Practice on SO2 Emission Trading in China

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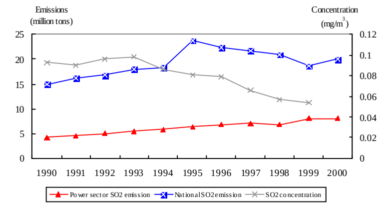
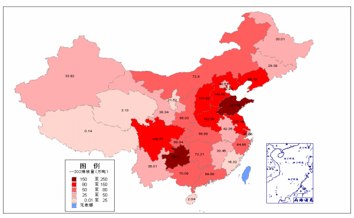
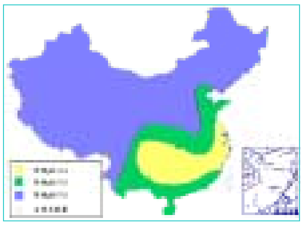
1. SO2 Emission in China

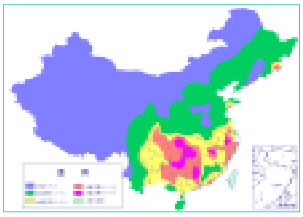
- Coal burning brings about a large amount of SO2 emission.
  - total SO2 emissions: 19.95 million tonnes, and 85% were from direct coal combustion
  - power sector is the major source of SO2 emissions: 8.90 million tonnes, account for 45% of total emissions





2. Acid rain and Environmental Impacts





- Acid rain are serious
  - Acid precipitation covers around 30 percent of the land areas
  - 48.9% of the cities suffer from acid rain
  - high stack sources contribute an increasing percentage of emissions
  - economic loss: more than 110 billion yuan

3. Control Policies

- Identifying Critical Control Zones
- Limiting the Extraction and Use of High Sulphur Coal
- Promoting SO2 Total Emission Control
- Levying SO2 Emission Charges
- Requiring Cities to Comply with National Ambient Standards for SO2 Concentrations
- Adjusting the Composition of the Power Sector
- Encouraging Desulphurisation

4. Requirements and Existing Foundations for Introducing ET

- Foundations
  - Compatibility of Emission Trading and the TEC Policy
  - Flexible Approach to Meeting Management Requirements
- Conditions
  - Variation of Marginal SO2 Abatement Costs
  - Regional Problem (Long distance transportation)
  - Emission Measurement
  - Legal Basis

5. Emission Trading Pilots

- Early in the 1980s, China began discussing and piloting emission trading
- Pilots in three stages:

  (1) 1990 to 1995 – establishing the concept;

  (2) 1996 to 2001 – exploring the theory and methods of emission trading; and

  (3) 2002 to present – piloting and designing emission trading programs.

SO2 Emission Trading in Jiangsu Province

Scope:	Power sector, 196 power plants in Jiangsu Province
Region:	The province
Cap:	TEC limits for the Tenth Five-Year Plan period
Allocation Method:	Emission performance Standards (EPS)
Legal Basis:	Document of provincial EPB and Economic and Trade Commission
Trading Situations:	Two power plants carried out a trade
Monitoring and Measurement:	CEMs, periodic source monitoring, and material balance

SO2 Emission Trading in Taiyuan City

Scope:	23 key pollution sources accounting for 50% of total SO_2 emissions
Region:	Urban area (excluding suburb districts and counties)
Cap:	Cap for year 2005: 125,000 tonnes
Allocation Method:	Historical emissions
Legal Basis:	Regulation on TEC in Taiyuan City and administrative regulation for SO_2 emission trading in Taiyuan City
Trading Situations:	Training, trading simulation, and implementation beginning January 1, 2003
Monitoring and Measurement:	CEMs, periodic source monitoring, and material balance
Management:	Emission and allowance tracking systems

6. Opportunities and Obstacles to Implementing Emission Trading in China

- Feasibility of National Implementation
- Issues and Barriers
  - Legal Authority
  - Uniform Allocation Method Uniform Allocation Method
  - Monitoring and Verification
  - Coordination with Other Policy Instruments

7. Proposed framework

- National SO2 TEC Targets
- Proposed Implementation Phases by Experts:
  - *Phase 1:* a pilot phase with trading limited to large power plants (i.e., annual SO2 emissions greater than 5,000 tonnes) in the TCZs;
  - *Phase 2:* an expanded pilot with trading between all power plants in the TCZs on the basis of phase I;
  - *Phase 3:* a nationwide program including all power plants in China; and
  - *Phase 4:* an expanded nationwide program including other types of high stack sources.

8. Conclusions

- **SO2 TEC in China should be combined with a national emission trading policy to help attain the control target at lower social cost.**
- **After nearly 10 years of analysis and emission trading pilots, several cities and regions have practical experience that provide the necessary foundation for introducing emission trading nationwide.**
- **There are issues and barriers to overcome before implementing a nationwide emission trading program, including legal authority, policy coordination, allocation issues, emission measurement and verification, and supervision and management systems.**

9. Suggestions

- **Establish an explicit legal basis for emission trading.**
- **Strengthen measurement and verification of SO2 emissions to improve accuracy.**
- **Design an equitable allocation method that provides proper incentives for sources to take action to reduce SO2 emissions.**
- **Strengthen education and outreach on emission trading.**

Thanks

PRACTICE ON SO2 EMISSION TRADING IN CHINA

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EXECUTIVE SUMMARY

Over the past 10 years, the Chinese State Environmental Protection Administration (SEPA) has actively investigated the potential to use emission trading to reduce sulphur dioxide (SO_2) emissions from electricity generators and industrial sources. In 1999, SEPA partnered with the U.S. Environmental Protection Agency (U.S. EPA) to cooperate on a study to assess the feasibility of implementing SO_2 emission trading in China. SEPA has also pursued emission trading pilot projects in several cities and provinces. The authors, using information from the feasibility study and pilot projects, introduce the circumstances necessary for SO_2 emission trading in China, outline the experience to date, and analyse implementation opportunities and barriers in China. The contents of the paper are: (1) SO_2 emission control policies in China; (2) institutional requirements and the basis for introducing SO_2 emission trading in China; (3) case studies of emission trading in China; (4) opportunities and barriers to implementing emission trading in China; (5) recommendations to transition from pilot projects to a nationwide SO_2 emission trading program; and (6) conclusions and suggestions.

1. INTRODUCTION

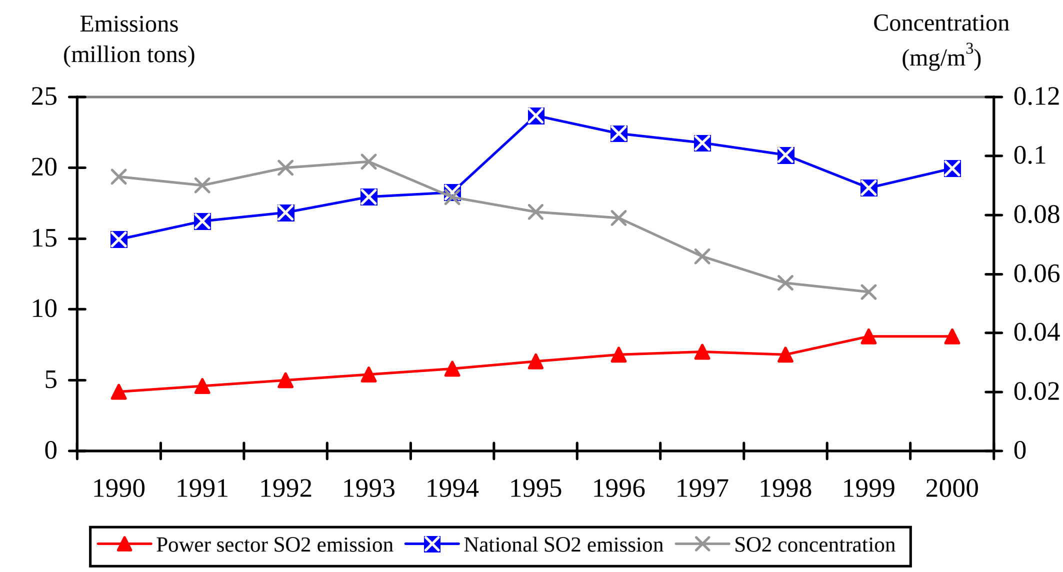
1. Acid rain and sulphur dioxide (SO_2) pollution in China are very severe – ambient concentrations in some regions are several times higher than air quality standards – and have significant impacts on human health, ecosystems, and cultural resources. The toll on human health and the economy from air pollution is estimated to cost as much as 2% of GDP annually (Xie, 1998). As a result, since 1995 the Chinese government has placed great importance on controlling acid rain and SO_2 pollution. In order to accomplish this, the government has identified key geographic areas where the problem is particularly severe and adopted a series of policies and measures to abate SO_2 emissions. Emission trading is one of the instruments the government is investigating. This paper analyses the opportunities and barriers to implementing SO_2 emission trading in China considering current institutional and legal conditions.

1.1 SO_2 Emission Trends

2. Coal is the principal energy source in China; it is used to meet approximately 69% of China's total primary energy demand (IEA, 2002). Due to a dramatic increase in China's coal consumption over the last two decades from rapid industrialisation and population growth, SO_2 emissions have increased and created serious environmental and human health problems. According to Chinese government statistics, SO_2 emissions in China were 19.95 million tonnes in 2000; of which, 85% were from direct coal combustion (Yang et al., 2002). The largest consumer of industrial coal is the Chinese power sector. As a result, the power sector is a major source of SO_2 emissions, leading to acid rain and acid deposition across China. These high-stack sources emit 8.9 million tonnes of SO_2 annually, 45% of total emissions.

3. Government data show that total SO_2 emissions in China increased between 1980 and 1995 to 23.7 million tonnes. Since a series of SO_2 control measures were implemented in 1995, SO_2 emissions have declined each year with a small increase in 2000. Figure 1 illustrates the annual SO_2 emissions trend in China during the 1990s.

Figure 1: Historic SO_2 Emissions in China



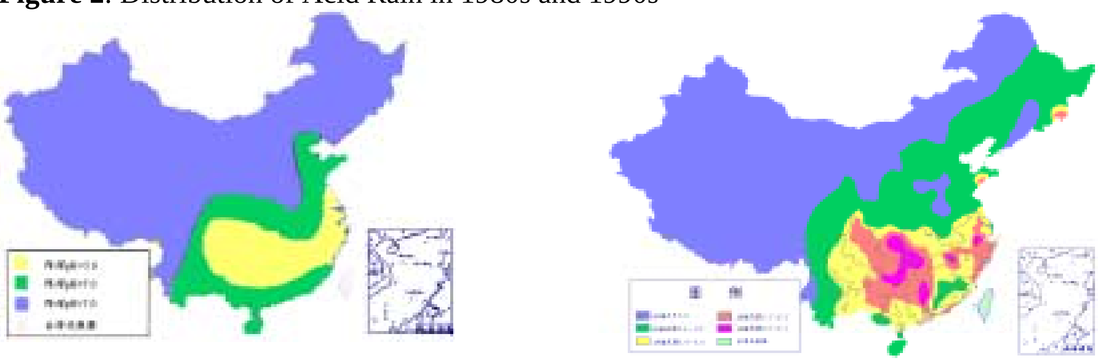
Source: China Environment Yearbook, 1990 to 2001

4. Emission projections through 2010 show a steady increase in energy demand in China. Much of this demand will continue to be met through coal combustion. By 2010, total annual coal consumption will reach 1.44 billion tonnes and SO_2 emissions are estimated to be 26.3 million tonnes (Yang et al., 2002). Therefore, the task of bringing SO_2 emissions under control is crucial though challenging.

1.2 Acid rain and Environmental Impacts

5. SO_2 emissions and the resulting acid rain have serious impacts on human health, visibility, agriculture, forestry, architecture, and cultural resources. From the 1980s to the mid-1990s, the area affected by acid rain increased by more than 1 million km^2. Currently, approximately 30% of China experiences precipitation with annual average pH values below 5.6 (Yang et al., 2002). The distribution of areas affected by acid rain is shown in Figure 2.

Figure 2: Distribution of Acid Rain in 1980s and 1990s



6. While overall emissions are still high, China's total SO_2 emissions have decreased since 1995. As a result, the number of cities meeting the SO_2 concentration standards has increased. But the problem of acid rain has not diminished and the area affected by acid rain and the degree of acidification have not

been effectively controlled. Precipitation monitoring data from 530 cities in 2002 showed that 48.9% of the cities suffer from acid rain, 171 cities or 32% have average annual pH values from precipitation below 4.5, and the number of cities with average annual pH values from precipitation below 4.5 is increasing (Qu, 2003). The main reasons are: (1) although total SO_2 emissions have decreased, high stack sources that transport emissions over long distances and contribute to acid rain are responsible for an increasing percentage of emissions ; (2) SO_2 emissions from the power sector, which is composed of primarily high-stack sources increased; and (3) there was an increase in emissions of nitrogen oxides (NOx) – another acid rain precursor.

2. SO_2 EMISSION CONTROL POLICIES

7. In an effort to control SO_2 emissions and lessen the effects of acid rain, China has adopted a series of control policies and measures since 1995.

2.1 Identifying Critical Control Zones

8. Based on areas affected by acid rain and high SO_2 concentrations in 1998, the government identified key acid rain control and SO_2 pollution control zones known as the "Two Control Zones" (TCZs). The first zone, the Acid Rain Control Zone, consists of areas with average annual pH values for precipitation less than or equal to 4.5, sulphate deposition greater than the critical load, and high SO_2 emissions. The second zone, the SO_2 Pollution Control Zone, consists of areas with annual average ambient SO_2 concentrations exceeding Class II standards, daily average concentrations exceeding Class III standards, and high SO_2 emissions. The TCZs are key areas for controlling acid rain and SO_2 emissions in China and receive priority for investment and management to control emissions.

2.2 Limiting the Extraction and Use of High Sulphur Coal

9. In 1998, China instituted policies to restrict the extraction of high sulphur coal and limit its use in the TCZs. Most cities now use low sulphur coal and have adjusted their energy structures to decrease urban SO_2 concentrations. The State Council explicitly requested in a national industrial policy that local governments shut down small, high-sulphur coalmines. Because of this policy, the sulphur content of coal combusted by the power sector has decreased every year (see Table 1 for average sulphur content values from coal combusted by the power sector).

Table 1: Average Sulphur Content of Coal Combusted in the Chinese Power Sector

1990	*1991*	*1995*	*1999*	*2000*	*Change*
1.20%	1.17%	1.09%	1.05%	1.00%	17%

Source: YANG, 2002.

2.3 Promoting SO_2 Total Emission Control

10. In the Ninth Five-Year Plan Period (1996 – 2000), the Chinese State Environmental Protection Administration (SEPA) began to promote a policy of total emission control (TEC). National SO_2 TEC targets were established. SEPA then assigned individual TEC targets to provinces, autonomous regions, and municipalities. The regional governments subsequently assigned TEC targets to local governments and/or emission sources.

2.4 Levying SO_2 Emission Charges

11. In order to promote SO_2 abatement, SEPA piloted SO_2 emission charges in 1992 in 2 provinces and 9 cities where acid rain was severe and SO_2 emissions were high. The SO_2 emission charges were extended to the entire area of the TCZs in 2000.

12. In 2002, the national SO_2 emission charges generated RMB 1.15 billion (U.S. $140 million). Much of the money is used to install pollution controls and for general environmental improvement. In addition to providing revenue for environmental protection agencies, the charges have played an effective role in encouraging emission sources to assess the economic implications of SO_2 emissions, advancing the use of emission controls at new and existing sources, promoting SO_2 pollution prevention, raising funds for pollution treatment, and, as a result of these incentives, controlling SO_2 emissions and acid rain.

13. The current emission charge of RMB 0.2 per kilogram of SO_2, however, is less than the average marginal abatement cost of SO_2 . As a result, the charges are insufficient to effectively stimulate pollution abatement to the necessary levels. To correct this, the government is gradually adjusting and enhancing the rate of the SO_2 emission charge.

2.5 Requiring Cities to Comply with National Ambient Standards for SO_2 Concentrations

14. To speed up urban air quality improvements, SEPA promulgated requirements that all cities should meet air quality standards and emission standards for key pollutants by 2000. Under this policy, urban SO_2 concentrations have improved significantly and more cities meet the air quality and emission standards.

2.6 Adjusting the Composition of the Power Sector

15. Beginning in 1997, the State Council and the State Economic and Trade Commission (SETC) started requiring power enterprises to shut down small generating units below 50 MW – units that are typically inefficient and emit significant pollution. By the end of 2000, small generating units with a total capacity of 10,000 MW were shut down. The resulting reduction in coal consumption and SO_2 emissions was 10 million tonnes and 400,000 tonnes, respectively. By 2004, an additional 25,000 MW of small generating units will be shut down, including 14,000 MW from the State Power enterprise.

2.7 Encouraging Desulphurisation

16. Research into desulphurisation began in the 1970s in China. Experimental facilities were set up in the mid-1980s, but desulphurisation equipment was not installed on large capacity generating units until the 1990s. By the end of 2000, desulphurisation equipment was installed and operated on 5,000 MW of generating capacity in China, about 70% of the units with controlled units were operated by State Power. State Power is currently expanding its use of desulphurisation equipment and has a total of 10,000 MW of generating capacity with desulphurisation equipment in operation or under construction.

3. REQUIREMENTS AND EXISTING FOUNDATIONS FOR INTRODUCING EMISSION TRADING IN CHINA

3.1 Foundations for SO_2 Emission Trading in China

17. The SO_2 problem in China is characterised by the following: (1) approximately 45% of total SO_2 emissions are from high-stack sources in the power sector; (2) energy demand is growing rapidly and, as a result, coal consumption is expected to continue increasing; and (3) many areas in China are suffering from SO_2 pollution and acid rain. There are many policies and measures in place to address the problem. There is, however, a need to explore additional mechanisms and management instruments to reduce emissions cost effectively without constraining economic growth. In addition to powerful regulatory instruments, the government is interested in introducing economic and market-based policies to address the problem. Among the current control policies and measures, most are regulatory command-and-control policies; the only economic instrument is the emission charge. Due to the low charge rate, however, the effect is limited and adjusting the rate to the economically efficient level is difficult because of political, social, and other factors. Therefore, SEPA is pursuing experiments with emission trading as another way to promote SO_2 emission reductions.

3.1.1 Compatibility of Emission Trading and the TEC Policy

18. The situation in China is particularly suitable for emission trading. Because a significant percentage of SO_2 emissions are from high-stack sources, the problem has become more regional in scope as SO_2 is transported to neighbouring regions. The TEC policy is aimed at controlling such pollution - it establishes a cap on total emissions, a key attribute of an emission trading program. The TEC limit for 2000 was 23.7 million tonnes but SO_2 emissions were only 19.95 million tonnes with additional abatement planned. During the Tenth Five-Year Plan period (2001 – 2005), the TEC limit is set to decline an additional 10% from 2000 emissions. In the TCZs, the TEC limit is even more ambitious with a 20% reduction from 2000 emissions. National and regional experts have acknowledged that emission trading can effectively lower the cost of achieving the TEC limits.

3.1.2 Flexible Approach to Meeting Management Requirements

19. Controlling SO_2 emissions will require an enormous investment of capital, a great deal of time, and long-term planning. Emission sources, according to medium- and long-term requirements, have the flexibility to determine how to control emissions. Emission trading formalises this flexibility and also enables emission sources to choose whether to invest in large-scale treatment and/or buy emission allowances in order to meet environmental requirements. In addition, revenue from the sale of surplus emission allowances can be used to offset investments in control equipment. Emission trading can further reduce costs by spurring innovation and encouraging competition between control options as demonstrated in the U.S. SO_2 and NOx emission trading programs (Burtraw, 2000).

3.2 Basic Conditions for Emission Trading

20. The U.S. experience has shown that emission trading can be an effective instrument to reduce emissions at lower cost than traditional regulatory policies. For it to be successful, however, several key conditions should be in place. Emission trading works best when:

(1) marginal SO_2 abatement costs differ among emission sources;

(2) the problem is regional or global in scope;

(3) emissions can be accurately and consistently measured;

(4) there is a strong legal basis for emission trading; and

(5) administrative institutions have sufficient capacity to administer the program.

3.2.1 Variation of Marginal SO_2 Abatement Costs

21. Based on a survey conducted by the Chinese Research Academy of Environmental Sciences (CRAES), there are major differences in marginal SO_2 abatement costs among SO_2 emission sources. Some of the difference is due to age and type of equipment, access to technologies, technical capacity, location, and fuels. The difference in costs can be as great as 30-50% between regions and 40% between different sectors (Wang et al., 2002). Emission trading has enormous potential to reduce overall costs to industry because of the differences in marginal SO_2 abatement costs (low-cost sources could reduce emissions greater than required and sell surplus allowances to high-cost sources, allowing all sources to attain the emission goals and saving money for high-cost sources.)

3.2.2 Regional Problem

22. Although overall SO_2 emissions have been decreasing in China, emissions from high-stack sources are increasing. As a result, sulphates are transported over a larger area creating regional acid rain problems.

3.2.3 Emission Measurement

23. An effective emission trading program is based on accurate emission measurement and consistent, effective enforcement. Accurate emission measurement from all sources is critical to determine compliance with SO_2 TEC policies. For the U.S. emission trading program, the U.S. Environmental Protection Agency (U.S. EPA) requires most emission sources to install continuous emission monitors (CEMs) for SO_2, NOx, and CO_2. The U.S. EPA created a data registry to collect, audit, manage, and disseminate emission data. In China, the introduction of SO_2 emission trading will necessitate the establishment and improvement of emission measurement and data management.

24. Presently, China has mechanisms in place to support SO_2 emission measurement. The current emission reporting program stipulates "sources must complete a 'Form of Emission Reporting' and provide all necessary data within the time specified by the local Environmental Protection Bureau (EPB)." The emission reporting program forms the basis of the EPBs pollution management. The problem, however, is that most of the SO_2 emission data reported by sources are calculated with material balance based on coal consumption and sulphur content of the coal. This approach can be relatively accurate and cost effective when the fuel inputs and production processes are stable. However, when control equipment is installed, material balance does not provide sufficient accuracy for emission trading programs. For a small percentage of enterprises the data are based on monitoring, but only periodic monitoring (e.g., once per quarter or once per year). This, however, is insufficient for emission trading programs because it represents operating conditions over a very short time period and may not adequately reflect conditions during the rest of the year.

25. Because SO_2 emission sources are numerous – power sector sources and various industrial and heating boilers – it is neither feasible nor necessary to require all sources to install CEMs. Therefore, it is important to classify SO_2 emission sources and determine the most appropriate measurement techniques, considering technical, scientific, and economic factors as well as the type and scale of control equipment.

3.2.4 Legal Basis

26. Emission trading is a market-based instrument to achieve the TEC limit already established in China. An emission trading program requires significant upfront work to ensure that the program's design is comprehensive and provides the proper incentives for sources to reduce emissions. Designing and operating a program involves setting the TEC target; allocating portions of the target to emission sources in the form of emission allowances; designing trading rules; collecting, verifying, and managing emissions data; managing allowance transactions; and enforcing the program and pursuing punishment for non-compliance. Unless the laws and regulations are clear and complete, the system may be difficult to implement and enforce.

27. A new amendment to the Air Pollution Prevention and Control Law further clarifies the TEC policy and requires local governments within the TCZs to check and approve total emissions from sources and issue emission permits in accordance with the conditions and procedures the State Council has stipulated, taking into consideration the principles of openness, fairness, and justice. The emission permit program explicitly defines emission rights for sources. When one enterprise obtains an emission permit, it receives the authorisation to emit the amount stipulated in the permit. The establishment of emission rights establishes a fundamental condition for emission trading – explicit or *de facto* property rights.

28. The current Air Pollution Prevention and Control Law does not contain provisions for a national emission trading program, but future amendments may create such a program.

3.2.5 Administrative Institutions

29. Regardless of the type of policy instrument, a control program will only be effective if the proper institutions are in place to adequately administer and enforce the program. SEPA is engaged with project partners to enhance the capacity to administer emission trading programs. In addition, pilot projects will help identify deficiencies in local environmental protection bureaus. A special division within SEPA should be set up to administer the program once the national program for SO2 emission trading is in place. This division will be responsible for overseeing the program, managing data systems to make sure the program on track and transparent to every stakeholder involved. [YANG – did you want to add more here on institutional issues following the discussions on this at the Forum? It is up to you.]

4. EMISSION TRADING PILOTS

30. Early in the 1980s, China began discussing and piloting emission trading in combination with new projects. The government carried out case studies on the compensated transfer of emission quotas. However, due to legal and regulatory constraints, limited experience, and implementation issues, these experiments were primarily conceptual. In the Ninth Five-Year Plan period, significant progress was made when TEC was promoted nationwide. Interest in emission trading had grown noticeably by the Tenth Five-Year Plan period when TEC became more formal.

31. Emission trading has made the transition from concept to pilot stage. SEPA is increasingly attentive of the issue of introducing nationwide emission trading. This transition has occurred over three stages: (1)

1990 to 1995 – establishing the concept; (2) 1996 to 2001 – exploring the theory and methods of emission trading; and (3) 2002 to present – piloting and designing emission trading programs.

4.1 Progress in Piloting Emission Trading in China

32. In 1994, SEPA conducted policy experiments in air pollutant emission trading in six cities (Baotou, Kaiyuan, Liuzhou, Taiyuan, Pingdingshan and Guiyang) on the basis of air pollutant emission permit pilots in 16 cities.

33. The pilot trades took many different forms, including:

- Allowance transfers within an enterprise;
- Environmental compensation fees to obtain additional emission rights;
- Investments in non-point source pollution control to obtain additional emission rights; and
- Allowance transfers from sources with surplus allowances to new or existing sources with insufficient allowances.

34. The trading during these pilots was influenced by political considerations and was not emission trading in the true sense. The pilots were combined with new, expansion, and technical innovation projects arranged by local EPBs. As there was no legal foundation for emission trading, the emission trading policy was implemented through the pollutant permit system that was not adopted nationwide.

35. In 1999, SEPA and the U.S. EPA began to cooperate on a study to assess the feasibility of introducing SO_2 emission trading in China. This study began with significant discussions about the theories, conditions, foundations, and methods of emission trading. The project further explored the opportunities and barriers to implementing SO_2 emission trading in the Chinese power sector. Through the cooperation, the countries have conducted several workshops and training activities. As a result, a number of Chinese management and research personnel have a much better understanding of how emission trading works and the conditions necessary for an effective program. The cooperation has promoted emission trading in China.

36. With financial assistance from the Asian Development Bank (ADB) and technical assistance from Resources for the Future (RFF) – a U.S. think tank – and the Chinese Academy for Environmental Planning (CAEP), Taiyuan city established an SO_2 emission trading program in 2001 to achieve their SO_2 TEC limit at least cost.

37. In 2002, in order to gain more experience and facilitate nationwide promotion of emission trading, SEPA organized pilots in seven provinces. After one year of preparatory work, some conditions necessary for emission trading were developed. For instance, two power plants in Jiangsu Province reached an agreement to trade SO_2 allowances to meet TEC limits.

4.2 Case Studies of Emission Trading

4.2.1 SO_2 Emission Trading in Jiangsu Province

38. Located in Eastern China, Jiangsu is a province with a relatively advanced economy and effective management institutions. SO_2 emissions in the province are significant – 1.2 million tonnes in 2000 – and acid rain has had serious effects on the region. In order to control total SO_2 emissions and attain the TEC limit (1 million tonnes) allocated by the central government, Jiangsu introduced an emission

trading program to promote cost-effective SO_2 abatement in the power sector. The policy framework is outlined in Table 2.

Table 2: The Emission Trading Framework in Jiangsu

Scope:	Power sector – 196 power plants in Jiangsu Province
Region:	The province
Total Emission Target:	TEC limits for the Tenth Five-Year Plan period
Allocation Method:	Emission performance standards
Legal Basis:	Document by provincial EPB and Economic and Trade Commission
Trading Situations:	Two power plants conducted a trade
Monitoring and Measurement:	CEMs, periodic source monitoring, and material balance

Source: Jiangsu Provincial EPB, 2003

39. Jiangsu focused on the power sector for the pilot study. The sector makes the largest contribution to SO_2 emissions in the province. The two power plants that participated in the allowance trade were located in different cities; thereby making the transaction the first inter-city allowance trade in China. Some of the reasons for the program's initial success where: (1) total allowable SO_2 emissions from the power sector are controlled by the provincial EPB; (2) allowances were allocated according to uniform standards set by the provincial EPB; and (3) allowances were allocated based on an emission performance standard, or generation performance standard, which is an advanced concept that promotes efficiency ; (4) the provincial EPB is capable to decide the total emission cap for the sector, identify the uniformed allocation method to facilitate the breakdown of cap to individual power plants involved and have the authority to give a go-ahead to this trade. [YANG – in paragraph you mentioned effective management institutions in Jiangsu province – did you want to mention the influence of these on the success of the program?]

4.2.2 SO_2 Emission Trading in Taiyuan City

40. SO_2 pollution in Taiyuan is very severe – ambient SO_2 concentrations were 0.2 mg/m3 in 2000, three times higher than the Class II standards of 0.06 mg/m3. In an effort to improve urban air quality, the city formulated an ambitious TEC target of 50% below 2000 emissions by 2005. With financial assistance from ADB and technical support from RFF and CAEP, Taiyuan initiated the emission trading project to attain the TEC target at lower cost. After one year of preparation and study, Taiyuan promulgated the "Administrative Regulation for SO_2 Emission Trading in Taiyuan City" in 2002 as a local regulation to conduct emission trading. Twenty-three major sources were identified to participate in the first phase of the emission trading program. On the basis of a detailed survey and analysis of SO_2 emissions from the sources, allowances were allocated using historic emissions or performance agreements with the city EPB as the basis for the new allocations. The U.S. EPA held training classes for the local EPB and the enterprises participating in the program. In addition, the U.S. EPA helped RFF and CAEP create SO_2 emission and allowance tracking systems. The policy framework for the Taiyuan emission trading program is outlined in Table 3. The training conducted by USEPA, RFF and CRAES had brought local officials and power plants representatives together to see simulation cases which facilitated their understanding the real emissions trading program and helped to build up the institutional capacities for the success of the Taiyuan program. The training also suggests that further extension training be held to clarify issues related to emissions trading such as the right of an allowance. [YANG – did you want to refer to some of the comments made by Ruth Greenspan-Bell at the Forum, and expand on any issues relating to the importance of the training held bu USEPA and building institutional capacities for the success of the Taiyuan program?]

Table 3: The Emission Trading Framework in Taiyuan

Scope:	23 key pollution sources accounting for 50% of total SO_2 emissions
Region:	Urban area (excluding suburban districts and counties)
Total Emission Target:	TEC limits for the Tenth Five-Year Plan period – 125,000 tonnes
Allocation Method:	Historic emissions
Legal Basis:	Regulation on TEC in Taiyuan City and administrative regulation for SO_2 emission trading in Taiyuan City
Trading Situations:	Training, trading simulation, and implementation beginning January 1, 2003
Monitoring and Measurement:	CEMs, periodic source monitoring, and material balance
Management:	Emission and allowance tracking systems

Source: Cao et al, 2002.

41. The Administrative Regulation for SO_2 Emission Trading in Taiyuan City creates a strong foundation for emission trading and provides detailed implementation requirements. There are seven key aspects of the regulation:

- Identifies Taiyuan city EPB as the supervising institution for SO_2 emission trading.
- Stipulates that enterprises participating in the emission trading program are not exempt from other environmental protection responsibilities.
- Specifies the allowance allocations for each year of the Tenth Five-Year Plan period. New sources must obtain allowances through purchases from the city EPB or other sources.
- Allows for the trading and banking of allowances. Surplus allowances from the current year can be banked for use in the future or sold to other sources. If surplus allowances are sold, the trading parties determine the price based on market conditions.
- Authorises an allowance auction by the Taiyuan EPB. Auction income is set aside for improving urban environmental quality.
- Requires the implementation of an emission tracking system and allowance tracking system to manage emission data and allowance transactions.
- Specifies the legal liability of enterprises and financial penalties for non-compliance.

5. OPPORTUNITIES AND OBSTACLES TO IMPLEMENTING EMISSION TRADING IN CHINA

5.1 Feasibility of National Implementation

42. Although current conditions are far from perfect for an efficient emission trading program, they create the foundation for pilot emission trading programs that can help further develop necessary conditions and institutions. Prevailing conditions include:

- Wide acceptance of the emission trading concept: The role of emission trading in decreasing costs to achieve an environmental goal is well understood.
- Implementation of SO_2 TEC limits: The TEC limits establish the environmental goal, while emission trading and market-based instruments provide the means to achieve the goal at a lower cost.
- Experimentation with emission trading pilots: Pilots in some provinces and cities have provided valuable experience and forged the path to expand emission trading nationwide.
- Outreach and capacity building for emission trading: SEPA has organized a series of studies and has developed technical capacity in the design of emission trading programs.

5.2 Issues and Barriers

43. Although there are favourable conditions for promoting nationwide emission trading, there are still some issues and barriers to overcome, including legal authority, policy coordination, allocation issues, emission measurement and verification, and supervision and management systems.

5.2.1 Legal Authority

44. There are currently no explicit legal provisions authorising emission trading at the national level. The current Air Pollution Prevention and Control Law supports the TEC policy but does not directly assist in the adoption of emission trading programs. The law indirectly requires the application of economic and technical measures to control air pollution, implying that emission trading is feasible. However, in the new amendment of the law there are still no explicit provisions for emission trading.

45. Some pilot provinces and cities have local regulations on emission trading but corresponding national regulations are vital if nationwide emission trading is to be pursued.

5.2.2 Uniform Allocation Method

46. The current TEC targets are allocated to administrative districts and then further allocated by the local governments to emission sources. Each of these levels of government is free to create their own allocation method. If a nationwide emission trading program is implemented, the TEC management system and allocation method should be adjusted to create a uniform TEC allocation method. Once a uniform allocation method is established, the allocation process will involve three steps: (1) identify sources participating in the emission trading program; (2) determine the TEC limit of the community of participating sources; and (3) allocate allowances to individual sources in accordance with uniform allocation principles and methods. Whatever allocation method is chosen, it should embody the principles of sound science, reasonableness, and equity.

5.2.3 Monitoring and Verification

47. The primary method for measuring and verifying SO_2 emissions is material balance. Few sources have installed continuous emission monitors (CEMs). For emission trading, however, it is important to provide accurate emission measurement to create a credible, effective emission trading program. Although material balance can provide the same level of accuracy as CEMs in certain circumstances (e.g., small units that are frequently cycled on and off), there are significant gaps between current measurement approaches and a system with the appropriate level of accuracy for an emission trading program. Emission measurement could be improved with standards for CEM installation and operation and alternative measurement methods. As the U.S. experience shows, sources participating in emission trading programs can rely on CEMs. However, because the SO_2 emission sources in China are numerous and CEMs are expensive, it would be difficult to install CEMs on all sources in the near

term. Therefore, when identifying sources to participate in the first phase of an emission trading program, SEPA and local environmental protection bureaus should consider measurement capabilities as a priority.

5.2.4 Coordination with Other Policy Instruments

48. The introduction of emission trading should be coordinated with existing regulatory policies to ensure that current protection policies are not diminished. In the U.S., emission trading is combined with traditional command-and-control policies and other market-based instruments to protect against emission hotspots that could occur if sources purchased allowances to increase emissions, causing a deterioration of local air quality. In China, emission standards and emission charges can integrate with an emission trading program to promote emission reductions. The emission charges are particularly important for raising revenue for general environmental protection. Therefore, consideration should be given to the design of an emission trading program to ensure that policies are compatible. Theoretically, the low charges for the emission charge system should not impede the effectiveness of an emission trading program (Ellerman, 2001).

49. In addition to environmental policy instruments, the power sector is faced with other policies that may affect the efficiency of an emission trading program. Some of these issues are discussed in the next section.

6. RECOMMENDATIONS FOR NATIONWIDE SO_2 EMISSION TRADING

50. SO_2 emission trading has the potential to lower the cost of attaining the TEC targets nationwide. Pilots and research demonstrate that implementing and operating a program within China is feasible. It should, however, be implemented in stages and applied more broadly after pilots are used to test different aspects of the policy. This section outlines some strategies to help nationwide adoption of emission trading.

6.1 National SO_2 TEC Targets

51. Emission trading is compatible with the national TEC targets. To ensure that the policies complement one another, the design of the emission trading policy should be integrated with the national TEC limit so as to facilitate the attainment of the TEC target.

52. SEPA has already established the national SO_2 TEC target for the Tenth Five-Year Plan period. The target limits SO_2 emissions in 2005 to 10% below 2000 emissions and 20% below 2000 emissions in the TCZs. Detailed TEC targets are presented in Table 4.

Table 4: SO_2 TEC Targets in 2005

	2000 ('000 tonnes)	*2005 ('000 tonnes)*
China	19,950	17,950
TCZs	13,164	10,536
SO_2 Control Zones	5,296	4,234
Acid Rain Control Zones	7,868	6,302

Source: State Council, 2001

6.1.1 The Power Sector SO_2 TEC Target

53. According to a CAEP research report on long- and medium-term emission control plans in the power sector, the TEC target for the power sector over the next 20 years will continue to decline (Yang et al., 2002). See Table 5 for the power sector TEC targets.

Table 5: SO_2 TEC Targets in the Power Sector – 2000 to 2020

Year	*TEC Target ('000 tonnes)*
2000 (base year)	8,900
2005	8,000
2010	7,300
2015	6,700
2020	6,300

Source: Yang et al., 2002

6.2. Implementing the TEC

54. The circumstances for SO_2 emission trading policies in China and the U.S. differ significantly, including:

- The composition, distribution, and contributions of the emission sources;
- The structure and role of central management institutions;
- Ownership – private versus state owned;
- Experience with markets for commodities like electricity;
- Access to capital and control equipment; and
- Existing policies and measures.

55. SO_2 emission sources in China are primarily classified as industrial or social. Alternatively, the sources can be classified into regions, such as the acid rain zone, the SO_2 control zone, and the general zone. They can also be classified by emission source, such as high-stack sources, low-stack sources, and non-point sources. High stack sources are found mostly in the power sector. There are a limited number of sources, they are often controlled centrally, and they are easier to manage. The low stack sources are various types of boilers and furnaces. They are numerous, widely distributed, and difficult to manage. The non-point sources are primarily diffuse residential stoves.

6.2.1 Power Sector

56. Promoting SO_2 emission trading in the power sector provides many advantages. The sector accounts for 45% of national SO_2 emissions, sources primarily use high stacks, and, as a result, are key contributors to the regional acid rain problem. Decreases in their emissions should significantly improve regional pollution problems. Other important conditions for emission trading exist in the power sector, such as strong management, good emission data, and a relatively high economic efficiency.

57. There are still, however, some key barriers to implementing emission trading in the power sector, such as:

   - *Ownership:* The enterprises in the power sector are mainly state-owned and currently undergoing restructuring. The progress of restructuring will directly affect the implementation of a SO_2 emission trading policy.
   - *Electricity pricing*: The price of electricity is an important factor limiting SO_2 abatement in the power sector. The government fixes prices and the sector cannot pass environmental costs to ratepayers. If the electricity pricing policy is not adjusted, sources of funding will be limited and it will be difficult for the sector to adopt effective abatement measures. However, the government is currently reforming national electricity price policy.
   - *TEC limit allocation:* The allocation of TEC limits is a two-stage process. First, portions of the national target are allocated to the power sector. Second, portions of the power sector target are allocated to individual sources. There is currently no standard allocation methodology for sources. In addition, allocations are often for short periods (e.g., five-year plan periods) and may not provide enough information for sources to develop investment plans.
   - *Emission measurement:* Few enterprises in the power sector, some 10 to 19 new plants, have CEMs. Even in the new plants, CEMs often fail to operate normally. In order to promote SO_2 emission trading, it is important to establish standards for certification, installation, operation, maintenance, and calibration of CEMs.
   - *Data management systems:* It is critical to establish management systems to collect, verify, manage, and disseminate emission data. It is also important to develop data standards for reporting.

6.2.2 Two Control Zones

58. Sixty percent of national SO_2 emissions occur in the TCZs. Since the TCZs are identified as areas of national focus for controlling SO_2 and acid rain, the promotion of SO_2 emission trading in the TCZs can be a part of a national SO_2 control strategy. There are abatement targets and emission caps already defined for the TCZs. Therefore, it is practical to conduct SO_2 emission trading pilots in the TCZs. In these pilots the following issues should be considered:

   – There are several types of sources in the TCZs and it is impossible to implement emission trading for all source types. It is therefore necessary to classify sources in the TCZs and select the key ones for an emission trading pilot before broadening the scope.

   – In the TCZs it is necessary to distinguish between high-stack sources and low-stack sources. The former have regional pollution impacts and can therefore trade in a larger area while the latter have primarily local impacts and should therefore only trade with other local sources.

6.3 Implementation Phases

59. The feasibility study on SO_2 emission trading in China prepared by CAEP, U.S. EPA, and other experts recommends implementing SO_2 emission trading at the national level in four stages (WANG et al. 2003):

- *Phase One:* a pilot phase with trading limited to large power plants (i.e., annual SO_2 emissions greater than 5,000 tonnes) in the TCZs;
- *Phase Two:* an expanded pilot with trading between all power plants in the TCZs on the basis of phase one;
- *Phase Three:* a nationwide program including all power plants in China; and
- *Phase Four:* an expanded nationwide program including other types of high-stack sources.

60. A pilot restricted to sources in the TCZs is consistent with China's current SO_2 management framework. Limiting the pilot to power plants focuses SO_2 control in China and facilitates management of emission trading. From the standpoint of the power sector, it is feasible to establish a national SO_2 emission trading program as it may help balance the cost differences in pollution abatement among different sources.

7. CONCLUSIONS AND SUGGESTIONS

In summary, the following conclusions and suggestions are provided:

7.1 Conclusions

- SO_2 TEC in China should be combined with a national emission trading policy to help achieve the control target at lower social cost.
- After nearly 10 years of analysis and emission trading pilots, several cities and regions have the practical experience that provide the necessary foundation for introducing emission trading nationwide.
- There are issues and barriers to overcome before implementing a nationwide emission trading program, including establishment of a legal authority, policy coordination, allocation issues, emission measurement and verification, and supervision and management systems.

7.1 Suggestions

In order to support national implementation of emission trading, some basic conditions should be improved, including:

- Establish an explicit legal basis for emission trading. SEPA should draft emission trading provisions that are integrated with the TEC regulation.

- Strengthen measurement and verification of SO_2 emissions to improve accuracy. Major stationary sources of SO_2 should install CEMs. Those sources without CEMs should be encouraged to apply more accurate emission measurement methods. SEPA should draft standards and/or guidelines for CEM certification, installation, operation, maintenance, calibration, and verification to ensure accurate emission measurement. SEPA should also develop procedures for measuring and verifying emissions from sources without CEMs.
- Design an equitable allocation method that provides proper incentives for sources to take action to reduce SO_2 emissions.
- Implement management systems to collect, verify, manage, and disseminate emission and allowance data. The management systems should complement existing systems already in place for the TEC policy.
- Strengthen education and outreach on emission trading.
- Implement emission trading in phases, with high-emitting, high-stack sources in the TCZs participating in the first phase and a gradual expansion as capacity increases.

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