regulation or by contract, to designated entities, and allow these entities to sell the allowances. The regulations or contracts governing the assignment of allowances should also define the allowable uses of sale proceeds. These allowance assignments can be coordinated in a comprehensive process guided by resource potential assessments, cost-effectiveness analyses, and market needs assessments.

This approach provides a reasonable balance between sustaining the public purpose of allowance allocation to efficiency resources and engaging a range of public and private entities in delivering efficiency in an equitable and cost-effective manner. It also limits the risk of potential diversion of funds to competing public purposes.

This discussion shows that, under the recommended direct-allocation system for efficiency-based allowances, state governments would play a special role in bringing efficiency resources into the cap-and-trade system. This would be especially applicable if states had a direct role in allocating allowances within the larger emissions cap. If a state wanted to earn allowances via its publicly supported efficiency programs and policies—including public benefits programs, building energy codes, and appliance efficiency standards—the state could do so on behalf of the customers, energy service companies, program administrators, and others that had implemented the efficiency projects. This approach also partially addresses the issues raised by the "allocation to load" concept.

Aggregation of Energy Efficiency Savings

The scale of most energy efficiency projects yields energy savings at magnitudes much smaller than the scale of supply-side projects, even small electric generating units. Proposals for multi-pollutant cap-and-trade systems now under consideration would involve generators at least 15–25 MW and larger (or similar equivalent size for other types of stationary sources, such as CHP or large industry boilers).

Even these smaller sources generate large amounts of power; for example, a 15 MW unit operating just 3,000 hours per year produces 45,000 MWh annually. A more typical unit, at 300 MW running 6,000 hours a year, generates 1.8 million MWh. Individual energy efficiency projects—and even entire programs—might yield analogous energy generation reductions in units of kilowatt-hours, not megawatt-hours. For example, a large customer using an average of 5 MW for 8,000 hours per year, which saves 20% of its energy use through efficiency, generates only 8,000 MWh in savings annually. A typical home using 10,000 kWh annually, which saves 20%, creates only 2 MWh in annual savings. The minimum block of energy savings in the Title IV program is 500 MWh; clearly, smaller customers and projects cannot effectively participate on a solo basis.

Consequently, multi-pollutant emissions trading systems must allow for aggregation of projects into some pragmatic minimum size for an entity to participate effectively and economically in the multi-pollutant allowance market. Any trading system that includes energy efficiency must provide for aggregation of individual efficiency improvements—such as by entire programs or portfolios of programs encompassing thousands or even millions of individual efficiency measures. The transaction costs of aggregation and participation in the multi-pollutant allowance trading markets generally would be too big a barrier for small businesses and other small organizations to participate individually in this market. Allowing for aggregation also encourages affected sources to partner with appropriate program and service providers in order to earn efficiency-based allowances, whether such providers are public benefits programs, state agencies, third-parties, or other organizations.

The recommended approach of making direct allowance allocations to public entities such as state agencies, and allowing assignment of allowances to a variety of efficiency providers, serves as an effective model for aggregating efficiency resources under the aegis of a public policy.

Eligibility Relative to Timing and Baselines

As discussed earlier, once accurate baselines are established that properly account for existing and ongoing energy efficiency policies and effects, efficiency-based allowances could be earned and credited as energy efficiency gains beyond the baseline. In addition to rewarding improvements above the baseline, there also should be provisions to award efficiency-based allowances for "early action" and ongoing energy efficiency programs.

In setting the cap and timetable, the program administrator will have to determine a base year from which efficiency projects would be eligible to receive efficiency-based allowances, or use some other benchmarking approach. Experience would suggest establishing a specific baseline year for eligibility. The administrator could set a year that would both establish the baseline level of efficiency for a site or facility and coincide with the baseline year used to establish the emission caps. Any efficiency improvements relative to the baseline year would become the basis for earning allowances. This "start date" could potentially pre-date the actual initiation of the cap-and-trade system for multiple pollutants. If so, it may reward companies that took early action through implementation of energy efficiency projects. The administrator, in designing the details of the cap-and-trade system, will need to balance this important objective of crediting early action with the larger objective of generating net emission reductions on a going-forward basis.

The administrator also will need to establish maximum "service lifetimes" for which entities will receive allowances for energy efficiency improvements. We recommend that administrators establish different classes of measures according to lifetime characteristics. For example, we recommend three classes: (1) plug in/movable measures such as appliances (5–7 years); (2) durable measures such as HVAC (10–15 years); and (3) new buildings (20–30 years). However the classes and lifetimes would be set, we would encourage administrators to take a conservative approach. The principal reason for such an approach is that while many investments might be in place for many more years than any assumed "average" lifetime, the potential turn-over and changes that are typical in businesses and industries warrant a more conservative approach. This would also encourage new efficiency investments over time.

Measurement and Verification

Awarding efficiency-based allowances must be based on accurate measurements and estimates of energy savings that result from energy efficiency improvements, new product purchases, or new construction projects. Measurement and verification of savings is a well-developed practice that is integral to successful energy efficiency programs.

For a national cap-and-trade allowance system that would award allowances for qualified energy efficiency projects and programs, it would be critical to apply verification protocols that provide reasonable levels of assurance that energy efficiency savings actually are achieved, but also are not too burdensome or costly. The program rules for applying for and receiving energy efficiency-based allowances should not impose undue costs on entities seeking this option. The program rules should strike an effective balance between the need for accurate accounting of emission reductions and the need for user-friendly, streamlined administrative processes required of participating entities.

Energy efficiency measures and investments might be classified in three distinct categories in terms of their M&V requirements, namely:

- ***Energy-efficient products.*** Certain well-known and simpler measures, such as energy-efficient lighting technologies, and other new product purchases could readily and accurately be captured by "deemed savings" or engineering estimates. The amount of savings per end-use application is estimated using an agreed-upon standard for that technology. Deemed savings are single-value savings assigned to specific product types for which savings data are well documented and are consistent across climate regions and applications. Engineering estimates rely on simple algorithms that adjust known impacts on energy demand by a few simple parameters, such as hours of use or climate zones.

- ***New buildings and facilities.*** New buildings and other major new investments (new industrial facilities) would best be analyzed using simulation of energy loads compared to codes or other baselines. Credits would be awarded based on simulation analysis, using software constrained by specific rules to maximize accuracy and minimize gaming. Such rules have been accepted for building energy code compliance in some states and are the basis for tax credit qualification under the pending federal tax credit legislation. For residential buildings, credits would be awarded based on energy savings relative to the 2000 International Energy Conservation Code (IECC) and updated as the code is revised. Qualification for emissions reduction credits would be permitted through both prescriptive and performance paths.

- ***Major upgrades and energy efficiency improvements in existing facilities***. Upgrades and improvements would best be analyzed using the International Performance Verification and Monitoring Protocols developed and in use to determine energy savings from projects.

Public benefits and demand-side management (DSM) programs are likely already to have in place some type of evaluation protocols and requirements, making them a natural fit with such verification for the requirements of obtaining efficiency-based allowances. In such cases, there might well be no additional efforts and associated costs needed to measure and verify energy savings. The international climate change community is seeking a consensus monitoring and verification protocol that could serve as a model. Various documents have been developed, many with common elements, including the World Resources Institute guidance document (WRI 2004). Many statewide programs already are tracking and recording emissions reduction benefits from energy savings realized. As the administrator for the Title IV SO_2 cap-and-trade program, EPA established measurement and verification criteria for earning allowances from qualified energy efficiency projects. The administrator established under a possible multi-pollutant cap-and-trade system would similarly need to set the M&V criteria for earning efficiency-based allowances. An option might be to accept any existing state M&V criteria as long as they are equivalent to national criteria adopted.

KEY STAKEHOLDER PERSPECTIVES AND CASE STUDIES

In the previous section we demonstrated that energy efficiency can reduce multi-pollutant air emissions at costs lower than alternative “smokestack” or other control strategies and that the potential emissions reductions that could be achieved by such increased investment in energy efficiency over other options are significant. Energy efficiency alone can’t meet likely national emission reduction targets, but our analysis shows that it can be a cost-effective option within a broader portfolio of control and mitigation strategies.

Demonstrating this potential is important, but ultimately using energy efficiency to meet clean air objectives will come down to choices made by individual firms and plant operators. In this section we examine the perspectives of three key players in any national multi-pollutant cap-and-trade system: large industry, energy service companies, and electric utilities. Understanding these perspectives—especially critical issues facing these different types of entities—is critical to developing effective policies to include energy efficiency as a multi-pollutant air regulation strategy.

Large Industry

Comprehensive multi-pollutant cap-and-trade systems are likely to have significant impacts on large industry. Some large industries would be directly included in such systems and therefore would have to procure and surrender sufficient numbers of allowances for their operation. This case study estimates financial impacts and discusses some of the challenges facing the policymaking process from the perspective of industrial firms. We estimate potential financial benefits using a hypothetical example of a company that is an industry environmental leader and has implemented an energy management plan and associated efficiency improvements.

Facility Example: "Chemcorp"

The hypothetical chemical production facility in this example, Chemcorp, implemented an energy management plan that generated cost and pollution reductions similar to measured gains by a real facility of similar size. Chemcorp is known as a corporate leader for its progressive approaches to energy and environmental issues. This example is used to start a discussion of industry-wide benefits and the policy challenges that might occur in a national cap and trade program for NOx and CO_2.[10]

In the mid-1990s, Chemcorp leadership launched an integrated management plan for regulatory, social, and economic reasons. Chemcorp created an energy management team of energy and floor managers from ten different divisions. The team designed a program to identify potential energy savings across the facility and sought ideas from internal staff, their utilities, their partners in government programs, and an outside consultant. Of the 200 ideas proffered, 75 of the most cost-effective were implemented in the first five years. By the fifth year, Chemcorp was saving over 20 million dollars and 4 TBtu, plus NOx emissions of 450 tons and CO_2 emissions of over 65,000 tons annually.

To estimate the additional energy savings that could result from a cap-and-trade program, we estimated the value of emission allowances. Despite a relative lack of program experience from which to draw data, we defined a range of credit values from available literature. The literature indicates that for NOx trading, the range of values is estimated to be between $100 and $1,000 per ton.[11] The range of credit values estimated in the literature for incipient CO_2 trading programs under the aegis of the Kyoto Protocols is between $2.50 and $20 per ton.[12]

Using these ranges for the potential value of NOx and CO_2 allowances, we estimated the additional value to Chemcorp of increased energy efficiency investment (see Tables 10 and 11). Recall that the overall savings the plant had experienced so far was $20 million. The

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[10] Only these two pollutants are included in this study because there is no estimated savings data for a facility of this size for methane. Further, measurement of sulphur oxides is complicated by the in-place EPA SO2 trading program, on which there is a wealth of published information.

[11] To determine the value of the credits for NOx, we drew from the few programs that have successfully traded NOx credits. The Ozone Transport Commission Board for Eastern States NOx trading valued the credits for 1,000 – $4,500 per ton of NOx ($4,500 was an outlier due to extreme market conditions and was rejected for this analysis). The Pilot Emissions Reduction Trading (PERT) project was set up by the Canadian government to test emissions trading under Canada's Kyoto Treaty agreements. Because 50% of the air pollution in Ontario comes from outside the province, this gave internal emitters an opportunity to encourage external polluters to reduce emissions (Cleaner and Greener[SM] 2005). Because most of the pollution and therefore the external reduction potential originates in the United States, the credits sold between U.S. and Canadian companies had an average value of US$743 for the duration of the program. Further literature suggests that the actual price of credits is a fraction of their predicted price, so this report also considers a lower valued credit at $100.

[11]New Zealand chose to meet its Kyoto Treaty agreements through an emissions trading system. Although they are still in the process of designing its program, it expects a range of value for credits at US$2.50 to 5.00 for each metric ton of CO_2. British Petroleum (BP) initiated an internal pilot program for emissions trading in 1998. The program ended in 2000, but the emissions credits were valued at around US$20 during the duration of the program (http://www.bp.com/genericarticle.do?categoryId=55&contentId=2006476). ACEEE staff discussions with experts involved in the European Union carbon trading scheme indicate that carbon emission allowances are currently valued between $10 and $20

addition of NOx and CO_2 allowance values was estimated to increase the dollar value of energy savings by 1.0 to 9.9% (see Table 12). This relatively small incremental gain indicates that while the credits alone may not justify efficiency investments, their presence could certainly increase the yield from these investments. As the next section discusses, however, other factors could motivate efficiency investments for environmental reasons.

Table 10. Additional Cost Savings from NOx and CO_2 Emission Allowance Values

NOx			CO_2			Combined
Value of Credit (US $/ton)	Additional Dollar Savings (assuming credits sold)	Percentage of Original Savings	Value of Credit (US $/ton)	Additional dollar Savings (assuming credits sold)	Percentage of Original Savings	Additional Savings (% of original savings)
100	45,000	0.2	2.50	162,000	0.8	1.0
500	225,000	1.1	10	650,000	3.3	4.4
1000	450,000	2.3	20	1300000	6.5	8.8
1500	675,000	3.4				9.9*

* The highest end of this range was computed by adding the largest potential value for both NOx and CO_2.

Table 11. Estimated Monetized Benefits to ESCOs Efficiency-Based NOx Allowances

Value of Credit (US $/ton)	Added Financial Value
100	2,500
500	12,500
1000	25,000

Table 12. Estimated Monetized Benefit to ESCOs for Efficiency-Based CO_2 Allowances

Value of Credit (US $/ton)	Added Financial Value
2.50	10,800
10	36,000
20	72,000

Ancillary Benefits of Including Energy Efficiency in Multi-Pollutant Policy

As shown in the case study, direct economic benefits to a firm are likely to be small from receiving allowances for qualified energy efficiency projects. However, related benefits in the form of increased productivity and other non-energy features have been documented in several analyses (Elliott, Laitner, and Pye 1997; Finman and Laitner 2001; Worrell et al. 2003).

Moreover, industrial investment decisions are not strictly driven by costs. In this section we examine issues identified through interviews with industry experts. Despite the small magnitude of financial savings from NOx and CO_2 allowances, there are other important reasons for both the business and environmental community to support this policy approach. They include:

(1) Inclusion of efficiency-based compliance options can create new incentives and bring management attention to efficiency investments. Environmental policy that takes an integrated approach to energy and environmental issues would bring fresh focus from corporate management on using energy efficiency to meet multiple objectives. And the extra financial benefits are enough to make some marginal projects cost effective.

(2) For certain types of industry, the value provided by efficiency-based allowances might provide a critical margin to remain competitive. This would be especially true for energy-intensive industries because such industries are likely to be "affected sources" and because energy costs comprise such a large share of their production costs.

(3) Efficiency investments can enhance corporate image and "stewardship" values. Corporate strategies to become "greener" (more environmentally responsible) are increasing, and because efficiency is one of the most cost-effective green strategies, it supports both business performance and environmental stewardship goals.

From the broader policy perspective, incorporating energy efficiency into cap-and-trade systems creates a direct way to quantify some of efficiency's environmental benefits. This helps define the full range of efficiency's value, which can help policymakers assess and tap its overall resource potential.

In summary, energy efficiency compliance options in cap-and-trade systems are not by themselves likely to drive industrial firms' efficiency investments, because of the relatively small incremental benefit of such options. While none of the representatives of companies we interviewed indicated they were opposed to energy efficiency compliance options, neither did they say efficiency would be a first priority in emissions compliance, nor that efficiency-based compliance would drive significant new efficiency investment. Allowance values could make a difference on the margin for some efficiency projects and could help integrate efficiency more fully into corporate environmental policy, but these effects were seen to be generally small.

Energy Services Companies

Energy services companies have matured as an industry over the past twenty or more years. ESCOs typically offer to define and implement energy efficiency measures at no upfront capital cost to the client, financing the project based on cash flows from energy savings. Because of the large transaction costs and other financial realities in this market, they tend to work with larger establishments, including industrial, commercial, institutional, and government facilities. Many ESCOs have also adapted their business models to work in concert with public energy efficiency programs, and some of these programs have been designed to use ESCOs as agents in delivering efficiency services.

This case study is of a hypothetical large ESCO, which serves as an aggregator of credits in a NOx and CO_2 trading program.[13] It illustrates the financial benefits to ESCOs from energy efficiency projects qualifying as emission reduction measures. It then discusses the challenges facing ESCOs in cap-and-trade programs, as well as the policy design challenges in engaging ESCOs effectively. While this example and other experience show that the energy efficiency's value added as a compliance measure is low (in the 1–2% range), industry experts and ESCOs agree that including efficiency in cap-and-trade systems is important for other reasons, such as quantifying environmental benefits and creating an additional marketing factor.

Energy Services Example

This example is based on an aggregation of actual project NOx and CO_2 savings to illustrate how a large ESCO could aggregate multiple projects to create enough emissions reductions to earn allowances.

The ESCO in this case aggregates 130 projects quantified under the International Performance Measurement and Verification Protocol (IPMVP). Together, the projects reduce annual electricity use by about 5,000 MWh, NOx emissions by 25 tons, and CO_2 emissions by 3,600 tons.[14] This would create 25 NOx and 3,600 CO_2 allowance credits awarded to the ESCO.

We used the same range of emission allowance values as were applied in the industrial case study. They are \$100–\$1,500 per ton for NOx and \$2.50–\$20 per ton for CO_2. Based on these values, we estimated the value to the ESCO of efficiency-based allowances, which is summarized in Tables 11 and 12. These results show combined allowance values in the \$23,300 to \$100,000 range. While we had no data on the original energy savings from the aggregated projects, we empirically derived an estimated value of the efficiency allowances to be 1–2% of the total value of the project. Based on this estimate, the aggregate-added dollar value of the savings would be between \$120,000 and \$3.3 million. This relatively small percentage suggests that efficiency allowance values alone would sell projects for ESCOs; they could increase the yield from energy efficiency investments. The next section discusses other factors that support ESCOs' interest in efficiency-based allowances.

Ancillary Benefits of Including Energy Efficiency in Multi-Pollutant Policy

We interviewed ESCO experts, and former customers and employees regarding the impact of efficiency-based allowances within a cap-and-trade policy. The overriding response was that energy efficiency should be included in such policy regimes. The general reasoning was that while direct financial benefits from the allowances would be small, not including them would have a negative effect on ESCOs' ability to market projects.

[13] Only NOx and CO_2 were used in this example because value of credit data, although limited, is available.

[14] CO_2 reductions were estimated from a general ratio of savings determined empirically and from other examples. The ratio applied is 1 CO_2 ton reduced = .007 tons of NOx reduced.

The role of the ESCO is to package the total value of an energy efficiency project for the client. The financial value of including energy efficiency as a compliance measure in a cap-and-trade system is generally considered to be between 1–2% of the overall project value for ESCOs (Dower 2003; Gilligan 2003; Schiller 2003). However, the overall benefit is much greater than the direct financial benefit, since increasing energy efficiency often increases productivity, employee comfort, and enhances the client's public image (Romm 1999). This suggests that small gains as indicated above can have large overall effects for the client, and in an increasingly competitive world, such marginal gains can be important.

The main value of including efficiency-based allowances in multi-pollutant cap-and-trade programs is in two significant ancillary effects:

(1) This quantifies energy efficiency benefits within the scope of environmental benefits. Although environmentalists and energy analysts have long seen the connection between increasing energy efficiency and decreasing emissions, putting quantifiable links in place through efficiency allowances makes it "official." This creates an important policy precedent and also a perception in the market that efficiency has real financial value in the wider environmental field.

(2) This creates a new sales tool for ESCOs, who can offer a tangible benefit to companies interested in "greening" their operation, as well as the additional financial benefits. For some customers, the combination of perceived environmental stewardship and direct financial benefits, however small, can be a powerful motivator to implement projects. ESCOs are constantly looking for value-added options to include in their offerings. The availability of an energy efficiency compliance option would be another tool to edge out competition and win clients.

Challenges

There are a number of challenges that must be addressed for an efficiency-based allowance program to be attractive to ESCOs. We discuss these below.

Measurement and verification. While most ESCO projects use monitoring and verification protocols, and rigorous protocols have been developed and accepted by ESCOs and governments, there is a risk that a cap-and-trade program may impose additional and burdensome M&V requirements beyond current industry practice. If this occurs, it could limit project participation in efficiency-based allowances if the added M&V costs outweigh the benefits to the ESCO and its clients (Gilligan 2003).

Cap-and-trade programs should build on industry standards and practices in developing M&V requirements, rather than imposing entire new protocols. If M&V requires costly procedures, such as continuous monitoring of all project facilities, then the program would not be economically attractive to ESCOs (Gilligan 2003; Hanson 2003).

As an example of how to address the M&V issue, a simple and straightforward M&V approach was suggested by a former ESCO executive. His approach boils down to two principles:

(1) Use the same basic M&V protocols for emissions savings as for energy savings. This reduces the net cost of the emissions-related M&V to almost nothing.

(2) Use a program-based instead of project-based documentation of savings. This involves taking random data samplings from the entire program and applying those results to projects on a statistical basis. This spreads the cost of M&V over the whole program. The challenge is to base the sampling protocol on robust statistics so that it accurately represents the overall program.

Aggregation. ESCO support for efficiency-based allowances was predicated on the assumption that projects could be aggregated. Because allowances are likely to come in large blocks, ESCOs would need to be able to aggregate the savings and claim allowances from multiple projects. The aggregation concept is only viable, however, if the administrative costs of aggregation are manageable (Gilligan 2003). Because the marginal financial benefit from efficiency allowances is small, the administrative cost of aggregation could quickly overrun any savings. Therefore, the success of aggregation depends on the monetary value for the allowances exceeding the cost of managing it.

Utilities

Utility Case Study

Introduction. This case study is intended to illustrate the perspective of a large investor-owned utility (IOU) on the concept of including efficiency-based allowances as a compliance option under a cap-and-trade program. The utility chosen for this case study was Xcel Energy. Xcel provides a useful model because it is a large, vertically integrated IOU with substantial ownership of generation (and would thus presumably have a large emission allowance responsibility under a cap-and-trade policy), and it also has considerable experience administering energy efficiency programs. Since Xcel would encompass both affected sources and potential efficiency-based allowances, its reactions to the concept of allowing energy efficiency as a clean air compliance option is particularly useful to consider.[15]

Description of the utility. Xcel Energy is an integrated electric and natural gas energy company with utility operations in eleven Midwestern and Western states, formed by the merger of Denver-based New Century Energies and Minneapolis-based Northern States Power Company in 2000. In 2003, Xcel Energy was the nation's fourth largest combined electric and gas utility, with total revenues of approximately $9.5 billion annually. The company offers a comprehensive portfolio of energy-related products and services to 3.2

[15] Xcel Energy's participation in this analysis does not constitute an endorsement of a Clean Air Act cap-and-trade policy incorporating energy efficiency. The information in this document is provided for discussion purposes only.

million electric customers and 1.7 million natural gas customers. Xcel Energy owns and operates regulated power plants that generate about 15,246 MW of electric power.

Xcel Energy spends annually over $60 million on energy efficiency and load management programs across its service territory. According to the U.S. Energy Information Administration's (EIA) annual report of DSM programs, Xcel Energy's program achievements place it among the nation's top five utilities in terms of energy saved. Xcel Energy's subsidiary Northern States Power-Minnesota has run a comprehensive array of energy conservation and load management programs since the early 1990s. These programs have produced approximately 3,349 GWh of first-year energy savings against spending of $471 million. The company's programs have received numerous accolades for exemplary performance.

Potential benefits from including energy efficiency as a compliance option. Xcel Energy considers the efficiency-based allowance policy approach a potentially attractive option for managing pollutants. The benefits to the company of such an option could include:

- Increased flexibility in determining the most cost-effective way to manage pollutants;
- Opportunity to further leverage benefits derived from energy efficiency and load management programs;
- Increased ability to meet certain pollutant goals, it could bolster the company's ability to support specific caps; and
- Opportunity for the company to bank or be a net supplier of credits in a cap-and-trade market, thereby increasing earnings.

Although it is difficult to quantify without specific measurement guidelines the benefits of a cap-and-trade approach that incorporates energy efficiency programs, it is possible to use values supplied in connection with the EIA's 1605(b) voluntary reporting process for such an estimate.[16] Using the state-specific emissions factors provided by EIA, Xcel Energy estimates that its DSM programs are avoiding the following levels of emissions[17]:

Table 13 shows that a large majority of Xcel's emissions reductions are attributed to energy efficiency. Due to consistent ongoing DSM activities in a number of states within Xcel Energy's service territory, efficiency's role in emission reductions is increasing modestly each year. Figure 2 provides a graphic display of energy efficiency's relative contribution to Xcel Energy's greenhouse gas emission reductions based on EIA 1605(b) methods of calculation.

[16] Note that the EIA does not specify a methodology for conducting this calculation; however, it provides state-specific emissions factors for CO_2, CH_4, and N_20 to use in the absence of utility-specific or power-pool-specific values. Factors for CH_4, and N_20 are in CO_2 equivalents. Currently, Xcel Energy uses these values to calculate its state-specific greenhouse gas emissions reductions. EIA is in the process of updating its 1605(b) form and may provide further guidance in the future. Calculations for SO_2 and Hg are based on regional numbers provided as part of Xcel Energy's annual environmental disclosure filings.

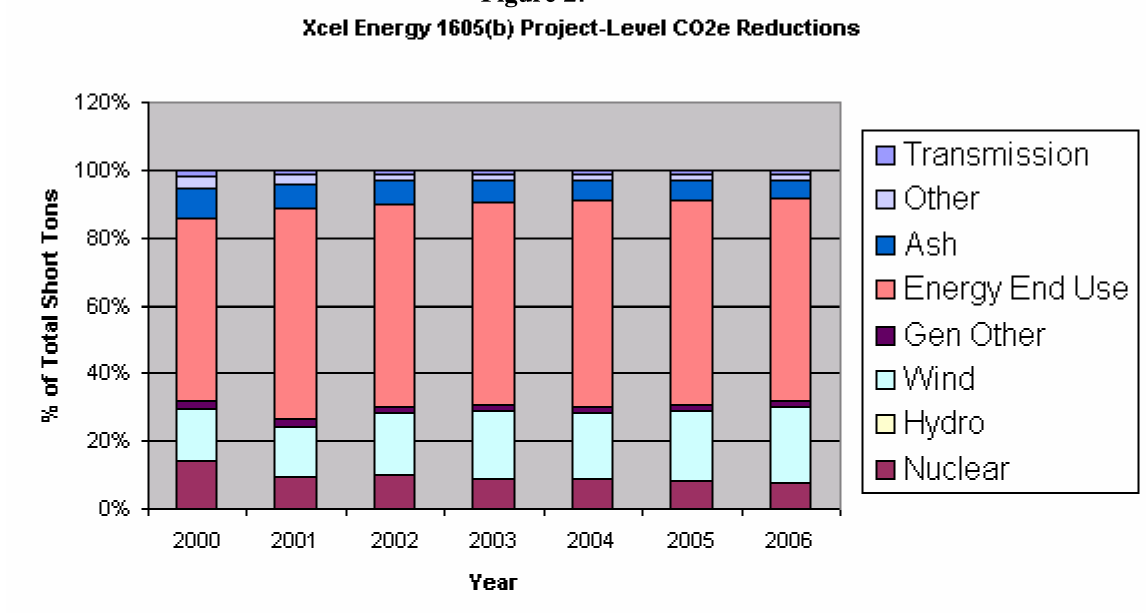
[17] State-specific emissions factors are not as accurate as company-specific values; however, they likely provide a reasonable estimate.

Table 13. Xcel Energy's 2003 Emissions Reductions

Pollutant	2003 EE—Contributed Incremental Reductions (Short Tons)—MN Only	2003 EE—Contributed Cumulative Reductions (Short Tons)—MN Only	Energy Efficiency's Contribution To Overall Reductions—MN Only*
CO_2	186,800	3,670,705	60%
CH_4	42	615	65%
N_20	930	14,280	86%
SO_2	422	5,416	N/A
Hg	3.02×10^{-6}	4.57×10^{-5}	N/A

* Based on cumulative data.

Figure 2:



NOTE: Approximately 99% of the Energy End Use component comes from EE projects.

While this data does not predict that a majority of Xcel's emission allowances would be achieved through energy efficiency under a cap-and-trade system, it does serve to illustrate the significance of the efficiency resource. Under a cap, the company would likely explore a variety of means to reduce covered emissions. However, the availability of significant blocks of efficiency resource as illustrated in these tables could make efficiency an effective emission reduction strategy.

Perceived drawbacks/challenges. Xcel Energy notes that such a policy also comes with attendant risks. For example, energy efficiency investments will reduce sales growth and without some compensation for lost margins, utilities will need more frequent rate relief. Also, energy efficiency programs could have the effect of increasing customer rates, which could further slow demand. This could in turn impact utility earnings and could potentially cause rates to become less competitive unless neighboring utilities are attempting to extract similar savings. Other potential drawbacks and challenges of such a policy would include:

- The impact such a policy might have on how Xcel runs its DSM programs,[18] namely–
  - Would DSM undergo significantly more scrutiny and require more evaluations, which might push the Conservation Improvement Program (CIP) programs to be non-cost-effective?
  - Would the state of Minnesota allow Xcel to receive a financial incentive for the conservation work as well as receive trading credits?
  - Would such a system, on a national level, require greater standardization of DSM programs and their underlying assumptions, and would that complicate Xcel's program administration with its unique state rules and requirements?
- How to handle contributions from states in which the utility's customers pay but the utility does not administer the DSM program (in Xcel Energy's service territory, this includes Wisconsin)?
- How would such a policy fit with the EIA 1605(b) reporting requirement?
- What reporting/administrative requirements would be associated with such a program?

Factors needed to include efficiency resources. The factors that would be most critical to encouraging Xcel Energy to participate in such a program include:

- Ability for Xcel to continue to earn state-authorized performance-based financial incentives for DSM;
- Ability to include load management programs and potentially rate design options within consideration of what constitutes energy efficiency;
- Flexibility for utilities to define ways to verify that energy efficiency results are occurring as estimated;
- Ability to include in energy efficiency calculations achievements from previous year's investments (because investments from prior years continue to contribute to offsets due to technology lifetimes); and
- Flexibility to administer programs as the utility sees fit without particular emphasis on one approach over another (e.g., market transformation vs. traditional rebates).

[18] Note that in Minnesota, the company is required by statute to spend annually a minimum of 2% of gross operating revenues on cost-effective DSM.

Discussion. Xcel Energy considers an efficiency-based allowance policy a potentially useful option to include in its methods for meeting Clean Air Act requirements. For next steps, it would be helpful to understand how other utilities might consider handling such an option, and whether other interested parties (e.g., state regulators, industrial customers, and environmental groups) would be supportive.

Xcel Energy's view of such a policy is colored by the way the company runs its current DSM programs. However, the company's approach to DSM may change based on evolving state requirements. We also recognize that few utilities remain under requirements similar to those that exist for Minnesota utilities. In Xcel Energy's case, Minnesota is the state in which the company runs its largest DSM program. Although the trend toward retail electric restructuring has slowed, the possibility remains that restructuring would be revived in the future. It would be helpful to understand how such a clean air policy would interact with retail and wholesale electric restructuring issues currently and into the future.

CONCLUSIONS AND RECOMMENDATIONS

This project has shown that efficiency can make a major contribution to emission reduction goals for multiple pollutants. It has also shown that efficiency can achieve emissions reductions at lower average cost than conventional smokestack emission reduction technologies. Moreover, a reasonable efficiency investment scenario would provide significant net benefits to the U.S. economy, creating over 400,000 new jobs by 2020.

From a policy perspective, efficiency has generally been acknowledged for its emissions reduction value. At the same time, policy approaches based on conventional economic theory have been inadequate to realize the level of energy efficiency investment that is economically justified and technically feasible. Declining energy intensity, a host of market barriers, and inherent barriers within cap-and-trade systems all serve to limit efficiency's potential contribution to air quality and climate protection goals.

Efficiency thus requires explicit treatment in emissions cap-and-trade systems. After reviewing the pertinent issues and a range of options for including efficiency in such systems, we recommend that efficiency resources receive direct emissions allowance allocations in the cap-and-trade design. States would be the primary recipients of efficiency-based allowances and would be able to assign them to various providers of efficiency services within their jurisdictions.

This direct allocation approach is the option best able to overcome the fundamental barriers to efficiency-based allowances in cap-and-trade systems. We also suggest that allowance auctions, with the proceeds used for efficiency investments and other emissions reducing resources, could be used as a complementary or alternative approach. In addition, we recommend that policymakers also pursue energy efficiency policies and programs in parallel with cap-and-trade systems, as this approach permits more aggressive emission reduction targets to be set and helps reduce the cost of meeting these targets.

The high transaction costs of assembling efficiency resources for participation in emission reduction programs, and the limited value of emission allowances to efficiency providers, among other barriers, would otherwise severely limit efficiency's ultimate contribution to reaching environmental goals at minimum costs. Our assessment is that direct allocations to efficiency resources, complemented with auctions and parallel policies, will result in lower total costs of meeting emissions caps and will thus make the economic effects of cap-and-trade systems much more favorable. The long-term result would be a cleaner environment and a stronger economy.

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