Colorado State University

ENERGY AND ENVIRONMENTAL SECURITY INITIATIVE
UNIVERSITY OF COLORADO LAW SCHOOL

Colorado Energy Research Institute
Colorado School of Mines

THE COLORADO CLIMATE CHANGE MARKETS ACT

EXECUTIVE SUMMARY REPORT

Report to the Colorado Legislature, March 15th, 2007

Authors: Rich Conant,[1] Dennis Ojima,[1] Keith Paustian,[1] Kevin Doran,[2] Lakshman Guruswamy,[2] Rob Keating,[2] Doug Vilsack,[2] Dag Nummedal,[3] Jason Deardoff,[3] and Genevieve Young[4]

PREAMBLE

Pursuant to C.R.S. § 25-1-1303, the University of Colorado, the Colorado State University and the Colorado School of Mines were commissioned to conduct research related to carbon emissions and storage. Colorado State University was charged with conducting research on the potential for the use of terrestrial carbon sequestration in agricultural, rangeland, and forest soils as a technique for mitigating the emissions of greenhouse gases (GHGs) in the state. The Colorado School of Mines reported on the potential for the use of geologic carbon sequestration; and the University of Colorado conducted research on emerging international and domestic markets in GHGs and on private firm activities in various economic sectors to reduce GHG emissions.

In contrast to some other large technological challenges over the past decades, such as the Manhattan project or the space race, climate change mitigation is not about national competition, it is about global collaboration to invent, deploy and operate large systems of new technologies and processes designed to reduce emissions and sequester (or "put away") those emissions we cannot yet eliminate. The State of Colorado is already the home for much of the research that has developed the understanding of climate change—through long-term basic research programs at the State's three research universities and the many prominent national research centers located in Colorado, such as the National Renewable Energy Laboratory (NREL), the National Center for Atmospheric Research (NCAR), the National Oceanic and Atmospheric Administration (NOAA), and the National Institute of Standards and Technologies (NIST). Moreover, Colorado citizens spoke in 2004 with an impressive renewable portfolio standard for our State; and Colorado is leading by example through greening its operations under a State Executive Order.

The enactment of the Colorado Climate Change Markets Act in 2006 was a significant first step on the road to a Colorado that could play a leading role in the greatest environmental challenge the world has ever faced. The act was included in the same House Bill that also established the Colorado Renewable Energy Collaboratory (HB 1322). This action expressed a clear understanding on the part of the Legislature that for Colorado to become a leader in the industry of climate change mitigation, it should start by forging links between Colorado's energy research institutions.

[1] Natural Resource Ecology Laboratory; Campus Delivery 1499; Colorado State University; Fort Collins, CO 80523-1499.
[2] University of Colorado Law School; Wolf Law Building 322F, UC-Boulder, CO 80309-0401.
[3] Colorado Energy Research Institute; Colorado School of Mines; 1500 Illinois St., Golden, CO 80401-1887.
[4] Colorado Geological Survey; 1313 Sherman St., Denver, CO 80203.

EXECUTIVE SUMMARY

The Need for Action

Over the last several decades industrial, transportation, agricultural, and household activities have led to dramatic increases in the atmospheric concentrations of carbon dioxide (CO_2; +43% increase), methane (CH_4; +148%), and nitrous oxide (N_2O; +18%)—the main greenhouse gases. All three of these gases are produced naturally by undisturbed ecosystems, but anthropogenic sources account for the majority of observed increases in atmospheric concentrations. Examples of anthropogenic sources of GHG emissions include the burning of fossil fuels for electricity production and transportation; agricultural activities, including the use of fertilizers that lead to higher N_2O concentrations; changes in land use; and deforestation. Actions to mitigate climate change will be expensive, but will still be vastly less than the cost of inaction.[5] Inaction implies covering the costs of reconstruction following increased frequencies of extreme storms, forest fires, relocation of resource industries, and global sea level rise with associated coastal flooding. Climate models show that warming will be most pronounced in high elevation areas, affecting the Rocky Mountain west more than any other U.S. region outside of the Arctic. Agriculture, the ski industry, as well as the real estate and retail sectors will be affected by problems such as decreased snow pack, increased incidence of severe weather and wildfire, all problems exacerbated by climate change. The insurance industry is already including climate impacts in risk assessments and the investment community is increasingly focusing on the risks of climate change.

Policy decisions made across the world are increasingly focused on stimulation of the most effective forms of direct action to reduce the threat posed by climate change. Responses that are now emerging in technology, policy and trading circles around the world include increasing energy efficiency, fuel switching to lower emissions fuels, improving land management practices to reduce emissions and sequester carbon, accelerating deployment of renewable energy generation facilities, and promoting industrial demand for some greenhouse gases (such as CO_2 for enhanced oil recovery). While some of these steps are cost effective in today's market, like replacing old, inefficient light bulbs, businesses are hesitant to take major steps to reduce their GHG emissions without government incentives or other support mechanisms. To spur these efforts, some countries have set up trading programs to force businesses to internalize the environmental costs of their emissions. Emissions trading can help to fix a market price for carbon by setting a cap on emissions and allowing firms the flexibility to trade emissions allowances or credits amongst themselves, thereby reducing the compliance costs of achieving an environmental target. By establishing a price signal for GHG emissions, long-term GHG reduction projects can become viable business opportunities, not just the product of government handouts. The removal of CO_2 from the atmosphere and storing it in geologic formations, soil and vegetation (i.e., carbon sequestration) is an example of one of these opportunities. Due to our current reliance of fossil fuels to satisfy our energy needs and lack of viable low-carbon alternatives to fully supply energy demands, carbon sequestration is a necessity if we are to reduce our impacts on the climate.

Potential Market Options

Emissions trading can improve the performance of a regulatory framework by giving sources affected by caps or restrictions on emissions the flexibility to achieve compliance more cheaply

[5] Sir Nicholas Stern. 2007. *The Economics of Climate Change: The Stern Review. Cambridge* University Press.

than with command and control alternatives or through the use of environmental taxes. The U.S. already has experience with emissions trading and found it to be successful in reducing nitrogen oxides and sulfur dioxide emissions, the key compounds in the formation of acid rain. While the causes and effects of acid rain are more apparent, GHG emissions and their climate forcing effects are much more worrisome. A study released by Tufts University in October 2006 calculated the cost of global warming at $20 trillion per year by the end of the century.[6] Another estimate pegs the costs of GHG reduction and mitigation at 6% to 8% of global economic output by 2100, while an exhaustive study commissioned by the United Kingdom predicts that climate change will cost an average of 5% of GDP per year, with total costs rising to 20% of GDP if a broader range of risks and impacts of climate change are taken into account. [5]

To mitigate this massive risk and take advantage of economic opportunities, the European Union, a consortium of northeastern states, the State of California, and groups of western states—as well as private firms in various economic sectors—are either already trading on emissions markets or taking major steps to do so. This recent proliferation of markets for GHG emissions stands to have a tremendous impact on the world's economy and environment. Governor Arnold Schwarzenegger of California has stated that the "economic argument for market-based solutions to global warming are overwhelming."[7] The global market for CO_2 credits totaled $21.47 billion through October 2006, up from $11 billion for the entirety of 2005.[8] Additionally, the United Kingdom's Environmental Market is expected to double in value by 2017 and will create at least 100,000 more jobs in the next decade.[9] Private firms are also realizing that they can improve their bottom-line while cashing in on the goodwill associated with "going green." Large corporations such as Wal-Mart, IBM, Ford and Whole Foods have taken steps to reduce their emissions through energy efficiency projects and purchases of green power. Colorado companies such as Aspen Ski Company, Ball Corporation, Roche Colorado, New Belgium Brewery, Vail Resorts, and others have also begun to take action. Voluntary markets like the Chicago Climate Exchange (CCX) and reduction initiatives like those encouraged by the Federal government's Climate VISION program, present opportunities for companies to reduce and trade emissions effectively.[10]

Emerging markets for the trade of GHG emissions present significant economic and environmental opportunities for Colorado. At the federal level, there are over half a dozen legislative proposals that seek to advance climate change mitigation through a national cap-and-trade system for GHGs. Though a federal GHG emission reduction program has yet to emerge, state-based emissions trading programs have been initiated in the wake of increasing public support for climate change mitigation and in anticipation of a federal program. States are positioning themselves to take advantage of caps on emissions by getting ahead of the curve and setting up a system to make sure they get credit for their reductions later. The following are some of the reasons Colorado should consider ways to contribute to a market-based approach to

---

6 Jeremy Lovell, *Climate Change Inaction Will Cost Trillions: Study*, REUTERS, October 13, 2006, available at http://www.commondreams.org/headlines06/1013-08.htm.

7 Stephen Siciliano, *Schwarzenegger Again Asks Bush to Waive Federal Preemption of Greenhouse Gases,* ENVIRONMENT REPORTER, Nov. 3, 2006.

8 *Market for CO2 credits reaches $22B*, Greenwire, October 27, 2006 at http://eenews.net/greenwire/print/2006/10/27/12.

9 Joanna Geary, *Black Country Poised to Grab Green Opportunity*, BIRMINGHAM POST, Feb. 24, 2007, at Business 17.

10 *See* Chicago Climate Exchange, http://www.chicagoclimatex.com/; *See* Climate Vision, http://www.climatevision.gov/.

emissions reductions: (1) Colorado's arid environment and climate-dependent economy make it vulnerable to climate change; (2) the State has great potential to profit from an emissions trading market due to its vast capacity for renewable energy production and carbon sequestration in geologic formations, forests and soils; (3) it provides businesses in Colorado more surety as to the potential GHG regulatory requirements in the state; and (4) other states in the region including California, Oregon, Washington, New Mexico and Arizona have formed the Western Regional Climate Action Initiative (WRCAI), an emissions trading platform that will increase the stability of emerging emissions trading markets in the U.S. and be easily accessible to similarly situated Colorado emitters.

CO_2 in Colorado- Sources and Sinks

Carbon sequestration is a "bridging technology" capable of taking some of the CO_2 out of the atmosphere. It is a "bridge" until that day in the future when the entire planet has moved beyond a dependence on hydrocarbons for energy. This bridging technology is already in a rapid phase of growth. Grasslands, forests, and croplands around the world take up and release CO_2 equivalent to about 10 times the magnitude of fossil fuel emissions to the atmosphere. However, the *net* exchange from between ecosystems and the atmosphere (the so-called biosphere "sink") is small. Some areas in the U.S. and elsewhere have implemented farm, ranch and forest management practices that help to increase the storage of carbon in soils and biomass. Such practices not only store carbon, but they also improve the quality of the soil. Substantial amounts of CO_2 are also being sequestered today in a number of oil and gas fields around the world. Yet, much more must be done.

Colorado CO_2 Sources

- In year 2000, CO_2 emissions were more than 92 million short tons in Colorado and are projected to increase by 2.4 percent per year through 2025.[11]
- Power generation in the state relies primarily on coal and as a result, 36 MT of CO_2 or 42 percent of the total emissions in Colorado are emitted from power plants in the utility sector.[12]
- Annual CH_4 emissions are approximately 15 million tons (CO_2 equivalent) per year with major contributions coming from coal mining, livestock, and landfills.
- Annual N_2O estimates are about 5 million tons (CO_2 equivalent) per year coming primarily from fertilizer use in croplands.

Colorado CO_2 Sinks

- Colorado contains large areas of four major land use types: rangeland (14.4 M Ha; 35.5 M acres), forest (7.7 M Ha; 18.9 M acres), cropland (2.75 M Ha; 6.8 M acres), and urban land (0.26 M Ha; 0.64 M acres) and Colorado has one of the largest livestock industries in the nation.

---

[11] Genevieve B.C. Young, Vanessa A. Lintz, Beth L. Widmann, David A. Bird, and James A. Cappa, 2007, CO_2 Sequestration Potential of Colorado, Colorado Geological Survey, Resource Series 45.

[12] U.S. Environmental Protection Agency, 2004.

- Currently, land uses in Colorado are sequestering 10-15 million tons of CO_2 per year, mainly on forest lands.
- The potential for increased carbon sequestration on agricultural lands is several-fold higher than current rates with implementation of best management practices, and there are opportunities to significantly reduce emissions of other greenhouse gases through improved land management. Equally important are practices and policies that *maintain* the large carbon stocks already existing in vegetation and soils, which are increasing vulnerable to losses under a warming climate, due to heightened risk for drought, fires, pest outbreaks, etc.
- Urban and suburban land, concentrated along the Front Range Corridor, is the fastest growing land use in the state. Significant opportunities exist to enhance carbon sequestration in "green areas" of urban lands and efficient urban landscaping can help reduce emissions through reducing energy demands for heating and cooling.
- Colorado has great potential for geological CO_2 storage because of its numerous oil and gas fields, deep coal seams that cannot be mined, and abundant deep aquifers. The total volume of potential storage in Colorado is estimated at more than 700 billion tons, providing several hundred years of carbon storage based on current state emission levels. The highest storage potential lies within the Denver basin and Canyon City embayment east of the Front Range, and the Piceance and Sand Wash basins in northwestern Colorado. The specifics are:
    - There are about 122 oil and gas fields in Colorado with a cumulative storage capacity of more than 1.9 billion tons of CO_2.
    - The estimate of CO_2 sequestration capacity for coalbed methane reservoirs in seven pilot study regions across the state is almost 18 billion tons.
    - Deep saline aquifer storage potential is conservatively estimated at 688 billion tons.
    - Mineral silicates also offer a promising sequestration option here in Colorado.
- Colorado is also the home to one of the Nation's earliest CO_2-enhanced oil recovery operations (Rangely field, NW Colorado, started in 1982), which has demonstrated that many of the state's oil reservoirs are suitable for CO_2 storage.

Some large international oil companies envision a future carbon sequestration industry on the scale of today's global oil and gas industry. Some of these companies also envision the future use of hydrocarbons not only with reduced emissions but zero emissions. This industry will capture and transport greenhouse gases from points of origin to identified and characterized storage targets, inject the gases (in supercritical fluid form) into the earth and predict and monitor the migration and ultimate permanent storage of the materials underground. Overall, geological carbon sequestration will open up a major new sector of economic activity associated with high demand for advanced technology and labor with new skills. Those states that invest in developing the support base for these new technologies the earliest will probably be the home for most of the new companies that will serve a wide range of related specialty needs across the globe.

Recommendations

By taking a number of actions, Colorado can position itself to begin mitigating greenhouse gas emissions and take advantage of existing emissions trading markets and prepare for a federal regulatory regime that will likely involve mandatory GHG reductions and a trading system:

(1) Set up a Colorado Office for Climate Change to study and implement policies for mitigating and adapting to climate change in the state and to educate stakeholders on the opportunities and risks associated with GHG reductions.

(2) Base Colorado's GHG inventory on the Department of Energy's 1605(b) standards to ensure that emission reduction projects in Colorado are credited if a federal GHG reduction or trading program emerges.

(3) Establish working linkages with existing emissions trading programs, especially the recently formed Western Regional Climate Action Initiative (WRCAI).

(4) Leverage with other states on developing a registry and trading program to reduce costs to Colorado businesses and citizens.

(5) Promote state policies to enable carbon sequestration in all potential sinks, including agricultural, grazing, and forest lands and geological targets.

(6) Stimulate the growth of a new carbon capture and sequestration industry in the state by providing incentives for companies with the appropriate skills to explore new business opportunities.

(7) Because carbon sequestration is a start-up industry and agricultural practice, the related research community is also just "starting out." Research support from the state at this time would therefore help ensure a leadership role for Colorado in this emerging industry.