Setting and Administering Output-Based Emission Standards for the Power Sector

A Case Study of the Massachusetts Output-Based Emission Control Programs

Prepared for the China Sustainable Energy Program

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I. Introduction

This workpaper describes output-based (or generation performance standard)[1] emission control programs in the United States (U.S.). Specifically, the purpose of this workpaper is to present and discuss methods for establishing the *emission standards* for (Section III), and *administering* (Section IV), output-based programs to control emissions from the power sector. The presentations are based upon actual standard-setting and administrative practices used by the Department of Environmental Protection (DEP) of the State of Massachusetts in the U.S., for programs developed in that state to control power plant emissions.

This discussion focuses on *state-based* program implementation. The U.S. Environmental Protection Agency (EPA) is the government entity responsible for setting *national* environmental standards and for designing federal (and multi-state) programs that must be implemented by individual states to meet the national environmental standards. In the U.S., state-level policies (which may correspond to the province- or city-level policies in China) to address air quality are developed for two purposes. First, states must develop regulations that apply to in-state sources to meet federal (EPA) requirements. Second, a state also may go beyond federal requirements and require further reductions from sources if it determines that doing so is necessary and appropriate to protect public health and the environment within its borders. The two state programs reviewed in this workpaper include an example of each.

Importantly, individual state programs and actions often precede – or lead to – federal action on emerging environmental issues. In this sense, states are often "pilots" for federal action. This appears to be true in the case of output-based emission controls for the power plant sector, where an increasing number of state and federal air quality programs are considering or applying output-based principles.[2] While Massachusetts is certainly not the only state that has made the move to output-based programs, it has set and administered output-based standards to a degree not found in any other state in the U.S to date. Thus, the review of the Massachusetts programs should provide a comprehensive description of how standard-setting and administrative issues have been addressed in the output-based regulatory context in the U.S.

Regardless of program design, and whether developed at the federal or state level, all emission control requirements begin with an environmental goal. Once the environmental goal is identified, the regulating agency works (1) to develop emission standards in consideration of the physical, economic, and social factors and priorities normally considered by government entities when developing regulations, and (2) to construct rules to administer and enforce control program requirements in a way that will provide certainty that the desired reductions are obtained while minimizing program costs. In this workpaper, we focus on those environmental, economic, and social factors considered at the state level that led Massachusetts to adopt output-based regulations, and on those aspects of program administration unique to output-based programs.[3]

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[1] The emission control programs described in these workpapers have been referred to as "output-based," "generation performance standards," and "emission performance standards." We consider the terms "output-based standards" and "generation performance standards" to be synonymous. The term "emission performance standards" generally refers to standards applied to retail suppliers. The distinguishing feature of all programs falling into these categories is that the emission control requirements are stated in terms of emissions *per unit of useful output* (as opposed to emissions per unit of fuel or heat input). In this workpaper, , we will refer to these programs using the most generic term of "output-based" programs or standards.

[2] USEPA has adopted an output-based standard for its New Source Performance Standards regulation for large electric utility steam generators (40 CFR 60, Subpart Da). Connecticut and New Jersey have also used a form of output-based standards in their allocations for the regional NOx program. Finally, the U.S. Congress is now considering proposed four-pollutant legislation that uses output-based standards.

[3] The factors related to setting standards and designing programs *at the national level* has been reviewed in a recent draft working paper as part of a Cooperative Project of P.R. China's State Environmental Protection Administration and the U.S. Environmental Protection Agency, "*Program Elements of an SO2 Cap and Trade Program – Feasibility Analysis of Design Options.*"

In summary, Massachusetts considered many factors in deciding to use output-based principles for the control of power plant emissions in DEP's air quality programs, but two stand out in particular. First, in *setting program standards* Massachusetts places a high priority on meeting environmental goals in a way that will increase the generation efficiency of the power sector, compared with other forms of emission control. This approach recognizes that increasing generation efficiency will improve the state economy while achieving an overall reduction in the environmental impacts of electricity generation (including impacts from controlled and uncontrolled pollutants).

Second, DEP recognized that using output-based standards would allow the state to *administer its emission control program* in a manner (1) that is compatible with a privatized, competitive electricity market, and (2) that uses data on electrical output that are already collected to monitor and settle financial transactions in the electricity market. Since a competitive electricity market is based on the buying and selling of megawatt-hours (MWh) of electrical output, basing the emission standards on tons emitted per MWh aligns the financial incentives of the emission control program with the price signals of the market, and reduces administrative costs by using existing, accurate data for compliance purposes.[4]

In Section II, we provide an overview of the Massachusetts output-based programs. In Section III, we describe the factors considered in setting the actual output-based emission standards, including how using the output-based method meets the state's economic and environmental goals. In Section IV, we provide important details of program administration that are necessary to ensure that the emission standards are met, including how basing the standards on useful output allows Massachusetts to increase the reliability of meeting its environmental goals while lowering overall program costs.

II. Overview of the Massachusetts Programs

Massachusetts has two recent programs to control power plant emissions that rely upon output-based standards. The first – which is an example of a state program developed to comply with a federal requirement – governs the allocation of emission allowances, or pollution "rights," to power plants in Massachusetts as part of a 22-state regional cap-and-trade program to reduce harmful ozone levels in the eastern half of the United States. This is referred to as the "NOx Allocation" in this paper. The second program – which is an example of a state program not related to, and that goes beyond, any federal requirement – limits the permitted level of (concentration-based) emission rates for several pollutants (CO_2, SO_2, NO_x and Mercury) at each of the highest-emitting power plants in the state. This is referred to as the "Multi-Pollutant Program" in this paper. A brief overview of each program is provided below.

NOX ALLOCATION

The U.S. Environmental Protection Agency (EPA), with authority provided by the U.S. Congress through the Clean Air Act law, has required that states with high levels of ozone in ambient air (ground-level ozone) take steps to control emissions from all in-state sources in order to meet the national ambient air quality standard for ozone. However, many states have had a difficult time in reducing ground-level ozone to concentrations below the federal ambient air quality standards, in part because ozone in individual states results not only from emission sources within those states, but also from pollutants transported into the state on prevailing winds from neighboring states. Consequently, EPA has used its legal authority under the Clean Air Act law to require 22 states to participate in a multi-state emission control program ("EPA SIP Call") to reduce the overall level of ozone across a broad region in the Eastern U.S.

[4] We note, however, that a competitive generation market is not a prerequisite for implementation of an output-based approach to emissions regulation; because it promotes economic efficiency in generation and emissions control, it also provides important incentives under other industry structures.

The EPA SIP Call is designed to help states meet the health-based ozone standards by capping summertime emissions of NO_x from large power plants in the affected states.[5] EPA took the following steps to establish a cap on summertime NOx emissions. First, EPA gathered data on historic operations of the power plants in each state. Second, EPA estimated the expected regional growth in generation and emissions over the next 5-10 years. Then, EPA set a regional NOx cap that would control summertime emissions to 85% of these expected future emission levels, which was equivalent to a standard of 0.15 lbs/mmBtu.[6] EPA then divided up this overall cap to affected states based on the historical operation of the affected units in each state, compared to the historic operation of the affected units in all states..

In the Massachusetts NO_x Allocation, DEP needed to determine how to divide, or "allocate," its portion of the EPA SIP Call state budget of approximately 12,000 tons, or allowances,[7] among all sources in the state greater than 15 MW, including roughly 30 power plants. . In addition, DEP needed to write enforceable regulations governing how the allocation will occur in each year, how sources will need to record and report data to demonstrate compliance, and how the state will review the data and take action against sources that fail to comply. The state's allocation decision is discussed in Section III, below. The administrative elements are discussed in Section IV. The regulations and related DEP program documents can be found at http://www.state.ma.us/dep/bwp/daqc/daqcpubs.htm#nox.

MULTI-POLLUTANT PROGRAM

In April, 2001, the Massachusetts DEP issued a comprehensive set of emission control requirements for the highest-emitting power plants located within the state. The regulations were issued in response to a growing body of evidence that the six largest, least efficient power facilities in Massachusetts represent a disproportionately large part of Massachusetts' contribution to regional and global environmental problems, and present a public health risk for the state's citizens. These facilities represented almost half of the state's SO2 emissions, over 80% of the stationary NOx emissions (about 10% of the state total), and about 30% of the CO2 emissions.

The Multi-Pollutant Program regulations require each affected plant to meet specific output-based emission rates for CO_2, SO_2, NO_x and Mercury.[8] The standards need to be met on an average basis (across all generating units at each plant) on a monthly and annual basis. In developing the standards for this program, DEP considered local, regional, and global environmental and public health impacts, as well as the availability and cost of compliance opportunities. As with the NOx Allocation, DEP needed to develop enforceable regulations that relied upon available emissions and electricity measurement methods and agency enforcement authorities. The state's output-based standards are discussed in Section III, below. The administrative elements are discussed in Section IV. The regulations and related DEP program documents can be found at http://www.state.ma.us/dep/bwp/daqc/daqcpubs.htm#regs.

[5] Areas of the United States that exceed the health-based standard for ground level ozone do so almost exclusively during the months of May through September. Control programs to address ozone include both year-round maximum emission rate requirements and summertime cap and trade programs.

[6] EPA considered allocating the regional NOx cap to the states on an output basis. However, all of EPA's past allocation decisions had been input-based, and they deemed it too difficult to switch at that point. EPA did, however, provide written guidance to the states on allocating their state NOx budget on an output basis.

[7] As in the federal acid rain program for SO_2, one allowance in the SIP Call Program is equal to one ton of NO_x emissions.

[8] Actual standards for CO_2, SO_2, and NO_x are included in the regulations. Mercury standards will be proposed upon completion of a DEP study on mercury control technologies.

III. Allocation Method and Multi-Pollutant Program Standards

DEVELOPMENT OF POLLUTION STANDARDS: Cost-Benefit Analyses and Other Considerations

The development of emission control standards should begin with clearly-articulated environmental goals.[9] Once these goals are understood, there are many factors that are considered by regulatory agencies in the U.S. when setting the appropriate emission control standard to meet the environmental goal. Some of the factors are measurable, and lend themselves to quantification for the purpose of formal cost-benefit analyses (CBA). Typically, federal and state regulatory authorities are required by law or policy to undertake at least a limited CBA to evaluate proposed regulatory actions or policy options. Through a well-constructed CBA, government agencies can: (1) compare the public benefits of policy proposals to implementation costs, (2) screen proposals to determine if they meet minimum public policy thresholds, (3) compare the relative benefits and costs of competing policy alternatives,(4) document the policy rationale for the affected sources and the public, and (5) use a consistent framework for organizing a complex set of data and information considered in the regulatory process.

Some examples of quantitative data that are often identified and quantified in CBAs include:

- Public Health Benefits
  - Fewer premature deaths due to exposure to air pollutants
  - Fewer lost worker days due to exposure to air pollutants
  - Fewer hospital admissions and emergency room visits due to respiratory and other pollutant-related ailments
  - Fewer health impacts of exposure to mercury and other power plant discharges

- Environmental Benefits
  - Reduced loss/increased yields from agricultural crops
  - Reduced loss/increased yields from forests
  - Increased visibility in national historic monuments/parks and recreational areas
  - Decreased damage to buildings and other structures

- Compliance Costs
  - Control technology installation and operation expenses
  - Monitoring and reporting expenses
  - Additional staffing expenses

- Administrative Costs
  - Regulatory design and proceedings costs
  - Ongoing oversight, monitoring, and enforcement expenses

It is important to recognize that there can be substantial drawbacks to relying *only* on CBAs to determine the path of regulatory action. These drawbacks are mostly related to the inherent difficulty in identifying categories of costs and benefits, and assigning accurate, objective monetary values to them. For example, CBAs (1) may miss or undervalue the most important policy benefits or costs if they are indirect, hidden, or intangible; (2) may be heavily dependent on data or forecasts that are incomplete, or highly uncertain or variable; (3) may rely primarily on administrative and subjective

[9] Examples of statements of environmental goals could include (1) attaining concentrations of ground-level ozone (or other pollutants) in ambient air at or below levels found to be necessary to protect the public health with an adequate margin of safety by 2007; (2) stopping and reversing the acidification of the nation's lakes; (3) reversing the progressive thinning of the ozone layer in the upper atmosphere; and (4) stabilizing the concentration of greenhouse gases in the atmosphere at pre-industrial levels by 2050. Although these goal statements seem very general, meeting the goals requires taking actions to reduce related emissions by specific amounts over set timeframes.

determinations of the value of fundamentally unquantifiable goods, such as life, health, and aesthetic value; (4) may be too narrow or broad in scope to provide useful guidance; and (5) may be too complex for public or policymaking purposes. Given these complexities, if not designed properly CBAs can provide very detailed and comprehensive answers to the wrong questions.

Some examples of the categories of benefits and costs that are generally not captured, or captured imperfectly, in CBAs include:

- Public Health
  - The economic value of life and health
  - Chronic decreases in respiratory function
  - Cancer and other long-term impacts
  - Lost worker productivity and health care costs not easily identified as resulting from pollution exposure
  - Developmental impacts in children

- Environmental
  - Aesthetic value
  - Progressive deterioration of vegetation and soil quality
  - Acidification of forests, streams and lakes
  - Eutrophication, and nitrification of watersheds and coastal waters
  - Species extinction
  - Local and global impacts of climate change

Due to the inherent difficulty and uncertainty associated with formal CBAs, regulatory decision-making rarely relies solely on a quantification of known program costs and benefits. Rather, state and federal policies also involve explicit and implicit consideration of a number of other factors, including:

- Categories of benefits and costs (such as those listed above) that are not easily measured or quantified
- Ancillary environmental benefits (such as coincident reductions in some pollutants not targeted by the proposed policy) and costs (e.g., increasing the level of hazardous solid waste by installing a control technology to decrease air emissions)
- Whether and how the quality and reliability of electricity service could be affected, and what impacts, if any, any interruption in reliability would have on government, industry, and the general public
- Secondary economic and employment impacts including, for example:
  - Additional local employment through new control technology construction, other labor-intensive control strategies, or the influx of new, cleaner facilities
  - Potential loss of local jobs through the shutdown of affected facilities, or in some states the closing of mines producing coal that is high in sulfur content
  - The impact of changes in electricity rates due to proposed regulations on the competitiveness of businesses or the performance of government functions and educational institutions
- The opinions and expectations of state residents to improving public health and environmental conditions
- Political considerations of government institutions and individual government representatives

It is easy, but not necessarily correct, to conclude that regulatory decisions should be based only upon a comparison of quantifiable costs and benefits. It is similarly easy to decide that such analyses are always too uncertain or inaccurate to be useful in evaluating regulatory policy. In practice in Massachusetts, as well as throughout the United States, policy decisions are based on a mix of quantitative analyses and qualitative considerations. What is important (from a technical and legal

standpoint) is that such analyses and policy preferences be developed in compliance with applicable requirements, through a public process, with input from interested parties and the general public, and that the rationale for the decision be stated clearly.

The end result of evaluating policy options through quantitative and qualitative analysis, and in consideration of other social and political factors, is a set of emission standards or policies that need to be met over an identified timeframe in order to achieve the stated environmental goal. The two output-based programs in Massachusetts were developed in this manner, but pursuant to very different program goals and obligations. For the NOx Allocation, DEP was responding to a prescriptive federal requirement to meet a summer-time (May to October) cap of roughly 12,000 tons on NOx emissions from power plants. The analysis therefore focused on how to meet this cap in a manner that would minimize costs while meeting the state's goals to encourage efficiency in electricity generation. For the Multi-Pollutant Program, Massachusetts acted on its own to address serious pollution impacts not fully addressed in federal environmental policy. The analysis therefore required a more comprehensive review of environmental, economic, and political factors to determine the appropriate standards. Each of these programs is discussed below.

NOX ALLOCATION

Program Goals

The NOx Allocation represents the state administration of a pre-specified federal requirement: the capping of summer-time NO_x emissions from the electricity generating sector in Massachusetts at approximately 12,000 tons, in order to help bring Massachusetts and neighboring states into attainment with the National Ambient Air Quality Standard (NAAQS) for ozone. The environmental goal is implicit in the EPA-specified state budget. That is, the states' budgets were set by EPA as part of the obligations (state and federal) of the federal Clean Air Act to attain the public health standards for ozone.[10] The EPA administration of a regional program was deemed necessary in order to address the fact that individual state actions to come into compliance with the NAAQS for ozone is frustrated by the transport of ozone and its precursors from upwind states who do not violate the standards themselves.

From the perspective of Massachusetts, then, the goal for the NOx Allocation program design was to allocate the state NO_x budget to affected power plants in a manner that would minimize costs and meet state priorities related to the operation and regulation of the electricity generating sector in the state.[11]

Cost/Benefit Analysis and Other Factors Considered

In developing regulations, state policy in Massachusetts requires a review of program costs and benefits, and to pursue a program design that will achieve the environmental objectives (or in this case, federal requirement) at the lowest cost to the state. The DEP review of these factors is summarized below. There are two overriding state policy objectives reflected in this analysis:

- *Fair Competition*: In late 1997, Massachusetts passed a law that restructured the electric industry in the state, privatized the generation of electricity, and allowed customers to choose their electricity supplier. In doing so, the state legislature and the regulatory body responsible

[10] The ozone NAAQS level is set based on a comprehensive review of epidemiological and clinical studies related to the health impacts of ozone on humans, and has been judged to be the level necessary to protect the public health with an adequate margin of safety.

[11] The EPA requirements encouraged, but did not require, administration of a cap and trade program for large point sources (mostly power plants) to meet the state emission budget requirements. While Massachusetts could have allocated emission rights under the program to sources other than electric utilities, it was clear from an analysis of possible program costs and administrative requirements that including only the large point sources would minimize program costs.

for overseeing the restructuring of the industry stressed the need to achieve fair competition among generators in order to ensure that customer choice would lead to lower prices over time. However, among in-state generating facilities, older and less efficient plants enjoy a competitive advantage over newer facilities, since they are not required to meet emission standards as stringent as those met by newer plants. Consequently, a critical concern in the development of state environmental policy is to establish standards in a way that treats all competing electricity generating facilities equally.

- *Pollution Prevention*: For several years, the Massachusetts DEP has tried to incorporate pollution prevention concepts into program design. In a general sense, pollution prevention seeks to reduce all waste streams (air and water emissions, solid waste) at the source of production wherever possible. In this specific context, pollution prevention means designing air quality programs in a way that reduces emissions of the targeted pollutant(s), but also encourages an overall reduction in all environmental impacts from electricity generation. Consequently, a major objective of program design focuses on encouraging improvements in generation efficiency in order to reduce the fuel consumed for – and thus all environmental impacts associated with – electricity generation.

The cost-benefit analysis is organized to review three primary areas: the overall public health and environmental benefits of the program, the costs to meet the federal requirements compared with the costs of alternatives, and the maximum increase in electricity prices resulting from the program.

Overall public health and environmental benefits

The benefits of the program derive from an annual reduction in emissions of NO_x by approximately 5,000 tons compared with current levels in the state (this represents approximately a 28% reduction in state NO_x emissions). The DEP review of health and environmental benefits reiterates the benefits identified by EPA in establishing the federal SIP Call program and setting state NO_x budgets. These expected benefits include:

- Fewer incidences of decreased lung function, asthma complications, and other respiratory-related illnesses;
- Fewer hospital admissions, emergency room visits, and lost work days associated with respiratory conditions;
- Reduced agricultural losses and damage to forests and ecosystems; and
- Reduced nitrification of water bodies and acid deposition.

In addition, DEP noted that, by allocating allowances based on electrical output (rather than fuel or heat input), the economic signal of the NOx Allocation Program would likely lead to (1) generating efficiency improvements at affected sources, and (2) a general increase in the operation of the most efficient generating facilities, reducing the output of the less efficient facilities. Consequently, less fossil fuel will be needed to produce the same quantity of electricity, leading to lower environmental impacts overall. DEP considered the delivery of these ancillary environmental effects through an output-based approach an important benefit of the NOx Allocation program.

The cost of the state's NOx Allocation compared with alternatives

Since the NOx Allocation Program at the state level began with an EPA requirement to reduce emissions by around 5,000 tons (to get to the EPA-mandated state budget of roughly 12,000 tons), the focus of DEP's cost analysis was to identify the least expensive way to achieve that reduction. In doing so, DEP considered

- The costs to control large point sources – or power plants – compared with the costs to control on- and off-road mobile sources, area sources, and smaller point sources;
- The costs to achieve reductions from power plants through a cap and trade program, compared with achieving the reductions through emission rate requirements or technology requirements; and
- The costs to implement a cap and trade program for power plants using an output-based allowance allocation compared with use of a fuel- or heat-input based allowance allocation.

In order to compare such costs, DEP relied upon existing studies conducted at the federal level concerning the costs to control emissions of NOx from various sectors, and on a review of the likely economic impacts of different allocation methods. DEP concluded that meeting the federally-mandated cap through a power plant cap and trade program using an output-based allocation of allowances based on historical electrical output would be the least-cost program alternative.

Estimate of the maximum increase in electricity prices

Finally, DEP considered it important to estimate the maximum cost increase for purchasers of electricity as a result of the program, assuming that all compliance costs would be passed on to consumers through the price of electricity. This was calculated by multiplying the total tons of emissions reduced times the maximum cost per ton to meet requirements (giving the maximum cost in dollars of program compliance), and dividing this times the total number of kilowatt-hours of electricity sold in the state. The result, approximately 0.02 cents per kilowatt-hour, was found to be a modest and acceptable level of cost to achieve the program benefits. The formula for this calculation is as follows:

$$C_{max} = (T \times P)/E_{MA}$$

Where:
C_{max} is the maximum unit program cost (in cents per kWh),
T is the total emission reduction required (in tons),
P is the cost to reduce one ton of emissions (in $), and
E_{MA} is the total sales of electricity in Massachusetts (in kWh).

In sum, by analyzing quantitative and qualitative considerations related to program costs and benefits given the environmental goal and state policy objectives related to the electric industry, Massachusetts chose an output-based allocation under the NOx Program as the program design most likely to deliver important public health and environmental benefits at the lowest cost.

Data Used in Setting the Allocation

As noted above, the Massachusetts output-based allocation began with a summer-time state budget of approximately 12,000 tons, and a requirement that total emissions from the affected power plants in the state not exceed that cap beginning in the year 2003 (the year the program begins). In order to determine the allocation of the state budget to affected sources using the output-based method, DEP used historical data on electrical output. For the allocation, DEP chose to average the two highest of the previous five years worth of data on net electrical output for each facility. DEP chose this method at the request of the facilities because (1) using the two highest years would generally give the facilities a higher allocation, and (2) EPA generally uses the most recent five-year period as indicative of a facility's performance.

A more detailed description of data used in setting output-based standards is contained in Attachment A. Data needs are discussed in terms of (1) once the desired reductions are identified, information that is needed to set the GPS standards (generally historical data); (2) information that is needed to monitor and enforce GPS standards (generally data from the compliance year in question); and (3) steps that

should be taken at the time of industry restructuring to facilitate the collection of adequate data to monitor and demonstrate compliance.

To determine an individual facility's allocation, DEP multiplied the state budget by the ratio of each facilities' average electrical output to the total of the average outputs for all facilities in the program.[12] Each year, DEP recalculates the allocation based on the most current information, including allocations for any new facilities.

Other possibilities for developing an output-based allocation include:

- Allowances could be allocated to the newest, most efficient facilities based upon their maximum rated emissions (rather than based on electrical output). If the allocation is based on electrical output, the cleanest, most efficient generating facilities would likely receive more allowances in each year than needed to cover actual emissions, which they could then sell to less efficient sources. This alternative approach (allocation based on maximum possible emissions) would provide these sources at least enough allowances to cover actual emissions, yet fewer allowances than they would receive under a "pure" output based allocation. Consequently, the likely effect of this alternative approach (compared to the pure output-based method) would be to reduce the allowances granted to newer facilities, increasing the percentage of allowances allocated to less efficient sources.
- Allowances could be assigned a set portion of the budget to new facilities at the outset, based upon the number of new facilities and their expected percentage of total generation.
- Extra allowances could be allocated to higher emitting sources in consideration of their age, emission rates and/or efficiency levels.
- The first step of the allocation could be to assign a set portion of the budget to different fuel types.

These alternatives approaches could be used initially to mitigate the economic impacts of an output-based approach. They could pave the way for a true output-based approach and be phased out over several years.

Other alternatives can be used to provide additional incentives for cleaner, more efficient generation. These include:

- Setting aside a portion of the budget for clean, more efficient facilities yet to be built;
- Designate a portion of the budget (e.g. 5%, or 600 allowances) to be awarded to programs or projects that promote the development and installation of energy efficiency measures and renewable power generation. Income from the sale of allowances awarded in this manner could be used to reduce the costs of these programs.
- Issue additional allowances to facilities for their useful heat or steam output.

MULTI-POLLUTANT PROGRAM

Program Goals

The Multi-Pollutant Program is an example of an emission control program developed at the state level to further reduce harmful pollutants that remain after meeting all federal requirements. DEP developed these regulations for three basic reasons. First, the oldest, least efficient power plants in Massachusetts – including all coal-fired and older oil-fired electricity generators – represent a

[12] As an example, assume the Massachusetts annual budget is 12,000 tons. If a facility had an average generation of 1,000 MWh, and the total generation of all affected facilities is 10,000 MWh, then the facility in question would be allocated 1/10th of the state budget, or 1,200 allowances.

disproportionately high portion of the states' emissions from power plants of several key pollutants contributing to the most important global and regional air quality problems, such as climate change, particulates, ground-level ozone, and acid precipitation.[13] Second, there is a growing body of epidemiological evidence that emissions of fine particles from coal-fired facilities, along with other emissions of fine particles, represent a very high public health risk for the state's citizens. Finally, Massachusetts recognized that the development of a competitive electricity market in the state requires the elimination of competitive advantages conferred upon these older facilities by state and federal environmental regulations that subject newer electric generators to much more stringent emission control requirements, while exempting older, less efficient facilities from such requirements.

In consideration of these important state policy considerations, the goals of the Multi-Pollutant Program can be stated as:

- achieving meaningful reductions in emissions of several pollutants at once from the older power plants;
- setting emission standards as close as is technically and economically feasible to the emission standards that must be met by the newer generating facilities against which they compete; and
- administering the program in a manner that encourages energy efficiency, is cost effective, and is consistent with the price signals of a competitive electricity market.

State policy makers considered these environmental and state policy goals in developing the programs, but also needed to consider the physical and economic attributes of the affected sources. For example, in light of the disproportionate impact of the oldest, least efficient coal- and oil-fired electricity generators, the program was limited to restrictions on emissions from these facilities. DEP originally considered including all large electricity generators in the state, but upon reviewing facility emission profiles determined that all but the older facilities would meet the requirements. In addition, although the Multi-Pollutant Program was in part designed to level the playing field for all electricity generators, state decision-makers realized that a sudden and severe emission reduction requirement could impact the competitiveness of the affected generators, and/or cause permanent closure of certain generating units. Consequently, the regulations include several program features intended to provide compliance flexibility in order to reduce the potential impacts on facility operation and economics, while achieving the needed emission reductions over time. These program design features included setting compliance deadlines in consideration of the time necessary to install control technologies in a manner least disruptive to facility operations, and alternative deadlines for projects that would require greater planning and implementation (such as facility repowering).

Cost/Benefit Description and Other Factors Considered

As mentioned in the description of the NOx Allocation, above, in developing regulations, state policy in Massachusetts requires reviewing program costs and benefits, and pursuing a program design that will achieve the environmental objectives at the lowest cost to the state. The DEP review of these factors for the Multi-Pollutant Program is summarized below. As with the NOx Allocation, equal treatment of generating facilities in a competitive environment, and encouraging improvements in generation efficiency, were fundamental considerations in the setting of standards and in program design.

The cost-benefit analysis included the following relevant information for each pollutant: the overall public health and environmental benefits of the program, and the costs of program compliance and

[13] In 1999, the US EPA issued a report entitled "*Analysis of Emissions Reduction Options for the Electric Power Industry*," which found that pollution control strategies to reduce emissions of these four pollutants, and the cost and other impacts of these control strategies, are highly interdependent. This report found that having advance knowledge of potential requirements for all four pollutants could lead firms to adopt significantly different (and less costly) control strategies, compared with compliance choices made if the pollutants are addressed individually.

agency administration. The benefit and cost findings of DEP are summarized below by pollutant. Following this, we summarize DEP's findings with respect to the impact of the Multi-Pollutant Program on the price of electricity in Massachusetts.

Public health and environmental benefits, and compliance costs

The benefits of the program derive from monthly and annual reductions in emissions of CO_2, SO_2, NO_x, and mercury. The levels of reductions are a function of the difference between current emission rates and those required by the regulation. The following list summarizes the specific standards and timelines of the emission reductions required under the regulation, the main benefits considered in setting the requirements, and DEP's findings.

- **SO_2**
  - Facilities must meet overall limits of 3 pounds per megawatt-hour (lbs/MWh) by October, 2006 or 2008. A level of 3 lbs/MWh represents a reduction of approximately 75% from current levels of 12 lbs/MWh at the affected facilities.
  - Facilities must meet an interim target of 6 pounds per megawatt-hour (lbs/MWh) by October, 2004 or 2006. A level of 6 lbs/MWh represents a reduction of approximately 50% from current levels of 12 lbs/MWh at the affected facilities.
  - These reductions in SO_2 emissions will be obtained even though the electrical generating capacity of these facilities will increase by almost 50% over the same time frame.[14]
  - Control requirements for SO_2 were developed in recognition of the fact that SO_2
    - is a respiratory irritant;
    - can exacerbate symptoms associated with lung disease;
    - leads to the atmospheric formation of fine particulates, which can trigger pulmonary irregularities that may result in death; and
    - causes acid deposition that damages trees and crops; affects the ability of certain areas to maintain healthy species diversity; and damages man-made materials, including buildings and historic monuments.
  - Levels were set in consideration of recent studies concluding that, despite federal acid rain reductions already implemented, reductions of an additional 50 – 75% in SO_2 emissions from the northeast and central U.S. would be necessary to allow sensitive ecosystems to recover from years of acidification.
  - Based upon a review of available control technologies, DEP concluded that the cost of meeting the program requirements is not likely to exceed $400/ton for any facility
  - DEP found $400/ton to be reasonable and cost-effective in consideration of the expected public health and environmental benefits, and in comparison with the relatively high cost (averaging approximately $4,800/ton) of achieving sulfur reductions from non-utility sources, as documented by the U.S. EPA.

- **NO_x**
  - Facilities must meet overall limits of 1.5 pounds per megawatt-hour (lbs/MWh) by October, 2004 or 2006. A level of 1.5 lbs/MWh represents a reduction of approximately 50% from current levels at the affected facilities.
  - These reductions in NO_x emissions will be obtained even though the electrical generating capacity of these facilities will increase by almost 50% over the same time frame.(same comment as above)
  - Control requirements for NO_x were developed in recognition of the fact that NO_x
    - is a respiratory irritant;

[14] Power capacity is increasing at affected facilities through the addition of new generating units fired by natural gas. The emission rates for the new combined-cycle natural gas are low enough that some facilities may meet the programs requirements while still adding generation capacity.

- can exacerbate symptoms associated with lung disease;
- lead to the atmospheric formation of fine particulates, which can trigger pulmonary irregularities that may result in death;
- contributes to eutrophication of water bodies;
- contributes to climate change;
- is a precursor to ground level ozone (see the description of benefits under the NOx Allocation, above); and
- causes acid deposition that damages trees and crops; affects the ability of certain areas to maintain healthy species diversity; and damages man-made materials, including buildings and historic monuments.

- Levels were determined to be a reasonable year-round NO_x emission rate, since they are consistent with the rate required of facilities during the summer ozone season under the EPA's SIP Call Allocation Program.
- DEP found a number of technically and economically viable control options are available to comply with the NO_x requirements of this program, including selective catalytic reduction, gas-reburn, coal gasification, and other clean coal technologies.
- To a significant extent, the implementation of controls to comply with the Multi-Pollutant Program are consistent with control strategies that companies will use to meet the requirements of the NOx Allocation, since NOx standard in the Multi-Pollutant Program is basically an annual extension of the summertime NOx Allocation program.

- **CO_2**
  - Facilities must comply with a facility cap on total CO_2 emissions, and must meet a facility-wide emission rate standard of 1,800 lbs/MWh by October 2006 or 2008.
  - This standard represents a reduction of approximately 10% below the current average CO_2 emission rate for these facilities. 10% was chosen as an appropriate initial step, recognizing that the New England region was working on a regional action plan (which was approved by Governors in late August 2001).
  - These reductions in CO_2 emissions will be obtained even though the electrical generating capacity of these facilities will increase by almost 50% over the same time frame.
  - The CO_2 standards can be met by increasing combustion efficiency at the facility, installing alternative boiler configurations, fuel switching, recovering waste heat to generate additional useful output (e.g., steam for heat or process applications), or achieving offsite reductions.
  - The expected cost of compliance for these reductions is in the range of $2-5/ton, based on recent examples of CO_2 trading.
  - Control requirements for CO_2 were developed in recognition of the fact that an international consensus is emerging that increasing concentrations of CO_2 (and other greenhouse gases) in the atmosphere will change our climate in ways that are detrimental to our physical, social and economic well-being. In particular, DEP considered a wide range of impacts of climate change on human health, agriculture and forestry, human infrastructure, terrestrial and aquatic ecosystems, and hydrology and water resources management.
  - Massachusetts is currently developing a CO_2 Action Plan to identify possible sources of CO_2 emission reductions. In addition, in August 2001 Massachusetts signed on to the New England Governor's / Eastern Canadian Premiers Climate Action Plan. The Multi-Pollutant Program is an example of one of the lowest-cost CO_2 emission reduction opportunities within Massachusetts.

- **Mercury**
  - DEP expects to set an emission standard for mercury and will propose that facilities comply with that rate by the end of 2006. However, DEP will not propose that standard

until it completes a study on the current status of mercury control technologies. DEP is required to propose a standard in 2003.

- DEP decided to move forward with mercury controls in recognition of the fact that
  - mercury is a powerful, persistent pollutant that can damage the brain, the central nervous system, and the kidneys;
  - small amounts of mercury can cause extensive contamination;
  - the Northeast U.S. has some of the highest levels of mercury deposition in the country;
  - numerous scientific studies have documented the serious impacts of mercury exposure in humans;
  - Massachusetts alone has over 80 water bodies for which health advisories are issued warning against consumption of fish species due to mercury pollution; and
  - air emissions of mercury play a significant role in the transport and dispersion of mercury throughout the region.
- In preparation for the upcoming standards, and to assist in developing those standards, the regulations require that all coal-fired electric generating facilities in Massachusetts complete a series of three stack tests for mercury emissions over the next 18 months. Facilities must also provide sampling data of each shipment of coal in the next 18 months.
- DEP will use the information from facility stack testing and fuel sampling to determine the appropriate mercury emission standards to propose for the affected facilities. These standards in turn will determine the level of costs necessary for compliance.
- DEP has recently required mercury emission reductions from municipal waste incinerators, and concluded that the coal-fired electric generators affected by the Multi-Pollutant Program are the next largest contributor to, and a cost-effective option for control of, mercury emissions.

In addition to the benefits associated with reductions in emissions from each pollutant, DEP noted that by allocating based on electrical output (rather than fuel or heat input), the economic signal of the Multi-Pollutant Program, in a competitive market, would likely lead to (1) generating efficiency improvements at affected sources, and (2) a general increase in the operation of the most efficient generating facilities, reducing the output of the less efficient facilities. Consequently, less fossil fuel will be needed to produce the same quantity of electricity, leading to lower environmental impacts overall. In addition, DEP expects that implementation of emission control requirements for several pollutants at once will help reduce the overall costs of compliance relative to achieving necessary reductions over time through separate control programs. Finally, DEP expects that achieving greater consistency in the emission control requirements faced by all generating facilities in the state will enhance the fairness and competitiveness of the electricity market. DEP considered the delivery of these ancillary environmental, cost, and market effects from the multi-pollutant and output-based approach important benefits of the Multi-Pollutant Program.

Finally, DEP considered a number of factors in seeking to minimize the costs of attaining the emission reductions in the multi-pollutant program, including**:**

- Emission monitoring costs are unlikely to increase since the monitoring requirements are the same as under existing federal and state emission control programs.
- The program introduces flexibility for companies by allowing the limited use of SO2 allowances and carbon offsets in compliance demonstrations; US EPA-issued SO2 allowances may be used in the second phase of compliance (where the standard is 3 lb/MWh) in a ratio of 3 allowances for every ton over the 3 lb standard. CO2 trading options are just being developed by the MA DEP and are likely to include several actions, such as increased efficiency at the facility, offsite reductions like the conversion of mobile sources to lower carbon fuels, and acceptable offsite carbon sequestration. MA DEP will propose revisions to its existing

trading regulations to specify which options will be allowed, and the procedures that need to be followed. That process will take place over the next two years.

- DEP will allow companies to choose the least-cost compliance path, and the history of pollution control has shown that actual compliance costs are generally significantly lower than anticipated at the time of program development; and
- The Multi-Pollutant Program allows for a longer time period before compliance for facilities that choose to repower or significantly modify their facility, in order to allow sufficient time for this potential control option.
- The Massachusetts facilities are expected to be able to meet the standards in this regulation without closing down. They will likely use a combination of switching fuels, adding pollution control equipment, and/or repowering units to be more efficient. Each facility must submit compliance plans to DEP by January 2002.

Estimate of the maximum increase in electricity prices

Finally, DEP considered it important to estimate the maximum cost increase for purchasers of electricity as a result of the program, assuming that all compliance costs would be passed on to consumers through the price of electricity.[15] This was estimated by calculating the difference between the cost per kilowatt-hour (kWh) to generate electricity from the affected sources, and the cost per kWh of purchasing electricity from an alternative electricity supplier (in this case, a new gas-fired power plant[16]). DEP concluded that in a competitive market, regardless of company compliance costs, the owners of affected facilities could not increase their prices charged to customers above the next most expensive electricity supply alternative. Based on this analysis, DEP estimated that the Multi-Pollutant Program would not cost electricity customers more than $6 per year, and concluded that program benefits were likely to exceed this potential cost.

In sum, by analyzing quantitative and qualitative considerations related to program costs and benefits given the environmental goal and state policy objectives related to the electric industry, Massachusetts chose output-based emission standards for several pollutants under the Multi-Pollutant Program in order to achieve important public health and environmental benefits at the lowest cost.

Data Used in Setting the Standards

Three basic pieces of information were used to set the standards for each pollutant included in the Multi-Pollutant Program – existing emission levels at affected facilities, the overall percent reduction in emissions desired, and historical information on useful electrical output from the affected facilities. For SO_2, DEP sought a reduction of 50% - 75% in annual emissions. Using historical information on emissions and electrical output, DEP estimated the current aggregate emission rate for all facilities to be approximately 12 lbs/MWh. DEP used this figure to set an ultimate standard representing a 75% reduction in SO_2 emissions at 3 lbs/MWh in 2006/2008, and an interim standard of 6 lbs/MWh (50% reduction) by 2004/2006.

Using similar data on emissions and electrical output, DEP set the standard for CO_2 at 1800 lbs/MWh, representing a 10% reduction from historical CO_2 emission rates. Finally, the standard for NOx was set based upon expanding the summer-only output-based allocation rate used in the NOx Allocation (1.5 lbs/MWh) to apply to facility emission rates on a year-round basis.

[15] While these cost calculations are useful and appropriate in the context of a competitive electricity sector, costs can also be estimated through an analysis of the capital, operating, and administrative costs of installing specific control technologies, or through participation in an emission cap and trade program.

[16] Massachusetts and neighboring states have recently privatized the electricity generation sector, and restructured the electric industry in the Northeast Region of the U.S. In part due to this restructuring, a major growth in the planning and construction of new gas-fired generation facilities in this region has occurred over the last few years. Consequently, new gas-fired power plants are considered the marginal resource in the region.

IV. Program Administration

Administration of environmental programs in the U.S. is generally governed by rules or regulations developed by the federal or state government agency with the legal authority to require individuals or businesses to reduce emissions. Government agencies are granted legal authority through the laws passed by state and federal legislatures. Consequently, legal authority granted by the legislature to develop and enforce emission standards is a fundamental prerequisite to the administration of pollution control programs in the U.S. This authority provides the agency with the ability to administer monetary or operational penalties on entities that do not comply with emission control standards. DEP is the agency with the authority to develop and administer rules to control the emissions of power plants located in Massachusetts; both programs described in this paper were developed in accordance with this authority.

DEP issued a set of governing regulations for each of the NOx Allocation and the Multi-Pollutant programs.[17] The regulations include the standards discussed in the previous section (that is, the actual emission rate or allocation requirements, and the timing when the requirements go into effect), as well as the rules governing administration of the emission control program. Administration rules for these programs are very similar, and can be divided into three essential components: monitoring of emissions and electricity output; data reporting and compliance demonstrations; and enforcement. Each of these elements is discussed below. Since the administrative elements of the NOx Allocation and the Multi-Pollutant Program are very similar, they will be discussed jointly in the sections that follow.

Monitoring of Emissions and Electricity Output

The foundation of a successful emission control program is the availability of reliable, accurate data. For output-based programs, this requires – at a minimum – reliable measurements or calculations of emissions and electrical output over the relevant time period for compliance demonstrations (e.g., continuous, daily, monthly, annually).

With respect to emission measurements, the Massachusetts programs rely upon the emissions data monitoring requirements of the U.S. EPA acid rain program, which requires continuous emissions monitors (CEM) for each affected facility that record the quantity of NO_x, SO_2, and CO_2 emitted from a generating unit. CEMS for mercury are under development, with some currently being tested at facilities. Until CEMs are in operation, stack testing, using a method developed for Ontario Hydro, will be used for measurement of mercury emissions. The EPA monitoring requirements (U.S. Code of Federal Regulations, 40 CFR Part 75) include monitoring technology specifications, calibration procedures, and "missing data routines." The robust level of detail in these monitoring requirements establishes a high degree of certainty in the readings of emission monitoring equipment. The missing data routines apply conservative assumptions about emissions (that is, they tend to overstate emissions in comparison with actual readings), providing a strong incentive for maintaining properly-functioning CEMs.

It is also possible to estimate data on emissions using information on fuel composition and consumption at the facility, stack testing of actual emission concentrations, measurements at facilities of similar technology and vintage, and other estimation techniques. However, the accuracy of CEMs is important to the administration of effective emission control programs, as it:

- reduces the inherent uncertainty in emission estimation methods;

[17] All state agency rules are published in the Code of Massachusetts Regulations (CMR). The NOx Allocation Regulations are published as 310 CMR 7.28, and the Multi-Pollutant Program Regulations are published as 310 CMR 7.29. These regulations can be found at http://www.state.ma.us/dep/bwp/daqc.

- provides a standard procedure for identifying emissions that can be applied consistently across sources that typically vary greatly in boiler technology and vintage, fuel source and quality, operational characteristics, and emission reduction equipment and procedures;
- reduces the level of administrative oversight required by government agencies to ensure the validity of source emission reporting;

All of the sources under the two Massachusetts programs currently have CEMs installed capable of measuring emissions of NO_X, SO_2, and CO_2. This is very important, as the affected sources compete against each other in the market for electricity in the region, which could increase the incentives for plant owners to be careless or misleading in emissions measurement. CEMs and the data reporting routines associated with CEM monitoring requirements can be an effective tool in this context. Installed CEMS result in a reliable determination of the tons of each pollutant emitted from the stack of affected facilities over the compliance period.

The second important data point in the Massachusetts programs is the measurement of net electrical output, which is necessary to determine final output-based allowance allocations under the NOx Allocation, and to demonstrate compliance with the output-based emission standards of the Multi-Pollutant Program. The administrative simplicity of obtaining highly-accurate electrical output data for compliance demonstrations is a strong advantage of output-based programs in the U.S., and an important driver in moving to this form of environmental regulation.

Highly accurate data on electrical output from the affected facilities is available for two reasons: first, the financial trading of electricity at the wholesale level in the U.S. has demanded the installation of high-precision electricity metering technology at all electricity generating facilities. Second, the public reporting of this electrical output information has been required for many years by state and federal governments to ensure the public availability of information necessary to understand the operations, characteristics, and financial implications of power plants owned by regulated electric monopolies.

In sum, output-based programs in Massachusetts require the continuous collection of two primary pieces of data for program administration: emissions (in tons), and net electrical output (in MWh). Since emissions and electrical output are already collected for compliance with federal requirements or for participation in financial markets for electricity, no additional measurement or metering technology requirements were necessary in the drafting of state rules for these programs. However, it was necessary to include in the regulation the required sources of compliance reporting data (i.e., CEM emission data and electrical output from power system operators).

Data Reporting and Compliance Demonstrations

The second important piece of program administration in the Massachusetts output-based rules is common to virtually any emission control program – the reporting of data in a common form in order to demonstrate whether the facility in question has met the prescribed standards. Regulations governing compliance reporting in the Massachusetts programs includes at least the following basic elements:

- the format and content of compliance report filings;
- a common date of filings;
- verification of report validity by the owner/operator; and
- the timing and nature of agency review of compliance filings.

Upon receiving the compliance report, DEP will verify compliance with the regulatory standards by reviewing reports and the data submitted by the facility according to formats specified by the agency (similar to the report formats required by EPA for the SO2 and NOx trading programs), request further data or information on the contents of the report, or refer the case for enforcement action (for example, if the report is incomplete, misleading, or indicates non-compliance). Under the NO_x

Allocation, DEP must take information received related to emissions over the compliance period and verify that affected sources hold sufficient emission allowances to cover their emissions of NO_x over that compliance period.

Enforcement

The final component of emission control program administration is enforcement of the standards. Of course, if compliance demonstrations are verified to be accurate, and demonstrate that the facility in question met the applicable standards of the regulation, then no further action is required by DEP. However, if the compliance demonstration is not complete, or indicates that the facility did not meet the prescribed standards, then the regulations must guide the agency in determining the appropriate action to take. Such guidelines may include:

- requirements for the filing of additional or supporting information and data;
- procedures for adjudication of or a public hearing on the filing;
- assessment of a standard financial penalty for non-compliance;
- revocation or suspension of the facility's permit to operate; and
- requirements for more stringent compliance standards to be in effect in a subsequent compliance period.

Enforcement provisions under DEP regulations include standard financial penalties that apply in the event of non-compliance under any one of several programs, as well as specific enforcement actions unique to the program in question. Enforcement provisions may also specify the rights of the affected source to appeal an enforcement decision to the agency or to a judicial authority within a specific timeframe.

Additional options for enforcement measures have been applied in other emission control programs, including the national SO_2 emission trading program under the Clean Air Act. The 1990 Amendments to the Act gave the US EPA and the states a broad array of new enforcement powers, ranging from on-the-spot fines to criminal prosecutions. Here are some examples of the enforcement options available for violations of the SO_2 emissions trading program:

Information Request: The overseeing agency can require a suspected violator to supply missing information by a specified deadline. A source's failure to provide the requested information constitutes a separate enforceable violation. The agency can also issue an administrative subpoena requiring a person to appear in person with necessary documents and give testimony under oath.

Unannounced Onsite Inspection: The agency can conduct unannounced onsite inspections when additional information is necessary, e.g. to conduct stack tests or review voluminous records.

Field Citation: EPA has authority to issue field citations, or on-the-spot fines, of up to $5,000 per day per violation. These citations are intended to address minor violations that are easily detected and simply corrected. Examples include failure to keep adequate records or operate and maintain the CEMS.

Administrative Compliance Order (ACO): For more serious violations that can be corrected in less than one year, the overseeing agency can issue an order requiring a violator to return to compliance by a specific date in accordance with a detailed plan, which can include verifiable interim milestones. Failure to comply with this order is a separate enforceable violation. ACO's may be issued, for example, when a source fails to follow the required procedures for permit modifications or amendments.

Administrative Penalty Order (APO): The overseeing agency can also issue an administrative penalty order up to $200,000 for violations that occurred less than one year ago. Examples of situations in which administrative penalties may be appropriate are failure to install a CEMS or approved alternative

monitoring system by the compliance deadline, and failure to file quarterly electronic reports, More severe enforcement options may be appropriate in cases of multiple or repeat violations.

Excess Emissions Penalties: Each source must have sufficient allowances to cover its annual emissions. If not, the source is subject to a $2,000/ton excess emissions fee. If the owner or operator fails to pay the penalty without demand, EPA can issue an additional administrative penalty. Failure to pay this penalty is a separate enforceable violation.

In addition, sources with excess emissions must offset the excess emissions in the following year. A utility may either have allowances deducted immediately or submit an excess emissions offset plan to EPA that describes how these cutbacks will be achieved. The offset plan must be submitted no later than 60 days after the end of any calendar year in which a utility had excess emissions. Each additional day of delay in submitting the plan becomes a separate violation subject to an administrative penalty of up to $200,000.

Civil Judicial Actions: In situations involving complex issues, violations more than one year old, repeat violations, penalties greater than $200,000, or compliance schedules requiring more than one year of activity, the agency must file a civil action in court. Examples include situations in which a utility fails to file complete permit applications and certification statements despite written requests. A court can issue penalties of up to $25,000 per day per violation. If the parties negotiate a settlement agreement to resolve the case, the agreement will be then be enforceable by the court.

Criminal Sanctions: Senior management and corporate officers can be imprisoned for up to five years for knowing violations of various Clean Air Act requirements. Knowing falsification of records or failure to report, or tampering with monitoring equipment, can be punished by up to two years of imprisonment. Knowingly failing to pay EPA penalties is punishable by up to one year of imprisonment. Citizens who provide information leading to a criminal conviction or other penalties can receive awards.

Citizen Suits: Monitoring data is available to citizens upon request. Citizens can bring lawsuits against violators after notifying EPA. Courts in such lawsuits can order the violator to come into compliance, as well as assess penalties, which will be paid into a special US Treasury Fund to be used to improve air pollution monitoring and compliance.

Contractor Listing: Criminal and violators can be barred from receiving government contracts, grants and loans.

ATTACHMENT A

DATA NEEDS FOR GPS (OR "OUTPUT-BASED") EMISSION CONTROL REQUIREMENTS

Introduction

The data needs for designing and implementing GPS (or "Output-Based") emission control programs are briefly summarized below. Specifically, data needs are discussed in terms of (1) once the desired reductions are identified, information that is needed to set the GPS standards (generally historical data); (2) information that is needed to monitor and enforce GPS standards (generally data from the compliance year in question); and (3) steps that should be taken at the time of industry restructuring to facilitate the collection of adequate data to monitor and demonstrate compliance. Attached is a table outlining the data elements that may be necessary in setting and implementing GPS standards.

I. Information Needed to Set Output-Based Standard: *HISTORICAL DATA*

In the initial (design) phase of implementing a GPS program, it will be necessary to collect aggregated emission and electrical generation data sufficient to determine at what level the standards should be set. In addition, depending on the type of GPS program implemented, it may also be necessary to collect historical data from individual sources (e.g., if GPS is used to determine emission allowance allocations, historical data on electrical output is necessary to divide up a state or regions emissions "budget" among affected sources). In particular, depending on the design of the program, some or all of the following data may need to be collected:

a) Aggregate (all affected sources) emissions (in tons) over control area for one or more recent years. These data could be obtained, for example, from stack-measured emissions, engineering specifications, or estimates based on fuel pollutant content or other factors (depending on the pollutant)
b) Aggregate generation (in MWh) over control area for the same years as in (a)
c) Aggregate of other useful output (if, for example, program applies to cogeneration or industrial facilities) such as steam for heat and process applications, over control area for the same years as in (a)
d) Distribution of emissions, generation, and steam applications among plant technologies and fuel types for the same years as in (a)
e) (If necessary) the same information as in items (a) through (d) for individual sources (e.g., for the purpose of emission budget allocations to individual sources)

II. Information Needed to Monitor and Enforce Output-Based Standard: *COMPLIANCE-PERIOD DATA*

Once standards have been set, compliance will be determined by comparing standards to each facility's actual performance during the compliance period (e.g., annually, quarterly, monthly). For this, essentially the same type of data is needed as in section I:

a) Plant- or unit-based useful output (generation and steam for heat or process applications) over the compliance period
b) Plant- or unit-based emissions over the compliance period

If a facility has not installed accurate continuous emission monitoring technology, information must be gathered to estimate emissions for the purpose of compliance demonstrations, such as:

c) heat input data (or fuel input and fuel heat content), and heat rate information
d) engineering-based emission factors (such as US EPA AP-42 factors, which comprise a large amount of text and data. These emission factors can be found on the web at the following address: http://www.epa.gov/ttn/chief/ap42/)
e) fuel sampling data for S content

III. Integration of Electrical Output with Emissions Data to Facilitate Compliance Monitoring and Demonstration

In designing and implementing output-based requirements in the US, we have found that computer systems used to settle financial accounts in the electricity market provide an accurate and efficient mechanism for linking electricity and emissions data to support compliance with a range of output-based policies.

For example, in New England (US), six states are faced with implementing a disparate array of output-based environmental policies, including information disclosure, emission allowance allocations under a cap/trade program, emission performance standards for retail suppliers, and requirements that suppliers provide electricity to consumers with a minimum percentage contribution from renewable resources. All of these programs require an accurate identification of the electrical output and emission (as well as fuel source) characteristics of generating facilities dispatched to meet electrical needs. In response to this challenge, state regulators and industry representatives have developed alternatives to support compliance through linking emissions data with actual electrical output data used for billing transactions that occur between buyers and sellers of electricity in the competitive market.

We therefore recommend that, as China restructures its industry and, in particular, develops computer systems to monitor electricity flows and for financial settlement of electricity markets, the capability to link emissions data to this electrical output/financial settlement data be included early on in the design process. This could greatly increase the potential for implementing GPS emission control requirements in this sector and sharply reduce the costs and data issues associated with program design and implementation. Including this capability at the time that these systems are designed for administration of electricity markets would be relatively easy and inexpensive; adding on this capability later on could be significantly more difficult and expensive.

TABLE 1: U.S. OUTPUT-BASED PROGRAM OPTIONS

Output-Based Policy Option	Geographic Scope	Regulatory Jurisdiction	Affected Entity	Data to Set Standard	Data Needed For Compliance
Programs Under Existing Frameworks					
New Source Performance Standards	National	EPA	Owners of New Power Plants	Desired Emission Rates for New Units	Measured Unit Emission Rates
Establishing State Budgets Under Cap/Trade Program	National/Regional	EPA	States and Affected power plants	Total Electrical Output In Each State	N/A
Allocating State Budgets to Affected Sources	State	State Departments of Environmental Protection	Owners of Affected Existing and New Power Plants	Electrical Output of Affected Sources w/in State	N/A
Programs Under Electric Industry Restructuring					
Emission Performance Standards	State	State Departments of Environmental Protection	Retail Sellers of Electricity	Desired Level of Emissions from Electricity Sector in State	Emissions and Electrical Output from All Sources in Supplier's Portfolio
Information Disclosure	State	State Public Utility Commissions	Retail Sellers of Electricity	N/A	Same as for EPS
Other Potential Program Areas					
Plant- or Company-Based Emission Rate Requirements	State, National	EPA or State Departments of Environmental Protection	Owners of Existing and New Power Plants	Desired Emission Rates for Affected Units	Actual Emissions and Electrical Output
Pollution Tax/Levy	State, National	EPA or State Departments of Environmental Protection	Owners of Existing and New Power Plants	Targeted Income; Emission and Output Data From Affected Sources	Actual Emissions and Electrical Output
New Facility Siting Requirements	State	EPA or State Departments of Environmental Protection	Owners/ Proponent of New Power Plants	Data on State-of-the-Art Boiler Efficiencies and Emission Control Technologies	Description of Boiler and Emission Controls; Demonstration that Unit Will Meet Standards

Table 2: Data Requirements for Setting and Implementing GPS

Data Category and Item	Historical Data	Compliance Period Data
Emissions (Tons)		
Monitored Emissions	A combination of measured and estimated emissions, *totaled for all affected sources*, may be used in combination with emission reduction goals to set GPS standard	Needed for each affected source *during compliance period (annual, quarterly, monthly)* to demonstrate compliance
Fuel Sulfur Content		Can be used in lieu of monitored emissions if necessary
Engineering Estimates of Emission Factors		
Output		
Net Electrical Generation	Measured net electrical generation, *totaled for all affected sources*, may be used to set GPS standard. Gross generation with estimated losses, or heat input with avg. heat rate, can be used in lieu of measured net generation	Needed for each affected source *during the compliance period* to demonstrate compliance
Gross Electrical Generation		Can be used in lieu of measured electrical generation and steam output, if necessary
Estimated Plant Use and Losses		
Heat Input		
Average Heat Rate		
Useful Steam Output	*Historical* measured or estimated steam output, *totaled for all sources*, may also be considered in setting the GPS standard	Needed for each affected source, *during the compliance period*, to demonstrate compliance

ATTACHMENT B

PROGRAM-LEVEL OPTIONS FOR EMISSION CONTROL PROGRAMS

This paper has included a description of program standards and administration for two examples of output-based programs implemented in Massachusetts. However, GPS is an approach to emission regulation that can take many different forms. For example, GPS can be applied on a facility basis, where each individual facility must meet the standard. GPS can also be applied on a company-wide basis, which will encourage the operation of more efficient units and facilities, or in a scheme which caps emissions on a regional or national basis. Finally, output-based standards may also be applied at the level of the retail supplier of electricity.

It is important to note that, in general, electric generating facilities may be subject to more than one form of pollution control requirement. For example, many power plants in the United States must meet prescribed emission rate limitations for emissions of NOx, but also are required to participate in a cap and trade program. Which program – or combinations of programs – are most appropriate for China will need to be determined based on China's consideration of environmental, economic, social and political factors. Below we provide several examples of different designs for output-based programs that could be considered.

1. Facility-by-Facility GPS

The most stringent way to apply GPS is at the facility level. Each plant would be required to meet the same uniform emissions limit per kWh. Plants that cannot meet the standard would have to shut down, clean up, or pay penalties (if the penalties are less than the costs of cleanup or shutdown, including net revenue loss). Assuming that shutdown or cleanup are the less costly actions, application of the standard will result in emissions reductions, and average emissions will decline. The effect is to reduce pollution from higher-emitting units to levels below the facility standard, without affecting emissions from those units that meet or are cleaner than the standard.

2. Company-Wide GPS

At the next level of aggregation, output-based standards could be applied on a company-wide basis. This allows companies to average the emissions and output at all their facilities to determine whether they can meet the standard. If the standard is applied on a company-wide basis, then emissions, output, and emission rates across more than one facility can be averaged, thus making it easier to comply with the output standard. However, average emissions will not decline at as rapid a pace as in the facility-by-facility approach.

3. Company-Wide Emission Caps

An alternative to applying output-based standards on a company basis is to set a company-wide cap on total emissions. This could prevent increases in emissions as output increases. For example, companies would need to demonstrate that their annual emissions meet their targeted emission levels. If a shorter averaging time is used (e.g., monthly) then the standard becomes more stringent. This step would use the same monitoring and reporting requirements as those needed for demonstrating that company has meet an output standard without a cap.

4. Regional Cap and Trade Programs

At the next level of aggregation, a regional cap and trade program could be established whereby companies and facilities demonstrate that they hold allowances for every ton of emissions generated during a set time period (usually a year). In this context, allowances could be allocated to facilities based on measured electrical and steam output. If their emissions are lower than their allocated allowances then allowances can be banked or sold to other facilities. This step requires establishing allowances as a currency for trading, and trading mechanisms. The U.S. EPA has successfully established such a program for SO_2 nationally and with

states for NO_x on a regional basis. EPA's program[18] requires equivalent monitoring and reporting requirements to ensure that allowances are worth same amount across trading program.

5. Portfolio Requirements for Retail Sellers of Electricity

The Emission Performance Standards included in recent state legislation would require that the *seller* of electricity (who may or may not own power plants) ensure that the average emission rates of all the power plants used to meet its customers' electricity needs not exceed specific output-based emission standards. Regardless of their forms, output-based standards can be used in a variety of ways to make the transition from traditional power plant air pollution regulation to methods that encourage efficient generation and pollution prevention.

[18] US EPA Draft Design Documents for an SO_2 Trading Program in China; 1999.