Market-Based Tool for Environmental Management:

Emissions Trading in the United States and South Korea

Michigan State University
Urban and Regional Planning Program
Mooneue Choi

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"There's so much pollution in the air now that if it weren't for our lungs there'd be no place to put it all." - Robert Orben

INTRODUCTION

Since the advent of urbanization and industrialization, environmental destruction has become a serious problem for human beings. For a long time, people did not realize how serious our environmental problems were; however, increases in the lack of water, food scarcity, drought from environmental destruction, and air pollution have helped people realize the severity of the problems we are facing today.

Agenda 21[1], adopted in 1992 at the United Nations Conference in Rio de Janeiro, is a good place to start a review environmental management methods. The most important subject dealt with at this conference was the importance of global cooperation as the only way to have a safer and a prosperous future.

[1] Agenda 21 is a comprehensive plan of action that is taken globally, nationally and locally by organizations of the United Nations system, governments, and major groups in the world. This was adopted in the Rio Declaration at the United Nations Conference on Environment and Development, (UNCED) which was held in Rio de Janeiro, Brazil in June 19992. (UN Division for Sustainable Development)

People have realized the importance of environmental conditions and the concept of sustainable development, which was defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" by the United Nations World Commission on Environment and Development (1987). This became the main concept of the environmental management efforts.

Under this norm of sustainable development, an air pollution problem such as global warming has been identified as the most serious problem. According to the Union of Concerned Scientists' website, there are numerous impacts on the climate that result from the use of fossil fuel energy sources in the United States and other developed countries. For example, the Lewis Glacier on Mt. Kenya has lost 40 percents of its thickness from 1963 to 1987 (Hastenrath and Kruss 1992). Moreover, the global sea level will continuously rise 0.5 to 2 meters by 2100 (EPA 1989). These have been identified as severe environmental threats. In order to reduce these effects, we will need a solution for this ongoing environmental destruction, specifically air pollution.

From examining past research, I recognized that there are many methods for environmental management. Different from the past command-and-control methods, market-based methods such as emissions trading are arguably a better solution for

environmental management. Therefore, I started to investigate emissions trading as a possible solution to air pollution control. My goal in this paper is to determine how others can use and modify this trading system appropriately in the future.

The purposes of this paper are as follows:

1. To recommend possible solutions to air pollution problems by using market-based methods such as "Emissions trading."
2. To look for appropriate emissions trading programs for the management of air pollution in South Korea through American case studies.

In addition, the research questions that this paper seeks to address are as follows:

1. What are the current situations of both the United States and South Korea in terms of air pollution control management?
2. Why have market-based methods like emissions trading program become central to environmental management? What is the justification?
3. Does "Emissions Trading" as a market-based method solve air pollution problems based on the case studies?
4. Is "Emissions Trading," as practiced in the United States, suitable for air pollution management in South Korea?

As a non-annex[2] country in the Kyoto protocol, South Korea needs a broader understanding about emissions trading. This paper will answer those questions as previously mentioned by comparing the current situation between the United States and South Korea. Because of possible detrimental effects on the economy, the United States purposely did not join the other countries in the Kyoto protocol. However, through the successful experience of the domestic emissions trading programs, such as Acid Rain Program and the RECLAIM program, the U.S. offers various lessons for air pollution control in South Korea.

In order to find out appropriate and reasonable tools to protect the environment, I chose the United States which has experienced successes and failures from the existing policies and methods. Learning from the environmental management cases in the United States will help South Korea to establish the new tools necessary for making better environmental management choices.

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[2] Countries that are not listed in Annex 1 and B of the Kyoto Protocol. For example, Annex 1 countries are the thirty-six industrialized countries in the UN Framework Convention on Climate Change (UNFCCC) Their responsibilities under the Convention include a non-binding commitment to reducing their GHG emissions to 1990 levels by the year 2000. On the other hand, Annex B countries are the thirty-nine industrialized countries in the Kyoto Protocol. Their emission reduction requirement is from an 8% decrease to a 10% increase on 1990 levels by the first commitment period of the Protocol from 2008 to 2012.

Past and Current Policies for Air Pollution Control: U.S. and South Korea

In order to understand the current tools used for air pollution control in the United States, it is a good idea to examine the past to figure out past environmental policies. Learning from the past policies and understanding the overall history of environmental policies will be the guideline for the current and future policy-making. Based on the lessons learned from the past, better policies can be created for the future. However, there are some obstacles that make good policy making. A government's financial restrictions at all different levels make policy-making extremely difficult. In addition, conflict between the political and economic system is significant. Even though these obstacles exist, air quality has still improved due to the current environmental policies. The following policies will be the examples that showed the development of the environmental policy systems of the United States. It will also explain how they have made gradual improvements of the air quality.

According to Augustine (2003), rapid industrialization and increasing population were the main reasons that the policy makers attempted to control air pollution in the United States. For instance, Chicago and Cincinnati enacted clean air laws for the first time to protect their serious environmental problems rising from industrialization and transportation system in 1881. After many state and local

governments had passed legislation related to air pollution, the federal government realized the need of a national solution.

Zafonte and Sabatier (2004) define the period from 1955 to 1970 as the formation and solidification of air pollution control. People started to change their perception about air pollution during this period. For example, the Air Pollution Control Act of 1955 was adopted and it identified air pollution as a national problem. This act provided research and technical assistance relating to air pollution control. It was the first federal legislative attempt to control air pollution. Thus, it brought in federal research programs for the health and welfare effects of air pollution. The federal government also provided technical assistance to state governments through this act.

The Clean Air Act of 1963 was passed by Congress eight years after the Air Pollution Control Act of 1955. The CAA of 1963 provided grants to state, local, and federal levels for examining and creating plans to reduce air pollution. The funds from the CAA program helped extend further research of toxic emissions from motor vehicles. Technology to remove sulfur from fuels was also created. Later on, with several amendments, the Motor Vehicle Air Pollution Control Act of 1965[3] established auto emission standards, and amendments of 1966 expanded local air pollution control

[3] Amendment of Clean Air Act of 1963 (1965)

programs. Also, the Federal Air Quality Act of 1967[4] that defined air quality control regions was enacted. It divided the nation into Air Quality Control Regions (AQCRs) to monitor ambient air. While the Clean Air Act was supported in the late 1960s, the oil embargo of 1973 and the energy crisis of the 1970s led to conflicts over air pollution control programs. During this period, presidents'[5] attempts at creating a national energy policy were met by fierce opposition. Because of high inflation and oil prices in the late 1970s, the government was forced to lower air pollution control requirements to some extent (Mendocino 1999).

The Clean Air Act of 1970 mandated National Ambient Air Quality Standards (NAAQSs) by EPA. Under this act, protecting human health was the primary standard while protecting buildings, forests, water, and similar nonhealth values were considered secondary standards. The NAAQS limited the allowable concentrations of six criteria pollutants[6], and the environmental agencies developed State Implementation Plans (SIPs) to reduce pollution. For instance, typical control measures such as stack-gas cleaning devices for power plants, and inspection and maintenance requirements for

[4] Amendment of Clean Air Act of 1963 (1967)

[5] Nixon, Ford, and Carter

[6] Sulfur dioxide, nitrogen dioxide, lead, ozone, carbon monoxide, and particulate matter (The standard for lead was added in 1977.)

motor vehicles were required. EPA provided technical assistant to pollution emitting industries through the CAA, so they could achieve the NAAQS.

On the other hand, the 1990 amendment to the Clean Air Act by Congress marked an overall change in the federal approach to air pollution control. This amendment emphasized controlling emissions of air pollutants and aimed at controlling acid rain, and halting ozone depletion in the atmosphere. Public concerns over acid rain and other hazardous air pollutants increased as efforts to amend the CAA continued from 1982 to 1990.

Different from other environmental policies, the 1990 amendment to the Clean Air Act rely mainly on market-based approach of air pollution control and prevention strategies. It allowed emissions trading, marketable permit programs, emissions fees, or early reduction credits to be utilized. For example, the 1990 CAA amendments encourage use of emissions trading or other economic instruments to control air pollution. These amendments were proposed to increase economic efficiency by giving greater flexibility to comply with air pollution regulations. Under this regulation, overall emission control costs were lowered and encouraged more reductions with the lowest cost. In summary, the Clean Air Act of 1990 had tight restrictions on automobiles, hardened timetables, granted new powers to enforce to the states, reduced SO2

emissions, and required the installation of Best Available Control Technology (BACT)[7] on all new sources (Dan York 2003).

Through these rigorous amendments, CAA was considered a success that improved, strengthened, and accelerated programs for the prevention and abatement of air pollution. The main purpose of the Clean Air Act has been to promote public health and welfare. This act granted $95 million to state and local governments and environmentally related agencies to conduct research and enact air pollution management programs. The Clean Air Act (CAA) is recognized as the premier example of contemporary environmental regulation by the federal government (Kraft 2001). However, because of the conflict between environmental protection and economic development, CAA has become a target of critics. Although environmentalists and public health specialists have tried to expand and strength the CAA, there has been continuous objections from people who believe that economy is more important than the environmental destruction.

Under Presidents Bill Clinton and George W. Bush, the U.S. Environmental Protection Agency (EPA) reinvented environmental regulation by using community

[7] Best Available Control Technology (BACT) means a control technology, based on the maximum degree of reduction for each regulated criteria pollutant that would be emitted from any new major stationary source in an attainment area.

based environmental protection, public-private partnerships, and enhanced flexibility in rulemaking and enforcement (Kraft 1999). New tools for ecosystem management and sustainable development have been created to stimulate comprehensive and long-term strategies for environmental protection (Cortner and Moote 1997).

As mentioned above, the history of the environmental policies in the United States have shown how the citizen's perceptions toward environmental problems are changing. Once again, such as public awareness and political pressure to control the environmental problem of air pollution have resulted in the inception of environmental regulations in the United States. There could be a major change in the environmental management system such as introduction of market-based tools with economic flexibility.

According to Vig (2003), George W. Bush withdrew from the Kyoto Protocol because of the reason that it could be harmful for the U.S. economy. He argued that the Kyoto Protocol was fatally flawed because it would place unfair burdens on the U.S. economy without requiring developing countries to control their emissions.

Bush's environmental philosophies are also based on opportunities for citizen participation in solving environmental problems (White House 2001). The Clear Skies Initiative of Bush Administration was made to reduce air pollution and to improve air

quality by using market-based approaches, which will be addressed later in detail. The Clear Skies Initiatives was proposed as an extension to the Clean Air Act. Mercury was added as a new requirement in emission limitations. Both Nitrogen Oxide and Sulfur Dioxide are currently part of the ongoing Clean Air Act. According to its proponents, there are mainly two benefits from the Clear Skies Act both environmentally and economically. While Clear Skies will reduce health risks and reduce destruction due to acid rain, it also reduces costs to consumers by allowing businesses more flexibility with their reduction methods than the Clean Air Act (EPA 2003).

Under the environmental policies stated above, air quality in the United States has improved and emissions reduced. For example, the Environmental Protection Agency[8] (EPA) conducts an evaluation of its environmental programs periodically to use the results for the better policy consideration. One of the stated goals of the Environmental Protection Agency (EPA) is overall reduction of harmful air pollutants. The EPA defined the six principal air pollutants for the national air quality standards as nitrogen dioxide (NO_2), ozone (O_3), sulfur dioxide[9] (SO_2), particulate matter (PM), carbon monoxide (CO), and lead (Pb). The EPA also measures and records annual

[8] Environmental Protection Agency: to protect human health and the environment. (Since 1970) http. www.epa.gov

[9] Sulfur is prevalent in all raw materials, including crude oil, coal, and ore that contains common metals like aluminum, copper, zinc, lead, and iron. SO_2 dissolves in water vapor to form acid, and interacts with other gases and particles in the air to form sulfates and other products that can be harmful to people and their environment. (EPA)

emissions to evaluate the effectiveness of their programs. For example, Figure-1 in the next page shows the relationship between gross domestic product (GDP), vehicle miles traveled, energy consumption, population growth and total emission from 1970 to 2003. According to the EPA, GDP increased by 176 percent, vehicle miles traveled increased by 155 percent, energy consumption increased by 45 percent, and U.S. population has grown by 39 percent. The total emissions of the six principal air pollutants have decreased by 51 percent.

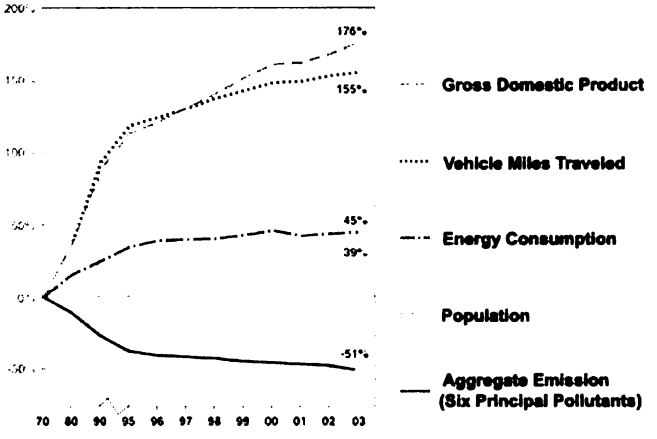

Figure 1: Comparison of Growth Areas and Emissions (Source: EPA)

For instance, in the Eastern of the United States, power plants reduced sulfur dioxide emissions by 33 percent from 1990 to 2003. As Figure-2 describes, there were significant regional reductions in SO_2 concentrations, reducing acid deposition and improving visibility. The reductions shown in Figure-2 mainly resulted from EPA's

Acid Rain program. Later in this paper, Acid Rain Program will be addressed in detail as a case program for emissions trading programs.

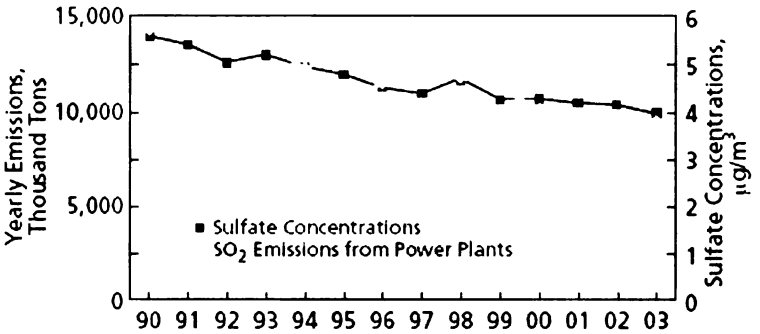

Figure 2: Eastern Annual Trends of Sulfur Dioxide Emission from Power Plants and Sulfate Concentrations (Source: EPA CASTNET Monitoring Network)

Conversely, South Korea faces a different situation than the United States. For many years, South Korea was one of the fastest-growing countries in Asia; rapid industrialization has been accompanied by an increase in its energy consumption and air pollution levels (Do-wan 2003). Moreover, because of the Asian economic crises of 1997 and 1998, Korea saw increased environmental problems. As the South Korean government wanted to stimulate its economy, grants originally intended for environmental programs were shifted to economic recovery projects, and long-term land development projects were postponed. Although South Korea has recovered from the Asian financial crisis, it has increased levels of carbon emissions and energy

consumption (EIA[10], 2003).

As Table-1 shows, there are three trends in the environmental policy of South Korea. Although there were only passive tools as an end of pipe treatment before 1990s, concerns about environmental management have become new issues because of continuous climate changes and environmental destruction.

Table-1: The Characteristics of the Environmental Policy Trends in South Korea

(Source: Ministry of Environment in South Korea and Korea Environment Institute)

	1980s	1990s	2000s
Policy Directions	End of pipe treatment	Plans to protect environment before the destruction	Comprehensive tools for environmental management
Main Research/ Environmental Concern	Water Pollution/ Sewer System management	Waste Water/ Water Pollution/ Air Pollution management and Environmental Effect Evaluation	Climate Change/ Soil Contamination/ Natural Resource Conservation/ Emissions trading/ Environmental Evaluation/ Non-point pollution management
Public-Private Relationship	Confrontation	Partly collaboration	Public-Private Partnership

Furthermore, the history of environmental policies in South Korea can be divided into four periods. In the 1970s, there were only basic environmental regulations to protect the public health and to solve environmental problems. Only a few industrial sectors regulated these polluting sources. In the 1980s, as the fundamental stage of

[10] The Energy Information Administration (EIA): created by Congress in 1977 and a statistical agency of the U.S. Department of Energy

South Korea's environmental policies, policies focused more on the regulation of pollutions from industrial sources and local hot spots. Basic emission charges and incentives for the pollution abatement investments were also used. Third (1990s), effective implementation of environmental regulation became an important issue. For example, environmental problems not only existed locally but also could be seen throughout the region and the nation. Hence, the Ministry of Environment was established in 1994. Economic development working together with the environment was emphasized. Environmental policies, based on incentives such as charges, deposit-refund system, and subsidies, were also developed during this period.

At present, command and control regulation is still the dominant policy direction; therefore, use of emission standards and regulation of technology are the primary tools to manage environmental destruction. However, as both economic and environmental concerns have become critical issues, regulations with economic incentives are considered more efficient tools. In addition, a monitoring system for air pollution such as monitoring stations, and telemetry system in polluting sources, helps to manage large and medium size facilities in contaminated areas (Seung-Jick, 2003).

As like the United States, Korea has reduced its total amount of emissions gradually. Table-2 and Figure-3 show that the amount of SO2 and CO emissions have

continuously decreased from 1993 to 2002. Although the amount of NO2 emission was not reduced in the 1990s, it has been gently decreasing since 2001.

Moreover, Figure 3 shows that there was a drastic drop in emissions between 1997 and 1998. Not only NO2 emission but also other major pollutants were decreased. The amount of SO2 emission was high in the middle of 1990's but it has been steadily decreasing. These decreasing trends have been attributed due to the governmental low-sulfur oil policy and fuel substitution from fossil fuel to natural gas in 1990's (Hong 2003).

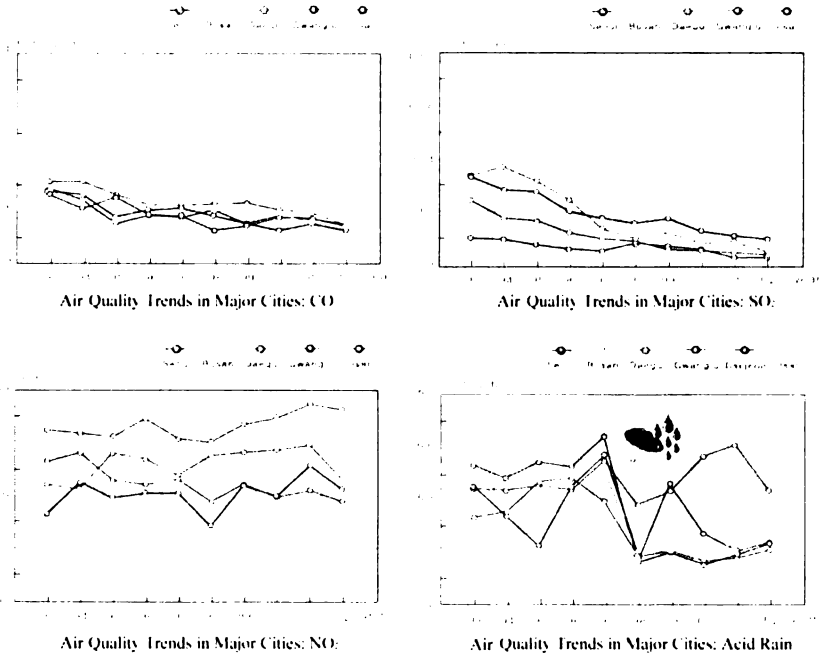

Figure 3: Air Quality Trends in Major Cities in Korea

(Source: Ministry of Environment)

Table-2: National Air Pollutant Emissions (Source: Ministry of Environment, Korea)

	1998	1999	2000	2001	2002	2003
SO_2 (ppm)	0.009	0.009	0.008	0.007	0.006	0.006
NO_2 (ppm)	0.020	0.023	0.024	0.025	0.023	0.024
O_3 (ppm)	0.020	0.021	0.020	0.021	0.021	0.021
CO (ppm)	1.0	1.0	0.9	0.8	0.7	0.7
PM_{10} ($\mu g/m^3$)	55	51	53	58	61	56
Pb ($\mu g/m^3$)	0.0959	0.0785	0.0934	0.0669	0.0695	0.0616

In contrast, NO_2 emissions increased from 1998 to 2001 in Seoul at a high rate. This resulted from an increase of automobiles in Korean society (See Figure 4). Since 1970, the total numbers of registered motor vehicles have increased drastically, Rising to 12 million in 2000. This is 21 times more than in 1981. Due to the exponential increase of motor vehicles, the total energy consumption has drastically increased and the level of NO_2 air pollution emission has become a serious problem. Even though this is a good example, which shows that automobile is one of the biggest factors that cause air pollution, we have to remember that this is only one out of many other factors that cause our air to be polluted.

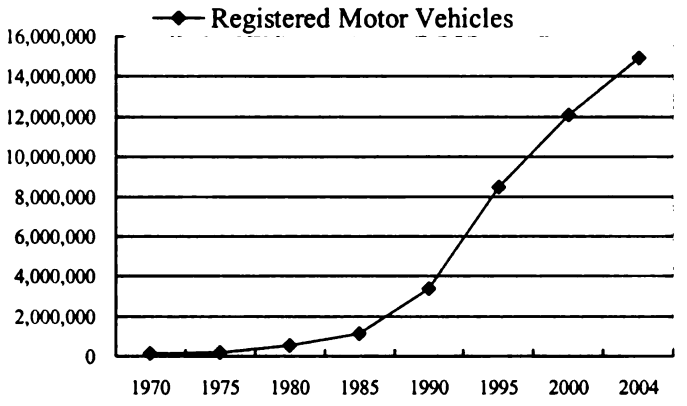

Figure 4: Registered Motor Vehicles in Korea

(Source: National Statistical Office, Korea)

In order to solve the environmental problems and reduce environmental destruction has been various policies and legislation in South Korea. For example, Green Vision 21, which was established by the Ministry of Environment, is the main environmental management program in South Korea since 1995. This approach focuses on providing better environmental services and making the environment more ecologically sound for the future. According to the Ministry of Environment, there are six main objectives in the Green Vision 21 Initiatives;

- Maintenance of a Sufficient Supply of Clean Water
- Preservation of Clean Air
- Establishment of an Environmentally-friendly Society which Recycles Wastes
- Creation of an Ecologically Sound Environmental Community
- Establishment of an Advanced Environmental Management System

- Assumption of a Leading Role in Global Environmental Preservation

An important concept of the Green Vision 21 initiatives is preserving clean air. Under this idea, cities are expected to reduce air pollution by using clean fuels. By promoting the use of low-emission diesel-powered vehicles and the use of electric automobiles, air pollution will be reduced. Furthermore, the Ministry of Environment (MOE) enforces diverse environmental methods regarding air pollution. For instance, Table-3 presents recent environmental policies in South Korea. The direction of environmental policy is changing with more flexibility. Different from the past policies like the end-of-pipe regulation, it focuses more on preventive methods. Also, the public demands and concerns for the environmental quality become more important parts of the decision-making.

Table-3 Recent Environmental Policies (Source: MoE 2003, UN 2002, MOCIE 2003)

Initiative	Outline
Environmental Industries Development Strategy (2001- 2003)	• To facilitate environmental technology and environmental industry development. • Contains 58 development measures in core priority areas
Eco-Technopia 21	• To support research and production of new environmental technologies • Divided into three stages (2001-2003/ 2004-2007/2008-2010)

Environmental Technology Evaluation System	• To appraise and disclose the technical performance of new technologies.
Ten-Year National Plan for Energy Technology Development (1997-2006)	• This plan incorporates three separate technology plans: conservation of energy, new and renewable energies and cleaning of energy.
Special Act on Seoul Metropolitan Air Quality Improvement	• To improve air quality in the Capital Region to average OECD-levels in ten years. • Key features: a total maximum loading system of pollutants, an emissions trading system and enhancement of low emission vehicle supply.

In Korea, environmental tools for addressing air pollution are mainly based on the de-sulfurization process in private industry, the expansion of clean fuel supplies, and the reduction of automobile pollution in large cities and industrial complexes. Under those concepts, the Korean government has operated a compressed natural gas (CNG) bus system, and plans to replace 20,000 city buses with pollution-free vehicles running by 2007. In addition, the oil industries must reduce their emission to meet their requirement (MOE 2000).

As mentioned above, various policies and programs have been made to reduce and manage air pollution. However, air pollution control needs more attention because it is directly related to the citizens' health and welfare. Moreover, once it is polluted, it is difficult and expensive to clean up. People have been looking for the solution regarding air pollution with both low cost and high efficiency. It is also important to

decide on a long-term strategy and without being only concerned with short-term successes. The short-term tool can help to alleviate air pollution but it will not solve the core problems.

Emissions trading is still at the beginning stages but there have been many successful stories that suggest that it can help South Korea's air pollution problem. In the following sections, I will investigate how both the United States and Korea can use market-based approaches and why this type of approach might benefit the environment.

New Trend: Market-Based Management & Emissions Trading

As I mentioned previously, market-based method have been considered as an alternative approach for sustainable development in environmental management. It is different from the traditional "command-and-control" method, or so-called direct control method. While market-based tools regulate and encourage behavior through market signals rather than through explicit directives in terms of pollution control levels (Hockenstein, Stavins, and Whitehead 1997), command-and-control regulations force firms to take the pollution-control burden, regardless of the costs (Helfand 1991).

According to Kellogg (2001), command-and-control regulation is inefficient and expensive. Uniform national standards take no account of the varying difficulties in

meeting environmental quality goals in different areas. Also, the costs of reducing pollution range widely from industry to industry and even from plant to plant. Holding all firms to the same target standards can be expensive. While target standards can limit the total emissions of pollutants, higher costs in the process are required, by forcing firms to use expensive means of controlling pollution. The costs of controlling emissions are different between firms, and even within the same firm the appropriate technology in one situation may be inappropriate in another (Stavins 1996). Early environmental policy, the Clean Air Act of 1970 is one of the examples. The U.S. has traditionally used mandatory command and control regulations to protect the environment. While this method has protected the environment, it has resulted in a policy framework that is inflexible and costly and whose effectiveness in further improving the environment may be diminishing (Esty and Chertow 1997).

Advocates argue that market-based methods such as emissions trading programs and pollution taxes can reduce air pollution in cost-effective ways. For instance, these approaches require less governmental processing getting information to set up regulations and the total amount of pollution as command-and-control laws do. In the market-based approach, regulators set the total amount of pollution; on the other hand, business sectors determine how efficiently they can clean up and solve environmental

problems. Under these situations, business groups and governments looked to economic instruments as a way of avoiding regulatory methods, which have been opposed by the affected industrial corporations and developers as well as by advocates of a free market policy.

Moreover, this cost-effective concept has led to market-based instruments such as emissions trading, deposit refund schemes, public disclosure of environmental information and voluntary programs that provide flexibility to firms to choose their least cost methods of pollution control to protect the environment (NCEE 2001).

Emissions Trading

According to the EPA, emissions trading is defined, "A market-based scheme for environmental improvement that allows parties to buy and sell permits for emissions or credits for reductions in emissions of certain pollutants. Also, emissions trading allow established emission goals to be met in the most cost-effective way by letting the market determine the lowest-cost pollution abatement opportunities."

After Kyoto Protocol in Kyoto, Japan, on 11 December 1997, which was made from the United Nations Framework Convention on Climate Change, emissions trading became a more prominent issue for air pollution control in terms of cost efficiency and

environmental protection. Many people anticipated that an emissions trading program might be a better solution than any other tool for environmental protection.

Through the emissions trading program, polluters have the right to discharge a certain amount of pollution, and also can buy and sell their air pollution rights. For example, if a polluter has the right to discharge ten tons of pollution, but discharges twenty tons of pollution, the polluter has two alternatives. A polluter should reduce the amount of pollution by ten tons or buy pollution rights with an additional ten tons from other polluters.

Different from the traditional regulatory method, each control requirement of the pollution sources is not important in emissions trading. The important part is the complete and accurate measure of all sources and reporting total emissions at the end of the compliance period.

According to the EPA report "Tools of the Trade: A Guide to Designing and Operating a Cap and Trade Program for Pollution Control," there are five steps in the emissions trading.

1) Set a cap on total amount of emission in a certain compliance period
2) Allocate the cap into allowances to emit a specific pollutant such as CO_2 and SO_2
3) Distributes allowances

4) Each source is measured and reported according to all of its emissions for the compliance period

In terms of economic benefits, polluters will choose the most cost-beneficial way between buying pollution rights and reducing the amount of pollution. Also, as the government has some of the pollution rights and sells them by auctions to polluters, the emissions trading program can become a source of income for the government and raise revenue (Stephen M. Johnson, 2004).

There are two main advantages in emissions trading. First, emissions trading are more cost effective compared to the regulatory control method. With emissions trading occurring, emission sources will make it profitable to keep reducing their emissions up to the point at which their marginal abatement cost equals the permit price, thereby guaranteeing the minimization of total abatement cost among sources. The command-and-control approach can bring the same result with detailed information on each source's cost function, which needs to be obtained at very high cost.

Secondly, emissions trading program encourages the adoption of innovative methods for preventing the pollution, degradation, or contamination of land, air, water, food and the workplace by giving sources incentives and implementing better ways to attain their reduction targets.

According to Steve Sorrell (2004), in order to achieve an air pollution target amount at the least cost level, the marginal abatement costs[11] of all the sources must be equal. This means different sources will reduce pollution by different amounts. If the annual emissions of each source are the same as the permit allowances or less than that, other surplus can be traded. For example, if the abatement cost[12] is less than the permit price, surplus of credits will be sold for a profit. On the other hand, if the abatement cost is higher than the permit price, polluters will buy more pollution rights so they can have more allowance to pollute. As a result, each source may minimize its compliance costs[13] through emissions trading. Moreover, public acceptance of an emissions trading is critical to ensure successful implementation. It is also important to engage in communication and outreach activities in the beginning of the policymaking process.

In the article, "Kyoto Mechanisms," Sijim says that the most important advantages of emissions trading are the financial incentives from air pollution reduction. Companies and countries can reduce emissions and have financial benefits under this program. For example, in "Evaluation of Compliance Costs and Allowance Market Performance," Montero and Bailey (1997) provide one illustration of the benefits of an

[11] the cost of reducing emissions with one additional unit

[12] defined as the least-cost combination of measures to reduce emissions

[13] the costs of complying with regulation for those being regulated

emissions trading program. In this example, there are two generating plants, and their environmental goal is the reduction of SO_2 emissions by two tons from current levels. Plant 1 can reduce SO_2 emissions at a cost of $25 per ton, and Plant 2 can do it at a cost of $100 per ton under the command-and-control approach. So, if a 2-ton reduction was mandated, the total cost would be $125 ($25 for Plant 1 and $100 for Plant 2). As an alternative, consider an emissions trading approach that allows each plant its current emissions minus one ton, thus maintaining the mandated 2-ton reduction. If Plant 2 buys an allowance from Plant 1 for $30, Plant 1 has an incentive to make an additional one-ton reduction and sell Plant 2 the unused allowance. Therefore, Plant 1 has a $5 profit for the one emission ton sold (though it still needs to pay another $25 for its original reduction requirement) and Plant 2 also benefits from purchasing an allowance for only $30, therefore avoiding the need to pay for the mandated reduction. In this mechanism, Plant 1 spends $20 and Plant 2 spends $30. As a result, under emissions trading, each plant benefits more than under a command-and-control system and total economic costs decrease.

In conclusion, emission trading has two notable advantages such as cost effectiveness and flexibility. Generally, market-based instruments allow any desired level of cleanup, the total amount of emission in air pollution to be realized at the lowest

overall cost to society. By providing incentives for the greatest reductions in pollution, firms can achieve emission reductions with cheaper tools. Rather than equalizing pollution levels among firms, market-based methods provide different options to set their emission levels to reduce pollution. As mentioned so far, emissions trading will reduce air pollution in both economically and environmentally efficient ways. From the next section, two case studies of the United States under the emissions trading concept will be introduced. Those case studies will be the guidelines of environmental policy direction in South Korea such as how to implement emissions trading programs.

U.S. Experience with Emissions Trading: Case Studies

Although the United States has not ratified the Kyoto protocol that includes international emissions trading, it implemented domestic emissions trading with the Clean Air Act in 1990[14]. In this program, the challenges of emissions trading regarding the market approach were addressed. As stated in previous sections, the Clean Air Act provides alternative choices for air pollution clean-up to the target companies. First, the companies choose their own methods to arrive at goals for air pollution reduction. Second, emissions trading programs offer economic incentives to companies when they

[14] EPA: http://www.epa.gov/oar/oaqps/peg_caa/pegcaa02.html#topic2

are successful and reach the goal of emission reduction. If oil companies produce cleaner gas than required, they can get credits and use these credits in the opposite case. In order to illustrate the overall emissions trading mechanism, the examples of domestic emissions trading programs in the United States will be used as case studies.

In the following section, two domestic cases in the United States will be presented: the National Acid Rain Program, and the RECLAIM program. These programs are used to reduce SO2 and NOx. Despite the successful lessons of those programs, several criticisms still exist.

Through the analysis of those case studies, I will compare some successful programs in regards to air pollution management, and will suggest further improvements.

Table-4: History of Market-Based Environmental Regulatory Programs in the US

Year	Program	Agency	Status
Various years: beginning in 1970s	Emissions trading credits; air emissions offsets, banking, netting, and bubbles	US EPA	Ongoing
1981	Water quality in Fox River, WI	Wisconsin Department of Natural Resources	Ended 1987
1983	Lead in gasoline trading/ banking	US EPA	Ended 1987
1983 and later years	Dillon Reservoir, Cherry Creek and Chatsfield Basin, Colorado	Colorado Water Quality Control Commission	Ongoing
1990	Acid deposition; SO_2 Program	US EPA	Ongoing
1994	RECLAIM NO_X/SO_X	SCAQMD	Ongoing

(Source: Journal of Environmental Planning and Management, 1997)

Acid Rain Program: Title IV of the 1990 Clean Air Act Amendments

Since market-based tools for environmental protection were introduced in the United States, there have been primarily six programs at the local level: the U.S. Environmental Protection Agency's (EPA) Emissions trading Program, the leaded gasoline phase down, water quality permit trading, the SO2 allowance system for acid rain control, and the RECLAIM program in the Los Angeles metropolitan region (Stavins and Whitehead 1996).

Under the market-based concept, Title IV of the 1990 Clean Air Act amendments, the so-called Acid Rain Program was established as the first long-term program for emission control. Sulfur dioxide (SO2) was the major target. This program is the first example that changed a fundamental system of air pollution control in the United States. Different from the previous environmental policies that focused on individual sources, the Acid Rain Program focused on aggregating emission levels. Thus, it gave polluters extensive flexibility in choosing how to reduce emissions at specific sources. In addition, the Acid Rain Program that used a cap-and-trade approach, different from the traditional command-and-control approach to controlling pollution emissions.

The Acid Rain Program is called one of the most successful examples of emissions trading programs so far, and was constructed in two Phases. Acid Rain Program was intended to reduce sulfur dioxide and nitrogen oxide emission by 10 million tons and 2 million tons respectively from 1980 levels by the year 2000. The first phase began in 1995 and the second phase was initiated in 2000.

In Phase I, from January 1995 through December 1999, 263 units at 110 mostly coal-fired plants in 21 eastern and midwestern states were included. Later, because an additional 182 units joined Phase I, total of 445 units participated. As a result, emissions data from 1995 indicate that SO_2 emissions were almost 40% below the required level (Figure-5).

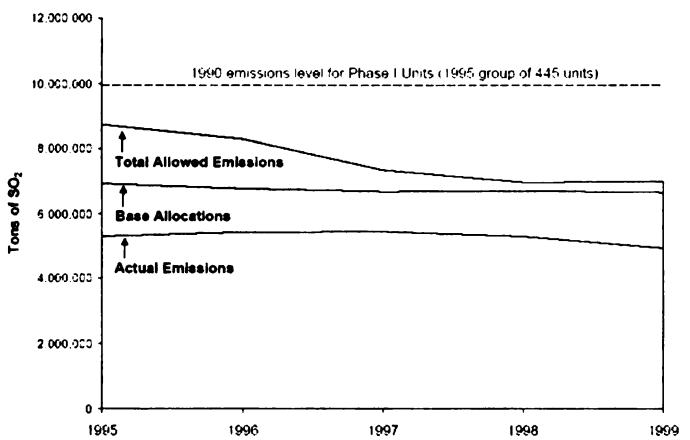

Figure 5: Phase I emissions performance - actual emissions vs. base allocations vs. total allowances (Source: EPA, Acid Rain Compliance Reports)

This graph shows that power plants in Phase I reduced their SO_2 emissions far below the level that was required. However, while 100% program compliance was completed during Phase I, plants reduced SO_2 emissions 22% below the levels of base allowance allocations initially allotted to them by Congress, with 7.3 million tons of extra emissions reductions (Environmental Defense 2000)[15].

It is important to note that despite the reduction of SO_2 emissions over the past years, both electricity generation and the United States economy have had strong growth. Yet, many people are worrying that it is possible to hurt the economy under this flexible method. For example, President George W. Bush did not agree to ratify the Kyoto Protocol because he did not want to hurt the economic situation in the United States (Shim 2003). Therefore, the results present more evidence to disprove the assumption that when economic growth happens, there would be more emissions.

In sum, these are the results of the evaluation in Phase I (Environmental Defense 2000):

- Achieving 100% program compliance during Phase I,
- Distributing the extra reductions in emissions to states whose power plants have participated in Phase I,

[15] From Obstacle to Opportunity: How acid rain emissions trading is delivering cleaner air, Environmental Defense September 2000 and Environmental Defense is a leading national, New York-based nonprofit organization with 300,000 members.(http://www.environmentaldefense.org/home.cfm)

- Emissions reductions can be used as other economic assets.
- The rapid fall in SO_2 emissions did not interrupt strong economic growth during the period.

On the other hand, Phase II began in January 2000 with a cap of 8.95 million tons of SO_2 emissions per year. The cap was set for existing utility units serving generators with an output capacity of over 25 megawatts and all new utility units. Almost all electric power-generating units were brought within the system. If polluters exceed their allowance, a penalty of $2,000 per ton of emissions is leveled. Moreover, the emission amount exceeding the cap should be offset in the next year, and it will continue at that level until 2010 when the cap fixes the permanent level of 8.95 million tons, 50% of electric utility emissions in 1980 (Ellerman 2003).

As a result, the Rain Acid Program has been successful in terms of emission reduction. Not only the SO_2 emission goal was achieved but also it was accomplished on time with lower costs than predicted. It is not a perfect policy but there are several general lessons under this program (Ellerman, Schmalensee, Joskow, Montero and Bailey 2000). For example, compared with the costs under the command-and-control regulatory tools it resulted in cost savings on the order of $1 billion per year (Carlson,

Burtraw (Cropper, and Palmer 2000). SO_2 emissions reduced by 39 percent from 1980 to 2001 (EPA 2002).

The primary compliance tool during Phase I was fuel-switching to low-sulfur coal. Fuel switching was generally considered as the least costly option for meeting emission caps. As EIA (1997) reported, fuel switching was used by 59 percent of the target units to meet SO_2 reductions and fuel gas desulfurization scrubbers were used by 28 percent of target units. The number of allowance transfers, so-called trading levels, increased greatly over time (Schmalensee *et all.* 1998; Stavins 1998; Burtraw and Mansur 1999; Ellerman *et al.* 2000). In 1995, only 613 allowances transferred, but 1,584 allowances were transferred in 1998, and 2,832 allowances were transferred in 1999. Furthermore, the number of allowance transfers increased to 4,900 in 2001 (Dan York 2003).

In other words, experience of the Rain Acid Program has shown that numerous target units did take advantage of the cost-saving flexibility provided by emissions trading. Overall, this market-based tool for environmental management has offered positive results.

Regional Clean Air Incentives Market (RECLAIM)

In the early 1940s, a serious air pollution problem in Southern California was first recognized. As a result of situation, the Los Angeles County Board of Supervisors set up the first local air pollution control district in the nation, and California also established the first agency to control motor vehicle emissions in the mid-1950s. Despite many efforts for the air pollution control since that time, the Los Angeles area continues to experience serious air pollution.

As a solution, the South Coast Air Quality Management District (SCAQMD) has taken extensive steps to clean up the air and the Regional Clean Air Incentives Market (RECLAIM) program was adopted in 1993 (Klier 1997). According to Klier, RECLAIM was an innovative approach to reduce NO_X and SO_X in the Los Angeles basin. RECLAIM was used to "provide facilities with added flexibility in meeting emission reduction requirements and lower the cost of compliance" (SCAQMD 1996). It was also seen as a blueprint, which could replace the traditional command-and-control approach with a market-based approach.

The main idea of RECLAIM was to exchange the air pollution rights between companies by selling and buying shares in an emissions trading market. SCAQMD allocated these emission reduction credits to the companies based on the level of

emissions of NO_X and SO_X (Oil and Gas Journal 1993). Through this program, when companies stay under the limit, they can sell the balance as excess credits. Also, SCAQMD provides financial incentives for companies (See Figure 6).

In addition, emissions trading systems under RECLAIM are also designed to promote dynamic innovations in control technology. RECLAIM forces firms to create new and cheaper emissions control technologies. Firms purchase these technologies to control emission levels and sell excess credits. Also, RECLAIM encourages firms to innovate the type of product produced at a specific location. This helps to encourage a firm to produce a new green product.

As a result, the most important argument in the RECLAIM is the introduction of a quantitative emission cap for a given area. It is a safe guideline against environmental deterioration in economic or population growth. As mentioned previously, the determination of the total volume of feasible emissions is a key element in a successful environmental policy program.

Like the Acid Rain Program, the RECLAIM is a beneficial program for air pollution management both in theory and in practice. In addition, on the political side, the belief in a market system is crucial to steer allocation processes towards socially desirable aims. The RECLAIM is a clear example that emissions trading can be

implemented in practice. To implement this in practice, pragmatic compromises and a more realistic view are necessary. They have certain advantages and disadvantages, and it may not be the best solution. However, by numerous experiences, RECLAIM can be the better idea for environmental management. There are a few key points that can make more efficient RECLAIM program.

- Early involvement in the initiation process: participation of a majority of stakeholders to be a reasonable alternative to the traditional environmental policy approaches.
- Long-term perspective and a definite political will: long-term plan can cope with the challenges of growth process in the economy.
- Although the initiation phase was prepared carefully, there are possible obstacles to be expected: alternatives for details need to be considered and open concepts need to be available to start a public discussion. (Zerlauth and Schubert 1998)

EMISSIONS TRADING: Pros and Cons

Throughout this paper, I have addressed how emissions trading work and what we've learned from past experiences. There are continuous debates between opponents and proponents about the efficiency of emissions trading. Table-5 shows pros and cons about emissions trading. Theses will further help to understand how we should implement emissions trading programs and which items should be considered.

Table-5: Pros and Cons of Emissions Trading

PROS	Cost-effectiveness: it allows companies to purchase emission reductions and the amount of total emission should be remained below agreed levels. Lowering the cost of meeting emission reduction goals (Philibert and Reinaud 2004).
	"Emissions trading or taxes provide a permanent incentive for technology development beyond the legal standard, while command-and-control regulations do not (Stavins 2003)."
	Flexibility: Rather than equalizing pollution levels among firms, market-based methods provide different options to set their emission levels to reduce pollution.
CONS	Ethics Issue: Some critics of emission trading call "the right to pollute." (EPA 2003)

	Unfairness: emission trading favors large companies at the expense of small companies/ the highest emitting facilities have lower cost for reducing emissions. (Ex) U.S. SO2 Allowance Trading Program (EPA 2003)
	Emissions trading do not reduce emissions: it merely shifts the location of existing pollution.
	Easy to cheat: emissions trading will allow companies to avoid their obligations because enforcement and oversight is left to "the market." (EPA 2003)

As mentioned above, some critics say that emission trading has serious flaws. For example, some people argue that it is unfair because companies can buy their way out of their responsibilities to reduce emissions (EPA 2003). Furthermore, some critics argued that emission trading favors large companies at the expense of small companies.

Because emission trading is still an ongoing and developing program it is difficult to say that emission trading has the best benefits for air pollution. However, it is clear that learning from our past experience will give us the right direction for the future policy decisions.

RECOMMENDATION: How to implement emissions trading program in South Korea

Based on the analysis in this paper, we have known that South Korea is attempting to shift from an end of the pipe management regime to precautionary approaches to maximize the effectiveness of environmental policies. Also, people realize that a new direction is needed environmental policy must include the integration of environmental and economic objectives.

Cost-savings has become an important issue for environmental management, therefore, the Ministry of Environment - the main organization of environmental problems in South Korea has begun to seek a foundation for a more scientific and systematic management of air quality. Specifically, emissions trading have become an appropriate tool because of its cost-saving and flexibility reasons. It is also used to foster the manufacture of automobiles that generate fewer pollutant. However, compared to the emission standards that were set up by developed countries, especially in Europe, South Korea's standard lags far behind and needs to be adjusted for more efficient use.

Although emissions trading are at the beginning stage in South Korea, it is clear that emissions trading are a possibility and an appropriate solution for environmental protection that considers both economic and environmental sides. The pilot program of

CO_2 emission program will start from 2005 and gradually emissions trading will be used in numerous fields. Its participants are electric power companies and it will extend to the energy intensive consuming industry from 2005 to 2007. The result of simulation about emissions trading shows some errors in expectation of the markets, and lack of experiences in trading: more education and information are needed. Also, monitoring and verification methodologies needed to be developed (Yoo 2003). While there are several policies for emissions trading like simulation program, there are not enough governmental systems or public understanding toward emissions trading yet.

We have seen numerous evidence that emissions trading programs can achieve cost saving with flexibility and simplicity. However, because it is not always the same as anticipated, lessons from past experiences can help to enforce a new program. Based on U.S. case studies, there are some recommendations for implementation of an appropriate emissions trading program in South Korea. These will help to enforce an emissions trading program.

- Flexibility: It is important to allow for a broad set of compliance alternatives. Banking allowances for the future use in the Acid Rain program was an important factor of this program (Ellerman *et al.* 1997).

- Monitoring and enforcement need: for example, the Acid Rain Program includes continuous monitoring of all sources (Burtraw 1996). Also, penalties that much higher than the marginal cost of abatement and sufficient incentives for emission reduction are needed (Stavins 2001).
- Clear Rules: rules should be clearly defined without ambiguity. According to Rico (1995), the absence of requirements for prior approval has reduced uncertainty for utilities and contributed to low transaction costs in the Acid Rain Program.
- Equity Problems: equity problems should be considered for the allocation of emission permits, differential impact among targeted industries and policy affects to the small size firms (Yoo 2003).
- Low transaction cost: when transaction costs are low, tradable permits will work best (Stavins 2001). According to Stavin, private markets will tend to make transaction cost minimal.
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CONCLUSION

Because most emissions trading programs have been enacted recently, it is hard to draw a conclusion about lessons to be learned from past experiences. As mentioned above, there are several lessons we can consider for an emissions trading program in South Korea. These might not be suitable in South Korea's case, but at least they show the directions where we should go. For example, its impact on technological change is

little known. Therefore, more research about empirical impact is needed in terms of environmental effect and cost-saving effect.

U.S. experiences show that cost-effectiveness and flexibility is the most important subject in emissions trading programs. Traditional command-and-control regulation is inefficient and expensive. It is difficult to manage quality goals in different areas and conditions with uniform standards. Because the costs of controlling emissions are different between industries and situations, holding the same target standards in all industries is inefficient.

Even though we need more research and experiences with implementing an emissions trading program in South Korea, lessons from U.S. experience can be the basic step toward understanding the system of emissions trading. As I mentioned in the recommendation section, consideration about flexibility, equity, monitoring and enforcement can make for better policies. Despite uncertainties, market-based tools have proven successful in the reduction of pollution cost, and they have moved center of environmental management tools. Although there are debates that emissions trading are characterized as licenses to pollute, all the other aspects such as flexibilities and cost-saving are the reasons why people are interested in an emissions trading program (Stavins 2001).

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