

**International Experience:
Incorporating Environmental Costs in Prices**

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INTRODUCTION¹

China is moving forward with power sector reforms that will result in competition between generators. A fundamental precondition of any market is that all costs be reflected in prices. If electricity generation becomes competitive and the cost of emissions/environmental degradation is not reflected in prices, the result will be in increased pollution.

In China, the cost of pollution (cost of health care, agricultural losses, resource degradation and resource depletion) and the cost of electricity will be determined by what plants get built, what plants get operated, how much is invested in pollution control, and how much is invested in energy efficiency. Fully incorporating the environmental cost of pollution in electricity prices is the best way to ensure that the total cost (environmental cost and electricity cost) is minimized.

Societies have struggled and experimented with the concept of internalizing external costs since it was described by A. C. Pigou over seventy years ago. There is significant international experience with a variety of strategies designed to make prices of goods and services reflect their true costs. These strategies are revised and refined often, as people learn from their mistakes and improve their understanding of how the market, the environment, public policy, and human behavior interact.

This paper will present case studies that may be useful as China prepares to reform the power market. The massive increase in the generation of electricity in China during the last 20 years has already resulted in many environmental problems. These new power reforms provide the opportunity to both reduce damage to the environment caused by electrical generation and increase the amount of electricity generated by renewable, sustainable methods.

1 CASE STUDIES

1.1 Overview

Recently many nations have moved from using regulations alone to curb pollution, to the use of economic instruments to internalize environmental costs. "Economic instruments, in theory, have all the efficiency properties of competitive market pricing: they trigger actions both among producers and consumers that allow the achievement of given environmental objectives at the lowest costs. The efficient nature of economic instruments is due to the flexibility given to the polluters for devising a cost effective compliance strategy."²

¹ The author gratefully acknowledges the assistance of the following persons who directed the author to valuable resources for this paper: Dr. Thomas Tietenberg, Professor, Colby College, Waterville, Maine; Ellen Baum, Richmond, Maine; and David Moskovitz, Regulatory Assistance Project, Gardiner, Maine. The author also thanks Elizabeth Heath for her patient introduction to the computer resources of the Regulatory Assistance Project.

² <http://www.rec.org/REC/Programs/SofiaInitiatives/EcoInstruments/sourcebook.html#2>

The challenge is to move from theory to practice. "The polluter pays" describes one clear mechanism for internalizing environmental costs. China's pollution levy system is a well-known example of this concept. Yet, China is still impacted by unacceptable levels of pollution. No country has developed the perfect system yet to balance the desired quality of life with environmental sustainability. However, sharing international experiences and instituting reforms can make progress made toward this goal.

In each example discussed in this paper, economic instruments are used in an attempt to internalize costs and therefore, to change the polluter's impact on the environment in a positive way. Levies, taxes or charges are placed upon resources used or the resulting waste so that pollution is lowered and resources used efficiently, or to collect money to pay for the damages. Deposits are charged and refunded to encourage environmentally sound disposal of materials. Rules and regulations are enacted to cap the emissions of pollutants. Then emissions permits are traded, minimizing the cost of reaching the emissions targets.

These attempts were often impacted by conflicting goals, lack of knowledge or unforeseen consequences. Issues of fairness, politics, technical feasibility, or other market goals might dilute the strategy's impact. It might take years of experience to determine what amount of levy is high enough to produce the desired outcome. The market might respond in an unexpected and undesirable manner that necessitates quick reform. "Only a few dozen standouts have been implemented with tax rates high enough or permit caps tight enough to do much environmental good, but these few have provided evidence of the effectiveness of the approach when properly pursued."³

The following case studies will describe strategies with positive outcomes, as well as a few topics of caution.

1.2 Pollution levies, charges, taxes

1.2.1 Description

This strategy has many names, but the result is the same. The producer and/or consumer pays when materials or processes are used that cause pollution. These fees are attractive because they create a very explicit charge for pollution. As a result, savings from reducing pollution are tangible.

At a minimum, this strategy raises money. The funds may be used to raise revenue for the general budget, to support environmental activities, to offset other taxes, or for other purposes. If the charges are high enough, levies and taxes can result in incentives to increase the efficient use of resources and reduce pollution. If they are high enough and conflicting subsidies are removed, they may result in the full internalization of environmental costs, and the market will move toward more sustainable uses of resources.

³ David M. Roodman, *The Natural Wealth of Nations: Harnessing the Market for the Environment* (New York, N.Y.: W.W. Norton and Company, 1998, Page 23)

Pollution levies, charges and taxes appear internationally in a variety of forms. The consumer may pay when purchasing a product if the pollution is too dispersed to measure (e.g. motor fuel). The charge may be on the use of raw materials with predictable pollution results (e.g. carbon tax, some sulfur taxes). The charge may differentiate between similar materials with different polluting characteristics (e.g. leaded vs. unleaded gasoline). The charge may be levied at discharge based on the volume or toxicity of effluent or emissions (e.g. NOX, solid waste, sewage).

1.2.2 Malaysia: effluent taxes

Problem: During the 1970's, the effluent from palm oil mills in Malaysia was killing important fisheries, contaminating drinking water and producing an unbearable stench in some areas.

Goal: To reduce water pollution and restore the fisheries.

Strategy: By 1977 the Department of Environment developed discharge standards that would become stricter with time, and imposed a two-part fee on mill effluent. The fee was composed of a constant charge per unit of effluent and an additional fee that increased with the oxygen depleting ability of the discharge.

Result: In response to the fees the industry developed new treatment technologies, developed commercial uses for waste products and even recovered methane in the process. By 1991, seventy five percent of mills were in compliance with the Biological Oxygen Demand(BOD) regulations. Ninety-eight to one hundred percent were in compliance with pH and nitrogen standards. Despite a three-fold increase in palm oil production, the BOD of emissions was less than 1 percent of its mid-1970s level.⁴

Issues: There is some concern that fees have not risen enough in recent years to pressure further improvements. The Department of Environment needs more funding for staffing, training, surveillance, monitoring and enforcement.⁵ . Some palm oil companies are looking to expand in countries with less regulation.⁶

1.2.3 Denmark: Solid Waste Tax

Problem: Limited landfill space and increasing solid waste.

⁴ *Integrating Environmental Considerations Into Economic Policy-Making Processes* @ <http://www.unescap.org/drpad/publication/integra/volume3/malaysia/3my000ct.htm>

⁵ *Integrating Environmental Considerations Into Economic Policy-Making Processes* @ <http://www.unescap.org/drpad/publication/integra/volume3/malaysia/3my000ct.htm>

⁶<http://amazonia.net/Articles/174.htm>

Goal: To increase the incentive to reduce waste, increase recycling and reuse, and promote more desirable disposal technologies (heat and power generation instead of landfills). Also, to generate revenue.

Strategy: A waste tax, based on weight, was placed on the disposal of non-hazardous wastes beginning in 1987. This tax was in addition to any municipal disposal charges. The charge varied with disposal site. Landfill taxes were the most expensive (\$48.60/T). Incinerators with heat recovery were less. Disposal at incinerators with heat recovery and electrical generation was the least costly tax (\$30.45/T).

Result: From 1987-1997 there was a 26% reduction in waste collected. From 1991-1995 the recycling and reuse of construction materials increased over 100%. Composting increased. The recycling of paper and cardboard went up 77%; glass recycling increased more than 50%.⁷

Issues: All improvements cannot be traced to the tax. During this same time access to recycling centers improved as rules made recycling of some materials mandatory. Other countries might have issues with illegal disposal. There is some evidence that some construction materials are being re-used improperly to avoid disposal costs.

1.2.4 Netherlands: water pollution tax

Problem: water pollution

Goal: To fully finance the costs of water purification.

Strategy: For large companies, the formula for the charge was based directly on the pollution load of discharges as measured by the biological-oxygen demand and heavy metals. Small companies and residential users paid a set amount. The charge program was administered regionally, clearly understood and rose gradually over time.

The levies vary regionally depending on a variety of factors. Water quality standards are higher in water catchment areas. Investment costs will be lower in a region where treatment plant costs are already depreciated. Large volumes of discharge with concentrated pollutants can sometimes be treated at a relatively low cost. Levy rates have continued to increase. As the volume of pollutants drops, the fixed costs per unit of discharge increases. The rising rates have continued to provide an incentive to decrease pollutants.

Result: Companies were not told how to reduce emissions but responded in a variety of ways. Efficiency was improved, new technologies were invented, consumers switched to less pollution intensive products and the Netherlands became a global leader in pollution

⁷ Casey Hufnagel, "National Taxes and Waste Reduction (Denmark)", from *Executive Summaries @* <http://www.colby.edu/personal/t/thtieten/swm-den.html>

control equipment. The result was a 72-99 percent reduction in industrial water pollutant emissions from 1976 to the mid-1990's.⁸

1.2.5 Vietnam: coal mining tax

Problem: Coal mining pollution decreasing tourism appeal.

Goal: To provide funding for pollution control.

Strategy: Tariffs on coal production were used to establish an environmental fund. Resources from the fund were made available to different mining companies for pollution control activities.

Result: Coal producers internalized some of the environmental damage costs associated with mining activities. The funds were primarily used to finance environmental improvements in Quang Ninh province, where open-pit coal mining had a negative impact on the tourism potential of neighboring Halong Bay.⁹

1.2.6 European Union: Carbon/Energy Taxes

1.2.6.1 Overview

Many countries of the European Union, individually, have been taxing raw materials, emissions, energy and electricity for over a decade. The goals of each specific plan have been varied, and their designs have been complicated and customized to meet each country's needs. "Other general features of implemented carbon/energy taxes are the following:

- They are only one instrument in a package of measures aimed at reducing emissions.
- They are often part of a general fiscal reform, by replacing other taxes on energy and by reducing the distorting impacts of traditional taxes (e.g. on labor and capital).
- They are usually gradually phased-in and adjusted over time to account for inflation.
- Exemptions and exceptions have been granted to energy-intensive industries or to industries facing international competition."¹⁰

⁸ David M. Roodman, *The Natural Wealth of Nations: Harnessing the Market for the Environment* (New York, N.Y.: W.W. Norton and Company, 1998, p.177); <http://iisd1.iisd.ca/greenbud/nether.htm>; World Bank Group, *Pollution Prevention and Abatement Handbook 1998* @ <http://lnweb18.worldbank.org/essd.nsf/Docs/PPAH>

⁹ <http://iisd.ca/susprod/displaydetails.asp?id=74>

¹⁰ Andrea Baranzini, Jose Goldemberg, Stefan Speck, *Are Carbon Taxes an Alternative to Prevent Climate Change?* International Academy of the Environment, Geneva, Switzerland, 1998 @ <http://ecolu-info.unige.ch/~barazin/WP/AIE-BP04.pdf>

The European Union did reduce their greenhouse gas emissions from 1990-2000.¹¹ Although these reductions cannot be attributed to their energy taxes alone, their experiences and experiments are worth studying. In this paper we will examine the European experience with energy taxes through two different lenses. First we will look at a few discrete tax/charge programs, to illuminate possible mechanisms. Then we will look at “Environmental Tax Reform” (ETR). This is the name given to measures taken specifically to shift the burden of taxation from desirable activities, like labor and investment, to undesirable activities, like pollution and resource depletion.

1.2.6.2 Finland: CO2 tax

Strategy: Finland implemented the world's first environmentally motivated carbon dioxide (CO2) tax in 1990. The rate was originally based on the fuel's carbon content. From 1994-1996, it was based on both the carbon and energy content. Since 1997 it has been based solely on carbon content, except for electricity, which is based on Megawatt hours.

Result: By 1998, the country's CO2 emissions had dropped by almost 7 percent.¹²

Issues: In order to stay internationally competitive, Finland's tax burden rests more on households and the service sector than on industry. Originally coal-generated electricity was highly taxed with the goal of promoting fuel-switching, but European Union realities compel Finland now to tax electricity itself, not its origin.¹³

1.2.6.3 Sweden: Sulfur charge/rebate scheme (“feebate”)

Strategy: Sweden instituted a high tax on the sulfur content of fuels, such as diesel fuel, heating oil, coal, and peat. They chose to charge the product rather than emissions. The burden of proof was on the polluter to show a demonstrated reduction in emissions over time. Documented reductions resulted in a rebate to the user. This program had the advantage of low administrative costs and high transparency.

Results: decreased emissions from the use of coal and peat and a decrease in the sulfur content of oil used.¹⁴

1.2.6.4 Sweden: NOx charge/rebate scheme

¹¹ Bernd Guegele, Manfred Ritter, *Annual European Community Greenhouse Gas Inventory 1990-2000 and Inventory Report 2002*, EEA, Copenhagen, 2002 @ http://www.eea.eu.int/technical_report_2002_75/en

¹² Bernie Fischlowitz-Roberts, “Restructuring Taxes to Protect the Environment”, *Earth Policy Institute Updates*, 2002 @ <http://www.earth-policy.org/Updates/Update14.htm>

¹³ J. Andrew Hoerner, Benoit Bosquet, *Environmental Tax Reform: the European Experience*, Center for a Sustainable Economy, Washington, D.C., 2001 @ <http://www.sustainableeconomy.org/eurosurvey.htm>

¹⁴ World Bank Group, *Pollution Prevention and Abatement Handbook 1998* @ <http://lnweb18.worldbank.org/essd/nsf/Docs/PPAH>

Strategy: In this case actual emissions of NO_x were charged. The target group was large energy users including power and heat producers, pulp and paper plants, chemical and metal processing plants. The money was rebated back to the users depending upon the ratio of final energy output to emissions. As a result this system built in a strong incentive to use fuel efficiently. The program was announced in 1990 and implemented in 1992.¹⁵

Result: Many plants started to reduce emissions in 1990 so that their charges would be as low as possible when the program started. Emissions by the target group dropped 50%. Innovations led to lower cost emissions monitoring equipment. Sweden extended the program to smaller companies in 1996.¹⁶ In some cases plant operators were given a salary bonus for low NO_x emissions.

Issues: Since only a fraction of Swedish companies are liable for this charge or refund, the refunding mechanism is seen as making it fairer. The rebate was seen as a way to reduce NO_x emissions while retaining the overall industrial sector's competitiveness.¹⁷

¹⁵ World Bank Group, *Pollution Prevention and Abatement Handbook 1998* @ <http://inweb18.worldbank.org/essd.nsf/Docs/PPAH>

¹⁶ David M. Roodman, *The Natural Wealth of Nations: Harnessing the Market for the Environment* (New York, N.Y.: W.W. Norton and Company, 1998)

¹⁷ <http://iisd1.iisd.ca/greenbud/nitro.htm>

1.2.6.5 Table of Emission Charges

Overview of Selected Emission Taxes/Charges in Selected European Countries
(1999/2000)

(Source: taken from Speck et al, 2000¹⁸)

Country	EUR per ton SO ₂	EUR per ton Nox
European Union Accession Country ¹⁹		
Czech Republic	27 (EC) 40.5 (NC)	22 (EC) 33 (NC)
Estonia	2.9 (EC) 29 (NC)	6.7 (EC) 67 (NC)
Poland	80 (EC) 800 (NC)	80 (EC) 800 (NC)
Slovakia	22.7 (ET)	18.2 (ET)
Denmark ²⁰	2700 EUR/ton S (PT) 1340 (ET)	0
France	27.4 (ET)	38.1 (ET)
Italy	53.2 (ET)	105 (ET)
Sweden ²¹	3470 EUR/ton S (PT)	4630

Notes: (ET) Emission Tax; (EC) Emission Charge; (NC) Non-compliance fine per unit emissions above permitted level; (PT) Product Tax.

1.2.6.6 European Environmental Tax Reform (ETR)

1.2.6.6.1 Overview

“‘Environmental tax reform’ (ETR) refers to measures that use the revenue from taxes on pollution or natural resource depletion to lower taxes on valuable economic activities, such as employment or investment.”²² Depending upon a country’s goals, the

¹⁸ Stefan Speck and Paul Ekins, *Update of Database of Environmental Taxes and Charges*, Forum for the Future, London, 2000 @ http://europa.eu.int/comm/environment/enveco/env_database/delivery.pdf

¹⁹ Revenues from emissions charges and fines in Czech Republic, Poland and Slovakia are earmarked for environmental expenditure via national or regional environmental funds. Estonia earmarks revenues within the central budget.

²⁰ Denmark’s SO₂ tax levied either on energy products (product tax based on sulphur content of the fuel) or emission tax (levied on actual SO₂ emissions)

²¹ Sweden’s product tax on sulphur is for coal and other solid fuels.

²² J. Andrew Hoerner, Benoit Bosquet, *Environmental Tax Reform: the European Experience*, Center for a Sustainable Economy, Washington, D.C., 2001 @ <http://www.sustainableeconomy.org/eurosurvey.htm>

environmental taxes can raise more, less or the same amount of money as the amount by which other taxes are reduced.

In a recent study, eight European countries' experience with ETR was examined in detail. Over 100 simulations of ETR impacts were analyzed. The authors concluded that ETR boosts employment, especially when environmental tax revenues allow payroll taxes to be cut. ETR can cut greenhouse gas emissions and promote a cleaner environment. At the same time ETR can result in very little change in the economy as measured by gross domestic product (GDP). The authors found ETR was most likely to have positive employment and GDP results when some of the environmental tax revenues are used to finance energy efficiency or renewable energy options.²³

It should be noted that most countries that have adopted ETR have adopted many other measures to promote cleaner technologies and discourage pollution at the same time. Also, the amount of revenue shifted through ETR is often less than the amount raised by environmental taxes. For instance, the Netherlands raised over 9% of total tax revenue from environmental taxes in 1997, but shifted only 0.5% of total tax revenues through ETR.²⁴

ETR is a very recent phenomenon and there is very little empirical data available to judge its effectiveness at this point in time. Here are several examples of ETR experiences that are quite different from each other:

1.2.6.6.2 Germany

The German ETR began in 1999 and will have at least five stages. They are in stage two now. Energy taxes on gasoline, heating oils, motor fuel, natural gas, and electricity have been raised. Employer and employee contributions to the pension fund have been cut. Energy taxes for many energy-intensive industries have been kept relatively low, due to concerns about international competition. Energy efficient co-generation plants are exempt from petroleum product taxes.²⁵

Tangible results so far: motor fuel sales were 5 percent lower in the first half of 2001 than in the same period in 1999, and carpool agencies reported growth of 25 percent in the first half of 2000. Germany has shifted 2 percent of its employment tax burden to taxation of environmentally destructive activities.²⁶

1.2.6.6.3 United Kingdom (UK)

²³ J. Andrew Hoerner, Benoit Bosquet, *Environmental Tax Reform: the European Experience*, Center for a Sustainable Economy, Washington, D.C., 2001 @ <http://www.sustainableeconomy.org/eurosurvey.htm>

²⁴ J. Andrew Hoerner, Benoit Bosquet, *Environmental Tax Reform: the European Experience*, Center for a Sustainable Economy, Washington, D.C., 2001 @ <http://www.sustainableeconomy.org/eurosurvey.htm>

²⁵ J. Andrew Hoerner, Benoit Bosquet, *Environmental Tax Reform: the European Experience*, Center for a Sustainable Economy, Washington, D.C., 2001 @ <http://www.sustainableeconomy.org/eurosurvey.htm>

²⁶ Bernie Fischlowitz-Roberts, "Restructuring Taxes to Protect the Environment", *Earth Policy Institute Updates*, 2002 @ <http://www.earth-policy.org/Updates/Update14.htm>

ETR in the UK involves a unique set of reforms. A landfill tax, begun in 1996, lowers employers' social security contributions. This tax increases with a built in escalator until 2004.

Another steadily increasing tax, in effect from 1993-1999 on motor fuels, was known as the fuel duty escalator. During its reign, fuel consumption used for road transportation dropped, and the average fuel efficiency of trucks over 33 tons increased by 13 percent. It raised close to GBP 1 billion in its third year and may have reduced carbon emissions by 2-3 megatons. The program was scrapped after complaints by truckers, and replaced with annual energy taxes earmarked for regional and public transport use.

In 2001 the UK adopted a CO₂ levy on commercial and industrial energy users that will provide additional offsets to employers' social security contributions. This program is full of exemptions, discounts and trading schemes to promote industrial efficiency and competitiveness. The UK expects to raise about GBP 1 billion and avoid the emission of 2 megatons of carbon annually.

Finally, a tax on virgin aggregate depletion (sand, rock, and gravel) will finance a national remediation fund for abandoned mines and quarries and reduce employer social insurance contributions.²⁷

1.2.6.6.4 The Netherlands

The Dutch recycle energy taxes in several ways. Two will be discussed here.

The general fuel tax taxes both the energy and carbon content of fuels. The tax is collected on all fossil fuels except those used as raw materials. Nuclear power is also taxed. The revenue becomes part of the general budget.

The regulatory tax on energy (RET), begun in 1996, was specifically designed to change the behavior of small energy users through improved energy conservation and efficiency. Large users are covered by other taxes, agreements or exemptions, so this tax falls primarily on individuals and small businesses. The RET is a CO₂ tax based on the CO₂/energy content of natural gas, electricity, fuel oil, and heating oil. 800 kWh per year are allowed tax free for fairness.²⁸

The RET is supposed to be revenue neutral. Taxes are recycled back to households and businesses by cutting personal income taxes, employer contributions to social security, and corporate income taxes.

²⁷J. Andrew Hoerner, Benoit Bosquet, *Environmental Tax Reform: the European Experience*, Center for a Sustainable Economy, Washington, D.C., 2001 @ <http://www.sustainableeconomy.org/eurosurvey.htm>

²⁸ J. Andrew Hoerner, Benoit Bosquet, *Environmental Tax Reform: the European Experience*, Center for a Sustainable Economy, Washington, D.C., 2001 @ <http://www.sustainableeconomy.org/eurosurvey.htm>

The RET has increased household energy costs. As a result electricity use has decreased 15 percent and fuel usage has decreased 5 to 10 percent.²⁹

1.2.7 Issues with Pollution Taxes, Charges, Fees, and ETR

Although pollution levies always raise some revenue, they do not necessarily meet their policy goals. Other government or social institutions may neutralize or dilute their impact. Funds earmarked for pollution abatement may not raise adequate revenues to do the job. Tax programs expected to change the behaviors of polluters may not provide enough incentive, or be enforced strongly enough, to produce change.

In Argentina, courts declared the decree creating pollution levies unconstitutional.³⁰ In Hungary, vehicle emission fines were not enforced. Inflation and evasion reduced the value of other pollution charges.³¹ In Russia, some charges were so low that polluters chose to pay fines rather than reduce pollution. Exemptions, waivers and legal loopholes were used to satisfy local political concerns or to avoid putting inefficient companies out of business. Earmarked funds were used for non-environmental purposes.³² In many countries, including Russia, reliable monitoring and inspection capabilities are inadequate.³³

In France, funds for water purification were tied to water pollution taxes. The tax rate was so low that revenues could not pay for necessary abatement.³⁴ In Germany, and other countries, the subsidy for coal erode the impact of levies.³⁵

The design of ETR systems will determine their effectiveness. “The weight of economic evidence suggests that, for most economies, elements of good design include a labor tax reduction, ideally targeted at lower-wage workers to maximize employment benefits and offset distributional problems; policies to protect the competitiveness of energy-intensive industries; measures to prevent a wage-price inflationary spiral; policies to promote the development and diffusion of new cost-effective clean technologies; and policies to compensate low-income households outside of the workforce.”³⁶

Exemptions and discounts given to energy-intensive industries slow the impact of pollution taxes and ETR. These tax breaks are often given due to legitimate concerns about international competitiveness. Presently carbon and energy taxes vary significantly

²⁹ Bernie Fischlowitz-Roberts, “Restructuring Taxes to Protect the Environment”, *Earth Policy Institute Updates*, 2002 @ <http://www.earth-policy.org/Updates/Update14.htm>

³⁰ Joachim von Amsberg, *Selected Experiences with the Use of Economic Instruments for Pollution Control in non-OECD Countries*, 1995 @ <http://ourworld.compuserve.com/homepages/jvonamsberg/econw.htm>

³¹ <http://www.rec.org/REC/Publications/PaperSeries/Paper1/principles.html>

³² <http://src-h.slav.hokudai.ac.jp/sakhalin/eng/nikitina.html>

³³ Kseniya Lvovsky cited in World Group Discussion Paper No. 381 @ http://www.worldbank.org/nipr/work_paper/huber/huber2.pdf

³⁴ <http://www.rec.org/REC/Publications/PaperSeries/Paper1/principles.html>

³⁵ David M. Roodman, *The Natural Wealth of Nations: Harnessing the Market for the Environment* (New York, N.Y.: W.W. Norton and Company, 1998, p.74

³⁶J. Andrew Hoerner, Benoit Bosquet, “Environmental Tax Reform: the European Experience”, Center for a Sustainable Economy, Washington, D.C., 2001 @ <http://www.sustainableeconomy.org/eurosurvey.htm>

from country to country. It is possible that using border tax adjustments might improve competitiveness while allowing tax systems to internalize environmental costs. Border tax adjustments allow companies to have taxes rebated to them upon export of their product and the taxes are added on to similar imports.

The following table illustrates the variability of energy taxation in a small sample of countries. Actual environmental costs do not shape these charges. Instead they reflect political, social, economic and traditional practices and concerns.

1.2.7.1 Taxes on Different Energy Products, in Purchasing Power Parity (\$PPP/ton CO₂)³⁷

(Source: taken from Baranzini et al, 1998³⁸)

Country	Petrol (gasoline unleaded)	Diesel	Diesel/Gas Oil (industrial use)	Coal (industrial use)	Natural Gas (industrial use)
Denmark	164	95	72 (69-63) ³⁹	67 (63-56)	15 (11-3)
Finland	232	113	19	14	15
France	245	129	27	0	1
Germany	205	109	14	0	17
Netherlands	242	117	36	5	29
Norway	216	140	16 (8) ⁴⁰	19	49
Spain	203	124	36	0	4
Sweden	189	103	64 (19) ⁴¹	52 (19)	56 (22)
Switzerland	148	129	1	0	0
UK	261	224	14	0	0
USA ⁴²	42	40	na ⁴³	na	na
Japan ⁴⁴	133	43	1	na	12 (4)

Source: adapted from Speck 1998a

³⁷ Tax rates for European countries are for 1998 in national currencies and then converted with 1997 purchasing power parities (PPP) 1997 (PPP source: OECD Main Economic Indicators July 1998, Paris)

³⁸ Andrea Baranzini, Jose Goldemberg, Stefan Speck, *Are Carbon Taxes an Alternative to Prevent Climate Change?* International Academy of the Environment, Geneva, Switzerland, 1998, p. 5 @ <http://ecolu-info.unige.ch/~barazin/WP/AIE-BP04.pdf>

³⁹ Tax rate is for light processes and heavy processes.

⁴⁰ Tax rate is for gas oil used in the pulp and paper industry.

⁴¹ Tax rate is for energy products used in the manufacturing industry and greenhouse horticulture sector.

⁴² Figures for USA: 1996 (source OECD/IEA: *Energy Prices and Taxes*. Paris, 1997).

⁴³ na: not available

⁴⁴ Figures for Japan: 1996 for petrol and diesel; 1995: gas oil; 1994 natural gas (source OECD/IEA: *Energy Prices and Taxes*. Paris, 1997). Japan has a general petroleum excise tax on all crude oil refined in Japan: rate was 1996 2040 yen/1000 l-12.1 \$PPP/1000 l (this figure is not included in the above table).

1.3 Deposit-refund Systems

1.3.1 Overview

A deposit-refund system always involves some form of charge for a product or action combined with a subsidy or refund upon the proper recycling or disposal of the product, or completion of the action. Deposit-refund programs usually involve items whose improper disposal would cause environmental harm and be difficult to monitor. Some of their uses have included beverage containers, batteries, appliances, tires and pesticide containers. “Several studies have concluded that deposit systems are more cost-effective than other methods of reducing waste disposal, such as traditional forms of regulations, recycling subsidies, or advanced disposal fees (ADF) alone.”⁴⁵

1.3.2 US: Bottle Bills and Lead-acid Batteries

Some states in the US have deposit-refund systems for beverage containers. Generally the consumer pays the retailer a deposit fee of \$.05-\$.10 per container. This deposit is refunded when the consumer returns the container to the retailer or a redemption center. Recent data on ten states with similar programs show redemption rates generally in the 80-90% range. In Oregon there was a 75-85% decrease in roadside litter. In addition, states with deposit-refund systems show a relatively high market share for refillable containers, compared to states without such programs (3x the national average).

A similar program involves lead-acid (vehicle) batteries. Consumers pay a deposit of \$5-\$10 upon purchase of the battery. This is refunded when the used battery is returned to the same retailer with proof of purchase. “The percentage of battery lead that has been recycled nationwide has exceeded 90% since 1988.”⁴⁶

1.3.3 Environmental Performance Bonds

An environmental performance bond is a form of deposit-refund system where a potential degrader of the environment has to pay into an escrow account before proceeding with an activity, such as coal ⁴⁷mining. In the US, certain laws require companies to deposit money before extracting certain natural resources (e.g. the Surface Mining Control and Reclamation Act). The money will only be refunded when the extractor fulfills obligations such as reclamation activities. To be effective, the deposit amount has to be enough for the regulatory authority to complete the reclamation if the company forfeits the deposit. Generally there are two incentives in this program: an economic incentive (getting the deposit back) and a regulatory incentive (satisfying this bond in order to be eligible for extraction permits in the future).

⁴⁵ National Center for Environmental Economics, *The United States Experience with Economic Incentives for Protecting the Environment*, USEPA, Washington, D.C., 2001, p.57

⁴⁶ National Center for Environmental Economics, *The United States Experience with Economic Incentives for Protecting the Environment*, USEPA, Washington, D.C., 2001, p.64

⁴⁷ National Center for Environmental Economics, *The United States Experience with Economic Incentives for Protecting the Environment*, USEPA, Washington, D.C., 2001, p. 66

1.3.4 Potential Problems

There are potentially high administrative and transaction costs involved in these programs. In addition, of course, disposal, reuse or recycling of the returned materials must be arranged. Deposit-refund programs often have difficulty due to design flaws and need to be refined. The Republic of Korea instituted a deposit refund system in 1992. It required producers and importers to pay deposits on a wide variety of packaging, appliances, tires, batteries and lubricants. The deposit was paid into a "Special Account for Environment Improvement." The companies were reimbursed by the Account according to their success in collecting and treating their wastes. "In general, the deposit-refund system failed to motivate manufacturers to collect and treat waste because the deposit was much less than the cost for collection and treatment of wastes. Therefore, manufacturers found it more economic to forfeit deposits than recycle."⁴⁸ The Korean Ministry of Environment hopes the gradual increase in deposit amounts will lead to improved participation in the program.

Note: There were some modest successes in Korea. After a recovery and recycling system for metal cans was developed by producers, refunds rose from 13.7% (in 1995) to 29.3% (in 1996) of the total deposits. Also, the higher deposit on cans with removable tabs resulted in an increase in cans with push-in typed tabs and a decrease in the removable tab cans.

1.3.5 Marketable Permits

1.3.5.1 Overview

Taxes set a price for pollution and the market decides how much pollution will be cut. Instead of taxing, a government can decide to set a target limit on pollution or resource depletion, then distribute permits for those activities. In a permit trading system, the market determines the price. A company that is unable or unwilling to live with its limits then has to buy permits from those who overcomply.

As companies compare their marginal abatement cost with the cost of a permit, market activity will take place to reach the lowest possible combined cost. As a result trading systems can cut compliance costs, create incentives to overcomply with regulations and support development of new technology.⁴⁹

Often the initial use of tradable permits has been when countries are very serious about reaching pollution abatement goals (e.g. SO₂) or reduced resource depletion goals (e.g. New Zealand fisheries) very quickly.⁵⁰ The combination of regulation with market

⁴⁸ http://www.ilsr.org/recycling/ftao/ftao41_krderesys.html

⁴⁹ National Center for Environmental Economics, *The United States Experience with Economic Incentives for Protecting the Environment*, USEPA, Washington, D.C., 2001

⁵⁰ David M. Roodman, *The Natural Wealth of Nations: Harnessing the Market for the Environment* (New York, N.Y.: W.W. Norton and Company, 1998, p.158

behavior has been very effective. In the US, the production of CFCs (chlorofluorocarbons) was virtually eliminated in less than 6 years through a trading program.⁵¹

1.3.5.2 US: SO₂

Problem: SO₂ emissions causing acid rain and subsequent health and ecosystem damage.

Goal: Reduce emissions by 2000 to 50% of the 1980 level.

Strategy: A 1990 cap-and-trade program for sulfur dioxide emissions from large power plants (expanded to other industries in 1995). Individual utilities have flexibility to choose compliance methods. Due to political considerations permits were granted proportional to previous emissions behavior, rather than auctioned off. Companies can use their permits to pollute, sell them to others, or bank their permits for future use or to sell to newcomers to the market. At the end of each year companies must have enough permits to cover their emissions or they incur stiff fines.

Results: The program exceeded its reduction goal at less than half the projected price. Although trading volume has been high, the cost of permits has been much lower than anticipated. "Cutting emissions...has proved far cheaper than almost anyone expected, so companies have been unwilling to spend much in the permit market to emit more."⁵²

1.3.5.3 Issues

Unless allowances are made, permit systems based on prior use can favor significant prior polluters and keep new, more efficient companies out. The geographic boundaries of the permit system need to be drawn to reflect environmental concerns. Seasonal factors may be relevant. For example if major health impacts due to NO_x peak during the summer months, emissions reductions have to be structured to occur during that time as well. Administrative and transaction costs should be minimized.

Marketable permits have established themselves as cost-effective methods to reach environmental goals. They have been used in recent years to eliminate the use of leaded gasoline and CFCs (chlorofluorocarbons), to reduce nitrous oxides (NO_x) and particulates, to reinvigorate fisheries, and to restrict land development.

“Worldwide trading of credits in carbon dioxide emissions linked to global warming is poised to more than triple this year to an estimated 67 million tonnes as companies prepare for the Kyoto treaty to limit carbon pollution, the World Bank said...Emissions

⁵¹ National Center for Environmental Economics, *The United States Experience with Economic Incentives for Protecting the Environment*, USEPA, Washington, D.C., 2001

⁵² David M. Roodman, *The Natural Wealth of Nations: Harnessing the Market for the Environment* (New York, N.Y.: W.W. Norton and Company, 1998, p.153

trading has been ramping up in Britain, Denmark, Japan and the European Union as companies that curb emissions of heat-trapping carbon try to cash in.”⁵³

1.4 Economic Instruments Promoting Renewable Energy Strategies

1.4.1 Overview

Most societies continue to subsidize water use, motor transport, petroleum product combustion and raw material extraction tomorrow. How can new, renewable, energy producers compete economically with the status quo? Countries continue to experiment with strategies that reach social goals and make economic sense. Grants, loans, subsidies, and other programs for new technologies may look inviting. However, this support must be balanced to encourage the new technologies to become efficient and cost-effective as well.

Here are several examples of different economic instruments being used to increase the amount of electricity generated by renewable sources of energy.

1.4.2 Tax-Subsidy: Australia's Renewable Remote Power Generation Program

Problem: Unreliable, fossil-fuel-based electrification in remote areas of Australia. Some residents have no electricity.

Goal: To reduce the use of diesel fuel, increase the use of renewable energy and improve access to electrification for remote users.

Strategy: Diesel fuel used to generate off-grid electricity is taxed. The taxes are used for rebates for conversion to renewable energy technologies, primarily solar, in remote areas of Australia. Use the increased demand for technology to develop and improve the renewable energy industry.

Results: The program just started in July 2000. Up to \$264 million is expected to be available over the four-year life of the program.⁵⁴

1.4.3 Systems Benefit Charge: UK (NFFO)

Problem: Pollution related to combustion of fossil fuels.

Goals: To reduce overall greenhouse gas emissions. To increase the security of energy supplies by increasing diversity. To stimulate an internationally competitive renewable energy industry.

⁵³ Julie Vorman, Reuters News Service, 2002 @ <http://www.planetark.org/dailynewsstory.cfm?newsid=18244&newsdate=21-Oct-2002>

⁵⁴ <http://www.greenhouse.gov.au/renewable/initiatives.html>

1993 goal: to produce 1,500MW from renewables by 2000.
Amended goal: to produce 10% of UK supply by 2010.

Strategy: To increase the amount of electricity generated by renewable resources through a systems charge that funds a combination of renewable resource generation obligations, competitive bidding, and long-term contracts. The Non-Fossil Fuel Obligation (NFFO) statute under the Electricity Act of 1989 allows the government to require the 12 regional electricity companies to procure a specified amount of generation capacity from non-fossil fuels (including nuclear and renewable resources). The law also allows costs to be met through a levy on customers.

In practice, the government has issued obligations at various times since 1989. The NFFO has been put out to bid each time. The twelve utilities have used the Non-fossil Purchasing Agency to enter into long-term contracts (up to 15 years) on behalf of the electric companies to provide stability to production. The projects have a five year limit to get up and running.

Result: This program has exceeded expectations in terms of price. The competitive bidding process has brought prices down. In 1990 wind-generated electricity was priced at \$0.147/kwh. By 1999 it was down to \$0.0485. 650MW of emissions free generation had been commissioned by the late 90's, although some projects were not online yet due to planning hurdles. At present pace, renewables are expected to produce 5% of the UK's electricity by 2003.

Issues: As the UK continues with power reform and electricity suppliers are separated from distribution, the NFFO will need to be overhauled. The concept of a Renewable Portfolio Standard, requiring all suppliers to use renewables to generate a set percentage of the electricity supply without a levy is being investigated. There is some concern that this will not be as cost-effective as the present system.⁵⁵

1.4.4 2.5.4 Renewable Portfolio Standards: Australia

Problem: Pollution related to combustion of fossil fuels.

Goal: Renewable sources will supply 9500 GWh of Australia's electricity by 2010. (Enough to supply the residential electricity needs of 4 million people.)

Strategy: The Renewable Energy (Electricity) Act 2000 requires that every wholesale purchase of electricity on grids greater than 100 MW of capacity will have to meet a targeted percentage of purchases from renewable energy sources. The percentage will increase every year from .24% the first year to 2% by 2010. Tradable renewable energy certificates may be utilized to meet goals. The Office of the Renewable Energy Regulator will enforce the program. Liabilities will be carried into the next program year.

⁵⁵ <http://energytrends.pnl.gov/uk/uk004.htm>;
http://www.env.go.jp/earth/g8_2000/forum/g8bp/summary/uk.html

Over a certain threshold, penalties of \$40/MW may be levied. Penalties may be refunded if goals are met in subsequent years.

Issues: The program is too new to evaluate. The development of renewable energy supplies is supported by many other loan, grant and tax programs.⁵⁶

1.5 Subsidies

There are subsidies that can be considered as environmentally harmful and those that can be considered environmentally friendly. Recent estimates of environmentally destructive subsidies range from \$500 to \$650 billion annually. Roodman⁵⁷, suggests a three step analysis for environmental subsidy reform:

- First, determine whether society needs the benefits the subsidy promises and whether the subsidy can bring about the benefit.
- Can the subsidy become more efficient through more precise targeting?
- Are the improvements in security, equity, and economic development worth the financial, social and environmental costs? Does it pass the fairness test?

As long as government subsidies encourage activities that environmental policies seek to discourage, the effectiveness of all the economic instruments discussed here will be limited.

1.6 Additional Lessons

As the case studies above illustrate, economic instruments can have a significant impact on environmental pollution or improvement. Some broad notes of caution should be mentioned. In some parts of Latin America, a tendency to over-legislate and under-fund resulted in unattainable goals. When programs were designed without the input of relevant agencies, laws were not easily enforced. "Institutional weaknesses-such as underfunding, inexperience, unclear jurisdiction, or lack of political will-limit the effective implementation of [economic instruments]."⁵⁸ In Russia, when privatization is "shaped to favor the 'insiders' (ministries, plant managers, local authorities, etc.) with no regard for economic efficiency issues, in such a way that many elements of the former centrally planned economy continue to exist...the basic structure of resource management remains virtually the same."⁵⁹

The best solutions will reflect the strengths and acknowledge the constraints of local culture and institutional conditions.

⁵⁶ "Mandatory Renewable Energy Target-Liability" @ <http://www.orer.gov.au/factsheets.htm>

⁵⁷ David M. Roodman, *The Natural Wealth of Nations: Harnessing the Market for the Environment* (New York, N.Y.: W.W. Norton and Company, 1998, p.98

⁵⁸ Richard M. Huber, Jack Ruitenbeek, Ronaldo Seroa da Motta, *Market Based Instruments for Environmental Policymaking in Latin America and the Caribbean: Lesson Learned from Eleven Countries*, 1998 @ http://www.worldbank.org/nipr/work_paper/huber/huber2.pdf

⁵⁹ http://www.unep.ch/etu/etp/events/Economic_Instruments/WG_EconInst_casestudies.PDF

2 Conclusion

This paper only describes the basics of the major economic instruments used to achieve environmental improvement. The details and implications of each strategy will be different if implemented in China. China's power sector does not have the border competition issues faced by members of the European Union. China may not have the same environmental goals as Australia. China may not have the compliance issues of Malaysia. The references cited provide a wealth of information about the implications and issues involved in these strategies.

China is in a unique position to address power market reform due to rapid changes in economic structure, rapid growth in power generation capability, strong central government leadership, solid belief in the polluter pays principle and the tangible social impacts of pollution. At the same time, China is in an excellent position to incorporate the lessons learned from other countries that have attempted to internalize environmental costs. In China, the cost of pollution (cost of health care, agricultural losses, resource degradation and resource depletion) and the cost of electricity will be determined by what plants get built, what plants get operated, how much is invested in pollution control, and how much is invested in energy efficiency. Fully incorporating the environmental cost of pollution in electricity prices is the best way to ensure that the total cost (environmental cost and electricity cost) is minimized.