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Conceptual Framework for Greenhouse Gas Sequestration Alternatives

GARY D. LYNNE Prof
University of Nebraska-Lincoln, GLYNNE1@UNL.EDU

Colby E. Kruse
University of Nebraska-Lincoln

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By
Gary D. Lynne
Professor, Department of Agricultural Economics and the School of Natural Resource Sciences, Institute of Agriculture and Natural Resources University of Nebraska-Lincoln

Colby E. Kruse
Graduate Research Assistant, Agricultural Research Division, Institute of Agriculture and Natural Resources University of Nebraska-Lincoln

102 Filley Hall
Lincoln, NE 68583-0922
(402) 472-8281
glynne1@unl.edu

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Executive Summary

The earth has a limited atmospheric capacity to absorb more greenhouse gases generally, and carbon dioxide in particular. It also has a limited capacity for agricultural lands to store a stock of carbon that might be drawn from the atmosphere and thus help alleviate the global warming problem. There are alternative mechanisms and mixes of mechanisms that might be used to address both scarcities and to work within the atmospheric limits on emissions and agricultural limits represented the capacity of soil and land to store carbon. These include a) government regulation, b) tax and subsidy programs, c) spontaneous evolution of markets, and d) cap and trade mechanisms.

An overview of each type of mechanism highlights the problems they incur. While subsidy and regulation programs have helped address a variety of natural resources conservation problems, some level of these problems generally persists and may be affected by changes in funding levels. Also, while a number of new activities have been stirred by the Kyoto Protocol, including carbon banks, international carbon certification firms and environmental product financial and brokerage firms, and unique public-private sector partnerships, perhaps none of this will produce much of substance unless governments first set carbon dioxide emission limits. It has become clear that in order to solve such public good problems, i.e., where there is little individual incentive to invest in solving the problem, that government approaches and markets must be jointly designed and implemented.

The public policy experiment with sulfur provides an example of how a market system might work if emission caps were in place. Government set emission limits in 1990. During the last 10 years or so, we have experienced the emergence of an active and quite effective sulfur allowances market. The market is helping firms find the least cost way to meet the emissions limits set through governmental action. Lessons learned in setting caps, distributing initial allowances, and facilitating sulfur allowances trading suggest that marketing can work; politics may play a lesser role than we might anticipate; markets where no markets existed before can develop; trading is surprisingly adaptive and can handle surprises; and, care must be taken to not give away too many allowances at the outset. Generally, the sulfur market has been deemed by most observers to be a success, reflecting a joint legitimization of both the government and the market. It is worth exploring the degree to which factors involved in carbon markets may be similar to or different from those involved in the sulfur market.

In regards to carbon sequestration the direction most often discussed in the U.S. and on the global scene moves away from direct regulations; green payment and subsidy, as well as programs that tax pollutants. The direction, rather, seems in part toward the baseline and credit systems that are largely spontaneous responses by the private sector to governmental emissions caps or the prospect of those caps. The latter involves both proactive government and equally proactive private parties to the market,.. A case study

approach could be taken wherein a carbon storage market mechanism could be designed and tested in Nebraska. A simulated market might be developed as a case study and perhaps tested with actual trades in carbon offsets in stock (COIS) certificates representing carbon stored in Nebraska land.

During the interim, and while such a test case is demonstrated, Nebraskans need to carefully watch the progress of two pieces of legislation moving through the U.S. congress, one titled the "Conservation Security Act of 2001" and the other "The Clean Power Act of 2001." The former proposes green payments to farmers and ranchers for applying certain kinds of conservation practices and technologies that, among other things, lead to more carbon being sequestered and stored in agricultural land. The latter set carbon emission limits on U.S. power plants at the level of emissions in 1990, which could well lead to emission allowance markets in carbon. Intriguingly, the two acts run somewhat counter to each other, in that the former does not propose to use market forces to solve the carbon problem while the latter does so. It remains an open question as to where the U. S. Congress will move on these two fronts, with the outcome having substantive implications for the next steps that Nebraskans might take to be a part of the solution to the carbon and global warming problem.

Conceptual Framework for Greenhouse Gas Sequestration Alternatives[1]

Gary D. Lynne and Colby E. Kruse[2]

Climate change is "the granddaddy of all public goods"
(Nordhaus, 1991 cited in Hahn, 1998, p. 60)

Climate change is an ongoing, natural phenomenon harkening back to the beginning of time. Human activities, however, can lead to more rapid changes bringing about stresses that may be difficult to handle by plant and animal systems and by the humans who depend on said systems. It is this possibility that has led to the concern with greenhouse gases generally, and with carbon dioxide and the possibility to sequester carbon in agricultural lands, in particular. It is hoped that perhaps terrestrial systems could perhaps provide a substantive sink for the excessive amounts of carbon being released to the atmosphere from the burning of hydrocarbons (U.S. Department of Energy, 1999). In effect, we would store the extra carbon in plant material and land.

From a political economic perspective, the essence of the problem reduces down, first, to recognizing two scarce resources, and second, to choosing an appropriate response mechanism to address the scarcities. The two scarce resources are a) the capacity of the atmosphere to process and otherwise accommodate more greenhouse gases, especially carbon dioxide, and b) the capacity of agricultural activities to sequester and to store carbon. The various forms of response mechanisms include a) government

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[2] Lynne is professor, Department of Agricultural Economics and the School of Natural Resource Sciences, University of Nebraska-Lincoln. Kruse is a Graduate Research Assistant funded through the Agricultural Research Division. Both authors are in the Institute of Agriculture and Natural Resources at the University.

regulation, b) tax and subsidy programs, c) spontaneous evolution of markets, and d) cap and trade mechanisms. We might also expect that complex mixes of these mechanisms may emerge. This is to say, while some carbon dioxide and other gases are essential to maintaining global temperatures and otherwise supporting life on the planet, excessive amounts may lead to great instability in the climate, and perhaps even lead to major long term consequences for life itself. We need to design mechanisms to deal with this possibility. Unfortunately, we do not really know the thresholds so we do not know exactly if we are in a situation of scarcity already, nor do we know the exact nature of the scarcity we need to be watching for, which makes it difficult to choose a mechanism(s). Said somewhat differently, we do not know the point at which rising levels of greenhouse gases could lead to cataclysmic outcomes, and the nature of the safe minimum standard we need to put in place. As a result, it becomes virtually impossible to decide before the fact which is the best mechanism(s) to address the problem.

In light of the uncertainty involved in this matter, the legal and economic challenge is to narrow the range of appropriate mechanism(s) for addressing the scarcity, and thus be positioned to move rapidly to design and choose a mechanism(s) that will resolve the problem no matter how and when it ultimately emerges. Flexibility and resiliency in the mechanism seems a prudent objective, in the face of the even more prudent objective being that of seeking a safe minimum standard for global warming.

In addition to the uncertainty, solving the resulting climate change problem also becomes a substantive challenge due to the public good aspects of greenhouse gases, as the quote from Nordhaus suggests. Describing greenhouse gas as a public good is to simply recognize that once such a gas is released to the atmosphere it affects everyone; as

economists say, the additional or marginal cost of providing one more unit of it to someone else is zero, in that all experience the outcomes whether they wish to or not. As a result, it is also the case that individuals, regions, and countries will tend to under-invest in both producing the gas for the cases when it is doing good (e.g., enhancing yields in corn fields) and in mitigation of the gas when it is doing bad (e.g., causing more severe storms in Nebraska). It follows that in order to achieve the economically efficient level of greenhouse gases that the government and other organizations of private individuals perhaps will have to ban together to help solve the problem. Such activity is legitimate. Yet, it is equally as legitimate that markets in emissions and carbon storage could also play a role. Due to the public good nature of greenhouse gases, then, the most appropriate mechanism will likely include a kind of symbiotic balance of both government (or other community effort) and market activity, both legitimized, and both playing key roles. It will likely not work well in this case, even though it has been our history with respect to the environmental debate to continue with the largely unproductive dialogue over which is better, government or market, in the matter of environmental enhancement (see Lynne, 2001).

In order to understand the reason for the focus in this background paper, most recent attention has been placed on the cap and trade mechanism. New interest has arisen in the potential for bringing market mechanisms into environmental enhancement through legitimizing roles for both government (public) and market interests through this mechanism. We will also delineate the main features of other time honored mechanisms, however, including direct government regulation and control; tax and subsidy including green payment programs; and spontaneously arising markets.

We especially address how these mechanisms might help in creating a new commodity market in carbon stored in agricultural land. We highlight the main design parameters for such a mechanism aimed at achieving and maintaining a safe minimum standard for the global climate through using storage. The matter of actual market design parameters is addressed in the companion paper (Lynne and Kruse, 2001).

An Allegory on Mechanisms Leading to a Mechanisms Framework

Perhaps we can start to understand the issues in narrowing the range of response mechanisms with this allegory (after McCloskey, 1985, pp. 107-110) about allocating football tickets, certainly a less consequential problem, but yet a helpful story for thinking about what we face. Consider the scarcity and mechanisms used to address this scarcity through the allocation and re-allocation of football tickets to a Husker football game. The number of seats, and the tickets, in Memorial Coliseum are in scarce supply. How do we initially set the seating capacity and allocate the seats and then at some point in the future best re-allocate this scarce supply of seats and tickets?

First, we have to understand that the scarcity itself was created by people. Decisions were made to build and re-build Memorial Coliseum to its current capacity. In effect, Nebraskans set a "cap" on the seating, and seats were initially allocated through a kind of "trading" process. A complex political, legislative and administrative mechanism interacting with the market for tickets was used to establish this cap, pointing to the reality that such decision forums can indeed successfully define a cap and initially allocate the capacity. Second, we have to understand that somehow the tickets will be

reallocated. Intriguingly, humans have a way of accomplishing these things, and do find solutions. We might call that which emerges the "trade."

Let's first look at the initial allocation within the cap. We might, say, a week or so before the first season, load all the tickets onto an airplane and, then, fly over the state dropping them out. This method would be biased toward those with good ticket searching skills. Such as not to bias the distribution on such grounds, we might try a lottery instead, perhaps randomly drawing driver's license numbers to allocate the tickets to Nebraska residents. This one also has bias, first, toward licensed drivers, and, second, toward residents: How about the avid Nebraska fan that lives in Council Bluffs? Still another way would be to give the initial bundle of tickets to the unicameral, making this a Legislative Matter. The unicameral may want to subsidize certain classes of users by giving some tickets at a low or reduced rate; others might be taxed such that these groups can be subsidized. In other cases, the unicameral might simply make a political decision to allocate the tickets in certain ways without any kind of tax and subsidy activity, i.e., perhaps creating a Department of Football Ticket Allocation. This agency may directly control who obtains the tickets each year.

Alternatively, a Special Purpose Football Ticket District(s), perhaps one in each part of Nebraska, might also be created. We might also create a Football Tickets Court to handle disputes, and even give the Court some constitutional mandates, in effect forcing certain kinds of allocations of the tickets, perhaps ½ to alumni and ½ to the students. The Court would also help evolve common law reflecting the common understanding among football ticket holders about what is fair and reasonable in the allocation.

Now, how about the reallocation from the initial endowment? Lacking a viable response mechanism, we might see bigger and stronger individuals simply taking the tickets by force from the weaker even though the weaker were able to obtain more tickets initially. In both cases, the criminals or bullies (a law would have to be passed making football ticket bullies into criminals) might be brought to the court, and a judge in the Football Ticket Court may decide who is to have these tickets. Alternatively, this might be a Legislative Matter, with season tickets reverting to the control of the legislature before each season, with the legislators rhetorically most capable being able to move tickets one direction or the other. Or, we might also just wait for the natural evolution of a market, perhaps starting out as a black market, with scalpers on every corner at games, illegally buying and selling the tickets. Eventually, there may be so many tickets exchanged this way that the illegal markets may be legitimized by a new law allowing market trade, in which case the Football Ticket Market could be said to have evolved spontaneously.

As part of the spontaneity, we might also see a Football Ticket Bank, such that all holders of tickets could deposit extra tickets in the bank and be given credit, with others borrowing tickets from the bank. The idea would be that borrowers would at some future time obtain tickets and repay the draws. Individuals active in the Football Ticket Market would work with the ticket brokers and speculators through the bank accounts. In a market, sellers would not sell unless the buyers were willing to pay the mutually agreed to price. The Department of Football Ticket allocations may even hold back a few tickets from the Market, in which case they could hold an auction every fall, with the idea to stir a lively and active market with many transactions, which is necessary to establishing the

value of the tickets. A thin market does not generate good values. Over time, the market in football tickets would clear, re-clear, and clear again perhaps at different prices every year, as the football team wins and loses. Various brokerage and deal-making services would evolve to help in facilitating the trading.

In summary, 1) we create and define scarcity; 2) we generally find a way to initially set caps and allocate access to a scarce resource; and 3) we usually find a way to reallocate the scarce resource over time, sometimes using markets and sometimes not. A variety of mechanisms, actually, mixes of mechanisms, are used. Said somewhat differently, what we see in the allegory is the real possibility that a multiplicity of legislative, administrative, special purpose district, judicial and market mechanisms could work together and lead to more satisfactory outcomes. We now turn to using this framework in narrowing the range in possible mixes of carbon mechanisms.

Regulatory Mechanisms with Direct Control

Since the start of the U. S. Environmental Protection Agency in the early 1970s we have had a tendency to use direct, command and control regulatory approaches to solve environmental problems. We set regulatory standards and mandate compliance, often with threats of fines or other strictures if one does not meet the standard. Agricultural uses of pesticides and herbicides, e.g., are controlled in the sense of being required to apply no more than a specified amount of the chemical, with it applied in certain ways, and the wastes (e.g., including even the vessels carrying the chemical to the farm) handled in specific, mandated sorts of ways. Also, during the years of commodity price

support programs farmers were mandated to have a conservation plan approved by the federal government before one could obtain the commodity payments. Yet, these kinds of programs can be effective, and have helped in many ways. As one reviewer of this paper claimed, these kinds of programs "… have been extremely effective and have met their legislative intent. Erosion on cropland was cut in half and wetland conversion on AG (Note: agricultural) land has nearly reached no net loss." It is conceivable, on momentum alone, that such approaches will also play a role in addressing the carbon and global warming problem.

Yet, it seems reasonable to argue that the regulatory approach will not have the strength of conviction during the next couple of decades that it has had in the past 30 years. Starting about 1990, we start to see a swing in the national mood on how to address environmental issues. This swing seems a part of the general move toward ever more individuation and privatization of society, inclusive of agriculture and the food system. The path seems to be away from command-and-control with mandates, e.g., mandates on how much carbon (and other greenhouse gases) agriculture could emit or how much it will store, and toward a path oriented to voluntary action associated with participating or not, in emerging markets. In a recent presentation to the American Enterprise Institute and the Brookings Institution, Senator Hagel, R-Neb called for crafting a plan, quoting the news reporter here (Seelmeyer, 2001) leading to "voluntary actions by government, industry and private organization to reduce or sequester greenhouse gas emissions as needed." This has been a theme in the current administration. We also seem to be in the mood of moving away from direct regulatory

controls as we ask markets to do more. The fascinating question remains about the role of the government on this path.

The Food and Agricultural Improvement Act (farm bill) of 1996, popularly referred to as the freedom-to-farm act, also placed agriculture on the market path. Farmers and ranchers were to orient decisions toward the market, especially finding ways to be competitive in the new global markets. Yet, regarding the new 2001-2002 farm bill, we again see dialogue about providing green payments as a provision in that bill, reflecting the approach more commonly used prior to 1996. It is difficult at this writing to predict the path, although it will probably be more along the line of a third way, with legitimate roles played by both government and market.

Tax and Subsidy (Payment) Mechanisms

Agricultural conservation programs have a long history of federal support in the form of providing for cost sharing and technical assistance for designing the installation of conservation technologies and practices. The wide array of programs currently available are summarized in the recent legislation (H.R. 1938) proposed by Representative Moran (Kansas) that proposes to extend and expand the conservation programs currently administered by the Department of Agriculture, including the 1) Environmental Conservation Acreage Reserve Program; 2) Conservation Reserve Program; 3) Wetland Reserve Program; 4) Environmental Quality Incentives Program; and the 5) Wildlife Habitat Incentives Program. The first four programs are all separate sections of the Food and Security Act of 1985 (essentially, all pieces of the farm bill), which Representative

Moran is proposing be extended from its current termination date of 2002 to the year 2012. The Wildlife program is a section of the Federal Agriculture Improvement and Reform Act of 1996, which Moran is also proposing be extended to 2012. All of these could have an influence on how much carbon is sequestered in land.

The Conservation Reserve Program (CRP) is of special interest wherein individuals basically sell the capacity of the land to produce marketable crops for a payment from the government. In effect, cropland is turned into grassland and held in reserve (it could be turned back to cropland at some later time) for said payment. Farmers and ranchers can bid land into the program with bids accepted at mutually agreed to prices to maintain the land in grass rather than cropland for a certain number of years, with payments made each year over the duration of the contract. Due to its focus on moving cropland back into grassland, CRP works to sequester substantive amounts of carbon, suggesting perhaps that the CRP program could be shifted to a carbon sequestration program as the CRP contracts reach their end.

New legislation being considered as this paper is being written includes the "Conservation Security Act of 2001" introduced by Senator Harkin (D-Iowa) in the Senate (S. 932) and by Representative Thune (R-SD) in the House (H.R. 1949). This act establishes a voluntary incentive program based on payments as high as $50,000 per farm per year to implement and continue conservation practices and systems. It focuses on stewardship of land currently being farmed and ranched in contrast to set aside programs such as the CRP program. Generally, it proposes to assist farmers and ranchers in practicing a wide array of conservation practices leading to enhancements in soil and water quality; air quality; biological diversity; and, for the purposes of understanding

how it relates to the carbon question, "reduction of greenhouse gas emissions and enhancement of carbon sequestration (S. 932, Section 1240Q(10))."

In light of the subsidies and government payments, both historically and as proposed in new legislation, it is intriguing that both soil and water quality associated with agricultural activity still is not what it could be. As Nowak and Korsching (1998, p. 159) point out while citing reports by the U.S. GAO (1977) and USDA (1989), the efficacy of the variety of subsidy and payment programs that have historically focused on "… reducing soil loss, reducing further soil quality degradation, and maintain clean water often is questioned," and perhaps need to be questioned. A National Academy of Sciences (1993) study also cited in Nowak and Korsching (1998, p. 159) highlights the continued deterioration of soil quality, measured by such things as carbon content. As Lockeretz (1990) has noted, the reason for this tendency toward payment (and regulatory) programs not achieving what is expected arises from our lack of understanding about what actually motivates farmers and ranchers to conserve and enhance natural resources. We only know that much more than financial aspects of the decision are at work (see Lynne and Casey, 1998), and little more. The social and behavioral (economic) science is missing; conservation programs and policy have been viewed mainly as technical matters, perhaps a kind of reasoning that will have to be changed if carbon sequestration and massive storage of carbon in land is to be accomplished.

In light of this experience, and reflecting a substantive lack of scientific understanding about the human and behavioral side of agriculture, it becomes reasonable to question the efficacy of subsidy and green payment mechanisms as the total answer in bringing about carbon sequestration in the future. It is not at all clear, e.g., that farmers

and ranchers will respond the same to government payments as they might to market prices.

Also, payment and regulatory programs have a tendency to lack consistency over time. It is at best difficult to keep the public tax dollars moving into payment programs at a sufficiently high level such as to keep the programs effective over time. Rather, we see a tendency for the public interest in conservation to wax and wane, with the representatives in congress acting accordingly to not always fully fund such programs. This could create special problems in the case of carbon sequestration, in that small amounts of carbon added to storage each year due to government programs supported over many years, and then suddenly dropped on some political whim, could result in all the gains in carbon storage being lost in a relatively short period of time. Also, we simply do not know much about how subsidy payments in contrast to payments coming through a market compare in effectiveness, or how the two approaches complement or compete with each other.

Tax mechanisms also face challenges, e.g., taxing the emissions of carbon and then using the collected revenue to perhaps support regulatory programs, or to cover the subsidies used to help firms change technologies. Taxes to bring about environmental change have not generally been politically palatable in the U.S. In Nebraska, even a relatively modest fertilizer tax that generated revenue for helping state agencies manage the nitrate pollution around well-heads was not popular, and, while operant for a few years with reasonably good results, was recently not reinstated. The tax was not supported in either urban or rural segments of Nebraska. Intriguingly, it perhaps needs to be asked why those in urban areas who perhaps would benefit the most (relative to the

costs they would pay) from the possibility of higher quality water, perhaps even improvements in outdoor recreational activities like fishing, also would not be supportive of taxes to induce environmental enhancement. While research is needed to know for sure, it probably reflects a general aversion to taxes, and even the word "tax" being much less acceptable than the word "price" to most, albeit a tax is essentially a price (although it is not set, or derived, in the same way as prices evolve in markets, which is probably why prices are preferred). In this case of a fertilizer tax, the tax would raise the price to include part of the damages caused by the fertilizer.

It is still the case, however, we would probably face much greater overall damage and lower quality of our natural resources today if it had not been for the conservation programs and technical assistance of the past. A reviewer of this paper noted how it is "also possible to argue that U.S. governmental programs have brought about marked improvements versus what would exist without those programs." We agree. The actions taken to stopping and preventing recurrence of the Dust Bowl days of the 1930's is case in point. Many specific issue programs, e.g., the Conservation Reserve Program, and programs to encourage conservation tillage of various kinds, have contributed measurably and substantively to carbon stocks and will continue to do so. Regarding carbon content of soils and declining soil quality, generally, however, perhaps the legislation has not been comprehensive enough, an idea also reflected in the more all encompassing Conservation Security Act. The many smaller pieces of conservation legislation in the past were not designed to completely correct the declining health of our nation's waters and soil quality. A more comprehensive program is needed, perhaps that proposed in this legislation. The "fickle nature of government funding" was also

highlighted by a reviewer; as we noted earlier, long term commitments will be necessary in order to ensure that once carbon is added to the soil that it is not suddenly all released as government support is pulled away, even for short periods of time. Importantly, government will have to play some role in bringing about reductions in emissions, and possible storage of the carbon in Nebraska land.

It seems, too, however, that the new cap and trade mechanisms that legitimize both a role for government and market will also play a role. As one reviewer characterized it,

> The cap and trade mechanisms in theory makes energy users/carbon emitters (all of us) pay in accordance with our net carbon emissions, whereas tax mechanisms cost all of us, but not necessarily based upon our level of net carbon emissions – a net plus for markets. The market may also be able to better negotiate credits at a somewhat lower price and better deliver the exact level of net carbon emissions you want. Finally, however similar, the market approach avoids the stigma of having the word "tax" attached to it. However, the market mechanisms will likely have some additional administrative costs and may conceivably have significantly higher measurement costs.

We concur, although the contention of additional administrative costs needs study (it may actually be less costly), and see the need to consider a variety of government and regulatory programs mixed with various market and market-like mechanisms and institutions to bring about more carbon sequestered in any given year, and more carbon stored over the longer term.

It also is only prudent, too, to move cautiously forward with using market mechanisms and institutions in the policy mix. These mechanisms are not a panacea, although *if an appropriate structure can be built into the foundation of a market*, i.e., the market is built in such a way as to better ensure that it is just, equitable and fair.

Participants need to be able to see a shared value system to which each individual can subscribe. In this case, environmental markets hold the potential to in some ways work better than direct control; tax, subsidy; or green payment mechanisms. We perhaps cannot emphasize enough that markets must be fair, equitable and just, or they will fail just as quickly and perhaps even more dramatically than the direct control, and the tax and subsidy mechanisms.

As alluded to several times, it appears a kind of third way is emerging, a third path as it were, going beyond both the strictly market and the strictly government (i.e., regulatory and/or tax and subsidy approaches). The question becomes: Will such mechanisms appear spontaneously, or will we need to actively design a suitable market mechanism, *suitable meaning both simultaneously efficient and fair as well as just*, that will complement and otherwise work jointly with a certain amount of government involvement in the matter?

Spontaneous Trade Evolving to an Optimal Mechanism?

Several entities have emerged on the world scene since the 1997 Kyoto Protocol. We place these activities in this section on the contention that such activities are a precursor of perhaps spontaneously evolving market trade in carbon emissions (and storage) among private entities. Countries considering a domestic emissions trading system include Australia, Canada, Denmark, France, New Zealand, Norway, Russia, United Kingdom and the U.S. Limited trading is already occurring within some of these countries. Global companies are also being positioned to participate in trading. The Kyoto Protocol has

encouraged emissions trading both within countries and across international borders even though it has yet to be, and perhaps never will be, ratified by sufficient numbers of nations to make it in any sense binding.

One such entity is the International Emissions Trading Association (IETA). It proposes to provide an ongoing overview of the status of trading by countries and global companies (See: http://www.ieta.org/). It is based on the premise that it is in the interest of all involved that an international trading scheme emerge and leading to the lowest overall abatement cost possible. This type of scheme will likely be the most useful after the second commitment within the Kyoto protocol in 2008, but it can also help during the preceding years. The national trading schemes that emerge will all have their unique characteristics. There could be elements that emerge which make them incompatible at an international level. In order for these national markets to be working together efficiently by 2008, the "bugs" must be worked out before then. That is why this time period leading to 2008 can prove to be quite valuable, and perhaps explains why we are seeing emergence of groups like the IETA. Facilitating these national schemes to work together will enrich all involved by bringing together the diversity of all involved. This will enable the elements that need to be standardized to become so, while at the same time preserving the distinctiveness of each individual approach (http://www.ieta.org/).

Carbon offset markets are evolving in several places, with special attention being paid to the rainforest areas of central and South America. Countries such as Costa Rica, El Salvador, Guatemala, and Honduras see the potential to profit from the capability of said areas to sequester more carbon at a faster pace and to hold larger quantities of carbon in place for an indefinite period. The focus is on sustainable development (Stewart and

Tirana, 1998) and using carbon markets to enhance the environmental and profit opportunities in such regions.

Certification companies are also emerging, e.g., SGS Société Générale de Surveillance, an inspection, testing, monitoring, and enforcement organization with offices in more than 140 countries. SGS was recently employed by the Costa Rican government to certify the carbon stored in a rainforest area, with the intent that Costa Rica could eventually sell such carbon offsets on the world market (See: http://www.sgsgroup.com/SGSGroup.nsf/pages/costarica.html). The certification of this carbon offset program could help ensure that over 1.25 million acres of Costa Rican forests are preserved. This SGS certification is the first under the terms of the Kyoto agreement on climate change, and it offers the possibility that these forests will remove more than 1 million metric tons of carbon equivalent from the atmosphere. These offsets could then be sold to companies in industrialized countries whose emissions exceed the agreed upon limits in the Kyoto Protocol.

This kind of activity is also ongoing in the U.S. as represented in the Montana Carbon Offset Coalition. The Coalition is a quasi-public entity created with the help of the Montana Legislature. Landowners can receive complete cost sharing to plant trees on land that is not naturally regenerating to trees. In turn, they receive payments to store carbon in the land and the trees. Contracts are signed for upwards of 100 years with the carbon credits transferred to Montana Watershed, Inc., the private entity associated with the Coalition that actually holds the credits. The idea is to help corporations mitigate their carbon emissions through purchasing the carbon offset credits associated with the now

forested land (See: http://www.digisys.net/mwi/Welcome.html and http://www.carbonoffset.org/eligible.html).

As a case in point, through the negotiating help of the Chicago-based firm of Environmental Financial Products, LLC (an investment bank and consultancy, who specializes in the design and implementation of market-based environmental protection programs), the Coalition was able to help the Confederated Salish and Kootenai Indian Tribes of northwestern Montana sell carbon offsets to the Sustainable Forestry Management (SFM) group through their London, U.K. office (See: http://www.envifi.com/News/sfm_SandK.htm). A total of 47,972 tons of CO2 equivalent will be sequestered over an 80-year period through reforestation of 250 acres of pineland forest. An investment by SFM will fund the reforestation of the land that was lost to fire. The trade will be monitored by tribal foresters to ensure carbon storage is maintained for a 100-year period.

The Pilot Emission Reduction Trading (PERT) program in Ontario, Canada is an industry-led organization that lays claim to memberships by many businesses and industries, as well as some government agencies and universities. PERT operates as a think tank on issues relating to emissions trading especially in the Windsor-Quebec corridor. It works at suggesting and designing trading rules that might work. As noted on the PERT website, it sees the mission "to help shape future legislation and commitments on emissions (See: http://www.pert.org/pert.html)." The Canadian government rewards private business and industry for participating in PERT. This kind of an approach is also spreading to other parts of Canada, e.g., in the Greenhouse Gas Emission Reduction Trading Pilot (GERT) in Saskatchewan. The GERT Pilot is a

"baseline and credit" mechanism, in the main privately operated, in contrast to a "cap and trade" mechanism where government plays a more direct role in setting limits. Each site or project starts with a certified base of emissions, and then earns credits from reducing said emissions below the baseline by avoiding increases in emissions that would have otherwise occurred, or perhaps actually reducing current emissions. The resulting credits can be sold to other companies (http://www.gert.org/faqs/#gert). Private businesses in Canada have been assured by the Canadian Government that credits certified now will be recognized in the future. A multi-stakeholder technical committee reviews each project and trade to assess whether it has resulted in actual emissions reductions that are measurable and verifiable at levels above what is already required by law. Again, a project such as GERT will provide practical experience for companies and industries so that they will be in a better position to contribute to future full-scale GHG emissions trading programs (http://www.gert.org/background/#ghgert).

A consortium of power companies in Canada has also been actively searching for carbon offsets that they might apply against their baseline emissions. In particular, a consortium of 10-power utilities that are responsible for 25% of Canada's GHG emissions and 55% of stationary point source emissions are negotiating payments with groups of farmers for installing an appropriate mix of best management practices that increase the carbon stored on the farms within the tract of land associated with the group over several years. Payments would be made each year during the time practices are in place. The idea is that the contracts would perhaps run for 10-20 years, with projections that payments of $0.50 to $1.50 per ton per year will bring farmers to shift to carbon sequestration practices. Some U.S. farmers apparently are already participating in this

initiative. The IGF Insurance Company, the fourth largest crop insurer in the U.S. with wide-spread operations in Iowa, has created a partnership with CQuest, a firm that helps implement carbon credit trading, to sell carbon emission reduction credits (CERCs). A CERC is the equivalent of one metric ton of atmospheric carbon dioxide reduced from an agreed-upon baseline (Zeuli, 2000, p. 244). These two companies have initially solicited carbon credits from farmers and other landowners in Iowa by working through IGF's crop insurance agents' network. The companies use formulas developed by the USDA Natural Resource Conservation Service to calculate the amount of carbon that is sequestered under alternative conservation practices. Price is negotiated independently for each contract. According to one news release (PRNewswire, cited in Zeuli, p. 245), 2.8 million metric tons of carbon credits have already been sold to the Canadian consortium, although we have not been able to confirm that this event actually has occurred, or that any money has actually changed hands. Also, it is our understanding that IGF was negotiating options to buy carbon credits, rather than buying actual credits, and offering quite modest option payments.

Several global firms are now positioned, and some are already involved in carbon offset trading. For example, Arthur Anderson, Credit Lyonnais and Natsource "have teamed ... to create an international carbon repository to serve the developing market in emissions trading (The Times of London, Monday, November 13, 2000, Business Section)." The Chicago Climate Exchange has also emerged as the "...first U.S. voluntary pilot program for trading of greenhouse gases." The pilot project is active in Indiana, Iowa, Michigan, Minnesota, Ohio and Wisconsin. The initial proposition is for phased-in commitments, starting with a target of 2% below 1999 baseline emission levels

during 2002 and gradually declining by 1% per year thereafter. Monitoring, verification, tracking, and reporting requirements will be implemented, and credits will be given for domestic and foreign emissions offset projects as well as certain carbon sinks (http://chicagoclimatex.com). The expectation in March of 2001 was that trading in the U.S., Canada, and Mexico would be ongoing by 2003 (Phase 3 of the pilot project). Environmental Financial Products, LLC of Chicago is also involved in this pilot project funded by the Joyce Foundation in a contract with the Kellogg Graduate School of Management at Northwestern University.

Innovest, an internationally recognized investment advisory firm, recently created the Innovest Carbon Finance Practice. The Carbon Finance Practice provides clients with clear, company specific research into the business risks and opportunities that global climate change presents at the corporate level. Their primary objectives are to: (1) understand and quantify the potential financial liabilities associated with carbon emissions generated through industrial processes and energy consumption; (2) benchmark corporate emissions profiles, financial exposure, and climate change strategy relative to industry standards; (3) optimize corporate greenhouse gas mitigation strategies; (4) identify hidden carbon-related assets and liabilities; and (5) stay abreast of strategic and operational best practices by tracking policy developments. Current analyses do not include a company's potential carbon risk exposure, which could represent as much as 40% of an energy-intensive manufacturing firm's entire market capitalization (See: http://www.innovestgroup.com/carbonpractice.pdf).

In response to this market void, Innovest offers services including company-specific carbon risk profiles, custom portfolio analysis, reviews and analyses of policy

developments, and custom advisory and consulting services. When creating a carbon risk profile, Innovest rates a company's current carbon management practices, potential carbon risk, and potential carbon profit opportunities. With these profiles, companies have a unique opportunity to be forward-thinking and to act more efficiently toward the emerging carbon market. Innovest has teamed with leading law firms, global energy brokers, carbon commerce service providers, and energy future speculators in order to be as well rounded as possible when offering their services. The target clients for Innovest's Carbon Finance Practice package are investment banks, insurance companies, industrial corporations, strategic investors, and pension fund managers (See: http://www.innovestgroup.com/carbonpractice.pdf).

Carbon banks are also emerging. The International Carbon Bank and Exchange (See: http://www.carbonexchange.com/about/) "provides a platform that enables individual and corporate clients to keep track of Greenhouse Gases in a secure environment." Emission baselines and emission reduction credits (ERCs) can be established and then banked, retired, or made available on the market to consumers or industry. A firm, for example, may start using wind energy in an action that produces ERCs, which can then be banked or sold. Even individuals can cover their emissions through the Bank. For example, a typical sports utility vehicle may emit 7-8 metric tons of carbon per year. A consumer owning such a vehicle can voluntarily buy ERCs to cover these emissions through the ClimateSafe program (used for consumers). A firm within an industry can similarly buy and sell ERCs through the CarbonExchange program (used for industry). These offsets can be bought and sold in real-time on this website. The ICBE uses the revenue from this program to finance renewable energy systems in

home and community systems (http://www.carbonexchange.com). This Bank and Exchange is operating under the "baseline and credits" notion, helping an individual, firm or industry verify and certify the baseline emissions and the changes made in the emissions leading to marketable credits. The baseline and credits idea may involve government agencies (as in the Canadian GERT project), but does not necessarily do so, with the baseline and credits evolving mainly in the private sector.

The spontaneous trading that is occurring right now is an encouraging sign of things to come. The pilot projects that are taking place are helping both industry and consumers to become proactive when dealing with GHG emissions reductions. By being able to establish baselines today, industries can monitor and reduce their emissions before any regulations are passed. Then, if in the future carbon regulations are put in place, industries that have already acted can be rewarded for the reductions they have made according to their established baseline. As noted earlier, the Canadian government, for example, has already assured industries that they will honor reductions that are occurring now from established baselines. Similar assurances could be forthcoming within the U.S. as well. Entities establishing baselines and certifying credits might also be rewarded by the market in being ready and able to move quickly if and when markets emerge.

The many pilot programs illustrate there is significant interest in this area, and this interest is only growing. This interest perhaps reflects the reality that once the government and public become more aware of what is occurring, the likelihood increases that laws will be passed placing caps on emissions levels. Being proactive on a voluntary basis may also prove to be more cost efficient as compared to some point in time in the near future when they are required to take actions not to their advantage. This

spontaneity, however, is still affected by the activities of governments even though not directed by government actions.

Current Status of U.S. Stance on Reducing Emissions in Accord with the Kyoto Protocol, Including Recent Legislation

In March 2001, President Bush announced in a letter to Senator Hagel (R-NE) that the Administration would not regulate carbon emissions from power plants, in effect formally abandoning the emission targets set under the Kyoto Protocol (see Lindla, 2001). The Bush Administration cited a government study that indicated energy costs, especially in California and other parts of the western U.S., would increase substantively if controls were put on carbon dioxide emissions. These formerly agreed-upon levels were to reduce emissions in the U.S. to 7% below 1990 levels during the period between 2008-2012. Currently, it is unclear when the U.S. will stabilize its carbon emissions. A November 1997 report by the Energy Information Administration projects U.S. carbon emissions to be 45% *above* 1990 levels by 2020 (See: http://cnie.org/nle/clim-5.html). However, proposals addressing the 1997 protocol are still going forward.

Two bills have been introduced into the 107th Congress propose a cap and trade system to address carbon emissions. Bills (S. 556 and H.R. 1256) introduced by Senator Jeffords (I-VT) and Representative Waxman, (D-CA), would reduce and cap emissions of carbon dioxide from electric generating facilities beginning in 2007. Both the Jeffords bill titled the "Clean Power Act of 2001" and the Waxman bill titled "Clean Smokestacks Act of 2001" would set aggregate carbon dioxide emissions from power

plants to the level in 1990, which was also the year of focus in the Kyoto protocol. Both bills note that the regulations promulgated under this legislation "may include … market-oriented mechanisms (such as emissions trading based on generation performance standards, auctions, or other allocation methods)… (S. 556, Sec. 132(b)(1)(B)(ii))."

At the international level, in Kyoto related developments, 178 countries agreed to sign a revised agreement during the Conference of the Parties meeting in Bonn, Germany, in July, 2001. Perhaps the most substantive outcome is the feature that allows counting new carbon (since 1990) stored in forest, grazing and cropland against current emissions. The U.S. chose not to be a party to this agreement, and it is not clear at this time what this implies for the overall success of the effort, due to the fact that the large U.S. economy contributes a substantive part of the total emissions of carbon. It is likely that the new agreement will lead to at least some limited market trading in emissions, and perhaps in storage, within and among countries in the agreement. Also, it is not clear if countries in the agreement choosing to cover emissions with storage could or would seek such storage in the U.S., although there does not seem to be any constraint on doing so. As highlighted in Lynne and Kruse (2001), the Montana Coalition has already helped some Montana Indian Tribes sell storage to a European entity through a brokerage, financial products firm in Chicago that is specializing in helping buyers and sellers find market clearing prices for storage (see http://www.carbon.unl.edu for further discussion of Kyoto, and current developments on both the domestic and international levels).

Intriguingly, in terms of market development in the U.S., the Environmental Protection Agency is already authorized under Title IV of the 1990 Clean Air Act Amendments to include market-oriented mechanisms, such as emissions trading, to

implement reduction targets and meet aggregate emissions limits for certain air pollutants (See: http://cnie.org/nle/clim-5.html). So, moving to emissions trading in carbon is not as dramatic a change in policy as it may sound, if at some point the U.S. decided to participate in the new Kyoto related agreement. (Although nothing equivalent to trading in carbon storage exists in the 1990 Amendment: Perhaps federal legislation would be needed to start trade in carbon storage). The EPA in consort with the private sector has already been operating a cap and trade mechanism in sulfur allowances, starting in 1993.

Cap and Trade Evolving to a Satisfactory Mechanism: Acid Rain and Sulfur Dioxide as a Case Study

Perhaps we can learn from the acid rain and sulfur (dioxide) problem and the mix of mechanisms being used in its resolution. While the sulfur released from burning hydrocarbons does not drive global warming, it does result in more sulfur dioxide in the atmosphere which then converts to sulfuric acid through combining with water (vapor) in the atmosphere, eventually precipitating down wind as acidic atmospheric vapor, acid rain and acidic snow. Acidic vapor and precipitation causes direct plant surface damage, while also reducing the ph of soil, making it more acidic which some plants cannot tolerate (although other plants thrive in it). The task is to describe what kinds of mechanisms emerged in the case of the acid rain problem involving 1) a cap on sulfur emissions, 2) an initial allocation of allowances, and 3) a sulfur allowances market

especially active toward the end of each year, and then again in the early part of the year surrounding a government sponsored auction of allowances every March. We draw heavily on Ellerman et al. (2000). The story starts back several years before the Title IV Amendment to the !990 Clean Air Act that helped the move to tradable emission allowances for sulfur. As noted earlier, we now are seeing an emerging third- way approach to the environmental enhancement problem, with this cap and trading system in sulfur a case in point.

Setting the Caps on Sulfur Emissions

Initially, approximately a 10 million ton per year cap on national emissions was advertised, which was then to be adjusted downward to a 9 million ton per year cap by the year 2000 and beyond (Ellerman et al., 2000, p. 6). It was decided to not place limits on emissions by region of the country but rather to treat emissions as a national problem even though the science suggested that wind patterns would move more sulfur loaded precipitation to the northeastern areas of the country, and lead to some haze problems in other areas. We need to keep in mind that the initial impetus for the sulfur program was the occurrence of acidic precipitation in the New England area of the northeastern U. S. and attributed to the use of high sulfur coal in Midwestern states. One way to address this problem would have been to provide fewer allowances to the dirtiest generators in the Midwest.

Initial Allocation of Sulfur Allowances

Each generator, mostly power plants, where each given a share of the overall limit as represented in 1-ton emission allowances. The starting point was calculated based on the assumption of (2.5 pounds of SO_2 / million Btus of heat input) multiplied by the baseline fuel amount used in the 1985-1987 period (Ellerman et al., 2000, p. 7). Ironically, the high sulfur burning power plants in the Midwest were given bonus allowances that recognized they produced more sulfur. These same firms were asked to install scrubbers, however, which then also gave them arguably more than a fair share of extra allowances to sell on the sulfur market. Western, generally newer power plants that were using lower sulfur coal or other fuel sources in the 1980s were given allowances in accordance with their lower emissions, so to some extent bore part of the burden of the dirtiest generators in other areas.

Interplay of Legislative, Administrative, Judicial, Special District and Market Forums in the Initial Allocation

A long history of interaction among the various decision forums led to the initial amendments to the 1990 Clean Air Act. The first legislation was put in place with the 1970 Clean Air Act which set forward stringent command and control procedures for improving air quality. It was clear by the time of the amendments in 1977 and again in 1982 that the Act was not achieving what had been intended. During the 1980s,

Midwestern and Appalachian high sulfur coal producing states effectively opposed any new acid rain controls. Debates over burning the high sulfur coal from the eastern coal mines led to allowing such burning as long as the plants installed scrubbers, which was a gain for the high sulfur coal mines (Ellerman, 2000, p. 16) and a relative loss for western coal mines that had low sulfur coal. The environmental movement of the late 1980s plus an administration open to market approaches to environmental enhancement brought the 1990 Amendments. The Environmental Defense Fund had proposed emissions trading (Ellerman et al., 2000, p. 22). Some concerns were expressed in the early years, prior to implementing the markets, over the possibility of hot spots and the market being too thin to reveal true value. We still moved ahead, with the Title IV amendments to create emissions trading eventually being approved on April 3, 1990 (Ellerman et al., 2000, p. 29).

Ellerman et al. (2000, p. 34) warn how the subsequent political economic allocation of initial allowances could reflect the reality of disbursed costs and concentrated benefits, i.e., those with the most to gain lobbying effectively for the most allowances. They carefully studied the role of special interests, and especially focused in on key committee chairs in the congress, as to document the influence each may have had on the distribution of allowances. One would have expected some rent seeking, i.e., decisions in the specific interests of certain key congressional and committee leaders. Yet, they conclude that initial allocations were pretty much the result of majoritarian politics rather than special interests or chairs of key congressional committees being the driving force. Even so, the allocation was not particularly uniform, with the Midwestern

and some Eastern states gaining relative to the Western states, overall, with perhaps the exception of Georgia who lost (Ellerman et al., 2000, p. 74).

Initial Trading and Outcomes

Intriguingly, sulfur dioxide emissions were falling during the 10 years or so before the market was implemented in 1993 due in part to deregulation of railroads that lowered shipping rates for low sulfur coal, and making it financially feasible to ship the coal to the Midwest. This was especially the case for locations within 600-1000 miles of western areas such as the Powder River Basin in Wyoming (Ellerman et al., 2000, p. 91). Arguably, these lower emissions were also due to the pending and actual changes in the 1990 Clean Air Act Amendments. The changing environmental mood and prodding by the administration in the late 1980s also perhaps had some affect on the shift to the lower sulfur coal, albeit the financial incentives to do so were also strong.

Starting in 1993, all emitters had to demonstrate each year that they had a sufficient number of allowances in their portfolios to cover the emissions during the previous calendar year. If not, they had to purchase allowances by January 31, or, if they had extra allowances, said allowances could be sold. The EPA became the central repository for the data on what firms held how many allowances, including changes in holdings as the market started to operate. The EPA in effect maintains a spreadsheet named the National Allowance Data Base (Ellerman et al., 2000, p. 38). Intriguingly, emitters had banked 7.4 million tons of allowances by 1997 for future use and emitted 1/3 less than allowed in Phase I for the period 1995-1999, with Phase II covering the

period 2000 and beyond. In the early years, most firms banked the allowances or traded them among plants within a company rather than place them on the market (Ellerman et al., 2000, p. 161). Also, a substantive number of firms outside those identified at the outset volunteered to be part of the program (Ellerman et al., 2000, p. 137) suggesting a moral dimension at work, i.e., many firms wanted to do the right thing even though not required to be in the market.

Trading is done privately and no government review is needed; only the amount transacted has to be reported. Auctions are also held by the EPA in March for a small 2-3 percent of the allowances.

Reallocations of Sulfur Allowances in the Market

Starting with Phase II in the year 2000, firms have moved to evermore external trading, including outside their own firms within a larger company, and to less banking of allowances. Firms may buy and sell on the spot market, or in the market for allowances representing coverage of emissions in each of the next seven years. The March, EPA auction sells only spot (this year) and advance allowances for the seventh year. Intriguingly, the auction is revenue neutral with each firm receiving part of the revenue from the auction in proportion to shares held back from each firm.

Prices for a 1-ton allowance have varied from an initial range of about $150 in 1994 to a low of $65 in 1996, and a high of $210 in 1998. Prices have since stabilized in a $170 – 210 range. The most recent EPA Auction (March, 2001) yielded prices in the lower end of this range. Intriguingly, prices are substantively lower than the simulation

models predicted prior to the markets being opened, suggesting costs of reducing sulfur emissions are lower than the models expected. This was largely due to the models underestimating the extent of voluntary compliance and "over-investment" (using this term from Ellerman et al., 2000, p. 308) in compliance by the regulated firms. We can attribute this to the models not accounting for the extent to which the moral dimension is at work, both the regulated and the unregulated wanting to the do the right thing. As a result, the models had not accounted for the extra allowances available on the market. The commentary in Ellerman et al. (2000) suggests they see efficiency as the only motivation in a market, while the evidence suggests something else along the lines of doing the right thing as an ongoing reality.

Several private financial and brokerage firms have become active in helping expedite the market including Cantor-Fitzgerald, Emission Exchange Corporation and Fieldston Publications. Individuals or groups (e.g., environmental groups) may also purchase or sell allowances. An environmental group may wish to in effect retire an allowance by purchasing an allowance each year, and thus contribute to an effective long-term reduction in the total number of allowances available on the market.

Conclusions and Lessons for the Carbon Markets

As Ellerman et al. (2000, p. 316) point out, trading can work; politics may play a lesser role than we might anticipate; markets where no markets existed before can develop; trading is surprisingly adaptive and can handle surprises; and, perhaps too many allowances were given away at the outset. Generally, the sulfur market has been deemed

by most observers to be a success, reflecting a joint legitimization of both the government and the market… each has its role… in solving a serious environmental problem. Yet, they warn us to be careful in extrapolating this case to others. The sulfur case reflects a small number of highly visible polluters all within one country, and all of which can be monitored (i.e., all emissions have to be measured and monitored, and emissions reported to the EPA). The carbon dioxide case is far more complex, involving all countries on the planet and many sources, small and large, and no easy way to monitor who is emitting how much carbon dioxide when and where. Also, the technologies available for reducing or removing carbon dioxide emissions are not as simply applied in that carbon is what we are burning when we use hydrocarbons, so it is pervasive and fundamental to the use of hydrocarbons, whereas sulfur is a relatively minor by-product.

The ways in which carbon dioxide is different than sulfur are very significant. A comparison can be made with water quality. Both regulatory and market approaches for point source surface water dischargers have been quite successful because the sources are relatively small in number and more easily found. However, non-point source pollution, especially to groundwater, has been far, far more difficult because the pollution can come from many sources and land uses and is even hard to measure. In the case of carbon, the emissions come from all of us as well, and is even more difficult to measure. As noted at the outset, this is a public goods problem of global scale, and will likely require public action to solve, and markets will likely have to play a lesser, while still substantive, role.

Intriguingly, one of the most promising technologies to address the emissions problem is carbon sequestration, including sequestering the carbon in growing plants and in agricultural land. As a result, much like with less costly low sulfur coal and scrubbers

as technologies applied to the sulfur problem, we would expect to see the application of carbon sequestration technologies in agriculture applied to the carbon dioxide problem. We might also posit that the prices of carbon allowances, if these are ever available on a carbon emissions market, will reflect the relative costs of applying the technologies to store carbon in a variety of places, including that of agricultural land in Nebraska. We can reasonably expect a relationship evolving as between the carbon emissions allowances market and the carbon storage market not unlike that which has evolved as between the low sulfur coal market and the sulfur (emissions) allowances market. If carbon storage goes down in price, we would expect the carbon allowances market to also go down; similarly, a rising price in the carbon allowances market would tend to drive higher prices in the carbon storage market.

Not unlike a hydrocarbon fuels market (e.g., natural gas, crude oil, coal), except operating on much shorter time frames, we would expect the carbon (a hydrocarbon) stored in soil to fluctuate in price as supply and demand conditions change. We need to think in terms of the root zone of agricultural crops in Nebraska as essentially a mine holding hydrocarbon (organic material) that has value on the carbon storage market. The stock in the mine, i.e., the carbon in the root zone, increases and decreases with the flow of carbon into and out of the stock with the flow driven by market prices for the stock in place in the land.

As noted in Lynne and Kruse (2001), thinking of organic material/ carbon as a hydrocarbon in a mine also raises the possibility that carbon might fall under mineral law rather than under standard contract for services business law. We refer the reader to Thorson (2001) regarding how carbon will be viewed in law and thus how the market

transaction can be structured. Also, see Lynne and Kruse (2001) for more discussion of the connection of the economic market to the legal instrument used to expedite it.

Conclusions and Final Considerations

President Bush has noted that (Time, April 9), "Our economy has slowed down…. We also have an energy crisis and the idea of placing caps on CO_2 does not make economic sense." The President has also noted the great promise that technology holds in finding ways to capture, store and otherwise sequester carbon. Events in the latter part of the year 2001 involving destruction of the World Trade Center in New York also suggests we face formidable problems in establishing world wide trade that is acceptable to at least most if not all, whether in emissions allowances and storage credits, or any other kinds of goods.

In spite of these challenges, we still face the reality of two kinds of scarcity in 1) the capacity of the atmosphere to absorb carbon and 2) the capacity of terrestrial systems, with the focus on agricultural land, to store the carbon. We also face the reality that these carry public good features, i.e., it is difficult to determine who is emitting how much carbon dioxide when and where, which generally, then, will require government involvement of some kind. Market processes, such as carbon allowance and storage credit markets, will operate in consort with government programs.

This paper focuses on alternative mechanisms to address that scarcity. We seek a framework … a conceptual framework… within which to order our thinking and to help Nebraskans influence the kinds of mechanisms needed to solve the problem. By understanding the features of the main kinds of mechanisms, we are positioned to better

understand how to interact with others in the process of building appropriate mechanisms, e.g., green payment programs and/or carbon storage markets.

We need to particularly assess the possibility that limits will be placed on carbon emissions. If such limits are set as being proposed in S. 556 and H.R. 1256, i.e., scarcity is recognized and legitimized through government set caps, it is clear that carbon sequestration emerges as one possible action that perhaps can be used to help offset the scarcity in the atmospheric capacity. At this point, it it could well become possible that we could use Nebraska's terrestrial sinks (as well as other areas in the Great Plains) represented in agricultural lands to store substantive amounts of carbon. At some point once the sale of carbon storage in place moves forward, we would also eventually experience scarcity in the capacity to sequester and to store carbon which then gives greater economic value to storage credits in place (see Lynne and Kruse, 2001) and representing carbon stored in ground. It is the possibility of Nebraskans being able to profit from selling or receiving a green payment for such credits on which we are focused in considering alternative mechanisms.

Four general kinds of mechanisms were delineated, including 1) regulatory based direct mechanisms; 2) tax and subsidy mechanisms; 3) spontaneous trade evolving to an optimal mechanism; and, 4) cap and trade evolving to a satisfactory mechanism. Each has its own advantages and disadvantages. In considering each, we need to recognize that the conservation work of the past has helped in reducing soil erosion, and ensured enhancements through conservation of natural resources generally. In looking to the future, we perhaps need to think creatively on how to mix and match the various mechanisms. An especially promising new approach, that will likely prove long-term to

be a viable partner with other more commonly used control and subsidy programs is represented in the cap and trade mechanism, as has been applied in reducing acid rain through government set caps on sulfur emissions and market trading in sulfur allowances.

Spontaneous evolution of carbon emission and storage markets without a proactive role by government is also a possibility. A number of firms are investing substantive amounts of time and money, speculating that this path will bear fruit. Yet, in light of recent steps taken by the current administration, and the experience with the sulfur allowances market, it is seems most likely we well eventually move down some variant of a cap and trade path instead.

This third way path recognizes an equally legitimate role for both government and market, with government working with the citizenry to set the cap, with the market playing the equally substantive role of handling the trading. Producing offsets through storage of carbon in place within farming and ranching operations requires technological and best management practice changes leading to the sequestration of carbon. The market trading serves the additional role of helping find the least cost and most profitable way to implement technological changes either to reduce emissions or to provide storage.

Nebraskans need to seriously consider how to be a productive player while working within such a cap and trade mechanism. It appears that cap and trade is a mechanism, an institutional design that when integrated with the various government approaches used in the past, can be effective. It is likely here to stay, and to be around in the longer run. It behooves us to look to the more distant future such that we may be positioned to be a leader operating with new mechanism in the policy mix. One alternative is to take a case study approach to this problem, perhaps even developing a

simulated carbon storage market, and, thus positioning Nebraskans to eventually participate in an actual market. Hahn (1998, p. 57) also concluded that the case-study or project, approach is a viable way in the face of great uncertainty to address the problems of mechanism design.

In the interim, however, the possibility that the "Conservation Security Act of 2001 (S. 932 and H.R. 1949)" will provide green payments for conservation practices bears watching. Senator Harkin (who introduced the Senate version), the new chair of the agricultural committee, recently declared "There will be significant changes" (quoted in the High Plains Journal) in the new farm bill, including more and larger payments, incentives for farmers and ranchers to practice conservation generally which also generally means more carbon (organic matter) sequestered in the land. Also, the "Clean Power (and Smokestakes) Act of 2001 (S. 556 and H.R. 1256)" would put in place aggregate emissions limits on carbon dioxide much like the limits placed on sulfur emissions in the Title IV, 1990 Amendments to the Clean Air Act. If by chance some version of both sets of bills are passed, we will likely see a mixture of green payments through more comprehensive government based conservation programs and prices emerging in markets for carbon stored in place. Payments and prices can jointly prove effective, as government and market work together in productive partnership.

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