Comment

SEQUESTRATION, SCIENCE, AND THE LAW: AN ANALYSIS OF THE SEQUESTRATION COMPONENT OF THE CALIFORNIA AND NORTHEASTERN STATES' PLANS TO CURB GLOBAL WARMING

BY
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The impacts of global warming are extensive and disastrous. Efforts to curb global warming are in full swing around the world. Although the U.S. federal government has yet to create a nationwide global warming prevention program, several states have started their own initiatives. Each initiative is anchored by the science surrounding global warming. In particular, each state-level program has a carbon sequestration element that is based upon current knowledge of how carbon is stored. This Comment describes the three major methods for carbon sequestration and examines the sequestration component of the initiatives in California and the northeastern states. The Comment argues that each program utilizes techniques that are scientifically sound; however, neither program takes advantage of the best available technology. Further, the methods of allowable sequestration are limited to sequestration by trees which is only one way that sequestration may be achieved. Lastly, this Comment demonstrates that while the sequestration components may underestimate the amount of carbon stored, this is inline with the overall policy of reducing emissions to slow the effects of global warming.

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I. INTRODUCTION

The impacts of global warming will be extensive and catastrophic.[1] Since 1990, the earth has experienced the ten warmest years ever, thus the effects of global warming are not a future threat but a present one.[2] In fact, global warming is "arguably the most far-reaching and formidable

[1] *See* INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC), CLIMATE CHANGE 2001: SYNTHESIS REPORT SUMMARY FOR POLICYMAKERS 8–16 (2001), *available at* http://www.qas.org/news/press_roomclimate_change/media/4th _spm2feb07.pdf (describing the projected effects of climate change, including increased sea levels, increased threats to human health, changes in ecological productivity, and increases in extreme climate events). *See also* IPCC, CLIMATE CHANGE 2007: THE PHYSICAL SCIENCE BASIS, SUMMARY FOR POLICYMAKERS 5 (2007), *available at* http://www.ipcc.ch/SPM2feb07.pdf (reporting that improved understanding of climate change has confirmed, with "a very high confidence," that human activities have increased greenhouse gas levels in the atmosphere since 1750, and this increase has had a warming effect on the earth).

[2] United States Environmental Protection Agency (U.S. EPA), *Climate Change—Science, Temperature Changes*, http://www.epa.gov/climatechange/science/recenttc.html (last visited Nov. 18, 2007) (citing reports from the National Oceanic and Atmospheric Administration and the National Aeronautics and Space Administration).

environmental issue facing the world."[3] Largely as a result of human activities in the past 200 years, the atmospheric concentrations of greenhouse gases (GHG) have increased; for example, carbon dioxide (CO_2) has increased by thirty percent.[4] Fossil fuels, which are the energy source the majority of the world's population depends upon, are the chief source of GHG emissions.[5] Although future energy demands are uncertain, rising human population and growing development ensure the continued increase of GHG emissions.[6] In order to stave off the effects of global warming, it is imperative for governments to develop laws and regulations limiting GHG emissions. Understanding the science behind global warming "is fundamental to determining the appropriate policy response."[7]

As the science surrounding global warming becomes more concrete, governments around the world are actively attempting to control factors that contribute to climate change. Since the increases in CO_2 are primarily attributable to fossil fuel emissions, it is one of the major components that climate change laws seek to control. The ultimate goal for these programs is to stabilize GHG emissions from human activities; since it is almost impossible that these emissions will ever be zero, this goal demands that GHG emissions be offset by methods that remove an equal amount of atmospheric GHG.[8] One process that achieves this offsetting purpose is carbon sequestration. The majority of programs, laws, and protocols designed to limit the effects of climate change include a carbon sequestration component.[9]

Sequestration of carbon has been called "the only credible option that would allow the continued use of fossil energy without the threat of dangerously altering Earth's climate system."[10] In 2004, sequestration of carbon in the United States offset approximately eleven percent of U.S. GHG

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3 PEW CTR. ON GLOBAL CLIMATE CHANGE, U.S. TECHNOLOGY AND INNOVATION POLICIES: LESSONS FOR CLIMATE CHANGE 2 (2003), *available at* http://www.pewclimate.org/docUploads/US%20Technology%20%26%20Innovation%20Policies%20%28pdf%29%2Epdf.

4 IPCC, CLIMATE CHANGE 1995: THE SCIENCE OF CLIMATE CHANGE, SUMMARY FOR POLICYMAKERS 1 (1995), *available at* http://www.ipcc.ch/pdf/climate _changes-1995/spm-science-of-climate-change.pdf.

5 *See* PEW CTR. ON GLOBAL CLIMATE CHANGE, *supra* note 3, at 2 (indicating that "over 85 percent of all U.S. GHG emissions can be attributed to energy consumption").

6 *Id.* at 3.

7 DAVID HUNTER ET AL., INTERNATIONAL ENVIRONMENTAL LAW AND POLICY 606 (2d ed. 2002).

8 PEW CTR. ON GLOBAL CLIMATE CHANGE, *supra* note 3, at 4.

9 *See, e.g.*, Kyoto Protocol to the United Nations Framework Convention on Climate Change, art. 2, ¶ 1(a)(iv), Dec. 11, 1997, 37 I.L.M. 22 [hereinafter Kyoto Protocol], *available at* http://unfccc.int/resource/docs/convkp/kpeng.pdf (allowing for sequestration credit). For other examples, see the California Climate Action Registry and the Regional Greenhouse Gas Initiative in the Northeast states, discussed *infra* Parts III.B and III.C. California Climate Action Registry, http://www.climateregistry.org/ (last visited Nov. 18, 2007) [hereinafter CCAR]; Regional Greenhouse Gas Initiative in the Northeast states, http://www.rggi.org/ (last visited Nov. 18, 2007) [hereinafter RGGI].

10 Editorial, *Capturing Carbon*, 442 NATURE 601, 602 (2006) [hereinafter NATURE Editorial] ("Speeding up deployment [of carbon sequestration] must . . . become a priority on the global energy agenda.").

emissions.[11] Since the switch from fossil fuel energy sources to alternative energy sources will not happen overnight, sequestration is crucial.[12] Critics of sequestration offsets in climate change laws argue that any credit allowed for sequestration "justifies a carbon emission that would otherwise not have occurred because it would have put the user of fossil fuels over its emission allowance."[13] While it is true that reductions are the ultimate goal when confronting global warming, it is imperative to have other options that decrease the amount of GHG in the atmosphere because it is unlikely that fossil fuels, for example coal, will ever cease to be used as an energy source.[14] Carbon dioxide sequestration has emerged as a viable option to offset the impacts of fossil fuels by removing CO_2 from the atmosphere.[15] It is an important element of GHG emissions control programs in California and the northeastern United States.[16]

Although the practices allowed by the GHG emissions programs in California and the northeastern states to receive credits do not adequately utilize scientific research and current technology, the methods allowed support an overall policy of reducing emissions, as opposed to merely escaping culpability through offsets.[17] This Comment will first discuss three major methods for carbon sequestration and the current state of the science supporting those methods. Then, it will outline two state-level greenhouse gas regulation regimes, from California and the northeastern states. In

[11] U.S. EPA, INVENTORY OF U.S. GREENHOUSE GAS EMISSIONS AND SINKS: 1990–2004, at 2–19 (2006), *available at* http://epa.gov/climatechange/emissions/downloads06/06_Complete_Report.pdf.

[12] *See* PEW CTR. ON GLOBAL CLIMATE CHANGE, *supra* note 3, at 5 (discussing the fact that it will be necessary to "replace or retrofit *hundreds* of electric power plants and *tens of millions* of vehicles" to curb global warming, and that "[t]echnological change on this scale cannot happen overnight").

[13] Forests and European Union Res. Network, *Climate Change—Carbon Sinks*, http://www.fern.org/campaign_area_extension.html?clid=6&id=3355 (last visited Nov. 18, 2007) (detailing arguments against the use of sequestration methods in relation to the Kyoto Protocol).

[14] Climate expert David G. Hawkins stated "[u]nder any plausible scenarios of global coal use, we are going to need carbon dioxide capture and storage." Matthew L. Wald, *In a Test of Capturing Carbon Dioxide, Perhaps a Way to Temper Global Warming*, N.Y. TIMES, Mar. 15, 2007, at C3, *available at* http://www.nytimes.com/2007/03/15/business/15carbon.html?ex=1331611200&en=db8831d023e2f1ff&ei=5090&partner=rssuserland&emc=rss. Hawkins has also said

> [t]here are three big tools in the global warming toolbox: efficiency, renewable energy, and carbon capture and storage for fossil fuels. . . . We need to use all of them. It will take all three to put together national and global recipes that can bring the problem of global warming under control.

Craig Canine, *How to Clean Coal*, ONEARTH, Fall 2005, at 29, *available at* http://www.nrdc.org/onearth/05fal/coal1.asp?r=n. Although Hawkins is mainly discussing carbon capture and storage, this viewpoint could easily be expanded to encompass all methods of sequestration.

[15] *See generally* Klaus S. Lackner, *A Guide to CO_2 Sequestration*, 300 SCI. 1677, 1677–78 (2003) (discussing the various ways that sequestration can slow the effects of climate change).

[16] *See* CCAR, *supra* note 9. *See also* discussion of the Regional Greenhouse Gas Initiative, *infra* Part III.C.

[17] *See* discussion *infra* Parts III.B, III.C.

particular, this Comment will analyze the carbon sequestration aspects of these programs in light of current scientific knowledge and technology. Finally, this Comment will demonstrate that although the sequestration components of these regimes are incomplete, they support an overall policy of emissions reductions, as opposed to an overall policy of offsetting emissions, which is in line with the ultimate goal of the GHG emissions programs. As the United States begins to seriously consider a federal GHG emission law, it is necessary to examine the relationship between science and the overall policy of the emissions reduction program.

II. CARBON DIOXIDE SEQUESTRATION SCIENCE

Carbon dioxide sequestration is an important component of programs designed to limit GHG emissions. In order to analyze the efficacy of the carbon sequestration components of these programs, it is imperative to understand the science that underlies each program. There are three main areas of carbon sequestration science: sequestration in forests, sequestration in agriculture, and carbon capture and storage sequestration.

A. Forests

Sequestration of carbon by photosynthesis is currently the only practical form of air capture of carbon dioxide.[18] Forests in the United States sequester 200 targograms (Tg) of carbon from the atmosphere per year, which is equivalent to approximately ten percent of the United States' CO_2 emissions from burning fossil fuels.[19] Changes in forest management practices could increase carbon sequestration by 100 to 200 Tg of carbon per year.[20] Some of these changes include afforestation of cropland and pasture, reducing deforestation, reducing harvest of forests, increasing agroforestry, and planting trees in urban and suburban regions.[21]

There are many uncertainties regarding the effectiveness of carbon sequestration in forest biomass. As forests mature, the rate of carbon sequestration declines.[22] Thus, carbon sequestration may be very high at the beginning of the life of a forest but then decrease as the forest ages. Besides

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18 Lackner, *supra* note 15, at 1678.

19 Richard Birdsey, Kurt Pregitzer & Alan Lucier, *Forest Carbon Management in the United States: 1600–2100*, 35 J. ENVTL. QUALITY 1461, 1461 (2006) [hereinafter Birdsey et al., *Forest Carbon Management*].

20 *Id.* at 1465.

21 *See* Richard Birdsey, Ralph Allg & Darlus Adams, *Mitigation Activities in the Forest Sector to Reduce Emissions and Enhance Sinks of Greenhouse Gases*, *in* THE IMPACT OF CLIMATE CHANGE ON AMERICA'S FORESTS: A TECHNICAL DOCUMENT SUPPORTING THE 2000 USDA FOREST SERVICE RPA ASSESSMENT 113–15 (Linda A. Joyce & Richard Birdsey eds., 2000) [hereinafter Birdsey et al., *Mitigation Activities*].

22 Birdsey et al., *Forest Carbon Management*, *supra* note 19, at 1466 ("The rate of carbon sequestration, as indicated by either net primary productivity (NPP) or net ecosystem productivity (NEP), increases after disturbance to a variable point in time, and then declines as forests mature.").

photosynthesis, other processes are crucial to the carbon cycle in forests, for example, soils in forests store carbon. Further, unexpected events like forest fires can release significant quantities of CO_2 into the atmosphere.[23] Additionally, forest harvesting and product use can have different impacts on carbon flow.[24] Also, ground-level ozone, or smog, can impede the ability of trees to uptake CO_2.[25] Despite these uncertainties, forest sequestration is one of the most widely used sequestration techniques. It is also an essential part of both the California and northeastern states' GHG emissions programs, which will be shown below.

B. Agriculture

Agriculture is another arena where carbon can be sequestered in great quantities. Globally, agriculture accounts for fourteen percent of greenhouse gas emissions.[26] There are approximately 11 to 21 Tg of carbon per year stored in agricultural soils.[27] Cropland has the potential to sequester up to 75 to 208 more Tg of carbon per year.[28] Grazing lands have the potential to store 18 to 90 Tg of carbon per year.[29] There are several ways for agricultural lands to sequester more carbon, including allowing fields to remain fallow or engaging in conservation tillage practices.[30] Scientists have discovered Amazon soil that is rich with carbon that allows crops to grow at higher rates.[31] Bio-char, which is formed when organic matter in oxygen-poor environments smolders instead of burns, is the main component of this soil and contributes to its high carbon content.[32] The process that is used to make biofuel results in bio-char that could be used to grow crops.[33] There is no known ceiling for bio-char addition to soil.[34] Currently, neither the California nor the northeastern states' programs allow for credit based on agricultural sequestration.

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23 Birdsey et al., *Forest Carbon Management*, *supra* note 19, at 1468.

24 Birdsey et al., *Mitigation Activities*, *supra* note 21, at 112–13.

25 Andrew Revkin, *Ozone May Offset Capacity of Trees to Sop Up Carbon*, N.Y. TIMES, Oct. 16, 2003, at A18.

26 Charles W. Rice, *Introduction to Special Section on Greenhouse Gases and Carbon Sequestration in Agriculture and Forestry*, 35 J. ENVTL. QUALITY 1338, 1338 (2006).

27 Erandathie Lokupitiya & Keith Paustian, *Agricultural Soil Greenhouse Gas Emissions: A Review of National Inventory Methods*, 35 J. ENVTL. QUALITY 1413, 1423 (2006).

28 RATTAN LAL ET AL., THE POTENTIAL OF U.S. CROPLAND TO SEQUESTER CARBON AND MITIGATE THE GREENHOUSE EFFECT 83 (1999).

29 Rice, *supra* note 26, at 1339.

30 *See* U.S. EPA, *supra* note 11, at 7–15 (indicating that carbon sequestration in agricultural land that remained cropland led to an increase in carbon stocks that was mostly due to "annual cropland enrolled in the Conservation Reserve Program, intensification of crop production by limiting the use of bare-summer fallow in semi-arid regions, increased hay production, and adopting of conservation tillage").

31 Emma Marris, *Putting the Carbon Back: Black is the New Green*, 442 NATURE 624, 624–25 (2006).

32 *Id.* at 625.

33 *Id.* (explaining that farm waste can be smoldered, which produces volatile organic molecules—a primary component of biodiesel—and can then be reapplied to the fields to sequester carbon and grow the next crop).

34 *Id.* at 626.

C. Carbon Capture and Storage

Injection of carbon dioxide gas into underground reservoirs is another option for carbon sequestration. Carbon capture and storage (CCS) technology involves capturing carbon as it is released from the gas stream of large emitters, such as coal burning power plants.[35] The captured carbon is then injected into reservoirs below the ground.[36] The reservoir may be below the ocean, as with a project in Norway that has been in existence since 1996.[37] Or it may be below land, as with former oil reservoirs in Texas that have been injected with CO_2 gas.[38] There is potential for this mode of sequestration to provide economic gains which would offset the costs, because injecting the gas into underground reservoirs may mobilize oil.[39]

Some issues may prevent CCS from becoming a viable option for carbon sequestration. Currently, the equipment required to extract CO_2 from the gas stream is expensive and takes up a lot of space.[40] Thus, there is a

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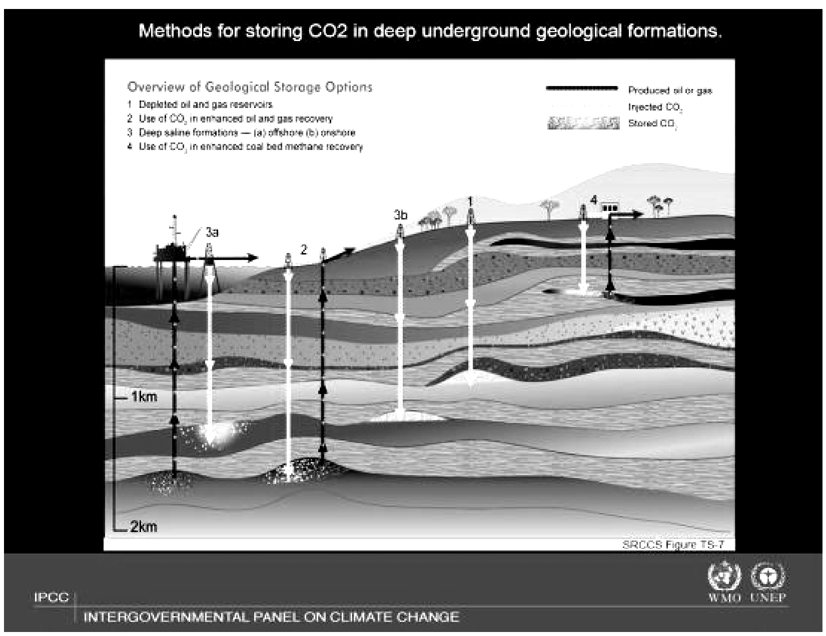
[35] Quirin Schiermeier, *Putting the Carbon Back: The Hundred Billion Tonne Challenge*, 442 NATURE 620, 622 (2006).

[36] *Id.* at 620. A graphical illustration is useful in understanding how CCS works:



IPCC, *Presentations and Graphics, Methods for Storing CO2 in Deep Underground Geological Formations*, http://www.arch.rivm.nl/env/int/ipcc/pages-media/srccs-find/graphics/jpg/large/Figure%20TS-07.jpg (last visited Nov. 18, 2007).

[37] Schiermeier, *supra* note 35, at 621 (describing a Norwegian project that has pumped around 10 million tons of carbon dioxide 1000 meters beneath the North Sea bed).

[38] Lackner, *supra* note 15, at 1677 (describing a project in Texas that consumes 20 million tons of CO_2 per year by injecting it into oil reservoirs).

[39] *Id.*

[40] Schiermeier, *supra* note 35, at 622.

need for development of more advanced technology in this area. Additionally, there is concern that some reservoirs may leak or suddenly release large quantities of CO_2, which would be catastrophic because it could trigger tsunamis or landslides.[41] Lastly, the long-term viability of saline aquifers is currently unclear.[42]

Despite these uncertainties, a recent report stated that "no knowledge gaps today appear to cast doubt on the fundamental likelihood of the feasibility of CCS."[43] Additionally, large-scale CCS projects are conceivable and necessary in order to increase public confidence in CCS and to address some unresolved technical issues.[44] Although this area shows the most potential to sequester carbon, neither the California nor the northeastern states' programs presently allow for credit based on CCS technology.

III. PROGRAMS INVOLVING SEQUESTRATION

A. The Move Toward State Regulation

The Kyoto Protocol (Protocol) was the first significant piece of legislation to include a carbon sequestration component.[45] The Protocol was developed by the United Nations Framework Convention on Climate Change (UNFCCC) in 1997.[46] It purports to set "binding targets to reduce emissions 5.2 percent below 1990 levels by 2012."[47] Article 3 of the Protocol allows credit for countries that engage in carbon sequestration practices.[48] Although it was ratified by more than 100 countries, the Protocol was rejected by the United States.[49] Despite its rejection by the United States, the Protocol is useful to study when examining the relevance of carbon sequestration in today's society.

When the UNFCCC was faced with how to determine carbon sequestration credits, it turned to the Intergovernmental Panel on Climate Change (IPCC) to develop a report regarding carbon sequestration in

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41 *Id.* at 621.

42 Lackner, *supra* note 15, at 1677.

43 MASS. INST. OF TECH., THE FUTURE OF COAL 44 (2007), *available at* http://web.mit.edu/coal/The_Future_of_Coal.pdf.

44 *Id.* at 97; *see also* Wald, *supra* note 14 (describing "the largest demonstration yet of capturing carbon dioxide from a coal-fired power plant and pumping it deep underground"). The article also points out that this will be the first power plant to use CCS. *Id.* The overall cost of the project will be $800 million, which the company hopes to supplant with federal grants and charging customers. *Id.*

45 Kyoto Protocol, *supra* note 9.

46 *Id.*

47 Pew Ctr. on Climate Change, *History of Kyoto Protocol*, http://www.pewclimate.org/history_of_kyoto.cfm (last visited Nov. 18, 2007).

48 Kyoto Protocol, *supra* note 9, art. 3, ¶ 4; *see also* HUNTER ET AL., *supra* note 7, at 645–46 (indicating the indefiniteness of Article 3 language and the necessity of negotiators to limit the reach of Article 3 to afforestation, reforestation, deforestation, conservation, forest management, and harvesting).

49 Pew Ctr. on Climate Change, *supra* note 47.

relation to land use, land-use changes, and forestry activities.[50] The report indicated uncertainties in the science of carbon sequestration. Although forests exposed to high concentrations of CO_2 have higher growth rates, the long-term effect of high CO_2 fertilization is unknown.[51] Additionally, the report showed that nitrogen deposition from anthropogenic sources will increase carbon sequestration.[52] The report also concluded that the sequestration ability of ecosystems changes over time, especially as a forest matures.[53] The UNFCCC used these results to declare that countries will not receive credits for sequestration rates that increased due to industrial CO_2 emissions and industrial nitrogen deposits.[54] Countries also may not credit increased sequestration from a forest's age.[55] Although the UNFCCC used scientific evidence in making the policy surrounding sequestration, it failed to indicate how these policies should be implemented. How are countries to determine how much sequestration is due to natural levels of CO_2 and nitrogen in the atmosphere and how much is due to human induced levels of those gases? Further, how are countries to determine how age affects the amount sequestered? Thus, science was used in developing the policy but there was a disconnect between the policy and the implications of putting that policy into practice. This disconnect was detrimental to the credibility of the sequestration component of the Protocol; this is a mistake that should be avoided as states develop GHG programs.

Although the federal government has declined to actively legislate to prevent climate change, many states have enacted legislation that directly targets GHG emissions.[56] Some of these state programs may end up serving as models for future federal GHG legislation.[57] Thus, it is important to consider these regimes. Two of the most prominent GHG programs are from California and a group of northeastern states.

B. California

In 2000, the California legislature created the California Climate Action Registry (CCAR), a non-profit organization that allows for the

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50 Dagmar Lohan, *Assessing the Mechanisms for the Input of Scientific Information Into the UNFCCC*, 17 COLO. J. INT'L ENVTL. L. & POL'Y 249, 300 (2006).

51 IPCC, LAND USE, LAND-USE CHANGE, AND FORESTRY: A SPECIAL REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 4 (2000), *available at* http://www.ipcc.ch/ipccreports/sres/land_use/index.htm.

52 *Id.*

53 *Id.*

54 U.N. Framework Convention on Climate Change, Oct. 29–Nov. 12, 2001, *Report of the Conference of the Parties on Its Seventh Session—Addendum: Part Two: Action Taken By the Conference of the Parties*, at 56, U.N. Doc FCCC/CP/2001/13/Add.1 (Jan. 21, 2002).

55 *Id.*

56 Robert B. McKinstry, Jr., *Laboratories for Local Solutions for Global Problems: State, Local, and Private Leadership in Developing Strategies to Mitigate the Causes and Effects of Climate Change*, 12 PENN ST. ENVTL. L. REV. 1, 15 (2004).

57 *Id.* at 16.

voluntary registration of greenhouse gas emissions.[58] The CCAR strives "to help companies and organizations with operations in the state to establish GHG emissions baselines against which any future GHG emission reduction requirements may be applied."[59] The CCAR has been recognized as "a gold standard for GHG accounting and monitoring."[60] Members of the CCAR report emissions based on the industry they belong to (e.g. forestry, power, cement). The emissions reported include direct and indirect emissions from the member's activities.[61]

On September 27, 2006, California passed a landmark global warming law which "establishes a first-in-the-world comprehensive program of regulatory and market mechanisms to achieve real, quantifiable, cost-effective reductions of greenhouse gases."[62] The California Global Warming Solutions Act of 2006 (Act)[63] aims to reduce greenhouse gas emissions statewide to 1990 levels by 2020.[64] The Act provides for mandatory reporting of greenhouse gases, starting with sources that contribute the most to statewide emissions.[65] Entities that voluntarily participated in the CCAR by December 31, 2006 are not obligated to drastically change their reporting or verification program under the Act, unless compliance necessitates such changes.[66] The State Air Resources Board is charged with determining a statewide GHG emissions limit by January 1, 2008, what early action measures can be used to decrease GHG emissions, and which methods for emissions reductions are acceptable, including sequestration.[67] Because the legislation is relatively new, it is uncertain what standards California will use to measure sequestration but presumably it will be similar to, if not identical to, the methods that the CCAR utilizes.

The CCAR allows for emissions offsets based on carbon sequestration.[68] However, the CCAR does not have a certification process for offsets and there appears to be no limit to the offsets that a company

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[58] Cal. Energy Comm'n, *Climate Change Proceedings*, http://www.energy.ca.gov/global_climate_change/ (last visited Nov. 18, 2007); *see also* S. 1771, 1999–2000 Leg., Reg. Sess.(Cal. 2000) (enabling legislation that created the California Climate Action Registry).

[59] CCAR, *About Us*, http://www.climateregistry.org/aboutus/ (last visited Nov. 18, 2007).

[60] Press Release, CCAR, California Climate Action Registry to Play Key Role in Implementation of Landmark Global Warming Bill (Nov. 17, 2006), *available at* http://www.climateregistry.org/docs/press/ab_32_signing_092706.pdf.

[61] CAL. CLIMATE ACTION REGISTRY, CALIFORNIA CLIMATE ACTION REGISTRY GENERAL REPORTING PROTOCOL: REPORTING ENTITY-WIDE GREENHOUSE GAS EMISSIONS VERSION 2.2, at 3–4 (2007), *available at* http://climateregistry.org/docs/PROTOCOLS/GRP%20V2-arch2007_web.pdf.

[62] Press Release, Office of the Governor of Cal., Gov. Schwarzenegger Signs Landmark Legislation to Reduce Greenhouse Gas Emissions (Sept. 27, 2006), *available at* http://gov.ca.gov/index.php?/press-release/4111/).

[63] California Global Warming Solutions Act of 2006, CAL. HEALTH & SAFETY CODE §§ 38500–38598 (West 2006).

[64] A.B. 32, 2005–2006 Leg., Reg. Sess. (Cal. 2006).

[65] CAL. HEALTH & SAFETY CODE § 38530(b)(1) (West 2007).

[66] *Id.* § 38530(b)(3) (West 2007).

[67] *Id.* §§ 38550, 38560.5(a), 38561(f) (West 2007).

[68] *See* S. 812, 2001–2002 Leg., Reg. Sess. (Cal. 2002) (allowing for the Registry to include procedures to account for carbon sequestration).

can claim through the CCAR.[69] On the reporting sheets, members are allowed to indicate emissions management programs and emissions reduction projects. The 2005 public reports demonstrate that entities reporting offsets from projects did not quantify these amounts numerically, rather they were just generally mentioned.[70]

Carbon sequestration reporting is required of CCAR members that are forestry sector entities and projects. Entities include timber companies, while projects include a set of actions to "remove, reduce or prevent CO2 emissions in the atmosphere through the conservation and/or increase in on-site forest carbon stocks."[71] The CCAR links forestry sector parties to scientific information to assist in inventorying and monitoring carbon offsets for forest-based projects.[72]

The Forest Project Protocol (FPP) details how to measure carbon pools in a forest project area.[73] The CCAR requires forest project members to report carbon pools from tree biomass, standing dead biomass, and lying dead wood; they are not required to report carbon stored in shrubs and herbaceous understory, litter, soil, and wood products.[74] The carbon

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69 CCAR, *FAQ: Frequently Asked Questions*, http://www.climateregistry.org/aboutus/faq/ (last visited Nov. 18, 2007).

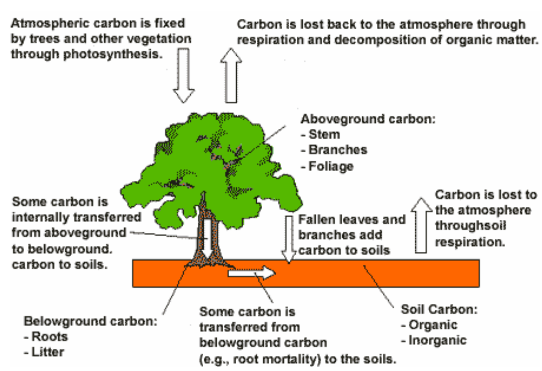
70 *See* CCAR, *Annual Emissions Report: Bentley Prince Street*, http://www.climateregistry.org/carrot/public/Reports.aspx (last visited Nov. 18, 2007) (describing offsets for planting trees, offering Cool Carpet options with their products, and general energy efficiency of their facilities).

71 CCAR, CALIFORNIA CLIMATE ACTION REGISTRY FOREST PROTOCOLS OVERVIEW 3 (2004), *available at* http://www.climateregistry.org/docs/protocols/forestry/04.06.14_final_forest_protocols_board_overview.pdf [hereinafter CCAR, FOREST PROTOCOLS OVERVIEW].

72 *Id.*

73 CCAR, FOREST PROJECT PROTOCOL 34 (2005), *available at* http://www.climateregistry.org/docs/PROTOCOLS/Forestry/Forest_Project_Protocol_10.21.04.pdf. The Forest Sector Protocol utilizes the same equations and provides the same information as the Forest Project Protocol. Therefore, when the Forest Project Protocol is referenced, the same applies for the Forest Sector Protocol. The main difference between the two types of protocols is that the Forest Project Protocol is designed for sequestration solely while the Forest Sector Protocol is for timber companies who have incidental sequestration. CCAR, FOREST PROTOCOLS OVERVIEW, *supra* note 71.

74 CCAR, FOREST PROJECT PROTOCOL, *supra* note 73. It is important to understand how carbon cycles through a forest ecosystem in order to understand what it means to accurately measure carbon in an forest. The following diagram provides an illustration of carbon cycling:



estimates are made using guidelines developed by Winrock International.[75] Winrock International recommends that entities use permanent sampling plots within the forest to monitor carbon pools.[76] By following Winrock's protocol, "a reasonable estimate of the net change in carbon stocks . . . can be achieved . . . within 10% of the true value of the mean at the 95% confidence level."[77]

The Winrock International report, relied upon by the CCAR to calculate biomass estimates of trees, based its findings on scientific research by Jennifer Jenkins.[78] According to the Jenkins study, carbon in live biomass is the most important carbon pool to measure in forests because it is the one that is most impacted by human activities and natural disturbances.[79] To determine the biomass of a forest on a large scale, Jenkins compiled studies that were performed by other scientists and developed species specific, diameter-based, allometric regression equations to determine the biomass of individual trees.[80]

To calculate standing dead biomass, the FPP instructs categorizing the biomass according to the species and its character (stump only, branches present, etc.).[81] For standing dead biomass with branches, the same allometric equations used for live trees should be utilized, and then leaf biomass should be subtracted.[82] If only a stump remains, or if the wood is lying dead wood, the volume and density should be calculated to determine the biomass.[83]

Although these regression equations allow measuring biomass with some degree of accuracy, their validity is not fully supported by the scientific community when applied to smaller spatial scales because at that level the likelihood of error is greater.[84] An alternative method to estimating biomass is remote sensing, which may provide validation to the equation-based estimates.[85]

U.S. EPA, *Local Scale: Carbon Pools in Forestry and Agriculture*, http://epa.gov/sequestration/local_scale.html (last visited Nov. 18, 2007).

75 CCAR, FOREST PROJECT PROTOCOL, *supra* note 73, at 40; WINROCK INT'L, METHODS FOR MEASURING AND MONITORING FORESTRY CARBON PROJECTS IN CALIFORNIA (2004), *available at* http://www.energy.ca.gov/reports/2004-10-29_500-04-072.PDF.

76 WINROCK INT'L, *supra* note 75, at 7.

77 *Id.* at 8.

78 *Id.* at 17.

79 Jennifer C. Jenkins et al., *National-Scale Biomass Estimators for United States Tree Species*, 49 FOREST SCI. 12, 13 (2003), *available at* http://www.uvm.edu/~jcjenkin/jenkins%20et%20al.%202003.pdf.

80 *Id.* at 13–14.

81 CCAR, FOREST PROJECT PROTOCOL, *supra* note 73, at 42–43.

82 *Id.* at 43. *See also* WINROCK INT'L, *supra* note 75, at 26.

83 CCAR, FOREST PROJECT PROTOCOL, *supra* note 73, at 42–44.

84 Richard Birdsey, *Data Gaps for Monitoring Forest Carbon in the United States: An Inventory Perspective*, 33 ENVIRONMENTAL MANAGEMENT S1, at S4 (Supp. 1 2004), *available at* http://www.fs.fed.us/ne/newtown_square/publications/other_publishers/OCR/ne_2004_birdsey001.pdf.

85 *Id.*

Although the CCAR has been commended for creating protocols and tools that allow companies to document their GHG emissions accurately and has been considered a "gold standard" for future measures,[86] the carbon sequestration component leaves much to be desired when considering the accuracy and diversity of sequestration options.

1. The CCAR fails to provide sequestration guidelines for non-forestry sector entities

Although non-forestry sector entities have the *option* to report offsets through sequestration programs, the CCAR merely leaves a space on their reporting form to indicate offset activities and fails to provide guidelines to actually quantify greenhouse gas emissions offset by their sequestration efforts. For the 2005 reporting period, out of thirty reports that were made public, only thirteen indicated they had any kind of emission reduction project.[87] Of those thirteen entities, all included a narrative of the project but did not quantify the amount of emissions that were actually offset by their project.[88] Out of all the projects mentioned in the reports, only two involved carbon sequestration programs.[89] Even if there were guidelines for determining emissions that could be offset by carbon sequestration projects, the CCAR would most likely not allow offsets since there is currently no certification process for carbon sequestration methods (with the exception of the FPPs).

Members of the CCAR would likely be more willing to use sequestration technology if the CCAR provided guidelines for entities to determine the amount of emissions sequestered through offset programs and provided a certification process for these emissions. Senate Bill 812 requires the CCAR to:

> [A]dopt procedures and protocols, including specified criteria, for the monitoring, estimating, calculating, reporting, and certifying of carbon stores and carbon dioxide emissions resulting from the conservation and conservation-based management of native forest reservoirs in California in order for registry participants to include the results of those conservation activities as a participant's registered emissions results, or as a part thereof.[90]

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86 GreenBiz.com, *California Climate Registry Makes Headway*, http://www.greenbiz.com/news/news_third.cfm?NewsID=25397 (last visited Nov. 18, 2007).

87 CCAR, *Annual Emissions Report*, *supra* note 70, *available at* http://www.climateregistry.org/CARROT/public/Reports.aspx (CCAR's database of public reports organized by reporting year).

88 *Id.* (the entities that reported an emissions reduction project were Bentley Prince Street, City and County of San Francisco, City of Palo Alto, Clif Bar & Co., Clipper Windpower, Hewlett-Packard, ICF International, Mojave Desert Air Quality Management District, Natural Resources Defense Council, Platte River Power Authority, The Climate Trust, The Pacific Forest Trust, and U.S. Borax).

89 *Id.* (only Clif Bar & Co. and The Climate Trust had sequestration offset projects).

90 S. 812, 2001–2002 Leg., Reg. Sess. (Cal. 2002) (introduction to the bill).

Although Senate Bill 812 was signed into law on September 7, 2002, the CCAR has yet to develop procedures and protocols for all of its members to report and certify carbon stores.[91]

2. The guidelines that the CCAR does provide for sequestration underestimate the amount of carbon stored in forests

Even though the CCAR provides guidelines for emissions reporting from carbon sequestration for the forestry sector, these guidelines underestimate the total amount of carbon stored in forests. The CCAR only requires forestry sector entities to report tree biomass, standing dead biomass, and lying dead wood.[92] This excludes the herbaceous understory, litter on the forest floor, and soil. Although these are not extremely large carbon pools when compared to the carbon stored in trees, the carbon pool in soil is still important to consider.[93] For instance:

> many cropland soils of the United States have lost as much as 50% of their original SOC [soil organic carbon] due to the effects of land clearing and tillage . . . . With proper management the US can put back much of the SOC depleted over the past two centuries.[94]

Thus, if a forest project entity is trying to revive an area with degraded soil and decides to turn it into a forest, the amount of carbon sequestered in the soil will greatly increase.

Although the sequestration component of the CCAR does not accurately measure carbon pools, it is still in line with the overall purpose of reducing emissions. Thus, underestimation of carbon sequestration is not necessarily a negative quality of the program. The sequestration component of the northeast states' GHG reduction program is based upon science that is similar to the California program. The northeastern states' program does account for more components of the carbon pool in a forest, however, it is not certain that this is an improvement upon the CCAR.

C. The Northeastern States

The Regional Greenhouse Gas Initiative (RGGI) is an effort shared by several northeastern states to create a regional cap-and-trade program to

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91 *See* State of California, STATE OF CALIFORNIA'S ACTIONS TO ADDRESS GLOBAL CLIMATE CHANGE § 2, *available at* http://www.climatechange.ca.gov/climate_action_team/reports/2005-12-08_STATE_
ACTIONS_REPORT.PDF (describing the history of climate change initiative in California).

92 CCAR, FOREST PROJECT PROTOCOL, *supra* note 73, at 34.

93 *See* WILLIAM H. SCHLESINGER, BIOGEOCHEMISTRY: AN ANALYSIS OF GLOBAL CHANGE 135 (Academic Press 2d. ed. 1997) (1991) (indicating that the soil in a temperate forest contains 11.8 kilograms of carbon per meter squared (mean) and that the biggest pool of terrestrial carbon is in soils).

94 Soil Sci. Soc'y of Am., CARBON SEQUESTRATION: POSITION OF THE SOIL SCIENCE SOCIETY OF AMERICA 2, *available at* http://www.soils.org/pdf/pos_paper_carb_seq.pdf.

regulate CO_2 emissions from power plants.[95] Since the focus of the RGGI is circumscribed to power plants, it is less ambitious than the CCAR, which seeks to apply the program to all entities. The RGGI began in 2003 and includes Connecticut, Delaware, Maine, New Hampshire, New Jersey, New York, and Vermont.[96] There are also several states that are "observers in the process."[97] The mission of RGGI is to "[d]evelop a multi-state cap-and-trade program covering greenhouse gas (GHG) emissions."[98]

Emissions of CO_2 from power plants in participating states will be capped at 121 million tons per year (the current level) beginning in 2009.[99] The RGGI calls for a thirty-five percent reduction in emissions by 2020.[100] Each power plant may not exceed their allowance, but the power plants may buy or sell allowances.[101] Additionally, the power plants may meet their emissions allowances through GHG reduction projects, which offset their total amount of emissions; offsets are limited to 3.3 percent of each plant's overall emissions.[102] For example, if a power plant is currently emitting 100 units and it is allotted 93.4 emission units, it can use sequestration to bring its emission level down to 96.7 units. The remaining 3.3 unit reduction required by RGGI will be achieved through control technologies. The purpose of the offset provision is to:

> [P]rovide for the award of CO_2 offset allowances to sponsors of CO_2 emissions offset projects or CO_2 emissions credit retirements that have reduced or avoided atmospheric loading of CO_2, CO_2 equivalent or sequestered carbon as demonstrated in accordance with the applicable provisions of this Subpart. The requirements of this Subpart seek to ensure that CO_2 offset allowances awarded represent CO_2 equivalent emission reductions or carbon sequestration that are real, additional, verifiable, enforceable, and permanent within the framework of a standards-based approach.[103]

Thus, the Model Rule seeks to "ensure" the accuracy of the offsets and the project.

The majority of projects that are eligible to qualify as offsets involve reducing emissions of GHG gases, however, one approved project allows

95 RGGI, *About RGGI*, http://www.rggi.org/about.htm (last visited Nov. 18, 2007).

96 *Id.*

97 RGGI, *Participating States*, http://www.rggi.org/states.htm (last visited Nov. 18, 2007) (indicating the District of Columbia, Massachusetts, Pennsylvania, Rhode Island, the Eastern Canadian Provinces, and New Brunswick are observers and that Maryland was expected to join RGGI in June 2007).

98 RGGI, *About RGGI*, *supra* note 95.

99 Press Release, RGGI, States Reach Agreement on Proposed Rules for the Nation's First Cap-and-Trade Program to Address Climate Change (Aug. 15, 2006), *available at* http://www.rggi.org/docs/model_rule_release_8_15_06.pdf.

100 *Id.*

101 *Id.*

102 *Id.*

103 REGIONAL GREENHOUSE GAS INITIATIVE MODEL RULE § XX-10.1 (2007) [hereinafter MODEL RULE].

sequestration through afforestation.[104] The project must allow the regulatory agency access to the physical site of the project to ensure its compliance and, if it is not in compliance, the regulatory agency has the ability to revoke "any and all CO_2 offset allowances."[105]

In order for the afforestation offset project to be eligible, it must: 1) be located on "land that has been in a non-forested state for at least 10 years preceding the commencement of the offset project," 2) be managed using "environmentally sustainable forestry practices," 3) contain mostly native species while avoiding introducing non-native species, and 4) have certification before a commercial timber harvest takes place.[106] To measure the amount of carbon sequestered, the Model Rule requires the project to make a baseline determination by measuring live above-ground tree biomass, live below-ground tree biomass, soil carbon, and dead organic matter that is made up of coarse woody debris (unless this pool is zero).[107] In addition, there are optional carbon pools that may be measured including understory, non-tree biomass, and dead organic matter on the forest floor.[108] Each carbon pool "must be directly measured using a measurement protocol and sample size that achieves a demonstrated quantified accuracy for the combined carbon pool measurement such that there is 95% confidence."[109] The chosen measurement system must have "an adequate sample size" and contain the minimum number of required sampling plots.[110]

The Model Rule does not provide an exact formula that should be used when determining the amount of carbon in the afforestation project; instead it directs sponsors to use guidelines established by the U.S. Department of Energy.[111] The Department of Energy utilizes the formula developed by Jenkins and employed by the CCAR to calculate living aboveground biomass,[112] and includes formulae from Sandra Brown and P. Schroeder specifically relating to pines and fir-spruce because the Jenkins equations are not as accurate for these species.[113] To determine this equation, Brown

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104 *Id.* § XX-10.3 (a)(1)(iii). *See also id.* § XX-10.3(a)(1) (describing approved projects such as "landfill methane capture and destruction," "reduction in emissions of sulfur hexafluoride," "reduction or avoidance of CO_2 emissions from natural gas, oil, or propane end-use combustion due to end-use energy efficiency," and "avoided methane emissions from agricultural manure management operations").

105 *Id.* §§ XX-10.3(g), 10.3(h).

106 *Id.* § XX-10.5(c)(1).

107 *Id.* § XX-10.5(c)(3).

108 *Id.* § XX-10.5(c)(3)(ii).

109 *Id.* § XX-10.5(c)(3)(vii).

110 *Id.* (indicating the minimum plot is calculated as follows: $n = (s \times 1.960)/(\text{mean} \times re)^2$ where n = the "number of sample plots for each reporting sub-population," s = standard deviation, mean = "mean reported carbon content for the sample population," and re = sampling error).

111 *Id.* § XX 10.5 (c)(3)(viii).

112 OFFICE OF POLICY AND INT'L AFFAIRS, U.S. DEP'T OF ENERGY, TECHNICAL GUIDELINES FOR VOLUNTARY REPORTING OF GREENHOUSE GASES (1605(b)) PROGRAM, ch. 1, app. 1, at 248 (2006), *available at* http://www.pi.energy.gov/enhancingGHGregistry/documents/PartIForestryAppendix.pdf.

113 *Id. See also* Sandra L. Brown & P. Schroeder, *Spatial Patterns of Aboveground Production and Mortality of Woody Biomass for Eastern U.S. Forests*, 9 ECOLOGICAL APPLICATIONS 968

and Schroeder compiled forest inventory data from the U.S. Forest Service Forest Inventory Analysis and used that information to determine parameters for regression equations, which could be used to estimate tree biomass from diameter.[114] In addition to equations that can be used to determine the baseline carbon pools of a project site, the U.S. Department of Energy report includes equations and techniques that can be used to determine changes in carbon pools over time.[115] To determine belowground tree biomass, the Department of Energy indicates that regression models based on knowledge of above-ground biomass are the most efficient method because other methods are time consuming.[116]

The Model Rule also requires projects to report soil carbon and dead organic matter. To measure soil carbon, projects must measure soil depth, soil bulk density, and the concentrations of carbon within the sample.[117] To measure carbon in dead wood, projects should measure wood volume and density and factor in the rate of decomposition.[118] Once each individual carbon pool is measured, they are added up to reach the baseline and then "[t]he net change in each carbon pool's carbon stock in each reporting sub-population is calculated by subtracting the baseline carbon stock . . . from the carbon stock at the time of current monitoring."[119] The amount of carbon sequestered in the offset project has to be measured "not less than every five years."[120] When the project reports the amount of carbon, the report must be verified by the regulatory agency or an independent verifier.[121] In addition to reporting changes in carbon pools, the offset project must allow a conservation easement to be placed on the property that indicates it will "be maintained in a forested state in perpetuity."[122] The RGGI sequestration component, while more carefully detailed than that of the CCAR, is not perfect.

1. The RGGI cap on carbon sequestration credit may be too limiting

The RGGI has been called "groundbreaking"[123] in its approach to creating a mandatory cap-and-trade program for greenhouse gases, however, its sequestration element could be improved. The RGGI's cap on emissions offsets from sequestration may be too limiting and may stifle the incentive to sequester carbon.

(1999) (detailing the research that led to the development of biomass equations for eastern tree species).

114 Brown & Schroeder, *supra* note 113, at 969–72.

115 U.S. DEP'T OF ENERGY, *supra* note 112, at 252.

116 *Id.* at 258.

117 *Id.* at 264–65.

118 *Id.* at 260–62.

119 MODEL RULE, *supra* note 103, § XX-10.5(c)(4)(ii).

120 *Id.* § XX-10.5(c)(5).

121 *Id.* § XX-10.5(c)(5)(ii).

122 *Id.* § XX-10.5(c)(6)(i).

123 *See* Union of Concerned Scientists, *Northeastern Governors Show Bold Leadership on Global Warming*, http://www.ucsusa.org/news/press_release/northeast-states-announce.html (last visited Nov. 18, 2007) (calling the initiative "groundbreaking" and "innovative").

The RGGI decision makers decided to put a cap on offsets for several reasons. First, there was a concern that "offsets are just one way of encouraging reductions outside a cap-and-trade system."[124] Along with that idea is the notion that offsets may benefit other areas but not the area immediately in the vicinity of the polluting power plant.[125] Second, there was trepidation regarding the practical implementation of the offset program.[126] How to quantify offsets was a major issue in part because a case-by-case basis is more effective than a standardized approach, yet the former would potentially drain the resources of the RGGI.[127] Third, sequestration in forests may be breached by a wildfire or other unpredictable event, thus there is a need for power plants to have a "diversified portfolio" of offsets.[128]

In light of these uncertainties, the RGGI decided to allow power plants to offset their allowances by 3.3 percent because that is approximately "half a source's emissions reduction obligation."[129] The guiding principle for this decision was that "at least 50% of avoided emissions should come from within the capped sector."[130] Although fifty percent of avoided emissions may be offset, the overall reduction allowance for offsets is only 3.3 percent. Since investing in an afforestation program will be costly for a power plant, the minimal offset may not be worth the costs. Although RGGI has a more accurate sequestration component than the CCAR, there is still room for improvement.

The CCAR program and the RGGI program are somewhat different in their approaches to offsets for carbon sequestration. It is imperative to determine which approach is the most consistent with the overall policy of reducing emissions as global warming becomes an issue at the forefront of policymakers' minds in the United States.

IV. THE INTERSECTION OF SCIENCE AND POLICY: CARBON SEQUESTRATION IN CALIFORNIA AND THE NORTHEASTERN STATES

The initiatives in California and the Northeast to combat climate change break new ground through their implementation of carbon sequestration science as a means to provide GHG emissions offsets. A combination of characteristics from both programs would serve to most effectively further the overall policy of the programs, which is to reduce GHG emissions.

Although the CCAR and the RGGI have some differences, the similarities between the sequestration programs are numerous. Of these

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124 RGGI, SUMMARY OF RGGI STAKEHOLDER WORKSHOP ON GHG OFFSETS 2, *available at* http://www.rggi.org/docs/offsets_workshopsummary.pdf.

125 *Id.* at 2.

126 *Id.* at 3–4.

127 *Id.* at 3.

128 *Id.* at 4.

129 Pew Ctr. on Global Climate Change, *Q & A: Regional Greenhouse Gas Initiative*, http://www.pewclimate.org/what_s_being_done/in_the_states/rggi/rggi.cfm (last visited Nov. 18, 2007).

130 RGGI, ANALYSIS SUPPORTING OFFSETS LIMIT RECOMMENDATION 2, *available at* http://www.rggi.org/docs/offsets_limit_5_1_06.pdf.

similarities, there are several areas where the programs could improve. First, the techniques that are utilized by both regimes to measure carbon sequestration are scientifically sound, yet they do not take advantage of the best available technology. Second, both programs fail to provide incentives for sequestration techniques that reach beyond the forestry sector. In considering these flaws with the strengths of the programs, the most effective sequestration component becomes apparent.

A. The science supporting the CCAR's and the RGGI's sequestration allowances is not the most accurate, however, it is in line with the overall policies of each program

Although the sequestration components of the CCAR and the RGGI are based on science that has been mostly accepted by the scientific community,[131] more accurate techniques are available. Both programs utilize the Jenkins formula for living tree biomass and similar formulas to calculate dead tree biomass. These techniques have been relied upon for many years by the scientific community and have proven to be accurate, for the most part.[132]

However, these techniques have been recently criticized because directly measuring biomass using a "non-random sampling approach" fails to adequately represent the mean regional biomass, which is a major premise these studies are based on.[133] The reasoning for this inaccuracy is that these types of techniques tend to be biased toward plots that contain trees with large diameters, thus resulting in an overestimation of biomass.[134] Additionally, allometric regression equations only measure stem volume (the trunk).[135] Also, forest height, which is not factored into the allometric regression equations used by the CCAR and the RGGI, has been called "a critical factor for controlling the magnitude of regional biomass density."[136] This may result in an overestimation of the amount of carbon sequestered in a forest. To remain on course with the ultimate goal of reducing emissions, it is imperative for sequestration components to never overestimate the amount of carbon sequestered. Thus, the RGGI and the CCAR should consider allowing participants to use other equations to calculate carbon sequestration.

131 *But see* Birdsey, *supra* note 84, at S4 (indicating that allometric regression analyses do not work well in smaller scale applications).

132 *See* Jingyun Fang et al., *Overestimated Biomass Carbon Pools of the Northern Mid- and High Latitude Forests*, 74 CLIMATIC CHANGE 355, 356 (2006) (indicating a need to accurately estimate carbon pools in forest biomass and "[f]orest inventory-based estimation with improved allometric regression equations is a way to accomplish such an accurate estimation").

133 *Id.*

134 *Id.*

135 *Id.*

136 *Id.* at 359–61.

B. The CCAR and the RGGI neglect to provide incentives for members to use sequestration methods beyond forests

As mentioned above, there are several emerging technologies to sequester carbon, however, the CCAR and the RGGI only officially acknowledge carbon sequestration in forests. This limited view of how to sequester carbon may be a result of the "need to go slow."[137] Both programs seem to take the approach that they should start small instead of overextending themselves at an early stage in the carbon sequestration process. While this viewpoint is understandable, considering that the impacts of global warming are already occurring,[138] it is imperative to have "[p]arallel development of several different approaches to carbon sequestration."[139] Thus, a slow start is unacceptable especially when there are viable alternatives available for entities to start using to sequester carbon. In particular, the CCAR and the RGGI should allow sequestration in agriculture, and through carbon capture and storage technology.

There are already programs that have agricultural component for their offset program. For instance, the Chicago Climate Exchange allows offsets for agricultural sequestration.[140] Their market-based approach allows farmers to change the way they manage their land or allow the land to go fallow and receive payment from entities that wish to offset their emissions.[141] This is similar to the way the RGGI approached the forest offsets, thus it does not seem like it would be difficult to incorporate this additional sequestration option. Since cropland has the potential to sequester up to 75 to 208 more Tg of carbon per year,[142] it would be prudent for the CCAR and the RGGI to allow entities to sequester carbon in agriculture.

Additionally, the CCAR and the RGGI should incorporate carbon capture and storage technology into their programs as a sequestration technique. There are more than 150 proposals for coal fired plants in the United States, yet few of these will be designed to include carbon capture

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137 RGGI, *supra* note 130, at 4.

138 Australian Broadcasting Corp., *Glaciers Melting Faster as Planet Warms*, http://abc.net.au/science/news/stories/2007/1836098.htm (last visited Nov. 18, 2007) (indicating that the United Nations has found mountain glaciers are melting faster and that 2006 was "one of the warmest years in many parts of the world").

139 NATURE Editorial, *supra* note 10.

140 *See* Chicago Climate Exch., *Agricultural Soil Carbon Offsets*, http://www.chicagoclimatex.com/content.jsf?id=781 (allowing offsets for "[c]omitting land to continuous no-till, strip-till, or ridge-till cropping in the central United States and other regions or countries as applicable" and "[i]nitiating grass cover planting in specified states, counties and parishes in the United States"). *See also* Chicago Climate Exch., *Emission Reduction Commitment*, http://www.chicagoclimatex.com/content.jsf?id=72 (describing the Chicago Climate Exchange as the first GHG emission registry where members must reduce their GHG emissions 6% below baseline by 2010).

141 Agriculture Online, *Farmers' Environmental Contributions Noted on Earth Day*, Apr. 22, 2005, http://www.agriculture.com/ag/story.jhtml?storyid=/templatedata/ag/story/data/agNews_050422crEARTHDAY.xml (last visited Nov. 18, 2007).

142 LAL ET AL., *supra* note 28.

technology.[143] One of the best ways to ensure carbon capture and storage is utilized is to "ensure that every new plant is 'capture-ready.'"[144] The CCAR and the RGGI could certainly encourage its power plant members to incorporate carbon capture and storage into their existing plants by allowing offsets for such advances and could demand new plants to be "capture ready." Since political will is necessary to make carbon capture and storage a widespread practice,[145] it is crucial for the CCAR and the RGGI to incorporate carbon capture and storage into their programs by allowing offsets for these projects.

C. Incorporating science and policy to create the most effective carbon sequestration component

Much of this Comment has described the science behind sequestration and how it is incorporated into the RGGI and the CCAR. The critique of the incorporation of sequestration revolves around what one legal scholar calls the "science process":[146] the process "we employ for describing something we want to know about the world around us and devising a means to provide an answer."[147] The science process is incredibly important in how scientists reach conclusions and how lawmakers subsequently apply those conclusions. To adequately answer questions that arise in the science process, such as what methods and data should be utilized to answer scientific questions, it is key to "deliberately and thoughtfully integrat[e] science with law and policy."[148] Thus, in approaching how to use science to develop a carbon sequestration component of GHG emissions legislation, it is important to consider how the science impacts the overall policy of the statute.

Three main policy considerations arise when examining how to apply science to a carbon sequestration component of GHG emissions legislation. First, what is the impact of underestimating the carbon in a forest? Second, how should the statute deal with the uncertainty that surrounds sequestration? Third, how should the statute incorporate technologies other than forest sequestration?

As indicated above, the CCAR underestimates the amount of carbon sequestered in a forest.[149] Although this underestimation is seen as a negative quality by the scientific community in many respects, could it be positive when considering the overall policy of the California Global Warming Solutions Act and CCAR? The overall policy of the California

143 NATURE Editorial, *supra* note 10, at 601.

144 Schiermeier, *supra* note 35, at 623.

145 NATURE Editorial, *supra* note 10.

146 Daniel Rohlf, Biosynthesis 3 (Mar. 20, 2007) (unpublished manuscript, on file with author).

147 *Id.*

148 *Id.*

149 *See supra* Part III.B.2.

Global Warming Solutions Act is to reduce emissions.[150] By underestimating the amount of carbon in forests, the CCAR serves to force reductions by entities that would have otherwise escaped culpability by offsetting their emissions with sequestration. Thus, a conclusion that scientists reached through the science process is important but policy must also inform how it is applied in the statute. Overall, when risks or uncertainties surround the science of a sequestration program, it is wise to underestimate the carbon contained in a forest.[151]

Many uncertainties surround sequestration in forests, as detailed above. What is the best way to deal with these uncertainties—policy-wise—in a GHG emissions program? Underestimation of carbon is one way. In terms of uncertainties relating to forest fires and other catastrophic events, the only real way to ensure entities are not claiming carbon sequestration for carbon that is no longer stored in biomass is to require certification. This could mean a forest manager would be required to have a government representative come out to inspect her forest and certify its sequestration capabilities at least once a year. The manager would be required to then report any large changes, such as a forest fire. Another method to address the uncertainties, especially in regard to declining rates of sequestration as forests mature, is to cap the amount of sequestration offsets that an entity may receive, like RGGI. This kind of cap would be an effective way to ensure that entities are not escaping liability to reduce their emissions.

This Comment argues that an ideal GHG emissions law would allow entities to sequester carbon through forest sequestration, agricultural management, and CCS technology. How should a GHG emissions law incorporate new technologies? The law should recognize existing sequestration technologies, like forests, agriculture, and CCS, and also leave room for new developments. A good model for allowing incorporation of new technological developments is the Clean Air Act.[152] Under the Clean Air Act, the Environmental Protection Agency, or the designated state, determines what the best available control technology is for a source that is applying to receive a permit.[153] Best available control technology is defined as:

> an emission limitation based on the maximum degree of reduction of each pollutant . . . which the permitting authority . . . determines is achievable for such facility through application of production processes and available methods, systems, and techniques, including fuel cleaning, clean fuels, or treatment or innovative fuel combustion techniques for control.[154]

A carbon sequestration component could include similar language. It could indicate the available technologies by stating, for example, "including forest

150 A.B. 32, *supra* note 64, at ch. 488.
151 Rohlf, *supra* note 146, at 11.
152 Clean Air Act, 42 U.S.C. §§ 7401–7671q (2000).
153 *Id.*
154 *Id.* § 7479(3) (2000).

and agriculture sequestration and CCS." Also, it could allow room for new technologies, or "available methods." Thus, it is imperative to consider the science process—the science used as well as the overall policy of the GHG emissions program—when determining the best sequestration component.

V. CONCLUSION

As global warming becomes an increasingly immediate problem, rather than a future one, it becomes necessary to develop legislation aimed at slowing and possibly preventing the effects of global warming. Scientists have been studying this issue for years and the vast majority agree that global warming is occurring due to human caused emissions.[155] The need for regulations that limit these emissions is stronger than ever.

Within any regime designed to limit GHG emissions, a sequestration component is necessary especially as the world begins to shift from fossil fuel energy sources to alternative sources. This shift will not be automatic. Therefore, sequestration techniques, such as forest sequestration, agricultural sequestration, and carbon capture and storage technology, are necessary.

Both the CCAR and RGGI are groundbreaking programs that take aim at preventing global warming, however, the sequestration components must be altered if these are to serve as the model for a potential federal climate change initiative. Both sequestration elements utilize well-supported science, but their scope, in terms of acceptable sequestration measures, is far too limited. They must be expanded to allow offsets for agricultural and carbon capture and storage sequestration, at the least. Without this broad range of options, the sequestration potential of the earth will not be fully utilized and global warming will continue to accelerate at an untenable pace.

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155 James Kanter & Andrew C. Revkin, *World Scientists Near Consensus on Warming*, N.Y. TIMES, Jan. 30, 2007, *available at* http://www.nytimes.com/2007/01/30/world/30climate.html?n=Top%2fNews%2fScience%2fTopics%2fGlobal%20Warming.