Market-Based Instruments with Chinese Characteristics:

The Feasibility of Cap-and-Trade Implementation to Reduce SO2 Emissions in China and the Role of the U.S. EPA

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LIST OF ABBREVIATIONS

CCP	Chinese Communist Party
EPA	Environmental Protection Agency (United States)
EU ETS	European Union Emission Trading Scheme
MBI	Market-Based Instrument
NGO	Non-governmental organization
SEPA	State Environmental Protection Administration (China)
SO2	Sulfur Dioxide

FOREWORD

This report is produced by students in the Master of International Public Affairs (MIPA) program in the Robert M. La Follette School of Public Affairs at the University of Wisconsin–Madison for Jeffrey Smoller, president of the Multi-State Working Group on Environmental Performance. The opinions and judgments presented in the report do not represent the views, official or unofficial, of the La Follette School or of the client for which the report was prepared.

The authors of this report are enrolled in the Public Affairs Workshop, International Issues, the capstone course in their graduate program. The workshop provides MIPA students the opportunity to improve their analytical skills by applying them to an issue with a substantial international component and to contribute useful knowledge and recommendations to their client.

I am grateful to Wilbur R. Voigt whose generous gift to the La Follette School supports the workshop projects. With his donation, we are able to finance the production of the final reports, plus other expenses associated with the projects.

The La Follette School offers a two-year graduate program leading to a Master of Public Affairs or a Master of International Public Affairs degree. In both programs, students develop analytic tools with which to assess policy responses to issues, evaluate implications of policies for efficiency and equity, and interpret and present data relevant to policy considerations.

The workshop provides practical experience applying the tools of analysis acquired during three semesters of coursework to actual problems clients face in the public, non-governmental, and private sectors. Students work in teams to produce carefully crafted policy reports that meet high professional standards. The reports are research-based, analytical, evaluative, and (where relevant) prescriptive responses to real-world clients. This culminating experience is the ideal equivalent of the thesis for the La Follette School degrees in public affairs. While acquiring a set of analytical skills is important, it is no substitute for learning by doing.

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May 11, 2007

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EXECUTIVE SUMMARY

Unprecedented economic growth in China has caused a rapid increase in environmental degradation, with sulfur dioxide (SO_2) emissions a major concern. China's government faces the challenge of reducing pollution without severely damaging the economy's capacity for growth. The U.S. Environmental Protection Agency and the Chinese State Environmental Protection Administration have agreed to pursue the use of market-based instruments to reduce SO_2 emissions in China.

This report explores the feasibility of using cap-and-trade, a specific type of market-based instrument, in reducing SO_2 emissions in the current Chinese context. We assess the political and regulatory feasibility, administrative feasibility, and the economic feasibility of China implementing a cap-and-trade policy to control SO_2 emissions.

We find that China does not meet many of the criteria necessary for a successful cap-and-trade policy, especially in the political and regulatory arenas. Many of China's regions and industries fall short of the necessary administrative and economic criteria. Some changes to current conditions may be feasible (and possibly forthcoming), but China is unlikely in the near future to meet many of the standards necessary for implementing a cap-and-trade policy that works. Moreover, the U.S. Environmental Protection Agency is unlikely to have much power to promote or shape changes needed to influence China in pursuit of better environmental standards, especially in areas where the Chinese government has already established its priorities. We conclude with the observation that command-and-control may be more successful than cap-and-trade in the current Chinese context and would help provide a base for an effective cap-and-trade policy in the future.

I. INTRODUCTION

Since the beginning of reforms in the late 1970s, China has experienced extraordinary economic growth, but this growth has severely increased environmental degradation. China now has the world's highest sulfur dioxide (SO_2) emissions, due mostly to its reliance on coal for energy generation. It is expected to overtake the United States as the world's largest emitter of carbon dioxide (CO_2) by 2009.[1] A report from the Chinese State Council estimates environmental damage costs China $200 billion a year, approximately 10 percent of its gross domestic product.[2]

Air pollution plagues many Chinese cities, and it has increased significantly in the past decades. The U.S. Environmental Protection Agency (EPA) and the Chinese State Environmental Protection Administration (SEPA) have identified SO_2 emissions as a target for pollution reduction in China.[3] These emissions have grown from 19.95 million tons in 2000 to 25.49 million tons in 2005.[4] SO_2 emissions in China are mostly generated from burning coal to produce electricity: China is the largest consumer and producer of coal in the world.[5] An unprecedented increase in urbanization, a growing demand for energy, and high vehicle density and traffic congestion have contributed to increased SO_2 emissions. The particulates that form as SO_2 reacts with other elements contribute to respiratory diseases. SO_2 creates acid rain, especially in the southern provinces, which acidifies water resources and renders them unsafe for humans and animals. Acid rain damages plants and accelerates the corrosion of buildings. SO_2 emissions are able to travel significant distances and therefore affect neighboring countries such as Korea and Japan.[6] We focus on China's SO_2 emissions in this report because of their identified contribution to environmental and health degradation.

Chinese leaders face the challenge of controlling pollution without derailing the economic growth from which the state derives legitimacy. Rapid environmental degradation will severely harm long-term economic growth in addition to compounding present health dangers. Therefore, China's government seeks to control pollution in an economically efficient manner. In pursuit of this goal, SEPA signed an agreement with the EPA and the Asian Development Bank on December 15, 2006, to support China's efforts to improve environmental protection and foster sustainable economic development by implementing market-based instruments—specifically, cap-and-trade mechanisms—to control pollution. (For more information on EPA and SEPA cooperation, see Appendix A: SEPA and the EPA Goals and Past Cooperation).

This report analyzes the feasibility of implementing a cap-and-trade policy to reduce pollution in China's unique political and economic context. Cap-and-trade programs use a market approach to reduce pollution by allowing firms to buy and sell government-issued emissions permits (see Appendix B for more information on this and

other MBIs to reduce pollution). We evaluate feasibility by analyzing whether China meets the political and regulatory, administrative, and economic criteria that cap-and-trade systems in other countries frequently meet. We then explore the changes needed for China to meet the criteria that it does not currently fulfill. We assess whether these changes are likely to be implemented and what possible role the U.S. EPA would play in promoting them. We conclude with observations on an alternative environmental policy option: strengthening the existing command-and-control system, which appears to be better suited to current conditions.

II. Economic Growth and Environmental Management in China

Prior to economic reform, the attitude in China toward the environment was one of control and domination. Nature was something to be conquered by mankind, not protected.[7] Since reform, this attitude has gradually diminished, but only insofar as protection of the environment did not hinder economic growth, a major source of legitimacy for the Chinese state. For the past two decades, China has experienced deregulation, decentralization, and the introduction of market mechanisms into its otherwise centrally planned economy. During this time, it also received large amounts of foreign direct investment, which, combined with increased international trade, has tied China ever closer to the world economy. As a result of the basic repudiation of Maoist economics, China has undergone rapid economic growth, development, and industrialization, thereby lifting millions of Chinese out of poverty. This growth has not come without consequences, however, with environmental degradation among the most serious.

Environmental protection has been a basic national policy since the 1980s in China, with the first Environmental Protection Law formally issued in 1989. This and many other associated regulations indicate the government's increasing concern about environmental protection.[8] However, despite these measures, China has largely not succeeded in its efforts to protect the environment. Environmental policies are generally only effectively enforced if they are congruent with promoting short-term economic development, security, or sovereignty over natural resources. SEPA (like its forerunner, the National Environmental Protection Agency) is among the least powerful central government organs. As with much of China's governance, policies set by the center are given to local environmental protection bureaus to enforce, which often cannot veto local economic development agencies. Moreover, a private business lobby is not the entity pushing economic development over environmental protection in China; government organs for economic administration often favor development over environment, setting up a potential internal struggle among ministries and different levels of government. Policies that foster economic growth and industrialization continue to dominate the government's agenda.[9] In fact, multiple ministries are charged with environmental management responsibilities, and they often subordinate environmental management to their primary responsibility (industrial development, transportation, energy production, etc.), further diluting the power of environmental protection laws and policies.

Agencies charged with controlling pollution in China usually rely on command-and-control regulation and "campaign"-style movements, though some market mechanisms have been used, notably to allow market pricing for coal and emissions charges. A common practice is that SEPA sets up key projects or regions that receive significant attention for a short period of time, in the same way a political campaign is conducted.[10] SEPA charges fees to combat water pollution and is considering a similar

system for SO_2 emissions. It already has the ability to levy fines on heavy SO_2 polluters, though the fines are not severe.

In the mid 1990s, SEPA instituted a total emissions control policy that limits maximum SO_2 emissions. Although there is a national target, the policy is devolved to the provincial level with each province having its own SO_2 emissions limit or target. In general, eastern provinces have lower emissions targets, requiring them to reduce emissions more than western provinces. The total emissions control policy was set up this way to reduce the economic burden of reducing emissions on western provinces, which tend to be poorer and less economically developed than eastern, coastal provinces.[11] Each province's emissions limit is divided up further among localities within that province.

More recently, the central government has issued "Green GDP" goals for local cadres (party or government officials or party members) to meet in addition to their economic targets. These targets are then used in evaluating cadres' performance, affecting their chances for career advancement. Green GDP targets try to hold cadres personally accountable for their region's performance in environmental protection in a similar fashion to their accountability for economic performance.

Finally, a few pilot programs using cap-and-trade mechanisms are under way, but they are only in select localities and have had mixed results.[12] With help from the EPA and the Asian Development Bank, SEPA has introduced the idea of emissions trading among firm representatives and has conducted workshops on the scheme. The 10th Five Year Plan includes a proposal to allocate allowances through local environmental protection bureaus.[13] While far from an operational cap-and-trade policy, these workshops and pilot projects have introduced the idea of cap-and-trade to China.

III. Analysis of Cap-and-Trade Feasibility in The Current Chinese Context

In evaluating the feasibility of cap-and-trade to limit SO_2 emissions in China, we assume that many criteria that appear necessary to support market-based instruments (MBIs) to reduce emissions in the United States and other countries are required for a similar regulatory regime in China. However, MBIs, including cap-and-trade, are still relatively new innovations. As such, there is a great deal of uncertainty associated with establishing a functioning MBI regulatory system. For this reason, we organize our feasibility analysis in the following way:

- We derive the criteria that sustain successful cap-and-trade policies from countries that use it and consider the extent to which China meets these criteria.
- We then ask which changes China must make to meet unmet criteria in the foreseeable future, and we evaluate the probability of these changes occurring.
- Finally, we explore the EPA's role in helping China make these changes.

Only a few environmental MBI systems function; the United States, for example, has adopted cap-and-trade systems to control some pollutants, such as SO_2, but not others.[14] This limits the number of cases from which we can generate necessary criteria. (For more information on MBIs, see Appendix B: Market-Based Instruments and Cap-and-Trade in Environmental Protection. For more information on global experiences with MBIs, see Appendix C: Global Experiences with Cap-and-Trade).

We address issues of feasibility under three general categories: political and regulatory, administrative, and economic. We evaluate political and regulatory feasibility first by examining the role of political will to implement environmental policy in China, then we look at political and regulatory methods of control, and then we discuss the role for non-governmental entities in China's environmental policy strategy. We evaluate administrative feasibility by examining the institutional and technological capacity of the Chinese government to enforce regulation, monitor compliance, and accurately measure emissions—all necessary components of cap-and-trade mechanisms and of environmental regulation more generally. Finally, we evaluate economic feasibility by outlining market and industry organization criteria that support cap-and-trade in functional systems elsewhere, and then use two industry cases as scenarios for hypothetical implementation.

1. Political and Regulatory Feasibility

All other cases of MBIs evaluated for this report had pre-existing, effective environmental command-and-control regimes. MBIs, although innovative, depend on these structures, in large part because the political and regulatory systems are already in place to provide routinized lines of political authority and accountability. China's political and regulatory systems differ substantially from those found in the United States and in other countries with successful environmental MBI policies. China also lacks the strong command-and-control foundation present in other countries with MBI systems. These issues cannot be discounted when evaluating the feasibility of cap-and-trade in China.

We consider the following criteria as necessary to the functioning of MBIs elsewhere:

- **Political Will**: The government must be willing to devote resources to controlling pollution. It must prioritize long-term environmental gains, often diffuse and uncertain, over short-term economic gains.
- **Political Control**: Assuming political will, the government must be able to realize goals consistently at all levels of government.
- **Regulatory Clarity**: There must be clear guidelines for implementation and consistent penalties for failure to implement.
- **A Role for Social Pressure**: If the government is unwilling or unable to hold its officials and agencies accountable, an outside source must be able to bring pressure to bear on the government, particularly in cases of government corruption or lack of government oversight.

We emphasize at the outset that we do *not* consider it necessary for China to meet these criteria in all areas of policy. We see broader issues of widespread rule of law,[15] liberal democratic governance, and general individual political rights as not substantially relevant to the question this report addresses, partly because there is some evidence that the Chinese government is willing, and has the capacity, to compartmentalize environmental regulation to a certain degree. Thus, at this time, it is only important that China's political and regulatory systems be able to meet the specific above criteria in the area of environmental policy so as to support the effective implementation of cap-and-trade to reduce SO_2 emissions.

Political Will

We consider this criterion only partially met. As in other countries, the government must have a sufficient interest in developing environmental policy to invest energy and resources in pursuing such an agenda through whatever political channels are available. In these other countries, political will depends largely on the pressure of citizens, either directly or through their political representatives; in China, the

Chinese Communist Party (CCP) leaders essentially determine political priorities. If CCP leaders decide that environmental degradation is a problem and wish to implement an MBI strategy, their power is enormous and largely autonomous from the will of ordinary Chinese citizens.

At the same time, CCP leaders do not act in isolation from outside influences. The decision to prioritize environmental protection comes from within the Party, but pressures influence that decision. Within China, significant social unrest is cause for concern because it disrupts economic development and destabilizes political power. China's Public Security Ministry officially reported 87,000 public protests in 2005 (up from 10,000 in 1994);[16] many of those protests were inspired by environmental degradation and rapidly decreasing natural resources, particularly water.[17] The Party has a stake in curtailing this sort of civil unrest and in preventing greater levels of violence. Another source of pressure is international economic leverage: "The American government has the economic and political power to frighten the Chinese government into compliance with international norms—indeed, it may be the only thing that can right now."[18] If the United States and other countries prioritize China's pollution, that choice may create greater impetus for China's leaders to reprioritize.

Once the Party leaders have determined priorities, the power of their political will has excellent implications for environmental policy if environmental policy *is* a main priority. There do appear to be some signs that the government recognizes the importance of reducing air pollution to protect its citizens' health and the stability of the nation's environment.[19] Cooperation with the EPA, new legal tools, and the upcoming Beijing Olympics seem to highlight a political intention to take pollution seriously.[20] Some inroads in other areas of pollution, such as water, present a more optimistic picture of political will.

However, separation of the government's rhetoric from its real priorities is still difficult at this time. The government continues to underfund and understaff SEPA's regional offices, and it places environmental protection far below short-term economic gains.[21] Rhetoric aside, environmental protection appears to rank significantly lower than economic development. The political will to increase environmental protection must itself increase relative to the commitment to economic growth.

Political Control

We consider this criterion partially met. Once policy priorities are determined, the political machinery must be adequate to implement them.

The CCP keeps authoritarian politics intact while pursuing economic and administrative decentralization. The linchpin of control is the *nomenklatura* system, by which

CCP committees, level by level, control appointment and promotion of all officials of even moderate importance, including formally elected officials.[22] CCP personnel control, combined with economic and administrative decentralization, is the core of China's current political system.[23] Local leaders who do not perform well are not promoted.[24] Economic performance is the key determinant of political mobility.[25]

Political control through the *nomenklatura* system could be useful for cap-and-trade. Rather than offering political mobility based on economic performance only, the CCP committees could make emissions standards an essential criterion for political mobility.

This change would require local compliance with emissions standards and wide-scale implementation of the "Green GDP," an accounting system that examines the contribution of natural resources to economic development as well as the costs caused by pollutants or resource degradation.[26] The Green GDP strategy has been experimentally implemented but without measurable success.[27] Nonetheless, as official assessments are the most important factor in determining promotions, and as those assessments are based almost entirely on local GDP growth, the Green GDP and environmental goals could be incorporated into assessments.[28] In this way, cap-and-trade emissions could be rendered compatible with the Chinese political system. The relationships among firms, local governments, and the central government are important for our evaluation of political control. Municipal, county, and township governments have a great deal of control over firms in their jurisdictions. This control ranges from taxes to regulatory rules.[29] The top priority of local governments is to maximize growth through local industry and commerce.[30] This creates two problems:

- Local environmental bureaus have inadequate authority, and
- Upper-level bureaucrats are constrained in their ability to compel local leaders to account for large environmental costs.

The first problem has to do with the status of SEPA. Although SEPA has been raised to ministerial rank, other ministries are more important because their role is to foster economic development, a higher policy priority. Moreover, although SEPA's reach extends in a line from the center to lower-level departments,[31] the local environmental protection bureaus are subordinate to their respective local governments.[32] They depend on government departments for their budgets. In this structural context, local government priorities of economic growth can trump environmental protection goals of SEPA and its local bureaus. This structure can create blockages for SEPA because, although it has ministerial authority, the horizontal government structure to which it must answer prevents it from accomplishing its purpose. As to the second problem, slowing economic growth in favor of environmental goals is ultimately not compatible with China's economic reforms.[33]

Regulatory Clarity

We consider this criterion unmet. Environmental regulation of any kind requires notice and transparency: to encourage compliance with regulation, a government needs to promulgate information about the law or regulation so that the relationship between action and consequence is clear, and citizens and officials alike can predict outcomes.[34] This is useful only if the judiciary also acts in a predictable way. Chinese legal and regulatory systems suffer from the decentralized nature of political decision-making: local and provincial officials do not have a clear procedural path to follow to enforce regulation, and they have no incentive to do so, so long as the consequences for non-compliance remain ambiguous and unevenly applied. Additionally, the courts themselves have conflicting interests[35] (provincial courts answer to provincial governments even if the laws and regulations are promulgated nationally) and conflicting information (even recently trained judges are not equipped to make consistent decisions without violating conflict-of-laws procedure).

China's legal and regulatory systems are generally complex, contradictory, decentralized, and inconsistently applied. The areas that function relatively well are in private law, a situation that reflects the government's main priority: economic development.[36] There is simply nothing comparable in the area of environmental regulation. Public law and regulation have been ignored in favor of profitable and international interests. While the development of private law indicates to some degree the Chinese government's capacity to target particular areas of regulation, the CCP has not yet done much for environmental regulation. As limiting pollution is not in the short-term economic interests of the parties involved, this situation is not likely to change in the near future.

A Role for Social Pressure

We consider this criterion only partially met. Other countries' environmental regulation systems specify legal roles for individuals and non-governmental organizations (NGOs) as the watchdogs of policy implementation. They also depend to a large extent on broad social pressure, often through the media, with electoral incentives also encouraging possibly resistant government.[37]

Although China's leaders have provided no political space for environmental concerns to be aired through a process, NGOs play a limited role. Social organizations have been encouraged to fill in gaps left by the state. These NGOs, especially government-organized NGOs, are not autonomous change agents but bridges between state and society.[38] Environmental NGOs provide inexpensive monitoring of local pollution, educate the public, and act as a political safety net by reaching where local government cannot.[39]

At the same time, the CCP subjects NGOs to strict regulations. This impedes development of a green movement. NGOs are permitted to serve only one constituency in a single locality, but environmental degradation (and SO_2 emissions in particular)

affects people everywhere.[40] The Chinese regulations define and limit NGO autonomy;[41] NGOs may achieve limited independence only if their goals match state interests.[42] There have been, however, some increased freedoms for the development of NGOs. The government has generally not targeted environmental activists. Instead, there appears to be some government interest to use these organizations to help track significant environmental crises.

Environmental NGOs in China essentially act as a fire-alarm system: calling attention to particularly egregious offenses, motivating higher-level leaders to respond by closing some high polluting factories, for example. However, closure is usually short-lived, an insufficient penalty to inspire substantial change.[43] Nor does it ensure governmental action.

Summary

MBIs remain a new and innovative solution for environmental regulation, and China is politically and legally unlike any country that presently utilizes MBIs. Our conclusions are summarized in Table 1. At this time, China's political and regulatory systems overall do not meet the necessary criteria to support MBIs. The increasing role for social pressure and the ability of the central government to exert political control bode well for MBIs in the future. Yet, so long as economic development is ranked far above environmental protection in policy priorities and regulatory clarity is lacking, MBIs do not present a feasible solution for implementing environmental policy.

Table 1:
Cap-and-Trade Implementation: Political and Regulatory Feasibility

Political and Regulatory Criterion	Status Quo in China
Political will	**Low:** Economic development continues to be primary concern; despite favorable rhetoric, no real investment has been made in environmental concerns by comparison.
Political control	**Moderate:** *Nomenklatura* system backed by political will has potential to be very useful for implementing environmental policy, but ambiguous political organization and role of political relationships complicate issues significantly.
Regulatory clarity	**Low:** Environmental regulation currently opaque due to lack of information dissemination, inconsistent application, and contradictory regulation. Without political will, unlikely to improve any time in near future.
A role for social pressure	**Low–Moderate:** Little political and regulatory space for non-governmental individuals and organizations, despite recent increased recognition by government of their potential value, particularly in environmental protection.

2. Administrative Feasibility

Even if the political and regulatory apparatus meets the corresponding feasibility criteria, environmental policy can prove to be unsuccessful if institutions lack the capacity to implement and administer the policy. In this section, we show that a positive correlation exists between institutional capacity and compliance in emissions control. We also discuss the importance of commitment to environmental concerns for effective policy execution. We then analyze the specific administrative criteria necessary for cap-and-trade and evaluate the feasibility of implementing cap-and-trade programs in provinces that have high and low institutional capacity.

In China, environmental policy is developed at the national level, and the implementation of policy is decentralized to the provincial and local levels. While localized policy implementation could be beneficial due to knowledge of local businesses, politics, and pollutants, it has also resulted in great variation in emissions control compliance across provinces. Weak enforcement in some areas of China has been attributed to weak institutional capacity of local environmental protection bureaus.[44] It is crucial to consider the implementation of cap-and-trade and compliance with environmental policy in a national context. If only some provinces comply, a dangerous race to the bottom is possible; inconsistent administration will ultimately lead to fruitless policy. Commitment and the capacity to measure, monitor, and enforce are the necessary administrative criteria for effective environmental policy.

Evidence on the Relationship between Capacity and Compliance in Emissions Control

As some provinces comply with environmental goals more than others, consideration of what might be responsible for the variation is important. We expect that provinces with high capacity, defined here as "the ability to implement official goals, especially over the opposition of powerful social groups, or in the face of difficult economic circumstances," will comply with central environmental policies more often than provinces with low capacity.[45] Jonathan Schwartz assesses provincial capacity in ten Chinese provinces.[46] The indicators of capacity Schwartz uses are human capital, fiscal strength, and reach into and responsiveness to society. He weights these indicators equally to rank provincial capacity.[47] Table 2 cross-tabulates capacity with compliance to emissions controls by province.

Table 2: Provincial Capacity and Emissions Compliance

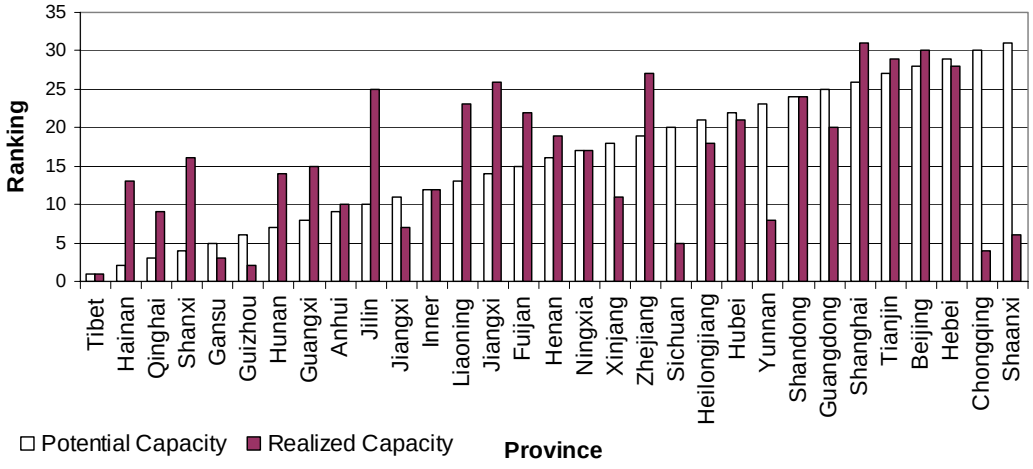
	Low Capacity	**High Capacity**
Low compliance	Guangxi, Henan, Hunan, Shandong, Yunnan	
High compliance	Hubei	Guangdong, Heilongjiang, Jiangsu, Liaoning

Source: Jonathan Schwartz, "The Impact of State Capacity on Enforcement of Environmental Policies: The Case of China."

As seen in Table 2, the relationship between capacity and compliance is strong and in the expected direction: high capacity is always associated with high compliance; low capacity is, with one exception, always associated with low compliance. Further examining the association between capacity and compliance, Wanxin Li analyzes what about capacity made a difference. In contrast to Schwartz, Li does not assume that human capital, fiscal support, and reach and responsiveness are weighted equally in measuring provincial capacity. Li ran two different regression models to see if human capital and financial resources have different effects on capacity.[48] From her regression analysis, Li concludes that the stock of human capital owned by local environmental protection bureaus makes a contribution seven times larger than that by financial resources.[49] This is important: it suggests that although funding from the Asian Development Bank is helpful, a stronger positive effect would come from training and education of local environmental protection bureaus employees, perhaps by the U.S. EPA.

Li also ran a more comprehensive study of the thirty-one provinces in China that compared provincial potential and realized capacity. Potential capacity is the amount of resources an environmental protection bureau receives for pollution control. Realized capacity is calculated by measuring the bureau's potential capacity and comparing it to the effectiveness and efficiency of its output. Figure 1 compares Li's potential and realized output rankings for provincial bureaus.[50]

Figure 1
Potential and Realized Capacity: Provincial Rankings



Source: Wanxin Li, "A Survey of Institutional Capacity of Local environmental protection bureaus in China."

As shown in Figure 1, potential and realized capacity varies greatly. Fifteen provinces underperformed; thirteen provinces overperformed. One of the most likely explanations for this variance is level of commitment. Schwartz argues that commitment is a necessary condition for environmental compliance. Although some environmental protection bureaus received increased funding, had better educated workers, and

enjoyed greater public support, officials still occasionally felt mixed in their commitment to take action on the environment.[51] There are numerous reasons for the lack of commitment. One reason is the fact that positions in the environmental bureaucracy are merely stops on the way to more important governmental positions; officials want to keep strong relations with industry and government ministries related to economic development for greater promotion potential.[52] An environmental protection bureau's employee admitted to Schwartz that bribes were tempting to environmental officials with low monthly salaries that generally average between US $50 to $160.[53] For feasible environmental policy to work administratively, capacity is not enough. Officials need stronger incentives to commit to environmental concerns. Thus both capacity of China's provincial governments to implement and administer environmental policies and commitment to do so are necessary conditions for policies to be effective.

Measurement, Monitoring, and Enforcement

To administer a cap-and-trade program to reduce SO_2 emissions, government institutions must have the capacity to accurately measure emissions, monitor emitting sources and emissions permits, and enforce policy.[54] Based on this theory, we evaluate administrative capability using these criteria:

- **Accurate measurement of SO_2 emissions from all sources.** Accurate measurement of emissions is absolutely vital for determination of the overall emissions cap for the area and verifying compliance by individual sources.
- **Monitoring of emissions sources and permits.** Sources participating in emissions trading must be monitored to ensure that they are operating in accordance with emissions permit allowances. A system must be in place to manage and keep track of emissions permits or allowances as they are distributed among emitters and then traded.
- **Consistent, effective enforcement.** Strict enforcement is necessary to send a message to firms that the government is committed to upholding environmental policy. Penalties for non-compliance in the form of fines are typically used to enforce cap-and-trade.

Accurate and consistent measurement of emissions lies at the crux of cap-and-trade.[55] In a cap-and-trade scheme, emitters are interdependent; once the overall emissions cap is set, the amount of SO_2 that one entity can emit depends on the amount that others are emitting. The price of emissions permits is determined by the amount of SO_2 that each polluter emits, the emissions cap, and the total number of permits. Thus the price of emissions permits also depends on accurate measurement

of emissions. At the same time, careful measurement must be joined with consistent and effective monitoring and enforcement to ensure that polluting entities comply with cap-and-trade emissions reduction requirements.

Measurement

Accurately measuring SO_2 emissions is one of the biggest challenges of implementing cap-and-trade in China. The Acid Rain Program in the United States utilizes an SO_2 cap-and-trade system that requires all existing SO_2 emitting plants over 25 megawatts and all new plants that are under 25 megawatts and burn fuels with a sulfur content greater than 0.05 percent to measure and report SO_2 emissions using continuous emissions monitors.[56] These measure SO_2 concentration and flow on an hourly basis and are equipped with data acquisition and handling systems to record, store, and compile data.[57]

The system that measures most emissions in China is mass balance calculation.[58] This method estimates emissions using a mathematical calculation that takes into account the size of the plant, the amount of coal burned, and the sulfur content of the coal. If the plant uses a filter or desulfurization equipment of any kind, the efficiency of this equipment and its hours of operation are added to the equation to calculate total emissions. However, as it is nearly impossible to ensure that the filtering equipment is always being used during the hours reported, this measurement system is not sufficiently accurate to determine if a firm is emitting more SO_2 than its permits allow.[59] China has begun installing emissions monitors on new power plants and large emitters, but polluting units with these devices represent a small number of all SO_2 emissions sources. Even the sources that do have continuous emissions monitors installed do not run them continuously but only once every quarter or year, which does not provide an adequate measurement of emissions for cap-and-trade.[60]

Although a solution for China would be to require all emissions sources to install monitors, the large number of firms that would require them and the financial and time costs make this neither feasible nor practical at the present time.[61] In the absence of continuous emissions monitors, more accurate and reliable emissions measurement techniques have to be ensured. One way to accomplish this with the mass balance calculation would be to obtain additional information from the plant or firm regarding product output levels and fuel purchases to verify fuel consumption. Regardless of the method, policymakers and firms participating in cap-and-trade must perceive the measurement method to be accurate and fair for it to be effective.

Monitoring

The complications of monitoring emissions in China can perhaps be best illustrated through example. One method of emissions reduction is the installation of scrubbers or filters on smokestacks that emit greenhouse gases. Although such control equip-

ment reduces emissions, electricity is required to operate it, which introduces a cost to the power plant or firm of running the desulfurization equipment.[62] A 2006 study done by China's National Development and Reform Commission found that about 60 percent of scrubbers were not used due to "lack of financial incentives and supervision from the State."[63] These lapses in oversight indicate that firms turn off their desulfurization equipment, resulting in ineffective policies. The use of continuous emissions monitors makes gauging emissions sources not as critical as watching the equipment and the SO_2 data they generate. In the United States, data regarding calibration, emissions, and other operations are collected electronically. This information is checked for calibration errors, missing data, and other calculation errors or problems.[64] Without continuous emissions monitors, closer and more frequent monitoring of emissions sources is needed to ensure that all information regarding fuel consumption and output is reported accurately.

Under a cap-and-trade system, monitoring of emissions permits or allowances is also required. Data about how many permits each source has and how much SO_2 each source emits must be collected, managed, and updated as permit holdings and SO_2 outputs change. The cost of implementing and maintaining a computerized permit tracking system or registry is estimated to be relatively inexpensive. Resources for the Future, a U.S. NGO, developed this type of system at a cost of $5,000 US.[65] However, such a tracking system is helpful only if the measurement data introduced into it are accurate and complete.

Enforcement

Under China's current total emissions control policy, the central government sets fees for non-compliance, and provincial and local governments can increase them. Studies indicate that, in general, fees are low, monitoring is minimal, and many local enterprises simply risk paying fines rather than installing the proper equipment or changing production processes to reduce pollution.[66] One study did find, however, that fees are apt to be higher in areas with more economic development and for old and state-owned emissions sources.[67] As most fees are too low, the current emissions control system lacks proper incentives for compliance and effective fines or penalties for non-compliance, thus weakening enforcement capacity.[68] Although fees should not be high enough to force a non-complying firm into bankruptcy, they should be higher than the cost to the company of reducing SO_2 emissions, offering an incentive to do so. For cap-and-trade to be effective, accurate record keeping and reporting of SO_2 emissions from polluting sources coupled with strict penalties and consequences for non-compliance are absolutely critical.

Summary

In Table 3, we assess the feasibility of achieving the three administrative capacity criteria—measurement, monitoring, and enforcement—in low capacity and high

capacity provinces. We assume that provinces found to have high capacity in Schwartz's study would continue to have high capacity under a cap-and-trade system and vice versa. In low capacity areas, characterized by low compliance with environmental policy, cap-and-trade is unlikely to be successful. These provinces do not have the human capital, financial resources, and other indicators of capacity necessary to carry out environmental policy. In provinces that demonstrate high capacity and high compliance with environmental policy, cap-and-trade could be implemented with some degree of success if only administrative feasibility is considered. Additionally, commitment from all players is needed; capacity alone is insignificant for administrative execution of policy.

Table 3.
Cap-and-Trade Implementation: Administrative Feasibility

	Status Quo, by Local Capacity	
Administrative Criterion	**Low Capacity Area**	**High Capacity Area**
Accurate measurement of SO2 emissions from all sources	**Low:** Material balance calculations not accurate enough for measuring SO2 emissions levels; continuous emissions monitors too costly.	**Moderate:** Material balance calculations not accurate enough for measuring SO2 emissions or buying and selling permits. Continuous emissions monitors, with sufficient funding, would better estimate emissions levels needed to establish caps and monitor permissible emissions output.
Monitoring of SO2 emissions sources and permits	**Low:** Material balance calculations are not accurate enough for measuring SO2 emissions levels; continuous emissions monitors are needed but costly.	**Moderate:** State monitors inspect more often and more accurately. Because firms potentially increase accountability in "competitive market," peer monitoring increases across firms.
Consistent, effective enforcement	**Low:** Due to varying levels of provincial control, provincial compliance varies. Variation could encourage firms in high capacity provinces to simply relocate to low capacity/low enforcement areas.	**Moderate–High:** Provinces can increase fines for noncompliance, which would provide disincentive for firms to emit more SO2 than allowed. Enforcement can be very effective at reducing non-compliance if measurement is accurate and monitoring is consistent.

3. Economic Feasibility

To evaluate the economic feasibility of cap-and-trade in China, we examine the practicality of instituting a cap-and-trade policy in two industries within a single high-capacity province. This focus allows us to provide a microanalysis of economic feasibility of cap-and-trade implementation under different business arrangements. It also illustrates some problems that SEPA may face in implementing a cap-and-trade regime nationally, even in the best of administrative capacity contexts.

We analyze the power and cement industries because they are among the largest industries and highest emitters of SO_2 in China. China's power industry generates 2,204 terawatt-hours of electricity, making it the second largest electricity generator in the world.[69] In 2004, more than 77 percent of electricity generation came from coal-fired plants,[70] accounting for 60 percent of the total SO_2 pollution in China.[71] The sheer size of the industry and volume of its emissions makes it an ideal target industry for a cap-and-trade program. The cement industry also depends on coal and was responsible for more than 5 percent of total industrial SO_2 emissions in 2004.[72] While emissions are significantly less than in the power industry, the presence of multiple forms of ownership structure and market prices in the cement industry means it may respond better to the market incentives that a cap-and-trade policy exploits. Cement production generally correlates with population density, with concentrations in the wealthier coastal provinces.[73] In these provinces, the percentage of SO_2 emissions from the cement industry is likely higher than the nationwide average, making the possible effect of emissions reduction greater.

Due to very high SO_2 emissions, the power industry would be the ideal case, but its inability to meet many of the economic criteria suggests it would not succeed at participating in a cap-and-trade program. We view the cement industry as an industry most likely to meet the economic criteria for a successful cap-and-trade program, but it does not meet the criteria entirely and represents a smaller proportion of total emissions.

We analyze these two industries in Guangdong province for several reasons. First, Guangdong is among the most economically developed provinces in China; it was one of the first provinces to implement economic reforms, is closely linked with Hong Kong, and has always been "one step ahead" of other provinces in economic development.[74] Second, as noted, due in large part to its higher level of development, Guangdong has greater institutional capacity and a higher rate of regulatory compliance than other provinces, suggesting a greater administrative potential to implement a cap-and-trade scheme.[75] The province also has a large power industry; it accounts for 10 percent of China's total installed generation capacity.[76] It is also the second largest producer of cement in the country.[77] Finally, as the ninth largest emitter of SO_2, Guangdong suffers disproportionately from acid rain.[78]

For emissions trading to succeed in China, the policy must meet a number of central economic criteria:

- **The damage caused by targeted emissions must be regional or global in scope**. The environmental damage cannot be localized or there would be no social benefit to or basis for trading emissions permits.[79]
- **The market must contain many firms, and each firm should face different marginal abatement costs**. The presence of many firms ensures multiple trading opportunities and an efficient market, as firms become price takers rather than price setters. Furthermore, as firms have different abatement costs, the opportunity for efficient firms to trade permits with less efficient firms would exist.
- **Firms can transfer the burden of pollution abatement onto consumers without affecting their competitiveness**.[80] This condition ensures that the incidence of environmental compliance is shared between firms and consumers. If firms are unable to shift some of the cost burden onto consumers, they are less likely to comply with the requirements of an emissions system.
- **A competitive market must exist within the country**. Cap-and-trade can only work efficiently if more than one permit holder exists. If no enterprise has independent ownership and no one has private interests, then market competition will not exist.[81] Absence of these conditions precludes a market-based approach to emissions control.

We briefly describe each industry, and then evaluate the economic feasibility of emissions trading in Guangdong using these four criteria.

Power Industry in Guangdong Province

Guangdong has 10 percent of China's installed generation capacity and generates 9 percent of total electricity consumed.[82] Guangdong's generation plants have more varied fuels than other provinces, with coal accounting for 45 percent of the total fuel mix in 1998.[83] However, projections for 2010 estimate that coal will account for 51 percent of the total fuel mix.[84] To reduce emissions levels, Guangdong has installed several energy-efficient coal plants, although many inefficient coal plants still operate.[85] Projections for 2010 indicate that plant efficiencies will continue to improve, although almost half of all generating capacity will remain inefficient.[86] Greater diversity in efficiency among generation units ensures greater variation in marginal abatement costs in the industry.

Reforms within the power industry have increased variation in ownership structure, with the majority of the generation units no longer under direct central government control.[87] Nevertheless, the industry functions under de facto state control, and plant managers have limited decision-making abilities. Lack of firm independence is especially reflected in the structure of electricity pricing. (For further discussion on ownership structure of the Chinese power industry and Guangdong in particular, see Appendix D: On the Power Industry).

Electricity pricing in China is based on periodic mandates that state planners issue to adjust the amount of power produced. This is in contrast to a market-based approach in which firms change the price to minimize their marginal costs of production. This government-centric approach limits the independent price-setting abilities of most plant managers and allows for political interference in the electricity market since the government structures prices based on production targets, which carry political weight for local officials. While the government has begun to move toward wholesale pricing of electricity and is interested in competitive rate pricing, such actions have yet to receive legal ratification. [88] Therefore, the power industry in China lacks the autonomy to function dynamically, as would an industry of private enterprises. (For further discussion on pricing in the Chinese power industry, and the industry in Guangdong in particular, see Appendix E: Power Pricing).

Cement Industry in Guangdong Province

China became the world's leading producer of cement in 1985 and supplies over one-third of total global output. Guangdong is the second largest producer of cement in China, and its production has expanded rapidly due to the unprecedented demand for construction material for infrastructure projects since the early 1980s, particularly the ongoing development of hundreds of new power plants.[89] Chinese planners predict this demand in cement production will continue to grow, having anticipated production of 660 million tons in 2005, another 750 million tons by 2010, and 800 million tons by 2015.[90] Cement production is very energy intensive, and the expansion of the cement industry has relied almost exclusively on an increased use of coal, which accounts for 40 percent of the total manufacturing cost of cement.[91] Consequently, this impressive industry growth has resulted in increased pollution.[92]

Across the country, estimates of the number of cement plants range between 8,000 and 9,300, but these do not include many illegal plants.[93] The central government considers the cement industry too dispersed, so it plans to increase its average cement production per plant across the country by closing many smaller and inefficient plants.[94] Implementing a market-based emissions control regime at the same time as this consolidation in the cement industry creates an opportunity to experiment with cap-and-trade.[95] Ownership patterns vary regionally: more than 50 percent of current production plants are owned collectively, and 10 percent are owned privately. Foreign compa-

nies own 3 percent, a proportion that is growing. The shrinking state-owned sector accounts for 24 percent of production plants.[96] Moreover, the deregulation of cement prices in 1996 has allowed various producers to compete, in contrast to previous regulations that allowed state-owned enterprises to set prices.[97] (For further information on price deregulation, see Appendix F: Cement Industry Price Deregulation).

Economic Feasibility Analysis

We find that the power industry meets or partially meets two criteria: scope of emissions and multiple firms with a range of marginal abatement costs. It does not, however, meet the criteria for transfer of costs to consumers or the presence in a competitive market. The cement industry fares better than the power industry, meeting or partially meeting all four criteria.

Power Industry

The power industry meets the scope of emissions criterion because SO_2 emissions travel considerable distances, even outside the borders of the country. Power plants themselves are distributed widely across the province.[98]

It partially meets the criterion of multiple firms and range of marginal abatement costs. Individual plants have wide ranges of technology, different emissions levels per unit of output, and different management efficiencies, all leading to different marginal abatement costs. This creates opportunities for individual plants to benefit from emissions trading. The actual number of firms may be relatively low, however, so an efficient market in which firms do not have individual pricing power on the permits themselves may not develop.

The power industry does not meet the criterion of transfer of costs to consumers. Firms have little ability to pass changes in cost structure on to consumers. Prices are still highly regulated, and though future price liberalization is possible, local authorities and enterprises will exert considerable pressure to retain price controls.[99] Moreover, many large buyers of power are state-owned industries, which would not be individually as sensitive to prices as private industries.

The presence of a competitive market criterion is also not met. On the face of it, power plants are managed by a number of different local authorities (provincial, municipal, and township) and have different sources of investment.[100] Yet, because of high central and provincial regulation, they are not fully independent in decision-making. Therefore, the extent to which there are multiple, independent firms is uncertain. The combination of state ownership and management and the lack of flexible pricing means firms and individual plants cannot independently make decisions that would affect their cost structures or emissions. Both power

producers and state-owned power consumers would be subject to various political pressures that may thwart the ability of market mechanisms to operate.

Cement Industry

The cement industry meets the criterion for scope of emissions. As with the power industry, SO_2 emissions from the cement industry are regional. The cement industry itself is also widely distributed.[101]

It also meets the criterion for multiple firms and range of marginal abatement costs. The cement industry has many firms of varying size, ownership type, and efficiency. The industry has a number of small enterprises, frequently collectively owned, that are often unprofitable.[102] A number of larger, more efficient firms are more profitable and use more advanced technologies.[103] Therefore, there are considerable possibilities for trading due to the wide variation in technologies and cost structures. The large number of firms suggests that the market for permits themselves could be efficient since no one firm can dictate prices by controlling a large proportion of the supply.

The cement industry largely meets the criterion for ability to transfer costs to consumers. The market sets cement prices; and therefore, costs of emissions abatement can be passed on to consumers. Most of the consumers of cement, however, will be large industries in construction and infrastructure, many of which are state-run operations. State-owned enterprises will have less sensitivity to prices if a government authority uses political pressure to overrule the price incentive by forcing certain projects to continue despite losses.

It partially meets the criterion of presence of a competitive market. The cement industry has a wide range of ownership structures and many firms. Most of the smaller firms are collective. The larger firms are generally state-owned or combine state and private ownership, including foreign ownership. The degree of state control in collective firms is difficult to ascertain, but collective enterprises typically have more management independence than wholly state-owned firms. Therefore, we can state cautiously that much of the cement industry is a market composed of independent, competing firms.

Summary

Table 4 summarizes our analysis of the economic feasibility of emissions trading in the power and cement industries in Guangdong Province.

Table 4:
Cap-and-Trade Implementation in Guangdong: Economic Feasibility

	Status Quo in Selected Industries	
Economic Criterion	**Power Industry**	**Cement Industry**
Area of targeted emissions that is regional or global in scope	**High:** SO_2 emissions travel considerable distances. Power plants distributed widely across province.	**High:** SO_2 emissions are regional. High concentration of plants across province.
Multiple firms facing different marginal abatement costs	**Moderate:** Varying ranges of technology, emissions levels, and different management efficiencies. However, number of firms relatively low.	**High:** Firms have different technology and efficiency levels. Small enterprises often unprofitable. Larger firms more profitable and use more efficient technology.
Ability of firms to transfer burden of pollution abatement onto consumers	**Low:** Prices still highly regulated. State-owned industries face pressures to keep price controls.	**High:** Cement prices generally set by the market. Costs of emissions abatement can be passed on to consumers.
Existence of competitive market	**Low:** Power plants not fully independent in decision-making. High provincial regulation and lack of market-pricing limits autonomous decision-making.	**Moderate:** Wide variety of ownership structure and many firms. Collective enterprises have higher management independence than state controlled firms.

From our consideration of economic criteria alone, we conclude that market-based emissions control mechanisms may work in the cement industry in the high capacity province of Guangdong but would likely not work in the power industry. Lack of control on pricing, lack of management independence, and lack of clear profit incentives limit the ability of the power industry to use cap-and-trade effectively, and the power industry is by far the largest producer of SO_2. The cement industry is more likely to respond to market incentives such that the cap-and-trade mechanisms would minimize emissions at a lower cost than current policies. The overall effect, however, of cap-and-trade on total emissions when used in industries such as the cement industry would be minimized by the relatively low emissions from those industries. Most of the other large emitters of SO_2 (metal smelting industries, for example) are more similar to the power industry in ownership and pricing than the cement industry. Less affluent provinces with less private industry and lower administrative capacity than Guangdong likely would not fare as well. In these cases, the cement industry may not meet the criteria as well as it does in Guangdong, especially in terms of the presence of a competitive market.

IV. Making a Feasible Cap-and-Trade Policy: Changes Required and a Possible EPA Role

For a cap-and-trade mechanism to be successful in China, a number of circumstances would need to change. In Table 5 we summarize these circumstances and the potential impact of the U.S. EPA in promoting these changes.

Table 5:
China and the EPA's Role for Cap-and-Trade Implementation

Feasibility Area	Change by Chinese Central Government	Feasibility of EPA's Potential Impact
Political and regulatory feasibility	Reprioritize environmental protection on par with economic development; political control, regulatory clarity, and role for social pressure criteria could then more easily be met.	**Low–Moderate:** EPA must use whatever leverage available through its role as U.S. government agency to encourage a foreign relations strategy to pressure China to invest sufficient political will.
Administrative feasibility	Build human capital in institutions charged with environmental protection.	**Moderate–High:** EPA should assist with training, seminars, and hosting conferences to help build human capital.
	Increase incentives to break strong ties between SEPA and industries and to reduce corruption.	
Economic feasibility	Create industry sector made up of multiple, independent firms.	**Low:** EPA will have limited role. However, technical assistance in restructuring industry organization may allow for creation of comprehensive deregulated system.
	Remove high provincial regulation and lack of market pricing to allow for autonomous decision-making.	

1. Political and Regulatory Feasibility

A strong and unambiguous political priority to reduce or control pollution is the primary criterion that must be met for China to implement cap-and-trade successfully. At this time, complex relationships among levels of political authority, the lack of clear regulatory directives and consequences, and diffuse and disempowered social groups are, and will continue to be, obstacles to any effective MBI for environmental regulation. All of these obstacles, however, might be resolved if the Chinese government placed environmental protection on par with economic development. The Chinese government has no alternative source that might hold it accountable and thus must hold itself accountable. Pollution control comes down to political will.

An EPA role in helping the Chinese government reach this point is less administrative and more political. The EPA itself has very little capability to force the political hand of the Chinese government, but it is an administrative body in the executive branch of the U.S. government, and its chief administrator is a political appointee. If the executive branch makes Chinese environmental policy a U.S. political priority, that choice would have a far greater impact on China's political will. The December 2006 agreement of SEPA, the EPA, and the Asian Development Bank to support China's efforts to improve environmental protection signifies some interest on the part of the U.S. government to encourage this shift, but it is unclear as to whether that interest is sufficient or if the United States is using other strategies to pressure the Chinese government in this area.

2. Administrative Feasibility

For cap-and-trade to be administratively feasible in China, implementing agencies must be committed and have the capacity to measure, monitor, and enforce policy. We believe that higher salaries for environmental officials, recognition of environmental successes in promotion, and stronger oversight from the central government to prevent corruption of local environmental protection officials are possible means of increasing incentives for commitment to environmental policy. Additionally, to reduce China's overall SO_2 emissions, all provinces must have high administrative capacity, not just some provinces. Expanding and strengthening SEPA's role is one way of achieving this goal; however, pressure from global partners, such as the U.S. EPA, can also play a role.

Several EPA actions are possible but improving administrative procedures would be easier than building commitment. The 2006 agreement reached by the Asian Development Bank, SEPA and the EPA included increased funding to create possibilities for administrative capacity building. However, as Li suggests, fiscal support is not the best means to increase capacity.[104] Assistance with training, seminars, and conferences would improve human capital in a way that would then increase administrative capacity.[105] Although the work may be frustrating and slow, we believe even small increases in human capital will have greater effects on administrative feasibility than will financial assistance. Conversely, the EPA can do little about commitment of administrators. SEPA is challenged to find incentives for its employees. Other opportunities for increasing administrators' incentives to commit could be realized by breaking the strong ties that SEPA has with industry, paying employees more so bribes are less tempting, and rewarding provinces and practitioners that exceed their potential capacity in their environmental protection bureaus.

3. Economic Feasibility

The keys to meeting economic criteria for cap-and-trade are pricing and industry organization. Cap-and-trade relies on firm sensitivity to the prices of the permits. A firm will only be sensitive to permit prices if it and its customers are sensitive to the industries' inputs and outputs. In other words, a firm's main objective must be to maximize profits, either by minimizing its costs or by maximizing the price of its products. In a competitive market, firms are unable to dictate these prices, which would optimally lead to the most efficient outcome.

To meet these criteria in a way that ensures a successful cap-and-trade mechanism with significant impacts, China will have to concentrate on reforming the power industry. This requires independent management of generation units in China, which would be best accomplished through privatization and creation of a common national market for power (a national grid). Privatization would create an incentive for managers to participate in a mechanism that ensures they realize private benefits such as lower compliance costs or benefits from trading pollution permits. A common market would provide local governmental authorities a choice regarding purchasing power, allowing them to purchase from plants that have lower costs than others. This would force firms to find the most efficient means possible to meet emissions targets.

The Chinese government would have to allow power-pricing decisions to be made in a relatively independent manner. This would require that regulatory authorities take into account factors such as the cost of installing pollution control equipment or participating in a pollution permit trading mechanism when negotiating prices. Power producers would then have the ability to transfer some of the cost to consumers, thereby maximizing the incentive to comply with the policy. The ability to pass on costs of compliance would place some responsibility for limiting emissions on consumers by forcing them to economize in order to offset possibly higher power prices.

The EPA has relatively limited ability to induce these sorts of changes. The EPA could provide technical assistance with industry restructuring in the effort to create a national power market, but it would have to enlist the assistance of other parties as this is not an EPA core competency.

V. Recommendations and Conclusion

In light of the challenges in implementing MBIs, we conclude that the EPA should help the Chinese government strengthen its existing command-and-control regulation. This type of regulation would form the foundation to move toward a market-based approach to pollution control, as has occurred in other countries that now use MBI systems. We investigate a possible command-and-control strategy under the same political and regulatory, administrative, and economic criteria introduced above.

In other countries, a command-and-control governance structure has always preceded functional MBI regimes. Environmental policy analysts generally agree that the political, regulatory, and administrative command-and-control apparatus is necessary to create incentives and to monitor and enforce environmental policy. This creates the pathways and structures that subsequently support MBIs and enables government to create a market by capping emissions.

China has some experience with command-and-control environmental regulation; therefore, command-and-control would not require the same extensive restructuring of the economic, administrative, or political spheres of governance as cap and trade. Politically, command-and-control is the most feasible policy for reducing emissions levels in China because sufficient political will could directly ensure regulatory compliance. China's political system is structured to comply with the CCP's policy choices. The Chinese government's drive for economic development and China's overwhelming success in this area demonstrates this. As with the criteria for implementing effective MBI strategy, the CCP's commitment to environmental policy choices can overcome challenges associated with political control, regulatory clarity, and social pressure.

The U.S. EPA has limited political leverage over the CCP, and thus has very little direct impact on encouraging command-and-control as a policy choice. However, as an agency of the U.S. executive branch, it could gain influence if the executive branch makes Chinese environmental policy a U.S. political priority.

Administratively, the Chinese government needs to strengthen institutional capacity in all provinces. Since the foundations for this already exist, implementation of command-and-control is as feasible as cap-and-trade—with proper commitment, accurate monitoring, consistent measurements, and enforcement.

The EPA does have the capability to help the Chinese government strengthen these institutions and to improve human capital, but this role is only marginally different from the EPA's potential role for helping China meet the administrative criteria for cap-and-trade. First, command-and-control imposes a greater burden on SEPA than

cap-and-trade would because it requires more government oversight than an MBI that encourages firms to monitor each other as a component of their competition for business. Thus, the EPA would need to assist SEPA establishing viable regional offices to strengthen SEPA's mid-level environmental bureaucracy and improve emissions monitoring. Second, the EPA could help SEPA establish, fund, and run environmental awareness programs such as the National Action Program for Environmental Publicity and Education. These awareness programs serve a twofold purpose: they educate the public and inform administrators about the environment and strategies to control pollution.[106] Public awareness and general education would increase expectations and accountability, particularly if a role for social pressure increases. However, the EPA has greater leverage to build capacity than to build commitment. As with political will at the central level, problems exist surrounding the commitment of the Chinese government in implementing these strategies provincially. Capacity without commitment leads to unsuccessful administrative outcomes under any strategy.

Economically, given the regulated nature of heavy industry in China, command-and-control has a greater chance of succeeding than cap-and-trade. Command-and-control requires no market incentives to work. Unlike under cap-and-trade, state-owned enterprises and non-state industries would respond to command-and-control. State-owned enterprises make production and operation decisions based on directives from the central government. Therefore, a mandate to engage in command-and-control policies to control pollution would force state-owned enterprises to install pollution control equipment and reduce emissions levels.

If the Chinese government implements an effective command-and-control regime, the EPA could encourage the Chinese government to use this regime to strengthen emissions limits for different industries, especially state-owned enterprises. The EPA could provide assistance with data collection pertaining to emissions output in the Chinese power industry and could recommend that the central government use the command-and-control policy to lower emissions limits. As the power industry is the largest polluter in China and remains under the control of the Chinese government, this strategy has a greater chance of success than a cap-and-trade policy. Also, it would not require deregulation of the power industry. Ultimately, command-and-control relies on a successful political and regulatory structure because it does not require market implementation. Given the current Chinese context and the limitations of the EPA to promote cap-and-trade, it is more feasible for EPA to concentrate on strengthening command-and-control structures rather than attempting to promote a cap-and-trade policy.

Our analysis concludes that the future of MBIs in China is largely uncertain. We also find, however, that traditional command-and-control presents a more viable option. A command-and-control regime would shift the monitoring burden entirely

away from the firms and onto the government. Nevertheless, in the final tally, command-and-control requires fewer structural changes than does MBI regulation. In the longer term, command and control would provide a foundation for the possible use of MBIs. The EPA's role in implementing an effective command-and-control strategy in China would not differ significantly from its intended role in building MBI regulation. The EPA can motivate and support the Chinese government's efforts to implement SO_2 emissions control in a limited but potentially beneficial manner.

APPENDIX A: GOALS AND PAST COOPERATION OF CHINESE STATE ENVIRONMENTAL PROTECTION ADMINISTRATION AND THE U.S. ENVIRONMENTAL PROTECTION AGENCY

The Chinese State Environmental Protection Administration, the U.S. Environmental Protection Agency, and the Asian Development Bank signed an agreement on December 15, 2006, to support China's efforts to improve environmental protection and foster sustainable economic development by implementing market-based instruments (MBIs)—specifically, cap-and-trade mechanisms—to control pollution.

The goals of the U.S. Environmental Protection Agency (EPA) as stated by the trilateral agreement are:

- Achieving effective and relevant policies and programs to improve human health and environmental quality in China while promoting sustainable economic growth, inclusive sustainable development, and improved governance.
- Collaborating with the Asian Development Bank on environmental policy and technical assistance in Asia.

The pact announces continued and renewed effort by the EPA to collaborate with the Asian Development Bank and the SEPA to improve China's environment while promoting "inclusive" economic growth and greater technical and governance capacity to increase sustainability.

The agreement specifically refers to the Memorandum of Understanding on Scientific and Technical Cooperation in the Field of Environment (hereinafter "Cooperation MOU") that China and the United States signed December 8, 2003. The Cooperation MOU addresses the prevention and management of air pollution, water pollution and pollution from persistent organic pollutants and other toxins through a series of arrangements forming committees and cooperative projects.[107] The Cooperation MOU thus becomes a primary resource for analysis of client goals and outcomes.

The 1999-2003 U.S.-China Air Quality Management Assessment Project Report is an important collaboration. This comprehensive study by the EPA and branches of SEPA provides extensive information about SEPA's efforts to diminish air pollution. The EPA's report not only evaluates SEPA's efforts from the EPA perspective, it offers insight into the EPA's expectations. For example, the study compares and contrasts U.S. environmental policy with Chinese environmental policy. It highlights China's lack of capacity and its inconsistency in implementation and enforcement of environmental regulations. These deficiencies are clearly a major concern for the EPA.[108] Subsequently, evaluating the proposed SO_2 cap-and-trade mechanisms with particular focus on the capacity of SEPA to monitor and enforce these mechanisms is important.

APPENDIX B: MARKET-BASED INSTRUMENTS AND CAP-AND-TRADE IN ENVIRONMENTAL PROTECTION

In the context of environmental protection policy, MBIs refer to programs that require polluting firms to meet emissions targets by buying and selling pollution or emissions permits or by taxing emissions that exceed mandated levels set by regulatory agencies. The former MBI is known as cap-and-trade; the latter is known as an emissions tax.

The cap-and-trade mechanism, also known as an emissions allowance trading program, is a market-based approach to reducing emissions from industries and electricity generating plants. Cap-and-trade programs create a market for emissions permits. The supply of emissions permits is decided by the government. The demand is determined by the cost to firms of reducing emissions by installing scrubbers on smokestacks, changing production processes, or purchasing newer, more efficient equipment. The system works through the government mandating a cap on total emissions, usually an amount lower than total current emissions. A fixed number of permits are allocated to the industry, with the requirement that each firm hold one permit for each ton of sulfur dioxide emitted. Firms can transfer or sell permits among firms or bank them for future use. The trading program allows firms with higher emissions abatement costs to purchase permits from firms with lower emissions abatement costs. Such an approach reduces SO_2 emissions at a lower cost to society than traditional command-and-control methods.[109]

The cost reductions arise through a phenomenon known as "dynamic efficiency." Emissions trading allows firms to realize dynamic efficiencies through innovation gains that lower pollution abatement costs and reduce expenditure on pollution permits or taxes. The program also helps firms realize significant cost savings through lower compliance costs. Within the U.S. power industry, for example, the cap-and-trade system provides firms with incentives to take advantage of investing in energy-efficiency measures. In fact, rather than patentable technological discoveries, emissions trading has promoted organizational innovations at the firm, market, and regulatory level. These innovations have allowed firms to function more efficiently and have provided them with incentives to restructure in order to realize savings under the emission-trading model.[110]

The second MBI used to control pollution is the emissions tax. The European Environmental Agency defines the emissions tax as a tax payment that is directly related to the measurement or estimation of pollution caused.[111] In other words, emitters pay a fixed fee on every ton of green house gas emitted into the atmosphere. The tax encourages emissions reduction due to the increased price associated with emissions, especially if the cost of installing emissions reduction equipment is cheaper than paying the tax. The emissions tax usually results in least expensive pollution reduc-

tion for the economy as a whole. However, the tax does not maximize economic efficiency in energy markets because of distortions prevalent in tax schemes. This makes it important to compare the welfare benefits of the tax against other policy alternatives. An emissions tax faces certain problems regarding its design. Policy-makers often take into account factors other than pollution in designing the tax, which can distort the effectiveness of the tax. Often the tax varies across different sectors of the economy, which can further reduce the tax's effectiveness. Furthermore, the tax requires constant oversight as its effectiveness is subject to shifting external situations such as changes in inflation, technology, and emissions levels. Inflation especially can increase the cost of abatement measures and reduce the effectiveness of the tax. In Eastern Europe, fixed emissions charges eroded in value due to high inflation levels.[112] Technology can also reduce emissions levels, which would require a corresponding adjustment in tax level. Finally, the designers of the tax have to account for new sources of emissions that may not fall under the purview of the tax.[113]

Both cap-and-trade and the emissions tax are based on the assumption of a rational response to incentives. By setting emissions levels for each industry, governments provide firms an incentive to reduce pollution by threatening a penalty for not complying. In trading permits, efficient firms benefit from permit sales, and less efficient firms gain time to improve production techniques through permit purchases. This system of incentives ensures that pollution levels do not exceed government-set levels set. In the case of an emissions tax, firms have an incentive to correct their actions or bear the cost of negative externalities. In other words, the tax acts as a disincentive that helps keep pollution levels under control. MBIs have been widely used in Europe, especially within the context of the European Emission Trading regime.[114] The United States has also been implementing several of these mechanisms.

APPENDIX C: GLOBAL EXPERIENCES WITH CAP-AND-TRADE

One of the earliest cap-and-trade systems for emissions controls is the sulfur dioxide emissions trading system within the United States. This program, under the framework of the Acid Rain Program, began in 1990 as part of the Clean Air Act. For example, it is mandated that the electric industry reduces 8.95 million tons of SO_2 annually thorough 2010. The goal of the program, to reduce the amounts of acid rain, has largely been met. The cap-and-trade program of SO_2 in the early 1990s evolved in numerous ways because of its success. Other emissions, including carbon and nitrogen, are capped in parts of the United States. Cap-and-trade of SO_2 permits have expanded to other regions of the world.[115]

Another example of a cap-and-trade system exists in the European Union, where it is known as the European Union Emission Trading Scheme (EU ETS). On January 1, 2005, EU ETS became the world's largest and first multicountry emissions trading scheme. The EU ETS intends to align itself with the benchmarks agreed to in the Kyoto Protocol for 2012. The scheme mandates that all EU member states develop national allocation plans that state how the nation will lower its emissions levels. The current permits are valid for three years (2005-2007); the next stage will be in effect from 2008-2012. At the beginning of each stage, each member country develops its plan, which the EU's Commission of ETS must approve. The national allocation plan determines how many carbon dioxide permits the country plans on issuing for a given stage, currently 2005-2007, and how the country intends on allocating the allowances. The scheme intends to progressively tighten emissions levels to meet the Kyoto 2012 goals.

The cost of the tradable permits program is less than what it would cost without the program. According to the European Climate Change Program website, "[Kyoto] targets can be achieved at an annual cost of 2.9 to 3.7 billion euros, which is less than 0.1 percent of GDP in the EU. One of these studies concluded that without the Emissions Trading Scheme costs could reach 6.8 billion euro."[116] Numerous firms were expecting the program to be costly; however, the ETS website states that "the scheme will not jeopardize, but rather protect, the competitiveness of the EU economy, as any alternative measures would mean imposing higher than necessary costs on EU businesses."[117]

Reviews of the first stage of the ETS plan are mixed. In its first year, 362 million tons of carbon dioxide was traded on the market for a sum of 7.2 billion euros.[118] Criticisms include that member states' national allocation plans did not significantly reduce pollution. The Climate Action Network deemed the first phase a major disappointment, stating that only Germany and the United Kingdom asked their industries to reduce levels lower than historical levels. Fifteen of the member states had allocations 4.3 percent higher than the base year.[119] Another major problem with the ETS's initial phase is the pricing and the issuing of permits. In May 2006, the trading price of permits leveled around 30 euros per ton. Soon after, the trading prices declined; prices reached as low as 1 euro per ton in February 2007. The main reason for this declining price is not weak enforcement, but each country issuing too many permits.

APPENDIX D: ON THE POWER INDUSTRY

The power industry in China has undergone a major transformation over the past fifteen years. Formerly the power industry in China was considered a strategic industry and was controlled by the central government. In the mid-1980s, the central government opened up the generation sector to non-central government investors and encouraged local governments to participate in electricity generation. In Guangdong, the main players are the provincial government through the Guangdong Electric Industry Bureau, county and municipal authorities, the central government, the State Southern Power Consortium, and the China Light and Power of Hong Kong Company. The largest players in the generation industry are generation companies controlled by county and municipal authorities. Despite the move away from a centrally planned electric industry, the state still dominates the electric industry in Guangdong even if the players are mainly local authorities.[120]

Compared to independent power producers in the West, the generating units that local authorities own are different because they often have the local government as an investor, rely on government power to secure market share, and serve government financial purposes. Most of these enterprises are also not able to make independent managerial decisions and are dependent on governmental sanction before undertaking an action. A survey of enterprise independence for China found that almost 81 percent of all enterprises lacked rights or possessed only partial rights with regard to setting prices and that 86 percent were fully or partially constrained in making investment decisions. Such data indicate that decision-making power continues to reside within the government. However, certain slackening in rules and enterprises can make decisions subject to their compliance with the government's electricity development plans. This has made the firms more sensitive to costs in making fuel and investment decisions as well as placing them under more pressure to increase productivity and reduce labor costs. Ultimately, new arrangements have left Guangdong with a power industry dominated by local authorities who control supply within their own jurisdiction and try to ward off intrusion into their closed market. While no longer a centrally planned industry, it still lacks the characteristics of a competitive industry.[121]

APPENDIX E: POWER PRICING

China's central government sets electricity prices based on the formula of "cost + profit + tax = electricity price/KWh." The provincial government implements this calculation. The electricity is sold to end-use consumers who pay differential rates based on their geographic location. Consumers are then further sub-divided into classes and accordingly receive subsidies or pay premium rates on their electricity consumption. The government uses this formula to adjust demand and supply for electricity. In times of supply shortages, it raises the price of electricity to increase generating capacity and at other times reduces fees to increase consumption.[122]

This government intervention in the market pricing of electricity reduces the efficacy of the price of generation serving as a market signal to consumers or producers. It allows inefficient producers to continue functioning. The system also remains subject to political abuse. Furthermore, the time lags between changes in the market and price adjustments by the government cause further distortions to creep into the electricity market.[123]

Of late, the Chinese government has begun to move toward greater price deregulation. In 2004, the Chinese government approved a mechanism to link power prices to changes in coal prices. The mechanism allows an adjustment of power prices each time coal prices change by greater than 5 percent. While this has ensured that power prices reflect input costs more closely, further reforms are needed to make prices truly market-based. In 2006, the Chinese government hiked prices to reflect the rising cost of coal, to promote renewable energy, and to capture the cost of installing desulfurization facilities at coal-fired plants.[124] While this move signals government commitment to reduce emissions, it demonstrates the government's continued intervention in the generation market.

APPENDIX F: CEMENT INDUSTRY PRICE DEREGULATION

Evidence of price deregulation arose when cement prices declined in 1997 due to deflation and increased competition. Soule, et al., cite price fluctuations such as Shanghai's steep price drop and a comparative reduction in cement prices around China as evidence of increased competition. Prices do vary across regions: "For example, prices in Guangdong rose in late 1997 and early 1998 and were expected to continue to rise."[125] CementChina.net posts weekly reports on nationwide cement pricing, frequently noting changes in particular provinces. "Cement prices were deregulated by the State Planning Commission and the State Administration of Building Materials Industry in 1996. This permitted major producers to compete on a local level with many township enterprises, which offered more flexible pricing. Prior to this move, 45 state-owned enterprises, which produced a large proportion of cement to priority infrastructure projects, were permitted 'price-setting rights' in 1993."[126]

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[14] For example, the United States has been unable to reduce mercury emissions through cap-and-trade, although efforts continue. In 2004, the Bush administration's plan has met with significant opposition from several state governments that argue that cap-and-trade will not reduce emissions sufficiently and quickly enough. See Lisa Heinzerling, and Rena I. Steinzor, "A Perfect Storm: Mercury and the Bush Administration," 34 *Environmental Law Reporter* (Environmental Law Institute.), 10,297, 10,297-98, 10,305 (April 2004) (chronicling the Bush administration's scientific and legal issues of mercury regulation).

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[26] Peiyuan Guo, and Jieyan Liu, "Comparable Green GDP and Its Implications to Sustainable Development in Western China," n.p., n.d.

[27] There are five major problems. First, it may not be the best way to ensure sustainable development as it does not include the health costs of pollution. Second, it is difficult to determine the value of natural assets, as they are not traded and have no price. Third, there is also resistance from local officials after some areas experienced a decrease in economic GDP figures. As mentioned before, decreases in GDP do have a negative impact on the promotion of local officials. Fourth, there is no consensus on what the components of the Green GDP should be. Finally, natural resources must be calculated at the outset to determine the subsequent depletion; analysts would need to do surveys, and completing this task is an enormous commitment of time and resources. For these reasons, the Green GDP has proved to be ineffective.

See Elizabeth C. Economy, "Environmental Governance: the Emerging Economic Dimension," *Environmental Politics* 15, no. 2 (2006): 175-178; and Peiyuan Guo, and Jieyan Liu, "Comparable Green GDP and Its Implications to Sustainable Development in Western China," N.p. n.d., 4-5.

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[30] Ibid.

[31] Kenneth Lieberthal, and Michael Oksenberg, *Policy Making in China: Leaders, Structures, and Processes* (Princeton: Princeton University Press, 1988).

[32] Ibid.

[33] Kenneth Lieberthal, *Governing China: From Reform Through Revolution* (New York: W.W. Norton and Company, 2004), 283.

[34] Predictable legal systems discourage conflict by either knowing in advance the likely outcome (Japan) or because they provide leverage by which parties negotiate for settlement before going to court (the United States).

[35] Provincial courts answer to provincial governments even if the laws and regulations are promulgated nationally, and conflicting information (even recently trained judges are not equipped to make consistent decisions without violating conflict of laws procedure). See Jim Yardley, "A Judge Tests China's Courts, Making History," *New York Times*, November 28, 2005.

[36] Much of the development of private law can be traced directly to a combination of party leaders' efforts to attract and support FDI, and foreign investors' (and their national governments) pressure on the Chinese government for predictable protection.

[37] It is important to note that social pressure is not a replacement for political will, though it often works to motivate political will, but rather an integral complement. Social pressure necessarily fills in the gaps where the political machinery does not function to implement political will, geographically or philosophically, where the government's arm does not reach, or reaches too far.

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[46] Ibid.

[47] Human capital is a measurement of graduates from higher education institutions, the number of classes and people trained in scientific research and education related to the environment.

[48] Li's models for good performers were:

Good performer =	(Total potential institutional capacity, Industry capacity, Environmental quality) and
Good performer=	(Potential financial resources, Potential human capital, Industry capacity, Environmental quality).

[49] Wanxin Li, "A Survey of Institutional Capacity of Local EPBs in China," Paper presented at 2005 Urban China Research Network Annual Conference: Chinese Cities in Transition, May 2, 2005, in Shanghai, China.

[50] Ibid.

[51] Jonathan Schwartz, "The Impact of State Capacity on Enforcement of Environmental Policies: The Case of China," *The Journal of Environment & Development* 12, no. 1 (2003)

[52] Ibid.

[53] Ibid.

[54]Sonja Peterson, "Monitoring, Accounting and Enforcement in Emissions Trading Regimes," (paper presented at the OECD Global Forum on Sustainable Development: Emissions Trading, OECD Headquarters, Paris, March 17-18, 2003), http://www.oecd.org/dataoecd/11/56/ 2957646.pdf (accessed April 7, 2007).

Peterson uses the term 'monitoring' to describe the process of measuring emissions and ensuring that polluting sources meet their emission allowance. She uses the term "accounting" to refer to the record-keeping of emissions permits. In our analysis, we separate emission measurement from monitoring and use the term "monitoring" to encompass both checking polluting sources to make sure that they are not polluting more than their permits allow and keeping track of the emissions permits themselves.

[55]Jintian Yang, and Jeremy Schreifels, "Implementing SO_2 Emissions in China," (paper presented at the OECD Global Forum on Sustainable Development: Emissions Trading, OECD Headquarters, Paris, March 17-18, 2003), http://www.oecd.org/dataoecd/11/23/2957744.pdf (accessed March 20, 2007).

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