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**CARBON TRADING AND HYDROGEN –  
POSSIBILITIES AND PITFALLS**

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## Abstract

Carbon "trading" programs are advanced as a means of providing an economic incentive to move from carbon rich fuels (coal) to carbon lean fuels (natural gas and hydrogen). Emission trading can stimulate technological innovation and restrain the costs of climate change policies, if government sets stringent pollution limits and permits broad trading. This paper identifies lessons learned in the U.S. in emission trading schemes for tropospheric ozone (smog) control and power plant sulfur dioxide (SO<sub>2</sub>) reduction, and identifies how trading could provide a means to move to a hydrogen economy.

## 1. THE CONCEPT OF TRADING

### An Exchange of Pollution Rights

The fundamental concept of emissions trading is a simple one. As in other markets, a pollution trade is an exchange of something of value -- here pollution rights -- in return for money or other consideration. One source of pollution maintains its level of emissions, or even increases that level, and another source of pollution reduces its emissions. The first source typically pays the second source (or a third party "middle man") in the exchange.

### Not a pollution control program

It is important to understand that trading is a *mechanism* to achieve pollution control goals, not a pollution control program. Trading by itself does not increase or reduce pollution levels although it does in practice shift the location of emissions. Trading may result in a cleaner environment, because it minimizes the economic cost of achieving an environmental goal, and because it stimulates technological innovation.

### Environmental Goals Must Be Set Separately

Trading accomplishes little unless a pollution reduction target has been established. This goal might be expressed in terms of an emission rate ("pounds per million Btu") or in terms of a limit on total emissions ("tons per year"). Unless government establishes environmental clean up requirements, there can be no market in pollution rights.

### Credits and Allowances

Trading must involve a buyer and a seller, but it may take many forms. The first trades were barter arrangements negotiated directly by the parties. More flexible and sophisticated systems require creating abstractions that can be bought and sold by third

parties. The two major systems for doing this are called "open" and "closed" market systems.

In an open market system, pollution "allowances" provide a medium of exchange, much like money; the pollution "credits" in a closed market system are more like products in a store. An "allowance" is, in essence, a right to produce a given amount of pollution. A "credit" is evidence of a specific pollution reduction. Either "allowances" or "credits" provide the means to create a sophisticated market. A pollution source may produce emission credits or obtain allowances and sell them directly to another source or to a middle man. They may be resold any number of times.

In the closed market system, the government defines a limited group of participants, creates a medium of exchange ("allowances"), allocates the allowances according to some established social priority, and enforces against those whose emissions exceed the number of allowances they hold at the end of the year. The system is called "closed" because the participants are limited to those identified by the government.<sup>1</sup>

In the open market system, anyone who is responsible for emissions can participate in the market. To participate, the person takes an action to reduce emissions below the permitted or actual level (whichever is more stringent). He then calculates the total emissions reduction, i.e. in credits, in tons (Ec), as follows:

$$\frac{[E_1 - E_2]}{[O - O]} \times nO = Ec$$

where E = emissions (in units of mass, e.g., tons); O = a unit of process output or surrogate (gallons, Btus, megawatt-hours, etc.); and  $E_1/O$  and  $E_2/O$  = the emission rates before and after taking an emission reduction action; and n = the number of units.

In an open market system, the government's enforcement role is reduced, because the creator of the credit is initially responsible to the buyer, not the government, to prove the credits represent actual reductions, with the government performing more of an auditing function.

In the United States, an acid rain program using a closed market was adopted beginning in 1990 and it has been hugely successful, though for reasons that are not universally applicable. Only about 1,000 sources are affected by the allowance program, for example. And the amount of allowances allocated was swollen by tens of thousands of tons of "extra" allowances assigned politically to various interests.

Credit trading is becoming more accepted at the state and local level in the United States -- e.g., the RECLAIM program in the Los Angeles basin in southern California -- but the capacity to support a national or international trading regime is untested.

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<sup>1</sup> Some might refer to it as a "socialist market," given the pervasive governmental role.

## 2. BENEFITS OF TRADING

Assuring that there is an environmental benefit from trading is a job for regulators and program designers. A trading program does allow a source with a high cost of control to reduce its cost with equivalent emission control benefits for society. Thus trading does -- or should -- result in cheaper control through economic efficiency and innovation.

### Private Benefits

The private sector benefits in several ways. The reduced cost of control leaves more capital in the economy for other investment. Trading spurs innovation because it provides an incentive to make maximum reductions at minimum cost. Thus trading attracts entrepreneurial energy and opens markets to innovators. Trading also provides business flexibility for managers. A plant modernization can be put on a schedule that is not driven by the pendency of regulatory deadlines. When modernization does take place, emission reductions beyond the regulatory requirements have cash value.

### Public Benefits

Trading also provides important benefits for the public interest. Through trading, pollution control objectives are achieved at lower cost. Trading also exposes the real cost of pollution control -- thus settling arguments over how much pollution control will cost when decisions are being made about pollution standards. The U.S. acid rain program is an eloquent refutation of the cost arguments advanced by electric utilities in opposing the program during the 1980s. The utilities' cost arguments convinced Congress to set a "default" value of a ton of sulfur dioxide allowances at \$1500. The market price today is less than \$100.

Trading provides a powerful incentive for innovation. The acid rain program shows how this incentive affects costs. The effect is hardly surprising: as economists point out, there is no incentive to conserve a free good, so once it has economic value it is easy -- and cheap -- to find ways to conserve.

## 3. TRADING AND CLIMATE CHANGE

Trading programs seem particularly well suited as a worldwide strategy to achieve the emission reductions needed to slow global climate change. Trading can help policy makers shape a response that is cost beneficial and manageable.

## **Benefits for the Developing World**

An important advantage of a trading program is its ability to address questions of economic equity between North and South. Pollution impoverishes everyone. The climate change phenomenon is a painful example of that reality. Developed nations have enjoyed the vast bulk of the economic benefits from the "free" discharge of waste gases into the air. There is now no place on earth safe from the consequences.

Developing nations face a choice: One option is to follow the example of their more developed neighbors and force everyone to absorb the pollution consequences of economic growth on the same model followed by the now-developed nations. The second option is to find ways to decouple pollution from economic growth in all countries. Trading can provide a means to achieve this goal.

### **"Mining the Rich Vein First."**

Trading has the potential to eliminate political boundaries in the search for pollution reduction. In the example of mining, the rich vein is mined first. It is the easiest to extract. As the ore becomes less rich, costs of extraction rise and technology improves in response. Ultimately, in some cases the mill tailings themselves are "mined" utilizing advanced technology. With an effective trading program, it will be thus with reductions in global warming gases.

Many of the cheapest reductions -- the "rich veins" -- are likely to be found in the developing world. Developing countries might think of such a system as creating a new domestic resource or export product -- CO<sub>2</sub> emission rights -- for sale on international markets. Trading will minimize the cost of dealing with global warming, leaving more to finance economic growth worldwide. All nations will enjoy the long-term benefits of innovation and the spread of advanced technologies.

### **A Focus on Money**

A key advantage of trading programs in the international arena is, perhaps ironically, that they focus on money, not pollution. International trade and monetary institutions typically support international commerce. Coal-fired power plants are a "known" technology whose export is supported even though the long term penalties for society are well understood. Regulatory innovation is often seen by them as a restraint of trade. Technological innovation may be seen as "untried" and therefore an unacceptable risk. Pollution control technologies are often considered "unproductive" investments robbing cash-strapped countries of capital necessary to finance "productive" development. With the right system, trading will allow international institutions to focus on something they know -- money -- while accomplishing the pollution control that society needs.

#### 4. DESIGNING A TRADING PROGRAM

We noted earlier that trading should be seen as primarily an implementation tool, rather than a pollution control program. Its success as a policy instrument depends upon the policy it implements. In the global warming case, the international community must reach a clear consensus on the emission reductions required in order to create a working market.

One could argue either way about whether Kyoto did that job. The agreement sets numerical goals only for North America and Europe and hedges that decision by crediting reductions that resulted from the collapse of the Soviet economy. At Kyoto, trading was seen by the U.S. as the primary implementation mechanism. The trading and compliance details will be included in negotiations at the November meeting in Buenos Aires. It is important to understand the choices involved in designing such a program, and to make the right choices, if the trading program is to yield all three benefits: lowest cost reductions, real economic data on prices and a balance of the equities between developed and developing nations.

##### Allocation of Emission Rights

A successful global climate change program will have to address the imbalance in stages of development in the world. If a cap-and-trade closed market system is adopted, allowances must be allocated in a way that recognizes the claim of the peoples of the less-developed world to economic development. An allocation scheme based more on population than on current CO<sub>2</sub> emissions would accomplish this. Such an allocation would also be an important stimulus to development. In the early years, developing countries would not need their entire allocation. The sale of unneeded allowances would help to finance development. As their economies grew, developing nations could keep their allocation to support their own economies. Thus the process of allocating greenhouse gas allowances could be a powerful mechanism for achieving greater environmental justice in the world.

##### Design Parameters

A trading system must address at least the following parameters:

*A. How is the environmental benefit guaranteed?* Assuring that human health and welfare benefits are achieved is fundamental. This requires emission limitations in each country that assure reductions in overall global emissions (this will also guarantee that there are buyers as well as sellers of credits or allowances).

In a credit program, the credits could be traded "at a premium" in order to assure progress towards the needed emission reductions -- say, 1.2 tons of emission reduction

might be required to generate a one ton credit. In a cap and trade system, overall allocations could be reduced periodically to assure downward pressure on emissions.

*B. Who is included in the market?* Limiting the number of pollution sources that can participate in a program (as in the U.S. acid rain program) yields a simpler, more easily enforceable system. But exclusions limit innovation and limit the economic efficiency of free market forces. The U.S. acid rain program, a closed market system, relies on reductions at about 1,000 electric generating units. It does not mandate reductions in sulfur levels in gasoline, for example, that would have a comparable public benefit. A closed market is attractive where a relatively few sources account for most of the pollution, but it may not be workable in the global warming context, where there may be many more sources to deal with.<sup>2</sup>

*C. Quality assurance and enforceability.* Any system must assure the quality of measurements and be easily enforceable. Perhaps surprisingly, many models could meet these criteria.

Closed market cap and trade systems tend to be highly quality assured and easily enforceable since the government issues the allowances. The difficulty in these systems is less quality assurance than the irresistible political pressure to grant more allowances than might be consistent with the needs of the environment. In addition, closed markets do not achieve the full market potential for economic savings and technological innovation available when all emitters are included in the market.

Open market systems provide a highly dynamic tool for reductions which can fully capture the potential for economic savings and technological innovation of the market. In open market systems utilizing credits, quality and enforceability are assured by enlisting the buyers of credits as part of the process. Mechanisms such as third-party certification, insurance, and enforcement through contract law can provide for quality assurance in an open market system. An analogous case is the credit card system. Despite occasional fraud, the system succeeds in transferring huge amounts of money each day across international boundaries with a high level of security and modest overt enforcement.

*D. Transaction costs / system efficiency.* High transaction costs can kill a trading system by removing the economic incentive to trade. State preapproval of credits cripples the market.

*E. Distance and direction.* Depending on the pollutants involved, trading systems must be crafted to deal with the realities of one source's being allowed to pollute the local air

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<sup>2</sup> A closed market system for CO<sub>2</sub> would select a set of major sources, such as major fossil fuel-fired power plants, for which there is a well-characterized emission inventory. Other source categories might be added if emission inventories were developed.

while a distant source is paid to clean up. Based upon what we know today, in a CO2 trading system this would be a minor consideration.

*F. Baselines.* The best designed closed market trading system will fail to achieve its public purposes if base lines are set politically rather than on the basis of measurement and science. Similarly, open market systems work when the credits are generated in the context of clear emission standards that achieve emission reductions.

#### **Innovative Approaches**

The development of "middle men" is a key element in any market. The World Bank may seem an unlikely candidate for this role, but the Bank has recently advanced the idea of creating an investment fund -- the "Global Carbon Initiative" -- that would invest in the creation of CO2 credits. This would be a major first step toward "Joint Implementation" of the Kyoto agreement. Norway, Sweden, Switzerland, Finland, and the Netherlands have pledged initial investments in the system.

### **5. EXAMPLE -- A HYDROGEN-FRIENDLY TRADING PROGRAM**

#### **Trading Will Benefit Hydrogen**

Placing a limit on CO2 emissions would benefit all clean fuels, most of all carbon-free hydrogen. Putting a price on pollution means that people interested in the bottom line are enlisted to make choices benefiting the environment, such as choosing to use hydrogen fuel. By making other fuels more expensive, a limit makes hydrogen more attractive. The more stringent the limit, the greater the incentive. When coupled with a trading system, such a limit would be a powerful incentive for innovation. It could be exactly what is needed to create a world hydrogen economy.

#### **The Trading System Design Matters**

At this point, the United States is urging that a "cap and trade" closed market system be used to address greenhouse emissions. There is a possibility that such a closed market would be limited to large power plants. If so, it would benefit hydrogen little, if at all. In addition, as we have already seen, allocating allowances for a closed market system is a political process, which can be very slow, and often results in logrolling that increases the allowance pool and undermines the benefits of the system.

By contrast, an open market system, beginning with Joint Implementation, would allow the market to begin working right away, establishing the true cost of CO2 emission reductions and stimulating innovation. This approach may make hydrogen a more viable fuel at an earlier date.

In conclusion, hydrogen, as a carbonless fuel, could receive a major stimulus in the fuels market with the implementation of a global carbon trading mechanism. The hydrogen community should be actively monitoring and participating in the negotiations to develop a trading mechanism supportive of that result.