INTERNATIONAL PRACTICES AND EXPERIENCES WITH INFRASTRUCTURE INVESTMENT AND POLLUTION CONTROL PROGRAMS

POLICY MECHANISMS WORKING TOWARD SUCCESSFUL ACHIEVEMENT OF THE 11TH FIVE-YEAR PLAN ENVIRONMENT TARGETS

Report submitted to:

China Council for International Cooperation on Environment and Development (CCICED)

Report submitted by:

Jeremy Schreifels, Senior Policy Analyst

U.S. Environmental Protection Agency

2007 August 27

Dr. Wang Jinnan, Vice President
Chinese Academy of Environmental Planning
8 Dayangfang Road, Chaoyang District
Beijing 100012

Dear Dr. Wang,

It is my pleasure to submit the report on international experience with environmental infrastructure financing programs and pollution control programs. The report reviews the experiences with wastewater discharge and air emission control programs in the European Union, United Kingdom, and United States.

The report is divided into four sections:

1. Federal and state environmental planning and coordination;
2. Air pollution trends and control programs;
3. Water treatment infrastructure programs; and
4. Recommendations.

I welcome your comments and questions on this report and look forward to our next task force meeting on October 24 and 25.

Best wishes,

Jeremy Schreifels

Table of Contents

Acronyms

ARAC: Acid Rain Advisory Committee

BACT: Best available control technology

Btu: British thermal units

CAA: Clean Air Act

CAIR: Clean Air Interstate Rule

CEMs: Continuous emission monitor systems

CO_2: Carbon dioxide

COD: Chemical oxygen demand

CWSRF: Clean water state revolving fund

DEFRA: United Kingdom's Department for Environment, Food, and Rural Affairs

EPA: United States' Environmental Protection Agency

EPB: Environmental Protection Bureau

ERCs: Emission reduction credits

EU: European Union

FGD: Flue gas desulfurization control devices (i.e., scrubbers)

LAER: Lowest achievable emission rate

LCPD: Large Combustion Plant Directive

NAAQS: National ambient air quality standards

NERP: National Emission Reduction Plan

NO_2: Nitrogen dioxide

NO_X: Nitrogen oxides

NSR: New Source Review

NSPS: New Source Performance Standards

O_3: Ozone

PM10: Particulate matter smaller than 10 microns

PSD: Prevention of Significant Deterioration

RACT: Reasonably available control technology

SEPA: China's State Environmental Protection Administration

SIP: State implementation plan

SO_2: Sulfur dioxide

UK: United Kingdom

US: United States

$\mu g/m^3$: micrograms per cubic meter

Introduction

The *11th Five-Year Plan for National Economic and Social Development of China* outlines requirements to reduce total emissions of chemical oxygen demand (COD) and sulfur dioxide (SO_2) by 10% from 2005 levels by 2010 – the end of the 11th Five-Year Plan period. This is a compulsory target that must be achieved by the government, industry, and the public.

While several laws, regulations, policies, and measures have been implemented in China to address these pollutants, current approaches are insufficient to provide an efficient and cost-effective solution to achieve the environmental protection targets. In an attempt to identify the policy mechanisms, including legal, economic, technical, and administrative measures, that will make it possible to achieve the environmental targets of the 11th five-year plan, the China Council for International Cooperation on Environment and Development (CCICED) has formed a task force to research policy mechanisms.

Three international experts are participating on the CCICED task force. Their objectives are to explore the overall strategic policy framework and provide recommendations for relevant policy measures, key conditions and prerequisites, and implementation practices based on a thorough analysis of the problems and drawing on relevant international experience.

This report provides information about international experiences in the European Union (EU), United Kingdom (UK) and United States (US) with the following:

- Programs to promote planning and accountability for provincial/state environmental bureaus;
- Policies to reduce air pollution, in particular, emission trading programs;
- Financing programs to facilitate investment in water treatment facilities and good management practices; and
- Discharge standards for stationary sources emitting to waterways.

This report also includes a set of recommended policies, measures, institutional enhancements, and activities intended to help the Chinese Government and industry achieve the environmental goals established in the 11th Five-Year Plan.

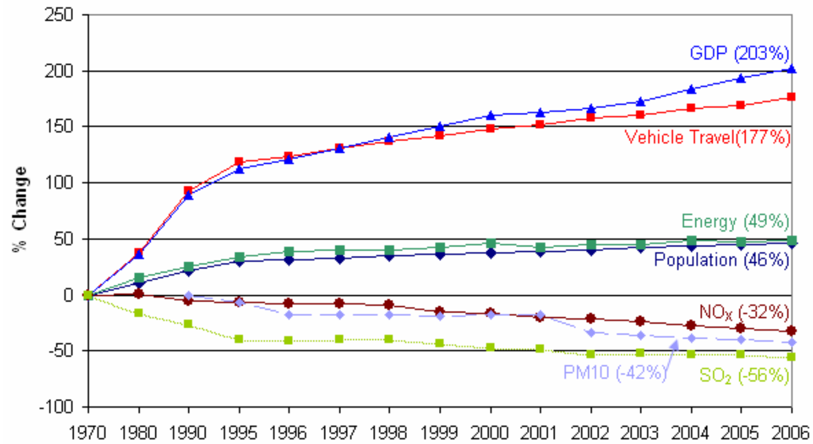
Promoting Planning and Accountability for Provincial EPBs

The US State Implementation Plan

The US, much like China, has a decentralized environmental enforcement structure. The national government establishes environmental standards, goals, and policy frameworks; state governments are responsible for interpreting rules and implementing most air and water quality programs within national guidelines; and the two levels of government share enforcement responsibilities. A decentralized structure allows the state governments to implement policies that account for each state's unique environmental, social, and economic conditions. It also encourages experimentation with new policies and programs. However, the drawbacks to such an approach include the creation of a complex collection of different, and sometimes conflicting, environmental policies, inconsistent enforcements, and a lack of accountability to the national government. One way that the US Environmental Protection Agency (EPA) establishes state government accountability to the national government is through the policy and program planning process.

The US Clean Air Act (CAA) requires that each state government develop a State Implementation Plan (SIP) indicating how it will achieve national ambient air quality standards (NAAQS). The SIP can be considered a "blueprint for clean air," describing policies, standards, and programs in the state to achieve the air quality targets. This process has yielded significant progress toward cleaner, healthier air at a time when the population, economy, vehicle travel, and energy consumption grew significantly (see Figure 1).

Figure 1: Comparison of Key Trends



The planning process helps state governments develop a strategic, integrated approach to achieve air quality goals. Additional benefits of the planning process include:

1. Improving the inventory of industrial emission sources and their emissions.
2. Improving the understanding of air quality impacts from industrial emissions.
3. Providing guidelines and goals and demonstrating how policies, standards, and programs contribute to the achievement of the goals.
4. Helping insure that a coherent set of actions is implemented that is consistent with the national goals and standards.
5. Establishing targets and timetables to evaluate progress toward meeting the national goals and standards.
6. Facilitating the allocation of limited resources like staff, funding, equipment, and time in an orderly and systematic manner.

Each SIP is intended to assign source-specific emission limitations and establish timetables for compliance by those sources, set up procedures to review new sources, establish systems to monitor air quality, and identify enforcement resources. The specific elements of a SIP include:

- Requirements for new and expanding industries to install control technologies to ensure that the air quality in the region does not deteriorate.
- In areas that do not meet the NAAQS for a specific pollutant:
  - Requirements and timetables for existing industries to retrofit their facilities with control technologies: and
  - Requirements for new or expanding industries to “offset” maximum potential emissions by reducing emissions at existing facilities (e.g., installing controls or more efficient combustion technologies at existing facilities, shutting down existing facilities, capturing emissions from existing facilities to use as industrial inputs.)
- Other state-adopted control measures that consist of rules and regulations, or source-specific requirements.
- Non-regulatory information to indicate the state’s progress toward achieving and maintaining the NAAQS, such as:

- ○ Emission inventories;
- ○ Monitoring networks;
- ○ Air quality data;
- ○ Modeling studies; and
- ○ Evidence of public participation.

- Demonstration that the state has the necessary laws and administrative capacity to enforce the SIP requirements.

While state governments must adhere to federal requirements, the CAA gives them some freedom to decide which emission sources and sectors should be included in the state air quality management programs. Additionally, states can choose the method of regulation, such as performance standards, technology requirements, or cap and trade programs.

Once the SIP is submitted to EPA, the EPA has the authority to approve or reject it. Once approved, the SIP is federally enforceable, meaning the state and EPA[1] have the authority to enforce provisions of the plan and penalize sources that are in non-compliance. In addition, EPA can penalize state governments that do not attain the NAAQS by specified dates. Mandatory sanctions include: (1) limiting new facility development by requiring emission offsets from existing sources at a two-to-one ratio (which has the practical effect of severely limiting growth of new facilities) and (2) withholding federal highway funds from the affected areas.

The EU Air Quality Planning Approach

The EU has a similar planning approach. In areas where the ambient concentration of a pollutant exceeds the limit values plus a margin of tolerance, the applicable Member State must develop a plan or program for meeting the ambient limit values within a prescribed time period. Monitoring requirements are also more onerous, including continuous monitoring (or frequent sampling) of stationary emission sources.

The Member State's plan must include the following elements:

- Where air quality exceeds the limit values, the size and composition of the population exposed to the pollution, emission sources responsible for the pollution, and the total quantity of emissions from those sources;
- Details of any measures for air quality improvement, including timetables for implementation and estimates of expected improvements in air quality,
- Details of any measures or projects planned for the long term.

While Member States have significant flexibility in how they meet the National Emission Ceilings (i.e., a limit on total emissions) and attain air quality limit values, the European Commission has an important oversight role with respect to air quality management plans. The Commission is responsible for reviewing plans and regularly checking implementation by examining trends on air pollution and progress toward meeting the limit values. The Commission also reports to the European Parliament on implementation and progress towards achieving the air quality targets.

The EU's 2001 Large Combustion Plant Directive (LCPD) gives the Commission more explicit powers with respect to national emission reduction plans, including the role of evaluating whether or not the plan meets the requirements and, if the Commission considers

---

[1] EPA has authority to seek civil penalties and injunctive relief against a source violating a SIP provision under the Clean Air Act's section 113(b) and criminal penalties under section 113(c)

that the plan does not meet requirements, informing the Member State that it must submit a report within three months of the steps taken to meet the requirements.

Challenges of the US and EU Air Quality Planning Process

The planning process in both the US and EU include mechanisms to encourage or enforce proper implementation of policies and programs by states or Member States. There are some differences, however. The US CAA gives the EPA specific powers over the states if they fail to meet the NAAQS, whereas the EU system relies more on peer pressure and persuasion, (e.g., through review of status of implementation, reporting of findings, and the prospect of additional measures.) This is indicative of the key difference between the two approaches – the US is a decentralized system of state governments with a powerful national government providing oversight while the EU is a decentralized system of sovereign national governments with a consensus-based commission consisting of representatives from the national governments.

The process of developing and periodically updating an air quality management plan is an important and essential part of achieving national and local air quality goals. A comprehensive air quality management plan can provide policymakers with critical information that is essential to developing appropriate and effective policies and programs. In addition, the US SIP requirements for emission inventories and air quality modeling have led to the development of uniform methods for quantifying emission and promoted the development of increasingly sophisticated air quality models. Nevertheless, the planning process has presented a number of challenges. In particular, the challenges for the US SIP process include:

- The SIP process has become overly bureaucratic, taking time and resources away from the more important issue of controlling emissions and tracking progress toward attainment of the NAAQS;
- The SIP process uses models to predict the impact of existing and future programs on future air quality, but does not include a simple iterative process to update data and assumptions to reflect new information and scientific tools;
- Programs can be very prescriptive and can stifle innovation; and
- A focus on individual pollutants that make it difficult to consider multi-pollutant approaches that may be more effective, both in terms of air quality improvements and compliance costs.

The US air quality management system might benefit from a more streamlined, flexible, holistic, and integrated approach to the SIP planning process. Influential stakeholders, including national and state regulators, academic researchers, industry representatives, and NGO policy analysts have recommended that the US SIP process be transformed to: 1) place a greater emphasis on performance and results, 2) encourage multipollutant control strategies, 3) allow for a streamlined, iterative process for updating and modifying SIPs, 4) provide more flexibility for innovative emission control measures, and 5) require periodic assessments to ensure that areas are making progress toward attaining the ambient air quality standards. These recommendations are valuable for any air quality management planning process.

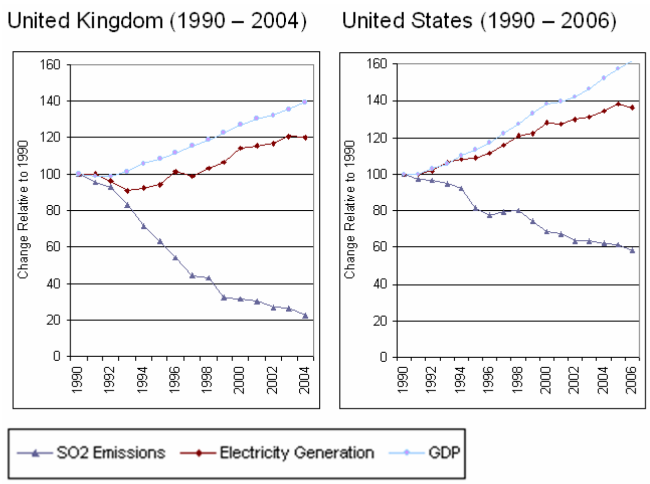
While the SIP process has been very important in the US, new air quality policies are shifting toward national-level programs to reduce emissions (e.g., the US Acid Rain Program). This is due, in large part, to regional transport issues and a need to alleviate competitiveness concerns on the part of some states. There is a similar need in China for more centralized regulatory actions in order to support local and regional air quality planning efforts.

Air Pollution Trends, Emission Standards, and Control Programs

Sulfur Dioxide Air Pollution Trends

SO_2 emissions in China have grown rapidly as GDP and electricity generation have increased. In contrast, SO_2 emissions in both the UK and US have declined significantly while GDP and electricity generation have increased (see Figure 2).

Figure 2: UK and US SO2, Electricity, and Economic Trends



During the period from 1990 to 2004, UK SO_2 emissions declined by 77 percent while GDP increased by 40 percent and thermal electricity generation increased by 20 percent. Although a number of factors contributed to the decline in SO_2 emissions, including the adoption of stringent emission limits under the EU's LCPD, the dominant factor was a shift from coal to natural gas for electricity generation. Between 1990 and 2004, coal consumption in the UK fell by 47.4 million metric tons, or 44 percent, while natural gas use increased by 40.2 billion cubic meters, or 69 percent (see Table 1).

In the US, SO_2 emissions declined by 42 percent between 1990 and 2006. During that same period, GDP increased by 62 percent and thermal electricity generation increased by 37 percent. As with the situation in the UK, several factors contributed to the decline in SO_2 emissions, but the most significant factor was the US Acid Rain Program, a cap and trade approach aimed at reducing SO_2 emissions from the power sector by 50 percent by 2010 in an effort to reduce the harmful effects of acid rain. Unlike the UK scenario, coal consumption in the US rose by 190.2 million metric tons, or 23 percent. US natural gas consumption also increased by 75.0 billion cubic meters, or 14 percent (see Table 1).

Table 1: China, UK, and US SO2, Electricity, Fossil Fuel, and Economic Trends

	1995	2000	2001	2002	2003	2004	2005	2006
SO_2 Emissions (million metric tons)								
China	N/A	19.95	19.5	19.3	21.6	22.5	25.5	25.94
United Kingdom	2.343	1.173	1.111	0.994	0.973	0.833	N/A	N/A
United States	17.41	14.74	14.37	13.57	13.59	13.27	13.23	12.45
Thermal Electricity Generation (billion kWh)								
China	756.1	1,041.5	1,132.2	1,271.1	1,484.2	1,701.8	N/A	N/A
United Kingdom	216.6	262.2	265.4	268.2	278.2	276.5	N/A	N/A
United States	2,293.9	2,692.5	2,677.0	2,730.2	2,758.7	2,825.0	2,910.0	2,874.0
Coal Consumption (million metric tons)								

China	1,356.0	1,163.3	1,230.7	1,281.8	1,560.6	1,871.0	N/A	N/A
United Kingdom	71.6	58.0	63.7	58.2	62.4	60.9	N/A	N/A
United States	872.8	983.5	961.7	967.4	993.2	1,004.5	1,021.0	1,010.8
GDP, Annual Growth (percent)								
China	10.9	8.4	8.3	9.1	10.0	10.1	N/A	N/A
United Kingdom	2.9	3.9	2.3	1.8	2.2	3.1	N/A	N/A
United States	2.5	3.7	0.8	1.9	3.1	4.2	3.2	N/A

Emission Performance Standards and Technology Mandates

Air quality standards in China, the UK, and the US vary significantly (see Table 2). Both the EU and US have shifted their energy from primary pollutants (e.g., SO_2, NO_X, and CO) to analyzing the effects of secondary pollutants (i.e., pollutants that form from other pollutants in the atmosphere), such as fine particulates (PM2.5) and ozone (O_3). In the US, many of the air quality standards were first set in 1971 and have not been revised since. In 2006, however, EPA revised the air quality standards for particle pollution; tightening the 24-hour PM2.5 standards to 35 micrograms per cubic meter (µg/m^3) and retaining the current annual PM2.5 standard at 15 µg/m^3. EPA also decided to retain the existing 24-hour PM10 standard of 150 µg/m^3 and revoke the annual PM10 standard, because available evidence did not suggest a link between long-term exposure to PM10 and health problems.

Table 2: Select Ambient Air Quality Standards

Pollutant (µg/m^3)	Averaging Time	China			US	UK
		Grade 1	Grade 2	Grade 3		
SO_2	1 year	20	60	100	80	20
	24 hours	50	150	250	365	350
PM10	1 year	40	100	150	N/A	40
	24 hours	50	150	250	150	50
PM2.5	1 year	N/A	N/A	N/A	15	N/A
	24 hours	N/A	N/A	N/A	35	N/A
NO_X/NO_2	1 year	40	80	80	100	40
	24 hours	80	120	120	N/A	N/A

To address air pollution from large stationary sources, the UK and the US have adopted similar strategies. The approaches can be grouped into three broad categories: (1) emission performance standards (see above), (2) technology mandates, and (3) cap and trade programs. The first approach, emission performance standards, simply specifies a maximum allowable emission rate (e.g., grams per million British thermal units (Btu) of heat input or milligrams per cubic meter) from a specific type of emission source. The source owners and operators have the flexibility to implement any combination of technologies and operational practices to meet the standard. In contrast to emission performance standards, technology mandates typically require the installation and operation of specific emission control technologies (e.g., flue-gas desulfurization (FGD) or scrubbers for controlling SO_2). The third and more recent approach, cap and trade, provides a cap, or limit, on total cumulative emissions from a group of emission sources (e.g., the electric power sector) in a given geographic area for a specific time period (e.g., calendar year). Each emission source is allocated a quantity of tradable allowances – authorizations to emit a specific quantity of a pollutant (e.g., one ton of SO_2) – that, in the aggregate, are equal to the cap. Each emission source has the flexibility to develop a compliance strategy that accounts for their facility's design, operational, management, and financial conditions. The compliance strategy for the emission source may include conventional pollution control equipment, process changes, fuel substitution, the purchase of allowances from another emission source, or some combination of the above options that leads to lower compliance costs.

US Emission Performance Standards and Technology Mandates

In addition to the state-specific policies contained in the SIP, the CAA requires states to establish and manage permit programs to control emissions from major emission sources. Under the permit program, each new or modified major emission source must apply for a permit before beginning construction. The permits contain detailed emission control requirements, including performance- and technology-based requirements, compliance schedules, monitoring requirements, and other conditions found in the CAA or SIP. Some of the key emission control provisions in the CAA that apply to the permit include New Source Performance Standards (NSPS), New Source Review (NSR), and Prevention of Significant Deterioration (PSD).

The first provision, NSPS, establishes performance standards, typically expressed as a maximum emission rate per million Btu for major and minor sources on a category-by-category basis. The limits apply to many types of industrial facilities such as power plants, iron and steel mills, pulp mills, smelters, glass manufacturers, and chemical plants.

NSPS are uniform national standards (see Table 3) that EPA is required to progressively tightens over time to, in theory, achieve a steady rate of air quality improvement without unreasonable economic disruption.

Table 3: Select US New Source Performance Standards

Stationary source type	Heat Input Capacity	SO_2 Limit value
Fossil-fuel Electric Power plants (constructed after 1971 August 14)	Heat input capacity > 250 million BTU per hour	Coal: 544 grams per million BTU Oil and gas: 363 grams per million BTU
Fossil-fuel Electric Power plants (constructed after 1978 September 18)	Heat input capacity > 250 million BTU per hour	Coal: 544 grams per million BTU **and** controlled to 90% below potential concentration **or** 272 grams per million BTU **and** controlled to 70% below potential concentration Oil and gas: 363 grams per million BTU **and** controlled to 90% below potential concentration **or** 91 grams per million BTU
Industrial boilers	Heat input capacity > 100 million BTU per hour	Coal: 544 grams per million BTU **and** controlled to 90% below potential concentration Oil: 363 grams per million BTU **and** controlled to 90% below potential concentration

Stationary source type	Heat Input Capacity	SO_2 Limit value
Industrial boilers	Heat input capacity ≤ 100 million BTU per hour **and** ≥ 10 million BTU per hour	Coal: 544 grams per million BTU **and** controlled to 90% below potential concentration **or** 272 grams per million BTU **and** controlled to 50% below potential concentration
Primary smelters (zinc, lead, or copper)	Not specified	0.065 percent by volume
Stationary gas turbines	Heat input capacity > 10.14 million BTU per hour	0.015% by volume at 15% oxygen on a dry basis of gases emitted **or** fuels that contains sulfur ≤ 0.8% by weight

The second provision, NSR, applies to areas that do not attain the NAAQS. Under NSR, new or modified major emission sources in nonattainment areas must meet strict emission control requirements. The requirements include installing and operating emission control equipment that has the lowest achievable emission rate (LAER) (see Table 4). LAER is based on either (1) the most stringent emission limit in any SIP for the class or category of emission source or (2) the most stringent emission limit achieved for a certain class or category of emission source. LAER does not consider equipment or operating costs when establishing the control requirement. In addition, to the technology requirement, the emission source must offset its emissions from the proposed new or modified facility with the purchase of emission reduction credits (ERCs).

The ERCs are created by reducing emissions from other emission sources in an amount greater than the permitted emissions of the new or modified emission source. This means that, for every ton of regulated pollutants that a new or modified source is permitted to emit, another source in the vicinity must reduce its emissions by more than one ton of pollution. The emission offset must be greater than the permitted emission increase from the proposed project in order to account for uncertainty in the baseline estimation and to ensure progress toward attainment of the NAAQS. In this way, the regulation helps non-attainment areas move closer to meeting the NAAQS requirement while offering emission sources some flexibility and allowing for industrial and economic growth.

Table 4: US Emission Control Technology Requirements for Power Plants

	New or Modified[2] Source	Existing Source
NAAQS Attainment Area (PSD Provision)	Best available control technology (BACT)	None
NAAQS Non-attainment Area (NSR Provision)	Lowest achievable emission rate (LAER) Emission offsets	Reasonably available control technology (RACT)

The final provision, PSD, is a program for emission sources in areas that already meet the NAAQS. It was designed to ensure that additional emissions from new and modified major emission sources do not lead to deteriorating air quality and also to counteract the unintended incentive of the NSR program for high-pollution industries to relocate to less-polluted states to avoid NSR permitting requirements. PSD, like NSR, requires new facilities to install and operate specific technologies, though PSD standards require the installation of best available control technology (BACT), accounting for impacts on energy, environment,

[2] Control technology requirements are applicable to any existing emission source that has made a “major” modification that increases the source’s potential emissions.

and economy as well as other costs. Thus, the control technology requirements under BACT can be less stringent than those under LAER. Moreover, PSD does not require emission offsets from existing emission sources in the vicinity.

EU Emission Performance Standards

The EU Member States agreed to a Europe-wide approach to reduce SO_2 emissions from large combustion plants, including power stations, petroleum refineries, steelworks, and other industrial processes running on solid, liquid, or gaseous fuel. The emission limit values (see Table 5) are established in the LCPD. In the UK, the emission limits are applied to all new combustion plants. Existing units – combustion plants licensed before 1987 July 1 – have the option of meeting the emission limits in the LCPD or participating in the National Emission Reduction Plan (NERP). The UK NERP, when fully implemented, will include a cap and trade program to reduce SO_2 and NO_X emissions.

Table 5: European Union Emission Concentration Limits

Electric output capacity	SO_2 Limit value
≥ 50 MW and < 100 MW	Coal and oil: 850 mg/m^3 Gas: 35 mg/m^3
≥ 100 MW and < 300 MW	Coal: 200 mg/m^3 Oil: 400 mg/m^3 to 200 mg/m^3 (linear decrease) Gas: 35 mg/m^3
≥ 300 MW	Coal and oil: 200 mg/m^3 Gas: 35 mg/m^3

Challenges of Technology Mandates and Performance Standards

The performance standards and technology mandates in the US and EU have contributed to significant emission reductions from large stationary emission sources without constraining economic development. In areas that do not attain the relevant air quality standards, the provisions provide a mechanism for construction of new emission sources to proceed without undermining efforts to attain the air quality standards. However, the provisions have some limitations as well. Some of the more challenging aspects of the provisions include:

- *Complexity and Inefficiency*. The US NSR and PSD permitting process has become complex and time consuming. Representatives of industry complain that the process fosters inefficiencies and unduly discourages economic growth and innovation.
- *Lack of Emission Controls for Existing Emission Sources*. The original programs in the UK and US did not require emission control technologies on existing emission sources, in effect "grandfathering" these facilities. These sources were exempted from emission

control requirements because (1) installing controls on these emission sources would be costly for both emission sources and customers; (2) it would be more efficient to install these devices on new emission sources; and (3) many of the existing emission sources were nearing the end of their operating lifetimes and would be retired soon, paving the way for new facilities in which the pollution control technology is required. Experience has shown, however, that many emission sources continue to operate with minimal modernization well after the expected 30-year operating life. In the US, this situation has been caused, in part, by a complex system of requirements for new, modified, and existing facilities that has provided incentives for not retiring or modifying facilities and the relatively high cost of retrofitting facilities to control emissions.

- *Uncertainty*. The US NSR provision requires emission control technologies on new and modified major emission sources. The provisions, however, lack a clear definition of a “major modification” that would establish the emission control obligation on an existing emission source. This has led to costly and time consuming litigation.
- *Cumbersome administration and high transaction costs*. The US NSR provision requires new and modified emission sources in areas that do not meet the NAAQS to offset permitted emissions by purchasing ERCs from existing emission sources that have reduced emissions. To be certified as credible, the relevant state environment agency must determine that the emission reduction: (1) is not required by existing regulations (i.e., surplus) (2) can be measured (i.e., quantifiable), (3) will endure for the life of the ERC (i.e., permanent), (4) represents real reductions, not “paper” reductions, and (5) the emission reduction and its corresponding new emission limit are legally and practically enforceable by the government. In addition, because this program was focused on local, not regional or national emission reductions, it was often necessary to assure that air quality would not deteriorate because of the trade; a process that could be time consuming and resource intensive. These challenges not only limited the usefulness of the offset programs, they also created relatively high transaction costs and long approval timelines for trades.

Cap and Trade Programs

Both the UK and US have adopted cap and trade programs as a way to cost effectively achieve a total emission limit – the national emission ceiling in the UK and a nationwide SO_2 cap in the US. However, because the NERP is still in the consultative phase, this report will focus on the US Acid Rain Program and US Clean Air Interstate Rule (CAIR).

Cap and trade is a market-based tool to cost effectively reduce and limit emissions. A cap and trade program establishes an aggregate emission cap, or limit, on the total mass amount of a pollutant from an industrial sector or group of sources. The regulator then creates allowances, each of which is an authorization to emit a specific quantity (e.g., one ton) of a pollutant, and distributes them to emission sources through an auction or no-cost allocation. The emission source is given the flexibility to develop a strategy to meet the emission limit that is appropriate for their facility. The strategy might include emission control technologies, cleaner fuels, production changes, buying allowances from other facility operators that reduced emissions more than was required, or a combination of these actions. To insure that the facility is in compliance with the emission reduction goals, the facility operator must accurately measure and report emissions to the regulator. And then, at the end of the compliance period, the government compares each source’s emissions and allowance holdings to determine if the facility is in compliance.

Because the cap ensures emissions will be at or below the specified level, the regulator does not need to define how or where the emission sources make the emission reductions; sources are free to design and implement customized compliance strategies and to buy, sell, or save – “bank” – allowances for optimum flexibility. Because allowances can be traded, sources that can make low-cost reductions have an incentive to reduce more than required and sell surplus allowances to sources with higher costs of control, thereby achieving the environmental goal at lower overall cost to industry and society.

Some benefits of a cap and trade approach include:

- *Environmental certainty*. The cap represents a maximum amount of allowable emissions that the universe of regulated sources can emit. The cap provides the environmental benefit; trading simply reduces the costs of achieving the cap. Penalties that exceed the costs of compliance and consistent, effective enforcement deter sources from emitting beyond the cap.
- *Incentives for additional reductions*. Banking, or the ability to save unused allowances for future use, provides temporal flexibility, creating an incentive for sources to decrease emissions below allowable levels sooner than required and providing earlier human health and environmental benefits. Banking also provides liquidity, a cushion for price volatility, and creates a safety mechanism for unforeseen events.
- *Accountability*. Compliance with the program must be based on complete and accurate emissions data. The quality of emission monitoring plays an important role in determining the market efficiency, investor confidence, and ability to meet the emission reduction target.
- *Cost-effective emission reductions*. Flexibility drives down the cost of reducing emissions by offering a wide range of emission control options and encouraging innovation. The effort to find ever cheaper emission reduction options can lead to experimentation that improves the understanding and wide-spread use of lower-cost options to reduce or avoid emissions.
- *Focused government role with low administrative costs*. The roles of regulator and emission sources are different when comparing cap and trade to traditional command-and-control approaches. Emission sources, which best understand their operation and business, have the flexibility to develop compliance strategies and make decisions about technologies, fuels, operational practices, and investments, and to change approaches as better methods become available, without needing government review and approval. The government is focused on setting the environmental goal, collecting and verifying emission data, tracking allowance transactions, and assessing and enforcing compliance.

While the benefits of cap and trade programs are significant, cap and trade is not appropriate for all environmental problems. Cap and trade is most effective when:

- The industry and government have the institutional capacity and infrastructure to monitor and verify emissions from each source;
- The costs of avoiding or controlling emissions vary across sources, creating the opportunity to reduce the overall costs of achieving the emission target;
- The pollutant and environmental problem is regional, national, or global, because the emission reductions are made across a region and there is no guarantee what level of reductions will be made in a specific location; and
- There are strong institutions that can consistently enforce the program requirements.

Case Study: The US Acid Rain Program

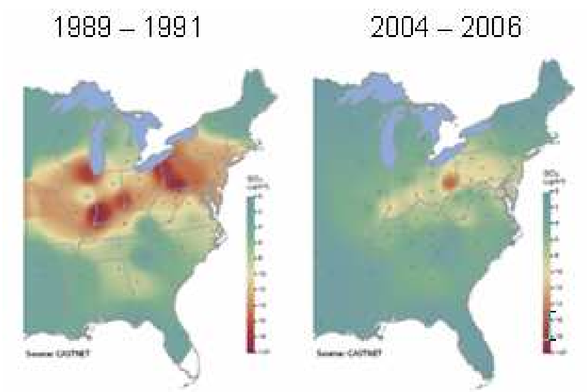
The US Acid Rain Program began in 1995 and has been one of the most successful air pollution control programs in the US. The goal of the Acid Rain Program is to reduce the harmful effects of acid rain on sensitive ecosystems by reducing SO_2 and NO_X emissions from fossil fuel-fired power plants in the US.

Under the Acid Rain Program, the electric power sector's SO_2 emissions were capped at 9.05 million metric tons for the year 2000. The cap gradually declines to 8.14 million metric tons per year in 2010. EPA is responsible for creating allowances equal to the level of the cap and distributing the allowances to emission sources using a prescribed formula. The emission sources have the flexibility to develop compliance strategies that account for relevant conditions at their respective electric power plant. In addition to the SO_2 reduction requirements, coal-fired electric generation units have to meet NO_X emission standards individually or through participation in a company-wide emission averaging program that provides a way to achieve NO_X reductions more cost-effectively. Throughout the year, electric power plants must measure their SO_2, NO_X, and CO_2 emissions and report the emission data and supplemental operations data[3] to EPA.

At the end of each compliance period, each emission source must hold sufficient allowances to compensate for its emissions during the compliance period. If an emission source does not hold sufficient allowances to offset its SO_2 emissions, each short ton of excess SO_2 emission is subject to a penalty of $3,152[4] for the 2006 compliance year and the surrender of one future allowance from the source's account to make the environment whole.

The Acid Rain Program has produced more reductions more rapidly and at a lower cost than anticipated when the legislation was passed. The emission reductions from the Acid Rain Program and the US NO_X Budget Trading Program – a cap and trade program for NO_X from electricity generators and industrial boilers – have led to significant reductions in concentrations of SO_2, PM2.5, and ozone, as well as reductions of dry and wet acid deposition (see Figure 3, 4, and 5).

Figure 3: Eastern US Annual Average SO_2 Concentration



[3] The majority of emission sources are required to provide supplemental data that may include the flow rate of exhaust gases, operating hours, heat input, and calibration and equipment test results. These supplemental data are used by EPA to audit the emission data to ensure accuracy and to assess whether the measurement equipment is properly operated and maintained.

[4] The CAA established a penalty of $2,000 per short ton with a requirement that EPA adjust the penalty amount to reflect inflation. For compliance year 2006, the penalty was $3,152 per short ton ($2,859 per metric ton).

Figure 4: Eastern US Annual Average Ambient Sulfate Concentration

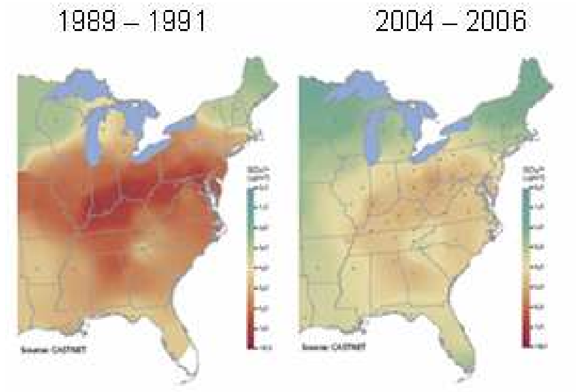
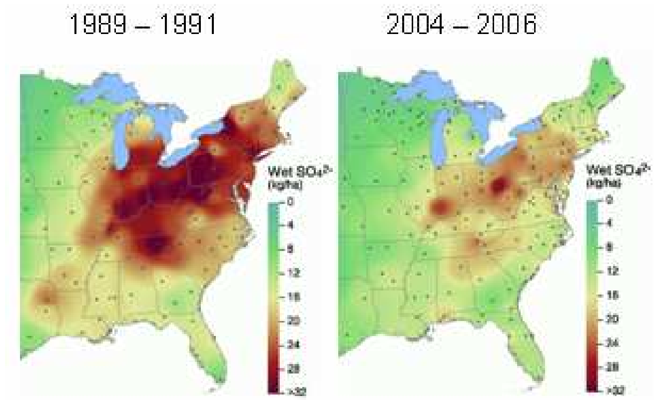


Figure 5: Eastern US Annual Average Wet Sulfate Deposition



A recent study estimated that the human health and environmental benefits of the Acid Rain Program exceed the compliance costs by a factor of 40 to one. Because of the program's success, it has been held up as a model approach for cost-effectively achieving broad, regional reductions of emissions from large stationary emission sources.

The following key elements are essential to the success of the Acid Rain Program:

- Emission cap;
- Rules and responsibility for meeting the emission cap;
- Infrastructure; and
- Institutions.

Setting the emission cap

Determining the appropriate level for an emission cap can be very challenging with a large amount of uncertainty. When setting the cap for the US Acid Rain Program, the US Congress and EPA evaluated a number of criteria, including:

- The effect of the primary and secondary pollutants on human health; buildings and cultural resources; and crops, forests, and waterways.
- The scientific consensus on the reductions necessary to resolve the human health and environmental problem.
- The technical and economic feasibility of meeting the cap. EPA does extensive analyses to predict how many controls will be installed, how much steel and other material is needed, whether there are enough skilled laborers to build the technology in time, if

there is sufficient transportation capacity for cleaner fuels, and the total investment and ongoing expenses required to achieve the cap.

Scientific studies at the time predicted that the program's primary objectives – reducing emissions to mitigate acid deposition problems in the Eastern US – might be attained by reducing nationwide annual emissions between 7.3 million and 10.9 million metric tons below the 1980 level. The ultimate goal, a 9.1 million metric ton reduction from all sectors, including a 7.7 million metric ton reduction from the power sector, was established as a long-term target for the year 2010. The long-term target provided power plant owners and operators with certainty about future emission reduction requirements and a sufficient time horizon to develop compliance strategies that minimize costs.

However, as EPA's understanding of fine particles improved, EPA realized that emissions had to be reduced even further to address the human health consequences of sulfates. That is why the new CAIR program reduces SO_2 and NO_X emissions by another 70 percent and 60 percent, respectively. Because the CAIR emission cap represents enormous emission reductions, the cap is implemented in multiple phases to give the facility operators and technology manufacturers time to develop and install control technologies.

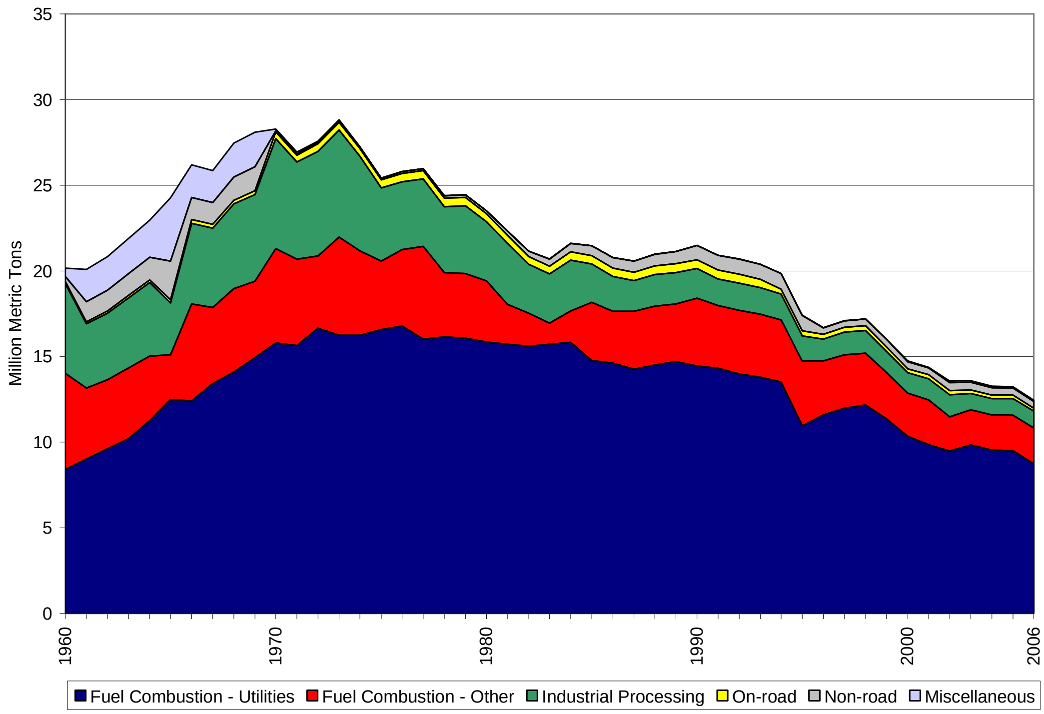
Rules and responsibility for meeting the emission cap

Once the cap was set, the next step was to develop the program rules, including:

Applicability

The cap and trade approach of the Acid Rain Program focuses on SO_2 emissions from the electric power sector, specifically, electricity generators that burn fossil fuels (i.e., coal, oil, or natural gas). When the 1990 CAA Amendments were approved, the electric power sector emitted approximately two-thirds of nationwide SO_2 emissions (see Figure 6). The power sector was also responsible for a significant amount of total NO_X emissions and, from an administrative standpoint, the sector was relatively easy to regulate – the number of sources was manageable (about 2,000 sources at the time the program was developed), emissions were easily monitored, emission control technologies were commercially available, opportunities to shift production outside the regulated region (i.e., leakage) were limited, and EPA had significant experience regulating this sector. It was clear that the best way to achieve the necessary emission reductions was to focus on the sector.

Figure 6: US Sulfur Dioxide Emission Trends by Sector



Allowance distribution

The level of the emission cap determines the number of allowances that are distributed to emission sources. The method for distributing these allowances, however, can vary from program to program. The allowances for the Acid Rain Program are distributed according to formulas that reflect historical fuel use and specified emissions rates. For Phase I (1995-1999) of the program, the general allocation formula was based on an emission source's average annual heat input (in million Btu) in the years 1985 to 1987. The allocation was calculated by multiplying the average heat input by 1.1 kilograms (2.5 pounds) of SO_2 per million Btu of heat input. In Phase II (beginning in 2000) of the program, the allocation formula was lowered to 0.55 kilograms (1.2 pounds) per million Btu of heat input. Allowances in the Acid Rain Program are distributed by EPA to emission sources in perpetuity at no cost.

Some of the more recent cap and trade programs, such as the NO_X Budget Trading Program, include optional updating provisions that require the state government to periodically recalculate the allowance allocations.

Regardless of the frequency and method of allowance allocations, it is important to provide emission sources with certainty about allocations so they may develop compliance strategies that minimize costs. Providing certainty requires that allowances be allocated or sold in advance of the program's start date and emission sources be provided with several years of allowances in advance. In addition, allowance holders must have confidence that the government will treat allowances *similar* to a property right (i.e., the allowance holders should have reasonable certainty that allowances will not be withdrawn without transparent, pre-defined procedures). Certainty is essential if a cap and trade program is to achieve its potential cost-effectiveness and environmental-effectiveness.

Allowance rules

One allowance represents the legal authorization to emit a specific amount of emissions (e.g., one short ton). At the end of the calendar year, emission sources must surrender sufficient allowances for every short ton of SO_2 emitted. If an emission source's annual emissions are below the allowance holdings, the emission source can save, or bank, the surplus emissions for use in the future. The option to bank surplus allowances provides emission sources with temporal flexibility and creates an incentive for emission sources to reduce emissions more than required in order to bank allowances that can be used in the future when emission reductions may be more difficult or expensive.

EPA does not place restrictions on allowance trades and does not interfere with private transactions (e.g., mandating or restricting transactions between firms). Emission sources are free to enter into transactions with any other market participant. Minimizing restrictions on the market for allowances helps minimize complexity, increase liquidity, and reduce overall compliance costs.

Penalties for non-compliance

Determining compliance with the allowance holding requirements of the Acid Rain Program is a simple mathematical check. At the end of the compliance period, the EPA compares each emission sources annual SO_2 emissions data against the source's SO_2 allowance holdings to ensure that the emission source has the appropriate number of allowances to compensate for emissions. When emissions exceed the number of allowances for the Acid Rain Program, the emission source must pay an automatic penalty $3,152 per excess short ton and forfeit one future allowance for each excess ton. These penalties are automatic; environmental regulators do not have discretion to negotiate the penalties with the non-compliant emission sources. This ensures that the programs move forward without delays due to protracted discussions and litigation and to assure the emission sources that when they do not comply with the allowance holding requirements, there are specific and stringent consequence.

Transparency

In an effort to build support for the program and to demonstrate that the program is properly enforced, EPA shares information and involves industry, state governments, and interest groups in the design of the program rules. This creates a stronger program because of the expertise these representatives can offer to the EPA. Additionally, emission data and allowance transfer information are posted on the Internet for review by interested stakeholders. This level of transparency demonstrates that EPA is properly enforcing the programs, enhances the program's credibility, and facilitates the allowance market.

Infrastructure and institutions

Two additional and critical elements of the Acid Rain Program are the emission measurement provisions and the compliance assistance services offered by EPA.

Emission Measurement

The Acid Rain Program includes provisions that promote accurate and consistent monitoring, reporting, and verification. All affected emission sources are required to measure and record SO_2, NO_X, and CO_2 emissions using continuous emission monitoring systems (CEMS) or, for emission sources not burning coal, an approved alternative measurement method. The vast majority of emissions are monitored with CEMS while the alternatives provide an efficient means of monitoring emissions from the large universe of units with lower overall mass emissions.

CEMS and approved alternatives are a cornerstone of the Acid Rain Program's accountability and transparency. Since the program's inception in 1995, affected sources have reported hourly emission data and supplemental data (e.g., operating hours, heat input, equipment calibration and test results) to EPA in quarterly electronic reports. Using automated software audits, EPA rigorously checks the completeness, quality, and integrity of these data. EPA also publishes all emission data via the Internet.

The emission data must be consistent and complete because it is used to determine compliance with the allowance holding requirements. Therefore, the enforcement of the US Acid Rain Program relies on strong quality assurance and quality control to assure data quality and promote self-enforcement. The EPA provides emission sources with software tools that allow them to routinely check their electronic reporting equipment and calculations before submitting this data to the EPA for annual reconciliation. Additionally, the EPA conducts electronic audits based on statistical criteria drawn from past emission reports and field audits. EPA and state environment agencies also conduct field audits to ensure that emission monitoring equipment is operated and maintained according to the approved monitoring plan, verify that the source is keeping records to support the emission measurements and the monitor's performance, and that all calibrations and checks are properly conducted.

While the program strives for 100 percent availability and accuracy of emission monitoring equipment, monitor availability averages slightly more than 98 percent. To address this discrepancy, the monitoring and reporting requirements include data substitution provisions that provide for automatic, predictable generation of substitute data by a data acquisition and handling system. The substitute data requirements become increasingly conservative (i.e., punitive) as the monitor's reliability decreases or the length of the missing data period increases. The punitive nature of the substitute data requirements ensures not only that sources do not underreport emissions, but also serves as an incentive to monitor properly and avoid the use of substitute data. This is a strong incentive to properly operate and maintain monitoring equipment because overestimated emissions from data substitution procedures require the emission source to give EPA additional allowances, each of which has a financial cost.

There are also incentives to improve the accuracy of monitors that are operating properly. Once such incentive is reduced testing. If a monitor performs well on a relative accuracy test audit the emission source can reduce the frequency by which they conduct the expensive tests.

The combination of strong data quality assurance and quality control, electronic and onsite auditing, and automatic and increasingly punitive data substitution provides the foundation for an easily enforceable program that delivers credible emission reductions.

Compliance Assistance

EPA works collaboratively with emission sources to continuously improve the monitoring provisions and the accuracy of emission data. EPA has a call center to answer emission sources' questions; discuss measurement issues; and clarify monitoring, verification, and reporting rules. EPA also has a formal petition process through which emission sources can request changes or exceptions to the measurement provisions. These interactions help EPA develop relevant and up-to-date rules, provide emission sources with a way to work one-on-one with EPA to understand program requirements and address problems when they first occur, and improve the accuracy of emission data.

EPA also works with program participants to improve compliance with the allowance requirements of the program. For example, several weeks before the end of the compliance period, EPA notifies program participants with insufficient allowances that they are at risk of noncompliance if they do not add allowances to their appropriate allowance account. These participants can then transfer allowances to their account, either by transferring from one of their other accounts or buying allowances from another source, to comply with the allowance requirements of the program.

Because of the simple rules, strong accountability, stringent and automatic penalties, and cooperation between EPA and industry, the compliance rate of the US Acid Rain Program has been greater than 99 percent every year.

Challenges of the Cap and Trade Approach

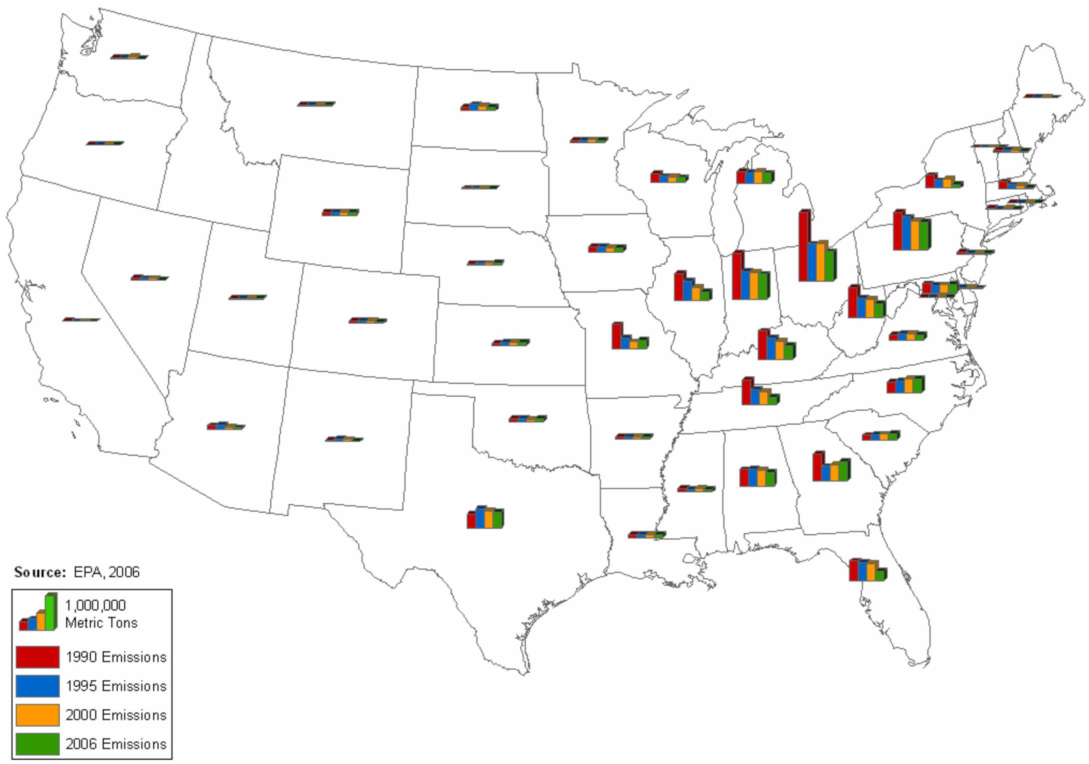
The Acid Rain Program has achieved substantial emission reductions at a cost much lower than a traditional technology- or performance-standard program. As with traditional control programs, cap and trade programs have issues and challenges that must be addressed. These issues and challenges include the spatial distribution of emissions, options to revise the emissions cap, potential consequences of allowance banking, equity in allowance allocations, and emission measurement, verification, and reporting.

Spatial Distribution of Emissions

A major reservation often expressed about a cap and trade approach is that it may produce "hotspots" – areas of high pollution concentrations due to increased emissions from emission sources that purchased allowances. Unlike more traditional regulation that may address regional and seasonal issues by defining technology or performance standards that are more restrictive in areas where or, at times, when environmental problems are more critical, the theoretical design of cap and trade programs allow trading across regions and banking of emission allowances without regard to the possible environmental consequences. After extensive review of the Acid Rain Program, EPA and independent analyses indicate that emission hotspots have not occurred. Even more significant, regions with the highest emissions, such as the north-central region, have had the largest reductions (see Figure 7). This occurred at both the regional level and near individual electric power plants. Perhaps more importantly, even areas where emissions increased slightly, monitoring data suggests that air quality in those areas still improved due to a large overall reduction in regionally-transported air pollution as a result of the Acid Rain Program.

Academic and government analysts have pointed out it is unlikely that any given area will have negative impacts from the Acid Rain Program because the cap is set low enough that it requires emission reductions by a large percentage of sources. In addition, local air quality programs can lock in emission reductions where states and local governments believe they are necessary. Emission sources must meet the state and local emission control requirements regardless of the number of emission allowances they hold; allowances from EPA's trading programs cannot be used to avoid meeting emission control requirements intended to protect local air quality.

Figure 7: State-by-State Sulfur Dioxide Emissions



Options to Revise the Emissions Cap

The concept of a cap – a limit on total emissions, not just emission rates – was a key innovation of the cap and trade programs. However, the Acid Rain Program does not include provisions for reassessing the emission cap and, if necessary, revising the cap level. New information from scientific studies, ecological assessments, and health observations may necessitate lower emission caps to adequately protect human health and the environment.

Cap and trade programs, to the extent revisions to the cap are authorized by law, could adjust to new information by changing the level of the cap through a transparent, pre-defined process. However, if the level of the cap is changed, it will be important to provide emission sources with sufficient notice and to establish a credible process for lowering the cap and an equitable process for the treatment of existing allowance holdings. For example, the CAIR program does not eliminate the surplus Acid Rain Program allowances that emission sources have banked because they reduced SO_2 emissions greater than necessary.

Potential Consequences of Allowance Banking

Another reservation sometimes expressed about cap and trade programs is the potential of banked allowances to permit temporary increases in emissions, thereby hindering the ability to achieve the environmental goal. Allowance banking provides a number of benefits, including temporal flexibility for managers of emission sources, stability in the trading market for allowances, and incentives to make early emission reductions in excess of what is required. However, since emission sources can save the surplus allowances for use in the future, banking can delay the achievement of the ultimate emission reduction goal. In US cap and trade programs, the US Congress and EPA have decided that the trade off between the benefits of banking and delaying the future emission reduction goal are worthwhile.

Notably, when EPA developed CAIR, the implications of banked SO_2 allowances were accounted for as a way to provide a smooth, gradual transition to the significantly lower emission caps. Already, the ability to bank Acid Rain Program allowances for use in CAIR is leading to early emission reductions for SO_2 and greater health protection for the public.

Equity in Allowance Allocations

Most academics that study the theory of cap and trade promote auctions as the most efficient approach to allocate allowances because it internalizes the cost of the resource – air quality – and ensures that pricing the resource leads to the most efficient use of the resource. However, academics do not see the auction of allowances only as way to achieve a desired result, but also as a way to generate revenues and to lower other distortionary taxes (e.g., labor). For political reasons, however, auctions are often not feasible so the majority of allowances are distributed to emission sources through no-cost allocations. While the allocation process does not have an effect on the environmental outcome of the program – the cap establishes the non-violate environmental goal – the allocation methodology can have economic and political consequences.

Different allocation methodologies can reward different behaviors and create "winners" and "losers" among emission sources. Because the allowances have economic value, owners and operators of emission sources may lobby for specific methodologies that maximize their allocation. But because the cap is fixed, increasing the number of allowances to any one emission source means there are fewer remaining allowances to divide among the other sources.

In the Acid Rain Program, allocations are based on historical heat input, not historical emissions, so emission sources that have already implemented approaches to reduce emissions (e.g., installation of FGD equipment or use of low-sulfur fuels) are not penalized for adopting early strategies to reduce emissions. Likewise, emission sources that have not taken action to reduce emissions are not rewarded for their inaction. Allocations based on electricity generation or output would, in theory, yield similar results.

Emission Measurement, Verification, and Reporting

Because compliance is based on total emissions and the value of allowances is based, in part, on the credibility of the program, consistent, accurate, and complete emission monitoring is essential to the success of a cap and trade program. If emission sources cannot accurately measure the pollutant(s) emitted, cap and trade, or any form of emission trading program, may not be the appropriate policy tool to attain significant emission reductions. It is worth noting that the inability to monitor emissions effectively is generally a problem for all types of control programs and should be resolved as soon as possible.

Accurate monitoring data is more critical in market-based policies such as emission taxes and cap and trade. In cap and trade programs, emission sources must surrender sufficient allowances to offset reported emissions. Because the allowances have a value, if a program is not strongly enforced and emission measurements are not properly verified, emission sources have an incentive to underreport emissions so that they can reduce the number of allowances required for compliance and sell surplus allowances to other emission sources. This not only undermines achievement of the emission cap, it also lowers the value of allowances because the underreporting of emissions increases the supply of allowances.

Lessons from the US Acid Rain Program

As seen in the US Acid Rain Program and subsequent cap and trade programs, the approach works. Setting strict rules for accountability and giving emission sources the flexibility to develop custom strategies to reduce emissions yields environmental results at significantly lower cost. While cap and trade is a very flexible tool, it is not appropriate for all air quality challenges. Local problems often require local control programs due to the nature of the emitters (e.g., mobile sources), proportion of the problem from a small number of major facilities, and other factors. However, the US experience has shown that a hybrid system of local controls to protect local air quality and cap and trade programs to achieve broad, regional reductions can complement one another and lead to improvements in local air quality.

There are several important design and implementation lessons from EPA's 18 years of experience designing and implementing cap and trade programs. The key lessons are discussed below.

Partnerships and Dialogue Improve Policy Design

During the design phase, the US Acid Rain Program benefited significantly from partnerships and dialogue with stakeholders. By providing the EPA, policymakers, industry, and NGOs with the opportunity to develop a better understanding of the goals, problems, and realities faced by the different players, these partnerships and dialogues resulted in significant time and cost savings. Perhaps the best example of this emerged from the success of the Acid Rain Advisory Committee (ARAC), forged immediately after the passage of the 1990 amendments to the CAA. This group – composed of 44 individuals representing industry, NGOs, state agencies, and academia – was created to advise the EPA on the design of rules to implement the US Acid Rain Program. From the beginning of the process, the members of ARAC became actively engaged in the rulemaking process and acted as a "sounding board" for the EPA as it considered various regulatory options. With the help of the committee, the EPA identified potential problems and developed solutions early on. Furthermore, because ARAC members were invested in the Acid Rain Program and therefore committed to its success, committee participants publicly promoted the program and voluntarily educated others within their stakeholder groups.

Flexibility Encourages Innovation and Reduces Cost

A key feature of the Acid Rain Program is the different roles that EPA and emission sources play compared to traditional emission control approaches. In the Acid Rain Program the managers of an emission source, who best understand its operation and business, have the flexibility to develop compliance strategies and make decisions on technologies, fuels, operational practices, and investments, and to change the approach as better methods become available, without needing government review and approval. The government is focused on setting the environmental goal and ensuring it is achieved. EPA collects and verifies emission data, tracks allowance transactions, assesses and enforces compliance, and publishes information about the program.

This flexibility and responsibility to develop compliance strategies creates a continuous opportunity for emission sources to seek customized, cost-effective approaches to control emissions. Emission sources are not forced to install technology that may not be appropriate for their configuration or business plan and the compliance strategies are not subject to complex review by EPA to determine if the decisions meet technical specifications or if pollution control equipment is operating properly. Because EPA does not review the compliance strategies, there is no uncertainty about regulatory approval. The stringency and simplicity of the emission cap ensure that the environmental benefits will be achieved regardless of individual compliance strategies. The result is that built-in flexibility not only keeps costs low for sources that choose cost-effective compliance strategies, but it also minimizes the administrative costs of the program.

The flexibility of the US cap and trade programs and the continuous incentives for emission sources to reduce emissions to either avoid using allowances or freeing them up for sale have led emission sources to adopt a wide range of compliance techniques and new types of control arrangements that have emerged over time. Emission sources complied with the Acid Rain Program by improving operation of existing scrubbers, retrofitting with scrubbers that get greater removal efficiency, moving to relatively lower sulfur coals from local coalmines, transporting low-sulfur coals from the Western US, and even importing less polluting coals or coal blends.

Accountability is a Prerequisite for Flexibility

Emission sources must be held accountable for accurately measuring and reporting all emissions, and complying with allowance holding requirements. This requires both complete and accurate emission measurement and strong, consistent enforcement of program rules. EPA believes the emission data underlying the Acid Rain Program, including SO_2, NO_X, and CO_2 emissions, is the most accurate and comprehensive emission data collected by EPA or any other US government agency. To determine that regulated sources are in compliance, EPA requires monitoring, reporting, and verification of emissions to ensure that emissions data are complete, consistent, and account for every ton. The quality of emission monitoring plays an important role in determining the market efficiency, investor confidence, and ability to meet the emission reduction target.

Emissions data are subjected to extensive, rigorous quality assurance checks by the emission sources and EPA to ensure completeness and accuracy. Sources implement a mandatory and comprehensive on-site quality assurance program where monitoring systems are subjected to daily calibration and a series of checks and tests, before certification and submission of their quarterly electronic data reports to EPA. After EPA receives the data, EPA audits the reported data through a several-step process, and then supplements this audit process with separate ad hoc analyses and data cleanup surveys. Additionally, EPA offers audit software to emission sources and state environment agencies to facilitate the reporting of consistent and accurate emission data. The high-quality emission data provide the basis for ensuring compliance and assessing achievement of the emission reduction goal and contribute to the credibility of the allowance market.

Simple and Clear Rules are Easier and Less Costly to Implement

Complexity may be required in some cases, but it should be minimized whenever possible. The Acid Rain Program has demonstrated that operating the program with simple, clear goals and rules saves time and money for both emission sources and EPA. Moreover, the high compliance rate with the critical elements of the SO_2 program – greater than 99 percent – is due in large part to rules that are clear and easily enforced. In contrast, complexity often requires more decisions, debate, and information collection. Such a situation can create uncertainty and unnecessary burden that may lead to delays, opportunities foregone, and, ultimately, higher costs.

While simplicity was a key objective of the Acid Rain Program, some areas of the program included unnecessary complexity. Some of these complexities were introduced in the political process as a way to gain support for the program. Two aspects of the program – allocation formulas and partial coverage of the electricity sector during Phase I – had the potential to increase uncertainty, program costs, and administrative burden, and may have benefited from greater simplicity.

Because Phase I of the Acid Rain Program covered only a subset of electricity generating units, there was a possibility of “leakage” – shifting generation from a Phase I electric power plant to an electric power plant not required to participate in the program until Phase II. The electric power sector is interconnected, meaning sources could easily shift generation from one combustion unit to another. To address the possibility of “leakage”, the program includes a reduced utilization provision that requires Phase I electric power plants that reduce utilization to demonstrate that the reduction was not offset by an increase at a non-Phase I electric power plant. If the Acid Rain Program had included all regulated sources in Phase I, there would have been no possibility of leakage and the complicated reduced utilization provision would not have been necessary.

Adaptability to Address New Information is Important

Air quality management approaches, including cap and trade, need the ability to adapt to new information, practices, or technology. EPA has made a number of changes to the Acid

Rain Program. Most of the changes were intended to streamline the programs; improve the quality of emission data; take advantage of advances in information technology and the Internet; minimize burden and costs for regulated sources, market participants, and EPA; and improve the environmental accountability and results of the program.

Cap and Trade Can Complement Local Air Quality Programs

Cap and trade programs work best on a regional or larger scale. By requiring significant reductions of regional pollution that is often transported across state boundaries, cap and trade programs may also, and often do, improve local air quality (see Figures 3 and 4). However, eliminating high, localized concentrations of emissions is not the primary purpose of cap and trade programs. To protect local air quality, cap and trade programs should complement, not conflict with, state or local programs.

In the cases of the Acid Rain Program, regulated sources must comply with all applicable local, state, and national emission requirements, regardless of the number of allowances held. This means that local and state governments can impose additional source-specific emission limits as necessary to protect local air quality. The governments may not, however, place restrictions on an emission sources ability to trade allowances with other emission sources or market participants.

Compliance Assistance Reduces Errors and Improves Compliance Rates

The goal of the cap and trade programs for both emission sources and EPA is the same – to reduce emissions. EPA's primary means of ensuring this goal is through sound monitoring, reporting, and enforcement that has clear, substantial automatic penalties with the addition of traditional enforcement approaches if necessary. However, the EPA and state-level staff that work on the Acid Rain Program also share a goal with the affected emission sources of achieving 100 percent compliance with key program requirements. These staff, where appropriate, work collaboratively with emission sources to ensure that the responsible people at the emission sources clearly understand their obligations (e.g., to monitor and report emissions, address issues as the arise, and hold sufficient allowances to compensate for total emissions). EPA has established a team of several full-time employees dedicated to providing assistance to emissions sources and reviewing the sources' activities throughout the year.

This close working relationship between EPA and the emission sources has led to positive interactions, and strong support for the programs and the role of the regulator. It has also facilitated very high compliance rates exceeding 99 percent. EPA believes that the viewing compliance as a joint commitment between the government and emission sources provides credibility to the program and improves the compliance rate.

Careful Policy Design can Create Proper Incentives

By design, cap and trade programs provide incentives for emission sources to develop strategies that reduce the costs of compliance. These incentives need to be clear and strong to be effective. In addition, they must account for or replace contradictory incentives created by other programs or rules.

At its most basic level, a cap and trade program must provide disincentives for non-compliance. This requires that the penalty provisions for non-compliance must exceed the cost of compliance (i.e., the penalties must be greater than the cost of reducing emissions to meet the emission source's target.) In the Acid Rain Program, excess emissions trigger clear, non-negotiable, automatic penalties; the EPA and state regulators do not have discretion to negotiate or cap the penalties. Because the penalty is issued for each excess ton of emissions, the more severe the non-compliance, the greater the total penalty. Other violations as well as excess emissions may result in supplemental civil and/or criminal penalties. Compliance is also encouraged through other disincentives (e.g., progressively punitive provisions for missing monitoring data) and incentives (e.g., reduced frequency for monitoring equipment quality assurance checks when superior test results are achieved.)

Allowance Banking Provides Flexibility

Allowance banking provisions of the Acid Rain Program provided significant benefits in the form of increased flexibility for emission sources and early emission reductions that provided improved air quality. There was significant overcompliance during the modest first phase of the program. Phase I emission sources reduced SO_2 emissions more than 3 million tons more than required by the cap. These excess reductions clearly provided a substantial amount of environmental and health benefits early in the program. Notably, the large bank of millions of allowances also provided a buffer for the expanded coverage and tightening of the emissions cap for Phase II and the new cap levels set in CAIR. Concerns about the overuse of the bank in a single year appear to be unfounded. Emission sources in the Acid Rain Program have not used excessive numbers of banked allowances in any year of the program's history.

Industry Needs Long-Term Emission Goals

Under a cap and trade program, emission sources must develop long-term compliance and investment strategies to cost-effectively reduce emissions. Effective planning requires certainty – certainty about the future level of the cap and the number of allowances the emission source will receive. While no study has been done on how far into the future a cap should be defined, providing emissions sources with certainty ten to 15 years in the future should provide enough certainty for the managers to make investment decisions. In addition to information about the level of the cap, an emission source needs to know how many allowances it will receive in the future. In the Acid Rain Program EPA issues allowances in perpetuity (i.e., the allowances don't change) for 30 years in advance.

Also, if allocations are recalculated, the allocation approach should create incentives for emission sources to reduce emissions by a greater amount than is necessary. For example, recalculating allocations based on historical emissions creates an incentive for an emission source to emit at the maximum permissible level so that they are not penalized in the next allocation calculation for the source's excess emission reductions. Basing the allocation on heat input or output would not create such an incentive. If allowance allocations are periodically recalculated, the length of time between recalculations should be long enough to provide the necessary certainty.

Information Technology Reduces Administrative Burden and Costs

The use of information technology to manage allowance holdings and transactions and collect, quality assure, and manage emission data, enables EPA to operate the Acid Rain Program with a very limited number of staff. Approximately 50 full-time staff operate the SO_2 cap and trade program. Most of these staff are responsible for certifying and auditing monitoring equipment and data and providing compliance support to the regulated community. Processing allowance transfers requires minimal EPA staff effort with 98 percent of the transactions done online by market participants.

Water Pollution Trends and Water Quality Programs

US Approach to Sustainable Water Infrastructure

Sustainable practices are a key part of the US strategy to change how governments and the public view, value, manage, and invest in water infrastructure. EPA works with the water industry to identify best practices that have helped many in the industry address a variety of management challenges and extend the use of these practices to a greater number of water and wastewater utilities. EPA has identified four elements, titled the "Four Pillars Approach", of sustainable practices.

Pillar 1: Better management of water and wastewater utilities

The objective of the first pillar is to shift the water management model beyond compliance to sustainability and improved performance. Some elements of better management can include:

- Asset Management: managing infrastructure to minimize the total cost of owning and operating the assets, while delivering the desired service levels.
- Environmental Management Systems: integrating the environment into everyday business operations; making environmental stewardship a part of the daily responsibility for employees across the entire organization.
- Capacity Development: providing assistance to improve the technical, financial, and managerial capacity of small water systems so they can provide safe drinking water consistently, reliably, and cost-effectively.

Pillar 2: Rates that reflect the full cost pricing of services

When measured as a percentage of household income, US water consumers pay less for water and wastewater bills than in many other developed countries. Because of this, the public has been led to believe that water is readily available and cheap. However, pricing that recovers the costs of building, operating, and maintaining a system is absolutely essential to achieving sustainability. Drinking water and wastewater utilities must be able to price water and services to reflect the full costs of treatment and delivery.

EPA has developed an extensive web site focused on water and wastewater pricing (http://www.epa.gov/waterinfrastructure/pricing/index.htm) to help implement pricing structures that effectively recover costs and promote environmentally sound decisions by customers.

Pillar 3: Efficient water use

The US has taken a broad approach to efficient water use by establishing water efficiency levels for products (e.g., faucets, toilets, irrigation systems); building partnerships with manufacturers, distributors, utilities and others to promote water efficient processes and products; and promoting an ethic of water efficiency through promotional and educational activities. EPA has developed a labeling and education program for water efficiency (WaterSense - http://www.epa.gov/watersense/) modeled after the very successful labeling and education program for energy efficiency (EnergyStar - http://www.energystar.gov/).

Pillar 4: Watershed approaches to protection

Effective and sustainable water quality programs must go beyond traditional geographic boundaries to create interstate and inter-local partnerships based on watershed boundaries. The focus should be on making sound infrastructure and growth decisions within the context of how water flows through a watershed. To encourage watershed management principles so that decision makers consider watershed-based, cost-effective alternatives alongside traditional treatment technology investments, the US has focused on:

- Watershed Based Permitting: address all discharge sources within a watershed rather than addressing individual pollutant sources on a discharge-by-discharge basis.
- Protecting Water Sources: it is more cost-effective to prevent pollution than to clean it up. Water quality can be threatened by many everyday activities and land uses, ranging from industrial wastes to the chemicals applied to farms, lawns, and gardens.
- Water Quality Trading: sources in a watershed can face very different costs to control the same pollutant. Trading programs allow facilities facing higher pollution control costs to meet discharge obligations by purchasing equivalent or better pollution reductions from

another source, thus achieving the same water quality improvement at lower overall cost. EPA has developed a water quality trading toolkit to assist communities and regions interested in implementing trading programs (http://www.epa.gov/owow/watershed/trading/WQTToolkit.html).

- Smart Growth: development that serves the economy, the community, and the environment. It changes the terms of the development debate away from the traditional growth or no growth question to "how and where should new development be accommodated."

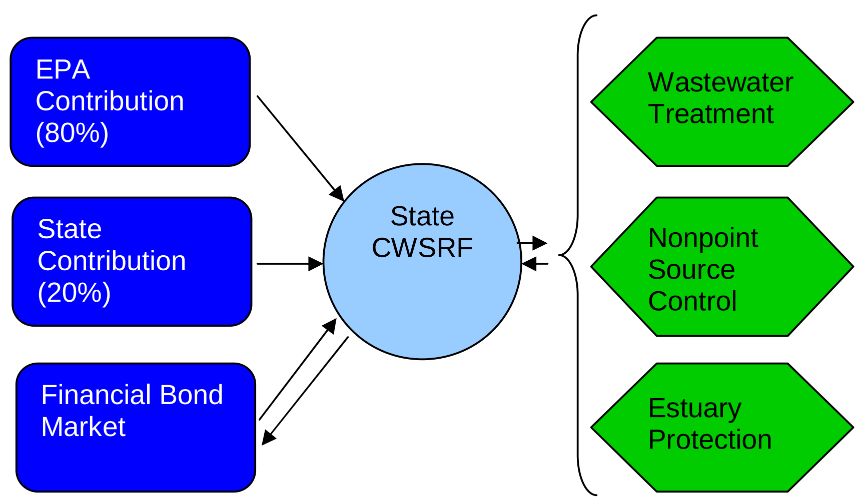
US Clean Water State Revolving Fund

The Clean Water State Revolving Fund (CWSRF) program is a financing program for water quality projects and infrastructure. Under the program, EPA provides grants or "seed money" to all 50 states plus Puerto Rico to capitalize state loan funds. The states, in turn, make loans to communities, individuals, and others for water quality projects. As the money is paid back into the revolving fund, new loans are made to other recipients to maintain water quality. Because of the funds' revolving nature, the national government's investment can result in the construction of up to four times as many projects over a 20-year period as an equivalent onetime grant would yield. Currently, the program has more than US $27 billion in assets.

The CWSRF program is a partnership between EPA and the states (see Figure 8). It gives state governments the flexibility to fund projects that address their highest-priority water quality needs. While traditionally used to build or improve wastewater treatment plants, loans are also used for:

- Controlling agricultural, rural, and urban runoff;
- Improving estuaries;
- Controlling stormwater and sewer overflows;
- Implementing alternative treatment technologies; and
- Performing water reuse and conservation projects.

Figure 8: Clean Water State Revolving Fund Components



Since the program is managed largely by the states, project eligibility varies according to each state's program and priorities. CWSRF programs in each state rank project applications according to public health and compliance criteria. The ranking systems ensure that funding goes first and foremost to projects with the greatest impact on human health and the environment. Eligible loan recipients may include communities, individuals, citizens' groups, and non-profit organizations. Loan funds may be used to improve the quality of watersheds through a wide range of water-quality-related projects; loans may also be used for the protection of groundwater resources. Recently, state programs have begun to devote an increasing volume of loans to nonpoint source, estuary management, and other water-quality projects.

States can also choose from a variety of assistance options, including loans, refinancing, purchasing, or guaranteeing local debt. States can also set specific loan terms, including interest rates—from zero percent to market rates—and repayment periods up to 20 years. There are also provisions to allow customized loan terms for small and disadvantaged communities. In 2006, 72 percent of all loans (21 percent of funding) were made to communities with populations less than 10,000. In addition, some states provide specialized assistance, including grants and no-interest loans, for communities that are experiencing financial hardship.

Lessons from the Clean Water State Revolving Fund

1. Each community has different needs. A comprehensive survey of the needs of each community is critical for establishing funding needs and priorities.
2. Accurate assessment of the existing infrastructure and necessary improvements is also essential for establishing funding needs and priorities.
3. Prioritizing projects by their impact on human health and the environment ensures that investments yield greater benefits for each dollar invested in the respective communities.
4. A decentralized program helps address regional differences better than a one-size-fits-all approach
5. Different communities will have different priorities and approaches to achieve their goals. Giving communities the flexibility to support infrastructure, technology, and management practices creates opportunities for more cost-effective water quality projects.
6. The amount of subsidy to a revolving loan fund should be based on the state's needs and fiscal capacity.

UK Scheme of Charges for Discharges to Controlled Waters

In 1995, the UK implemented a scheme to a) create a financial incentive for stationary sources to reduce discharges to waterways, and b) generate revenues to operate a discharge permit program. The program includes two types of charges/fees – a permit fee and an annual maintenance fee. The permit fee is a fixed charge payable by everyone who applies for a new or revised discharge permit. The fee is due at the time of application. The annual maintenance fee is payable by everyone with a discharge permit and is due each April. The amount of the maintenance fee is dependent on four factors:

- The receiving water – groundwater, coastal, surface, or estuary;
- Volume - maximum daily volume of discharge permitted;
- Content of discharge – pollutants included in the discharge; and
- Financial factor – a fixed monetary multiplier.

The standard permit fee for 2007 is £825; a reduced fee of £117 is available to sources that discharge less than five cubic meters per day. The annual maintenance fee financial factor for 2007 is £637. That financial factor is multiplied by a receiving waters factor ranging from 0.5 to 1.5 (see Table 6), a content factor ranging from 0.3 to 14, and a volume factor ranging from 0.3 to 14(see Table 7). For example, a source that discharges 25 cubic meters of an herbicide to a surface water would calculate the annual maintenance fee as follows:

RW x V x C x FF = Charge

1.0 x 1.0 x 14.0 x £637 = £8,918

While the charge program generates substantial revenue (£64 million), the costs of the discharge control programs are approximately £1 billion. Therefore, the charges provide only 6.4 percent of total cost of the programs.

Table 6: Discharge Maintenance Fee Receiving Waters Factors

Receiving Waters	Factors
Groundwater or land	0.5
Coastal waters	0.8
Surface waters	1.0
Estuary waters	1.5

Table 7: Discharge Maintenance Fee Volume Factors

Discharge Volume	Factors
$\leq 5\ m^3$	0.3
$> 5\ m^3$ and $\leq 20\ m^3$	0.5
$> 20\ m^3$ and $\leq 100\ m^3$	1.0
$> 100\ m^3$ and $\leq 1{,}000\ m^3$	2.0
$> 1{,}000\ m^3$ and $\leq 10{,}000\ m^3$	3.0
$> 10{,}000\ m^3$ and $\leq 50{,}000\ m^3$	5.0
$> 50{,}000\ m^3$ and $\leq 150{,}000\ m^3$	9.0
$> 150{,}000\ m^3$	14.0

Recommendations

China has established ambitious environmental goals under the 11th Five-Year Plan. In order to cost-effectively meet the goals, the government must address the inconsistent implementation and enforcement of environmental policies and improve the rates of compliance. The following recommendations are aimed at addressing those needs.

Enhance Efficiency and Clarity

There is a range of policies and programs in place to address industrial pollution and integrate environmental protection and economic development. However, many of these policies and programs are not consistently implemented and enforced at the local levels. While there are a number of factors that contribute to this “implementation disparity”, some of the most basic factors are a lack of clarity, lack of transparency, and contradictory language and rules. To overcome these basic factors contributing to the “implementation disparity”, the State Council, SEPA, and NDRC could initiate an effort to review and streamline existing environmental policies and programs. The review would provide the opportunity to revise the policies and programs to create greater clarity, consistency, and compatibility. It is also an opportunity to replace outdated or ineffective programs with a more streamlined set of policies that provide the proper incentives to achieve the nation’s environmental goals.

Improving the transparency of existing policies and programs is also important. Some of the international lessons from programs to improve local governments’ and industries’ understanding of environmental policies and programs may be beneficial in a Chinese context. For example, EPA provides extensive training and guidance documentation to state and local environmental officials to describe proper implementation and enforcement of new policies and programs. SEPA could develop implementation and enforcement guides for local EPBs that clearly outline the EPBs' responsibilities and the procedures for implementing, enforcing, and assessing the programs.

To assist industry with environmental protection efforts and improve the understanding of industries' environmental obligations, EPA has developed the Sector Notebook Project (http://www.epa.gov/compliance/resources/publications/assistance/sectors/notebooks/). The sector notebooks provide state and local environmental officials, industry representatives, and the public with information about specific industries' environmental impact; commercially available emission control technologies, good practices, and emission avoidance opportunities; and relevant environmental regulatory requirements. SEPA, in conjunction with research institutes and engineering universities, could develop similar implementation and enforcement guides for local EPBs, and industry-specific documents to highlight environmental impacts, emission avoidance and control options, and regulatory requirements. These documents, in conjunction with integrated operating permits, would provide facility operators with the information necessary to develop compliance plans. They would also improve local EPBs' understanding of the environmental requirements of local industrial sources.

Require Accountability for Emissions

The EU and US use a structured, obligatory environmental planning program for Member States and states to inventory emission sources and emissions, describe policies and programs to achieve air quality goals, and demonstrate that there are sufficient resources to implement and enforce the policies and programs. China could adapt its current integrated environmental planning process and create a provincial environmental planning process in which provincial governments would have to describe policies and programs that would enable the province to achieve air and water quality goals as well as energy efficiency goals. SEPA could require that the plans be submitted to the Central Government for approval and, if necessary, revision. Once a provincial plan is approved by SEPA or its designee, compliance with the plan could be an essential part of the performance evaluation score for local and provincial officials.

Institute National Air Pollution Control Policies

Inter-provincial transport of pollution is a major issue in the more populated coastal regions of China – approximately half of the particulate pollution in Beijing is from outside the municipal region. As the Beijing government has discovered, it can be very difficult to coordinate with surrounding governments. To address these challenges, SEPA could pursue national-level policies to reduce major pollutants, including particulates, SO_2, and NO_X.

One such approach is a cap and trade approach. Several local governments have piloted emission trading schemes with little success. Most of these programs failed due to poor monitoring, insufficient penalties for noncompliance, lack of enforcement, and, most importantly, lack of political support. SEPA can overcome these problems but it will require significant effort.

Require Accurate Emission Measurement

Emission measurement is the foundation for cap and trade programs, but it is also helpful for traditional pollution control programs (e.g., to ensure that a power plant is operating a required emission control device.) SEPA and the National Environmental Monitoring Center could establish clear requirements for power plants and other large stationary sources to use emission monitors or equivalents to measure SO_2, NO_X, and CO_2.[5] Specifically, this may include:

---

[5] CO_2 emission data can be a valuable metric for quality assuring both SO_2 and NO_X emission data and is helpful as a diluent gas for calculating NO_X concentrations.

- Refining the standards for the certification of emission monitoring technologies (e.g., continuous emission monitors) to account for demonstrated monitor performance, including reliability and accuracy.
- Developing protocols for the proper installation, operation, calibration, testing, and maintenance of emission monitoring technologies to ensure accuracy and consistency.
- Establishing electronic reporting requirements for emission data (e.g., SO_2, NO_X, and CO_2) and supplemental data. Supplemental data, such as heat input, output (e.g., electricity generation), operating hours, CO_2 emissions, and monitor calibration and test results, can improve quality assurance efforts.
- Developing a national database of power plant emissions to collect and store emission information and supplemental data on a daily (or more frequent) basis. A single, high-quality, centralized database can support air quality modeling and air quality management efforts, as well as allow for improved access to data for assessing compliance and studying emission trends. It can also improve data consistency, facilitate electronic data audits, and improve efficiency.
- Developing electronic auditing checks to verify that emission data are complete and accurate.
- Providing training programs and guidebooks for local and provincial environmental monitoring center staff and industry representatives to communicate the required (and proper) protocols for emission monitoring, data collection and reporting, and recordkeeping.
- Creating emission monitoring audit teams to review and approve monitoring plans; inspect industrial emission monitoring equipment, procedures, and recordkeeping systems; and train provincial and local environmental monitoring staff.

Pursue Multi-Pollutant Strategies

Based on the US and UK experience, an integrated cap and trade program for all pollutants (e.g., SO_2, NO_X, mercury, and CO_2) will reduce compliance costs by providing the incentive for facility operators to develop integrated solutions that achieve the emission reduction goals at lower cost than separate programs. SEPA does not, however, have to require emission reductions for all pollutants on the same schedule. For example, SEPA may establish an SO_2 cap for 2010 and every year thereafter and a NO_X cap for 2015 and every year thereafter. By including both pollutants in the initial legislation and requiring emission monitoring, reporting, and verification for all of the pollutants, SEPA will send a clear message to industry that emissions will have to be reduced and the improved emission inventory will assist with the development of future emission caps.

Provide Greater Certainty and Consistency

Regulatory certainty can assist provincial and local environment agencies and industries as they try to develop long-term pollution control policies and infrastructure and investment plans. SEPA should consider establishing long-term emission targets. These long-term goals (e.g., 10 to 15 years in advance) set clear, predictable emission goals that, if properly enforced, can lead to more cost-effective and environmentally-effective decisions by emission sources.

Expand Environmental Rating Schemes

Another policy approach that has been piloted in different parts of China is an environmental and energy rating system. Under these pilots, certified auditors assess emission sources on how well their manufacturing processes and building standards meet a set of energy efficiency and environmental targets. The scores (and the factors that determine them) are disclosed to environmental officials, customers, and the public via the

Internet, newspapers, and brochures. Expanding such programs nationally and providing technical assistance to emission sources with subpar performance could dramatically improve environmental performance and energy efficiency.

Prioritize Water Infrastructure Investment

SEPA and the Ministry of Water Resources could survey the existing water treatment and water supply infrastructure and the future infrastructure needs to identify the investment levels required over the next decade. This survey can be the foundation for prioritizing water quality investment and implementing a financing scheme.

Penalties for illegal or excessive discharges could be raised significantly with the resulting money used to finance high-priority water quality investments.

Improve Enforcement

Noncompliance and inconsistent enforcement are critical problems in China. SEPA has limited resources to police the implementation and enforcement efforts of local and provincial authorities. In order to provide sufficient oversight and manage the national-level policies, such as cap and trade programs, SEPA, in conjunction with the NDRC, could conduct an assessment of staffing and resource needs, including needs at the new regional offices.

It will also be essential to create proper incentives for compliance if the country is to achieve the environmental target. The State Council and SEPA should consider developing a non-compliance penalty system that is based on the severity and frequency of non-compliance, without caps on the penalty amount.