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VOLUNTARY CARBON OFFSETS: GETTING WHAT YOU PAY FOR

HEARING

BEFORE THE

SELECT COMMITTEE ON ENERGY INDEPENDENCE AND GLOBAL WARMING HOUSE OF REPRESENTATIVES

ONE HUNDRED TENTH CONGRESS

FIRST SESSION

JULY 18, 2007

Serial No. 110–10



Printed for the use of the Select Committee on Energy Independence and Global Warming

globalwarming.house.gov

U.S. GOVERNMENT PRINTING OFFICE

58–085 WASHINGTON : 2010

For sale by the Superintendent of Documents, U.S. Government Printing Office
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VOLUNTARY CARBON OFFSETS: GETTING WHAT YOU PAY FOR

WEDNESDAY, JULY 18, 2007

HOUSE OF REPRESENTATIVES,
SELECT COMMITTEE ON ENERGY INDEPENDENCE
AND GLOBAL WARMING,
Washington, DC.

The Committee met, pursuant to call, at 9:30 a.m., in Room 2318 Rayburn House Office Building, Hon. Ed Markey [chairman of the Select Committee] presiding.

Present: Representatives Markey, Blumenauer, Inslee, Larson, Solis, Cleaver, Hall, McNerney, Sensenbrenner, Shadegg, Walden, Sullivan, and Blackburn.

The CHAIRMAN. Good morning, ladies and gentlemen. In part because of the federal government's continued failure to regulate global warming pollution, American consumers and corporations are increasingly turning to the purchase of voluntary offsets to help reduce their carbon footprint. The basic idea of offsets is to reduce greenhouse gases by supporting projects that either reduce emissions, or sequester carbon. Leading corporations, like Google, have announced plans to go carbon-neutral, partly relying on carbon offsets to do so. And a growing number of consumers are buying offsets to compensate for the emissions associated with a plane trip, or a daily commute to work.

As a result, there are now over three dozen offset providers based in the United States. Globally, the voluntary offset market is valued at over $100 million per year, and some expect it to grow to half a billion dollars in the next few years.

No one thinks the voluntary market alone can make a major dent in global warming, or that it can supplant the urgent need for mandatory federal limits on global warming pollution. Still, this market has an important role to play. Voluntary offsets can provide substantial funding for projects, such as renewable electricity generation that can deliver real carbon reductions. Global warming is a massive challenge, and every ton counts.

Equally important is this market's power to educate people about global warming, and to help get them engaged in supporting solutions. Some criticize voluntary offsets as a kind of modern-day papal indulgences designed to allow jet-setting celebrities to soothe their guilt, without changing their lifestyles. But today's testimony indicates that most offset purchasers are conscientious individuals and companies that are already taking steps to reduce their own emissions, and who want to use offsets to supplement those steps.

Although this market holds promise, it also presents some real challenges. This market is almost completely unregulated. In the past year, a series of journalistic reports have called into question the market's credibility. Those reports have alleged that in some cases, companies are selling offsets based on projects that would have happened regardless of the offsets. This raises doubts about whether consumers are getting what they paid for, real carbon reductions. These concerns are heightened by the fact that many offset providers offer very little information about their projects, or their carbon accounting methods.

And, finally, there are some tough scientific questions about whether certain kinds of offset projects will actually deliver real and permanent carbon reductions.

All this has led some to characterize the voluntary offset market as the wild west. I think that's overstating it, but I do think we need to bring order to this market to ensure that consumers don't get ripped off, that this source of funding for carbon reductions isn't wasted, and that the public does not lose confidence in offsets as a potential tool in a future cap and trade system.

The question is, what kind of sheriff do we need to hire? The offset industry and some environmental groups are trying to meet that challenge by developing voluntary standards. That's a positive step, but it remains to be seen whether it will be adequate.

Right now, we're talking about an unregulated market, where if the offset is not real, the main consequences are that an individual or corporate conscience is falsely soothed, and that potential funding for carbon reductions is wasted. But when we move to a regulated carbon market, where offsets might be a compliance option, the consequences of ineffective offsets will be excess carbon emissions that undermine national and global climate policy.

Today, the Select Committee begins the process of looking at how to make the voluntary offset market work for everyone: for consumers, for corporations, for national climate policy, and, ultimately, for a healthy planet.

The time for the opening statement from the Chair has expired. The Chair will recognize the ranking member, Mr. Sensenbrenner from Wisconsin.

[The statement of Mr. Markey follows:]

Opening Statement for Edward J. Markey (D-MA)
"Voluntary Carbon Offsets – Getting What You Pay For"
Select Committee on Energy Independence and Global Warming
July 18, 2007

In part because of the federal government's continued failure to regulate global warming pollution, American consumers and corporations are increasingly turning to the purchase of voluntary offsets to help reduce their carbon footprint. The basic idea of offsets is to reduce greenhouse gases by supporting projects that either reduce emissions or sequester carbon. Leading corporations like Google have announced plans to go "carbon neutral," partly relying on carbon offsets to do so. And a growing number of consumers are buying offsets to compensate for the emissions associated with a plane trip or a daily commute to work.

As a result, there are now over three dozen offset providers based in the U.S. Globally, the voluntary offset market is valued at over $100 million per year, and some expect it to grow to half a billion dollars in the next few years. No one thinks the voluntary market alone can make a major dent in global warming – or that it can supplant the urgent need for mandatory federal limits on global warming pollution. Still, this market has an important role to play. Voluntary offsets can provide substantial funding for projects, such as renewable electricity generation, that can deliver real carbon reductions. Global warming is a massive challenge and every ton counts.

Equally important is this market's power to educate people about global warming and to help get them engaged in supporting solutions. Some criticize voluntary offsets as a kind of modern papal indulgences, designed to allow jet-setting celebrities to soothe their guilt without changing their lifestyles. But today's testimony indicates that most offset purchasers are conscientious individuals and companies that are already taking steps to reduce their own emissions and who want to use offsets to supplement those steps.

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All this has led some to characterize the voluntary offset market as the "Wild West." I think that's overstating it. But I do think we need to bring order to this market – to ensure that consumers don't get ripped off, that this source of funding for carbon reductions isn't wasted, and that the public does not lose confidence in offsets as a potential tool in a future cap-and-trade system. The question is what kind of sheriff do we

need to hire? The offset industry and some environmental organizations are trying to meet that challenge by developing voluntary standards. That's a positive step, but it remains to be seen whether it will be adequate.

Right now, we're talking about an unregulated market, where if the offset is not real, the main consequences are that an individual or corporate conscience is falsely soothed – and that potential funding for carbon reductions is wasted. But when we move to a regulated carbon market where offsets might be a compliance option, the consequence of ineffective offsets will be excess carbon emissions that undermine national and global climate policy. Today the Select Committee begins the process of looking at how to make the voluntary offset market work for everyone – for consumers, for corporations, for national climate policy, and ultimately for a healthy planet.

Mr. SENSENBRENNER. Thank you very much, Mr. Chairman. At the beginning, let me say that, unfortunately, I'm going to have to be in the Judiciary Committee marking up the Patent Reform Bill for most of today's hearing, but I will read your testimony and absorb it over there, probably.

Today's hearing may be the most relevant yet in the short life of this Select Committee. Offsets hold the potential to help control greenhouse gas emissions, especially carbon dioxide. They also hold the potential to give people warm, fuzzy feelings for saving the earth, while actually doing nothing to tangibly help the environment. I hope that today's hearing helps us learn which it is.

The U.S. Supreme Court recently ruled that carbon dioxide can be regulated as a pollutant. Despite this fact, billions and billions of plants around the world have continued to breathe this naturally occurring gas, and exhale the oxygen that supports the diversity of life all over this planet.

While I question the term "pollution" is appropriate for CO_2, I do not question that there are significant scientific findings to show that this gas is contributing to global warming. Many who advocate taxes and regulations as a solution to global warming like to emphasize their point by using the image of smokestacks emitting dirty, black soot into the air, but that image is a bit dishonest, isn't it? We're not here to talk about black smoke. It's an entirely different environmental issue that's regulated by, and under the jurisdiction of a different committee.

Global warming is all about the clear invisible gases that don't show up in these menacing photographs, like carbon dioxide. Whether it comes from the coal-fired power plant, or the mouth of the former Vice President, Mr. Gore, carbon dioxide is plant food, and this fact helps create many possible solutions for the global warming problem.

By breathing CO_2, trees help take it out of the atmosphere. That's why I've said that smart, healthy forest management should be a part of any global warming policy. Trees can also play a part in the global warming solution by being a carbon offset. In fact, trees live up to one of the principles that I staunchly advocated by providing an actual tangible benefit to the environment. We not only know that trees take CO_2 out of the atmosphere, we generally know how much they take out.

Some carbon offset projects have the potential to promote advanced technology, which lives up to another principle I champion. I'm still not sure fertilizing carbon dioxide eating plankton would be an effective global warming solution. That's up to the scientists to determine, but this idea is an example of the creative possibilities that technology can produce. However, while offsets hold some potential to control CO_2 in the atmosphere, we also have to be realistic about the true capacities of offsetting. We can't offset our way out of the global warming problem. We certainly can't offset our way to meet Mr. Gore's goal of 80 percent greenhouse gas reductions by 2050. The only way to meet these goals is through the development and promotion of technology that creates energy without emitting carbon dioxide, such as nuclear power, renewable energy, or carbon sequestration.

I'm also very concerned that offsetting is the first step on the path to onerous global warming regulations. Depending upon how offsetting is structured, there is the potential for fantastic abuse of taxpayer dollars. Some offset projects can be legitimate, such as tree plantings, wind energy, and biomass fuels. Yet, other projects are questionable, and in some cases, may even border on fraud.

Does investing in an energy project that would have happened anyway really make you carbon neutral? Call me skeptical. There are also indications that some offsets are counted twice, which doesn't get the world any closer to carbon neutrality.

Carbon offsets give those who are deeply concerned about global warming an option to put their money where their mouth is, without having to adopt Grizzly Adams' lifestyle. But it is always the case, when money changes hands, let the buyer beware. The carbon offset industry is a business, but buyers of offsets should use due diligence in researching these firms and their standards before handing over a check. And that goes for the federal government, too. Thank you.

The CHAIRMAN. Thank you. The gentleman's time has expired. The Chair recognizes the gentleman from Oregon, Mr. Blumenauer.

Mr. BLUMENAUER. Thank you, Mr. Chairman. And, I, too, will apologize in advance. We have a Ways and Means mark-up that is occurring, but I am very interested in hearing the panel. I've had a chance to review some of the testimony. I come from a city. One of the opportunities I want when the committee comes to Portland, is to be able to introduce the Climate Trust that's based in Portland, which we like to think is the leading non-profit dedicated to providing these solutions. It provides offsets for power plants, regulators, business entities of all sizes, and individuals. I think it was the first offset, almost 3 million cubic tons of CO_2 at this point. Looking forward to an opportunity, as I say, to include that as part of the Portland tour, and look forward to hearing the testimony.

The CHAIRMAN. Okay. The gentleman's time has expired.

The gentleman from Washington.

Mr. INSLEE. Thank you. I want to welcome the witnesses particularly Mr. Romm, who's written "Green Brook", which I really appreciate his work on. I'm interested, and I hope the panelists will address how an offset program would work, if the offsets are in countries that don't have caps. And I've always wondered how an offset works, if you buy it in a country that doesn't have caps, what are you actually achieving, because you're not actually taking up a certain amount of the allocation, if you will, of CO_2. I'm interested in your observations about that.

I just want to note one thing. Mr. Sensenbrenner referred to CO_2 as plant food, and I thought it was important to relay something I saw last weekend up in the Cascade Mountains. CO_2 is plant food, obviously, and it's necessary for photosynthesis, but up by Robin and Tuck Lakes up by Mount Daniel in the Central Cascade Mountains last weekend, I was coming down from these lakes that I last visited 25 years ago, and these beautiful, beautiful alpine lakes, and as you come down, we came down through these Silver Fir and True Fir, and a little Douglas Fir forest. They were dead, or appeared to be dying for miles, and miles, and miles due to the spruce bloodworm, and the spruce bloodworm is a worm, it's a na-

tive worm, but when winters don't get cold enough, it doesn't kill them, and it doesn't suppress them. At least, this is one hypothesis is what's going on, and you end up with dead and dying forests. This has happened with the bark beetle with tens of thousands, if not hundreds of thousands of acres in Alaska and British Columbia, now starting in the eastern slopes of the pine forest on the Cascade range, as well. So it is plant food, but it's also causing the devastation of forests. Thank you.

The CHAIRMAN. Thank you. The gentleman's time has expired.

The Chair recognizes the gentlelady from California, Ms. Solis.

Ms. SOLIS. Thank you, Mr. Chairman. I'll submit my statement for the record, but I just want to leave one question, and that is, when we talk about cap and trade, and offsetting negative emissions, I worry about those communities that I represent, environmental justice communities, low-income communities, that may not be able to provide sufficient funds to help offset some of the negativity. So where is your thinking about helping those communities that typically are communities of color, in urban areas, or poor rural areas?

The CHAIRMAN. The gentlelady's time has expired.

The gentleman from Missouri, Mr. Cleaver is recognized.

Mr. CLEAVER. Thank you, Mr. Chairman. And thank you for calling this hearing, and I express appreciation to this distinguished panel this morning. Thank you for being here, and I'm looking forward to hearing your testimony.

I'm one who believes that we are moving in the right direction with regard to carbon offsets. I'm not certain that voluntary carbon offsets will work, but I am interested in your opinion on this issue. But I do agree, and believe that carbon offsets encourages the use of renewable energy, and that we can reduce greenhouse gases. But I'm sure you've heard all of the skepticism prior to coming here today, and all of the issues that need to be resolved, so I look forward to hearing your testimony, and also to the opportunity to raise some questions with you. Thank you, Mr. Chairman.

[Prepared statement of Mr. Cleaver follows:]

U.S. Representative Emanuel Cleaver, II
5th District, Missouri
Statement for the Record
House Select Committee on Energy Independence and Global Warming Hearing
"Voluntary Carbon Offsets – Getting What You Pay For"
Wednesday, July 18, 2007

Chairman Markey, Ranking Member Sensenbrenner, other Members of the Select Committee, good afternoon. To our distinguished panel of experts, I would like to join my colleagues in welcoming you to the Select Committee on Energy Independence and Global Warming. I look forward to listening to your testimony today and hearing any insights you can share on the market for voluntary carbon offsets.

Public consciousness of global warming has grown past traditional environmentalists and into the business and government sectors. In order to reduce the carbon footprints of agencies, individuals, and groups, the purchase of carbon offsets has been selected as a means to mitigating climate change. Carbon offsets encourage the use of renewable energy and the prevention of the release of large quantities of greenhouse gases. The increased utilization of such technologies as wind energy and solar photovoltaic energy can aid our country in achieving energy independence, and they can do this in a clean and environmentally sound manner. While this is certainly positive, there remains concern of the effectiveness of the system in reducing the effects of climate change. There is no question that the effects of global warming must be slowed in order to address this global emergency, though it remains to be seen what the lasting effects of a carbon offset system will be on our climate.

I look forward to hearing from our witnesses regarding the market for voluntary carbon offsets, and if the current systems in place are the best in preventing the harmful and irreversible effects of global warming. I thank them for their insight and for being with the Select Committee this morning to answer our questions.

Thank you.

The CHAIRMAN. I recognize the gentleman from New York, Mr. Hall.

Mr. HALL. Thank you, Mr. Chairman. I'll just enter my statement in the record, and look forward to hearing the testimony of the witnesses. Yield back.

The CHAIRMAN. The Chair recognizes the gentleman from California, Mr. McNerney.

Mr. MCNERNEY. Thank you, Mr. Chairman. I'm going to fold my time into the Q&A period, and yield back.

The CHAIRMAN. Great. So all time for opening statements from the members of the Select Committee has concluded, so we'll now turn to our first witness. And I am pleased to welcome him, Mr. Derik Broekhoff. He is a Senior Associate at the World Resources Institute. He's an expert on voluntary carbon market. He's the author of the WRI's Greenhouse Gas Protocol for project engineering. He's led their initiative on carbon accounting and standard setting for project-based offsets. He has participated extensively in stakeholder efforts to develop voluntary standards for the voluntary offset market. Thank you so much for joining us this morning. Whenever you're ready, please begin.

STATEMENT OF DERIK BROEKHOFF, SENIOR ASSOCIATE, WORLD RESOURCES INSTITUTE

Mr. BROEKHOFF. Thank you, Mr. Chairman. And I thank the Committee for this opportunity to testify about the voluntary carbon offset market.

Carbon offsets have been around in one form or other for nearly two decades. Most recently, and most significantly, as a compliance tool under the Kyoto Protocol. But interest in them has also steadily grown as a way for buyers to voluntarily offset their greenhouse gas emissions.

By some estimates, demand for voluntary offsets may achieve global reductions of several hundred million tons of CO_2 per year by 2010. This would be a notable but modest contribution to reducing the 25 billion tons of greenhouse gases emitted every year due to human activities.

The primary challenge, as several people have noted, faced by the voluntary carbon offset market is that it's developing in a regulatory vacuum. Carbon offsets are a completely intangible product, and their value depends entirely on how they are defined, represented, and guaranteed. What the market lacks are common standards for defining and guaranteeing carbon offsets in order to assure consumers that they're getting what they pay for.

There are three basic requirements for creating a standardized carbon offset commodity. First, accounting standards for quantifying the emission reductions that offset projects generate. Second, verification standards to ensure that projects have their performance adequately reviewed by qualified parties. And, third, publicly reviewable registry and enforcement systems to ensure that emission reductions are not sold more than once, or claimed by more than one party.

A number of initiatives over the last two years has attempted to set standards for the voluntary offset market, but so far, none of them has adequately addressed all three of these requirements.

Rather than bringing clarity to the market, the proliferation of multiple standards has created confusion, and even skepticism.

The case for some level of government oversight would seem to be clear. The question remains, at what level should the federal government engage in the voluntary carbon offset market? In the future, this market could be largely superseded by a mandatory program. Nevertheless, I would argue that oversight today may be desirable to protect consumers and the public interest, to allow learning, and inform the development of a future mandatory program, and to provide greater certainty for investors.

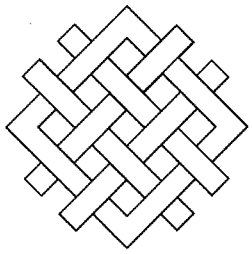
Oversight could take several forms, ranging from endorsing particular standards and programs, to providing guidance on accounting standards, accrediting offset verifiers, certifying carbon offset registries.

In general, any government oversight should build off the work of existing standards and programs, and should seek to bring minimum standards of transparency, consistency, and quality to the voluntary offset market. Government oversight should not seek to limit the market, but should encourage maximum participation, subject to minimum standards.

On balance, carbon offsets afford real opportunities, and should be encouraged. They allow their buyers to do more than they otherwise could to help avert climate change. Realizing even their modest potential, however, will require creating a standard carbon offset commodity that consumers can trust.

Thank you for this opportunity to provide my input to your deliberations, and I look forward to answering any questions you may have.

[The prepared statement of Mr. Broekhoff follows:]



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Testimony of Derik Broekhoff before the House Select Committee on Energy Independence and Global Warming

"Voluntary Carbon Offsets – Getting What You Pay For"

July 18, 2007

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Executive Summary

Carbon offsets are an innovative tool for allowing companies and individuals to reduce greenhouse gas emissions beyond what they can easily achieve on their own. In the past two years, interest in carbon offsets has grown dramatically as companies and concerned consumers have sought ways to help mitigate climate change. However, the global market for voluntary carbon offsets is currently unregulated, which has led to growing concerns about whether buyers are really getting what they are paying for. Various non-government programs and initiatives have sought to address these concerns by establishing standards. So far, none of these initiatives has managed to establish all three required elements of a true carbon offset commodity standard, namely: (1) accounting standards for emission reductions; (2) project verification standards; and (3) publicly reviewable registration and enforcement systems.

In the future, the domestic voluntary carbon offset market may be largely superseded by a mandatory U.S. trading program for greenhouse gas emissions. Even if it is, there may be grounds for government oversight of the voluntary market today. Oversight may be desirable, for example, to protect consumers and the public interest, to allow learning for regulators, and to provide greater certainty for investors. Oversight could take several forms, ranging from endorsing specific (complete) standards and programs, to providing guidance or certification for accounting standards, verifiers, and registries. In general, oversight should build off the work of existing standards and programs, and should seek to bring minimum standards of clarity, consistency, and quality to how voluntary carbon offsets are defined and guaranteed. Government oversight should not seek to limit the market, but should encourage experimentation with different types of projects subject to minimum standards.

What are carbon offsets?

In simplest terms, a "carbon offset" is a purchased reduction in greenhouse gas (GHG) emissions. Carbon offsets allow buyers to achieve a particular GHG emissions goal without having to reduce their own emissions directly.[1] They are useful wherever direct emission reductions would be too costly or difficult. A well-designed market for carbon offsets can allow companies, organizations, and individuals to achieve GHG emission reductions at lower cost, which ultimately means they can afford do more to help avert climate change.

Carbon offsets can have other benefits as well. Offset revenues can help spur investment in innovative technologies that help transition the economy towards lower GHG emissions. Many types of projects that reduce GHG emissions, such as renewable energy,

[1] Because the effect of greenhouse gases is global, it does not matter where they are reduced.

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energy efficiency, transportation, and forestry projects, have significant secondary environmental and social benefits.

Although the very first carbon offset project was voluntary,[2] much of the work to establish real markets for carbon offsets has been done in the context of designing regulatory programs. Many experimental carbon offset projects were undertaken in the 1990s, for example, in order to inform negotiations under the Framework Convention on Climate Change about the design of an international GHG emissions trading system. Experience from these projects led to the creation of the "Clean Development Mechanism" (CDM) under the Kyoto Protocol, which now constitutes the largest functioning market for carbon offsets. Through the CDM, emission reductions in developing countries can be used to offset emissions in industrialized countries, whose total emissions are capped. Credits issued for these offsets allow industrialized countries to increase their emissions (effectively increasing the "cap"), on the premise that net emissions to the atmosphere remain the same. The CDM is also envisioned as a way to help less developed countries grow sustainably through the transfer and deployment of beneficial technologies and practices. A separate Kyoto Protocol mechanism, called "Joint Implementation" (JI) recognizes carbon offsets from projects in industrialized countries.

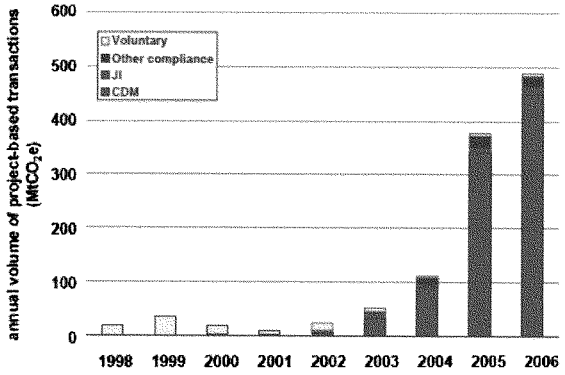
The global market for carbon offsets has grown dramatically over the last few years since the CDM was formally established (Figure 1). In 2006, the total market value of CDM carbon offset credits was $5.5 billion.

[2] See Faeth, P., M. Trexler, and J.M. Kramer, 1989. *Forestry as a Response to Global Warming: An Analysis of the Guatemala Agroforestry and Carbon Sequestration Project.* World Resources Institute, Washington, D.C.

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Figure 1. Annual Volumes of Carbon Offset Transactions in Millions of Tons of Carbon Dioxide Equivalent



Source: Capoor and Ambrosi 2007, *State and Trends of the Carbon Market 2007*. World Bank Institute, Washington, D.C.

What is the voluntary carbon offset market?

Although the majority of carbon offset purchases in the world today are by companies or governments seeking to comply with the Kyoto Protocol, growing concerns about climate change have led to an interest in carbon offsets among a much wider group of buyers. Demand for "voluntary" carbon offsets comes from two distinct groups:

1. **Wholesale buyers**. These are mainly companies seeking to reduce GHG emissions for reasons of social responsibility, public relations, or anticipation of future regulatory requirements (either to gain firsthand experience with carbon offset trading prior to regulation, or in hopes of gaining recognition under a future regime). In some cases, these buyers are purchasing and retiring offsets on behalf of customers. For example, they may offset the GHG emissions associated with the production or consumption of their products in order to offer a product that is "carbon neutral." Wholesale buyers currently dominate the voluntary carbon offset market; according to a recent survey, they were responsible for over 60 percent of voluntary offset purchases in 2006.[3] Around 20 percent of wholesale purchases consist of carbon offsets purchased on behalf of customers.[4]
2. **Retail buyers**. These buyers consist of smaller organizations or individuals seeking to offset the GHG emissions for which they are personally responsible.

[3] Harris, E., 2006. *Working Paper on the Voluntary Carbon Market: Current and Future Market Status, and Implications for Development Benefits*. International Institute for Environment and Development, London, October 2006.
[4] Ibid.

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They may be travelers who offset emission associated with their airplane flights; individuals or organizations who offset the emissions they cause in order to become "carbon neutral"; or conference and event organizers who wish to offer "carbon neutral" events. According to the IIED, these buyers are responsible for less than 40 percent of voluntary offset purchases, but they are a fast growing segment. The number of retail carbon offset providers in the United States and internationally has grown markedly in just the past two years.[5, 6, 7]

The voluntary carbon offset market overall is growing rapidly. Worldwide voluntary offset purchases amounted to around six million tons of CO_2-equivalent emission reductions in 2005, growing to over 10 million tons in 2006.[8] The total market value globally for the voluntary offset market is now estimated at over $100 million, with prices for GHG emission reductions ranging anywhere from $1 to nearly $80 per ton of CO_2-equivalent.[9] Although projections are always difficult in a fledgling market, expectations are that the global market could reach a size of 400 million tons by 2011 (including 250 million tons in the United States),[10, 11] with a market value possibly rivaling that of today's CDM market.

What kinds of projects are being funded through the voluntary carbon offset market?

There are a vast number of technologies and practices that can be employed to reduce GHG emissions for the purpose of generating offsets. In addition, GHG emissions can be offset through certain kinds of land use and forestry practices that remove CO_2 from the atmosphere. According to a survey from 2006, projects involving land use and forestry practices are in fact the most common type being funded by voluntary offset purchases.[12] The next most common type of project involves renewable energy production, followed by demand-side energy efficiency improvements (Table 1).[13] The proportion of actual emission reductions or removals may be different from the numbers of projects, however,

[5] Hamilton, K., et al., 2006. *Offsetting Emissions: A Business Brief on the Voluntary Carbon Market.* Business for Social Responsibility and Ecosystem Marketplace, San Francisco.
[6] Clean Air-Cool Planet, 2006. *A Consumers' Guide to Retail Carbon Offset Providers.* Clean Air-Cool Planet, Portsmouth, New Hampshire.
[7] Kollmuss, A., and B. Bowell, 2006. *Voluntary Offsets for Air-Travel Carbon Emissions: Evaluations and Recommendations of Voluntary Offset Companies.* Tufts Climate Initiative, Boston.
[8] Capoor, K. and P. Ambrosi, 2007. *State and Trends of the Carbon Market 2007.* World Bank Institute, Washington, D.C.
[9] Ibid.
[10] ICF International, 2006. *Voluntary Carbon Offsets Market: Outlook 2007,* ICF International: London.
[11] Trexler , M., 2007. "US Demand?" presentation at the Point Carbon "Carbon Market Insights 2007" conference, Copenhagen, 13-15 March 2007.
[12] Harris, E., 2006. *Working Paper on the Voluntary Carbon Market: Current and Future Market Status, and Implications for Development Benefits.* International Institute for Environment and Development, London, October 2006.
[13] Ibid.

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since certain kinds of projects produce far greater volumes of CO_2-equivalent reductions than others. This is especially true of projects involving non-CO_2 gases (such as methane or HFCs), whose contributions to atmospheric warming are many times higher than CO_2 on a per weight basis.

Table 1. Types of Projects Funded by Voluntary Carbon Offset Purchases

Type of Project	Percentage by Number of Projects
Land Use and Forestry	56%
Renewable Energy	25%
Demand-Side Energy Efficiency	10%
Fugitive Emissions (e.g., methane capture)	6%
Supply-Side Energy Efficiency	3%

Source: Harris, E., 2006. *Working Paper on the Voluntary Carbon Market: Current and Future Market Status, and Implications for Development Benefits.* International Institute for Environment and Development, London, October 2006.

Can the voluntary carbon offset market really help to address climate change?

The answer to this question is partly a matter of perspective. Current scientific evidence suggests that to mitigate the risk of dangerous climate change, global GHG emissions must be reduced by 60 to 80 percent by mid-century, [14] equivalent to many billions of tons of annual reductions. In this context, the contribution of the voluntary carbon offset market – even under the most optimistic demand scenarios – is likely to be small. Instead, globally coordinated mandatory policies will be needed to drive significant near-term reductions in emissions and achieve long-term stabilization of atmospheric GHG concentrations.

Voluntary carbon offset markets may still have a role to play. In simplest terms, the magnitude of effort required is large, and every little bit helps. Voluntary carbon offsets allow companies and individuals to reduce emissions beyond what they could achieve on their own, by tapping into project opportunities that would otherwise go unexploited. The benefits of carbon offsets can be multiplied to the extent they drive innovation in emission-reducing technologies and create new markets for them. Finally, the voluntary offset market can play a very significant role in educating the public about climate change and about effective and affordable ways to mitigate it. Ultimately, however, mandatory emissions trading systems, particularly if they allow offset projects, are likely to subsume the advantages of a voluntary regime.

[14] Intergovernmental Panel on Climate Change, 2007. *Climate Change 2007 – Mitigation of Climate Change: Working Group III Contribution to the Intergovernmental Panel on Climate Change Fourth Assessment Report.* Cambridge University Press.

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Won't demand for voluntary carbon offsets evaporate once we have mandatory regulations to control greenhouse gas emissions?

It makes sense that when governments implement policies requiring reductions in GHG emissions, public interest in *further* voluntary emissions reductions will diminish. It is quite likely that much of the current demand for voluntary carbon offsets is driven by buyers' concerns that governments are not going far enough yet to address climate change. Nevertheless, it also seems likely that substantial demand for voluntary GHG emission reductions can exist even where there are regulatory requirements. "Carbon neutrality" has become a goal for many companies seeking to attract customers by providing environmentally friendly products and services. Likewise, growing awareness about climate change has sparked an interest among many individuals to do their part to help solve the problem. Given the magnitude of emission reductions required, it is quite reasonable to expect that many firms and individuals will continue to seek ways to cost-effectively mitigate their "carbon footprints" even after mandatory GHG limits are in place. In fact, a significant segment of the demand for voluntary carbon offsets exists in Europe, where limits on GHG emissions are already in place.

Perhaps a more central question is whether a separate system for voluntary offsets will be required once a mandatory regime is in place. If a mandatory regime encompasses all sectors and all types of projects, this would not be necessary. However, if a mandatory program were to begin with limited coverage of project types, there is still likely to be a place for a voluntary system, in large part to serve as a proving ground for new types of technologies and projects.

Why are some people concerned about the voluntary carbon offset market?

Voluntary carbon offsets have been traded in relatively small volumes and on a demonstration basis since the late 1980s. Some organizations, such as the Climate Trust in Oregon, have many years of experience in purchasing and retiring offsets on behalf of clients or customers (the Climate Trust was established in 1997 to assist new power plants in Oregon to meet a state regulatory requirement for net CO_2 emissions). As the data above indicate, however, there has been a dramatic increase in the last two years in the number of voluntary offset transactions, with an accompanying expansion in the number of suppliers. Unlike the Kyoto Protocol's CDM offset market, however, where there are clear rules, standards, and oversight mechanisms, the voluntary market is operating in a regulatory vacuum. Many observers are concerned about the lack of standards and oversight for voluntary carbon offsets, and wonder whether buyers are truly getting what they pay for, i.e., real emission reductions.

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The issue is not so much a question about the integrity of carbon offset providers. Most suppliers in the market today are well-meaning private companies and non-profit organizations that sincerely want to help their customers do good for the environment. The questions that arise are really about the definition of the "commodity" being sold. Carbon offsets are an intangible good, and as such their value and integrity depend entirely on how they are defined, represented, and guaranteed. What the market lacks are common standards for how such representations and guarantees are made and enforced.

What elements are necessary for a carbon offset standard?

Much of the literature on carbon offsets (and nearly all aspiring "standards") point out that credible offsets must be "real, surplus, permanent, verifiable, and enforceable" – or some variation of these terms.[15] Different sources do not always agree on the definitions of these criteria, however, and having a "standard" for carbon offsets really depends on how they are interpreted. What the criteria boil down to are three things, all of which need some form of official certification or oversight to create a true carbon offset "commodity": (1) accounting standards; (2) monitoring and verification standards; and (3) registration and enforcement systems.

1. GHG Emission Reduction Accounting Standards

Accounting standards address the actual quantification of GHG reductions that carbon offsets represent. Accounting standards are a first-order requirement for ensuring that a ton of emission reductions from one project is the same as a ton from another, and ensure that offsets are "real, surplus, and permanent."

As might be expected, a lot of work has been done over the years to develop accounting standards for offsets. In December 2005, the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD) published the *Greenhouse Gas Protocol for Project Accounting* ("Project Protocol"), which provides a general framework for quantifying emission reductions from offset projects, based on the accumulated knowledge of an international group of experts from businesses,

[15] The concept of emission offsets originated under the "New Source Review" program established by the United States Clean Air Act of 1977. Under this program, offsets are required to be "real, creditable, quantifiable, permanent, and federally enforceable." These basic criteria have been modified and adopted in general form under a variety of other offset programs, including programs for carbon offsets. The "surplus" criterion is generally added to distinguish offset reductions from reductions that would occur for other reasons. The criteria that carbon offsets must be "real, surplus, permanent, verifiable, and enforceable" are now the most frequently cited and are, for example, enshrined in the Memorandum of Understanding establishing the Regional Greenhouse Gas Initiative in the northeast United States. See, for example, Liepa, I., 2002. *Greenhouse Gas Offsets: An Introduction to Core Elements of an Offset Rule.* Climate Change Central, Alberta, Canada.

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governments, and environmental groups.[16] It has since been supplemented with two sector-specific accounting protocols, one for land use and forestry projects, the other for renewable energy and energy efficiency projects.[17, 18] These documents provide an internationally recognized basis for the elaboration of detailed accounting standards for specific types of projects.[19] The largest body of standard accounting methodologies established to date exists under the Kyoto Protocol's Clean Development Mechanism. Very few of the carbon offsets sold in the voluntary market, however, explicitly follow the WRI/WBCSD Project Protocol or CDM methodologies.

Probably the most important part of offset project accounting is making a determination about "additionality" – that is, whether the purchase of emission reductions really enabled (or induced) a project to happen, or whether the purchase is essentially being wasted on a project that would have happened anyway (in which case its emission reductions effectively have zero value for the purpose of offsetting emissions). Many would say that "additionality" is the key to the environmental integrity of an offset purchase – but it is also vexingly hard to determine in many cases. It has proven very difficult to establish true standards for additionality, and even the CDM requires regulators to make essentially subjective judgments about it on a case-by-case basis. Two recent reports on the voluntary carbon offset market suggest that many providers do not clearly indicate how they determine the additionality of their projects.[20, 21] A standard set of guidance or criteria would aid the credibility of offset markets tremendously.[22]

2. Monitoring and Verification Standards

Monitoring and verification standards are required to ensure that offset projects perform as expected and to quantify their actual emission reductions. Monitoring protocols are generally developed in conjunction with accounting protocols. Verification usually requires the services of a third-party professional verifier, or a government regulator. If

[16] Greenhalgh, S., D. Broekhoff, and F. Daviet, 2005. *The Greenhouse Gas Protocol for Project Accounting*. World Resources Institute and World Business Council for Sustainable Development, Washington, D.C. and Geneva.
[17] Greenhalgh, S., F. Daviet, and E. Weninger, 2006. *The Land Use, Land-Use Change, and Forestry Guidance for GHG Project Accounting*. World Resources Institute, Washington, D.C.
[18] Broekhoff, D., 2007 (forthcoming). *Guidelines for Quantifying GHG Reductions from Grid-Connected Electricity Projects*. World Resources Institute and World Business Council for Sustainable Development, Washington, D.C. and Geneva.
[19] The WRI/WBCSD *GHG Protocol: A Corporate Accounting and Reporting Standard* is the most widely used international accounting tool for government and business leaders to understand, quantify, and manage greenhouse gas emissions. For more information, see http://www.ghgprotocol.org.
[20] Clean Air-Cool Planet, 2006. *A Consumers' Guide to Retail Carbon Offset Providers*. Clean Air-Cool Planet, Portsmouth, New Hampshire.
[21] Kollmuss, A., and B. Bowell, 2006. *Voluntary Offsets for Air-Travel Carbon Emissions: Evaluations and Recommendations of Voluntary Offset Companies*. Tufts Climate Initiative, Boston.
[22] For further insight into establishing "additionality" standards, see Trexler, M., D. Broekhoff, and L. Kosloff, 2006. "A Statistically-Driven Approach to Offset-Based GHG Additionality Determinations: What Can We Learn?" in *Sustainable Development Law & Policy*, Volume VI, Issue 2, Winter 2006.

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third-party verifiers are used, they need to meet minimum qualifications and have some expertise related to the types of projects they are verifying. This is one of the biggest gaps in the voluntary carbon offset market right now. Although there is a generic international standard for the accreditation of verifiers (ISO 14065), and there are certainly verifiers with well-established reputations for competence and integrity, a publicly accountable certification process for verifiers could greatly enhance the credibility of the voluntary offset market.

Finally, verification does not mean very much without clear accounting and monitoring standards against which to verify. This emphasizes the need to adopt common accounting and reporting standards.

3. Registration and Enforcement Systems

One concern about the voluntary offset market as it continues to grow is the possibility that suppliers may sell the same reductions to multiple buyers, because there is no central authority to track their transactions. Related to this, questions can arise in some instances about who "owns" emission reductions and who in fact has the right to sell them. In some cases, multiple parties may conceivably lay claim to the same reduction. For example, both the manufacturer and the installer of energy efficient lightbulbs might want to claim the emission reductions caused by the lightbulbs – as might the owners of the power plants where the reductions actually occur. Right now, establishing the right to an offset reduction largely consists of making public marketing claims and trying to exclude others from doing the same.

This is another area where some kind of oversight and public accountability may be desirable. Key requirements (which might be established either though federal policy, or more realistically, through non-profit or commercial enterprises) are:

1. A registry (or registries) containing publicly available information that can be used to uniquely identify offset projects.
2. In the same registry system, a mechanism to assign unique identifiers (e.g., serial numbers) to offset credits generated by each project, and a system to transparently track their ownership and status (i.e., whether they've been "used" to offset emissions by someone).
3. Contractual or legal standards that clearly identify the original "owner" of emission reductions, and that specify compensation mechanisms for GHG removals or reductions that are reversed (e.g., re-emitted from destroyed forests) or not actually achieved.

Is anyone trying to create standards for the voluntary carbon offset market?

To address the current shortcomings in the voluntary carbon offset market, a number of organizations involved in the industry have initiated efforts over the last two years to

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develop voluntary standards. The first such standards were the WRI/WBCSD Project Protocol (noted above) and the ISO 14064 standard.[23] The WRI/WBCSD Project Protocol is a set of guidance documents for offset project accounting, while the ISO 14064 standard is a checklist of essential accounting elements. Neither is a full-fledged standard for determining the emission reductions for specific technologies or practices – although both together provide a toolkit for policymakers to create such standards. Furthermore, while the ISO standard does cover verification (and accreditation of verifiers under ISO 14065), neither the WRI/WBCSD Project Protocol nor the ISO standards cover all three of the required elements for a fully standardized carbon offset commodity noted above.

Other standard-setting efforts have tackled different pieces of the puzzle. The California Climate Action Registry (CCAR) is developing a series of accounting standards for specific types of offset projects, compatible with the WRI/WBCSD Project Protocol. So far they have approved protocols for forestry sequestration projects and agricultural methane digesters.[24] Projects can be registered with CCAR, and CCAR maintains a list of accredited verifiers. CCAR does not yet have a facility for tracking trades or retiring offset credits, although this may be developed in the future (possibly as part of the recently announced multi-state Climate Registry).[25] Similarly, the U.S. Environmental Protection Agency Climate Leaders Program has begun developing a set of standards for quantifying emission reductions for several types of projects. [26] These standards are still in draft form, however, and would need to be supplemented with monitoring and verification standards and a registry to establish a credible carbon offset commodity.

The Center for Resource Solutions (CRS) has recently completed work on a "Green-e GHG Product Standard."[27] Under this standard, CRS will certify carbon offsets that are created under programs that already have credible accounting and verification standards in place. The CRS standard does seek to provide an enforcement mechanism (by requiring offset marketers to disclose information to buyers) but relies on other programs for accounting and verification rules.

The Climate Group (based in London), the International Emissions Trading Association, and the World Economic Forum are currently developing (with stakeholder input) a global "Voluntary Carbon Standard" (VCS) that will in principle cover accounting rules, verification standards (including accreditation of verifiers), and the establishment of a registration and enforcement system.[28] Initially, the VCS will most likely reference CDM accounting and verification standards, although it may incorporate other standards over

[23] ISO 14064, International Organization for Standardization, Geneva, Switzerland, 2006.
[24] See http://www.climateregistry.org/PROTOCOLS/.
[25] See http://www.wri.org/climate/topic_content.cfm?cid=4460.
[26] See http://www.epa.gov/stateply/resources/optional.html#offset.
[27] See http://www.green-e.org/getcert_ghg_standard.shtml
[28] See http://www.v-c-s.org/

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time. Its credibility will largely rest on the decisions of designated verifiers, which will effectively be responsible for its enforcement in place of a central regulatory authority.

The Chicago Climate Exchange (CCX) has operated a voluntary trading system since 2003 that includes a carbon offset component. In principle CCX offsets can be used to voluntarily offset emissions for companies and individuals who are not CCX members, just as CDM offsets can (some retail providers already offer to retire CCX offsets on behalf of customers). The CCX program includes proprietary accounting rules, verification standards, and a registry to track credits and project information. One of the criticisms of the CCX, however, is that little information is publicly available about its standards and individual projects.

Other voluntary carbon offset standards, including the "CDM Gold Standard," primarily reference the CDM's accounting and verification requirements. They do not provide separate accreditation of verifiers, nor have they established strong registry or enforcement systems.

In short, most of the "standards" developed under voluntary initiatives to date do not incorporate all of the elements of a true carbon offset commodity standard. Some of these initiatives could develop into full-fledged standards and oversight programs, but are not there yet (e.g., CCAR or Climate Leaders). The VCS may cover all the bases when it is launched, but it may also have a loose oversight structure. The CCX currently has a functioning offset commodity standard, but suffers from lack of transparency and public accountability.

Might these efforts eventually be sufficient, or is there a need for government oversight?

One answer to this question is "time will tell." Pieces of a full voluntary offset standard are coming together under various initiatives, and it is possible that the market will sort itself out as these pieces either fall away or become incorporated into a single program or set of programs. Currently, however, the proliferation of standards – many of which are incomplete – is creating more confusion than clarity.

This risk with a "wait and see" approach is that the market may never cohere around a single standard or program. Even fully established standards are not all alike. Differences in accounting and verification rules – especially with respect to additionality – can significantly affect the "quality" of carbon offsets offered to the market. Many would argue that it is not necessary to have unified quality standards, and that buyers should be able to discriminate between different quality offsets according to their needs. But given the complexity of carbon offsets as a commodity, it is not clear that typical consumers could effectively distinguish "good" quality from "bad" – especially unsophisticated buyers in the retail offset market. Allowing multiple standards of varying quality could

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just as easily sow confusion and skepticism among the buying public, a process that already seems to be underway.

The consequences of skepticism about the voluntary offset market are hard to predict. In the extreme case, the risk is that it could cause the voluntary market to dissolve and foster opposition to the development of mandatory offset programs. This could mean the loss of significant low-cost opportunities for mitigating climate change. Avoiding this outcome may require some kind of government oversight to ensure a minimum level of consumer protection in the voluntary carbon offset.

Ultimately, the government's focus should be on developing strong mandatory offset programs that incorporate all three required elements of a standard. As mentioned above, the true value of the voluntary market may be as a proving ground for innovative project types not incorporated in a mandatory regime. At the end of the day, however, we are still talking about a commodity whose primary purpose is to benefit the public good by helping to mitigate climate change. This alone argues for public oversight in shaping the standards that define the commodity's quality.

Why should the government regulate voluntary carbon offset markets when future mandatory programs (e.g., a federal cap-and-trade system) could supersede them?

In principle, there is no reason why voluntary carbon offset markets and mandatory regulatory programs cannot coexist. The real question is whether mandatory regulations might render unnecessary the standards and systems established under a voluntary market – and whether that would be a bad thing.

In fact, the prospect of mandatory regulations creates real risks for the voluntary market. If a CO_2 emissions cap is placed on power plants, for example, no offset projects claiming to reduce emissions from the power grid (e.g., renewables or energy efficiency projects) could continue to make that claim (because a ton of emissions reduced would simply free up an allowance that another power plant could use to emit more). Moreover, a mandatory emissions trading program could establish carbon offset rules and compel voluntary offset purchasers to abide by those same rules.

Of course, one response to these risks is to say "let the buyer beware." There are several reasons, however, why active regulation of the voluntary market today may make sense:

- *Buyers are looking for offsets now.* As the market data cited earlier indicate, demand in the voluntary carbon offset market is growing rapidly. The desire among consumers to voluntarily contribute to climate change mitigation is something that should be harnessed and encouraged. Waiting until a full-fledged mandatory trading program before establishing offset standards could stunt the market before it has a chance to develop and undermine receptivity to offsets in

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the future. And given that a public good is at stake, there may be sound reasons for intervention on the grounds of consumer protection.

- *Voluntary offsets can inform the development of mandatory trading systems.* Initiating an oversight process for the voluntary offset market could actually assist with the development of a future mandatory program, by giving regulators hands-on experience with the evaluation and establishment of accounting standards, verification requirements, and registry systems.
- *Mandatory and voluntary markets won't necessarily be redundant.* It is not necessarily the case that a mandatory program will fully supersede voluntary offset programs. Under a mandatory program, for example, the government might decide to allow only a limited number offset project types, leaving other more experimental emission-reducing opportunities open to voluntary demand. While government oversight of the voluntary market could be less restrictive (and should not discourage innovation), there may still be some need for minimum quality standards.
- *Current oversight could provide certainty for the future.* One reason for government oversight today is to provide some assurance about the interaction of voluntary offset markets and mandatory programs in the future. Official endorsement of projects in certain sectors, for example, could indicate to voluntary offset buyers and sellers where they can safely invest their money to avoid conflict with future regulations. Oversight of the voluntary offset market could even form the basis of an "early action" crediting program for potentially regulated businesses. Policymakers must decide, however, whether they are willing to establish such precedents before a mandatory program is fully developed.

What form should government regulation or oversight take?

There are basically two ways the federal government could help bring consistency and credibility to the voluntary carbon offset market. The first would be to officially endorse offset credits from a particular program or trading system with its own credible oversight and enforcement mechanisms. The second would be to provide guidance, oversight, and/or enforcement for the voluntary market directly.

Endorsing a Particular Program or Trading System

The United Kingdom Department for Environment, Food, and Rural Affairs (DEFRA) floated a "best practice" guideline for voluntary offsets earlier this year recommending that only officially certified CDM credits, or allowances issued under the European Union Emissions Trading System, should be used for voluntary offsets. DEFRA's argument was essentially that only offset credits (or tradable allowances) from these mandatory programs currently meet all the required elements for a credible carbon offset commodity.

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Something similar could make sense for the United States. The question would be which program(s) to endorse or certify. Currently, only the Chicago Climate Exchange meets the basic requirements for a full standard, but its lack of transparency has raised questions about its credibility. Another alternative might be to endorse carbon offsets credits issues under the Northeast Regional Greenhouse Gas Initiative (RGGI), a multi-state cap-and-trade program for greenhouse gases. The RGGI program, however, will not be operational until 2009. Other programs mentioned above might qualify as well as they are further developed or launched.

A "best practice" guideline like this would of course not be binding, but could serve as a kind of quality benchmark for the market and promote consistency.

Establishing Guidance and Oversight for the Voluntary Carbon Offset Market

Direct oversight of the voluntary carbon offset market could take several forms, with varying degrees of involvement. In essence, however, it would involve ensuring that a consistent set of basic building blocks for a credible carbon offset standard are in place: accounting standards, verification standards, and registration and enforcement systems.

The objective of government oversight should be to bring clarity and consistency to how voluntary carbon offsets are defined and guaranteed. Any regulation or guidance should build off the work of existing standards and programs.

1. Accounting Standards

As noted above, several organizations are developing offset project accounting protocols applicable to specific types of projects in the United States. These protocols and others could be tapped to form the basis of a federal government "best practice" standard for voluntary carbon offsets. Protocols to evaluate for inclusion would include those developed by CCAR, the U.S. EPA Climate Leaders Program, RGGI, and the CCX. CDM accounting methodologies could also be considered, particularly for projects located in other countries, where protocols designed for the United States may not apply. There is some overlap in coverage among these programs' various protocols (each of them, for example, has a separate protocol for agricultural methane projects), and any differences will ultimately have to be reconciled. Federal guidance designating "best practice" protocols for the voluntary offset market could be tremendously helpful.

As noted above, one of the most critical carbon offset accounting issues involves making determinations about "additionality." U.S. programs have adopted a fundamentally different approach to additionality than the CDM, based on setting benchmarks against which projects can be objectively evaluated, rather than asking regulators to make subjective judgments about individual projects. Both approaches are potentially

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legitimate, but a standard set of guidance for additionality would greatly aid the credibility of the voluntary market.

2. Monitoring and Verification Standards

Of existing U.S. standards and programs, only CCAR and the CCX maintain lists of accredited verifiers. Other standards rely primarily on CDM-accredited verifiers. The VCS will formally accredit verifiers once it is launched. Nevertheless, the credibility of the voluntary carbon offset market would be enhanced by an official government accreditation program, identifying qualified verifiers for specific types of projects in the United States. A publicly accountable accreditation process could lend confidence to the voluntary market, and would not have to preempt or conflict with lists of verifiers maintained by existing programs.

3. Registration and Enforcement

Various registries are being developed that could perform essential disclosure and tracking functions for the voluntary carbon offset market. CCAR is one such registry (although it does not yet track the trading and retirement of credits), and the nascent multi-state Climate Registry will be another. The VCS plans to certify a registry (or multiple registries) to handle disclosure and tracking functions. The CCX maintains a registry, but does not publicly disclose information.

It would not make sense to create an entirely new registry for the voluntary carbon offset market. Nevertheless, there may be a compelling government interest to certify registries to ensure that they disclose essential information, and also to ensure that a proliferation of independent registries does not lead to the double registering and selling of the same GHG emission reductions.

Finally, the voluntary offset market would benefit from a clarification in law or regulation of who owns the "property" rights to specific types of emission reductions.

Are there certain types of projects that should or should not be used to offset GHG emissions?

The universe of potential carbon offset projects is both large and varied. If the goal of carbon offset markets is to achieve emission reductions at the lowest possible cost, then it makes sense to cast a wide net and include as many project types as possible. Nevertheless, most carbon offset programs expressly forbid projects with potential adverse social or environmental impacts (including, in nearly all cases, projects involving nuclear power), and it makes sense to adopt this as a minimum standard.

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Some observers argue that carbon offsets should only come from projects whose emission reductions are easy to quantify and verify. This is a good general rule, but it should not be interpreted too strictly. Generally, there is a tradeoff between projects that are "slam dunks" for offset credibility, but have few other redeeming qualities (e.g., HFC destruction), and those whose effects are difficult to quantify or verify, but have many secondary benefits (e.g., forestry). As noted previously, the ultimate value of the voluntary offset market may be as a tool for demonstrating innovative types of projects in areas that would otherwise be unexploited. The role of government oversight should be to ensure that accounting and verification methods follow basic standards for quality, without categorically excluding projects that may have multiple positive benefits.

Ultimately, a "portfolio" approach makes sense. Currently, the voluntary carbon offset market appears dominated by forestry projects, which tend to face significant quantification uncertainties. This points up the need for credible accounting guidelines, such as those developed under the WRI/WBCSD Project Protocol. The CDM market has faced an opposite problem, however, where a large quantify of offsets have come from projects whose reductions are easily quantified, but whose sustainable development benefits are minimal.

The CHAIRMAN. Thank you very much.

Our second witness is Joseph Romm. He is currently a Senior Fellow at the Center for American Progress. A physicist by training, Mr. Romm is a former Acting Assistant Secretary of Energy for Efficiency in Renewable Energy. He's recognized as one of the leading national experts on clean energy technology, and climate issues. He is the author of the recent book, "Hell and High Water: Global Warming—The Solution and the Politics", and he's been an active commentator on the voluntary offset market. Mr. Romm, thank you.

STATEMENT OF JOSEPH ROMM, SENIOR FELLOW, CENTER FOR AMERICAN PROGRESS

Mr. ROMM. Thank you, Mr. Chairman, members of the Committee. I appreciate the opportunity to share my views on carbon offsets, which are based on dozens of discussions with leading environmentalists, energy experts, and companies over the past 15 years.

I believe there is something very wrong about the general understanding of offsets. If a smart company like Google can seriously think it can go green by burning coal, and they buying offsets; if a smart company, like PG&E, is bragging about a new program that allows customers to offset their electricity emissions by measures, such as tree planting, if something as controversial and unproven as ocean fertilization can be sold to the public under the name carbon offset, and if the Vatican can announce its intention to offset all its emissions with a Hungarian Forestry Initiative. We all want to avoid catastrophic global warming, such as 80 foot sea level rise, and that means limiting future warming to 2 degree Fahrenheit, and that requires mandatory regulations cutting greenhouse gas emission 60 to 80 percent by 2050.

Absent that mandatory action, it is no surprise that individuals and companies have sought voluntary or unregulated strategies for reducing emissions, of which offsets are a prime example.

No consensus set of rules exist for determining what offsets are credible, as you just heard. Absent a legal framework, many different groups are offering their own set of standards, and many companies are offering offsets that are questionable, at best, such as trees, and ocean fertilization.

Trees are very popular offsets. Unfortunately, trees are lousy offsets for many reasons. First, trees grow slowly, so that the carbon pollution you emit today won't be sequestered fully for many decades. Second, trees aren't permanent. They can be cut down, or die. Third, it is hard to measure the amount of carbon absorbed by a forest. Fourth, how do you know that preserving trees in one place, doesn't just lead to more deforestation in other places? Congressman Inslee, that's sort of the answer to your question. If you don't have a cap in a country, then you don't know preserving a thousand acres of Brazilian rainforest won't just lead to 2,000 acres being cut somewhere else.

Fifth, trees often fail the additionality test. As one, I've been blogging on this extensively at Climate Progress, and have gotten a lot of phone calls. And one forestry expert told me, "Everybody

is selling offsets for things they were already doing." Certainly, that's not good.

Finally, because forests are relatively dark compared to what they replace outside the tropics, they absorb more of the sun's heating rays. That may negate the benefit trees have soaking up carbon dioxide.

The co-author of a 2005 study on the subject said bluntly, "To plant forests to mitigate climate change outside of the tropics is a waste of time." Large-scale ocean fertilization is more problematic. A leading group studying this issue, The Surface Ocean Lower Atmosphere Study, or SOLAS, said just last month, "Given our present lack of knowledge, the judgment of the SOLAS Scientific Steering Committee is that ocean fertilization will be ineffective, and potentially deleterious, and should not be used as a strategy for offsetting CO_2 emissions." We just don't know whether ocean fertilization can deliver measurable and verifiable emissions reductions, and we don't know if it will do more harm than good.

What type of offset projects make sense? The two key points are, we need deep cuts in greenhouse gas emissions, and burning fossil fuels is responsible for 85 percent of U.S. emissions. Therefore, the major focus of offsets should be aimed at reducing fossil fuel combustion, and the best offsets will jumpstart the transition to a low-carbon economy.

The gold standard is one international standard for offsets, whose projects focus exclusively on reducing fossil fuel emissions at the source, primarily through energy efficiency, and renewable energy. And I certainly endorse that standard.

In conclusion, I don't believe the voluntary offset market can make a significant contribution to greenhouse gas mitigation for one simple reason. The scale and speed of mitigation the nation must pursue to avoid catastrophic climate impacts is so great, 60 to 80 percent reductions by 2050, that only a mandatory regime can plausibly achieve such cuts. And that regime must be put in place within the next few years by Congress, together with the President.

Once a mandatory cap and trade system is in place, I believe the voluntary market will largely disappear. People may still wish to purchase offsets to become carbon neutral, but then they will almost certainly just purchase credits, or allowances on the regulated traded market.

I would, therefore, urge Congress to focus its efforts on developing and implementing a mandatory regime. And I know the Chairman has been a leader in that regard.

Thank you very much, and I look forward to your questions.

[The prepared statement of Mr. Romm follows:]

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STATEMENT OF

JOSEPH ROMM

SENIOR FELLOW

CENTER FOR AMERICAN PROGRESS

before the

SELECT COMMITTEE ON
ENERGY INDEPENDENCE & GLOBAL WARMING

of the

HOUSE OF REPRESENTATIVES

July 18, 2007

Mr. Chairman, members of the Committee, I am delighted to appear before you today to discuss the subject of voluntary carbon offsets. By way of background, I am a Senior Fellow at the Center for American Progress here in Washington, DC where I run the blog *ClimateProgress.org*. I am author of the recent book *Hell and High Water: Global Warming—the Solution and the Politics* (Morrow, 2007) and have published and lectured widely on climate science and solutions.

I served as Acting Assistant Secretary at the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy during 1997 and Principal Deputy Assistant Secretary from 1995 though 1998. In that capacity, I helped manage the largest program in the world for working with businesses to develop and use clean energy technologies. I hold a Ph.D. in physics from M.I.T. All references in this testimony can be found in my book or on my blog.

We are all grappling with the complex issue of how we can best avoid catastrophic global warming, which is to say how we drive a significant amount of money into projects that reduce emissions of heat-trapping greenhouse gases. Offsets are one possible strategy. Yet

- if a smart company like Google can seriously think it can go green by burning coal and then buying offsets
- if a smart company like PG&E is bragging about a new program that allows customers to offset their electricity emissions by measures such as tree planting
- if something as controversial and unproven as ocean fertilization can be sold to the public under the name carbon offset.
- if the Vatican can announce its intention to offsets all of its emissions with a Hungarian forestry initiative

then there is something is very wrong about the general understanding of offsets.

I appreciate the opportunity to share my views on the subject, which are based on dozens of discussions with leading environmentalists, energy experts, and companies over the past fifteen years.

BACKGROUND

The question of how significant a contribution the voluntary market can make to climate mitigation can be understood only with a full appreciation of the scale of climate mitigation the nation and the world must pursue. Global concentrations of carbon dioxide, the primary greenhouse gas, are rising at an accelerating rate in recent years—and they are already higher than at any time in the past 3 million years. While as recently as six years ago, most scientists thought that neither the Greenland nor Antarctic ice sheets would contribute significantly to sea level rise by 2100, both ice sheets are

already losing mass, leading Penn State climate scientist Richard Alley to note in May 2006, "The ice sheets seem to be shrinking 100 years ahead of schedule."

Worse, the ocean's heat content will keep reradiating heat into the earth's atmosphere even after we eliminate the heat imbalance, meaning the planet will keep warming and the glaciers keep melting for decades after we cut greenhouse gas emissions. Therefore, we *must* act in an "anticipatory" fashion and reduce emissions long before climate change is painfully obvious to everyone.

The planet has warmed about 0.8°C since the mid-19th century, primarily because of human-generated greenhouse gas emissions. If we don't sharply reverse the increase in global greenhouse gas emissions within the next decade, we will be committing the world to an additional 2° to 3°C warming by century's end, temperatures not seen for millions of years, when Greenland and much of Antarctica were ice free, and sea levels were 80 feet higher.

How fast can the sea level rise? Following the last ice age, the world saw sustained melting that *raised sea levels more than a foot a decade*. NASA's James Hansen—the country's leading climate scientist—believes we could see such a catastrophic melting rate within the century.

To avoid this fate, we must sharply reduce global carbon dioxide emissions from fossil fuel combustion. As an example of the kind of reductions required by climate change, both Florida Governor Charlie Crist and California Governor Arnold Schwarzenegger have committed their states to reduce greenhouse gas emissions to *80% below 1990 levels by 2050*. The Safe Climate Act, which Chairman Markey has sponsored, requires similar cuts. The United States Climate Action Partnership—a group of businesses and leading environmental organizations—has embraced 60% to 80% cuts. Former Prime Minister Tony Blair committed the United Kingdom to a 60% reduction by 2050. All industrialized nations, including the United States, need to achieve reductions of 60% to 80%, which requires emissions to peak in the next decade.

And yet governments—especially here in United States—have been slow to embrace the regulations needed to avoid catastrophe. Absent regulations, it is no surprise that individuals and companies have sought voluntary or unregulated strategies for reducing emissions, of which offsets are one of the prime examples.

CARBON OFFSETS

Wikipedia has an excellent introduction to offsets, which I reprint here:

> When one is unable or unwilling to reduce one's own emissions, carbon offset is the act of reducing ("offsetting") greenhouse gas emissions elsewhere. A well-known example is the planting of trees to compensate for the greenhouse gas emissions from personal air travel.
>
> The idea of paying for emission-reductions elsewhere instead of reducing by own actions is also known from the closely related concept of emissions trading. However, in contrast to emissions trading, which is regulated by a strict formal and legal framework, carbon offsets generally refer to voluntary acts by individuals or companies that are commonly arranged by commercial or not-for-profit carbon-offset providers.
>
> A wide variety of offset methods are in use — while tree planting has initially been a mainstay of carbon offsetting, renewable energy and energy conservation offsets have now become increasingly popular, and purchase and withdrawal of emissions trading credits is also seen....
>
> The Kyoto Protocol has sanctioned official offsets for governments and private companies to earn carbon credits which can be traded on a marketplace. This has contributed to the increasing popularity of voluntary offsets among private individuals and also companies. Offsets may be cheaper or more convenient alternatives to reducing one's own fossil-fuel consumption. However, some critics object to carbon offsets, and many have questioned the benefits of certain types of offsets (such as tree planting), and other projects.

No consensus set of rules exist for determining what is a credible and viable portfolio of offsets. In the absence of a legal framework, many different groups have come forward to offer their own set of standards, and many companies have come forward to offer offsets that are questionable at best. Let me focus on two of the most problematic types of offsets in the news: trees and ocean fertilization.

FORESTRY OFFSETS

Trees are very popular offsets. Both the Vatican and the utility PG&E have embraced them. Unfortunately, they are lousy offsets, for many reasons. Adam Stein, the cofounder of TerraPass, an offset company, recently noted several "fundamental reasons exist to be wary of trees as a source of carbon offsets" in a post at the Gristmill blog:

> The biggest one is timing. A carbon offset represents not just a specific amount of greenhouse gas reduction, but also a specific period in which the reduction takes place. One of the most basic principles of offset quality is that, other things being equal, you want to sponsor reductions that are taking place now, not at some far-off point in the future.
>
> Unfortunately, trees grow rather slowly. And particularly when they're small, they don't sequester much carbon. The small print on tree-planting offsets typically indicate a 40-year maturity. If you buy a tree-based offset today, you're sponsoring a reduction that won't be complete until 2047....

> A second concern with tree-based offsets is permanence. An offset is only an offset if the reduction is real and ongoing. Trees have an unfortunate habit of dying or being cut down. Particularly given the time frames involved, with all the attendant issues over land rights, it can be very tricky to say what will happen to an individual forest several decades down the road. Some offset companies claim to guard against this risk by padding their tree offset purchases, but such tactics don't seem to guard against large-scale deforestation.
>
> There are additional problems with tree-planting projects, which I catalog below. But before delivering the whole list, I want to provide some perspective to this downbeat picture.
>
> The first bit of perspective is that tree-planting projects make up an extremely small percentage of offsetting projects worldwide. For example, reforestation accounts for 6 out of 1,783 projects in the Clean Development Mechanism (CDM) pipeline. Consumers are disproportionately aware of trees because such projects make up a disproportionate share of the tiny voluntary market. As mentioned, marketers love these projects because they're cheap and consumer-friendly....
>
> A third concern, after timing and permanence, is measureability. It's fairly complicated to measure the amount of carbon absorbed by a forest; some planting practices can actually result in a net release of carbon from the soil. A fourth is the aforementioned sunlight absorption issue [see below]. A fifth is the possibility of "leakage," which means that the new trees just displace deforestation, rather than reduce it.

Let me add that after blogging on this subject, I spoke to a forestry expert who works with carbon offset aggregators, and he told me "Everybody's selling offsets for things they were already doing." That is the so-called additionality problem.

For me, one of the biggest questions about trees is what might be called the law of unintended consequences. Just as fossil fuel consumption turned out to have the unintended consequence of climate change, tree planting may have its own unintended consequence. Because forest canopies are relatively dark compared to what they replace outside the tropics—grass, croplands, or snowfields—they absorb more of the sun's heating rays that fall on them. That negates the "carbon sink" benefit trees have soaking up carbon dioxide.

A 2005 study by the Lawrence Livermore National Laboratory and the Carnegie Institution of Washington, "Climate Effects of Global Land Cover Change," examined this issue and concluded "more research is necessary before forest carbon storage should be deployed as a mitigation strategy for global warming. In particular, high latitude forests probably have a net warming effect on the Earth's climate." One of the authors, Carnegie Institution's Ken Caldeira, summarized the results this way: "North of 20 degrees [latitude] forests had a direct warming influence that more or less counterbalanced the cooling effect of carbon removal from the atmosphere" which led him to conclude "*To plant forests to mitigate climate change outside of the tropics is a waste of time.*"

One can envision two rare cases where tree offsets might work: certified urban trees and certified tropical forest preservation. The word "certified" is key in both cases. Let's start with urban trees.

Shade trees in particular reduce the urban heat island, providing direct cooling as well as reduced air conditioning use. I would support urban trees that were 1) planted as shade trees and 2) part of an overall heat island mitigation strategy that included lighter color roofs. That said, I am unaware of any tree offset program that actually focuses on urban trees—primarily because they tend to be more expensive to plant and more expensive to maintain and monitor than trees outside of cities, which can be planted in large number in a small space (rather than individually over a large city). The tricky part of urban tree planting is to set up a certification system that ensures these trees are permanent—and not, say, cut down by some landowner expanding their house or lost in a storm.

Tropical forest preservation is clearly both important and difficult. The key problem is—How can we be sure that the project is resulting in a net increase in tropical trees? Imagine planting 1000 acres of trees in Brazil, where the full extent of annual deforestation is not known precisely. How do we know 2000 acres won't be chopped down somewhere else in the country? Until countries with tropical forests join an international greenhouse gas treaty and are subject to rigorous verification strategies, tree-related offset projects will not deliver guaranteed, quantifiable benefits.

Addressing this "leakage" problem requires a country-wide certification system. Reuters reported on a forthcoming (December 2007) UN report on this very subject, "Reduced Emissions from Deforestation" (RED): "RED schemes would be run via national carbon accounting and verification, rather than being project-based. Remote sensing technology and 'ground truthing' checks would verify reductions and monitor their 'additionality' (a net reduction) and 'leakage' (man-made damage to forest carbon stores)." In short, project-based forest preservation, which is how offsets have typically been conceived, is no good. You must do genuine certification, but again, this won't be cheap or easy.

LARGE-SCALE OCEAN FERTILIZATION

The law of unintended consequences calls into question another potential offset strategy. I am not an expert on large-scale ocean fertilization, though it must be said that few if any such experts exist. I did do my Ph.D. thesis research on physical oceanography at the Scripps Institution of Oceanography. That work gave me a great deal of insight and experience into the ocean system—and a great deal of

respect for both professional oceanographers and the complex nature of the coupled ocean-atmosphere system.

One of the leading groups studying the ocean-atmosphere system is the Surface Ocean – Lower Atmosphere Study (SOLAS), a new international research initiative aimed at achieving a "quantitative understanding of the key biogeochemical-physical interactions and feedbacks between the ocean and atmosphere, and of how this coupled system affects and is affected by climate and environmental change." Last month the SOLAS Scientific Steering Committee—18 leading experts from 13 countries—issued a Position Statement on Large-Scale Ocean Fertilisation:

> Large-scale fertilisation of the ocean is being actively promoted by various commercial organisations as a strategy to reduce atmospheric CO2 levels. However, the current scientific evidence indicates that this will not significantly increase carbon transfer into the deep ocean or lower atmospheric CO2. Furthermore, there may be negative impacts of iron fertilization including dissolved oxygen depletion, altered trace gas emissions that affect climate and air quality, changes in biodiversity, and decreased productivity in other oceanic regions. It is then critical and essential that robust and independent scientific verification is undertaken before large-scale fertilisation is considered. *Given our present lack of knowledge, the judgement of the SOLAS SSC is that ocean fertilisation will be ineffective and potentially deleterious, and should not be used as a strategy for offsetting CO2 emissions.*

The References for this statement can be found at http://www.solas-int.org/.

In 2001, ocean scientists Sallie Chisholm, Paul Falkowski, and John Cullen wrote an article in *Science*, "Dis-Crediting Ocean Fertilization." They point out the leakage problem:

> Despite the claims of the proponents, carbon sequestration from ocean fertilization is not easily verified. Besides measuring carbon flux profiles and comparing them with a control basin, one would have to determine what fraction of the natural stores of N [nitrogen] and P [phosphorus] used up in the fertilized patch would no longer be available for phytoplankton growth in downstream ocean regions. This would require complex numerical models of large-scale ocean physics and biogeochemistry, the predictions of which cannot be validated through small perturbations such as patch fertilizations.

They also note that while "no single application" of small-scale fertilizations subsidized by carbon credits "would cause sustained ecosystem damage":

> But if it is profitable for one, it would be profitable for many, and the cumulative effects of many such implementations would result in large-scale consequences--a classic "tragedy of the commons."
>
> One simple way to avert this potential tragedy is to remove the profit incentive for manipulation of the ocean commons. *We suggest that ocean fertilization, in the open seas or territorial waters, should never become eligible for carbon credits.*

I excerpt the article at length in the addendum to this testimony.

GOLDEN OFFSETS

What type of offset projects makes sense? The two key points are 1) we need deep reductions in greenhouse gas emissions and 2) combustion of fossil fuels—coal, oil, and natural gas—is responsible for over 60% of anthropogenic (human-caused) global warming. Indeed, in the United States, fossil fuel combustion is responsible for 85% of greenhouse gas emissions. Therefore, the major focus of offsets should be fossil fuel combustion, and the best offsets will jumpstart the transition to a low-carbon economy.

The Gold Standard (www.cdmgoldstandard.org) is an international standard for offsets whose projects focus exclusively on reducing fossil fuel emissions at the source. As a joint statement by World Wildlife Fund and other environmental groups explained, the Gold Standard, only certifies projects that meet the following criteria:

- they must be energy efficiency or renewable energy projects (this includes methane to energy in certain circumstances);
- they must pass a sustainable development screen—i.e. there must be evidence that the project is making a real contribution to sustainable development and that it benefits the local community;
- they must only provide an energy service that helps catalyse the transition to non-fossil fuel based energy systems. Projects which generate credits from the destruction of industrial waste gases such as HFC's are not eligible. These projects have little or no wider sustainable development benefits; and
- they must follow a conservative, guided interpretation of the additionality requirement that is necessary to demonstrate that a project delivers real emission savings which would not have occurred anyway under 'business as usual'.

The Gold standard explicitly excludes forestry projects. I would favor allowing 10% of offset projects to be certified urban tree projects and certified nationwide tropical forest preservation. But in general the bias should be for high-quality offsets, since this is a voluntary and unregulated market, and hence prone to abuse.

CONCLUSION

Let me conclude by specifically answering the questions posed by the committee in reverse order:

Q4: What is the future of the voluntary market, and what ought to be the relationship between the voluntary market and any future mandatory cap-and-trade regime in the U.S.?

A4: Once there is a mandatory cap-and-trade regime in the U.S., I believe the voluntary market will essentially disappear or be folded into that regime. People may still wish to purchase offsets in order

to become carbon neutral, but then they will almost certainly simply purchase credits or allowances on the regulated, traded market. If there are credible but inexpensive emissions reductions (i.e. offsets), they will inevitably be captured by the mandatory cap-and-trade regime. If the emissions reductions are not credible, no one will buy them in a voluntary market.

Q3: How can we ensure that individual consumers and companies that purchase carbon offsets are getting what they pay for and that offset projects have environmental integrity, with regard to both climate and non-climate effects? Are industry standard-setting initiatives adequate, or is there some role for government regulation? If so, what form should regulation take?

A3: I do not believe industry standard-setting is adequate, so the only way to ensure integrity in the voluntary market is government regulation. However, I am not certain regulation is worth pursuing given 1) the complexities and controversial nature of offset projects, and 2) the likelihood—the necessity, really—of a mandatory regime in the near future. That said, a mandatory regime will need to set credible and transparent protocols for greenhouse gas baselines and reductions. Such protocols are also needed for offset projects, so it might make sense for the government to begin a consensus-based effort to develop those protocols in any case.

Q2: What offset project types are most likely to be effective in mitigating climate change without adverse side effects, and what types present the greatest problems?

A2: I have discussed this at length in my testimony. The best offset projects satisfy the Gold Standard—energy efficiency and renewable energy investments that meet tough "additionality" tests and that jumpstart the transition to a low-carbon economy. The types of offset projects that present the greatest problems are trees and geo-engineering such as ocean fertilization.

Q1: How significant a contribution could the voluntary offset market make to mitigation of climate change, and what steps, if any, could increase that contribution?

A1: I don't believe the voluntary offset market can or will make a significant contribution to climate change mitigation for two reasons: 1) The scale of climate mitigation the nation must pursue to avoid catastrophic impacts is so great—60% to 80% reductions by 2050—that only a mandatory regime can plausibly achieve such cuts, and 2) We must—and I believe we will—put in place a mandatory cap-and-trade regime within the next few years to have any realistic chance of meeting the necessary reductions. Such a regime would render the offset issue largely moot. I am not certain I would recommend that Congress take steps to increase that contribution, but rather would urge Congress to focus its efforts on developing and implementing a mandatory regime.

ADDENDUM

An Excerpt from Chisolm et al., "Dis-Crediting Ocean Fertilization,"
Science, 12 October 2001: Vol. 294. no. 5541, pp. 309 - 310

Despite the concerns of many oceanographers and environmental groups, the concept of industrial ocean fertilization is winning advocates. Proponents claim that ocean fertilization is an easily controlled, verifiable process that mimics nature; and that it is an environmentally benign, long-term solution to atmospheric CO_2 accumulation. These claims are, quite simply, not true.

It is not easily controlled. A fertilized patch in turbulent ocean currents is not like a plot of land. The oceans are a fluid medium, beyond our control.

It does not mimic nature. The proponents argue that ocean fertilization is similar to the natural iron deposition from atmospheric dust, and to the natural upwelling of nutrients from the deep sea. These analogies are flawed. Phytoplankton species that bloom in response to upwelling are adapted to a turbulent regime, and a complex mixture of upwelled nutrients that are part of the natural nutrient regeneration cycle of the oceans. Furthermore, proposed designs employ an artificial chelator, lignin acid sulfonate, which is designed to keep iron in solution and is chemically different from atmospheric iron sources. Finally, in intensive commercial ocean fertilization, iron would be delivered to ecosystems at rates that do not mimic the 1000-year time scales of glacial transition periods.

Despite the claims of the proponents, carbon sequestration from ocean fertilization is not easily verified. Besides measuring carbon flux profiles and comparing them with a control basin, one would have to determine what fraction of the natural stores of N and P used up in the fertilized patch would no longer be available for phytoplankton growth in downstream ocean regions. This would require complex numerical models of large-scale ocean physics and biogeochemistry, the predictions of which cannot be validated through small perturbations such as patch fertilizations.

The proponents' claim that fertilization for carbon sequestration would be environmentally benign is inconsistent with almost everything we know about aquatic ecosystems. Fertilization changes the composition of the phytoplankton community; it is precisely this feature that gives it the potential for increasing carbon flux to the deep sea. Correspondingly, the oceans' food webs and biogeochemical cycles would be altered in unintended ways. We have learned this from inadvertent enrichment of lakes and coastal waters with nutrients from agricultural runoff, something we have been trying to reverse for decades.

Fertilization advocates try to counter these concerns by arguing that the oceans have already been compromised. Indeed, we have known for decades that human activities have resulted in depleted fisheries, coastal eutrophication, heavy metal accumulation, and rising dissolved CO_2 in the surface waters. But does this unintended deterioration justify large-scale, purposeful interference with ocean ecosystems? The oceans provide valuable ecosystem services for the maintenance of our planet and the sustenance of human society, and the carbon cycle is intimately coupled with those of other elements, some of which play critical roles in climate regulation. One cannot sequester additional carbon without changing coupled biogeochemical cycles.

Models predict, for example, that sustained fertilization would likely result in deep ocean hypoxia or anoxia. This would shift the microbial community toward organisms that produce greenhouse gases such as methane and nitrous oxide, with much higher warming potentials than CO_2. Some models predict that Southern Ocean fertilization would change patterns of primary productivity globally by

reducing the availability of N and P in the Equatorial Pacific. The uncertainties surrounding these cumulative, long-term, consequences of fertilization cannot be reduced through short term, small-scale experiments.

To us, the known consequences and uncertainties of ocean fertilization already far outweigh hypothetical benefits. Models predict that if all of the unused N and P in Southern Ocean surface waters were converted to organic carbon over the next 100 years (an unlikely extreme), 15% of the anthropogenic CO_2 could be hypothetically sequestered. Because deep ocean CO_2 reservoirs are eventually re-exposed to the atmosphere through global ocean circulation, this would not be a permanent solution. It is argued, however, that it would buy us time. Given both the certain and likely consequences of widespread ocean fertilization, which at some critical scale would not be reversible, we do not find this justification compelling.

We are not arguing against selective small-scale iron enrichment experiments designed to answer questions about how ocean ecosystems function. Such experiments have proven to be extremely valuable scientifically and produce very transient effects. Our objections are to commercialized ocean fertilization--the scaled-up consequences of which could be very damaging to the global oceans.

To put ocean fertilization as a carbon sequestration option into perspective, we need to remind ourselves why CO_2 is increasing in the atmosphere at such a rapid rate and to ask how sequestration could mitigate this rise. Two basic carbon cycles operate on Earth. The first cycle is driven by volcanic outgassing of CO_2 coupled to the metamorphic weathering of silicate rocks. This cycle operates on time scales of millions of years. The second cycle involves the biological reduction of CO_2 to organic matter and the subsequent oxidation of the organic matter by respiration. A tiny fraction of organic carbon escapes respiratory oxidation and is incorporated into the lithosphere, forming fossil fuels. This process transfers carbon from the fast, biologically driven cycle to the slow, tectonically controlled cycle.

By burning fossil fuels, humans are bringing carbon from the slow cycle back into the atmosphere. The biological sinks—chiefly forests and phytoplankton—cannot adjust fast enough, and do not have the capacity to remove all this anthropogenic carbon from the atmosphere. For carbon sequestration to work as a climate mitigation strategy, CO_2 must be sequestered back into the slow carbon cycle. Ocean fertilization does not do so; nor does direct injection of CO_2 into mid-ocean waters, another proposed method for carbon sequestration. Direct injection short-circuits the biological pump but it may trigger unknown effects on deep sea life and thus on biogeochemical processes.

Given all of the risks and limitations, why has the idea of industrial scale ocean fertilization not been summarily dismissed? One answer lies in carbon trading. One need not fertilize entire ocean basins to sequester an amount of carbon that could yield commercial benefits on this anticipated market. If scientifically sound verification criteria could be developed, relatively small-scale fertilizations could be very profitable for individual entrepreneurs. True, no single application would cause sustained ecosystem damage. But if it is profitable for one, it would be profitable for many, and the cumulative effects of many such implementations would result in large-scale consequences--a classic "tragedy of the commons."

One simple way to avert this potential tragedy is to remove the profit incentive for manipulation of the ocean commons. We suggest that ocean fertilization, in the open seas or territorial waters, should never become eligible for carbon credits.

The CHAIRMAN. Thank you very much. Our next witness is Mr. Erik Blachford. He is the CEO and Director of TerraPass, the nation's largest retail carbon offset provider. He has had a distinguished career in business, having served as CEO of Expedia, and later IAC Travel Expedia, one of the world's largest online travel booking companies. Thank you so much for joining us.

STATEMENT OF ERIK BLACHFORD, CEO, TERRAPASS, INC.

Mr. BLACHFORD. Thank you, Chairman Markey, and members of the Select Committee on Energy Independence and Global Warming for the invitation to speak today. TerraPass applauds the work of the Committee, and welcomes this opportunity, the carbon market.

A few months ago, I became CEO of TerraPass, a leading retailer of carbon offsets. TerraPass has helped over 50,000 citizens balance their emissions, driving, flying, and home, purchasing offsets from clean energy and energy efficiency projects in the U.S. voluntary carbon market. Household carbon reductions totaling 175 metric tons, at the same time, over half a million Americans have calculated some aspect of carbon footprint on the TerraPass website, and over 30,000 readers subscribe to our email newsletter. Some have asked whether these individuals buy offsets to avoid directly reducing carbon emissions. Votes from a recent TerraPass customer survey make it clear that the opposite is true.

For example, almost two-thirds of TerraPass customers have bought energy-saving light bulbs. Five times more likely to commute by public transportation, 31 times more likely to drive a hybrid vehicle, 210 times more likely to have a solar energy system installed on their houses. We strongly believe that our government must lead the effort to fight global warming.

As a retailer of carbon offsets, TerraPass does not engage in project development. Rather, we have designed a portfolio of high-quality carbon reductions which we offer to consumers at a mark-up that provides a path to allow us to cover our overhead expenses. We are exclusively focused on the consumer segment of the voluntary carbon market, directly through our website at TerraPass.com, and through our partnerships with other consumer business firms, such as Ford, Expedia, and Sam's Club. We source our carbon reductions from projects falling into three categories, each representing one-third of our portfolio. These are wind power, dairy farm, methane digest, more commonly known as cow power, and landfill gas flaring projects.

We subject each of our projects to a rigorous quality screening process with efforts focusing on different levels of our operations. First, we enforce project level quality using a combination of existing industry protocols and internal review; wind projects under the Green-e program of the Center for Resource Solutions; dairy farm methane by C&S Gas, and landfill gas flaring by First Environment.

Second, TerraPass adheres to a wide variety of portfolio-level quality metrics. All offsets we sell are generated in the same year as the consumer purchase. This quality practice precludes most tree-planting projects, and most projects for carbon accounting extends into the future.

Third, we believe in disclosure. We have always listed in our website all projects that we support, a practice which we believe to be unique in our industry.

Fourth layer of quality enforcement, we submit to an annual audit by the non-profit Center for Resource Solutions to assure that our carbon purchases match our customer obligations.

Finally, to ensure we're making responsible marketing claims, our marketing literature for both TerraPass and TerraPass partners is reviewed by the Center for Resource Solutions. We believe our approach is robust, but also believe the time is right for the development of a consumer protection standard in a retail voluntary carbon offset market, and encourage the appropriate agency of federal government to play an active role in the standard-setting process.

As a stakeholder in existing standard development efforts, and as a leader in subsequent efforts, we believe a standard is necessary to spur growth in voluntary carbon offset markets, which exist not only to generate immediate reductions in carbon dioxide emissions, but also to serve as something of a laboratory for policy innovation, at no cost to taxpayers, and to give businesses and individuals experience working in the carbon markets.

In conclusion, TerraPass believes that the voluntary retail carbon market can drive citizen awareness of the impact of their lifestyle choices, and educate citizens on actions they can take in their everyday lives to reduce carbon emissions, and to generate incremental carbon emission reduction, by giving consumers a simple mechanism for funding American entrepreneurs and companies who wish to reduce carbon emissions.

Americans want to take action in the fight against climate change, and TerraPass welcomes government involvement to make those citizens more confident in a voluntary retail carbon offset market. Thank you.

[The prepared statement of Erik Blachford follows:]

terrapass

Testimony of Erik Blachford before the Select Committee on Energy Independence and Global Warming
July 18, 2007

I wish to thank Chairman Markey and members of the Select Committee on Energy Independence and Global Warming for the invitation to speak today. Two months ago I became CEO of TerraPass, a leading retailer of carbon offsets. TerraPass has helped over 50,000 citizens balance their emissions from driving, flying or home energy use by purchasing offsets from clean energy and efficiency projects in the U.S. voluntary carbon market. The carbon calculators on our web site have also helped ten times that number calculate their total carbon dioxide emissions, or "carbon footprint," increasing awareness of the overall environmental impact of lifestyle choices and spurring consumers to take ongoing action.

TerraPass applauds the work of the Committee and welcomes the opportunity to answer questions about the scope, environmental integrity, progress on standards, and future of the voluntary carbon market.

TerraPass' involvement in the voluntary carbon offset market

Founded in 2004 in a classroom at the Wharton School of the University of Pennsylvania, TerraPass was the result of Professor Karl Ulrich's desire to balance his own carbon footprint by supporting clean energy production. Ulrich challenged his students to create a consumer-friendly offsetting service. Six weeks later, TerraPass was born. Today you can buy a TerraPass for your automobile, flights, home energy use, dorm room, and even your

wedding. TerraPass is available through a variety of outlets, including a successful partnership with Expedia.com, the world's largest online travel agency.

Over half a million Americans have calculated some aspect of their carbon footprint on the TerraPass web site. We have sold over 65,000 units, representing carbon reductions totaling 175,000 metric tons. We produce a popular email newsletter on fighting climate change distributed weekly to over 30,000 readers. Recent research suggests that 39% of TerraPass members implemented new energy conservation strategies after purchasing their TerraPass.

As a retailer of carbon offsets, TerraPass does not engage in project development. Rather, we have designed a portfolio of high-quality carbon reductions which we offer to consumers at a mark-up that provides a path to allow us to cover our overhead expenses. We also offer a variety of calculators, sustainability tools, and environmental content relevant to Americans interested in fighting climate change and fostering energy independence. We are exclusively focused on the consumer segment of the voluntary carbon market, and we work with other consumer-facing firms such as Ford, Expedia, and Sam's Club to reach their customers.

Our current staff is seven, which we expect to double by early 2008.

TerraPass projects

TerraPass projects fall into three categories, each representing one-third of our portfolio.

1. Wind Power. We support wind energy generation by purchasing and retiring Green-e certified renewable energy certificates (RECs).[1]

2. Anaerobic digestion. Dairy farm methane digesters (or "cow power") create a direct offset by destroying the greenhouse gases associated with agricultural byproducts. We buy SES-certified[2] offsets directly from farmers.

3. Reductions from corporations. We support direct reductions from corporations and municipalities with carbon-producing assets. To date, our efforts here have focused on landfill gas flaring projects certified by First Environment.[3]

TerraPass negotiates purchases from anaerobic digestion and landfill projects directly with project developers and then registers the trades on the Chicago Climate Exchange (CCX). TerraPass joined the CCX in January 2005 as the first offset retailer on the exchange. We were also one of the first to make use of provisions in the CCX allowing for direct bilateral contracts with project developers. This unique approach combines the auditing, certification, registration and market-making benefits of the CCX with the full flexibility and integrity of project-based offsets. We do not buy generic credits, often referred to as "allowances," on the CCX, as we feel customers benefit from a more direct connection with the carbon reducing projects their monies support.

TerraPass' approach to environmental integrity

TerraPass believes that the best way to uphold environmental integrity in the voluntary carbon market is through the development of industry standards that provide clear rules to market participants and guidance to consumers. TerraPass actively participates in the voluntary standards development process presently underway, and our own quality

assurance process has served as a test bed for many practices now being more widely adopted in the industry. This is a young industry still wrestling with several important policy questions, so we seek continuous feedback and improvement as we chart a path forward.

TerraPass' own quality efforts focus on multiple aspects of our operations.

First, we enforce project-level quality using a combination of existing industry protocols and internal review. TerraPass sources verified, permanent, and additional reductions from clean energy and efficiency projects in the U.S. All wind projects are certified under the Green-e program of the non-profit Center for Resource Solutions (CRS). All other projects issue detailed verification reports that have been accepted by the CCX offset committee (which includes the World Resources Institute (WRI) as a member) and reviewed by TerraPass staff.

Second, TerraPass adheres to a variety of portfolio-level quality metrics. In particular, we employ a matched maturity model, meaning that all offsets we sell are generated in the same year as the consumer purchase. This quality practice precludes most tree-planting projects and projects whose carbon accounting extends into the future.

Third, TerraPass adheres to strict disclosure and transparency guidelines. We list all projects that we support on our web site, as well as every single carbon transaction (date, source, and amount), a practice which we believe to be unique in the industry. Every product we sell comes with a Product Content Label (PCL)[4] that lists the amount and source of the offsets, and provides consumer protection disclosures.

Fourth, TerraPass is audited by an independent third-party to ensure that we adhere to our stated quality practices. The CRS performs an annual statistical audit of our customer database to assure that our carbon purchases match our customer obligations. TerraPass was the first U.S. offset retailer to publish a verification report[5] containing the results of this third-party audit. We commit to our portfolio make-up at the beginning of each calendar year, and we provide our customers with a toll-free number for our third party auditor.

Fifth, TerraPass applies quality guidelines to our marketing and communications, as well as the communications of our partners. Marketing literature for both TerraPass and TerraPass marketing partners is reviewed by CRS to ensure we are making responsible claims.

Despite these safeguards, TerraPass has not been immune from criticism directed at the voluntary market for real and perceived problems. We take all such criticism as an opportunity to improve our own processes. The following case study illustrates how we have addressed such criticisms, sheds light on challenges facing the industry, and suggests ways for the government to help by structuring market institutions and processes.

Case study: Tontitown landfill gas flaring project

On March 26, 2007, *BusinessWeek* magazine published an article critical of the voluntary carbon market that specifically examined projects in TerraPass' portfolio and elsewhere. The article devoted particular attention to the Tontitown landfill gas flaring project.

The offsets generated by Tontitown had been verified by First Environment, approved by the CCX offset committee, and reviewed by TerraPass. By all counts they seemed consistent with prevailing rules and standards.

The article's primary allegation was that the Tontitown LFG project was "non-additional" – that is, not undertaken in anticipation of carbon offset sales – because it was implemented under regulatory compulsion due to groundwater contamination problems. One of the most basic additionality tests is that a project must be voluntary, or "super-regulatory."

But the article based its charges on comments from people not involved in the original project and unfamiliar with the carbon abatement aspects of the landfill flaring system. To assess the allegations, we assembled a panel of academics with expertise in carbon abatement.

We then launched a public evaluation of the Tontitown project via a series of tests used by the international community, publishing regular updates on our website for the benefit of our customers and the public at large, and published the final analysis for review on May 7, 2007.[6]

The panel disagreed with *BusinessWeek* and judged the reductions as additional. It also proposed a series of process improvements which TerraPass has incorporated into our standard procedures. (We have included both the letter from the panel and our own report on the Tontitown project in an appendix to our written testimony.)

The case illustrates the current market reality. Credible participants in the market do their best to seek out high-quality reductions based on available rules and standards. Outside observers in the press and elsewhere, often acting without a thorough understanding of the prevailing rules and standards, either support or cast doubt on the quality of reductions, resulting in consumer confusion. And until there are broadly accepted and well-understood standards in place, there can be no authoritative arbiter when questions arise. This situation is not optimal for retailers like TerraPass, for consumers, or for entrepreneurs and clean energy developers attempting to forecast future revenue likely to come from the sale of reductions.

We discuss in the next section ways in which the industry is working to clarify the rules and how the government can help.

Industry-wide and government-led efforts to improve the voluntary carbon market

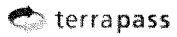
The time is right for the development of a consumer protection standard in the retail voluntary carbon offset market. The voluntary carbon industry will greatly benefit from the development of an industry-wide standard governing both project quality and marketing practices. Because disagreement remains on even basic technical matters such as the establishment of additionality, we believe that only a stakeholder-based standards effort will see successful adoption. A standard will also provide guidance and reassurance to consumers, who today are unable to evaluate the competing claims of offset retailers.

Two high-profile standards-development efforts will come to fruition later this summer. The first is the Green-e Certified Greenhouse Gas Emission Reduction Product Standard,[7] established by Center for Resource Solutions. CRS has prior success in establishing standards for voluntary consumer markets. Over 100,000 Americans buy green power certified under CRS' Green-e program every year.[8]

The new Green-e offset standard establishes a consumer protection program, a set of stakeholder-based rules and a governance process for various voluntary and regional offset schemes in the voluntary market. Representatives from leading U.S. non-governmental organizations such as National Resources Defense Council and WRI serve as advisors to the CRS process. The new standard has been board-approved and was publicly released this week.

The second is the Voluntary Carbon Standard (VCS), promulgated by The Climate Group and the International Emissions Trading Association (IETA). This standard provides a mechanism for adoption of the rules of the UNFCCC in the voluntary carbon market. Supported by international project developers and financiers, this standard would bring a well-developed set of tools into non-Kyoto countries for carbon offset project development.

The two standards are not necessarily redundant. VCS provides a project-level standard. CRS is a meta-standard that can be used to validate VCS for use in the U.S. voluntary market. Further, CRS specifies consumer protection guidelines for the market as a whole.



TerraPass and other key members of the voluntary carbon market have participated in both standards' stakeholder processes.

A useful role exists for the government in ensuring the integrity of the voluntary carbon market. We make the following recommendations:

1. The government's primary focus should be the passage of economy-wide carbon legislation to reduce U.S. carbon emissions to a scientifically recommended safe level as quickly as possible. The voluntary market is not a substitute for a regulatory solution, and we believe that the passage of economy-wide legislation will quickly force the voluntary market to match the quality of the regulated market.

2. The government should participate as a stakeholder in the open standards development processes already underway. The Environmental Protection Agency has provided useful input but no formal comment. TerraPass welcomes greater participation from government representatives.

3. The government can further aid the development and integrity of the voluntary carbon market by offering to become itself the convening party for the development of a retail carbon standard. The stamp of approval from a government-led standard would help mitigate risk to entrepreneurial project developers who are concerned about market acceptance of their offsets. A government standard would also provide maximum assurance to consumers.

Any government-led standard must take care not to stifle the innovation that characterizes the young voluntary market. It must be flexible enough to accommodate new project types and business models. Further, the government should not take on roles successfully being performed now by the private and non-governmental sectors, such as project certification.

The role of the voluntary offset market in the future

The voluntary carbon market provides a number of useful functions that it will continue to serve even after the adoption of economy-wide carbon regulation.

First, the voluntary market is creating incremental greenhouse gas reductions now. Several years are likely to pass before the adoption and implementation of economy-wide carbon regulation in the U.S. Even the laudable Regional Greenhouse Gas Initiative (RGGI) will not require emissions reductions until 2015.[9] In the interim, we expect to see continued growth of the voluntary market, resulting in a revenue stream for the promotion of domestic clean energy production and for carbon abatement programs that financially reward forward-looking entrepreneurs such as small dairy farmers who install methane digesters.

Second, the voluntary market is a useful laboratory for policy innovation and experimentation that can eventually be incorporated into formal legislation. Despite being strictly voluntary, the CCX is the second largest carbon market in the world. Various protocols and lessons from the voluntary market are being used to inform and improve the regional initiatives now under development. Such policy innovation is costless to the

American taxpayer and should help the U.S. avoid many of the difficulties that have affected other attempts at large-scale carbon regulation.

Third, even in the presence of a regulated market, the voluntary market will help bring carbon reductions to areas of the economy that don't fall under regulation. Once a clear price signal is set, the voluntary market can move rapidly to find unexploited niches and cost-effective sources of greenhouse gas reductions.

Fourth, the voluntary carbon market gives individuals and businesses useful experience with the process of managing their carbon impact. Most businesses find that seeking efficiency improvements can actually be a source of cost savings, but they first have to clear the initial hurdle of understanding, measuring, and monitoring their impact. A healthy desire to stay ahead of the policy curve explains much of the current interest in the voluntary market on the part of corporations.

Fifth, the voluntary market serves as a useful tool for those individuals and businesses that want to go beyond the minimum requirements for reducing their impact. Some critics have suggested that the voluntary market is a distraction from necessary measures, a way to avoid undertaking real change. The data from TerraPass members tell a different story. The tens of thousands of Americans who have purchased carbon offsets are the seed of a grassroots movement that is deeply committed to addressing climate change.

Results from a recent survey are striking. 86% of TerraPass customers watch the thermostat and 64% have installed energy-saving light bulbs. 69% donate to non-profit environmental

groups. TerraPass customers are five times more likely than other Americans to commute by public transportation. They are 31 times more likely to drive a hybrid vehicle, and a whopping 210 times more likely to have a solar energy system installed on their houses.

And most importantly for this Committee, these climate change fighters strongly believe that our government must lead the way. Over half of our members have contacted government representatives to express concern over global warming.

In conclusion, TerraPass believes that the voluntary retail carbon market can drive citizen awareness of the impact of their lifestyle choices, educate citizens on actions they can take in their everyday lives to reduce carbon emissions, and generate incremental carbon emission reductions by giving citizens a simple mechanism for funding American entrepreneurs and companies who wish to reduce carbon emissions. American citizens want to take action in the fight against climate change, and TerraPass welcomes government involvement to make those citizens more confident in the effectiveness of these and ongoing innovations in the voluntary retail carbon offset market.

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Notes and References

[1] Each REC represents a megawatt-hour of renewable energy generation. TerraPass makes carbon claims on these RECs using methodologies published by CRS, a non-profit renewable energy standards and market monitoring group. More information is available at http://www.green-e.org/

[2] SES verifies both the quantities of GHG reductions as well as adherence with the requirements specified in the relevant CCX protocol. For more information see: http://www.ses-corp.com/GAS.htm

[3] First Environment verifies both the quantities of GHG reductions as well as adherence with the requirements specified in the relevant CCX protocol. For more information see: http://www.firstenvironment.com

[4] For a sample product content labels, please see http://www.terrapass.com/projects/verification.html

[5] See http://www.terrapass.com/news/terrapass-verification-report-2004-2005.pdf

[6] For complete analysis, see http://additionality.terrapass.com

[7] Please see: http://www.green-e.org/getcert_ghg_standard.shtml

[8] For a full report on the impact of the Green-e standard, please see: http://www.green-e.org/docs/2005-Green-e_Verification_Report-forweb.pdf

[9] New Carbon Finance, Deep Dive, North America, June 2007

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Appendix A: Sample Product Content Label

CROSS COUNTRY FLIGHT TERRAPASS : PRODUCT CONTENT LABEL

TerraPass is a Carbon Dioxide (CO2) offset product for airline travel. CO2 is a greenhouse gas (GHG) that contributes to global warming. According to the U.S. Department of Energy (DOE), 2002 airline jet fuel consumption represented about 13% of US transportation CO2 emissions from energy use and about 4% of total US CO2 emissions from energy use. TerraPass estimates of per-flight emissions are based on the WRI/WBSCD protocols for emissions reporting, but your actual emissions may vary from these estimates due to differences in aircraft utilized, capacity utilization, length of your flight and cargo load. For each Cross Country Flight TerraPass purchased, 2,500 lbs of CO2 reductions are purchased and retired on your behalf. TerraPass does not actually reduce the CO2 emissions created during your flight, but offsets the release of 2,500 lbs of CO2 emissions elsewhere. TerraPass will not prevent the release of or offset the emissions of other harmful pollutants from your flight, such as particulate matter, methane, ozone, lead and nitrous oxide (NOx). This product matches 100% of the estimated CO2 from your flying.

This product is comprised of the following mix of RECs and carbon credits:

Renewable Energy Certificates

A REC represents the environmental attributes associated with a unit of renewable electricity. For every unit of renewable electricity generated, an equivalent amount of RECs are created. The purchase of RECs supports renewable electricity generation, which helps offset conventional electricity in the region where the renewable generator is located. RECs can be quantified in tons of CO2 based on regional data provided by the Department of Energy's E-GRID program.

Percentage	Total kWh	Pounds of CO_2
33.3%	440 – 1,034	833
Renewable Resources		General Location
Wind		Nationwide
The Green-e Program certifies that the RECs used in this product meet the minimum environmental and consumer protection standards established by the non-profit Center for Resource Solutions. For more information on Green-e certification requirements, call 1-888-63-GREEN or log onto www.green-e.org.		33% Renewable

Carbon credit offsets

A Carbon Credit Offset represents the reduction of one unit of carbon (typically a metric ton) from a baseline scenario or regulatory requirement by an emitting entity. A lynchpin feature of the Kyoto Protocol, Carbon Credits rely on the concept of flexible trading to allow that a market based system directs funding to the lowest marginal cost project areas.

Carbon Credits can be generated when a corporation or organization makes a reduction of carbon beyond a baseline scenario. The purchase of Carbon Credits helps support carbon reduction by giving a payment for each unit of carbon reduced beyond a baseline scenario. Where a protocol is available, TerraPass Carbon Credit Offsets are registered, and retired on the Chicago Climate Exchange.

Percentage	Purchasing Market	Pounds of CO_2
66.7%	CCX or bilateral contracts adhering to CCX protocols	1667
Carbon Credit Resources		General Location
Biomass (including agricultural and landfill methane abatement and biofuels)		Nationwide
Industrial efficiency		Nationwide

For specific information about this product, you may contact TerraPass toll free at (877) 879-8026, or contact TerraPass at http://www.terrapass.com or info@terrapass.com.

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Appendix B:

Committee letter and additionality report for the Tontitown Landfill Gas Flaring Project (documents follow)



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May 7, 2007

TONITOWN PROJECT DETERMINATION

William Schlesinger, Duke University
Dan Kammen, University of California, Berkeley
Michael Gillenwater, Princeton University

The following is the consensus response of the Tontitown review committee.

Overall Summary

Q1. Does the Tontitown LFG Project adhere to the rules and regulations of the CCX offset rulebook?

Yes, the project meets the CCX rulebook requirements, but the rulebook is not an adequate test of project additionality.

Q2. Does the committee concur with the Business Week assessment that Tontitown project was forced by Arkansas regulators?

No. Some (possibly most) of the reductions at the site are likely to have been the result of voluntary actions. However, it is not clear why Waste Management took these actions. Corporate commitments or other internal environmental policies and impending regulatory or other legal liabilities or risks may have all been factors.

Q3. Should TerraPass submit the Tontitown tons in our 2006 annual verification audit? If not, should we repurchase the 2005 tons from other projects?

Our overall assessment is that the project meets a minimal threshold of additionality. TerraPass does not need to repurchase any tons from the Waste Management for 2005 and may submit the Tontitown tons for the 2006 annual audit.

Q4. Should TerraPass continue to dedicate funding to Waste Management projects in the future?

We recommend that TerraPass apply a stricter definition of additionality to projects in the future and prioritize other projects over Tontitown and other Waste Management projects.

The analysis suggests that the project passes commonly applied additionality tests. However, the sale of offset credits has not clearly led to the implementation of the project. We can



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accept a modified definition of additionality based on the claim that the offset credit revenues from this project are making the implementation of other projects possible. This type of argument is an unusual approach to determining additionality, and it introduces questions regarding the additionality of the other landfill gas methane projects funded by this "project breeder" scheme.

This situation is an example of a broader issue related to determining project additionality in a developed country, where corporate entities voluntarily take on commitments to reduce their emissions. If an entity commits to reducing greenhouse gas emissions from its own operations, can it then decide to sell emission reductions from some of the project activities? It is typical for Clean Development Mechanism projects to regard that the sale of offset credits as a necessary factor for projects that are validated after the project start date.

Detailed Additionality Tests

Q5. Does the committee believe the project passes the financial additionality test?

Yes. The project does not have a viable financial return without carbon offset revenues. However, it is possible that Waste Management may still have elected to implement the project in the absence of offset revenue.

Q6. Does the committee believe the project passes the timing test?

Yes. The project's timing is consistent with an intention to sell carbon credits on the Chicago Climate Exchange.

Q7. Does the committee believe the project passes the regulatory test? Is the baseline substantially accurate even given local environmental pressures at the facility?

The evidence provided indicates that Waste Management went beyond the minimum required for regulatory compliance by installing a comprehensive landfill methane collection and flaring system at the Tonitown landfill.

Final determination

TerraPass should consider the following determination formally binding:

The Tontitown project meets a minimum threshold of additionality. TerraPass does not need to repurchase any 2005 credits, and it can submit Tontitown credits as part of its 2006



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verification audit. For future commitments, TerraPass should prioritize other projects over Tontitown.

TerraPass should apply stricter additionality tests to future projects. We recommend implementing the following procedures:

1. Make public a formalized set of interview questions and answers with all project developers and site owners.
2. Include contractual attestations to the voluntary nature of all projects from which carbon credits are purchased.
3. Perform a public literature review on all projects prior to purchasing, with a focus on local environmental or regulatory issues.
4. Establish a 30-day public comment period prior to purchasing.

Further suggestions

TerraPass should consider the following items as non-binding but recommended:

TerraPass could employ the new UK/DEFRA Code of Best Practice for the provision of carbon offsetting by procuring offset credits from CDM projects or emission allowances from Phase II of the EU Emissions Trading Scheme. The lack of standardization in the U.S. voluntary offset market is likely to continue to present risks for TerraPass as a business.

Title: Consultation on establishing a voluntary Code of Best Practice for the provision of carbon offsetting to UK customers
Department: Department for Environment, Food and Rural Affairs
Year: 2007
URL: http://www.defra.gov.uk/corporate/consult/carbonoffsetting-cop/index.htm



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Tontitown LFG Project Review Document

V1.1 - 4/7/07

Note: this document is also available, with a full history of edits at http://terrapass.pbwiki.com/project-review-document

Additional resources including blog posts, full document library and interview notes: http://terrapass.pbwiki.com



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Introduction

Waste Management, Inc. (WM) operates a Class 1 landfill in Tontitown, Arkansas. As a founding member of the Chicago Climate Exchange (CCX), Waste Management has developed a number of landfill gas (LFG) flaring projects to reduce methane emissions. These projects, including one at the Tontitown facility, serve as a source of carbon offsets traded on the CCX.

In the absence of a regulatory requirement to flare methane, carbon offsets from LFG projects such as the one at Tontitown are generally considered to be highly additional. That is, they represent a reduction of greenhouse gas emissions beyond a business-as-usual baseline, because the only revenue stream to the projects come from the sale of credits.

An article that appeared in the March 26, 2007 issue of BUSINESSWEEK magazine raised questions about the additionality of the Tontitown LFG project, based on local regulatory requirements and other factors. The purpose of this document is to evaluate the claims of the BusinessWeek article in greater detail through a public review of relevant documents and interviews with project participants.

In this review, we find that:

1. Waste Management undertook the LFG flaring project at Tontitown voluntarily.
2. Waste Management subsequently used the LFG flaring system to satisfy a regulatory requirement to address groundwater contamination and surface air issues at the site.
3. The LFG system in place at Tontitown represents a significant material investment and reduction in greenhouse gas emissions beyond what was necessary to address the regulatory requirement.
4. The Tontitown carbon offsets are generated from elements of the LFG system distinct from the portion required to address the regulatory requirement.

Based on these findings, we conclude that the carbon offsets generated from Tontitown are additional.

TerraPass involvement with Tontitown

As one of the leading retailers of carbon offsets in the voluntary market, TerraPass has assembled a portfolio of greenhouse gas reductions drawn equally from three sources: wind energy projects, dairy farm methane digesters, and landfill gas flaring projects. All carbon offsets purchased by TerraPass must meet an outside additionality review, and TerraPass' own purchase history and adherence to quality standards is verified by a third party, the Center for Resource Solutions.



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TerraPass has purchased approximately 15,600 metric tons of carbon offsets from the Tontitown LFG project since the summer of 2005.

- 8/19/05: 1,000 tons of 2005 and 2006 credits from Tontitown
- 10/17/05: 1,600 tons of 2005 and 2006 credits
- 5/2/06: 3,000 tons of 2006 credits
- 1/22/07: 10,000 tons of 2006 credits from Tontitown and CrossRoads landfill. Exact quantities pending verification report totals.
- **TOTAL purchases: up to 15,600 tons.**

TerraPass' original assessment of project additionality was based on CCX eligibility, a performance standard that takes into account the timing of the project and the regulatory regime under which it operates.

Additionality controversy

On March 9, 2007, Ben Elgin, a reporter for *BusinessWeek* magazine, contacted TerraPass with information calling into question the additionality of the Tontitown project. In addition to raising questions about the timing of the project, Elgin highlighted regulatory pressures exerted on Waste Management by the Arkansas Department of Environmental Quality (ADEQ).

Both Waste Management and ADEQ agree that Waste Management began the LFG project voluntarily in 1999. Further, both parties agree that Waste Management was never under a formal regulatory requirement to implement an LFG flaring system.

However, over a year after the project began, ADEQ placed Waste Management under a "corrective action" and compelled remediation of two issues: a groundwater contamination problem and a surface air problem.

Although ADEQ did not specifically require Waste Management to install an LFG flaring system, the LFG system already underway was eventually put forth as the solution to the environmental problems cited in the corrective action. Installation of the system did, in fact, successfully address both problems. Despite the lack of a formal regulatory requirement to install an LFG system, the corrective action raises questions about whether the system installed is truly additional to the business as usual case.

Additionality review

TerraPass conducted a brief review of the Tontitown project by March 13, 2007, in time to issue a comment affirming our initial assessment of project additionality before the



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BusinessWeek story closed for publication. The purpose of this document is to expand on that brief review, and to present formally the project details to an outside committee for consideration. Based on the committee's determination of project additionality, we will perform any corrective required to ensure the environmental integrity of our portfolio. We also hope to use this public review process as a test case for an improved set of project review procedures.

The additionality of the Tontitown project hinges primarily on a few questions:

1. Did Waste Management install the LFG system due to de facto regulatory pressure from a state agency?
2. Were alternative solutions to the requirements of the corrective action available to Waste Management?
3. Does the LFG system represent a material investment and reduction in greenhouse gas emissions above and beyond the available alternatives?

To answer these questions, we will establish a detailed project timeline and then apply a series of additionality tests: regulatory, financial, and timing. We will also apply the CDM framework for demonstrating additionality to the Tontitown project as an alternative lens through which to gauge project additionality.

Project background

History of the Tontitown facility

Prior to the issuance of solid waste permits, the property at the Tontitown landfill was used as a local solid waste disposal site by private individuals. In response to environmental concerns raised by ADEQ, the Tontitown landfill was permitted on January 27, 1978 to Sunray Services. The two Tontitown waste disposal sites initially operated by Sunray were known as Site #3 and Site #4. Both sites were originally unlined gully-fill waste disposal areas. As required by ADEQ, landfill liner and leachate collection systems were installed beneath the sites. WM still recovers leachate from Site #3 and Site #4 today.

Waste Management assumed responsibility for the Tontitown landfull as a result of the August 1995 acquisition of Sunray Services by USA Waste and the 1998 merger between USA Waste Services and Waste Management.

Two additional Class 1 waste disposal cells, the north phase and the south phase cells, were constructed at Tontitown prior to 1996. The north and south phase cells were designed and constructed to meet more stringent Regulation 22 standards for Class 1 landfills.



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Today Tontitown landfill consists of a Class 1 Municipal Solid Waste (MSW) landfill and a Class 4 landfill located in Springdale, Arkansas. Based on an operating permit of 2.555 Mg/yr, the facility is governed by federal New Source Performance Standards (NSPS) and required to monitor its non-methane organic compound (NMOC) emissions. Even after a 2004 revised permit expanding the landfill's size, the current NMOC levels of 19.3Mg/yr are well within the 50Mg/yr limit. Therefore the facility has no federal obligation to install a gas collection and control system (GCCS).

For a more complete documented history of the Tontitown project, please see http://wiki.terrapass.com/f/10239.pdf.

Project baseline and offset generation

Greenhouse gas reductions must be measured from an emissions baseline to determine the number of carbon credits generated from a project. The TerraPass baseline planning assumption for landfills not under NSPS requirements is that all methane created by the landfill is vented directly into the atmosphere. Therefore, all measured and flared methane is typically eligible as a source of carbon credits.

TerraPass uses a performance standard of additionality for LFG projects. We regard LFG project eligibility under the performance standard of the CCX LFG protocol (Ch 9, CCX rulebook) as an indication of additionality. This simple rule is appropriate for LFG projects because financial additionality is assured by the lack of alternative revenue streams. For a landfill gas flaring project that doesn't generate electricity, carbon credits represent the only economic return to the project.

In the Clean Development Mechanism (CDM) tool for the demonstration of additionality, LFG projects use the simple cost analysis method rather than a benchmark or investment comparison analysis (http://cdm.unfccc.int/methodologies/PAmethodologies/AdditionalityTools/Additionality_tool.pdf).

With financial additionality assumed, the primary question centers on the regulatory regime. Using federal guidelines to establish the regulatory baseline is a standard approach. The authority for federal air standards, including emissions from landfills, falls under the Clean Air Act. State rules may also be implemented, and they must be at least as strict as the federal rules.

The relevant regulations, codified in 40 CFR Subpart WWW (http://www.epa.gov/ttn/atw/landfill/fr12mr96.pdf), are the New Source Performance Standards, which apply to landfills of a certain capacity (over 2.5 megagrams) and date of



service (active on or after May 30, 1991). Tontitown meets both criteria and therefore is subject to the NSPS rules. However, being subject to NSPS rules is not a sufficient condition for mandatory installation of a GCCS. The EPA rules only require a GCCS on sites with NMOC emissions rates of 50Mg/yr.

The eligibility requirements for CCX offsets from LFG projects are cited here (Ch 9, CCX Rulebook):

> Exchange Methane Offsets will be issued to owners of GHG emission reductions achieved by landfill and agricultural methane collection and combustion systems placed into operation in the [sic] on or after January 1, 1999. Landfill methane collection and combustion systems in the U.S. may be registered with CCX and may earn XMOs only for mitigation occurring during time periods for which the landfill was not required to collect and combust methane in accordance with U.S. regulations requiring such actions under the New Source Performance Standards.

The following measurements of NMOC emissions indicate that the Tontitown landfill has consistently been below the level of 50 Mg/yr necessary to trigger mandatory GCCS under the NSPS rules.

- 6/22/1999: 13.7 Mg/yr
- 2/11/2000: 16.9 Mg/yr
- 5/23/2003: 22.7 Mg/yr
- 5/19/2003: 25.3 Mg/yr
- 6/14/2004: 26.3 Mg/yr
- 1/13/2005: 15.9 Mg/yr
- 3/01/2006: 19.3 Mg/yr

Waste Management claims their model does not show the 50 Mg/yr threshold being reached until 2024 (http://wiki.terrapass.com/f/24757.pdf). Consistent with the judgment of the CCX Offset committee, TerraPass found that the project was eligible for CCX credits.

Local environmental regulations

TerraPass did not investigate local rules regarding landfills prior to selecting the Tontitown project. Solid waste facilities in the state of Arkansas are governed by the Arkansas Pollution Control and Ecology Commission's Regulation 22 (http://www.adeq.state.ar.us/regs/default.htm). Regulation 22 was reviewed in the 2004-2006 time period, and a revised document was put into service April 26, 2006. A brief review of the document indicates no material changes in the regulations for surface gas or groundwater regulations.



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Two aspects of the local regulations pertain to the project. The first is the regulation of groundwater quality and specification of a process for dealing with exceedance of acceptable groundwater contamination levels (http://wiki.terrapass.com/f/Reg22_Ch12.pdf). The second is a requirement of regulated landfills to control combustible emissions (http://wiki.terrapass.com/f/Reg22_415.pdf). These regulations are relevant to both a potential regulatory mandate to control methane emissions at Tontitown and a calculation of the proper baseline for credit generation.

The *BusinessWeek* article alleged that a confluence of these local environmental issues was the real reason an LFG system was installed (http://www.businessweek.com/magazine/content/07_13/b4027057.htm).

> Asked about Waste Management's response, Gerald Delavan, a supervisor at the Arkansas environmental agency, says: "It started out as a voluntary effort" by the company. "But it ended up being guided by corrective action,'" imposed by the state.

TerraPass' own interview with Gerald Delavan corroborates this point.

> "It was like the confluence of two freight trains. Between the water issues and the LEL [Lower Explosive Limit] limits, they had to do this project."

Groundwater contamination

The site of the Tontitown facility has a long history of groundwater issues. Over time, the site has hosted completely unregulated cells (pre-1978), unlined cells (#3 and #4), and modern lined cells (north and south cell, collectively the Tontitown Class 1 landfill). A Class 4 landfill also exists on the site. Groundwater issues at the site are further complicated by a cave-filled karst geology susceptible to rapid water flow.

Regulation 22, Chapter 12 specifies that a groundwater monitoring program must be in place in all modern operating Arkansas landfills to monitor a variety of elements for a statistically significant increase above established background levels or applicable absolute values. Monitoring is accomplished through a series of monitoring wells (MW) placed around the landfill.

A distinction is made between "in-refuse" and "out-of-refuse" monitoring wells. In-refuse refers to any wells in the active landfill cell. Out-of-refuse refers to any wells placed in undisturbed earth. All monitoring wells at Tontitown are placed in out-of-refuse areas. A detailed map shows all monitoring wells, gas proves (GP), extraction wells (EW) and other

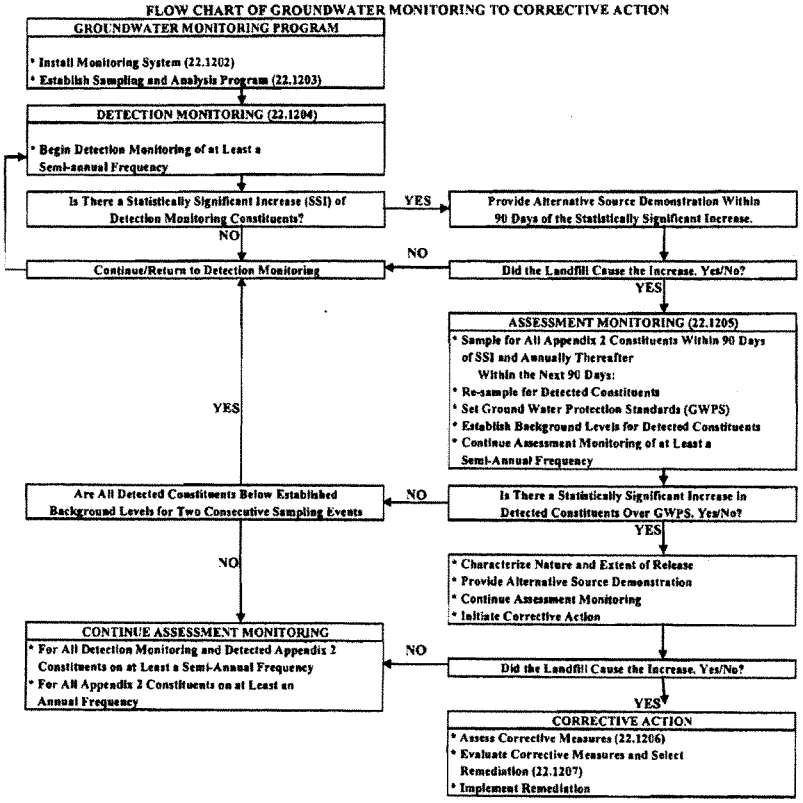


features of the Tontitown facility (http://wiki.terrapass.com/f/TTLF-EXIST%20SITE%20FULL%20SITE-200%20scale%20ow%20wells.pdf).

As noted in the *BusinessWeek* article, the Tontitown facility was placed in "corrective action" as a result of contamination of groundwater with vinyl chloride. A corrective action is a defined step in a process laid out in Reg 22, Ch 12, triggered by successive groundwater tests that show levels of contamination exceeding limits set in a performance standard agreed to by Waste Management and ADEQ. The figure below from ADEQ shows the process surrounding corrective action as related to groundwater issues.

Figure 12-1

FLOW CHART OF GROUNDWATER MONITORING TO CORRECTIVE ACTION



Surface air issues

A second issue at the Tontitown facility involved the incidence of high methane emissions at the surface of the landfill. Under Reg 22.415, monitoring procedures must be put in place to ensure that the concentration of methane gas does not exceed 25% of the lower explosive limit (LEL) in facility structures and 100% of the LEL at the property boundary. Elevated Level Contingency Measures are to be put in place if the gas limits are exceeded. These measures include the development of a remediation plan within 60 days.



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As *BusinessWeek* reported:

> "After probes subsequently detected methane levels exceeding allowable levels, Dennis John Burks, then chief of the Solid Waste Management Div. of the Arkansas Environmental Quality Dept., wrote to Waste Management on June 27, 2001, saying that the state "strongly urges WM to bring the newly installed Tontitown Landfill gas extraction system online as soon as possible."

These claims were substantiated in our own interview with Gerald Delavan.

Project design

Well placement

As noted, a distinction is made in the formal documentation between in-refuse and out-of-refuse wells. A landfill gas flaring system can consist any number of extraction wells, and the exact placement and number of wells reflects the different purposes to which they can be put. Out-of-refuse wells refer to wells drilled in undisturbed ground. In-refuse wells refer to wells drilled in either active or historical landfill cells.

A review of the geography and site history suggests that the environmental benefits to groundwater are distinct across three different areas of the landfill site. The fundamental issue of groundwater contamination by landfill gas is believed to be caused by the collection of landfill gas over pools of water. The purpose of a GCCS is to create an extraction barrier to ensure the landfill gas does not meet groundwater.

The modern subtitle D area of the landfill as well as the closed sites #3 and #4 already contain barriers to limit the expansion of landfill gas. The subtitle D area has a full "bathtub" style barrier, installed prior to operation. Sites #3 and #4 have less complete landfill liners, installed after the sites stopped accepting waste.

The 46 out-of-refuse wells are sited where no barriers exist to control landfill gas migration. The 37 in-refuse wells, on the other hand, are placed in the subtitle D area and sites #3 and #4, areas that do contain gas barriers. (Map available at http://wiki.terrapass.com/f/well-map.pdf)

From the initial 1999 discussions of a GCCS, Waste Management planned a site-wide LFG system. In interviews, Waste Management claims that the out-of-refuse wells are the only aspect of the system that have a role in controlling the groundwater and surface air problems, both of which occurred in the out-of-refuse areas.



Project costs

Project cost for an LFG flaring system is mainly determined by the number of wells. Drilling a well costs between $5,000 and $10,000 per well. In-refuse wells are typically more expensive, as care must be taken to not penetrate the landfill liner. The wells share a central flare, which costs between $75,000 and $150,000. Miscellaneous additional costs include piping, headers, blower systems and construction labor.

Based on these estimates we calculate a cost for the in-refuse system alone between $260,000 and $520,000, and for the out-of-refuse system alone between $305,000 and $610,000. The full system costs between $490,000 and $980,000 (the totals don't add as both systems share one flare).

We have not been able to corroborate these estimates with formal P&L data from the site. However, a 2002 newspaper article declares that Waste Management spent $1.3 million on the full landfill gas flaring system.

A 2006 upgrade to the flare, header, and monitoring systems cost an additional $800,000.

Abbreviated timeline

The following abbreviated timeline traces the development of the Tontitown LFG project, including efforts to address the groundwater and surface air problems. A far more detailed timeline, with supporting documentation, is available in Appendix A.

- October 1996: volatile organic compounds (VOCs) are detected in the groundwater at levels that do not require a corrective action.
- July 1999: Waste Management begins planning and design of an LFG system.
- November 2000: ADEQ places Waste Management under corrective action in response to groundwater contamination at Tontitown.
- March 2001: Drilling begins on first 26 in-refuse wells.
- April 2 2001: Waste Management proposes 21 additional out-of-refuse wells as an interim corrective for the groundwater problem.
- May 31 2001: First 26 in-refuse wells are completed.
- June 14 2001: Notice of elevated surface air methane levels is delivered to Waste Management.
- July 24 2001: ADEQ sends a letter to Waste Management strongly urging that the flares be lit on the in-refuse wells to address the surface air problem.
- October, 2001: Waste Management lights the flares on the in-refuse wells.
- February - November 2002: Remainder of wells are installed.



- November 2003: Waste Management provides an assessment of corrective measures that only discusses the out-of-refuse wells. No mention is made of the in-refuse wells.

Additionality analysis

Key issues

The question of project additionality hinges on a few critical issues. It is helpful to examine each of these issues in turn as a prelude to applying a series of formal additionality tests.

Was the LFG System ever formally mandated?

Both ADEQ and Waste agree that no full or partial LFG system was ever mandated by ADEQ. But Gerald Delavan at ADEQ suggests that installation of the LFG system was an inevitable result of the groundwater contamination issues. When asked whether the LFG system was mandated, Delavan responded:

> "No, this was a voluntary effort initially that made more sense as the evidence built."

A review of documents supports the contention that at the time of the installation, the LFG system was viewed by both parties as a voluntary decision and that the state was in fact skeptical of some of the benefits of an LFG system:

- After a June 24, 1999 meeting in which GEC proposed that landfill gas was the source of the groundwater problem, ADEQ staff geologist Dave Ann Pennington wrote a memo criticizing Waste Management for "pressuring us to 'hurry' up and concur with their conclusion that landfill gas is causing the problem at the landfill."
- In a July 12, 1999 memo, ADEQ stresses the voluntary nature of the LFG project (referred to as the Gas Demonstration Project) and the fact that installation of the system will have no effect on a requirement to address the groundwater issue.
    - "First, ADEQ would like to reiterate that WMI's plan to move forward with the Gas Demonstration Project following ADEQ review and approval is at the sole discretion of WMI. The final outcome of the Gas Demonstration Project, even if it is determined landfill gas has adversely impacted groundwater will not ultimately change or effect the present status of WMI's groundwater assessment activities as prescribed under Regulation No. 22."
    - "As you are well aware, WMI is presently under assessment monitoring at the Tontitown landfill. If the data gathered at the next scheduled groundwater sampling event places WMI into corrective action, ADEQ under the terms of and conditions of Regulation 22 will require WMI to proceed with implementation of corrective measures for the Tontitown landfill."



- On January 4, 2002, after installation of the LFG system, the ADEQ Solid Waste Management Division (SWMD) sent a letter to the EPA regional administrator highlighting the history of groundwater issues at Tontitown and expressed skepticism that the LFG system would provide a complete solution to the problem.
    - "ADEQ SWMD staff have not inferred capturing and flaring of the landfill gas at the Tontitown landfill will solve all the water contamination issues at this facility. SWMD staff believe landfill gas is a contributing factor to ongoing ground water contamination at this facility but, also believe as previously stated, that releases of leachate from old poorly lined cells is also a contributing factor to ground water contamination in and around the site. SWMD staff do not believe reducing the volume of landfill gas will solve all the existing ground water contamination problems identified to date."
- The documents from ADEQ cited above show that installation of the Demonstration Gas Project did not remove the obligation under Reg 22 to control the groundwater issues. The regulations prescribe target levels for groundwater contamination, but do not prescribe any particular course of action.
- The surface air issue likewise did not come to light until after the LFG project was underway and decisions regarding design and construction were already made. In fact, the agreement to light the flare was signed before the elevated methane levels were detected.
    - Engineering drawings for the gas extraction system were submitted on June 1, 2001
    - The Administrative Agreement to light the flare for the system was signed June 6, 2001
    - The date of the exceedance of allowable methane gas reading occurred on June 7, 2001
    - The notice of elevated meter readings was delivered on June 14, 2001
    - ADEQ issued a letter strongly urging WM to bring the flare online on July 24, 2001
    - The flare was lit in October, 2001.

By the time the "urging" letter was published, only blowers and miscellaneous flare piping had to be installed for the wells already in place. Both required either approval from the state under the lengthy air permit process or an agreement from the state to waive those requirements. Moreover, the bulk of expenses associated with installation of an LFG system are incurred by the drilling of the wells. Drilling logs show that drilling of the in-refuse wells was completed between mid-March and mid-April 2001 (http://wiki.terrapass.com/f/16065.pdf).

In summary, both parties agree that the LFG was initially undertaken voluntarily. Further, much of the planning was done prior to the corrective action, and work on the original wells



was completed (and expenses incurred) prior to the detection of the surface air problem. Finally, ADEQ never prescribed any particular response to either environmental problem, and in fact expressed some doubt that an LFG would be a full solution.

Did alternatives exist to remedy the problem?

Regardless of whether a formal requirement was in place to compel Waste Management to install an LFG system, if the LFG system was the only or clearly most attractive means of addressing the groundwater or surface air problem, the corrective action may have represented a de facto requirement to implement the project.

It is important to note that LFG systems can vary dramatically in scope and purpose. The costs and effects of such a system depend on the placement and number of wells. It is reasonable to consider different types and configurations of LFG systems as possible alternatives to the project Waste Management actually pursued.

We asked Waste Management if they examined alternatives to the LFG system. They provided the following list of alternative solutions to the groundwater problem examined under assessment of Corrective Measures (http://wiki.terrapass.com/f/23274.pdf). This process started in April 2001 and ended in November 2003.

- Control of landfill gas migration
- Installation of a barrier wall
- In situ treatment
- Pumping and treating groundwater
- Natural attenuation

Our analysis of the first alternative, control of landfill gas migration, suggests from the documents that this is generally understood to be control of out-of-refuse landfill gas.

Waste Management has provided to TerraPass the approximate financial impact, including cost ranges and median cost estimates, for each alternative. These estimates are consistent with the assessment of corrective measures report (http://wiki.terrapass.com/f/21816.pdf). Other factors were also considered in the Waste Management document, including performance, reliability, and ease of implementation. These are discussed fully in the assessment of corrective measures report.

The financial estimates for the LFG system are based on a per-well estimate of drilling costs of $5K to $10K per well, and a flare cost of $75K to $150K. A cost estimate from an outside firm provided in March, 2001 indicated a project cost of $332K, in line with the estimate below (http://wiki.terrapass.com/f/13434.pdf).



Table 1: Alternatives to Project

Corrective Measure	Cost Range	Median Cost
LFG System for out-of-refuse landfill gas migration (37 wells)	$260K to $520K	$390K
Installation of Barrier Wall	$750 to $1500K	$1125K
In situ Treatment	$250 to $1000K	$625K
Pump and Treat Groundwater	$250 to $1000K	$625K

We note that the out-of-refuse LFG system is the least-cost method and also was judged to be the most effective method of interim corrective assessment by Waste Management. The evidence presented supports the assessment from Delavan that "it was easy to see early on that the LFG system was the best. Others were costly or not appropriate for the site. [The] most reasonable approach was to control with an LFG system."

Waste Management stated in an interview that the rationale for the out-of-refuse system was "to use the LFG system in the out-of-refuse area to form a barrier...It was the best way to get ahead of the groundwater issue."

For the surface air problem, no formal documentation exists that shows an exploration of alternatives to the LFG project. However, interviews with both Waste Management and ADEQ suggest that other more localized alternatives may have also been appropriate solutions.

In an interview, Michael Caldwell from Waste Management suggests that without the LFG system already installed they would have considered three other alternatives:

One option, lets call this option A, would be to get as close to the edge of the landfill as possible and install a trench inside the landfill itself. Then you get some pipe and some risers and a few whirligigs like you see on attics. This helps the methane escape.

Option B would be probably get all the way up to the edge and try to relieve the pressure with a passive system. No blower, no flare, no pressure head.

Option C would be a series of approaches external to the landfill. Maybe a passive vent system here could short circuit it. Or sometimes we like to use the solar powered tiki torches. These are like your backyard tikis, with a solar unit to relight the gas when the flow gets too low. It's got a little magneto set up. It's not unusual for these things to burn 24x7.



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We note for clarity that among the alternatives, only tiki torches involve any adjustment to the emissions baseline. According to Waste Management, "the levels are so low [from tiki torches], that you can't even measure the methane."

In summary, we find that reasonable alternatives to the present LFG system do exist. A subset of out-of-refuse wells would likely be adequate to address the groundwater contamination problem, with a price tag considerably lower than the $1.3 million Waste Management spent on its LFG system. And in the absence of an already installed LFG system, localized solutions to the surface air problem could be deployed with negligible effect on baseline emissions.

Does the LFG system go above and beyond the requirements of the corrective action?

The existence of alternatives to the LFG system is only relevant if the alternatives have a different impact on greenhouse gas emissions at the site. In other words, for the LFG system to represent a reduction in emissions over a business-as-usual scenario, the project should represent a reduction in emissions above and beyond credible alternatives.

For the surface air issue, it is simple to demonstrate that the LFG system goes above and beyond the alternatives. Of the three alternatives proposed, only one -- solar tiki torches -- results in the destruction of any methane, and the amount is considered negligible. Further, only two of twenty gas probes at the site registered surface air problems. The 83 wells installed far exceed the number required to address a localized surface air problem.

Greater contention exists over whether the LFG system goes above and beyond the requirements posed by the groundwater problem. Waste Management claims that the in-refuse wells are not necessary to address the groundwater problem, which by its nature involves landfill gas migration outside of the landfill cells. According to Waste Management, "[we] could clean up the groundwater with nothing more than the out-of-refuse wells."

ADEQ does not have a formal position on whether the LFG system goes beyond the requirements of the corrective action, as assessing such matters is outside of their purview. They are tasked with reviewing and approving Waste Management's plans, not with considering possible alternatives.

Nevertheless, when asked, members of ADEQ have offered conflicting opinions regarding whether the out-of-refuse wells would be sufficient to address the groundwater problem. Initially, Delavan disagreed with this premise:



> "Just collecting the gas from the out of refuse area? That's probably not appropriate -- it's just not how it's done. You really want to capture across the waste mass, across both out-of-refuse and in-refuse."

Delavan did qualify his statement, however: "But I don't really know. I'm not a gas engineer. I don't deal with these issues" He further acknowledged that other solutions to the groundwater issue may have been feasible, although it was not possible for him to offer a full determination without more details: "I guess they could have gone with a passive system. But did they go beyond the scope of regulation? I don't know."

Others at ADEQ offer support for Waste Management's contention that the LFG system exceeds any requirement imposed by the corrective action. Brian Leamons from ADEQ states, "They went well beyond the scope of the original design plans"

Given the disagreement between the two parties, we consulted the documents produced in the selection of interim corrective assessments and found numerous occasions where the interim corrective assessment referred only to the out-of-refuse wells. These statements were mainly made in letters submitted by Waste Management. The November 18, 2003 formal "assessment of corrective measures" report submitted by Waste Management only mentions out-of-refuse wells as an interim corrective measure (http://wiki.terrapass.com/f/21816.pdf).

- SCS Engineers' first Scope of Work in March 2001 for a comprehensive LFG system at the facility shows 10 out-of-refuse wells (http://wiki.terrapass.com/f/13434.pdf).
- As an interim corrective action, Waste Management provides formal notification to ADEQ of the preliminary gas system design system. In this notification Waste Management re-proposed 10 out-of-refuse wells for an initial phase and an additional 11 out-of-refuse wells (http://wiki.terrapass.com/f/13453.pdf).
- September 26, 2001: Waste Management indicates that as part of interim measures they will be installing out-of-refuse collection points to control landfill gas emissions from the facility.
- February 13, 2002: Waste Management provides a plan to install an additional four in-refuse wells and approximately 10 out-of-waste wells in the northeast side of the facility (http://wiki.terrapass.com/f/16079.pdf). See also Feb 27 drilling logs for out of refuse wells (http://wiki.terrapass.com/f/16139.pdf).
- November 12, 2002: Waste Management provides a plan to install additional interim corrective measures in support of the gas system in the southwest of the facility including 4 in-refuse wells and an undetermined number out-of-refuse wells (http://wiki.terrapass.com/f/18765.pdf)



- November 18, 2003: Waste Management provides an assessment of corrective measures analyzing the interim corrective measures of 16 out-of-refuse wells. The report contains no discussion of in-refuse wells as being a part of corrective measures (http://wiki.terrapass.com/f/21816.pdf).

This documentation supports the notion that both parties regarded the out-of-refuse system as the primary interim corrective measure. The timing of implementation also supports the notion that the in-refuse wells were not conceived as part of the solution to the groundwater problem. The in-refuse wells were implemented first, the result of planning that had begun in 1999, over a year before the corrective action was issued.

Application of Additionality Tests

Timing Test

A timing test is used to determine whether the timing of the project is compatible with the notion that carbon offsets played a role in its development. The *BusinessWeek* article was critical of the timing of the Tontitown project:

> Regardless of who deserves credit for taking the initiative, one thing is clear: The methane system was launched long before any promise of carbon-offset sales.

The specific timing test for the CCX is codified in the eligibility requirements for CCX Offsets from LFG projects and are cited below (Ch 9, CCX Rulebook).

> Exchange Methane Offsets will be issued to owners of GHG emission reductions achieved by landfill and agricultural methane collection and combustion systems placed into operation in the [sic] on or after January 1, 1999

The LFG system at Tontitown was placed into operation in October, 2001, almost two years past the CCX cutoff. We therefore conclude the timing test for CCX eligibility requirements is satisfied.

It also makes sense to examine whether the CCX timing performance standard is appropriate in this instance. The Chicago Climate Exchange was formally founded in May 2000. Waste Management is a founding member of the Chicago Climate Exchange, and along with 25 other corporations participated in the design phase for CCX. The announcement of the founding companies occurred on May 30, 2001. In July 2001, Waste Management became one of the original design phase members of CCX.



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Waste Management has a stated interest in carbon accounting and offset projects that they claim drove the decision to join the CCX. Amy Banister of Waste Management told TerraPass:

> The CCX provides a valuable opportunity to learn how to establish an emissions baseline and inventory our emissions, develop, maintain and verify offset projects and trade offsets in a functioning market.

Therefore we also conclude that the specifics of the project timing are compatible with the notion that carbon offsets played a role in the project development.

Financial Test

The financial test asks whether a project would be financially justified in the absence of revenue from carbon offsets. A variety of accounting methods can be employed for a financial additionality test. Generally speaking, it is not enough for a project merely to break even for it to be considered financially justified. Rather, a project has to either provide comparable returns to an alternative project that yields the same ends, or a project must meet some typical NPV or IRR benchmark for the project developer.

However, no such methods are necessary to establish financial additionality for LFG flaring projects. The project generates no financial or economic benefits other than the revenue stream from carbon offsets, so a simple cost analysis can be used to demonstrate that the project is not financially justified in the absence of offsets. In the case of Tontitown, $1.3 million price tag associated with the LFG project is material. (More recently, Waste Management has invested an additional $800,000 in the LFG system.)

However, given that some action was necessary to address the groundwater problem, we must select an appropriate cost baseline. We accept Waste Management's contention that the out-of-refuse wells alone would be a viable alternative solution to the groundwater problem. Given an estimated median cost of $390,000 for the out-of-refuse wells alone, the actual project cost is materially larger than the credible alternative.

Regulatory Test

The regulatory test is the central additionality hurdle for Tontitown. Although it is indisputably true that Waste Management was under no strict or legally binding requirement to implement a methane flaring system, it is also true that Waste Management used the methane flaring system to correct groundwater contamination and surface air problems that it was under pressure to fix.



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Since there is no clear regulatory mandate that led to the project, we focus our examination of the super-regulatory nature of the project with the question of whether alternatives available to Waste Management were compatible with local regulations. The text of the CDM tool for establishing project additionality is a useful framework here. The outcome of our alternatives analysis should show:

Identified realistic and credible alternative scenario(s) to the project activity that are in compliance with mandatory legislation and regulations taking into account the enforcement in the region or country and EB decisions on national and/or sectoral policies and regulations.

Determining which strategies are realistic and credible is a challenge. Waste Management claims that each of the corrective measures analyzed were valid alternative strategies to the project activity. Those alternative corrective measures analyzed were:

- Control of landfill gas migration
- Installation of a barrier wall
- In situ treatment
- Pumping and treating of groundwater
- Natural attenuation

ADEQ is less sure about the viability of alternatives. Delavan said, "We probably would have not accepted these as reasonable corrective measures." When asked whether such alternatives would even be considered by ADEQ if accompanied by relevant data, he said, "Yes, we would have considered it. We didn't tell them they couldn't do it."

The Arkansas regulations provide some guidance about what level of viability is required and which party is responsible for selection of corrective measure selection. Regulation 22.1207 specifies that the "owner or operator shall select a remedy" to achieve the groundwater protection standards (http://wiki.terrapass.com/f/Reg22_Ch12.pdf). The regulations even let an owner an operator abandon a chosen remedy if it is not achieving the desired results. We have also confirmed that all the alternative solutions are listed and described on the Federal Remediation Roundtable (www.frtr.gov), a reasonable measure of common practice.

Although a full cost and feasibility analysis of the proposed alternatives would be prohibitively expensive and time-consuming to conduct retrospectively, they do nevertheless appear credible mechanisms to address the requirements of the corrective action. Perhaps more importantly, the LFG system actually in place appears to go far beyond the requirement to address the groundwater problem.



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Case study: CDM-approved projects where regulatory compulsion exists

The LFG system at Tontitown appears to be serving multiple purposes. On the one hand, Waste Management has designed a number of wells to address a specific groundwater contamination problem. Additionally, some of the originally planned wells have been instrumental in alleviating a surface gas problem. Finally, a number of in-refuse wells primarily exist to draw off and destroy landfill methane.

Precedent exists for projects in which carbon offsets are generated from activities that are at least partially brought about by regulatory compulsion. It may be instructive to investigage how such projects have been treated under the CDM. One such project is the Salvador da Bahia Landfill Gas Project in the Municipio de Salvador, Estado da Bahia, Brazil. (http://wiki.terrapass.com/f/CDM_ConcessionLFG_methodology.pdf)

Bahia's CDM documents establish a methodology for distinguishing between contractually demanded actions and voluntary actions. The method, in brief, is to adjust the emissions baseline downwards to reflect the contractual obligations of the developer. By adjusting the baseline downwards, the developer only claims reductions above those required by law or contract as a source of carbon offsets. From the concession methodology, additionality is established:

If the actual quantity of methane flared is greater than the baseline quantity flared, the project activity is additional. The emissions reductions will be zero if the project activity is not additional. Since the baseline quantity flared is determined by the contractual requirement, which is established through a competitive bidding process the baseline reflects what would occur in the absence of the project activity.

We could apply a similar methodology to the Tontitown project, on the assumption that some portion of the LFG system is a mandatory requirement of the corrective action. Although the system was never formally mandated and credible alternatives existed, Waste Management's selection of the out-of-refuse system for interim corrective assessments provide grounds for taking a conservative view of the project baseline.

The key question in applying a concession methodology is to determine what portion of the reduction from baseline is at risk due to regulatory issues. To gain insight into this question, we first review the architecture of the landfill (http://wiki.terrapass.com/f/well-map.pdf).

The landfill consists of an in-refuse area consisting of both active areas (subtitle D, Class 4) and inactive areas (sites #3 and #4). Surrounding these sites are undisturbed out-of-refuse areas. Below we review the problem areas and note that all are out-of-refuse.



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Problem category	Well #	Location
Surface emissions	GP1	Out-of-refuse
Surface emissions	GP-12	Out-of-refuse
Groundwater	MW-7	Out-of-refuse
Groundwater	MW-8	Out-of-refuse

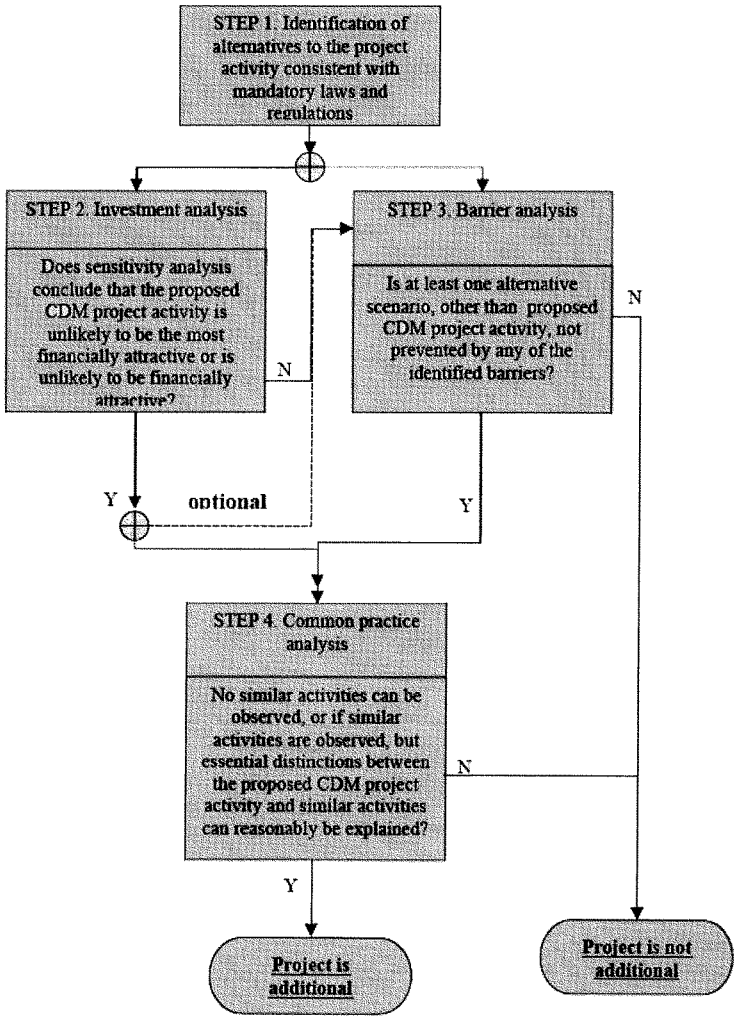
Remediation of these problems, whether formally required or simply reasonably expected, is limited to these localized areas. Mike Caldwell of Waste Management states, "The only imaginable thing we could have been required to do was install the LFG system in the out-of-refuse area. Everything else we did was completely on our own."

It is worth examining the impact on baseline emissions is if we assume the 46 out-of-refuse wells are part of a regulatory requirement. Based on preliminary readings from one month's emissions, less than 10% of the total volume of air (in standard cubic feet per minute) comes from the out of refuse wells, and about 1% of the total methane flared. 99% of the methane flared at the site comes from in-refuse wells, which we regard as the strictly voluntary portion of the LFG system.

We have formally asked Waste Management to perform a short field work exercise to document and confirm these monthly figures. They anticipate a week's worth of work and have agreed to share this information with us.

Application of CDM accepted methodology for demonstration of additionality

Although not widely used in the US market, the UNFCC's "Tool for the Demonstration of Additionality" provides another useful framework through which to examine the Tontitown project. Below we show the schematic of tests that accompany the tool:


STEP 1. Identification of alternatives to the project activity consistent with mandatory laws and regulations
STEP 2. Investment analysis
Does sensitivity analysis conclude that the proposed CDM project activity is unlikely to be the most financially attractive or is unlikely to be financially attractive?
N
Y
optional
STEP 3. Barrier analysis
Is at least one alternative scenario, other than proposed CDM project activity, not prevented by any of the identified barriers?
N
Y
STEP 4. Common practice analysis
No similar activities can be observed, or if similar activities are observed, but essential distinctions between the proposed CDM project activity and similar activities can reasonably be explained?
N
Y
Project is additional
Project is not additional



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Step 1. Identification of alternatives to the project activity consistent with current laws and regulations

For most LFG projects, the baseline alternative is simply venting the methane into the atmosphere. While there was no formal regulation requiring an LFG system, local regulations compelled Waste Management to address groundwater and surface air problems, either through an LFG system or some other means. Consistent with the application of Step 1b, we void the "do nothing" alternative and instead contemplate other options consistent with controlling groundwater under local regulations. For clarity, the effect on the emissions baseline is also noted.

Table 2: Alternatives to Project

Project alternative	Median cost	Effect on baseline
LFG System for out of refuse landfill gas migration	$309K	1% decrease due to flaring out of refuse emissions if forced by regulator to adopt
Installation of Barrier Wall	$1,125K	None
Insitu Treatment	$625K	None
Pump and Treat Groundwater	$625K	None
In-refuse and out-of-refuse LFG system	$735K	As determined by review

Step 1b. Consistency with mandatory laws and regulations

As discussed above in our regulatory test, we believe all alternatives to be consistent with mandatory laws and regulations.

Step 2. Investment analysis

The project activity generates no financial or economic benefits other than offset related income, so a simple cost analysis is used (Option I). The costs in the table above are estimates from Waste Management experts. Reported financial data has been requested. Based on preliminary numbers, it is concluded the proposed project is not financially attractive in-refuse and out-of-refuse LFG system is not financially attractive compared to other credible options.

Step 4. Common practice analysis



Sub-step 4a. Analyze other activities similar to the proposed project activity:

The project activity is unique. We are not aware of other voluntary flaring initiatives in Arkansas or by Waste Management that do not involve registration of carbon offsets.

Sub-step 4b. Discuss any similar options that are occurring:

Federal regulations mandate LFG systems across Arkansas and the U.S. The technology is mature and common. These projects are universally financially unattractive and the result of regulatory compliance rather than an economic benefit.

TerraPass recommendation

In light of the information revealed in this document, TerraPass makes the following Recommendation:

We find the Tontitown project passes the application of all the necessary tests to establish project additionality.

1. The LFG project timing is consistent with both CCX and common-sense criteria.
2. The LFG project meets CCX project eligibility requirements because NSPS regulations do not apply to the site.
3. The LFG project, by common agreement, was not specifically mandated by ADEQ.
4. Credible alternative mechanisms exist to address local regulatory issues at the Tontitown facility.
5. The LFG project represents both a financial investment and a reduction in greenhouse gas emissions that materially exceeds the baseline scenarios established by those credible alternatives.

However, as a matter of conservative practice, we recommend an adjustment to the project emissions baseline to reflect the multiple purposes served by the LFG project. Granting that the project, though voluntary, has developed at least partially in response to local regulatory issues, we feel that it is prudent to except methane extracted from the out-of-refuse wells from carbon offset eligibility.

Based on sample readings, this exception requires a 1% adjustment in the emissions baseline, or the repurchase by TerraPass of 156 metric tons of carbon offsets. Before making a final determination on the size of the adjustment, we will ask Waste Management to proceed with a formal study of out-of-refuse methane generation.



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We further propose the following improvements to the TerraPass project selection and purchasing process:

1. *Project developer and stakeholder interviews*

   Current practice focuses on informal interviews with project developers and site owners. These interviews should be formalized. Specifically, a set of common project interview questions should be developed and answers to each of these questions should be published as part of the public review process. These interview questions should cover local impact issues specific to the activity where the carbon offset project is taking place. Generally, at least three stakeholders should be identified and interviewed for each project.

2. *Contract attestation*

   Current attestation and carbon purchase agreements should include specific language from the project developer attesting to the voluntary nature of the offset credits.

3. *Public Literature search*

   A formal newspaper and literature search should be conducted on the last 10 years of history for the project location.

4. *Public Stakeholder Review*

   Before supporting a new project, TerraPass should open a public comment period for the project for a period of 30 days. All comments should be published and made publicly available.

We look forward to the questions and feedback of the committee. We further wish to thank all who have been generous with their time in helping us assemble and review this document.



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Appendix A: detailed project timeline and documentation

Consistent with the process under Regulation 22 Chapter 12, the following events led to the Tontitown facility being placed under corrective action. Where publicly available, files are linked to documentation recording the sequence of events.

- March 31, 1995: Assessment monitoring formally began for volatile organic compounds (VOCs) in monitoring well 1 (MW-1).
- August 1995: USA Waste buys Sunray Services.
- Aug 1996: The facility began hydrogeologic investigations.
- Oct 1996: Environmental consultants Genesis Environmental Consulting (GEC) draft a memo listing possible reasons that VOCs had been detected in the groundwater:
    - (a) Well proximity to waste mass
    - (b) Upgradient source concentration
    - (c) Landfill gas migration
    - (d) Leachate seepage into groundwater
- March 11, 1998: USA Waste agrees to merge with Waste Management.
- June 24, 1999: GEC drafts a letter summarizing the history of the groundwater monitoring project, and presents it at a meeting between ADEQ, GEC, and WM (http://wiki.terrapass.com/f/9034.pdf). The letter notes that the facility remains in assessment monitoring, but "detected concentrations have not statistically exceeded the groundwater protection standards and appear to be decreasing in most cases." In this meeting GEC suggests that concentrations of VOCs in the groundwater are the result of landfill gas migration (http://wiki.terrapass.com/f/9089.pdf) . This is also the first time a Gas Demonstration Project is proposed. The Gas Demonstration Project includes a plan to drill additional landfill gas monitoring probes to attempt to determine the volume and flow of gases in the landfill area, and contemplates installation of a gas collection and capture system. GEC requests an Alternate Source Demonstration to show that older landfills are the likely source of groundwater contamination.
- July 9, 1999: Dave Ann Pennington, geologist at ADEQ, writes a memo criticizing WM for "pressuring us to 'hurry' up and concur with their conclusion that landfill gas is causing the problem at the landfill." (http://wiki.terrapass.com/f/41546.pdf).
- July 12, 1999: ADEQ denies the Alternate Source Demonstration but encourages WM to "proceed with the landfill 'gas collection project' as a system designed to improve air quality and to possibly lessen the adverse impact from the landfill gas on local ground water supplies." (http://wiki.terrapass.com/f/July%2012-1999%20Letter.pdf).



- July 14, 1999: WM and ADEQ meet to discuss the Gas Demonstration Project. The meeting summary notes that "WM submitted the Gas Demonstration Report and currently has plans to design a landfill gas system, on a voluntary 'proactive' status and not as a regulatory driven mandate." (http://wiki.terrapass.com/f/9192.pdf)
- July 29, 1999: ADEQ reminds WM of several issues related to the Gas Demonstration Project (http://wiki.terrapass.com/f/7-29-99.pdf):
    - "First, ADEQ would like to reiterate that WMI's plan to move forward with the Gas Demonstration Project following ADEQ review and approval is at the sole discretion of WMI. The final outcome of the Gas Demonstration Project, even if it is determined landfill gas has adversely impacted groundwater will not ultimately change or effect the present status of WMI's groundwater assessment activities as prescribed under Regulation No. 22."
    - "As you are well aware, WMI is presently under assessment monitoring at the Tontitown landfill. If the data gathered at the next scheduled groundwater sampling event places WMI into corrective action, ADEQ under the terms of and conditions of Regulation 22 will require WMI to proceed with implementation of corrective measures for the Tontitown landfill."
- June 5, 2000: Tontitown facility has triggered assessment of corrective measures (http://wiki.terrapass.com/f/33082.pdf).
- November 30, 2000: Notice of corrective action (CAO) is delivered to WM. This notice requires assessment of corrective measures within 90 days (http://wiki.terrapass.com/f/10239.pdf). The CAO prescribes the following actions:
    - (1) Within 14 days, WM will make a record of which appendix 2 parameters have been exceeded
    - (2) Within 30 days, WM will perform a hydrogeological investigation
    - (3) After characterizing the nature and extent of the contamination, WM will implement interim remedial measures
    - (4) Within 60 days, WM will submit a full remedial action plan and proposed schedule for implementation
- February 27, 2001: WM advises ADEQ that they have started assessment of measures including the construction of a landfill gas system, investigation of in situ treatment options and further hydrogeologic study (http://wiki.terrapass.com/f/13161.pdf).
- March 16, 2001: WM delivers Scope of Work for comprehensive LFG system at the facility (http://wiki.terrapass.com/f/13434.pdf). The plan encompasses 10 out-of-refuse wells and carries a total cost estimate of $332K.
- March 26, 2001: Waste Management proposes a schedule for the LFG system (http://wiki.terrapass.com/f/3-26-01.pdf).
    - March 26 2001 - Mobilize drill rigs to the site
    - April 15, 2001 -Completion of installation of gas probes



  - April 20, 2001 - Completion of Preliminary Assessment and Engineering Deslgn
  - May 30, 2001 -Completion of installation of extraction wells
  - June 1, 2001 - Submittal of As-Built Engineering Drawings of Gas Extraction System
- April 2, 2001: As an interim corrective action, the facility notifies ADEQ of the preliminary gas system design and drawings. 10 wells are re-proposed for an initial phase and an additional 11, all out-of-refuse, for a total of 21 out-of-refuse wells (http://wiki.terrapass.com/f/13453.pdf).
- April 24, 2001: WM applies for a minor air source permit. The permit reflects the 21 out of refuse wells (http://wiki.terrapass.com/f/13818.pdf).
- May 30, 2001: The in-refuse gas collection system is complete. This contains the 26 wells in the in-refuse area (http://wiki.terrapass.com/f/16065.pdf).
- June 6, 2001: The parties agree to an administrative agreement to light the flare (http://wiki.terrapass.com/f/flare-agreement.pdf).
- June 27, 2001: In relation to surface air issues, ADEQ tells Waste Management that it is hoped that, "utilization of this gas extraction system will reduce or eliminate excess methane gas build-up in the landfill and reduce the potential for gas migration offsite" (http://wiki.terrapass.com/f/6-27-01.pdf).
- September 26, 2001: WM indicates that as part of interim measures they will be installing out of refuse collection points to control the emissions from landfill gas from the facility (http://wiki.terrapass.com/f/15363.pdf).
- October 5, 2001: The minor air source permit is received (http://wiki.terrapass.com/f/15481.pdf).
- January 4, 2002: ADEQ officials, in a letter (http://wiki.terrapass.com/f/41521.pdf) to the EPA regional administrator, highlight the history of groundwater issues and place the gas collection system in perspective with the groundwater challenges.
  - "SWMD staff believe landfill gas is a contributing factor to ongoing ground water contamination at this facility but, also believe previously stated, that releases of leachate from old poorly lined cells is also a contributing factor to ground water contamination in and around the site. SWMD staff do not believe reducing the volume of landfill gas will solve all the existing ground water contamination problems identified to date."

- February 13, 2002: Waste Management provides a plan to install an additional four in-waste collection wells and approximately 10 out-of-refuse collection wells in the northeast side of the facility (http://wiki.terrapass.com/f/16079.pdf). See also Feb 27 drilling logs for out-of-refuse wells (http://wiki.terrapass.com/f/16139.pdf).
- November 12, 2002: Waste Management provides a plan to install additional interim corrective measures in support of the gas system in the southwest of the facility

including 4 in-refuse wells and an undetermined number out of refuse wells (http://wiki.terrapass.com/f/18765.pdf).

- November 18, 2003: Waste Management provides assessment of corrective measures report analyzing the interim corrective measures of 16 out of refuse wells and natural attenuation. There is no discussion of in-refuse wells as being a part of corrective measures (http://wiki.terrapass.com/f/21816.pdf).
- May 21, 2004: Waste Management summarizes the analysis of alternative measures and selects the corrective remedy (http://wiki.terrapass.com/f/23274.pdf).
    - The corrective measures analyzed were
        - Control of landfill gas migration
        - Installation of a barrier wall
        - Insitu treatment
        - Pump and treat groundwater
        - Natural attenuation
    - "The primary selected remedy is control of landfill gas migration through the extraction and collection of landfill gas from the waste unit(s). A supplemental remedial measure that has been determined to be effective for site-specific constituent of concern and subsurface geologic conditions is natural attenuation."
- July 1, 2004: Waste Management provides schedule for initiating and completing remedial activities (http://wiki.terrapass.com/f/23572.pdf). This letter includes a useful graphical summary of the actions taken and dates of completion:

The CHAIRMAN. Thank you, Mr. Blachford, very much. Our next witness is Mr. Russ George. He is the President and CEO of Planktos, Inc. Planktos has attracted considerable attention recently with its proposal to generate carbon graphics through ocean fertilization near the Galapagos Islands. Planktos Hungarian subsidiary, KlimaFa, has recently donated carbon graphics from reforestation projects to the Vatican in support of the Vatican's announcement of its intent to become the first carbon neutral sovereign state. Welcome you, Mr. George. When you're ready, please begin.

STATEMENT OF RUSS GEORGE, PRESIDENT AND CEO, PLANKTOS, INC.

Mr. GEORGE. Thank you very much for having me here. I very much appreciate the chance to talk about ecco restoration of the trees and seas of this planet. This planet is 72 percent ocean, and 28 percent land. And the problem of global warming of excess anthropogenic CO_2 is on the living planet. That's what we're concerned about. That living planet is diminishing in its life capacity. The oceans especially are in dire circumstances. Seventeen percent of all plant life in the North Atlantic Ocean has disappeared since the early 80s, when we got satellite observations up, and were really able to monitor it. Twenty-eight percent in the North Pacific Ocean, and in Antarctic, a recent article in the Journal of Science, paper in the Journal of Science, as much as 50 percent in the subtropical, tropical oceans of plant life has disappeared. That's equivalent to the 1 percent per year annual rate of loss of the rainforests on land. But on land, the rainforests cover 3 percent of this planet. The ocean forest, ocean plants cover 72 percent of this planet.

So in each three to four year period, the loss of ocean plant life on this planet is equal to losing all of the rainforests on this planet. So I maintain, and we maintain that the greatest crisis on this planet is the catastrophic decline of plant life in the oceans.

If you looked in the scientific literature about a week and a half ago, you might have seen an article that reported the discovery of the clearest water on earth, from the American Geophysical Union. That report talked about the sub-tropical Pacific Ocean south of the Galapagos Islands, having been noted as having the clearest water on the planet earth. The only place on earth where the water was as clear, was in the lakes that are under two miles of ice on the Antarctic Continent. It's clear because it is lifeless water, and it's not supposed to be that way. It is supposed to be pea soup. Right? And that's the status of the decline, the catastrophic decline of ocean plant life.

My company is involved in tree planting projects. Beginning in 1972, I started a tree planting company in British Columbia. That company is still continuing today. It's planted about a quarter of a billion trees across Canada. Right now, we're involved in a major tree planting project in the European Union. We are planting a quarter of a million acres of new natural, native mixed species forests into the European Union's national parks, because if you're going to bank carbon dioxide in a carbon bank account, which is a forest, you need a bank guard. And we've selected the European

National Park System as the bank guard for our carbon deposits that we're banking. We think that's safe, secure carbon.

Our ocean projects have come under a rather blistering criticism by a number of groups who've attacked us, because they say we're going to dump iron near the Galapagos Islands, and possibly endanger those beautiful environments. Well, in fact, the reason why we go there, the reason why two projects in the past funded as part of the 20-year, hundred million dollar research projects on iron fertilization that have taken place, much of that money has come from the United States, and have had international projects, is that the Galapagos Islands, themselves, provide a rich amount of iron into the oceans, produce a massive bloom that envelops and enshrouds those islands, and goes a thousand miles to the west, and it is a life-giving feature to those islands. So it's natural that we go there to conduct the next logical step in ocean fertilization, iron fertilization projects, which the science community has called for, which is scaling up the projects that have been done to-date with $100 million worth of public funds one order of magnitude to the next logical size, and seeing if its got commercial legs, and seeing if the offsets are measurable.

Many papers have reported that the measurement of carbon sequestration by ocean plankton is well in hand, and readily available to be done, and it's quite a substantial thing. One paper that came out recently suggested that in two locations in the Pacific Ocean, in one case, 20 percent of the plankton bloom was sequestered, the carbon was sequestered. And in another case, 50 percent was sequestered. Well, those are large, large numbers relative to this, and so the ocean forests ought to be in play, because the ocean forest is the most endangered forest on this planet.

So that's what our business does, and we think the voluntary market is part of it. Yes, we did, indeed, work with the Vatican over the better part of a year to review with them, and show them what we were doing in our tree planting projects. We think they took an extremely slow, careful look at our work, and two weeks ago, they agreed to finally sort of go public with this information, that they would become the first sovereign state owner to go green with our tree planting projects in Europe, and they have been taking an active role to promote the faithful of the Catholic Church do the same, which we think is a mighty testimony to the effectiveness of this. So I'm here to answer all your questions.

[The prepared statement of Russ George follows:]

Information Provided by Russ George, President CEO Founder Planktos Inc. and Planktos Corp., Founder Managing Director KlimaFa, Founder Haida Climate

Provided To House Select Committee on Energy Independence and Global Warming Wednesday 18 July 2007 in response to their invitation to appear before the committee.

The committee has provided the following questions for address (rough version of questions):

1. What is the nature and scope of business in the voluntary carbon offset market? Kinds of projects, business model for selling offsets, and scope of our offset business.

2. What's our response to the recent controversy regarding your company plans to undertake marine "iron fertilization" project near the Galapagos Islands.

3. What is our response to the criticism of forest-based offsets, for example based on the grounds that the permanence of carbon sequestration cannot be guaranteed or that albedo effects of reforestation in northern forests negate the carbon sequestration benefits.

4. How can we ensure that individual consumers and companies that purchase carbon offsets are getting what they pay for and that offset projects have environmental integrity, with regard to both climate and non-climate effects. Are industry standard setting initiatives adequate or is there some role for government regulation. If so what form should regulation take.

5. What is the future of the voluntary offset market, and how significant a contribution can that market make to mitigation of climate change.

Introduction and Comments as to the Nature and Scope of my work and the work of the companies I am part of in the emerging Carbon Markets.

I'd like to thank the Select Committee on Energy Independence and Global Warming for inviting me to present my views on topics important to this committee, the nation and indeed the global environment. As a lifelong ecologist and businessman I am personally very concerned about the dramatic declines being observed and reported in global ecosystems, especially among plant communities, on the 28% of this planet that is land and the 72% that is ocean. I hope you will bear with me as I avoid the use of the term 'global warming' which I believe constrains and restricts important scientific considerations of other critical impacts of the modern fossil fuel age which are better described as 'climate change' and perhaps best described as 'ecosystem change'. Simply put, vast ecosystems on this planet are being dramatically altered and diminished by the influence of our CO2 emissions and one consequence of those changes is commonly referred to as 'global warming.'

I am engaged in a number of businesses as Founder/Officer/Director/Scientist, all of which are working to develop and deliver green solutions to the environmental crises brought on by our increasing CO2 emissions and the staggering diminishment of the natural CO2 sequestration capacity of ecosystem CO2 sinks most easily described as the seas and trees. These businesses include my primary company called Planktos Inc. and a public company called Planktos Corp. Both are headquartered in the San Francisco Bay area of California. A second company which was developed in parallel to and is presently a subsidiary of Planktos Inc. called KlimaFa (Climate Tree in Hungarian) is headquartered in Budapest Hungary, and a third company called Haida Climate is headquartered in the village of Old Masset on the British Columbia islands known as Haida Gwaii and in Vancouver, British Columbia. Further I work and consult regularly with governments and organizations in Europe, China, and North and Central America

to assist development of land and sea ecorestoration projects to revive plant communities and ecosystems for their myriad ecosystem services and benefits including the newly emerging ecosystem service commonly called a carbon offset or carbon credit. For the record I am also personally and professionally engaged as President CEO and Scientist in a business called D2Fusion based in the Silicon Valley of California and in Los Alamos New Mexico which is the culmination of nearly 20 years of work in quantum and nuclear physics. D2Fusion is working to deliver safe clean nuclear fusion energy based on solid state fusion conditions which offer a technological solution that I am convinced will one day soon safely and affordably relieve us of our energy dependence on fossil fuels.

Present Corporate Brief on Planktos

Planktos' ocean work is in an early stage of classic R&D, with an emphasis on the "D" side of the equation. We are following in the footsteps of 20+ years and upwards of $100 million in research efforts by international public science agencies on investigations of the role of mineral micronutrients, especially iron, in ocean phytoplankton (plant life) ecology. Our interpretation of this work is that it has provided dramatic evidence that ocean plant life, plankton blooms, are tightly linked to mineral micronutrients that mostly arrive in the form of Aeolian (wind-borne) dust, from coastal shelf mineral sources, and from ocean upwellings. The results of the work to date has been most illuminating when once considers the role of Aeolian dust and the analog to that dust which is iron added by intent by ocean science organizations. Our basic business plan has been provided on our web site for many years and recently has been widely reported by the media. Our plan follows the consensus opinion of many ocean scientists who have called for larger, more controlled, and more fully monitored iron addition trials that will generate the multidisciplinary data needed to understand this technology's true capacity as a tool for CO2 mitigation and ocean stewardship. As a for profit business, we are of course also interested in the economic implications of that data and have designed our studies along the lines of small commercial pilot projects. Toward this end we have been able to raise funds in an ongoing fashion to support this frontier enterprise effort. We consider this work to be akin to the development of the applied science and technologies of agronomy and forestry, and believe it can finally foster similar stewardship based enterprises for the world's oceans.

Our diverse business involves both forest and ocean based ecorestoration projects, but given our start-up status in which we are just beginning our first major projects, it is impossible to make precise projections of the volumes of offsets we may produce. We are encouraged by the very dramatic international market that trades in excess of €50 - €100 million per day of carbon offsets in the European Union markets. This is why the bulk of our efforts are directed at developing and serving those EU markets and why we are so actively engaged in developing approved and approvable methodologies for providing our ecorestoration offset products into the EU and Asian markets. Our forestry efforts seek to restore hundreds of thousands of acres of land to mixed species native forests within the national park systems of the EU. Our initial projects in collaboration with Hungary's government, Academy of Sciences and National Parks Directorate involve the creation of 10,000 hectares of new "climate forest parks" that will prove out the model and generate millions of JI Track 1 credits for Kyoto markets. We take some guidance from other ecoforestry projects that have provided carbon offsets that have reaped in recent years sales agreements of as much as $145 million for 25,000 acre ecoforestry projects.

Voluntary markets for climate change offsets are emerging slowly in the United States and more dramatically abroad in countries that are signatories to the Kyoto Accord. At present the volume of credits sold by our company into the voluntary market is very a small number, not exceeding a few thousand tonnes. We don't expect this voluntary market, especially in the USA, to become a significant part of our business.

It is easy to imagine a larger voluntary market one day emerging but at this point in time we still do not see evidence of that especially in the USA. To the best of our knowledge, the US voluntary market at present amounts to no more than tens of thousands of tonnes of CO2e per year. As such the economic value of that market is quite inconsequential as prices for such voluntary offsets generally is in the $5 - $10 per tonne range. We question whether organizations selling into the US voluntary market at present recoup fully burdened costs associated with those sales. We do not, but then again we are working to develop awareness through this effort so our voluntary market sales are in part an educational outreach activity. Many organizations have aspirations to turn the corner and become profitable in this voluntary market and if that becomes possible we are well positioned to do so as well.

Our ocean plankton restoration pilot projects will generate the first substantial iron seeded blooms aimed at serving our twin purposes of restoring ocean plant ecosystems and sequestering atmospheric CO2. Since these projects are designed to obtain knowledge of ocean processes as well as the engineering, economic, political, and regulatory factors surrounding this activity, they require 'forward looking methods' to predict production volumes. Our stated goal is to conduct a series of up to six modest sized blooms that are on the order of 1%-2% the size of natural iron stimulated blooms in order to capture the data needed to answer many questions about this work's potential. These blooms will be about one order of magnitude larger than the largest iron stimulated blooms created by the earlier multinational science teams and be consistent with the size those teams have stated is the next appropriate step.

We take as a guiding principle authoritative science reports that the recent critical decline in ocean plant life has diminished annual ocean fixation of CO2 by at least 3-4 billion tonnes based on NASA and NOAA documented baselines from 1979~81. Note that this diminished capture of CO2 by ocean plants represents roughly half the net anthropogenic CO2 surplus of 6-8 billion tonnes per year. We leave it to you to judge whether this 3-4 billion tonne annual carbon capture deficit might serve to stimulate an ocean restoration industry funded in part by monetized carbon offsets.

Recent Ocean Iron Fertilization "Controversy"

Comments on Recent Misleading Press Releases and News Stories on Planktos Proposed Ocean Work .

Planktos is about to conduct a carefully planned series of ocean restoration pilot projects aimed at developing methodologies and technologies to restore dramatically damaged ecosystems of ocean phyto-plankton via replenishment of depauperate micronutrient iron. Ordinarily we'd rejoice at being covered in the media, however we take issue with the slanted portrayal of our work in various recent news stories. In the fever of a fabricated controversy many journalists have fallen prey to doing the story right now instead of doing the story right.

The press releases from some NGOs that fueled the debate about Planktos' pilot project efforts employed the classic straw man tactic, first portraying our work falsely then criticizing us for their fabricated description. Ordinarily one expects responsible journalists to at least fact check when reporting controversies with potentially momentous implications; and we were sincerely surprised when so many writers quite apparently did not. One reporter characterized hematite, a ubiquitous natural form of iron on the planet, as an "industrial waste product." This would have simply seemed sad if it had not been written in a famous science journal and fit so neatly into our critics "ocean dumping" claims.

The noted Journal Nature made a subsequent assertion that gauging how much carbon blooms sequester "is still unclear" but that same journal might have at least responsibly referenced Blain et al's detailed study on just that question in their own April issue as well as Buesseler et al.'s simultaneous report in Science, both of which document that such assessments can and are being accurately achieved. Moreover,

their studies show that depending on location 20~50% of the bloom fixed carbon is reaching 1000 meters in depth where it is effectively sequestered from the atmosphere for many centuries. The reporter from Nature goes on to quote without comment charges that these are premature "large-scale operations" when our pilot projects are only an order of magnitude larger than the last multinational iron fertilization project in 2002 and exactly the size that researchers from the ten previous trials have been calling for as the next logical step in developing this field.

The Planktos project involves replenishing missing micronutrient iron to a patch of ocean rich in major plant nutrients but low in productivity; and we will for the first time in the history of ocean science the resulting plankton bloom will have a dedicated research ship remain with the bloom for its entire 4~6 month life cycle. This work will take place hundreds of miles west of the Galapagos well away from any possible influence on or from the islands. The reason for this location is that the islands themselves are a major source of iron which results in a massive plankton bloom called the Galapagos Plume. It is the existence of this massive natural iron stimulated bloom that initially drew ocean scientists researching iron replenishment to the region for two previous successful though smaller iron experiments. The vast natural Galapagos bloom serves as a perfect scientific control for studying such iron induced blooms. It is also this vast natural bloom that creates the unique marine oasis that makes the Galapagos environment so bountiful and unique.

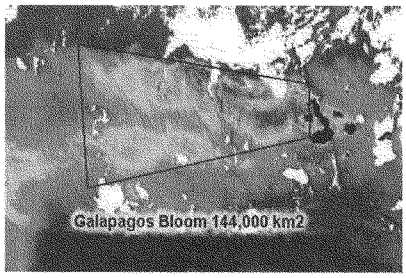
Now here's the twist, unfortunately WWF's US office and two other groups decided to oppose this work, but instead of engaging us on the merits of the project or ever mentioning the 50% plankton decline in the region we are working, they fabricated another straw man and falsely claimed our work would endanger the magnificent Galapagos environment and the livelihoods of the people who live there. Although aware that the project will take place far out to sea in currents that will bear our bloom even further away, they falsely portrayed our work in widely disseminated press releases as a senseless endangerment of a natural wonder to generate public alarm. They suggest this endangerment would derive from the micronutrient iron Planktos will put into the ocean to raise iron concentrations by mere tens of parts per trillion and the plankton bloom that would initiated. However the alarms of these NGO's opposing the work of Planktos are based on utterly false and intentionally misleading declarations that the work of Planktos poses a threat to the Galapagos Islands which are themselves a massive natural source of iron to the regions ocean resulting in a vast plankton bloom that enriches that very region.

Besides this initial shock tactic, they fabricated a litany of negative environmental impacts they propose will likely result from this work. Had the media examined these claimed "ill effects " they would have easily and surely found that the implied danger of every one of these alarming impacts is refuted by their absence in the natural but much more massive Galapagos bloom that envelopes the islands and extends far to the west. In the absence supporting facts, to the unwary and uninitiated these fears all may seem worthy of great concern, but in this case not only is there a complete absence of corroborating facts there is an overwhelming number of countervailing facts.
What is worse they have ignored the right story which is the desperate crisis in the world's oceans where a rapid mass extinction of plant life is underway. Ocean plants, the phytoplankton, are dying off at a phenomenal rate and have been doing so for scores of years and something must be quickly done to slow and reverse this trend. The primary causes of this decline are higher surface temperatures and the shortfall of micronutrient iron from rapidly diminishing Aeolian dust.

Ocean net primary productivity as calculated by the satellite measure of chlorophyll in the oceans has been shown as suffering losses of 17% in the North Atlantic, 26% in the North Pacific, and 50% in sub-tropical tropical oceans since the early eighties when our first competent measures of this sort began. To put this into a lay context we are seeing about the same 1% loss per year of ocean forest that the rainforests are shown to be suffering. However the rainforests cover a mere 2-3% of the planet while the ocean forest covers 72%. One can thus easily infer that in each 3-4 year period an amount of ocean plant

life equal to all rainforest plants on earth disappears. The fact that Planktos is working carefully, in the best traditions of science, to develop the ability to slow this ocean ecosystem collapse we would have thought was a great story. Unfortunately sensational misinformation seems to have offered many reporters a much easier story that was just too good to check.

Here's an image the media might have chosen to run to inform and salve public fears. It shows the massive Galapagos bloom which is so critically important to any story on Planktos' work. The existence of the massive Galapagos bloom enveloping the islands and extending its vast "plume" of plankton fertility might have contained a caption explaining that this natural iron induced bloom is responsible for the marine oasis effect that makes the Galapagos such natural wonder. It ought to be clear to anyone looking at the image that our tiny project 1/15th the size of just this portion of the natural bloom and hundreds of miles to the west could not impact the islands' environment or the lives of residents in any way.



Temperate Forest Albedo

A recent theory posited by Ken Caldeira of Stanford claims planting trees in temperate latitudes may actually warm the Earth rather than help reduce global warming. Quite simply we do not believe that an oversimplified mathematical climate physics model provides any worthwhile insights into the complex reality of the environment and it would be absurd to employ it as a to guide climate policy.

The Caldeira study makes a bold assumption that everything important about the role of CO2 and forests is captured within the context of atmospheric warming effects governed entirely by the phenomenon of "albedo" or light reflectivity. Since light-colored surfaces on Earth reflect more of the sun's heat back into the atmosphere than do dark surfaces, the study claims that, given the Earth's curvature, conversion of light-colored surfaces non-forested lands to dark colored surfaces, forests, in boreal and temperate regions would warm the planet more over time.

Most importantly the model offers neither acknowledgment nor accommodation of the powerful complex interdependencies and effects of CO2 that are mitigated when it is fixed and sequestered in forests as opposed to being allowed to circulate and impact other vital ecosystems such as dry lands and oceans. In some of those systems forest CO2 mitigation or the lack thereof exerts a potent forcing effect on the overall planetary carbon cycle. For example higher CO2 in the atmosphere due to temperate forests not fixing CO2 is shown to result in greater growth of CO2 sensitive vegetation especially dry land grasses. This forcing effect causes the production of more 'ground cover' and reduces Aeolian dust. The diminished dust supply correspondingly starves the oceans of vital mineral micronutrients accelerating the devastating decline in the ocean's net primary productivity. Even more importantly forest CO2 sinks help slow the deadly pace of ocean acidification, which the Royal Society predicts will start triggering mass extinction events in the ocean in as little as 50 years.

Our colleagues at the Pacific Forest Trust have also studied the issue and agree the study's assertion is based on a theoretical, narrow and highly simplified computer model which generates highly speculative, preliminary, and untested results. This dangerously reductionist "physics only" view not only cavalierly

dismisses the crucial role forests play in helping to stabilize the climate, it totally ignores the life-sustaining services it offers to life in the seas.

"Among other flaws, the Caldeira study does not take into account the real role forests play in the global warming equation. It ignores the fact that forest loss is a significant, historic source of CO2 emissions and that extensive deforestation continues today. Restoration of some part of that lost forest cover must logically restore some of the ecological balance to the global ecosystem with regard to carbon fixation and sequestration.

Forest loss, scientists agree, is responsible for roughly 25% of all man-made, global CO2 emissions today (and more than 40% in the past when forestlands were cleared to make way for cities and farmlands). In the U.S., for example, roughly 1.5 million acres of forests are currently lost to development and conversion each year. Figured conservatively, this forest loss results in the release of 275 million metric tons of CO2 into the atmosphere – *a release equivalent to the emissions output by 53 million vehicles over a one-year period.*

Forests alone, of course, cannot solve global warming. The challenge is enormously complex and will require multi-faceted solutions from multiple sectors to effectively address. Nonetheless, it's important we all recognize here and now that forest loss has been a substantial part of the problem, forest conservation and stewardship are part of the solution, and that forest carbon sequestration is an essential complement to the absolutely necessary focus on reducing the use of fossil fuels."

Regulation of Voluntary Markets…..

Voluntary markets for climate change offsets are emerging slowly in the United States and much more dramatically outside of the USA in countries that are signatories to the Kyoto Accord. At present our company volumes of credits sold is a small number and not a significant part of our business. We don't expect this voluntary market, especially in the USA, to become a significant part of our business. Rather we are almost entirely focused on the mandatory markets in the Kyoto complaint world of Europe and Asia.

It is easy to imagine a much larger voluntary market one day emerging but at this point in time we do not see evidence of that market materializing especially in the USA. To the best of our knowledge the US voluntary market is at present not more than a few tens of thousands of tonnes of CO2e per year. As such the economic value of that market is quite tiny as prices for such voluntary offsets generally is $5-$10 per tonne. Surely organizations selling into the US voluntary market at present do not recoup costs associated with those sales. However many organizations have aspirations to turn the corner and become profitable in this voluntary market.

We are unaware of examples where such voluntary actions that might be considered roughly equivalent to the sale of carbon offsets are regulated or have federal oversight save through ordinary consumer protection statutes. Given the present small size of the voluntary market we'd not expect federal regulation above and beyond ordinary consumer protection provisions are warranted.

However with respect to the work we do to offer our own standards from its inception several years ago, Planktos has been committed to reasonable and fair market standards to ensure 'real, additional, verifiable, permanent, enforceable and transparent' GHG offsets; that is, to ensure what consumers and companies are getting what they pay for. Planktos believes that most companies active in this space are of a similar mind.

Whether in the voluntary or the regulated arena, Planktos encourages performance-based standards as opposed to technology-based standards, believing that so long as any method or technology can demonstrate 'real-to-transparent' criteria, all such methods should be allowed to help society head off the worst effects of climate change.

In the absence of leadership from the US federal government to create mandatory climate change requirements or to engage in the climate change market a voluntary marketplace has emerged and been hard at work to develop and standardize performance requirements for GHG offset providers. Understanding the importance of standard business practices, Planktos was involved in the formation this year of the Carbon Offset Providers Coalition (COPC), a trade association to which institutions providing testimony here today may belong. Alongside of other COPC members, Planktos has been involved in creation of the Voluntary Carbon Standard (VCS) planned for release later this year by The Climate Group. In addition, Planktos is participating in creation of the Greenhouse Gas Emission Reductions Product Certification Standard sponsored by the Center for Resource Solutions, creators of the Green-e Standard for renewable energy. Thirdly, as part of a recent GHG offset proposal submitted to the Oregon Climate Trust, Planktos adopted the GHG accounting standard developed by the World Resources Institute and the World Business Council for Sustainable Development.

As important as a discussion of voluntary standards is, it cannot be separated from discussion about regulatory standards. This is because the two approaches help inform one another. So, on the regulatory front, as past of its membership in the California Climate Registry, Planktos has hired TetraTech/EMI to help develop, review and submit verifiable protocols for its ocean biomass carbon sequestration work. These methods may someday serve as the basis for a certified ocean biomass protocol under the California Global Warming Protection Act, AB 32. Further, there may be reciprocity for a California-approved standard in other regions of the US, or with some eventual federal program. Finally, Planktos has also engaged Det Norske Veritas (DNV) based in Oslo, Norway, to support its efforts towards a Kyoto-approved protocol for ocean biomass sequestration.

What is the future of the Voluntary Carbon Offset Market and how significant a role might it play…..

The voluntary market originates as a grass roots expression of the need for individuals and institutions to address the looming effects of climate change and related environmental catastrophes (such as ocean decline). In Europe, the voluntary market is growing.

The voluntary market for carbon offsets will continue to reflect the needs, wants, preferences and desires of society while governments continue to wrestle with enforceable GHG emission reduction standards, or mechanisms of certifying GHG mitigation. Whether this will remain so depends on government's ability to cooperate in the face of almost certain economic and environmental chaos brought on by accelerating climate change effects.

Carbon offsets generated by restoration of ecosystem services can have an enormous positive effect on both the national economy and the nation's environmental health. Policies dedicated to protecting and enhancing these services now lead to application of tested methodologies in the disciplines of restoration ecology, conservation biology and adaptive management. Further, the role of the marketplace in rewarding eco-restoration initiatives has long been established, evidenced by markets for airshed improvements via bank-and-trade strategies for SO2, NOx and VOCs; or markets for wetland restoration and for biodiversity enhancement; or markets for watershed improvement and for aquifer recharge. Creation of markets for GHG mitigation – characterized by remediation of rising CO2 via biological /

ecosystem capture – is but another step towards building and reinforcing the environmental economy that will likely serve as the basis for all human productivity in the not so distant future.

As but one example of what might be achieved, consider that a typical EU Planktos forest project is planned for about 10,000 hectares, and produces about 8-9 million emission reduction units (carbon credits) over a 50 year period. Planktos plans on implementing ten such projects in Hungary alone, and it is possible that up to 1,000,000 hectares might ultimately be brought back into forest cover there. In addition to reducing the impacts of climate change, these projects will result in new economic opportunities associated with forest management and tourism. And there will be enormously important additional values related to air, soil and water quality, and biodiversity.

A typical modest scale ocean restoration project will cover about 10,000 square km, fix many million of tonnes of CO2 from the air as biomass, and produce 2 or more million ERUs over a six month period. This is because plankton are adapted to take advantage of the presence of micronutrient iron mineral dust, and they rapidly respond when it is available. And just like traditional land based farming, where one recently grown tract is allowed to recover while a neighboring tract is planted, so in the oceans another adjacent plankton community can be restored, generating additional millions of tonnes of reductions in atmospheric CO2 in incredibly short order.

How much of the ocean can be managed in this way? According to NASA studies published in 2003 and 2006, the planet has lost about 13% of ocean plankton productivity over the past 30 years. This equates to loss of about 4 billion tonnes (gigatonnes) in uptake of atmospheric CO2. This means that if society were to collectively undertake restoration of plankton productivity to 1980-type levels, and go no further, about 70% of the entire worldwide GHG emission profile (said to be about 6 gigatonnes) could be mitigated by this method alone.

And, as with forests on land, the value of returning plankton productivity to 1980 levels would bring highly valued co-benefits in the form of rejuvenated populations of sea birds, mammals and fish, including a host of commercially valuable species that otherwise will not be able to sustain themselves in the face of continually growing resource demands.

The information provided in this brief paper is far from comprehensive or sufficient to present a thorough understanding of the topics covered. I would be happy to provide additional information more extensively covering the questions raised by the committee.

My thanks to the committee for the opportunity to make this abbreviated presentation.

We have also appended several brief papers and reports that document our claims and hopefully draw the Committee's attention to the extraordinary need for and potential of ocean restoration as a climate policy tool.

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Crucial Marine Food Chain Link Withers
By Seth Borenstein,
Associated Press
December 07, 2006

WASHINGTON -- The critical base of the ocean food web is shrinking as the world's seas warm, new NASA satellite data show. The discovery has scientists worried about how much food will grow in the future for the world's marine life.

The data show a significant link between warmer water _ either from the El Nino weather phenomenon or global warming _ and reduced production of phytoplankton of the world's oceans, according to a study in Thursday's journal Nature.

Phytoplankton are the microscopic plant life that zooplankton and other marine animals eat, essentially the grain crop of the world's oceans.

"Everything else up the food web is going to be impacted," said oceanographer Scott Doney of the Woods Hole Oceanographic Institute. "What's worrisome is that small changes that happen in the bottom of food web can have dramatic changes to certain species at higher spots on the food chain."

This is yet another recent scientific study with real-time data showing the much predicted harmful effects of global warming are not just coming, but in some cases are already here and can be tallied scientifically, researchers said.

A satellite commissioned by NASA tracked water temperature and the production of phytoplankton from 1997 to 2006, finding that for most of the world's oceans when one went up the other went down and vice versa, said study lead author Michael Behrenfeld, a biological oceanographer at Oregon State University.

As water temperatures increased from 1999 to 2004, the crop of phytoplankton dropped significantly, about 200 million tons a year. On average about 50 billion tons of phytoplankton are produced yearly, Behrenfeld said.

During that time, some ocean regions, especially around the equator in the Pacific, saw as much as a 50 percent drop in phytoplankton production, he said.

However, the satellite first started taking measurements in 1997 when water temperatures were at their warmest due to El Nino. That's the regular cyclical warming of part of the Pacific Ocean that affects climate worldwide.

After that year, the ocean significantly cooled until 1999 and the phytoplankton crop soared by 2 billion tons during those two years.

"The results are showing this very tight coupling between production and climate," Behrenfeld said.

Phytoplankton, which turn sunlight into food, need nutrients such as nitrogen, phosphates and iron from colder water below, Behrenfeld said. With warmer surface water, it's harder for the phytoplankton to get those nutrients.

Behrenfeld said the link between the El Nino changes and phytoplankton production is clear. For years scientists warning about climate change have said warmer waters will reduce phytoplankton production and this shows it's happening, he said.

Other oceanographers agree with the El Nino link but said with only a decade of data it is harder to make global warming connections.

"It's something you certainly can't ignore, because its potential is quite significant," said James Yoder of the Woods Hole Institute. "But there are some caveats because of the shortness of the record."

Another worry is that with reduced phytoplankton, the world's oceans will suck up less carbon dioxide, increasing the Earth's chief global warming gas, said NASA ocean biology project manager Paula Bontempi. That's because phytoplankton take carbon dioxide out of the atmosphere in making food.

This is at least the third significant peer-reviewed research paper in the past six months showing that long-anticipated global warming biological side effects are already happening.

A study earlier this year linked increases in Western U.S. wildfires to global warming and a mega-study showed that dozens of species of plants and animals were dying off from global warming.

"What you're looking at is almost an avalanche of each individual effect," said Stanford University biological sciences professor Stephen Schneider. "As it gets warmer and as we measure more things, the evidence accumulates."

Source: Associated Press
http://enn.com/globe.html?id=1403

Open Letter to the Marine Science Community: Has Personal Bias Derailed Science?

Steve Kerry, July 2006
Carbon Sequestration Blog
http://carbonsequestration.blogspot.com/2006/07/open-letter-to-marine-science.html

Has Personal Bias Been Allowed to Derail the Normal Progression of Ocean Fertilization Science? An Open Letter to the Marine Science Community

Given the extreme hazard of global warming, the recent revelations of ocean acidity, and reports of bio-system collapse of various sorts, one would think that the concept of Ocean Iron Fertilization would get be treated most seriously. Although controversial and not yet completely proven, this technology still might be very important to the world. As Ken Johnson of Monterey Bay Aquarium Research Institute said: "We're headed towards climate conditions that Earth hasn't experienced in millions of years...We can't afford to ditch any potential solutions just now."

For a technology of such potential, one would think that marine scientists would have been diligently researching it, discovering in detail the underlying mechanisms, proposing methods to optimize or control such a process, and preparing to advise, in a rational and unbiased fashion, the decision makers and public of the world.

Unfortunately, this doesn't seem to have happened. Reviewing the literature of the past decade, there seems to be an inexplicable lack of progress understanding the science. Worse, there seems to be a general hesitation and even hostility by the marine sciences to the progress of this field, and in many cases arguments of political feasibility are being substituted for factual arguments.

We cannot help but suspect that this is because certain key individuals are personally opposed to the concept. These people have political and personal convictions that the process is immoral, or that the world community cannot be trusted to have it. Based on these personal convictions, these scientists have steadily opposed the field the field, in some cases quite openly, slowing down research and discouraging advancement. It's a process of "negativization" of science which is so pernicious and difficult to fight.

Some may believe that scientists have an ethical and moral right to discourage research that they believe is dangerous. That may be true in the case of weapons or obvious dangers. But this is not that kind of technology. It is not obviously harmful or destructive. In fact, if finally proven out and used smartly and carefully, this technology could be extremely beneficial to world, not only as a carbon sink but as a one tool for restoring damaged sections of the ocean. Contrary to the somewhat frantic rhetoric of the opponents, there is absolutely no reason to assume that the technology will be "easy to abuse" or will spin out of control; quite the contrary, the very size of the ocean and the scale of effort precludes such abuse. There is every reason to assume it will be possible to control and monitor to the satisfaction of all, especially on a small-to-medium scale. Yes this will require a lot of hard science and engineering, to identify the proper procedures and protocols, but this is nothing unusual – other fields such as terrestrial ecological restoration have successfully overcome similar uncertainties, and there is no reason ocean fertilization couldn't do the same.

Critics are opposed not because it's inherently bad, or because they possess a complete understanding of it, but because they "believe" that it's impossible for the human race to use it smartly or carefully, they "worry" that it "might" be misused at some unspecified time in the future. They believe that commercial firms or corporations, driven by the profit motive, are inherently abusive and will "pollute the commons" for greed. These people don't appear to have come to these conclusions based on facts or analysis, but because they disliked the concept from the very first moment they heard it, and have subsequently filtered all new data to fit their pre-conceived views.

These views aren't science, not based on facts are logic. They are just opinions (and rather emotional, extreme opinions at that) of a few individuals. And so may we ask: why are personal beliefs detouring the progress of a major science? Is this appropriate?

Case in Point: Dr. Sallie Chisholm

Dr. Chisholm is an accomplished and respected head of an MIT laboratory and a member of the first iron experiment cruise. Yet Dr. Chisholm's entire contribution to the field has been to oppose it, apparently from the very beginning.

From Science News, September 30 1995, p 220:

(Before the first cruise, which Chisholm was on) Oceanographer Sallie W. Chisholm of the Massachusetts Institute of Technology often argued with him (Martin) about the ethics of geo-engineering, or even of conducting research toward that goal…

"I think it's folly. It would just cause another environmental problem," says Chisholm. "It's so naive to think that we can do one thing and it's going to have a predictable effect. The arrogance of human beings is just astounding."

The picture here is quite clear. Dr. Chisholm has thought the concept was "folly" and was actively lobbying to prevent even the research towards it, even before the first cruise. She believes that the human race – the other 6 billion human beings and their elected representatives – are too arrogant to even have the chance to choose. Her mind appears set was set before any data was even collected, and has not changed since.

In keeping with her views, Chisholm has written papers, convened symposiums (see below), and lobbied government agencies, all for the single purpose: to ensure that her view of right and wrong is upheld.

None of these actions are by themselves inappropriate. Dr. Chisholm has ever right to lobby for her views. However, it is important to understand that by these actions, Dr. Chisholm is has assumed the role of an activist, or political partisan, not a scientist. She has made it her mission to stop any development of the field, and has used her scientific position to do this, fighting by every means possible to slow down or block this technology, for reasons of personal ideology.

Most likely her views will continue to be debated in the political sphere, at some point in the future when and if a large scale process is proposed. But right now, it's important to ask the question: Is the ocean science community making a clear distinction between Chisholm the activist and Chisholm the respected scientist? Are they making the necessary allowance for her personal bias? And finally, are her personal views, as strongly worded as they are, acting to obstruct or prevent the normal process of scientific investigation for this nascent field, thus preventing the world community from getting a complete presentation of the facts necessary to make informed decisions?

Case In Point: Dr. Kenneth Coale

From Science News, September 30 1995, p 220:
"We had predicted the response, but none of us was really prepared for what it would look or feel like," says (Kenneth) Coale, a researcher at the Moss Landing (Calif.) Marine Laboratories. "There were some of us who were quite pleased and others of us who would walk out on the fantail and burst into tears. It was a profoundly disturbing experience for me"
Coale and many others who witnessed iron's tremendous greening effect loathe the idea of tinkering with the globe in such a heavy-handed way.
From Discover, October 2003 "Watery Grave"

Coale thinks it's unfair, if not impossible, to expect the oceans to absorb more than 6 billion tons of excess carbon each year. "There are many of us who consider the oceans to be sacred," he says. But "we've let the cat out of the bag. We have to keep looking at it now, whether we like it or not."

"Iron fertilization for geo-engineering or fish product has been driven by a kind of quick-buck philosophy..."Note the phrases "burst into tears" "profoundly disturbing" "loath" "sacred". Clearly Dr. Coale has strong emotional feelings about the entire business. Again, Coale is entitled to his opinions, but we must point out: he is the director of the Moss Landing Laboratory, and is therefore in charge of what is arguably the central lab studying the effect.

If Coale has such virulent feelings on the topic, which he expresses in almost every article written on the subject, how can he support unbiased research into the topic? How could any young researcher or student working under him dare to work optimistically on the subject when the leader of their group is so firmly opposed to it?

It seems more likely that Coale's conflict of conscience spills over into the field that he leads, and that this negativity creates a wet blanket smothering progress.

Again, this should not be taken as personal criticism of Coale. We have no doubt that he is a dedicated leader of his group who honesty tries to do justice to the problem. But it seems unlikely he is able to do so.

Case in Point: American Society of Limnology and Oceanography (ASLO) 2001 Ocean Fertilization Symposium.

The ASLO conference was billed as a symposium with presentations by a wide variety of interested parties. From this description, an average scientifically-literate citizen or government regulator would suppose that it represented an unbiased, or at least broad, view of the issues. This symposium created a "Policy Statement" which warns against ocean iron fertilization. Such a warning might very strongly affect the views of the public.

The problem is, this conference appears to have been biased from the start, organized for the sole purpose of creating such a warning. The lead-off speakers for the conference were the two mentioned above, Chisholm and Coale. Chisholm gave the overview presentation, in which she made it very clear the purpose of the conference was to warn against the technology. So the question must be asked: how can such an event, organized in this way, possibly have arrived at an unbiased consensus of views? Of course it couldn't and wasn't intended for that purpose. Thus it is not a "scientific" event but an "activism" event, the equivalent of a political rally, which has been clothed as science to gain it increased respect.

If this meeting was nothing more than a meeting of activists for one particular side of the debate, then it needs to be clearly labeled as such, so that future decision-makers won't give it more consideration than is due such activism.

Withholding Science From Society?

Scientists are entitled to their political opinions. But when those opinions become the driving force for an entire scientific field, we question if this veers into ethical conflict.

Individuals, no matter how strongly they may feel, do not have the right to obstruct the normal progress of scientific discovery and commercialization, in order to satisfy their personal beliefs. In fact, to some extent scientists have a larger obligation to research diligently and present unbiased facts so that the world community and elected representatives can make their own decisions. There are billions of citizens of the world who, through taxes, grant money, and goodwill, are funding scientific research, and who expect in return to get conclusions untainted by the personal beliefs.

Therefore:

- → We respectfully suggest that the ocean science community needs do some "soul searching" if systemic bias has affected the progress of this research.
- → We believe that the literature of the field deserves a complete review to identify places where "negative spin" has been added prematurely, or where political or social commentary has been used to argue feasibility.
- → We suggest that the 2001 ASLO Symposium findings (Summary Statement April 25, 2001) be formally stricken and a new symposium be convened, in which a legitimate and valid cross-section of opinions, both pro and con, are represented.
- → Finally, we suggest that researchers refrain from such negative remarks about commercial firms. Academic-commercial partnerships are a well-proven structure for making progress and solving problems. There is no need for scorn.

If we are off-base or over-stating the problem, then we apologize. This letter is certainly not meant as an accusation, but instead, a serious question: has the Marine Science community gotten "off track" in regards to Ocean Fertilization, and if so, can it get back on track?

Steve Kerry
Carbon Sequestration Blog

Note
Responses welcome, and will be published in entirety in the Carbon Sequestration Blog.
Please address sbkerry@hotmail.com or visit http://carbonsequestration.blogspot.com

Is Ocean Fertilization Credible and Creditable?

Science 19 April 2002:
Vol. 296. no. 5567, pp. 467 - 468

Kenneth S. Johnson, Monterey Bay Aquarium Research Institute & David M. Karl, Department of Oceanography, School of Ocean and Earth Science and Technology, University of Hawaii

It is possible that the increase in atmospheric carbon dioxide, which drives global warming, could be partially mitigated by adding iron to ocean waters. In their Policy Forum "Dis-crediting ocean fertilization" (12 Oct., p. 309), S. W. Chisholm et al. argue that "the known consequences and uncertainties of ocean fertilization already far outweigh hypothetical benefits." We believe that they have greatly overstated the current knowledge of ocean processes in reaching their opinion that iron fertilization is not a viable option for CO2 management.

Presently, there are no easy means to offset the atmospheric increase in CO2 that results from the burning of fossil fuels. The most optimistic plans, including large reductions in fossil fuel consumption, still allow for a substantial increase in atmospheric CO2 (1). Only one fact seems certain: The ocean will change in response to an altered climate. Indeed, there is substantial evidence that this is already occurring (2-4). It is not known whether the changes driven by warming in the absence of iron fertilization will be more or less significant than changes that might result from deliberate iron fertilization.

Chisholm et al. assert that ocean fertilization "is not easily controlled." The residence time of iron in surface waters must be substantially less than 1 year (5). Following large-scale iron fertilization, concentrations would be reduced to biolimiting values within 1 year, after winter deep mixing and other export processes, and in the absence of other inputs. The particulate carbon standing stock of the ocean, including phytoplankton, is known to turn over on average every 7 days (6). Upon cessation of fertilization, the phytoplankton stock would rapidly return to prefertilization conditions as iron concentrations decreased to ambient levels.

They write that ocean fertilization "does not mimic nature." Yet, large, natural episodic iron addition events of similar magnitude to the IronEx II addition (7) regularly occur in the ocean. We recently observed an aerosol deposition event in the North Pacific that raised dissolved iron concentrations to 0.7 nM over hundreds of kilometers (8). Such events may periodically stimulate nitrogen fixation, alter ecosystem structure, and result in the export of carbon (9). Elevated iron concentrations have also been observed in surface waters of the equatorial Pacific after rain (10) and along the ice edge in the Antarctic (11). In the coastal ocean, large iron injections that fertilize the spring bloom occur during the onset of deep-water upwelling (12).

Ocean fertilization "is not easily verified" according to Chisholm et al. Neither is global warming, although abundant indirect evidence supports the almost inescapable conclusion that it is occurring. The critical issue regarding ocean fertilization is not verification to claim carbon credits, but whether it is a feasible strategy to mitigate increasing CO2 in the atmosphere.

Chisholm et al. state that ocean fertilization "would likely result in deep ocean hypoxia or anoxia." These conclusions are based on calculations using a model with zero-order kinetics for carbon consumption (13). Increasing the carbon flux to the deep sea must increase oxygen consumption there. However, paleoceanographic data do not indicate widespread anoxia (14). Oxygen utilization rates appear to decrease in low oxygen areas, which shifts carbon and oxygen consumption to deeper, more oxygenated zones of the ocean (15).

Considerable uncertainty remains about these issues. Decisions to initiate or abandon ocean fertilization must be weighed carefully after we have learned substantially more about carbon cycling through the ocean. It is simply not credible, or creditable, to suggest that we know enough to understand the impacts of ocean fertilization at the present time.

References and Notes

1. J. T. Houghton et al., Eds., Climate Change 2001: The Scientific Basis (Cambridge Univ. Press, UK, 2001).
2. S. Levitus et al., Science 287, 2225 (2000).
3. J. Barry, C. H. Baxter, R. D. Sagarin, S. E. Gilman, Science 267, 672 (1995).
4. D. Roemmich, J. McGowan, Science 267, 1324 (1995).
5. K. W. Bruland, K. J. Orians, J. P. Cowen, Geochim. Cosmochim. Acta 58, 3171 (1994).
6. P. Falkowski, R. T. Barber, V. Smetacek, Science 281, 200 (1998).
7. K. H. Coale et al., Nature 383, 495 (1996).
8. K. S. Johnson et al., in preparation.
9. P. Falkowski, Nature 387, 272 (1997).
10. A. K. Hanson, N. W. Tindale, M. A. R. Abdel-Moati, Mar. Chem. 75, 69 (2000).
11. P. N. Sedwick, G. R. DiTullio, D. J. Mackey, J. Geophys. Res. 105, 11321 (2000).
12. K. S. Johnson et al., Geophys. Res. Lett. 28, 1247 (2001).
13. J. L. Sarmiento, J. C. Orr, Limnol. Oceanogr. 36, 1920 (1991).
14. J. L. Morford, S. Emerson, Geochim. Cosmochim. Acta 63, 1735 (1999).
15. A. H. Devol, H. E. Hartnett, Limnol. Oceanogr. 46, 1684 (2001).

REVIEW

Mesoscale Iron Enrichment Experiments 1993–2005: Synthesis and Future Directions

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Since the mid-1980s, our understanding of nutrient limitation of oceanic primary production has radically changed. Mesoscale iron addition experiments (FeAXs) have unequivocally shown that iron supply limits production in one-third of the world ocean, where surface macronutrient concentrations are perennially high. The findings of these 12 FeAXs also reveal that iron supply exerts controls on the dynamics of plankton blooms, which in turn affect the biogeochemical cycles of carbon, nitrogen, silicon, and sulfur and ultimately influence the Earth climate system. However, extrapolation of the key results of FeAXs to regional and seasonal scales in some cases is limited because of differing modes of iron supply in FeAXs and in the modern and paleo-oceans. New research directions include quantification of the coupling of oceanic iron and carbon biogeochemistry.

The work of John Martin (*1*, *2*) sharply focused attention on the role of iron (Fe) in ocean productivity, biogeochemical cycles, and global climate by proposing "that phytoplankton growth in major nutrient-rich waters is limited by iron deficiency" (*2*). The candidate mechanism of Martin (*1*, *2*) points to the importance of changes, over geological time, in the magnitude of macronutrient uptake by phytoplankton in waters where macronutrient concentrations are perennially high (*1*). Specifically, Fe supply to the ocean was much higher during glacial maxima than at present (*1*), and it is estimated that the increase in Fe-induced productivity could have contributed perhaps 30% of the 80-ppm drawdown in atmospheric CO_2 observed during glacial maxima by enhancing the ocean's biological pump (*3*).

Early results from shipboard incubations in high nutrient–low chlorophyll (HNLC) waters presented compelling but equivocal evidence that phytoplankton growth was limited by Fe availability (*2*). After rigorous discussion, a consensus was reached (*4*) that, because shipboard experiments have artifacts, mesoscale Fe addition experiments (FeAXs) offered the best approach to resolve questions about the role of Fe in ocean productivity, C cycling, and climate. The main objective of FeAXs was to test whether Fe enrichment would increase primary productivity in HNLC waters, but additional questions focused on how Fe enrichment would affect nutrient use and export (*1*).

The era of mesoscale Fe enrichments started with IronEx I, where Fe and the conservative tracer SF_6 (*5*) were added to tropical HNLC surface waters (*6*). A further 11 FeAXs of similar design (*7*, *8*) in different HNLC regions (Fig. 1) later confirmed the capability to study pelagic ecology and biogeochemical cycling in a discrete water parcel over time and space scales of weeks and kilometers. Complementary approaches include ship-based observations of persistent blooms within HNLC waters (Fig. 1), termed here FeNXs (Fe natural enrichment experiments), that are driven by sustained and localized Fe enrichment (*9*).

Common Findings in FeAXs

FeAXs have each used a common framework (*7*) that enables comparison of their biogeochemical signatures (Table 1 and tables S1 to S3). The results of FeAXs have substantially increased our understanding of ecological and biogeochemical dynamics and their interrelationships, and many findings are consistent with theory-based predictions of ecosystem dynamics. For example, they have shown that phytoplankton grow faster in warmer open-ocean waters (table S2), as predicted by algal physiological relationships (*10*), and that blooms across a range of FeAX sites display an inverse relationship between chlorophyll concentration and mixed-layer depth (Table 1), as forecast by theoretical relationships between light penetration and mixed-layer depth (*8*, *11*, *12*). More specifically, FeAXs have verified that Fe enrichment enhances primary production from polar to tropical HNLC waters (Table 1) and confirmed that Fe supply has a fundamental role in photosynthesis (photosynthetic competence, table S1), diatom sinking, Fe uptake rates (*13*), and other physiological processes. FeAXs have demonstrated reduced silica requirements of diatoms when relieved of Fe stress (*14*), confirming results from bottle experiments (*15*).

These mesoscale experiments have provided detailed time-series observations, within a tracer-labeled parcel of water [i.e., a Lagrangian framework (*7*)], of open-ocean blooms from initiation through evolution and decline (Table 1). Data collection within a Lagrangian framework gives unparalleled insights into bloom dynamics and clarifies how the interplay of factors such as initial conditions (table S1) and loss processes defines properties such as bloom magnitude, which exhibits a factor of 10 range in chlorophyll concentrations between FeAXs (Table 1). The broad suite of measurements and their high temporal resolution in FeAXs will be a useful tool to better interpret the less highly resolved observations available for naturally occurring blooms [e.g., the Antarctic Environment and Southern Ocean Process Study (AESOPS) (*16*)]. Furthermore, the high-resolution data sets have enabled the establishment of a mechanistic understanding, in some FeAXs, of the evolution, termination, and decline phases of blooms (*17*) (Table 1). The durations of these bloom phases provide an estimate of the lag time between the accumulation of phytoplankton C and its subsequent export (*17*); such an estimate has proved elusive in previous studies (*18*).

This experimental approach has presented a platform to examine in detail the interactions of top-down and bottom-up control—outlined in the ecumenical Fe hypothesis (*19*)—on phy-

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toplankton community structure. For example, stocks of all phytoplankton groups increased initially upon Fe enrichment, but only the diatoms bloomed (Table 1) by escaping grazing pressure. Thus, unlike bottle incubations, FeAXs offer a holistic approach to studying the entire pelagic food web. This enables assessment of the interplay of ecological processes and the resultant biogeochemical signals, such as Fe-mediated increases in haptophyte abundances (table S2) and consequent faunistic shifts within the microzooplankton (*20*) (table S2) that lead to changes in dimethyl sulfoniopropionate (DMSP) (*20*) and dimethyl sulfide (DMS) concentrations (*20*) (Table 1), respectively. These changes in DMS concentration demonstrate that climate-reactive biogenic gases—in addition to CO_2—must be considered to obtain the cumulative effect of Fe enrichment on climate.

The scale of FeAXs, and in particular their use of the SF_6 tracer, enabled the construction of pelagic biogeochemical budgets for C (*17*) and Fe (*21*) under high-Fe conditions. FeAXs have permitted the study of whether speciation controls Fe bioavailability (*22*), the mechanisms behind changes in the production of Fe-binding ligands (FeBLs) in response to enhanced Fe (table S3), and other aspects of Fe chemistry. The SF_6 tracer has also helped demonstrate that the underlying physics at FeAX sites alters the bloom biogeochemical signature both by diluting phytoplankton stocks (Table 1) and by increasing the macronutrient inventory of the patch (table S3). Such patch dilution may result in experimental artifacts including arrested bloom development (*23*), which leads to reduced macronutrient uptake.

Together, the wide range of experimental conditions and resulting breadth of bloom signatures evident from FeAXs (Table 1 and tables S1 to S3) provide an essential data resource to improve existing ecological and biogeochemical models and to develop new ones. For example, a new model of DMS dynamics developed during Subarctic Ecosystem Response to Iron Enrichment Study (SERIES) provides a better understanding of how the complex interplay of physical, photochemical, and biological processes affects the temporal evolution of mixed-layer DMS concentrations (*24*).

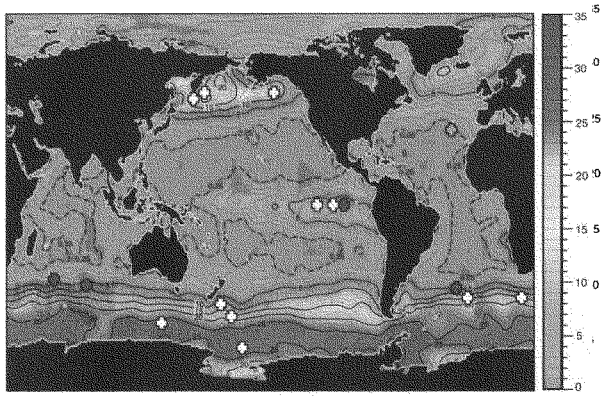


Fig. 1. Annual surface mixed-layer nitrate concentrations in units of μmol liter^{-1} (*48*), with approximate site locations of FeAXs (white crosses), FeNXs (red crosses), and a joint Fe and P enrichment study of the subtropical LNLC Atlantic Ocean (FeeP; green cross). FeAXs shown are SEEDS I and II (northwest Pacific; same site but symbols are offset), SERIES (northeast Pacific), IronEX I and II (equatorial Pacific; IronEX II is to the left), EisenEx and EIFEX (Atlantic polar waters; EIFEX is directly south of Africa), SOIREE (polar waters south of Australia), SOFEX-S (polar waters south of New Zealand), SOFEX-N (subpolar waters south of New Zealand), and SAGE (subpolar waters nearest to New Zealand). FeNX sites shown are the Galapagos Plume (equatorial Pacific), Antarctic Polar Front (polar Atlantic waters), and the Crozet and Kerguelen plateaus (Indian sector of Southern Ocean; Crozet is to the left of Kerguelen). For the geographical positions of the FeAXs, see (*8*). FeeP investigated whether N-fixing phytoplankton are simultaneously limited by Fe and P; see Table 1.

Scaling Up the Results from FeAXs

A key issue to be addressed is how natural or anthropogenic variability in Fe supply affects ocean biogeochemistry and global climate (*25*). FeAXs are relatively short-term experiments specifically designed to test whether Fe supply limits primary production in HNLC waters, and therefore they can address this issue only by extrapolation. Here, we consider whether findings from FeAXs can successfully be scaled up temporally (seasonal to geological) and spatially (regional to global). Four issues, addressed below, are central to tests of the validity of such extrapolation.

Macronutrient Uptake

The degree of Fe-mediated algal uptake of the mixed-layer macronutrient inventory will determine bloom longevity (*17*) and influence the magnitude of C sequestration (*1*, *3*). FeAXs, on a time scale of weeks, have exhibited a wide range of nutrient uptake (table S3), with depletion of >0.75 and >0.6 of the mixed-layer silicate and nitrate inventory, respectively, in several cases (table S2). Polar FeAXs, although of longer duration (Table 1), have resulted in <0.3 of the macronutrient inventory being used, although inventories at polar FeAX sites are greater than in other HNLC regions (table S2). Fe-mediated diatom blooms in both FeAXs (table S2) and natural conditions (*16*, *26*) can deplete silicate but not nitrate, which has led to bloom decline. SERIES suggests that both Fe supply and diatom species succession, as a result of decreasing silicate concentrations, set the silicate:nitrate uptake stoichiometry (*17*). Thus, although longer-term Fe enrichment (months) may result in uptake of a greater proportion of the macronutrient inventory, it is difficult to scale up the findings of FeAXs without information on the long-term stability of phytoplankton community structure, such as diatom species succession (*17*).

Mediation of bloom decline via macronutrient depletion means that grazer control of phytoplankton stocks is less likely on the shorter time scales typical of FeAXs. This may also apply in some cases to the Last Glacial Maximum, as abundant diatom resting spores from Southern Ocean sediment cores indicate substantial export from diatom blooms in the Atlantic sector triggered by nutrient exhaustion rather than grazer control (*27*). Thus, FeAXs may mimic naturally occurring blooms that are transient (weeks) and are terminated by rapid nutrient depletion with consequently little change in the grazer community (*17*).

Bloom Time Scales and Food Web Dynamics

FeAX blooms may be subject to zooplankton grazing (Table 1), which would result in less

efficient downward export of algal C (*20*) and an increase in pelagic Fe recycling (*28*). However, the generation times for grazers range from days (microzooplankton) to months (macrozooplankton), whereas FeAX blooms evolve over 2 to 3 weeks (Table 1). Increased microzooplankton and, in some cases, mesozooplankton abundances (Table 1 and table S2) and subsequent alteration of food web dynamics were evident during FeAX blooms (table S2). If FeAXs were of longer duration, would stocks of large zooplankton increase with sustained Fe-elevated productivity? If so, how would they influence the bloom signature? Heavy grazing pressure, exerted by macrozooplankton, occurs in some upwelling regions (*29*) where a continuous nutrient supply (months) maintains a high-productivity system. Recent FeNXs, at sites with sustained nutrient supply (*9*), will reveal whether such an adaptive grazer response occurs during long-term blooms within HNLC waters, and hence whether upscaling the results of FeAXs to sustained naturally occurring blooms (months) is valid. If such an adaptive grazer response is observed, the potential long-term biogeochemical feedbacks of grazer-mediated Fe recycling and reduced export efficiency of algal C should be explored via modeling simulations.

Modes of Iron Supply

Initial attempts to relate the Fe supply during FeAXs with that in the modern or paleo-ocean (*30*) were hampered by relatively poor understanding of Fe biogeochemistry. Since the mid-1990s, our understanding has advanced considerably through better estimates of the solubility (*31*) and upper ocean residence time of aerosol Fe (*32*), improved regional coverage of dissolved Fe (DFe) concentrations (*33*), and greater insight into the key role of FeBL in maintaining Fe in the upper ocean (*34*). Although measuring DFe remains challenging, many technical issues have now been addressed (*35*). Our improved understanding is reflected in better models of dust depositional fluxes (*25*), oceanic DFe distributions (*36*), and the impact of higher Fe supply to the paleo-ocean (*14*), providing a more realistic picture of Fe supply to HNLC waters both now and in the geological past (Fig. 2).

A comparison of modes of Fe supply in FeAXs, FeNXs, and naturally occurring perturbations (Fig. 2) reveals a wide range in the magnitude, chemistry, residence time, and spatial and temporal scales of Fe supply. Although the pulsed Fe enrichments during FeAXs are

Table 1. The main findings from the 12 FeAXs (in chronological order from left to right) conducted between 1993 and 2005 [for additional details, see (*8*)]. See tables S1 to S3 for further details of initial conditions, ecosystem structure, and biogeochemical responses. Light climate, defined as the mean irradiance available to phytoplankton in the mixed layer, was calculated according to $I = I_0[1 - \exp(-K_e z)]/K_e z$, where I is mean mixed-layer irradiance (PAR), I_0 is the subsurface PAR, K_e is the vertical light attenuation coefficient (m^{-1}), and z is the depth of the upper mixed layer. Dilution rate is the mean growth rate of the SF_6-labeled patch over the duration of each FeAX. Each property is expressed volumetrically but can readily be converted to a column integral by using the data on mixed-layer depth (MLD). Terms prefixed with a delta such as ΔDIC denote maximum minus initial concentrations; nc, no significant change (relative to the surrounding HNLC waters); blank cells indicate that no data are currently available. The ratio of maximum to minimum primary production is based on column integrals.

Property	IronEX I (*6*)	IronEX II (*30*)	SOIREE (*49*)	EisenEx (*56*)	SEEDS I (*57*)	SOFEX-S (*54, 58*)	SOFEX-N (*58*)	EIFEX (*46*)	SERIES (*17*)	SEEDS II (*59*)	SAGE (*59*)	FeeP (*59*)
Fe added (kg)	450	450	1750	2350	350	1300	1700	2820	490	480	1100	1840
Temperature (°C)	23	25	2	3 to 4	11	−1	5	4 to 5	13	9 to 12	11.8	21
Season	Fall	Summer	Summer	Spring	Summer	Summer	Summer	Summer	Summer	Summer	Fall	Spring
Light climate (μmol quanta m^{-2} s^{-1})	254 (max) to 230 (min)	216 to 108	59 to 33	82 to 40	178 to 39	103 to 62	125 to 74		173 to 73		59 to 52	
Dilution rate (day^{-1})	0.27	0.18	0.07	0.04 to 0.43	0.05	0.08	0.1		0.07 to 0.16			0.4
Chlorophyll, $t = 0$ (mg m^{-3})	0.2	0.2	0.2	0.5	0.9	0.2	0.3	0.6	0.4	0.8	0.6	0.04
Chlorophyll, maximum (mg m^{-3})	0.6	3.3	2.3	2.8	23.0	2.5	2.4	3.0	5.5	2.4	1.3	0.07
MLD (m)	35	40*	65*	80*	13	35	45	100	30*	30	70*	30*
Bloom phase (duration, days)	Evolving (5) subducted	Decline (17)	Evolving (13)	Evolving (21)	Evolving (10)	Evolving (28)	Evolving (27) subducted	Partial decline, evolving (37)	Decline (25)	Evolving (25)	No bloom (17)	No bloom (7)
δDIC (mmol m^{-3})	6	26	17	14	58	21	13		36		nc	<1
δDMS (μmol m^{-3})	0.8	1.8	2.9	1.3, then to 0†	nc	nc	Increased		8.5, then to −5.7†	nc	nc	nc
Dominant phytoplankton	Mixed	Diatom	Diatom	Diatom	Diatom	Diatom	Mixed	Diatom	Diatom	Mixed	Mixed	*Cyanobacteria Prochlorococcus*
Export	nc	increase	nc	nc	nc	Increase	Increase§	Increase	Increase	nc	nc	
Mesozooplankton stocks	Increase‡	Increase	nc	nc	nc	nc	nc	Increase	Increase	Increase	nc	nc
Primary production (max/min ratio)	4	6	9	4	4	6	10	2	10		2	1.7

*Changes in MLD were observed during the study; the maximum MLD is shown (for initial MLD, see table S1). †An initial increase in DMS concentration followed by a decline by the end of the study. ‡Based on anecdotal evidence. §Increased export was mainly associated with a subduction event.

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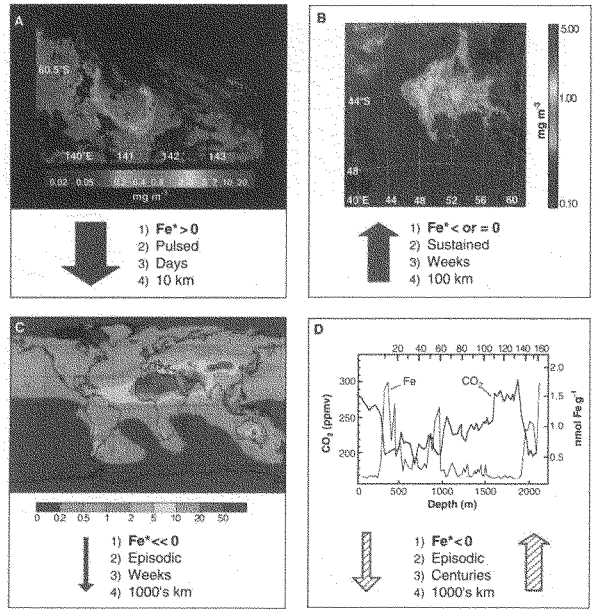


Fig. 2. A comparison for Southern Ocean waters of mechanisms responsible for perturbations in Fe supply. Numbers in each panel: 1) Fe*, the relative magnitude of Fe supply relative to macronutrient supply (*36*); 2) the mode of Fe supply; 3) the time scale over which surface waters receive increased Fe supply; and 4) the length scales of Fe supply events. **(A)** Satellite image of a purposeful in situ Southern Ocean FeAX [SOIREE (*49*)]. **(B)** An FeNX near Crozet within the HNLC Southern Ocean, where naturally occurring blooms are evident from remote sensing (*9*). **(C)** An atmospheric dust deposition event (dust units are g m^{-2} $year^{-1}$) in the modern Southern Ocean [e.g., from Patagonia (*25*)]. **(D)** Fe supply to the Southern Ocean during the glacial maxima from direct [i.e., higher dust deposition (*1*, *39*)] and/or indirect [i.e., upwelling of waters with higher Fe concentrations (*40*)] sources. The magnitude of this supply is unknown; hence, Fe* is expressed as < 0. Fe* is defined as Fe* = [Fe] − {(Fe/P) algal uptake ratio × [PO_4^{3-}]} (*36*). If Fe* > 0, primary production is ultimately macronutrient-limited; if Fe* < 0, production is ultimately Fe-limited. The width of red arrows denotes the relative magnitude of changes in Fe supply; the hatched arrows in (D) denote uncertainties about whether Fe supply in the geological past was episodic or sustained (see text). In (B) to (D), downward- and upward-pointing arrows represent atmospheric and oceanic (upwelling) supply, respectively. Consideration of Fe chemistry for each of these modes of supply is beyond the scope of this review, but see (*22*).

analogous to episodic dust events, the total Fe supplied in FeAXs is much larger, and Fe solubility is greater than from dust deposition [(*7*); see also (*31*)]. Also, there is little evidence of blooms (i.e., >1 mg chlorophyll m^{-3}) after episodic dust deposition into both HNLC (*37*) and low nutrient–low chlorophyll (LNLC) waters (*38*).

During the glacial maxima, increases in Fe supply are evident over a time scale of centuries (*1*). Aerosol Fe supply to the Southern Ocean during the glacial maxima was higher than at present by a factor of 10 (*1*, *39*). The magnitude of this supply is potentially comparable to that during FeAXs and FeNXs (Fig. 2). However, there are uncertainties about the mode of Fe supply during glacial maxima. Supply was either episodic and localized from dust storms [e.g., Patagonia (*39*)] and/or sustained and global, being driven by Southern Ocean upwelling and oceanic circulation (*40*) in conjunction with global dust deposition as the main Fe source (*14*). A major unknown in the geological past is the fate of Fe incorporated into phytoplankton blooms. Was dust-mediated Fe supply lost to the deep ocean as declining blooms sank [as aggregates (*23*)], or was it efficiently recycled by biota in the subsurface ocean and subsequently upwelled? Uncertainty over the fate of Fe is highlighted by comparing two modeling studies. They indicate that substantial atmospheric CO_2 drawdown resulted from the routes of high dust deposition with no Fe recycling (*41*) and from lower rates of dust deposition with recycling and subsequent upwelling (*14*). The pulsed Fe supply in FeAXs may therefore be more relevant to a paleo-ocean with episodic dust supply (weeks) and Fe export to the deep ocean, whereas FeNXs are a better proxy if Fe supply was sustained (months) by upwelling and recycling. Comparison of the results of FeAXs and FeNXs via modeling studies will provide insights into how different modes of Fe supply affect oceanic Fe and C biogeochemistry.

Coupled Iron-Carbon Biogeochemistry

The degree to which the biogeochemical Fe and C cycles are linked is central to determining the impact of increased Fe supply on atmospheric CO_2 drawdown and global climate in the geological past. A key parameter is the efficiency of phytoplankton C fixation per unit DFe [i.e., δ(POC formation)/δ(Fe supplied), where POC is particulate organic carbon], as the resulting δPOC export term will set the atmospheric drawdown efficiency [δ(air-sea CO_2 exchange)/δ(POC exported)]. Also, because Fe supply during the geological past was elevated for centuries (Fig. 2D), it is important to determine the fate of C relative to Fe in the upper ocean over longer time scales: Is Fe retained via remineralization in the water column or exported to the sediments? [i.e., δ(DIC remineralized)/δ(Fe remineralized) and δ(POC exported)/δ(PFe exported), where DIC is dissolved inorganic carbon].

There are few published data on Fe/C ratios for particle production, remineralization, or export (Fig. 3). A range of three orders of magnitude in Fe/C molar ratios is evident, which is probably due to the use of different approaches as well as actual differences in C and Fe biogeochemistry. This variability in Fe/C ratios has been

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ascribed to a number of processes, such as differential remineralization of Fe and C on sinking particles [due to processes including scavenging on Fe (*36*, *42*)], which results in increased PFe/POC ratios with depth (Fig. 3). Also, phytoplankton in high-Fe surface waters may take up more Fe per unit of C fixed [i.e., "luxury" Fe uptake (*13*, *43*)], resulting in greater Fe remineralization than C remineralization on sinking particles relative to particles in HNLC waters (*33*). The available data on PFe/POC ratios indicate that settling particles from natural blooms (northeast Atlantic; Fe/C molar ratio 2.7×10^{-4}) and FeAXs (Fe/C molar ratio 3.1×10^{-4} to 2.1×10^{-3}) have higher ratios than those in HNLC waters (Fig. 3). During FeAXs, much of the Fe added is rapidly lost via precipitation and patch dilution (*21*); hence, Fe/C ratios from FeAXs will be overestimated by a factor of more than 2 (Fig. 3). Moreover, the time scales of FeAXs do not permit the fate of Fe (recycled or exported) initially added to the mixed layer to be assessed (*44*), and hence the ultimate efficiency of (Fe added):(C sequestered to depth) cannot be determined. Thus, upscaling the Fe:C stoichiometry from FeAXs to greater spatial and temporal scales is not currently recommended.

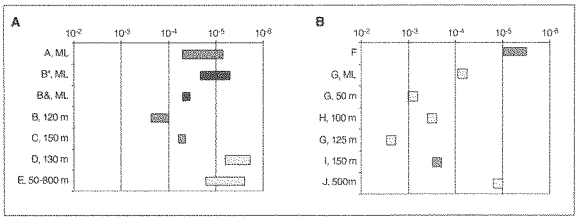


Fig. 3. Summary of published Fe/C molar ratios (on a log scale) from **(A)** low-Fe HNLC waters and **(B)** high-Fe waters and FeAXs (FeAXs denoted by hatched bars). Ratios were obtained from a range of sources: mixed-layer phytoplankton (green), suspended biogenic particles (red), sinking biogenic particles (brown), and remineralization of particles inferred from dissolved constituents (blue). Symbols in (A): A, Southern Ocean (*50*); B, subantarctic (*42*); C, subarctic Pacific (*51*, *52*); D, northeast Pacific (*1*); E, the low-Fe North Atlantic (*43*); ML, surface mixed-layer samples; *, biogenic Fe only; &, lithogenic and biogenic Fe. Symbols in (B): F, a ratio from an Fe-replete algal culture (*53*); G, SERIES (*17*); H, SOFEX-S (*54*); I, the northeast Atlantic (*51*); J, the high-Fe North Atlantic (*33*). The ratios were derived from a wide range of approaches including algal lab cultures (*53*), sediment traps (*42*), vertical nutrient profiles in HNLC waters (*1*), and particle regeneration from apparent oxygen use versus DFe (*33*, *43*). Assessing the bioavailability of Fe (*22*) is a confounding factor in estimating Fe:C ratios, over and above the effect of patch dilution in FeAXs on the fate of the added Fe. The Fe/C ratios derived from FeAXs in (B) are (Fe added):(C exported) and assume that the Fe term is the total amount of Fe added, which may overestimate this ratio by 100% or more (*21*, *55*).

Second, although the mode of Fe supply is important (Fig. 2), the factors that influence the availability of the Fe supplied to the biota are critical. We hypothesize that the magnitude of the Fe available to the biota will be determined by the mode of Fe supply and in particular by the subsequent mobilization and retention of this Fe by upper-ocean processes. For aeolian Fe supply, these processes include aerosol Fe mixed-layer residence time (*32*), photochemistry, FeBL concentrations (*25*) and their joint impact on aerosol dissolution, and the ability of bacteria to access lithogenic PFe (*42*). The bioavailability of Fe supplied from upwelling may be influenced by processes such as photochemistry or by the concentration and binding strength of the upwelled Fe and FeBL relative to those in the surface mixed layer.

Regarding the issue of Fe and C biogeochemistry, we offer a third hypothesis: that the addition to magnitude, the stoichiometry of macronutrient and Fe supply to HNLC surface waters is equally critical in determining whether blooms are transient (weeks) or sustained (months). This in turn will dictate the planktonic community that develops and the subsequent biogeochemical balance between Fe recycling within, and export from, the surface mixed layer.

The Future: Key Questions and Approaches

Key findings from FeAXs offer insights for modelers, although a limited number of these findings can be extrapolated directly to regional and seasonal scales for Fe enrichment. Such limited extrapolation relates to limitations in the FeAX design (*7*) and to uncertainties in our understanding of Fe biogeochemistry in the paleo-ocean. Key questions center around the issues of macronutrient use, ecosystem responses, modes of Fe supply, and coupling of Fe-C biogeochemical cycles, for which we propose three hypotheses.

First, with respect to macronutrient uptake and ecosystem dynamics, we hypothesize that in relative importance of the processes that set particulate Fe/C ratios and their controlling factors will vary both regionally and seasonally. These processes, which will dictate Fe and C export, include algal Fe uptake and the differential rates of particle remineralization for Fe and C in surface and subsurface waters. Each of these, in turn, will be determined by a range of factors such as DFe concentration [algal Fe uptake (*43*)], food web structure and grazing activity [remineralization rates (*45*)], and particle properties and transformations including sinking rate or scavenging [export efficiency (*36*, *42*)].

Testing these hypotheses will require both specific and multistranded approaches that link FeAXs, FeNXs, and biogeochemical Fe and C studies in a range of locales. Three are advocated:

1) Modeling studies to apply our improved understanding of Fe biogeochemistry in the modern ocean to the geological past. Model simulations should also capitalize on the complementary approaches offered by FeAXs and FeNXs into how pulsed versus sustained Fe supply affects ecosystem dynamics and biogeochemistry.

2) Improved experimental designs to overcome the limitations of FeAXs, such as smaller and more frequent Fe doses, greater patch length scale (>>10 km), and additional measurements that provide insight into the impact of Fe enrichment on climate (e.g., biogenic gases) or Fe cycling (e.g., fate of Fe). Detailed comparison of the biogeochemistry of differing FeNXs would help us understand better the influence of a range of Fe:macronutrient stoichiometries on bloom dynamics and C biogeochemistry. Such experiments require application of both existing [aircraft, laser imaging detection and ranging (*46*)] and new [gliders, sensor arrays (*47*)] technologies, and should be linked to regional circulation models with embedded biogeochemistry. The utility of shipboard Fe enrichments to study algal physiology in detail should not be overlooked (*15*).

3) Biogeochemical studies to jointly measure key properties in the Fe and C cycles, such as Fe/C ratios and FeBL concentrations associated with particle transformations, will require specific investigation of end members—HNLC, LNLC, and high-Fe waters in coastal and offshore waters. These, in conjunction with the improved experimental designs described above, will provide insights into temporal and spatial controls on Fe/C ratios in both high- and low-Fe regimes.

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References and Notes

1. J. H. Martin, *Paleoceanagraphy* **5**, 1 (1990).
2. J. H. Martin, R. M. Gordon, S. E. Fitzwater, *Limnol. Oceanogr.* **36**, 1793 (1991).
3. D. M. Sigman, E. A. Boyle, *Nature* **407**, 859 (2000).
4. S. W. Chisholm, F. M. M. Morel, *Limnol. Oceanogr.* **36**, 1507 (1991).
5. A. Watson, P. Liss, R. Duce, *Limnol. Oceanogr.* **36**, 1960 (1991).
6. J. H. Martin *et al.*, *Nature* **371**, 123 (1994).
7. The design of FeAXs has involved single or multiple infusion (time scale of days) of iron, as a salt dissolved in acidified seawater, and concurrent addition(s) of SF_6 to the surface mixed layer of initial areal extent (50 to 225 km^2). The use of the SF_6 conservative tracer was essential to track this mesoscale region of iron-enriched surface ocean and avoids the uncertainty imposed by fixed-point sampling in Eulerian studies. This design (in particular the amount of Fe added) has changed little between FeAXs because of the need to ensure a large measurable biogeochemical signal during a relatively short period in a logistically challenging and dynamic environment.
8. H. J. W. de Baar *et al.*, *J. Geophys. Res.* **110**, C09S16 (2005) and references therein.
9. FeNXs have examined naturally occurring blooms within HNLC waters near the Galapagos [see (*4*)], within the Antarctic Circumpolar Current (*8*), and recently near the Southern Ocean islands Crozet and Kerguelen, where the studies Crozex (Crozet Circulation, Iron Fertilization and Export Production Experiment) and KEOPS (Kerguelen: Etude Comparée de l'Océan et du Plateau en Surface et Subsurface) took place from November 2004 to January 2005 and during January and February 2005, respectively (*8*).
10. K. Banse, *Limnol. Oceanogr.* **36**, 1886 (1991).
11. G. B. Mitchell, E. A. Brody, O. Holm-Hansen, C. McClain, J. Bishop, *Limnol. Oceanogr.* **36**, 1662 (1991).
12. The model in (*11*) was based on an adaptation of Sverdrup's critical depth theory (i.e., the relationship between the respective depths of the mixed and euphotic zones) for Southern Ocean waters.
13. M. T. Maldonado *et al.*, *Limnol. Oceanogr.* **46**, 1802 (2001).
14. A. J. Watson, D. C. E. Bakker, A. J. Ridgewell, P. W. Boyd, C. S. Law, *Nature* **407**, 730 (2000).
15. D. A. Hutchins, K. W. Bruland, *Nature* **393**, 561 (1998).
16. W. O. Smith Jr., R. F. Andreson, J. K. Moore, L. A. Codispoti, J. M. Morrison, *Deep Sea Res. II* **47**, 3073 (2000).
17. P. W. Boyd *et al.*, *Limnol. Oceanogr.* **50**, 1872 (2005).
18. K. O. Buesseler *et al.*, *Deep Sea Res. II* **50**, 579 (2003).
19. F. M. M. Morel, J. G. Reuter, N. M. Price, *Oceanography* **4**, 56 (1990).
20. P. W. Boyd, S. Doney, in *Ocean Biogeochemistry—The Role of the Ocean Carbon Cycle in Global Change (IGOS)*, M. J. R. Fasham, Ed. (Springer-Verlag, Berlin, 2003), pp. 157–187.
21. A. R. Bowie *et al.*, *Deep Sea Res. II* **47**, 1708 (2001).
22. M. L. Wells, *Mar. Chem.* **82**, 101 (2003).
23. P.W. Boyd, G. A. Jackson, A. M. Waite, *Geophys. Res. Lett.* **29**, 10.1029/2001GL014210 (2002).
24. Y. Le Clainche *et al.*, *J. Geophys. Res.* **111**, C01011 (2005).
25. T. D. Jickells *et al.*, *Science* **308**, 67 (2005).
26. K. Lochte, H. W. Ducklow, M. J. R. Fasham, C. Stienen, *Deep Sea Res. II* **40**, 91 (1993).
27. A. Abelmann, R. Gersonde, G. Cortese, G. Kuhn, V. Smetacek, *Paleoceanagraphy* **21**, PA1013 (2006).
28. D. A. Hutchins, W. X. Wang, N. S. Fisher, *Limnol. Oceanogr.* **40**, 989 (1995).
29. B. W. Frost, *Nature* **383**, 475 (1996).
30. K. H. Coale, *Nature* **383**, 495 (1996).
31. A. R. Baker, T. D. Jickells, M. Witt, K. L. Linge, *Mar. Chem.* **98**, 43 (2006).
32. T. D. Jickells, *Mar. Chem.* **68**, 5 (1999).
33. B. A. Bergquist, E. A. Boyle, *Global Biogeochem. Cycles* **20**, GB1015 (2006).
34. J. Wu, E. Boyle, W. Sunda, L.-S. Wen, *Science* **292**, 847 (2001).
35. K. Johnson *et al.*, *Eos* **86** (Ocean Sci. Meet. Suppl.), abstract OS11N-02 (2006).
36. P. Parekh, M. J. Follows, E. A. Boyle, *Global Biogeochem. Cycles* **19**, GB2020 (2005).
37. J. K. B. Bishop, R. E. Davis, J. T. Sherman, *Science* **298**, 817 (2003).
38. K. S. Johnson *et al.*, *Global Biogeochem. Cycles* **17**, 10.1029/2002GB002004 (2003).
39. E. W. Wolff *et al.*, *Nature* **440**, 10.1038/nature04614 (2006).
40. N. Lefevre, A. J. Watson, *Global Biogeochem. Cycles* **13**, 727 (1999).
41. L. Bopp, K. E. Kohfeld, C. Le Quéré, O. Aumont, *Paleoceanography* **18**, 10.1029/2002PA000810 (2003).
42. R. D. Frew *et al.*, *Global Biogeochem. Cycles* **20**, 10.1029/2005GB002558 (2006).
43. W. G. Sunda, *Mar. Chem.* **57**, 169 (1997).
44. A. Gnanadesikan, J. L. Sarmiento, R. D. Slater, *Global Biogeochem. Cycles* **17**, 10.1029/2002GB001940 (2003).
45. R. Strzepek *et al.*, *Global Biogeochem. Cycles* **20**, 10.1029/2005GB002490 (2006).
46. L. J. Hoffmann, I. Peeken, K. Lochte, P. Assmy, M. Veldhuis, *Limnol. Oceanogr.* **51**, 1217 (2006).
47. J. Bell, J. Betts, E. Boyle, *Deep Sea Res. I* **49**, 2103 (2002).
48. H. E. Garcia, R. A. Locarnini, T. P. Boyer, J. I. Antonov, in *World Ocean Atlas 2005, vol. 4, Nutrients*, S. Levitus, Ed. (U.S. Government Printing Office, Washington, DC, 2006).
49. P. W. Boyd *et al.*, *Nature* **407**, 695 (2000).
50. B. S. Twining, S. B. Baines, N. S. Fisher, *Limnol. Oceanogr.* **49**, 2115 (2004).
51. J. H. Martin, S. E. Fitzwater, R. M. Gordon, C. N. Hunter, S. J. Tanner, *Deep Sea Res. II* **40**, 115 (1993).
52. P. W. Boyd *et al.*, *Deep Sea Res. II* **46**, 2761 (1999).
53. W. G. Sunda, S. A. Huntsman, *Mar. Chem.* **50**, 189 (1995).
54. K. O. Buesseler, J. E. Andrews, S. M. Pike, M. A. Charette, *Science* **304**, 414 (2004) doi:10.1126/science.1086895
55. P. Boyd, unpublished data from SERIES.
56. F. Gervais, U. Riebesell, M. Y. Gorbunov, *Limnol. Oceanogr.* **47**, 1324 (2002).
57. S. Takeda, A. Tsuda, *Prog. Oceanogr.* **64**, 95 (2004).
58. K. H. Coale *et al.*, *Science* **304**, 408 (2004).
59. SEEDS II took place in July 2004, SAGE in March–April 2004, and FeeP in May 2004. For more details, contact tsuda@ori.u-tokyo.ac.japan, m.harvey@niwa.co.nz, and njpo@pml.ac.uk, respectively.
60. The workshop "A Synthesis of Mesoscale Iron-Enrichments," held in Wellington in November 2005, was supported by the Surface Ocean–Lower Atmosphere Study, NSF, NIWA, the New Zealand Royal Society, the UK Royal Society, Belgian Federal Science Policy, and the Natural Sciences and Engineering Research Council of Canada. We thank E. McKay and K. Richardson for the graphics, and two anonymous reviewers for their helpful comments and insights. This manuscript is dedicated to the memory of R.B.

Supporting Online Material

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Tables S1 to S3
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NASA: Ocean Plant Life Slows Down and Absorbs Less Carbon

Top Story : September 16, 2003

Plant life in the world's oceans has become less productive since the early 1980s, absorbing less carbon, which may in turn impact the Earth's carbon cycle, according to a study that combines NASA satellite data with NOAA surface observations of marine plants.

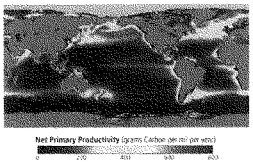


Image 1: Distributions of Ocean Primary Productivity (1997-2002)

The image shows ocean net primary productivity distributions from the Sea-viewing Wide Field-of-view Sensor (SeaWiFS) data on the OrbView-2 satellite (1997-2002). The units are in grams of Carbon per meter squared per year. Light gray areas indicate missing data. Credit: Images by Robert Simmon, GSFC Earth Observatory, based on data provided by Watson Gregg, NASA.

Microscopic ocean plants called phytoplankton account for about half the transfer of carbon dioxide (CO2) from the environment into plant cells by photosynthesis. Land plants pull in the other half. In the atmosphere, CO2 is a heattrapping greenhouse gas. Watson Gregg, a NASA GSFC researcher and lead author of the study, finds that the oceans' net primary productivity (NPP) has declined more than 6 percent globally over the last two decades, possibly as a result of climatic changes. NPP is the rate at which plant cells take in CO2 during photosynthesis from sunlight, using the carbon for growth. The NASA funded study appears in a recent issue of Geophysical Research Letters.

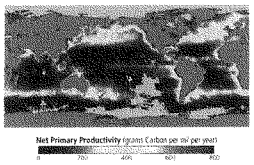


Image 2: Distributions of Ocean Primary Productivity (1979-1986)

The image shows ocean net primary productivity distributions from the Coastal Zone Color Scanner (CZCS) aboard NASA's Nimbus-7 Satellite (1979-1986). The units are in grams of Carbon per meter squared per year. Light gray areas indicate missing data. Credit: Images by Robert Simmon, NASA GSFC Earth Observatory, based on data provided by Watson Gregg, NASA GSFC.

"This research shows ocean primary productivity is declining, and it may be a result of climate changes such as increased temperatures and decreased iron deposition into parts of the oceans. This has major implications for the global carbon cycle," Gregg said. Iron from trans-continental dust clouds is an important nutrient for phytoplankton, and when lacking can keep populations from growing. Gregg and colleagues used two datasets from NASA satellites: one from the Coastal Zone Color Scanner aboard NASA's Nimbus- 7 satellite (1979-1986); and another from Sea-viewing Wide Field-of-view Sensor data on the OrbView-2 satellite (1997- 2002).

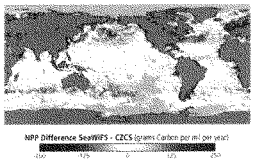
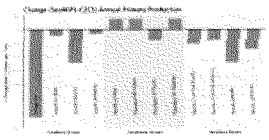


Image 3: Difference in Distributions of Ocean Primary Productivity between 1997-2002 and 1979-1986 Data

The image shows the difference in ocean net primary productivity between the SeaWiFS era (1997-2002) and the CZCS era (1979-1986). To obtain the differences, the CZCS results were subtracted from the SeaWiFS results. The units are in grams of Carbon per meter squared per year. Light gray areas indicate missing data. Credit: Images by Robert Simmon, NASA GSFC Earth Observatory, based on data provided by Watson Gregg, NASA GSFC.

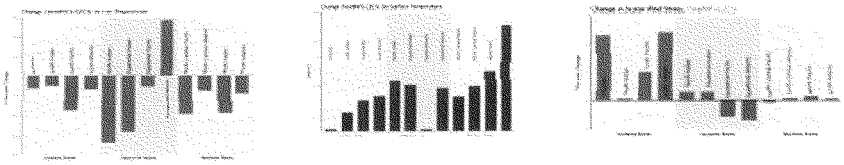
The satellites monitor the green pigment in plants, or chlorophyll, which leads to estimates of phytoplankton amounts. The older data was reanalyzed to conform to modern standards, which helped make the two data records consistent with each other. The sets were blended with surface data from NOAA research vessels and buoys to reduce errors in the satellite records and to create an improved estimate of NPP.
The authors found nearly 70 percent of the NPP global decline per decade occurred in the high latitudes (above 30 degrees). In the North Pacific and North Atlantic basins, phytoplankton bloom rapidly in high concentrations in spring, leading to shorter, more intense lifecycles. In these areas, plankton quickly dies and can sink to the ocean floor, creating a potential pathway of carbon from the atmosphere into the deep ocean.



Images 4a-d: Differences between the SeaWIFS (1997- 2002) Data and the CZCS (1979-1986) Data in the 12 Oceanographic Basins

These graphs show differences between the 1980s and 1990s for a number of ocean variables that impact phytoplankton production as well as annual primary production of marine plant life. To obtain the differences, the CZCS results were subtracted from the SeaWiFS results. Image 4a: Change in annual primary

production in petagrams of Carbon per year. Image 4b: Change in iron deposition in percentages. Image 4c: Change in sea surface temperature in degrees Celsius. Image 4d: Change in mean wind stress on the oceans' surfaces in percentages. Credit: Images by Robert Simmon, NASA GSFC Earth Observatory, based on data provided by Watson Gregg, NASA GSFC.



In the high latitudes, rates of plankton growth declined by 7 percent in the North Atlantic basin, 9 percent in the North Pacific basin, and 10 percent in the Antarctic basin when comparing the 1980s dataset with the late 1990s observations. The decline in global ocean NPP corresponds with an increase in global sea surface temperatures of 0.36 degrees Fahrenheit (F) (0.2 degrees Celsius (C)) over the last 20 years. Warmer water creates more distinct ocean layers and limits mixing of deeper nutrient-rich cooler water with warmer surface water. The lack of rising nutrients keeps phytoplankton growth in check at the surface.

The North Atlantic and North Pacific experienced major increases in sea surface temperatures: 0.7 degrees C (1.26 F) and 0.4 degrees C (0.72 F) respectively. In the Antarctic, there was less warming, but lower NPP was associated with increased surface winds. These winds caused plankton to mix downward, cutting exposure to sunlight.

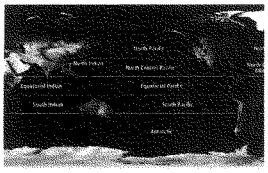


Image 5: Major Ocean Basins

Credit: Images by Robert Simmon, NASA GSFC Earth Observatory, based on data provided by Watson Gregg, NASA GSFC.

Also, the amount of iron deposited from desert dust clouds into the global oceans decreased by 25 percent over two decades. These dust clouds blow across the oceans. Reductions in NPP in the South Pacific were associated with a 35 percent decline in atmospheric iron deposition.
"These results illustrate the complexities of climate change, since there may be one or more processes, such as changes in temperature and the intensity of winds, influencing how much carbon dioxide is taken up by photosynthesis in the oceans," said co-author Margarita Conkright, a scientist at NOAA's National Oceanographic Data Center, Silver Spring, Md.



Image 6: Animation of Changes in Ocean Primary Productivity (1997-2002)

This animation depicts monthly changes in ocean net primary productivity from the Sea-viewing Wide Field-of-view Sensor (SeaWiFS) data on the OrbView-2 satellite (1997-2002). The units are in grams of Carbon per meter squared per year. Light gray areas indicate missing data. Credit: Images by Robert Simmon, NASA GSFC Earth Observatory, based on data provided by Watson Gregg, NASA GSFC.

Other recent NASA findings have shown land cover on Earth has actually been greening. For information and images, visit: http://www.nasa.gov/home/hqnews/2003/jun/HQ_03182_green_garden.html

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National Aeronautics and Space Administration

Find this article at www.nasa.gov/centers/goddard/news/topstory/2003/0815oceancarbon.html

The CHAIRMAN. Thank you, Mr. George, very much.

Our final witness is Mr. Thomas Boucher. He is the President and CEO, and one of the co-founders of NativeEnergy, one of the country's leading voluntary offset providers. NativeEnergy is a Native-American owned company that generates offsets primarily from renewable energy projects, many of them located in Native-American communities. NativeEnergy has provided offsets for a number of prominent companies and events, including the recent Live Earth Concerts, and the movie, "An Inconvenient Truth".

Thank you so much for being here, Mr. Boucher. Whenever you're ready, please begin.

STATEMENT OF THOMAS BOUCHER, PRESIDENT AND CEO, NATIVEENERGY LLC

Mr. BOUCHER. Thank you, Mr. Chairman, and members of the Committee for allowing us to be here today, and share a bit of what we do.

We have been a leader in the emerging voluntary carbon offsets market over the past six years. And in that time, building a business and the critical relationships with partners to make that happen. We are a privately-held company, and in 2005, did become majority-owned by a Native-American interest. And we have found, actually, their long-term perspective on the environment and beyond to be very helpful in this regard.

The formation of this Committee, the number of global warming bills now being entertained demonstrate the timeliness of our actions on combating global warming pollution. And NativeEnergy is very proud of providing and promoting high-quality offsets to this new marketplace.

My written testimony provides detailed answers to the four specific questions that were posed, and what I'll do here is simply briefly cover the items in that written testimony.

As I said, we've been a pioneer and active participant in the U.S. voluntary carbon offsets and renewable energy credits market for over six years. We market renewable energy credits as green power, and we also turn to renewable-based offsets, and other carbon offsets from wind, biomass, solar, and agricultural methane abatement.

To date, we have enabled 25 new renewable energy generation projects that depended on the voluntary market to be implemented. All of these projects are owned and operated by Native-American tribes, Alaska Native villages, family farmers, communities, and are provided distributed generation to enhance grid reliability, help build sustainable local economies, and increase energy security.

Although our early growth was what you might call painfully slow, growing public awareness through events, such as Live Earth, through films like, "An Inconvenient Truth", and simply the catastrophic weather events that have occurred over the last few years have really promoted action now.

We have an expanding staff of more than 20 employees and consultants, and are expecting to market and sell this year more offsets than all our prior years combined.

Our customers and business partners include individuals and households throughout the U.S., and really around the world, in-

clude small businesses and NGOs, regional and multi-national corporations and NGOs.

We employ two principal business models for purchasing and selling carbon offsets. As most marketers do, we do sell carbon offsets generated in the year they are produced. We also designed a forward-stream model. This enables our customers to directly fund new projects that come on line as part of an up front one-time payment to the projects. Most of our customers prefer this forward-stream model. It provides the project the financial equivalent of long-term revenues, it can help small and mid-sized projects overcome their lack of economy of scale, as what occurs here is a one-time transaction for a 10 to 25 year sales volume.

It enables customers to match their share of the expected carbon offsets from these projects with their own carbon footprint. In that way, they can be associated with a specific new project that they can help build each year.

We ensure the environmental integrity of the offsets we sell in two principal ways. We sell offsets from renewable energy projects, we are confident do not have significant adverse environmental impact. And we sell offsets from projects that demonstrate additionality, in accordance with the United Nations Framework Convention on climate change, tool for the assessment and demonstration of additionality. We believe the overall environmental quality of the offsets being sold into the voluntary market is good.

In our experience, most carbon offset marketers are well aware and follow the principles set forth in the Consumer Protection and Unfair Trade Practices law, and various environmental marketing guidelines. These provide adequate protection, but there's further protection provided by non-profit certifying organizations, whose standards are developed through open stakeholder processes.

Voluntary offset market does not, at this point, need government regulation, and we don't believe it would benefit from it significantly. You see the market improving in quality through the availability and use of third-party certification, and the competitive forces.

The voluntary market has provided leadership in the United States, demonstrating how carbon offsetting works, how easy and cost-effective it can be. And in the European Union, a vibrant voluntary market has complemented the mandatory cap and trade system in place known as the Kyoto Protocol. We expect this to be the case in a future cap and trade regime here in the U.S.

However large the voluntary offset market becomes, it is much more than tons of carbon avoided and offset. It's about engaging people. The voluntary market gives ordinary individuals and businesses a genuine and effective way to take a significant step to address their contribution to global warming. Thank you.

[The prepared statement of Thomas Boucher follows:]

WRITTEN TESTIMONY OF

THOMAS C. BOUCHER

PRESIDENT & CEO

***NATIVE*ENERGY, LLC**

BEFORE THE

SELECT COMMITTEE ON ENERGY INDEPENDENCE AND GLOBAL WARMING

UNITED STATES HOUSE OF REPRESENTATIVES

JULY 18, 2007

Thank you Mr. Chairman and members of the committee for the opportunity to provide this testimony to the Select Committee on Energy Independence and Global Warming. As a leader in the emerging voluntary carbon offsets market, NativeEnergy has been building both a business model and critical relationships with our business and NGO partners since 2000 – building upon previous in-market experience of our founders and staff.

We became Native American majority-owned in 2005 through a structure that complements our interests in helping tribes expand from hosting wind farms to entering the retail market for the renewable power that their vast wind resources can produce. We have found that we have much to learn from our tribal partners' long term perspective.

The formation of this very committee, and the number of global warming-related bills now being considered, all demonstrate the importance and timeliness of our actions on combating global warming pollution. NativeEnergy is proud of its role in providing high quality carbon offsets for and in our pioneering work expanding the voluntary carbon offsets market.

We have recently worked with Congressman Welch to identify his offices' carbon footprint and to provide him quality carbon offsets to complement energy efficiency measures he has also undertaken. The recent decision by Congress to reduce and offset the capitol's contribution to global warming pollution is one more demonstration of the voluntary market at work.

The testimony provided below responds to the questions posed in the letter we received inviting our testimony.

1. What is the nature and scope of your company's business in the voluntary carbon offset market" Specifically, what kinds of projects does your company undertake, what is your business model for selling offsets, and what is the magnitude of your offset business?

NativeEnergy has been an active participant in the voluntary carbon offsets and renewable energy credit (REC) market for six years. We market RECs as a green power option, and REC-based offsets and other carbon offsets from wind, biomass, solar, and agricultural

methane abatement.. To date, we have enabled 25 new renewable energy generation and other offset projects that depended on the voluntary market to be implemented and operate successfully. All of these projects are owned and operated by Indian tribes, Alaska Native Villages, family farmers and local communities and businesses, providing distributed generation to enhance grid reliability, help build sustainable economies, and increase energy security.

We launched operations early in the development of the U.S. voluntary market, and our early growth was slow. More recently, with growing public awareness of global warming (recent Live Earth concerts being a prime example), catastrophic weather events, and the release of the film "An Inconvenient Truth," the carbon offset market has grown dramatically. We and our affiliate, NativeEnergy Travel Offsets, LLC, together now have an expanding staff of more than twenty employees and consultants, and are expecting to market and sell this year more offsets than in all prior years combined, with cumulative sales exceeding 1 million tons. Our customers and business partners range from individuals and households throughout the U.S. and around the world, small businesses and NGOs, and large regional and multi-national corporations and NGOs.

We employ two principal business models for purchasing and selling carbon offsets. As most marketers do, we sell carbon offsets generated in the year produced by operating projects. This model helps projects that are dependent on annual offset revenues.

We also employ our patent-pending business model that we developed to address certain critical failures of the voluntary market that are inhibiting the implementation of a class of important and valuable projects. We designed our "forward stream" model to enable our customers' purchases to achieve directly the principal goal of the voluntary market – to fund the development of carbon mitigation projects that would not have happened without incremental funding from the voluntary market. Our model reflects the fact that by providing a portion of the incremental funding the project needs, enabling it to be implemented, each customer is thereby "responsible for" a portion of the result – the carbon reductions the project will generate over its operating life.

The problem we faced is that while most offset projects are financed on a long-term basis, and so need the incremental revenues on a long-term basis, most customers will purchase only on a short term basis. To enable short term purchases to bring new projects on line directly, we structured our model so that the customer purchases, and pays up front for, exactly what that customer is "responsible for," namely, a share of the project's long-term offsets output. Our commitment to the project to purchase its long-term output displaces the need for incremental debt or equity, and enables the project to proceed with implementation. Our payment, in a lump sum upon commercial operations, provides the financial equivalent of the incremental revenues the project would otherwise need on a long-term basis, discounted to present value.

Our customers then donate their rights to their forward streams of offsets to a 501(c)(3), Clean Air-Cool Planet, subject to a retirement restriction. Having ensured retirement, the customers claim the estimated quantity of carbon offsets to be generated by their share of the project as offsetting their current year's footprint. We make contingency plans to substitute an alternate project if the initial target project fails in development. To insure against project under-

performance over time, we discount the projects' expected carbon reductions. The effect of this double protection is that projects financed through our forward purchasing and crediting can be expected to perform, on average, at least as well or significantly better than we estimate. Perhaps most important of all, our model enables our customers to help finance "their own" new projects that will produce their offsets.

Our "forward stream" model fixes a market failure, bridging the gap between the projects' long term requirements and the voluntary market customers' short-term requirements. Due to this market failure, any project that truly needs incremental revenues for its offsets must – in the absence of our model – have an investor that is willing to take the risk that the necessary revenues will be forthcoming, or the project will not be implemented. Many potential offset energy projects have no one to take that risk, and are going unbuilt. Those that lack such investors are typically the smaller, distributed projects that we need to implement everywhere across the country, to reduce carbon emissions, to enhance the reliability of our electricity grid, and to provide local economic benefits to our local communities. Typically the multi-national, increasingly foreign-based, corporations that are investing in large-scale renewable energy projects are not interested in these kinds of project. NativeEnergy's model allows farmers, Indian Tribes, and small business to become project owners.

Further details on our forward purchasing and crediting model are provided on Appendix A. Our estimating and discounting methodologies are provided on Appendix B. Appendix C shows the impact our model has from the perspective of a recent community-owned project.

2. What does your company do to ensure the environmental integrity of the offsets you sell, and how would you characterize the overall quality of the offsets being sold into the U.S. voluntary market today?

We ensure the environmental integrity of the offsets we sell in two principal ways: We sell offsets from renewable energy projects that we are confident do not have significant ancillary adverse environmental impact; and we sell offsets from projects that demonstrate additionality in accordance with the United Nations Framework Convention on Climate Change Tool for the Assessment and Demonstration of Additionality. We believe that both are important to environmental integrity, and as a matter of practice, we follow the standards set by WWF Gold Standard.

We believe that the overall environmental quality of the offsets being sold into the voluntary market today is good. In addition, NativeEnergy has confidence that the experts who are overseeing certification standards will continue to bring rigorous judgment to the offset market, which leads to the third question.

3. How can we ensure that individual customers and companies that purchase carbon offsets are getting what they pay for and that offset projects have environmental integrity, with regard to both climate and non-climate effects? Are industry standard-setting initiatives adequate, or is there some role for governmental regulation? If so, what form should regulation take?

In our experience, most carbon offsets marketers are well aware of and follow the principles set forth in the consumer-protection and unfair-trade practices law and various environmental marketing guidelines. These provide an adequate protection. Further protection is provided by non-profit certifying organizations whose standards are developed through open stakeholder processes. While offset marketers and project developers have a voice in the development of such standards, these standards are essentially imposed upon the industry by the environmental NGO community. As occurred with respect to Green-e certification in the green power/REC market, once such standards become available, using them quickly becomes a business imperative for marketers.

The organizations who are actively involved in developing and implementing standards – principally WWF Gold Standard, the Climate Group and the Center for Resource Solutions – have environmental protection as their core mission, and so can be trusted to ensure the environmental integrity of the offsets they certify. Such organizations, as environmentally-focused non-profits, have much more consumer appeal than regulatory agencies. In addition, such organizations have much greater flexibility than regulatory agencies in being able to modify their standards to reflect the innovation that is occurring in this emerging market.

The voluntary offset market does not at this point need government regulation, and neither would it benefit from it significantly. We see the market improving in quality through the availability and use of third party certification, and growing rapidly to the point at which carbon neutrality is the rule among businesses and as commonplace as recycling among households. Given the pace at which certification standards are being developed and embraced by marketers, we expect offset quality to be sound and consumer confidence to be high.

4. What is the future of the voluntary offset market, and how significant a contribution can that market make to mitigation of climate change?

The voluntary market has provided leadership in the U.S. demonstrating how carbon offsetting works, how easy and cost effective it can be, and has provided regulators and legislators a benchmark for considering future mandatory carbon emission reductions. In the E.U., a vibrant voluntary market has complemented the mandatory cap and trade system in place under the Kyoto Protocol, and we expect this to be the case in a future cap and trade regime in the U.S.

Various estimates exist for the size of the voluntary carbon offsets market today. We believe the market is now in the process of moving from tens of millions to hundreds of million tons per year. Each million tons of reductions is equivalent to reducing gasoline consumption by 100 million gallons.

However large the voluntary offset market becomes, it is about much more than tons of carbon avoided and offset. It is about engaging people. The voluntary market gives ordinary individuals and businesses a genuine and effective way to take a significant step to address climate change. As people enter into the market, their actions become an uncommonly forceful form of advocacy. Elected representative will not sit on the sideline when they realize their constituents want them to take action and those constituents are themselves leading the way.

One final point: The biggest threat to the realization of the long-term benefits of the voluntary offset market is the potential for the necessary government regulation of greenhouse gas emissions to undermine well-designed renewable-energy-based offsets. Said simply, government regulation could kill a significant portion of the voluntary offset market unless policymakers take care to align renewable energy and greenhouse gas policies.

Grid connected renewable electricity generators reduce carbon emissions. Every kilowatt-hour delivered to the grid by renewable generators results, on average, in one less kilowatt-hour generated by fossil fuel-powered generators. Most offsets sold today are from renewable electricity projects, and that will likely continue to be the case – Gold Standard, for example, certifies offsets only from renewable energy or energy efficiency projects.

If the U.S. implements a cap and trade regulatory system to reduce greenhouse gas emissions that does not have a mechanism to credit renewable energy generators with the carbon reductions they produce, in a way that enables them to market and sell that credit into the voluntary market, the very foundation of that market will be lost.

A full discussion of the protection of a viable voluntary market for renewable energy in the context of greenhouse gas emissions regulation is beyond the scope of the Committee's request for our testimony. Nevertheless, we would ask that the Committee note the seriousness of this issue for upcoming cap and trade legislation.

I thank the Committee for this opportunity to speak and I look forward to working with you and your colleagues to ensure success in developing market-based approaches as part of a comprehensive plan to address climate change.

Appendix A

*Native*Energy's Forward Stream CO_2 Offsets Model

*Native*Energy's patent-pending business process provides the highest level of "additionality" – bringing upfront payment to renewable projects for their discounted future REC/offset output, enabling our customers to help directly finance the construction of new wind farms and other renewable energy projects with strong social and economic justice value. Here's how it works:

> Show me a wind farm that gets built with just a year or two of its RECs under contract, and I'll show you a wind farm that was going to be built anyway. Investors and lenders look at the long-term revenues, and if the committed power sale revenues aren't enough, a short-term RECs sale won't make a difference.
>
> *Dale Osborn, President*
> *Distributed Generation Systems, Inc.*

Project Selection:

We focus on projects under development that can demonstrate not only that they are "additional" in the sense that their financial success is dependent on revenues from the REC/offsets markets, but also that they cannot depend on the "prospect" of successive annual short-term purchases from that market – i.e., projects that need their REC/offset revenues secured on a long-term basis to get financed and built.

Our Commitment to the Projects:

We commit (by contract) to the project that if it proceeds with development and achieves commercial operations by a specified date, we will purchase and pay for at that time, all of the RECs and/or offsets the project is estimated to generate over a fixed term equal to its conservatively expected project life. In no case do we pay the projects before demonstrated commercial operations, so our customers never lose money to a project that fails in development. Our payment can displace long-term debt or provide a valuable early return on an equity commitment with an otherwise inadequate return. Our commitment to make the payment makes the project pro forma pencil out, and enables financing.

The Projects' Commitment to Us:

The projects commit to use that they will use commercially reasonable efforts to build the project and to cause it to achieve commercial operations by a specified date. Thereafter, the project is obligated to use commercially reasonable efforts to continue operating the project and to maximize its production. Importantly, the project is also independently motivated to do so – while our payment provides a significant amount of financial support (e.g., 15 to 25% of the project cost), the bulk of the return on investment comes from its sale of the generic power over time. Despite this commitment and motivation, the project is not liable to us for underproduction over time. This is another important value we bring o the projects – risk avoidance.

Our Customers' Role:

To finance our purchase from the projects, we sell to our customers capacity-based shares of the projects' estimated long-term REC/offset output. For example, a customer buying 100,000 MWh from us would buy the estimated REC output of a little more than 1.3 MW of a wind farm (assuming a 25 year stream) with an expected net (net of our discounts, see below) capacity factor of 35%. Each of our customers buys a slice of the forward estimated output, and collectively (or individually, with large enough purchases) they buy it all. Our customers then donate their present rights to the future REC/offset output to Clean Air-Cool Planet, for permanent retirement as the RECs/offsets are generated. This has two principal advantages:

- First, for the customers, using up the value of the forward RECs/offsets in the year of purchase, through the donation for retirement, enables them to deduct the cost of the purchase in year one, rather than having to amortize the cost over the generation period;

- Second, it ensures that the renewable energy project supported is never used by a utility to meet minimum renewable portfolio requirements later (many RECs are available cheaply today that are being sold into the market by utilities that have taken long term positions on wind in anticipation of future RPS's, and who are selling off the early years' RECs they have no use for).

Potential for Project Failure:

We commit to our customers that if their project is not built by a specific date, we will use their purchase dollars to help build an alternate project by specific date generally not more than 12 months later, and will provide for them a capacity-based share of its forward output sized to generate their target kWh or offset quantity. If we are unable to do so, we will ultimately supply a firm quantity of RECs or offsets from existing sources equal to their target quantity. We only commit to projects that, after due diligence, appear to have strong prospects (with our financial commitment). We reserve 100% of our cost of goods until the target or alternate project achieves commercial operations, so we can fund the replacement purchase.

Potential for Project Under-Performance:

Each of our customers purchases a share of the project's estimated long-term REC or offset output, which may be more or less than we estimate. Working with the *Natural Resources Defense Council* (NRDC) and the other national and international non-governmental organizations on the Climate Neutral Network's certification board, we developed a model that uses a combination of discounting of the projects' expected future output and conservative assumptions about improvements in the grid emissions profile to self-insure against underproduction risk. This model is intended to overcome

the practical impediments to guaranteeing each project's future output, and to ensure that the projects we help build perform as well or better than we estimate, on average. The effect of spreading the performance risk across all our projects is that each of our customers is entitled to claim the estimated forward REC/offset quantity as offsetting their current year footprint, regardless of the risk associated with their specific project. Details of our discounting and grid improvement methodology are available online at http://www.nativeenergy.com/how_we_calculate.html, or in PDF upon request.

Generation Over Time:

Certainly our customers' RECs/offsets are generated over time. Our forward model, however, is designed to enable the construction of projects that are dependent on forward purchasing and crediting in order to get financed and built. We take the view, as do our customers (including NRDC, the film *An Inconvenient Truth*, and businesses that are the best known leaders in corporate social and environmental responsibility) that the cost of the delay in generation is outweighed by the benefit of those RECs/offsets being generated at all.

Regulatory Risk:

Understanding the regulatory risks associated with forward purchasing requires an understanding of the risks associated with the alternative – purchasing RECs/offsets generated in the year of purchase by existing projects. Once built, most renewable energy or offset projects will generate all of their RECs/offsets whether they are purchased or not. Except in rare cases, purchasing "current-year" RECs/offsets does not increase generation by the projects themselves. Rather, the principal justification for purchasing "current-year" RECs/and offsets is to stimulate demand for and investment in other projects to be built later – projects that will generate their RECs/offsets over their operating lives, and that will be subject to having their RECs diverted to meet utilities' minimum renewable portfolio requirements, or to having their offsets stripped away by inappropriately structured carbon cap-and-trade systems. The projects built with forward purchasing are subject only to the latter of those two risks.

Ultimately, deciding whether forward purchasing is appropriate to meet your GHG reduction goals comes down to a choice (assuming that you do not have the capacity to enter into a long-term purchase contract):

> Do you want to be 100% certain that each and every one of your RECs/offsets will be generated, knowing that each and every one would have been generated regardless of your purchase, or
>
> Are you willing to tolerate some modest and well mitigated uncertainty to know that you made a real contribution to financing the construction of a specific new project that will generate truly incremental RECs/offsets?

Communicating a Forward Purchase:

Talking about a forward purchase involves a few extra words. Our customers generally view that not as a burden, but as an opportunity to demonstrate that they went the extra mile to do it right. Certainly it would be easy to say:

> "We achieved a portion of our greenhouse gas reduction goals by buying RECs from national wind farms. These RECs represent reductions in emissions of approximately 100,000 tons of carbon dioxide[1], the primary contributor to global warming."

But isn't it more powerful and compelling to say:

> "We achieved a portion of our greenhouse gas reduction goals by helping finance the construction of new wind farm under development on the Rosebud Sioux Reservation in South Dakota and a wind turbine on a Midwest family farm. In partnership with *Native*Energy, a Native-owned company, we brought critical up front funding to these clean energy projects by purchasing a share of the RECs they will generate over their operating lives, directly helping enable them to get financed and built. Together, these projects will prevent emissions of an estimated 100,000 tons of carbon dioxide, the primary contributor to global warming. In addition, our purchase is helping build sustainable economies in Native America, and is helping family farmers compete as family farms."

[1] A purchaser could make this claim credibly only if the wind farms possessed the requisite additionality, determined on a case by case basis.

Appendix B

METHODOLOGY FOR FORECASTING LONG-TERM REC GENERATION AND CO_2 AVOIDANCE IMPACTS

GRID CONNECTED WIND PROJECTS

REC Generation

We start with the project's nominal capacity factor based on the project engineer's best estimates of gross generation (e.g., theoretical performance based on wind data and manufacturer's power curves), and apply all discounts recommended by project engineer to account for scheduled and expected unscheduled downtime (maintenance and repair), wind turbulence, blade icing and soiling, and related losses or similar efficiency degradation to arrive at the baseline capacity factor. We require this baseline capacity factor to be consistent with the project pro forma assumptions utilized for the project financing. We then discount the baseline capacity factor by 5% to insure against any further underproduction risk. Our final REC generation estimate is determined in accordance with the following formula:

NGC x 8760 hours/year x DCF x POL

where: NGC = the project's nameplate generating capacity
DCF = the final discounted capacity factor
POL = the project's assumed operating life, which is the shorter of 25 years or the expected equipment operating life, assuming commercially reasonable maintenance, repair and parts replacement for wear and tear.

CO_2 Avoidance

We start with the average fossil CO_2 emissions rate for the applicable power control area based on most recent EGRID data. We then improve the PCA Emissions Rate by 0.8% of the original amount per year over the project's assumed operating life. Beginning with the year in which the then-current EIA Annual Energy Outlook shows planned or unplanned capacity increases of fossil generating capacity in the applicable NERC region, we average the annual improving average fossil rate (which represents the emissions rate for the energy the project will displace) with the emissions rate for the first planned or unplanned fossil generating capacity (which represents the emissions rate of marginal generating units whose generating capacity may theoretically be displaced by the project) to derive our assumed long-term average emissions rate. We then multiply this levelized average emissions rate by the assumed REC generation to determine the expected CO_2 reductions the project will produce over its assumed operating life, and allocate appropriate shares of its generating capacity to each customer.

To get a sense of how conservative this is, for the Rosebud St. Francis Wind Farm actually to displace energy over its operating life at the average rate of 1705 Lbs./MWh rate that we assume, the NERC region average fossil rate would have to improve from 2.37 lbs./kWh in year one to

1.04 lbs./kWh in year 25 ((2.37 + 1.04) / 2 = 1.705). That would require the fossil plants feeding that grid to convert from being about 98% coal fired to being about 98% gas fired within 25 years. The 2005 EIA Annual Energy Outlook predicts that the fossil plants feeding that grid will still be more than 95% coal fired in 2025.

ALASKA DIESEL MICRO-GRID WIND PROJECTS

REC Generation

We start with the project's nominal capacity factor based on the project engineer's best estimates of gross generation (e.g., theoretical performance based on wind data and manufacturer's power curves), and apply all discounts recommended by project engineer to account for scheduled and expected unscheduled downtime (maintenance and repair), wind turbulence, blade icing and soiling, and related losses or similar efficiency degradation to arrive at the baseline capacity factor. We require this baseline capacity factor to be consistent with the project pro forma assumptions utilized for the project financing. We then discount the baseline capacity factor by 5% to insure against any further underproduction risk. Our final REC generation estimate is determined in accordance with the following formula:

NGC x 8760 hours/year x DCF x POL

where: NGC = the project's nameplate generating capacity
DCF = the final discounted capacity factor
POL = the project's assumed operating life, which is the shorter of 25 years or the expected equipment operating life, assuming commercially reasonable maintenance, repair and parts replacement for wear and tear.

CO_2 Avoidance

Based on the fact that these projects are interconnected to 100% diesel powered micro-grids, we assume that each kWh generated by the wind turbines reduces diesel generation by one kWh. Based on information from the project developer, these diesel generators produce 13 kWh for each gallon of diesel fuel they burn. Burning diesel fuel produces 22.3 Lbs. of CO_2 per gallon. As a result, these wind turbines displace 1721 pounds of CO_2 per kWh they generate. To be conservative, we assume that this rate will stay constant over the projects' assumed operating lives (25 years for new Northern Power turbines, 20 years for reconditioned turbines), despite the fact that these grid operators fully expect to be required in the next few years to switch to low sulfur diesel, which produces significantly fewer kWh per gallon (and so is significantly more CO_2 intensive).

GRID CONNECTED FARM METHANE PROJECTS

We help build manure digesters on farms whose baseline practice is to store their manure in storage ponds, where it is kept pending bi-annual or tri-annual spreading on the fields. In these storage ponds, all but the very surface of the manure has no access to oxygen, so bacteria that thrive without oxygen decompose the manure, giving off gases including methane (CH4) as a byproduct, which bubble up and enter the atmosphere. There, methane has 21 times the global warming impact of carbon dioxide. Each 95¼ pounds of methane can be expressed as one ton of CO_2-equivalent, or CO_2e.

The farms we work with install anaerobic digester systems in place of the storage ponds. These are heated (with heat recovered from the generator), airtight systems that accelerate the decomposition and capture the methane, which the farms then burn to generate electricity and useful heat. The digested manure is then pumped from the digester to pre-spread storage lagoons, with virtually no future methane off-gassing. As the CO_2 emissions from burning the methane for electricity and heat are equivalent to the CO_2 that would have been emitted if the manure was put directly onto the fields, the electricity and thermal energy are considered CO_2-neutral. As a result, the farms create three sources of CO_2 or CO_2 reductions:

- Reductions from the displacement of electricity from fossil fuels that results from the farms' generation of electricity and delivery of that electricity to the grid ("Electricity-Based CO_2 Reductions");
- Reductions from the displacement of the farms' use of fossil fuels for heating and cooling needs that results from the farms' capture and use of heat given off by the generators ("Avoided Fossil Fuel CO_2 Reductions"); and
- Reductions from the avoidance, or abatement, of fugitive methane emissions that would have resulted from the farms' continued pond storage of manure that would have occurred in the absence of the digester ("Methane Abatement CO_2e Reductions").

Electricity-Based CO_2 Reductions

REC Generation

We start with the project's nominal capacity factor based on the project engineer's best estimates of gross generation (e.g., theoretical performance based on expected methane generation), and apply all discounts recommended by project engineer to account for scheduled and expected unscheduled downtime (maintenance and repair) and related losses or similar efficiency degradation or losses to arrive at the baseline capacity factor. We require this baseline capacity factor to be consistent with the project pro forma assumptions utilized for the project financing. We then discount the baseline capacity factor by 5% to insure against any further underproduction risk. Our final REC generation estimate is determined in accordance with the following formula:

NGC x 8760 hours/year x DCF x POL

where: NGC = the project's nameplate generating capacity
DCF = the final discounted capacity factor
POL = the project's assumed operating life, which is the shorter of 25 years or the expected equipment operating life, assuming commercially reasonable maintenance, repair and parts replacement for wear and tear.

CO_2 Avoidance

We start with the average fossil CO_2 emissions rate for the applicable power control area based on most recent EGRID data. We then improve the PCA Emissions Rate by 0.8% of the original amount per year over the project's assumed operating life. Beginning with the year in which the then-current EIA Annual Energy Outlook shows planned or unplanned capacity increases of fossil generating capacity in the applicable NERC region, average the annual improving average fossil rate (which represents the emissions rate for the energy the project will displace) with the emissions rate for the first planned or unplanned fossil generating capacity (which represents the emissions rate of marginal generating units whose generating capacity may theoretically be displaced by the project) to derive our assumed long-term average emissions rate. We then multiply this levelized average emissions rate by the assumed REC generation to determine the expected CO_2 reductions the project's electricity will produce over its assumed operating life, and allocate appropriate shares of its generating capacity to each customer. (Note – although the project emits CO_2 when it burns the methane, that CO_2 amount is equivalent to the assumed baseline of field-spreading the manure, so the electricity is assumed to be CO_2-neutral).

Avoided Fossil Fuel CO_2 Reductions

Thermal Energy Generation

For those farm methane projects that utilize waste heat from the electricity generator to reduce their consumption of fossil fuels, we start with the project engineer's best estimates of the BTU's of recoverable and usable thermal energy and apply all discounts recommended by project engineer to account for scheduled and expected unscheduled downtime (maintenance and repair) and related losses or similar efficiency degradation or losses to arrive at the baseline usable thermal energy capacity. We require this baseline thermal energy capacity to be consistent with the project pro forma assumptions utilized for the project financing. We then discount the baseline thermal energy capacity by 5% to insure against any further underproduction risk.

CO_2 Avoidance

We assume a BTU-for-BTU displacement of the kind of fossil fuel (diesel, propane, etc., based on historic purchase records) that will be displaced by the project's thermal energy output, over the project's assumed operating life, and quantify the CO_2 avoidance based on the emissions profile (Lbs. CO_2/btu) of the displaced fuel.

Methane Abatement CO_2e Reductions

The EPA has developed a methodology listed in **U.S. Methane Emissions 1990-2020: Inventories, Projections, and Opportunities for Reductions (EPA 430-R-99-013) (September 1999)** for calculating baseline methane emissions from various manure management systems based on factors presented in the 1996 Revised Intergovernmental Panel on Climate Change (IPCC) Guidelines.

Three principle factors are needed to calculate baseline methane emissions from manure management systems: Quantity of Manure Volatile Solids; Manure Characteristics; and Manure Management System used. IPCC Tier II standards require these factors to be specific to country location and animal type and class. The EPA utilizes USDA data and conversion factors from the Natural Resources Conservation Service (NRCS) and provides criteria by state. The resulting equation in the EPA methodology is:

$$CH_4 = Manure_{ij} * MF_{ijk} * VS_{ij} * Bo_j * MCF_{ijk}, \text{ where:}$$

CH_4 = Methane created at baseline
$Manure_{ij}$ = total manure produced by animal type *j* in state *i*
MF_{ijk} = % of manure managed by system *k* for animal type *j* in state *i*
VS_{ij} = % of manure that is volatile solids for animal type *j* in state *i*
Bo_j = Maximum methane (CH4) potential of manure for animal type *j*
MCF_{ik} = Methane conversion factor for systems *k* in state *i*

We apply the following formula based on information provided by the farms regarding their baseline number of cows, cow types (milkers, heifers, dry cows), feeding practices and manure handling practices, which we confirm through one or more site visits. An example for calculating methane emissions from a liquid/slurry storage system (*k*) for manure from 500 dairy milking cows (*j*) in Pennsylvania (*i*) might look like:

CH_4 = (80lbs manure /1000# animal weight *500 cows@1400lbs/cow) *.4536 kg/lb * 100% in system * .1062 (%VS) * 0.24 m^3 CH_4/kg (Bo) * 0.35 (MCF of liquid/slurry system)

= 226.60 m^3 CH_4/day = 82,710 m^3 CH_4/yr = 181,960 m^3 CH_4*1.4956 lbs/m^3 = 123,701 lbs CH_4/yr

=123,701 lbs CH_4 * 21 GHG factor† = 2,597,722 Lbs CO_2e

= 1298.86 tons CO_2e per year

Note: The Bo factor of 0.24 m^3CH_4 and the MCF of .35 are IPCC Tier 2-developed factors that recognize the existing animal diets for North American livestock and the temperate climate zone of Pennsylvania respectively.

*Native*Energy's methodology refines this base equation by including the average monthly ambient temperature effect, by county location, on the speed of manure decomposition in the lagoon using the van't Hoff-Arrhenius equation from the EPA's 2003 Annex M to calculate the effective MCF:

$f = exp[E*(T2-T1)/(R*T1*T2)]$
where:

f	Conversion efficiency of Vs to CH_4 per month.
E	Activation energy constant (15,175 cal/mol).
T2	Ambient temperature (Kelvin) for the climate, by county (NOAA data).
T1	303.16 (273.16° + 30°) in example of 30° C ambient
R	Ideal gas constant (1.987 cal/ K mol).

Using farm-specific data, we also reflect the tempering effect on fugitive methane production of the daily loading of raw manure into the lagoon and the semi-annual or scheduled unloading for field spreading.

Once we have determined the expected annual CO_2e reductions pursuant to the foregoing, we then apply the following discounts:

- a non-cumulative 5% discount to each year's assumed volume to account for potential methane leakage from the digester
- a cumulative annual 5% discount to the 20-year stream of reductions to account for the potential mainstreaming of the technolog

Appendix C

WRD-2

Ron Howard
Superintendent

January 12, 2007

To Whom It May Concern:

The Wray School District RD2, is a public school that serves 670 students K-12, in a rural community of 2500 people. Over the past six years, Wray has suffered from a decrease in the number of students attending the school and a depressed economy. Recent changes in state school finance formulas, coupled with declining rural populations, have created school budget shortfalls in many schools across Colorado. A few years ago, the District had to cut three quarters of a million dollars out of a 5 million dollar budget. The challenges we face have brought the community together in a "Renew the Spirit" Campaign.

At this time the Wray School District staff was challenged by its superintendent to find new ways to create additional revenue streams for the district, emphasizing projects which would enhance the districts educational experience. Our district spends approximately $80,000 a year on electricity. Our Wray High School Vo-Ag instructor, Jay Clapper, proposed to the district that it consider the construction of a wind turbine. This project would offset the district's annual energy costs and provide a renewable energy educational component to the school's curriculum. The Board of Education agreed to support this idea, and a wind committee, including Mr. Clapper and a number of interested Wray citizens, was formed. The committee involved spent almost three years exploring the potential of this resource and gathering the necessary support and resources to move forward. The Wray High Vo-Ag students have collected wind data on-site and the school district contracted for a cost benefit analysis by Tom Wind of Wind Utility Consulting, Inc. The results of the study concluded that the geographical area around Wray is highly suited for wind energy development. Although in the feasibility study we used a 16 mile per hour wind average, numerous anemometers have shown an 18 mph wind average.

Many agencies have provided support for this project. The community of Wray is extremely excited about this opportunity and has provided a tremendous amount of support through donations and in-kind services. To begin the process the Rocky Mountain Farmers Union provided us with $3,000 seed money to begin the process. Highline Utility was instrumental in the technical and professional support. A $10,000 Carl Perkins grant was used to complete a feasibility study and purchase two weather stations and technical support for collecting wind data. The City of Wray, Y-W Electric, and our local Yuma County Economic Development corporation all played a significant role in our success. The District applied for and received a $350,000 Energy Impact Grant to assist with the project. We have received numerous letters of support including Congresswoman Marilyn Musgrave, Governor Bill Owens, Department of Energy, as well as, numerous other agencies, and individuals.

In spite of this tremendous support from the community and the state the substantial startup costs are still prohibitive to the success of the project. Bond premium and interest from the recently completed 7.79 million dollar bond project, a pledge from the Kiztmiller-Bales Trust, individual personal pledges and an ending fund balance from the school district comprises about three fourths of the required funds. We also have accepted an interest free loan from the City of Wray to be committed to the project. These funds added to the Energy Impact grant still leave us with approximately a fourteen percent shortfall on the funding needed to complete the wind turbine project.

To attempt to cover this shortfall, the Wray School District began looking at the possibility of pre-selling the renewable energy credits (RECs) to a renewable energy company. Anticipating that most renewable energy companies would only purchase the RECs as they were generated over time, we were extremely pleased to find that NativeEnergy's practice is to purchase RECs on an up-front basis, and that they were very interested in purchasing the RECs from our turbine. With both parties of the Wray School District and Native Energy realizing that there was an end in sight we agreed to sell all RECs for the life of the wind turbine to NativeEnergy, with payment to be made upon commercial operations of the turbine. The funding made available by selling the RECs to NativeEnergy makes up substantially the amount we were in deficit, and will enable us to see this project finalized.

This project will be a self-sustaining model of energy production, income generation and innovative educational opportunity for Wray School District RD-2 and rural Colorado. It will also be a pilot program educating utilities, rural communities, businessman, farmers, and other schools on the tremendous value a wind turbine can be. Our project promotes the idea of clean, renewable energy promoting a more responsible attitude towards our environment.

It is the mission of Wray RD2 to develop an educational model for the students and community of Wray. This will be a wonderful real life lesson to show students the benefit of clean renewable energy. The success of this project will be measured in part by the enthusiasm it will create. The promotion of clean energy, sustainability, independence, and innovation will be a tremendous working model for students and rural communities to look upon.

R Howard

The CHAIRMAN. Thank you, Mr. Boucher, very much.

That completes the time for opening statements. Witness will now turn to questions from any Member. The Chair will recognize himself for questions.

Mr. Romm, Planktos' subsidiary has donated carbon offsets to the Vatican, but you say that offsets based on temperate forest projects are not effective. Are you suggesting that Planktos has led the Pope astray, that this is not a project that will, in fact, successfully offset the Vatican's emissions?

Mr. ROMM. Trees are a messy business. They—I think the research that's been done on trees calls into serious question whether outside of the tropics tree projects actually help the climate. There are, certainly, leading climate scientists in this country who think that they don't.

I mean, I would note that in clean development mechanism of Kyoto, which also oversees offset projects under the rubric of Kyoto, only six out of 1,783 projects are trees, so in Kyoto—under the Kyoto Protocol, not a lot of trees are being done as offsets.

The European Emissions Trading System doesn't allow trees as part of emissions trading, and the gold standard that I mentioned that's been endorsed by a number of environmental groups explicitly doesn't allow forestry projects. So I just think our problem is you burn fossil fuels. That carbon dioxide is in the atmosphere for a long time. According to James Hanson, a quarter of all emissions from burning fossil fuels stay in the atmosphere forever. Trees can take decades before they're sequestering a full amount.

I don't want to leave people with the impression that they can burn fossil fuels on the one hand, and plant some trees on the other hand, and that's going to solve climate change. Thank you.

The CHAIRMAN. Mr. George, you've heard Mr. Romm's argument. How would you respond?

Mr. GEORGE. Well, number one, our KlimaFa project based in Hungary is a Kyoto-qualified joint implementation track one verified, certified project in the European Union. And it's judged by the—it's been set up in association with the Hungarian Academy of Sciences, the Sopron School of Forestry. We have the third-party verification agencies of the European Union on board with us, and we also have the buyers from the major buying organizations of the EU buying those credits from us, as well. So the Pope wasn't misled. He is getting the most highly regulated, highly certified product on the planet, and those trees are going into the national park system of the European Union. And they provide a plethora of other ecco system service values, from clean water, to biodiversity benefits, so there's a vast amount of positive signs on the tree things.

And the comments about the one single climate scientist on the planet who has posited one hypothetical mathematical model suggesting that you can reduce forest ecco systems to a few climate physics equations about albido and warming, that's just that one single hypothesis has not stood the test of time. It is highly disputed by all forest ecologists everywhere.

The CHAIRMAN. Thank you, Mr. George. Mr. Blachford, Mr. Boucher, and Mr. Broekhoff, the Federal Trade Commission has guidelines for environmental marketing claims, which could be applied

to offsets. Do you think that Federal Trade Commission oversight of offset providers' compliance with these guidelines would be a useful step? Mr. Broekhoff?

Mr. BROEKHOFF. Thank you, Mr. Chairman. Certainly, that could be a useful first step in providing some assurance to the market. However, I'm not sure that the real issue here is a question of whether we have a bunch of fly-by-night operators offering fraudulent products on the market. The issue that we're dealing with here is, essentially, a definition of the commodity that's being sold. And without some standards for how you define these carbon offsets, how you quantify the reductions standards for how they get verified in a registry, where there's publicly available information about these projects, I think you're still going to have these issues about—some confusion about what it is that's actually being traded, and that's what's really needed.

The CHAIRMAN. Mr. Boucher.

Mr. BOUCHER. I would just add that I believe the existing guidelines that are out there can be used to inform us in this new market. And the issues at-hand, as the other panelists have indicated, are really fundamental in terms of defining the products that are being sold. And I think the standards that are coming out now will get us to the finish line there, and make it far less confusing in the marketplace.

The CHAIRMAN. All right. So just go down here; yes/no, Federal Trade Commission Oversight. Yes/no, go down. Broekhoff.

Mr. BROEKHOFF. Yes, as an initial first step.

The CHAIRMAN. Okay. Mr. Blachford.

Mr. BLACHFORD. Yes.

The CHAIRMAN. Mr. George.

Mr. GEORGE. More help, not less.

The CHAIRMAN. Great. Mr. Boucher.

Mr. BOUCHER. Yes, over time.

The CHAIRMAN. The Chair's time has expired. The chair recognizes the gentleman from Arizona, Mr. Shadegg.

Mr. SHADEGG. Thank you, Mr. Chairman.

Mr. Romm, I'd like to give you an opportunity to educate me a little bit, and explain to me, is it just that trees take too long to absorb carbon, or in this dispute between you and Mr. George, is there further argument—I think Mr. George referred to it as to why trees are not an appropriate offset?

Mr. ROMM. Yes. I will say that if you talk to the environmental community that's interested in offsets, many of them are not opposed to trees being part of the portfolio, but they really have a problem with someone offsetting their emissions 100 percent with trees. Yes, I think there's issue, that trees take a long time to sequester carbon. I think there's issue with permanence, how can you be certain that the trees are going to stick around, that they're not going to be burned down, or cut down?

There's problems with what's called additionality. As I said, I talked to a forester who works with an aggregater in this country of trees for carbon offsets, and he said to me, "Everybody is selling offsets for things they were already doing."

I mean, I think it's a great—trees have many, many benefits, and I'm a big fan of trees. That's why people plant them, and save for-

ests, anyway. So the big question is, are you paying for something that would have happened anyway? Is someone going to preserve that forest, because it's a good idea for 10 other reasons? And I do think that the scientific community has called into serious question what happens if you're planting trees in the north, in the northern hemisphere, are you increasing the—decreasing the earth's reflectivity; and, therefore, helping warm up the planet?

The CHAIRMAN. Mr. George.

Mr. GEORGE. Well, to address this question about the scientists in the community who have questioned trees in the temperate zones being a problem, there is one scientist who has written one mathematical model that's a highly restrictive model, that only considers the warming effect, atmospheric effect of trees. And it fails to deal with the fact that trees—the carbon dioxide that comes out of the atmosphere and is parked inside of a tree would be somewhere else influencing some other system, so there's a complex world of interdependencies in our ecology. And we know that most of that carbon dioxide is going to end up in the ocean, where it's going to produce ocean acidification, because H_2O plus CO_2 equals H_2CO_3, which is carbonic acid, which tastes great in a carbonated beverage, but kills ocean life. And we have to slow that process down. That's a desperate problem. And trees will have a dramatic influence on that effect, as will the ocean plants.

Mr. SHADEGG. This isn't really where I had intended to go, but let me ask this question. Given that, at least, Mr. Romm thinks trees are less than perfect, I'd like to ask anybody on the panel to respond to this.

Do you think offsets should be awarded for the construction of either hydro power facilities, or nuclear facilities, given that they generate electricity, generate energy, but produce no hydrocarbon, or no carbon emissions at all?

Mr. GEORGE. All the work with the living planet, the plants of the planet, the trees, and the plants, and the ocean isn't going to be enough. That's not enough. If we're lucky, it might be half the problem, half of the solution.

Mr. SHADEGG. So would you give credits for those——

Mr. GEORGE. Sure, I'd give credits for them. I mean, we need to throw everything at this problem that we can come up with. And all of the technologies——

Mr. SHADEGG. You just go down and——

Mr. GEORGE. Yes.

Mr. SHADEGG. Would you?

Mr. BROEKHOFF. Well, I would say that rule number one for offsets is that they should not have any deleterious, adverse effects. And a concern for those types of projects, nuclear and hydro, large hydro dams, is that they may have adverse effects on local communities, or in terms of environmental——

Mr. SHADEGG. So your definition of adverse effects wouldn't be just carbon. Mr. Romm?

Mr. ROMM. Yes, I'm mixed. There really is a lot of large hydro around the world to be done. Nuclear, I think—I mean, I agree with Vice President Gore. I think you can't rule out anything that doesn't produce carbon dioxide emissions, and generates electricity. I'm not certain it's going to be a big part of the solution.

Mr. SHADEGG. Mr. Boucher.

Mr. BOUCHER. I think until nuclear has a solution for storage, that one has to remain really off the table. I think large-scale hydro would need to meet strict environmental criteria, and that's pretty difficult to do.

Mr. SHADEGG. So your answer is no.

Mr. BOUCHER. I think case-by-case is the way to look at it.

Mr. SHADEGG. I'd like to ask, if I have time.

The CHAIRMAN. A quick question.

Mr. SHADEGG. Just, the Financial Times had an article recently in April, which was very critical of this current voluntary market. I think you've answered it by saying all of you would agree with the Chairman's suggestion that, or all of you, I think, agree that FTC monitoring would be helpful, so that answers the question. Thank you.

The CHAIRMAN. Thank you.

Mr. SHADEGG. Yield back.

The CHAIRMAN. The gentleman's time has expired. The Chair recognizes the gentleman from Washington State, Mr. Inslee.

Mr. INSLEE. Thank you. I really appreciate your comments. I want to ask a question, focus on this issue of what are you getting when you buy an offset? Now let's say that I found some great tree-hugger friend of mine that would give me $5,000 if I would agree that Jay Inslee would not build a coal-fired generating plant. I'd probably take the money, but I'm not sure what he'd be getting, because I wasn't going to do it, anyway.

If I'm a tree farmer in Brazil, and I own 10,000 acres, and I'm going to cut a thousand acres a year, and I say I'll give you $5,000 not to cut this thousand acres, he says fine, I'll take your $5,000. I'll go cut another thousand acres on the rest of my plot. What am I getting?

If a dredger utility that's planning a nuclear power plant, as one was recently, and built it, and some person says I'll give you $5,000 if you'll build a nuke plant instead of a coal-fired plant. Great, I'll take your money, but what am I getting? I was going to build a nuke plant, anyway.

So one of the great conundrums I have is that, what asset can we say we're really bringing to the table to reduce overall CO_2 reductions, when this behavior—we can't guarantee this behavior wouldn't have been the same, anyway? So how you guarantee that, Mr. Blachford, Mr. George, how do you know these behaviors would not have taken place, anyway?

Mr. BLACHFORD. It's a—you're basically asking the question, how do you know that a reduction is not simply part of business as usual? How do you know that it's actually incremental, or additional, as people in the industry talk about it? You have to apply a series of tests. And if a project can't pass the tests, then it shouldn't be used as an offset.

So as a consumer, what you're getting there is a verified reduction because that flaring would not have occurred absent the offset market.

If it's not true, it wouldn't have occurred, and then he doesn't have the offset, and it can't be used——

Mr. SHADEGG. But how do you determine that? I can see your logic when you're saying we're going to fund activities that have no economic value, except CO_2 reduction. So flaring CO_2 may have no economic value, except CO_2 reduction, so in that case, I can see where you're buying an offset, you're inspiring a behavior that has no economic incentive, other than the fact that you're going to sell the offset.

But how about the fact that you're going to—what do you do with a biodigester that has economic value, that I might decide to put in, anyway, because it's going to generate electricity? So how do you distinguish, you just tell me in your operations, how do you distinguish that? You do some third-tier economic analysis to determine whether they would or not, which would require incredible sensitivity to figure that out? How do you do that?

Mr. BLACHFORD. Now you understand why we're asking for standards. Basically, yes. There are standards that are out there. There's a variety of them, which makes it confusing, but what we would typically do is we'd go in, we'd look at the financials. A number of other tests you have to put it through, as well.

Mr. SHADEGG. Gotcha. I want to ask a quick question of Mr. George.

On plankton, no sequestration, I don't know what the life cycle is of plankton. I don't know how long it is. It's less than the cedar trees, probably.

Mr. GEORGE. But the beauty about plankton, about the ocean forest, is it's a very—we call them plankton blooms because they're a very sudden, vibrant events that are very short——

Mr. SHADEGG. What happens when they die, where does their carbon go?

Mr. GEORGE. Well, plankton takes the carbon dioxide out of the air, turns it into the plant biomass. That's the grass of the ocean, the sea life eats it, a bunch of it, so——

Mr. SHADEGG. They respirate it.

Mr. GEORGE. They eat it, and they recycle it back into CO_2.

Mr. SHADEGG. Right. That's what I'm saying.

Mr. GEORGE. Some portion sinks.

Mr. SHADEGG. Okay. I want to get to that. Plankton live, they take CO_2, they die.

Mr. GEORGE. Right.

Mr. SHADEGG. Somebody eats them, they're respirated, CO_2 goes back into the atmosphere.

Mr. GEORGE. Some portion goes back into the system, and some portion sinks.

Mr. SHADEGG. What portion?

Mr. GEORGE. Well, it depends on the location, and the kind of bloom, and the duration of the bloom. Blooms never last more than about six months at a time, so instead of a forest that lasts hundreds of years, you have a forest that lasts months, so the accounting time frame is very much easier to handle. The amount that sinks, in two recent studies, one in the North Pacific near the Hawaiian Islands that looked at natural plankton blooms, they found 20 percent of the net biomass of the bloom sank to great depth, where it was sequestered for at least 1,000 years.

In the North Pacific, where the blooms are more vibrant, 50 percent of the net biomass sank, so they're quite efficient in terms of sequestering biomass into the deep ocean where the recycle time back to the atmosphere is on the millennial scale. And that's why 20 years and $100 million of public funds makes it time to try this as a pilot project.

The CHAIRMAN. The gentleman's time has expired. The gentleman from—Mr. Sullivan.

Mr. SULLIVAN. Thank you, Mr. Chairman. And this will be from anybody that wants to answer it.

Would you agree that it would be better for an individual or a company to try to directly reduce their emission-generating actions, rather than purchase an offset?

Mr. BROEKHOFF. Absolutely, I think that would be better. And I think in terms of the approach to offsets, we should encourage people to reduce emissions that they're personally responsible for in any way they can. I think the question is, do you want to afford them the opportunity to go beyond what they could easily reduce, or what they could afford to reduce. And carbon offsets are a mechanism for doing that, so it's an opportunity to achieve more than what people might be able to do on their own.

Mr. SULLIVAN. Mr. Romm.

Mr. ROMM. Yes, I couldn't agree more. I think people need to reduce their own emissions, and particularly, their own fossil fuel consumption, because that's 85 percent of U.S. emissions. There are activities that are hard to reduce the emissions from, air travel, one-time events, so I think that makes sense to buy offsets for.

Mr. GEORGE. You know, we all need to reduce every way we can. I was in the London Underground the other day, and I saw an ad that pointed to a plastic water bottle. And it said if you recycle that bottle, you save six hours of light time of 100 watt lightbulb on your energy thing. And if you don't use the bottle at all, it's more like three times that amount. So if you pour your water out of a pitcher, instead of out of a plastic bottle, you save a day's worth of lighting, so we need to do everything to solve this problem. And most of the solutions are really easy, they're readily at-hand. And if we throw a little bit of everything at this problem, we'll solve it.

Mr. BOUCHER. Most of our customers are trying to get to carbon neutral, really to get to a net zero. The only practical way to get there is to use offsets. And, certainly, most of them are doing all they can to reduce their carbon footprint along the way, so it's really a two-pronged effort. Do all you can to continue to reduce your carbon footprint, use offsets to get to zero. And, again, most of our customers are trying to get there, which I think the merit of the voluntary market is that it's going to be a slow-burn, I think, on the mandatory side, whereas, voluntary purchasers are getting to net zero.

Mr. SULLIVAN. Kind of answered my next question, but I'd like to ask, is it Blachford, your business came about, and is very successful, was it because of the growth of a voluntary market? It was because of that, a voluntary market, your students, I guess, creative students, those kinds of things, or was it more government action? Which one do you think was a contributor to your success more?

Mr. BLACHFORD. Well, I would say in the near-term, it's only been around for two and a half years. And I would say it came entirely from entrepreneurial desire to help solve the climate change problem in a way that would make them feel good about what they're doing, and come back and do it some more. So I think to the extent that the government, in particular, I think the Environmental Protection Agency has been very helpful. Certainly, the voluntary market couldn't exist as it does today without some of these standards that are now in place. And to that extent, government has been helpful, but I think I would, generally speaking, say that it's the product more of just an entrepreneurial incentive to solve the problems.

Mr. SULLIVAN. Thank you, and I thank the rest of the panel. I yield back, Mr. Chairman.

The CHAIRMAN. The gentleman's time has expired. The Chair recognizes the gentlelady from California, Ms. Solis.

Ms. SOLIS. Thank you.

I asked a question earlier regarding carbon offset. Perhaps collaboration with some urban groups, if there's an incidents of that going on now? My concern is that, again, in communities that are poorly represented, under-represented, that we have environmental justice issues where you could typically have generators, or landfills that surround a district, which is very typical of my district. Folks that could typically afford to pay for these carbon offsets are, obviously, the big companies. And what happens then to those communities, and how can we help empower them? So I would just start, whoever wants to answer.

Mr. BROEKHOFF. Certainly, there are some concerns about offset projects. As I said earlier, the first rule of offsets should be a portion of the Hippocratic Oath, they should do no harm. But there is the potential for carbon offsets, I think, to benefit poorer communities. And, particularly, if you're looking at projects in energy efficiency, renewable energy, if you're talking about landfills in your community, and providing an incentive to cap the emissions, and improve the safety of those landfills, carbon offsets can provide a mechanism to fund those kinds of opportunities. So there can be a win/win situation here.

Mr. ROMM. I agree. And I think it would be useful for the Congress to start the process of setting up protocols for what is a legitimate offset. And one could clearly set up some protocols to make low-income housing more energy efficient, which would, obviously, have multiple benefits, so I tend to agree with that, yes.

Mr. BLACHFORD. I think, if you can hear me okay, I think that really efficiency is probably the most logical place to look, as well as, there's probably a number of other things that could be investigated. I'm more aware right now of the offset market helping from an income point in rural communities, specifically, small family farms that maybe wouldn't be able to make a go of it without some new sources of revenue. I'm not as aware of things happening in the urban centers.

Mr. GEORGE. Our projects very specifically involve hiring people from poor communities that do the work planting the trees, and in our ocean projects, we've been approached by a number of island nations around the world, whose fisheries resources have dramati-

cally dwindled because of the collapse of the ocean food chain, the collapse of the phytoplankton. And they've asked us whether our projects are ocean restoration projects, will revitalize those local fishing economies.

I met with the chief scientist of the United Kingdom some months ago. He pointed out to me that his studies have shown that the collapse of the North Atlantic Fishery was largely due to the collapse of the plankton food chain, below it. So as we work on these issues, we are certainly going to impact and influence in a very positive way the lifestyles of people who are living by the land, or by the sea.

Mr. BOUCHER. We see social justice issues as a key component of our projects. That has really caused us to focus on travel projects, in particular, but also, the farming communities, and other local communities where our projects have extra benefit. They're helping build local sustainable economies.

For the tribes, there's great potential there to build out wind on their reservations, and they want to be an owner/operator to the extent they can, and to the extent that tax law really enables that. Right now, that's a bit of a problem. But, to us, the social justice side is very important in our selection of projects that we support.

Ms. SOLIS. I'm very interested in learning more about what's happening on Native-American reservations, because we hear many very troubling stories about high levels of contamination, previous use of projects there, and lack of cleanup, and the fact that we still have communities that are exposed to very harmful residue that was not collected, or not being cleaned. And I know that the Native-American tribes also have a tremendous influx of funding now through casinos and gaming in the State of California. That's something that also——

Mr. BOUCHER. Yes. I mean, there's a combination of opportunities there. Some of the tribes with more wealth can help develop projects on Native-American lands and other places. Much of the wind resources on tribal lands where there is not a big casino operation, and they are some of the poorest areas in the country, Pine Ridge, Rosebud Reservation, but they have tremendous wind resources. So the solution there is to build projects and have local native involvement.

Ms. SOLIS. I didn't get a response, though, about any groups or coalitions, if that's something that you are aware of, so——

Mr. GEORGE. I could make one mention. I'm working very closely with the Haida First Nations in the Province of British Columbia, as well as a group of 13 First Nations people on Vancouver Island in British Columbia, where we are developing climate forest projects that are majority-owned by those First Nations people. And the bulk of the value of those projects, they will produce a new series of ecco forestry careers, green collar jobs, for those people, and long-term revenue streams for decades to come from the carbon credits from those new forests.

Ms. SOLIS. Thank you. Thank you, Mr. Chair.

The CHAIRMAN. The gentlelady's time has expired. The Chair recognizes the gentlelady——

Ms. BLACKBURN. Thank you, Mr. Chairman. And I want to thank all of you for being here. It's so interesting, as we look at the car-

bon credit market, and talk about carbon offset. I find it so interesting, having had the opportunity with some of my colleagues from this Committee and Energy and Commerce Committee to look at it. They call it a scheme, and I think that's probably a pretty appropriate name for it, because I'm not certain that it's what it's cracked up to be. I'm not certain that gets us where we would like to be, at being better consumers.

You know, one of the things we do have to realize is that it should be encouraging us to make better personal decisions when it comes to conservation, and when it comes to efficiency.

Mr. George, I appreciate that you just talked about the water bottle issue. And there are a lot of people that thought that the bottled water industry was much to do about nothing for many years. I find that quite interesting.

On the carbon market, there are a couple of things that disturb me, or concern me, or cause me to take pause as we look at the Chicago Exchange, and the European Exchange, and debate this issue here amongst us. And one of those is lack of consistency of quality, and that is of concern to me. And I do have a couple of questions I want to touch on.

Mr. George, I think I will come to you first, and then probably go to the others on the Committee. Do you, with Planktos, do you provide your consumers with detailed information on all your projects, and what the money is going toward with carbon offsets? Do your consumers have full exposure——

Mr. GEORGE. Yes, they do, in so far as the primary focus of our business is the European Union's regulated marketplace, where in order to sell our products, we have to pass through their very rigid third-party regulatory mechanism. And so, if we fail to do that—our plankton projects are, in fact, the pilot projects. We've proposed to do six pilot projects, and part of the purpose of that is to develop the methodology, and present that methodology to the EU's regulatory process, and have it accepted.

If we succeed, we will have created a new industry. If we don't succeed, we will have produced a lot of great science. But it's a very highly regulated process, so in so far as people who seek to buy the credits from us in the voluntary market, they're getting the same degree of regulatory oversight that comes from the most highly regulated carbon market on the planet. And we are being very transparent about our work, in that we're presenting what we're doing, where we're doing, how we're doing, and we're engaging the scientific community as participants in it.

Ms. BLACKBURN. Okay, and Terrapass does that. Do you have the same type transparency with your group?

Mr. BLACHFORD. Well, we do. It's a slightly different flavor transparency because we don't originate projects ourselves. What we do is post out for public consumption on the website every project we've ever bought from, how much we've bought from them, what's the date of the purchases.

Ms. BLACKBURN. Okay, and Mr. Boucher.

Mr. BOUCHER. Yes, we post a full disclosure really on a website for each project that is being supported with the exception of the specific wholesale or margin involved with the project. That is information for competitive reasons. Obviously, we cannot post. But

we provide the full calculation of the offset, the methodology that is used by different types of offset projects and I support the view that the more that can be shown on the website the better in terms of full disclosure, folks know what they're supporting and where their dollars are going.

Ms. BLACKBURN. Now let me ask you. Do you get government subsidies for selling electricity through renewal energy?

Mr. BOUCHER. We certainly do not ourselves.

Ms. BLACKBURN. You do not. You all do not.

Mr. BOUCHER. No.

Ms. BLACKBURN. Thanks.

The CHAIRMAN. And the lady's time has expired.

Ms. BLACKBURN. Oh, I'm already out of time. Well, I guess I'll have to submit the rest of my questions.

The CHAIRMAN. We'll have a second round if you would like.

Ms. BLACKBURN. Okay. Good. Thank you, Mr. Chairman. Thank you.

The CHAIRMAN. The gentleman from Missouri, Mr. Cleaver, is recognized.

Mr. CLEAVER. Thank you, Mr. Chairman. Let me—The first time I went to London I went down from my room into the restaurant area to have pot of tea and biscuits and I wanted to get a full breakfast and they brought down hot tea and cookies and the British didn't seem to know that cookies in the United States where English originated should be sweet and cookies. They turned things around. They think that biscuits are cookies and cookies are biscuits.

And one of the problems that the woman from Tennessee mentioned is in Europe they use the word "scheme" and she absolutely right except they are confused again. The word "scheme" in Europe is synonymous with the word "plan" in English where it originated here in the United States. And so I just wanted to make sure that in Europe they are not trying to say there is some kind of underhanded opportunity to do people in. I hate that she left.

But at any rate, I'm on the Financial Services Committee and we always have difficulty when the need is for us to do something. For example, people after Katrina including at least two members of Congress have not had their insurance to pay out as of today. I think Senator Lott had his home paid for and whenever we hold hearings as we did yesterday, there's always resistance that the government should stay out of it, that the insurance industry will fix it up. The same thing holds true with subprime lenders, don't get involved. The government should stay out.

And so with this kind of attitude in Congress certainly there will be those who would say that with regard to carbon offsets that we just let it go, the government should stay out, that we don't need it. Can I just hear from you whether you think that voluntary offsets will continue and whether or not you think that the reason we have voluntary offsets now is because government has moved in and if government moves in and it's all encompassing, then we don't need offsets and if we don't need voluntary offsets, that the government would take in all of it. Anyone. Mr. Romm.

Mr. ROMM. I certainly agree with that. I think that once the absence of the government taking action has led individuals to try to

do what they can and so you're handed up with this voluntary market. I believe that once the government establishes a mandatory cap and trade system, that will establish official emissions reductions and then if someone wants to reduce their emissions, they will purchase their tons on that market and they won't go to some voluntary vendor.

Mr. GEORGE. I might add though in Europe where there's a highly regulated, well-established market there's a very large voluntary market, much larger than here in the United States. So the voluntary market will exist side by side with the regulated mandatory market.

Mr. CLEAVER. I mean even if the government implements some kind of program that encompasses just about every sector.

Mr. GEORGE. Well, that's the case in Europe. The voluntary market still exists. I mean the government I don't think will ever go all the way down to sort of the root level individual.

Mr. BROEKHOFF. I think we had to distinguish between the voluntary demand for carbon offsets which is quite alive in Europe and the voluntary supply because if we have a mandatory program that defines the rules for creating these carbon offsets, there may be a limited space for any kind of voluntary market to develop, to have its own rules, in addition to the mandatory program. The voluntary demand will still be there. The voluntary supply will be primarily, I think, a way to experiment with new types of projects and technologies perhaps.

Mr. BOUCHER. We also think there will be always a demand for more than simply the offset volume itself. It's whether it's supporting a special program. Are there's other benefits associated with the program? So I don't think it's going to all collapse to a single commodity.

Mr. GEORGE. We have a lot of companies in Europe who aren't in the regulated markets space but are asking to buy from us voluntary credits that meet the full certification requirements of the mandatory market. So, in fact, the voluntary market I think will always remain. The mandatory market will set the standard though for the quality of the product.

Mr. BLACHFORD. Let me make just one final point on this subject. Most cap and trade markets today have as their goal a percentage reduction in carbon that's usually in the 10 to 20 percent over time range. Most individuals and companies who are using carbon offsets are self-imposing a cap that looks like a 100 percent. They want to go to carbon neutral. I can't imagine a government regulation that is going to make the vast majority of businesses and consumers 100 percent carbon neutral. Those people who want to go above and beyond a government standard are always going to look to a voluntary market.

Mr. CLEAVER. Thank you, Mr. Chairman.

The CHAIRMAN. Gentlemen, time has expired. Several members has asked unanimous consent that they be allowed to submit questions in writing. That will be so ordered and it is, by the way, the intention of the Chair to conduct a second round of questions. The Chair recognizes the gentleman from California, Mr. McNerney.

Mr. MCNERNEY. Thank you, Mr. Chairman. I want to thank the Board for coming and giving your expert testimony. It's very en-

lightening and there is a diversity of viewpoints. So it's going to be useful, I think.

I'm going to start with Mr. George. Your testimony on the state of the oceans is very startling and I'd like to know how important has global warming been in that devastation of ocean plant life?

Mr. GEORGE. Well, global warming is probably not the way to go on that. It's really anthropogenic CO_2. It's carbon dioxide. All the carbon dioxide that's going into the air from fossil fuel today, natural gas and oil was plankton 200 million years ago. It's solar energy stored in plankton biomass that went through the geologic process and we've burned it up. We've burned up a 200 million year savings account in about 150 years or so. It's a heck of a party and we've left a big mess and we need to clean it up.

That CO_2 is going back into the oceans, converting the oceans, making the oceans acidic. They've become 10 percent more acidic in the last few decades. The Royal Society of the U.K. reported a year and a half ago that acidification would reach a state that by the year 2050, sometime between the year 2050 and 2100 CO_2 saturation would occur.

Well, about a month ago, a paper came out and said in the Southern Ocean of surrounding Antarctica, CO_2 saturation had already suddenly appeared a hundred years ahead of schedule and there's no wonder that we've seen an 80 percent decline in the krill populations of the Southern Ocean. So there is an enormous crisis on the planet of carbon dioxide that's influencing the ocean through direct effects, being soluble and making that oceans acidic.

The other probably more important effect is that CO_2 feeds plants on land. Well, this planet is mostly grass, not mostly trees and when grass gets—grass is that stuff that's green in the spring and brown in the summer and when it's brown, it's not such good ground cover. If a dust arrives, that dust feeds the ocean. In the past 30 years, we've seen the dry grasses of the world that go brown in the summer stay green for two to three weeks longer every year in the summer, two to three weeks in the summer. That's a big piece of summer and the amount of dust circulating in the planet's atmosphere is measurably clearly shown by the atmospheric agencies to have dramatically declines. That dust in the wind was the vital mineral micro nutrients for the ocean and that's what the past 20 years and hundred million dollars worth of public spending has been targeting to see if we can unravel that mystery and see if we could reverse it.

And we think the result of that research says we can do it. We can take a shot at actually restoring starting selectively in a few locations that ocean plant life.

Mr. MCNERNEY. Thanks for the clarification that the cause of global warming is also the same cause as much of the devastation in the plant life. Do you have any evidence or proof that the ocean fertilization will lead to a healthy ocean as opposed to some other form of problem?

Mr. GEORGE. Well, sure. The reason why we're going to the Galapagos Islands and the reason why the first two iron fertilization experiments that were funded by the U.S. Government went there was that the Galapagos Islands themselves are a major source of iron for that portion of the world's oceans and the iron that leeches

off of those islands produces a massive plankton bloom that envelopes and surrounds those islands and drifts 1,000 miles to the west and everything we know about that plankton bloom which is stimulated by iron is that it produces a wonderful marine oasis effect and that's why the Galapagos Islands are so famous.

So we use that bloom. The two previous projects have used that bloom and we will use that bloom as natural control study site so that we can try to match up the bloom that we produce by adding a very small amount of iron to an area of about 1/50th of the size of the natural Galapagos bloom and if we're lucky, if we do everything right, we might be able to mimic that effect and develop this as a technology that might have major utility in helping to reverse the decline of the ocean ecosystems.

Mr. MCNERNEY. Thank you. Mr. Broekhoff, you gave us three elements in the early part of your testimony, the accounting standards, the monitoring and verification standards, and registration and enforcement standards. Do you think those could form the basis of federal oversight of the voluntary system?

Mr. BROEKHOFF. Yes, absolutely and I should note that there are various voluntary initiatives that have been developing pieces of these standards. So you have my institute has developed accounting standards for carbon offsets projects but without the verification and the registry pieces there. You need all three pieces in order to establish a commodity.

Mr. MCNERNEY. Thank you. One last question. Mr. Romm, your written testimony has a discussion, the Golden Offsets, and what I would like you to do is discuss that keeping in mind how we might find that useful in developing federal regulations or federal statutes.

Mr. ROMM. Sure. Well, this is called the Gold Standard which is an international standard for offsets that a number of environmental groups have endorsed and they are fairly rigid criteria for meeting these. That's why they're called the Gold Standard and in particular, really need the project need to energy efficiency or renewable energy projects or methane to energy to projects and they have to pass a sustainable development screen and they must provide an energy service that catalyzes the transition to a clean energy economy.

I mean I think people need to understand offsets aren't going to solve the global warming problem, but they could help spur the transition to the clean energy economy that we need and I think that's why I personally think that offsets should focus on energy efficiency and renewable energy projects.

So that was the thinking behind the Gold Standard and I think that the government is going to have to set protocols for what is an offset and what isn't an offset. Sooner or later, it's going to have to set up offsets in the mandatory regime for what is a real emission reduction and those same protocols in the mandatory regime, if they are started earlier, could be used in the voluntary regime.

Mr. MCNERNEY. Thank you. I yield.

The CHAIRMAN. Great. The gentleman's time has expired. The gentleman from Oregon, Mr. Walden.

Mr. WALDEN. Thank you very much, Mr. Chairman, and I appreciate the panel here. I'm sorry I had a conflict earlier this morning

and wasn't able to be here for all of it of your testimony, but I have it.

I want to follow up on some discussions that took place regarding forestry. Prior to this Congress, I chaired the Forest Subcommittee. On the Resources Committee, I've been very active on these forestry issues and I understand there's been pretty good discussion here today about the role of forests' potential sequesters of carbon. My understanding, there was a study done by a Dr. Helms who, I believe, testified before this committee that in extreme cases wildfire, catastrophic wildfire where everything burns, you could have up to 100 tons per acre of greenhouse gas emissions. On average, according to Winrock International wildfire estimates, or Winrock International, they say wildfire averages about 6 tons of carbon per acre, so somewhere, worst case 100 tons per acre, best case probably more like 6 tons. Now I'm told that the average vehicle on the road today in America emits about 5 tons of carbon per year. So if you have one acre burn at the low end of the scale you're emitting 6 tons of carbon gas versus a vehicle that's 5 tons.

So far this year, in American, we've burned 3.1 million acres. Most of my district in rural Oregon is literally on fire today. I flew over it this weekend. I'm going back this coming weekend. So that means we've emitted 18.9 million tons of carbon from wildfire.

It strikes me that if, indeed, the globe is warming and the Pacific Northwest is going to see temperatures increasing by upwards of six to seven degrees potentially within 100 years, that the need to get in and manage the Federal Government's land which constitutes 55 percent of the State of Oregon is even more important than ever because you're going to have more drought, therefore, more pressure on the trees, therefore, more bug infestations and, therefore, more wildfire.

Would you all care to comment on the need to change Federal land policy so that we prepare our forests that we own as taxpayers so that they are more fire tolerant, disease tolerant, insect tolerant and more adaptable to the change in climate? Mr. George, do you want to comment on that?

Mr. GEORGE. Well, it's a challenge I've been working forest ecology all my life and trying to manage forests against fire risk is a tough problem. I'm not sure that cutting them down is a good alternative because you emit an awful lot of carbon when you cut and clear forests as well.

Mr. WALDEN. I didn't say go in and cut them all down and blacktop.

Mr. GEORGE. Yes. No.

Mr. WALDEN. Although with pressure on the industry, a lot of it is getting converted into residential land if it's private.

Mr. GEORGE. Sure.

Mr. WALDEN. I'm talking about Federal land that is overstocked and if you've been in forest ecology, you know it's overstocked on the Federal ground.

Mr. GEORGE. Sure.

Mr. WALDEN. Fuels and everything else.

Mr. GEORGE. Sure, and there is room for intensive forest management on many lands, but whether or not the economics are there to do that kind of intensive forest management is another

question. The carbon credit value in forestry isn't competitive with commercial aspects, you know, with the timber values in forests.

To address your question of the emissions from a forest.

Mr. WALDEN. Yes.

Mr. GEORGE. We're working on several different forest projects in different parts of the world in the temperate rainforest of British Columbia which parts of Oregon are similar to that.

Mr. WALDEN. Right.

Mr. GEORGE. A forest there at maturity is storing 2,000 tons per hectare or something like that or 2,500 tons per hectare or 1,000 tons per acre of carbon dioxide in that forest. In the temperate forests of Europe, it's about half that amount. In Costa Rica, it's in between those two sums, those two amounts. So forests do store a lot of carbon dioxide and indeed when they burn, it doesn't all go into the air instantly.

Mr. WALDEN. I understand that. I guess I'm confused by your comment. So are you saying forests, it doesn't really matter what we do out there as it relates to carbon?

Mr. GEORGE. Well, they're big ecosystems. I'm not sure we can manage them for their risk, for their fire risk, because I'm not sure that fire risk management has worked in forests.

Mr. WALDEN. Oh, I guess because I live around them and seen them where we have managed and done the thinning and opened up the stance, gotten them back to their historical separation of tree patterns. You know, we suppressed fire for 100 years.

Mr. GEORGE. In our old ecology, but we're entering an age of new drier ecology and we're going to have more fires.

Mr. WALDEN. Right, but what I've seen on the ground and in reality in almost every case where we have gone in and thinned back to what the historical stumpage should be per acre when they do get a fire it drops the ground and they get it out as opposed to these crown fires. I have fires out there that are spotting a mile ahead right now.

Mr. GEORGE. Yes.

Mr. WALDEN. In the Malheur National Forest. A mile ahead.

Mr. GEORGE. Yes, I've been on the fire line on big fires like that. So I know them well.

Mr. WALDEN. Well, my time has expired.

The CHAIRMAN. The gentleman's time has expired and we will move to a second round of questions. The Chair will recognize himself.

Mr. George, the IPCC, the Scientific Group of the London Convention and other scientific groups have all suggested that we should not go forward with large scale ocean fertilization tests until we know more about the potential risks posed by such projects. Given the weight of scientific authority, why should Planktos be permitted to go forward with its planned project in Galapagos at this time?

Mr. GEORGE. Well, our projects have been highly misrepresented by a lot of organizations who have suggested that they involve a lot of risk and danger to the environment when, in fact, these very projects, the scope and scale of our projects are on the record as proposals by many nations through their national science foundations and agencies.

In Germany, for instance, the Alfred Wegener Institute in Bremerhaven has a project almost identical to our pilot project series on the book scheduled for 2011. We've been in close discussions with the Wegener Institute about helping to fund that project, to accelerate it in the near term instead of waiting until 2011. We know the team at Moss Landing Marine Labs which originated this field has had many proposals at the National Science Foundation to do this next scaled-up experiment.

What we are as a company is we thought we were the government research industry's dream come true. After 20 years and $100 million worth of public funds, we're a private company who says "That was fantastic research. There is a terrific opportunity here. Let us step in and do a series of carefully planned pilot projects, six, that match exactly what the scientific community has said has to be done to discover whether this is viable to gather the information. We're not going to only academic science. We're going to do intensive academic science."

But like any true commercial pilot project, we're going to look at the cost of engineering, the economics of the process, the regulatory requirements, the public requirements and, of course, the environmental impacts of that and if we don't do that, we won't have the knowledge that we need to answer these questions that are being asked.

The CHAIRMAN. Okay. Why would it be unreasonable for the EPA to require you to obtain a permit under the Ocean Dumping Act before dumping 100 tons of iron into the ocean? What permits have you sought or received?

Mr. GEORGE. What we have is we've received one fax from the EPA asking me to phone them. I telephoned them. I had about an hour long, informal phone conversation with them. The very next thing I heard from the EPA, well, I heard about the EPA, was I received a telephone call from a reporter in Ottawa, Canada who said that a very radical environmental group called ETC based in Ottawa had handed the reporter the contents of the EPA's presentation to the London Dumping Convention meeting in Spain that was taking place at that very moment and would I comment on the EPA's criticism of our work. So it was a little bit extraordinary to discover that the EPA's comments about our work weren't made to us, weren't presented to us in any formal fashion or presented to a radical environmental group who went to a reporter in their country and who challenged us to answer these accusations and I don't know if that's normal procedure and protocol for the U.S. EPA to address a U.S. company through a foreign media and foreign radical environmental group just before it files a position statement that includes the text of that radical group's position statement on us which is utterly false and misleading with an international body. I think that's an extraordinary behavior of a U.S. regulatory agency.

The CHAIRMAN. Mr. George, I'm going to ask Mr. Romm to comment on it.

Mr. ROMM. Yes. It is worthwhile to pursue these experiments if they meet appropriate EPA regulations. I think it's inappropriate to sell consumers, to charge consumers money, under the claim that this has been proven to avoid, sequester, a certain amount of

carbon dioxide. As you said, there are a lot of scientific organizations that have a lot of doubts about this organization. I included in my written testimony an extended statement that was issued just last month by one of the leading groups of experts on the ocean atmosphere system which went out of their way to issue this statement saying, "We don't think this is a good idea at all." And in the addendum to my testimony, I have an excerpt from a science magazine article that says point blank ocean fertilization should not be allowed carbon offsets credits. So that's certainly my position.

The CHAIRMAN. The Chair's time has expired. The Chair recognizes the gentleman from Washington State, Mr. Inslee.

Mr. INSLEE. Thank you. I spent the last year co-authoring a book about clean interview, about how we develop a clean interview future, and we called it Apollo's Fire because we want to harken back to the idea of the original Apollo Project.

In looking at this thing, I became more and more convinced that you have to develop new technologies to help solve this problem. It's just absolutely fundamentally key to solving this problem. There is just no way we can do enough trees or algae. We just have to have new technology.

If that's true, and I'll ask this of Mr. Blachford and Mr. George and Mr. Boucher, doesn't it make sense if we're going to have offsets to focus on those that Mr. Romm suggested in this gold standard that direct this offset investment towards investments that will sprout new technological growth both in efficiency and in renewable energy sources as opposed to sequestration or land use or some areas. Isn't that a higher view and, if so, what does the consumer know about that between the various offset markets that are out there?

Mr. GEORGE. Could I answer that briefly? When you don't put a ton of carbon dioxide into the earth's atmosphere, you don't cause any further harm to the planet. When you hire a tree or a green plant in the ocean to take that ton of carbon dioxide out of the atmosphere and turn it into those living plants, that living ecosystem, it's no longer harming the planet, but it's also healing the harm done to date and providing an ongoing healing form and what we're concerned about with carbon dioxide in the air is the harm it does to the living planet. It's the harm that it's doing to the ecosystems of the planet. So why not employ those ecosystems which are in a dramatically reduced state, why not bring them back?

In Hungary, it used to be 70 percent forest. It's now 17 percent. We're going to plant a quarter of a million acres of new forest in Hungary that goes into the national parks system there that will be very heavily protected. It will be a long term, enormous benefit to that ecosystem there and the same thing goes in restoring the ocean.

If we don't restore the harm already done by climate change by carbon dioxide, what good does it do to do no further harm? We have to also heal the harm done.

Mr. INSLEE. I just want to know. One concern I have is what really results in geological storage. You have to have geological storage to make this. Trees fall over and die and they decompose and then their CO_2 is emitted and I suppose what you're telling me

is that these credits you're buying is to keep these forests in perpetuity. So you just replace the tree that's fallen down and decomposed. Is that the idea?

Mr. GEORGE. Forests are self-sustaining green machines that keep themselves going in perpetuity. The fossil fuel age is only about 200 years old at best, really 100 years old in high gear. You know, by all accounts it's only going to last a few hundred years longer. In the ocean, it's very easy to see CUB and repositioned in the deep ocean for periods of millennia. It may be back 2,000 years from now, but the fossil fuel age will be long gone.

Mr. INSLEE. I want to ask about the European Certified Emission Reductions. As I understand, these are certificates in Europe.

Mr. GEORGE. Yes.

Mr. INSLEE. Do your markets, and I ask all of you, do you use those? Do you invest in them? And are they a prototype that we should concern in the United States for a certificate? I want to ask all the panel, not just Mr. George. Anyone who wants to answer the question go ahead. Anyone?

Mr. BROEKHOFF. Mr. Inslee, the certified emission reductions are actually units that are created under the Kyoto protocol. The European Union has a trading system set up that recognizes those credits. I think certainly within the framework that the Kyoto protocol has established these, these are credible carbon oxide instruments. Questions have been raised about projects here and there, but overall it's a pretty credible mechanism.

Mr. INSLEE. So, Mr. Blachford, in your company do you sell those? Do you meet those certification standards?

Mr. BLACHFORD. No, because they're really for sale within the Kyoto protocol. They're not really for sale in the voluntary market. There are VERs, voluntary emission reductions, that are again it's a just a denomination of the credit but are held to a very similar standard typically from developing countries. We sell projects that are in the United States. So we don't right now sell anything that would qualify there.

I think there are standards in development though, including the gold standard that Mr. Romm was talking about before, that incorporate most, if not all, of the same attributes that those CERs and VERs have.

Mr. INSLEE. So would you meet their standards in a domestic context?

Mr. BLACHFORD. Today's it's no so much a question of whether we meet the standards. It's more a question of whether the projects do. I actually went to a gold standard project database this morning anticipating some of this conversation and there is only one project listed in that database that's operational today.

Mr. INSLEE. Thank you.

Mr. GEORGE. You know, you have to understand that carbon credits are, you should think them in terms of bottles of wine. They have a vintage year and a label and there's quite a large variety of different carbon credit markets out there. It's important each year. The vintage is important because we retire the credits on an annual basis. But the label is also critically important. So there is plethora of different labels of carbon credits emerging in the mar-

kets around the world especially those markets where there is mandatory requirements.

The CHAIRMAN. Gentleman's time is expired. The Chair recognizes the gentlelady, Ms. Blackburn.

Ms. BLACKBURN. Thank you, Mr. Chairman. A couple of quick questions. Mr. Broekhoff, you said you all were developing some accounting standards for carbon offsets. So let me ask you this. Do you think that it is possible or that we should even try to develop federal guidelines for voluntary carbon offsets, develop some guidelines that would clarify the voluntary carbon offset industry and still preserve it as a voluntary industry? What is your take on that or should we just leave it alone and avoid full scale government regulation?

Mr. BROEKHOFF. I think it's possible for the Federal Government to provide some oversight and guidance, for example, in recommending best practice accounting protocols for the quantification of carbon assets, also perhaps in terms of certifying verifiers or certifying registries that could serve this market without directly controlling the market or providing direct regulation.

Ms. BLACKBURN. Mr. George.

Mr. GEORGE. Well, you know, it's all about money. But if you buy carbon credits from a hybrid car or vehicle purchaser, right, you buy your hybrid vehicle and you pay about $5,000 extra for the hybrid vehicle as with a gas version of that vehicle, it does emit about two tons of carbon dioxide a year but you've paid $5,000 up front for it. If you invest in, if you buy carbon credits from trees and ocean projects around the world, you might pay about $5 a ton for it.

So not everybody can afford to go out and buy a brand new automobile with a $5,000 premium on it to reduce their carbon footprint by two tons a year. But everybody can afford to plant enough trees to get two tons a year. That's $10 a year. Everybody can afford to do that. A family of four in the United States has a carbon footprint of about 20 tons per year. At $5 a ton, that tree planting project are selling. That's about $100 bucks a year. That's $8.33 a month. So buy Mother Nature one cheap cocktail a month and you've taken care of her.

Now people who don't like offset projects, who want the high priced engineered solutions, are very opposed to this. But it's part of the solution and it also heals the harm that's done. And everybody can afford it. So the voluntary market to choose these affordable low end solutions, the green solutions, is a very practical step.

Ms. BLACKBURN. I can tell you, Mr. George, if you're talking about hiring a tree, I think some of my foresters in Tennessee have a lot of trees that they can hire out for you. Now you're a for-profit company.

Mr. GEORGE. Yes. We're a for-profit public company.

Ms. BLACKBURN. And you are looking to increase and stabilize your income stream. So do you think that the entrepreneurial spirit that we have in the country, the entrepreneurial we're seeing around this industry, coupling with an increase environmental awareness by American families and certainly that organizations and companies could drive the voluntary carbon offset market without burdensome government regulation?

Mr. GEORGE. Yes, I do and we're somewhat of an anomaly. You know, we're an American entrepreneurial activity. We do all of our science here and virtually 100 percent of our money comes from Zurich and London.

Ms. BLACKBURN. So you would leave government out of voluntary carbon offset market and Mr. Broekhoff says he thinks that it would be helpful in establishing——

Mr. GEORGE. I'd love to have the government aboard on this voluntary market. I think it would help. I think people would have more confidence if there was some government oversight. It would make life a lot easier. I mean, heaven help me, sometimes the bureaucracy is a bit burdensome, but it's a positive thing generally.

Ms. BLACKBURN. Mr. Boucher, I know I'm going to run out of time and I may submit my question to you. I'm curious about selling electricity through renewable energy and I had asked you about if you had received any government subsidies and I know that the wind turbine project with the Sioux Rosebud did receive some and I know there was a DOE grant and I think a Rural Development Grant in that. So I have some questions surrounding that.

If you will, sir, I will submit those to you in writing for an answer in writing from Native Energy and I think it's important for us to look at whether or not this is something that is sustainable and something that is going to be profitable and doable and duplicative so that it can be replicated. So let's—I do have some questions about that. I will go and yield back my time and then submit that in writing. Thank you, Mr. Chairman.

The CHAIRMAN. The gentlelady's time has expired and we ask the panel to respond in writing to the gentlelady's questions when she propounds them. The Chair recognizes the gentleman from Missouri, Mr. Cleaver.

Mr. CLEAVER. Thank you, Mr. Chairman. I think, Mr. George, you partially answered this question. Several estimates suggests that the average American family generates 20 tons of carbon dioxide annually and I think about 4.5 for the rest of the world.

Mr. GEORGE. The rest of the world's much lower.

Mr. CLEAVER. Yes. And then you talked about the fact that to buy an automobile that actually generates less greenhouse gas contributors will cost more money. Do you think that the reverse ought to be the case in the United States, in other words, that you essentially pay for money if you buy a large emitter? If you want a big SUV, you pay more for that than you would pay for buying a hybrid because right now, if you're trying to be environmentally sensitive, it costs you more money and so just like cigarettes cost more money, if you want to go ahead and smoke in spite of the hazards and the way you contribute to the rising health costs in the country, okay. It's going to cost you $4 a pack. Is it clear enough?

Mr. GEORGE. Yes. I think sure large footprint items ought to pay their way and hopefully, recently we had an owner of a large mega yacht. It's kind of like the most extreme example of an object that somebody might own and they contacted us because they were tied up next to our research ship that's down in Florida picking up scientific gear and it's just the most beautiful thing you've ever seen, polished to a high polish and the owner of the yacht, I was drinking coffee on our research ship one morning and he was drinking

coffee on his and we were literally tied together so we could almost touch and he said, "Well, tell me about all this carbon sequestration stuff." And I said, "Well, you tell me about your boat. How many gallons of fuel do you burn?" And he told me how many gallons of fuel he burned and I said, "Well, let's do the calculation" and I just did the back-of-the-envelope calculation. I said, "If you wanted to reduce the carbon footprint of this 140 foot mega yacht, bigger than our research ship, you would have to pay about $2,000 a year to make that zero by planting trees." And he said, "I just paid more than that to varnish the back rail on this boat." And he said, "Let me get my checkbook out" and he did.

So if it's affordable, people will do this. But if you have 20 ton footprint and you have to pay effectively $2500 a ton, right, that's Toyota's charge per your footprint, well, that's a big number. You have to shell out $50,000 to go carbon neutral.

Well, nobody—Some people can afford that. I can't. Most people can't afford that. But I can afford $100 a year to do the right thing for the greener solution. And that's why the British Stern Report that talked about the need to spend $3 to $4 trillion immediately to solve and address this problem of climate change is such a staggering number. It's because they use that engineering metric to come by that number. If you use the green metric to come by the cost of making a really meaningful part of the solution, the part of the solution of climate change, we can afford it easily. It's very low cost.

Mr. CLEAVER. Thank you, Mr. Chairman.

Mr. GEORGE. And it's immediately available. We can do it today.

The CHAIRMAN. The gentleman's time is expired. The gentleman from California, Mr. McNerney.

Mr. MCNERNEY. Thank you, Mr. Chairman. The United States has historically been the biggest contributor to greenhouse trapping gases in the atmosphere. But that's changing now and we have some other competitors out there that are going to at least as good a job as we are of contributing those gases. And I think one of our biggest challenges is to work with those other countries to find ways to cooperate toward reducing our footprint and their footprint at the same time. What lessons can we learn from the voluntary system out there in maybe moving toward mandatory systems that could be applied that we could sort of encourage other countries to follow that may be large contributors in the future and I'll take an answer from anyone.

Mr. BLACHFORD. I guess I would just point out that under the Kyoto protocol part of the idea of having the offset project type fee based in emerging markets is precisely to try to stimulate the development of renewal energy and other clean development. In those markets because as they mature and as there's increasing demand for energy in those markets, it would be nice if it was energy that was renewable instead of energy that's based on fossil fuels. So I think that's one very obvious way we can encourage the development of projects in those countries.

Mr. GEORGE. You know every place in Europe you go you see an advertisement on the wall put up by some public agency or some organization giving a people an education on how to reduce their carbon footprint. Everywhere you go in Europe you find them.

Mr. MCNERNEY. I'm not talking about Europe. I'm talking about Asia.

Mr. GEORGE. But that's producing this fantastic effect of stimulating thinking and the Kyoto accord has been a fantastic success story because its job was to stimulate people to try to think our way and vent our way out of this crisis and we're doing it.

Mr. MCNERNEY. It just seems that a market-based approach would be the most effective and if we can produce laws that will be useful in encouraging Asia, in particular, to move forward in this it would be good to have that input from the market and from you guys.

Mr. GEORGE. Two and a half months ago I was in China meeting with several different Chinese government organizations. I was given tours around China of the tree planting that's going on there and I'm a tree planter. So I know a new tree when I see one. I saw 25 years of extensive tree planting going on there in China.

China and Costa Rica are the only two countries on the planet that are ahead of the game on forestry, planting more trees than they're clearing every year. The Chinese are enormously dedicated to climate change solutions. They're working on it. They are very insular. They don't really talk about it.

I was amazed when I met with foresters there who were asking me about how to create carbon credits. I met with one group about wind power. Some of these guys here are wind power guys and they said, "Well, can you earn a carbon credit with wind power?" And I said, "Yeah." And I said, "Are you going to put wind power in?" They said, "Yeah, we're looking at 250 megawatts right away in one little area." And they said, "Can we earn a carbon credit for that?" And I said, "Well, of course." So those countries are in fact actually working on it.

On the other side of the equation, you know they're burning the nastiest coal on earth. Do you know the mercury that we worry about in tuna in the open ocean? Where does it come from? It all comes from Chinese coal pollution. That's why mercury has suddenly appeared in the fish world is that mercury has come from those Chinese coal plants. So we have to shut those things down with other means and for other purposes other than strictly climate change.

Mr. ROMM. To get to your question, I think the rate of development in countries like China and India is going to have to be met with intelligent cap and trade regulations that they're going to have to sign onto to spur clean energy technologies and carbon sequestration. I think that they're not going to act. I'm sure if you've talked to them, you know they're not going to act until we take some action ourselves. So I think the first step is the development of U.S. mandatory regime and then working with them as quickly as possible to get them to develop a mandatory regime.

Mr. GEORGE. You know, in China, every man, woman and child by law in China has to plant five trees per year. That's six billion trees per year go in the ground and everywhere in China where you go if you're an old tree planter like me, you see that that's going on. I see those trees are in the ground growing. So they're working on it.

Mr. MCNERNEY. Okay. Thank you.

The CHAIRMAN. The time has expired. The gentleman from Oregon, Mr. Walden.

Mr. WALDEN. Thank you, Mr. Chairman. I appreciate that. I'm intrigued, Mr. George, by your comment about what great foresters the Chinese are because there was an extensive series of articles or at least one article in the Washington Post recently about all the illegal logging that's going on in China and despite their rules, they're incapable of enforcing them in the provinces. So I'm glad that your view on that is a different picture than what we read in The Post because that was pretty devastating in terms of the harvest levels there, Russia, Indonesia, Malaysian, other tropic countries where the rain forests are being wiped out so they can ship the wood to China so they can process it into furniture so we can buy it here and feel good about ourselves, I guess. So I'm glad to hear they're doing more in China than what we read.

It strikes me, too, that in China we're told that they're putting two 500 megawatt coal burning power plants online, I think, it's every week this year. Mr. Romm, is that——

Mr. ROMM. Yes. No, it's staggering. It's like the equivalent of a new California every year.

Mr. WALDEN. And isn't that why somehow by hook or crook we need to get China and India and the other big carbon emitters in with us globally to address this issue?

Mr. GEORGE. China, the premier of China did commit to about two months when he was visiting with the premier of Japan or prime minister of Japan, that China would be a full compliant member of Kyoto beginning in the second period following 2012.

Mr. WALDEN. Well, I'm——

Mr. GEORGE. So, yes, they have made that commitment.

Mr. WALDEN. Yes, Mr. George, I'm glad to hear the commitments. I've seen it in trade issues, too, where they've made a lot of commitments and, gosh, some of them aren't always followed and I actually supported putting China in WTO so that we'd have international compliance and all. So I'm glad if he's making that level of commitment.

Mr. GEORGE. Those coal prints are the ugliest thing on earth.

Mr. WALDEN. Mr. Romm, let's continue on with this because I know they are also committed to do other energy sources. But are they using the latest technologies in these new plants that they are putting on line? Do you know?

Mr. ROMM. No, I mean, they're not and they're using—I think by and large, they're using pulverized coal which may be very difficult to retrofit to capture carbon. I think the top priorities for the United States should be to develop a mandatory regime ourselves just so we have credibility to go to other countries. If you've talked to people from China and India, you know that they scoff at the notion that the poorer countries shouldn't—that the rich countries can't act until the poor countries act.

Mr. WALDEN. Right.

Mr. ROMM. But they're going to have to act right after we act. So I think we need to do something for our own credibility. I also think we have to figure out how to do this technology transfer because they're going to build coal plants.

Mr. WALDEN. Right.

Mr. ROMM. And so we have to figure out how to make sure that they build coal plants that can capture carbon and work with them to figure out how and where to sequester it.

Mr. WALDEN. Who among you is sort of up on sequestration? Because when some of us were in Europe earlier this summer, we went out to a coal plant where they were working on a sequestration facility although we didn't end up getting to see that facility itself. But my understanding is that's still pretty experimental in trying to actually sequester carbon from a coal plant.

Mr. ROMM. Yes. I mean, we haven't—the Bush Administration has FutureGen which I think is kind of a very slow process that won't demonstrate the successful integration of everything for ten years for sequestration. I think frankly a top priority of the Federal Government should be to (a) start doing demonstrations projects which I think are occurring, but (b) someone has to go out and identify and certify geologic repositories.

Mr. WALDEN. Right. In fact, that was an issue that came up in Europe. They actually have on their books in some countries, I'm told, antipollution laws and they treat carbon as a pollutant and so they have to modify their law because you can't put pollutants in the ground legally. So once they figure out how to sequester carbon, they have to fix their law because you're injecting a pollutant into the ground, a violation of law.

The other issue that came up in our discussions was not only how you resolve which could be done, but are there other liability issues that could occur? Does carbon injected in the ground force something else out that you become liable for? Does it escape at some point and therefore how do you deal with the escape gas if it does? Are you familiar with any of this?

Mr. ROMM. Sure. The answers to your questions, they are all good questions, and no one has addressed them formally in any consensus based process and I would certainly urge again the Committee or the government to pursue that aggressively because carbon dioxide is an invisible gas. It is exceedingly difficult to detect and in a worst case scenario, a massive leak of carbon dioxide would cause harm.

Mr. WALDEN. In fact, there's that lake I just saw.

Mr. ROMM. The lake in Africa, absolutely yes.

Mr. WALDEN. Where if the bubble pops, it could kill everybody around there because it would inundate them with carbon.

Mr. ROMM. So people may not be thrilled to have a large carbon dioxide repository in their backyard and, I think, setting up a certification process is a very urgent thing.

Mr. WALDEN. Good point.

Mr. ROMM. Look. It's taken—How long have we been trying to certify one nuclear repository? I don't think it was as hard to certify a carbon repository, but we're going to need dozens of them.

Mr. WALDEN. Maybe we can put them both there in the Yucca Mountain. What do you think? My time's expired, Mr. Chairman. Thank you for your comments.

The CHAIRMAN. Thanks, gentlemen. Yucca Mountain won't be storing nuclear waste in the near future. So maybe it's something that could serve a dual purpose. So here's what I'd like. I'd like each of the witnesses to give us their one minute summation on

what it is that you want the Select Committee to remember from your testimony as we move forward over the course of the next several months and couple of years looking at this issue. Let's begin with you, Mr. Boucher, if you would give us your final one minute.

Mr. BOUCHER. Thank you. Despite our position in the voluntary carbon offsets market, I think the one thing we would like to see Congress do as soon as possible is a well-designed mandatory cap and trade put in place and I think the evolving voluntary market will continue to support that. It will help folks get from whatever level is established by mandates to net zero for those who want to get there.

The other point I wanted to make is that in designing that it has to be very well designed so that the mandatory cap and trade does not strip away the benefits of renewable energy projects in particular in the same way that has occurred on SO_2 cap and trading in that basically any reduction from a renewable project goes to the benefit of the utility. The utility then has additional allowances it can sell. There has to be direct allocation of rights to the renewable energy projects, so preserve the voluntary market in that future cap and trade regime.

There has been discussion about the gold standard and I would just like to note for the record that we are working with gold standard to bring forward the first gold standard certified project in the U.S. and we expect that to happen later this year. It will be Owl Feather War Bonnet Project on the Rosebud reservation. Thank you.

The CHAIRMAN. The gentleman's time has expired. Mr. George.

Mr. GEORGE. Well, I think you should pay attention to the fact that there are sides forming on this issue. There are people who are in favor of offsets from biological forestry and other sources and there are people who are sort of in the engineering world and there's a lot of territoriality being expressed and we're not going to solve this problem if we sort of let this thing disintegrate into factions, competing factions.

We really need all of the solutions on the table. There simply isn't time to engage sort of prohibitions of certain things because we don't know enough yet when we're trying to prohibit the ability to develop that knowledge. We simply need to look at all of the possible solutions as fast as we can and find the ones that work and I think it will sort itself out.

The CHAIRMAN. Mr. Blachford.

Mr. BLACHFORD. I would echo Mr. Boucher's call for a well designed, mandatory cap and trade or a combination of cap and trade with other forms of regulation at the highest levels. I would also again just repeat my call earlier for some level of government involvement in forming better and more persistent standards for offset project quality. I think it's just essential for this market to really thrive and for these reductions to happen for there to be clear rules of the road.

My company, it's wonderful that we were invited here today, but the reality is we're six people sitting in a single room in San Francisco trying to make a difference, trying to play by the rules, and we have to have some rules so we know how to play by them. We're doing the best we can but we really could use some help.

The CHAIRMAN. Thank you, Mr. Blachford, very much. Mr. Romm.

Mr. ROMM. I mean I think I agree with the need for a mandatory regime. Obviously, it's going to take awhile to set up the rules of the road there. I think it is important for Congress to not wait until you've passed the mandatory regime to start the process of developing protocols for what are verifiable emissions reductions because that could take two or three, four or five years. So if we have to wait to, let's say, 2009 to start that process, we may not get those rules for three or four or five years after that. So if there is any way you can do some things in parallel over the next two years, I just think that would be immensely valuable.

I will make one final point. We do need to figure out a way to preserve tropic forests. They are the lungs of the planet and the deforestation that is occurring is catastrophic from a climate and many other points of view. I think you have to do that at a nationwide level. That's what the U.N. is moving towards rather than a project based level.

So I don't want to leave people with the impression that the solution to our fossil fuel problem can be solved just by planting trees. Trees could be part of the solution, but the big part of the solution is energy efficiency and renewable energy and perhaps carbon capture and storage from coal plants.

The CHAIRMAN. Thank you. Mr. Broekhoff.

Mr. BROEKHOFF. I agree with Dr. Romm. If there's a choice between developing a mandatory program over C&D voluntary market, I think the choice, the focus, should be on a mandatory market program. However in the interim period, there's a role for the voluntary market to play to provide a learning experience. In developing these kinds of protocols, I think if the Federal Government does choose to provide some oversight of this market, it should build off of the standards and programs that have been developed to date and can either take the form of endorsing one of these programs or providing some explicit guidance on the quantification protocols, the verification, accreditation of verifiers and the establishment of certification of registries so that we have a consistent carbon offset commodity that people can trust. That's what the market needs.

The CHAIRMAN. Thank you, Mr. Broekhoff, and we thank all of you. What I'm going to do on behalf of the Select Committee is write to the Federal Trade Commission and ask them to begin a public process to look at this area of voluntary offsets. There already is something in place that the FTC uses in environmental programs. I think that clearly under Section 5 of the Federal Trade Commission Act there is a place here for that agency to look to ensure that consumers get what they have as an expectation if they spend money and I hope that Chairwoman Majoras at the Federal Trade Commission will respond to that request.

This hearing has been very helpful to us. It is, I think, the first hearing that has been held on this subject and I think that it's something that's very illuminating and can be very helpful in the long run as long as there are standards which are transparent and understood by the marketplace.

So with that and the thanks of the Select Committee, this hearing is adjourned.

[Whereupon, at 11:51 a.m., the Select Committee was concluded.]

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September 20, 2007

Ms. Ali Brodsky
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Dear Ms. Brodsky:

With sincere apologies for the lateness of this reply, please see my responses to the follow-up questions submitted by the Select Committee. I appreciated the opportunity to testify before the Committee in July, and I welcome any further inquiries from members of the Committee on this or related topics.

Sincerely,

Derik Broekhoff

1) **On page two of your testimony, you state that "government oversight should not seek to limit the market, but should encourage experimentation with different types of projects subject to minimum standards." Does this seem to be a realistic delicate balance to achieve?**

The answer depends on one's view of the primary role of the voluntary offset market and what it should achieve. As explained in answer to Question 3, there are at least two competing visions for the objectives of the voluntary market. The first is to serve as a learning and experimentation ground for companies; the second is to serve as a high-quality mitigation and education tool for consumers. Under the first vision, government should seek to set minimum enforcement and verification standards (e.g., certifying the competency of verifiers), while allowing some flexibility in accounting methods and criteria. Under the second vision, more strict standards and some restrictions on accounting methods and "additionality" criteria may be warranted, at least for the segment of the market focused on meeting retail consumer demand.

2) **On page seven of your testimony, you note that people are concerned about the voluntary offset market – I would add to this to say that people should be concerned about the offset market whether it is voluntary or mandatory – because we want to be certain that offsets of either type are actually doing what they are billed to do – providing tangible environmental benefit. Do you agree that this should be the concern for all offsets?**

Absolutely, the same concerns about standards and oversight matter for all offsets, whether they are created under voluntary or mandatory programs. The distinction is that current mandatory programs have comprehensive accounting, verification, and enforcement systems for crediting emission reductions, whereas voluntary markets currently do not. As I noted in my testimony, for example, the Kyoto Protocol's Clean Development Mechanism (CDM) has clear rules, standards, and oversight mechanisms. This is part of the reason that the governments of the United Kingdom and Norway are advising voluntary offset purchasers to only buy offsets certified under the CDM (or comparable mandatory system, like the EU Emissions Trading System).

Just having clear rules and standards, of course, does not guarantee that carbon offsets will provide real emission reductions. The rules and standards must be well designed. One challenge for carbon offsets is that the answer to "how good is good enough?" is inevitably in the eye of the beholder. Carbon offset emission reductions are measured against a counterfactual baseline, i.e., the emissions that would have occurred if the market for offsets did not exist. The baseline can never be proven; instead, it must be inferred. The quality of

carbon offsets depends to a large extent on the presumed accuracy of accounting methods used to make an inference about baseline emissions.

For some types of projects, the "correct" baseline may seem obvious. For others careful analysis is required, whose accuracy will inevitably be somewhat subjective. Even the CDM, for example, has come under scrutiny concerning the accuracy of its baseline and "additionality" determinations.[1] Because some amount of subjectivity is inevitable, transparency about how baseline emissions are estimated is critical. Standardized accounting methods are ideal, because they leave little ambiguity about how emission reductions are calculated and they allow buyers to know what they are getting without researching every purchase. In the absence of standards, transparent disclosure of offset project information and the methods used to estimate baseline emissions is imperative. One way governments could enhance the credibility of voluntary offset markets is to establish basic requirements for information disclosure, e.g., based on the reporting requirements of WRI/WBCSD *GHG Protocol for Project Accounting*.[2]

Finally, because the adequacy of carbon offset accounting (and verification) rules is ultimately somewhat subjective, it is important that standards be developed in consultation with a wide range of stakeholders.[3] This is true for both mandatory and voluntary carbon offset programs.

3) You make a good point in your testimony about carbon offsets being "intangible." That being the case, don't you think that agreement on standards for how they are valued and guaranteed will be very difficult to achieve?

As my answer to the previous question suggests, the issue is not just that offset reductions are intangible, but also that they are quantified against a hypothetical baseline. The inherent subjectivity in quantifying carbon offsets has historically made agreement on standards difficult. In seeking agreement, however, it can help to break carbon offset standards down into the three components I mentioned in my testimony: (1) accounting standards; (2) monitoring and verification standards; and (3) registration and enforcement systems.

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[1] See, for example, A. Michaelowa and P. Purohit, 2007. *Additionality Determination of Indian CDM Projects*, Climate Strategies, London. http://climatestrategies.org/uploads/additionality-cdm-india-cs-version9-07.pdf.

[2] Greenhalgh, S., D. Broekhoff, and F. Daviet, 2005. *The Greenhouse Gas Protocol for Project Accounting*. World Resources Institute and World Business Council for Sustainable Development, Washington, D.C. and Geneva. Available at: http://www.ghgprotocol.org.

[3] For an example of stakeholder consultation requirements for carbon offset standards, see *The Green-e Greenhouse Gas Emission Reduction Product Certification Program Standard, Version 1.0*, specifically the requirements under "Principle 1: Transparent Program Development." Available at: http://www.green-e.org/getcert_ghg_standard.shtml.

It should be relatively easy, for example, to reach agreement on registration and enforcement mechanisms, the requirements of which are listed on page 10 of my testimony. These mechanisms are necessary to provide buyers and sellers of offsets a credible claim to the ownership of emission reductions. The design requirements of a registry are largely technical and legal in nature, and do not have to depend on the specifics of accounting and verification standards. Standards for offset registries should, however, specify the types of information that must be tracked and disclosed about offset projects and their associated reductions. Reaching agreement on these standards should not be difficult, and models for such an agreement already exist or will soon be forthcoming.[4]

Likewise, many aspects of monitoring and verification (M&V) standards are technical in nature and can be relatively easily agreed. There already exists an independent, international standard for assessing the competency of entities that verify projects involving GHG emissions (ISO 14065).[5] This accreditation standard could be referenced in establishing a comprehensive "commodity" standard for carbon offsets. A similar standard exists for the general technical and procedural requirements of verifying GHG emission reduction claims (ISO 14064, Part 3).[6] The questions of greatest contention in setting M&V standards concern the required frequency of verification, and the levels of documentation required.[7] Answering these questions involves making tradeoffs between obtaining accurate information, and imposing costs on offset suppliers. While there are likely to be different points of view among stakeholders on where the right balance is, the issue is not insurmountable. For a functioning market, the most important thing is to have consistent standards for minimum levels of frequency and documentation.

The most difficult component of carbon offset standards to agree on involves accounting for GHG reductions (including methods for estimating baseline emissions and determining additionality). The reason is that the sufficiency of these standards depends on the overall level of confidence they provide, not on their closeness to a technically or objectively ascertainable number. Furthermore, deciding on their sufficiency involves considerations about the overall objectives for a carbon offset market. As noted in the WRI / WBCSD *GHG Protocol for Project Accounting*, "[carbon offset] accounting necessarily involves making decisions that directly relate to policy choices faced by GHG programs. These policy choices involve tradeoffs between environmental integrity, program participation, program development costs, and administrative burdens."[8] The right additionality criteria, for example, can

[4] For example, the California Climate Action registry is already set up to register information about offset projects and their emission reductions; the Voluntary Carbon Standard will establish basic requirements for voluntary offset registries, including serializing and tracking emission reductions.
[5] Available at http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=40685
[6] Available at http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=38700
[7] ISO 14064, Part 3 is flexible on these questions.
[8] *Greenhouse Gas Protocol for Project Accounting*, p. 18.

depend on whether one is more concerned about pure environmental integrity, or about maximizing the size and overall level of investment in the offset market, which in turn may depend on one's expectations about overall demand for carbon offsets.[9]

In the voluntary market, there are likely to be a diversity of perspectives on what the right balance is. Furthermore, there is no central authority to reconcile different points of view and decide on the overall "purpose" of the voluntary offset market. At the broadest level, there are two possible visions for the voluntary market and what it should accomplish:

1. *A Learning Laboratory for Companies.* Under this vision, the notion is that voluntary offset markets should primarily serve to allow companies to learn about GHG emissions markets generally, and offset credit generation and trading in particular. The function of the market should be to encourage experimentation and investment in new technologies, and innovation in methods used to quantify and guarantee reductions. Under this vision, environmental integrity is important, but flexibility and open participation are equally important objectives. Accounting and verification standards should not have to be as strict as they would be under a mandatory program. Until the recent upsurge in demand for retail offsets and "carbon neutral" products, this was the dominant model for the voluntary offset market.

2. *An Environmental Mitigation and Education Tool.* Under this vision, the voluntary offset market's main purpose is to provide general consumers (retail buyers, or companies with carbon neutral products) with a high-integrity product for helping them to mitigate climate change. The market should serve a public education role, not only with respect to knowledge about climate change and ways to avoid it, but also with respect to the role that markets can play in delivering climate change solutions. Under this vision, the voluntary offset market would serve as the "public face" of emissions trading and market mechanisms for addressing pollution. In this role, strict environmental integrity is paramount in order to build public trust in market institutions. Arguably, accounting and verification standards should be as, or more, strict as they would be under a mandatory program.

These two visions are competing, and while it is possible they can co-exist to some extent, they lead to very different conclusions about where to strike the balance on the sufficiency of accounting standards. Even if the federal government were to refrain from specifying the exact methods and tests that must be used to quantify emission reductions – which would be necessary for

[9] See Trexler, M., D. Broekhoff, and L. Kosloff, 2006. "A Statistically-Driven Approach to Offset-Based GHG Additionality Determinations: What Can We Learn?" in *Sustainable Development Law & Policy,* Volume VI, Issue 2, Winter 2006.

a true "standard" – it could help tremendously by setting out a preferred vision for the voluntary market (or different segments of the market), against which accounting methods could be assessed. Reaching agreement on this vision could be relatively easy.

One possibility might be to establish minimum registry and verification requirements for all voluntary offsets, while restricting the types of offsets that could be used to serve the retail market (e.g., by limiting eligible projects to those in categories with high additionality and quantifiability).

4) You also note that there are sector specific standards. In your testimony you mention work you have done on land use and forestry and on renewable energy and energy efficiency. How many potential sector specific standards would there have to be?

In theory, the number of sector-specific standards could be quite large. The Kyoto Protocol's Clean Development Mechanism (CDM) has so far approved 57 different sector-specific methodologies, along with 13 "consolidated" methodologies for projects in sectors sharing broadly similar characteristics.[10] More CDM methodologies are in development.

Initially, however, it generally makes sense to focus on developing standards for sectors with the greatest potential for providing credible emission reductions. The Northeast Regional Greenhouse Gas Initiative has developed standards for five different sectors (landfill methane, agricultural methane, afforestation, electric utility SF_6 reductions, and end-use thermal energy efficiency projects). The U.S. EPA Climate Leaders program has developed draft standards for a similar set of sectors, as has the Chicago Climate Exchange. The California Climate Action Registry has developed standards for agricultural methane and forestry projects.

As noted in answer to Questions 1 and 3, it might be desirable to limit eligible sectors in the retail voluntary offset market to those where there is high confidence in the additionality and quantifiablity of emission reductions. In this case, the "required" number of sectoral standards could be low. If the objective for the voluntary market is to provide learning and experimentation, however, it may be desirable to allow the development and use of multiple methodologies as long as they adhere to credible accounting guidelines, such as those developed under the WRI / WBCSD *GHG Protocol for Project Accounting*.

5) On page 9 of your testimony, you state that "Very few carbon offsets sold in the voluntary market, however, explicitly follow" the World Resources

[10] http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html.

Institute protocol or the Kyoto Clean Development Mechanism methodologies. Why is that?

This situation is changing as more offset providers realize that adherence to recognized standards is essential for credibility in the marketplace. Until recently, however, many voluntary offset providers adopted accounting methods on an *ad hoc* basis suited to the specific context of their projects. In some cases, these methods have been credible and reflective of good practice, even where they do not explicitly reference established protocols. In other cases, quantification methods have been inadequate or methodologically incomplete. There are a variety of reasons why established standards may not have been followed, including perceived costs, lack of direct applicability to the types of projects being developed, or a perceived lack of need – since following the GHG Protocol or CDM methodologies outside the context of a specific offset program does not guarantee credibility or acceptance. Furthermore, buyers may not be demanding adherence to standards in some cases, instead relying more on the perceived reputation of individual providers.

6) **On the issue of "additionality," don't you think that determining if a project would have been built regardless of the offset credit is incredibly subjective? How would it be possible to even come up with a standard for that? Would there be a time limit to determine additionality? Would the project have been commercially viable and completed in 2007? 2017? 2027?**

As explained in answer to Question 2, determinations about additionality and emissions baselines will always be somewhat subjective. This does not mean, however, that we cannot be reasonably confident about additionality under some circumstances, and where certain criteria are met. Consider a project that flares methane emitted from an abandoned coalmine, in an area where such flaring is not legally required and there are no other reasons (such as safety concerns) for installing flaring equipment. We can be confident that this project would not have occurred in the absence of any offset credits, because it would involve costs without any reward.

There are two basic approaches to testing for additionality. *Project-specific* tests seek to assess, by weighing certain evidence, whether a project in fact differs from an imagined "business-as-usual" (BAU) scenario (i.e., where there is no carbon offset market). Generally, the project and its potential alternatives are subjected to a comparative analysis of their implementation barriers and/or expected benefits (e.g., financial returns). If an option other than the project itself is identified as the most likely alternative for the BAU scenario, the project is considered additional. Project-specific additionality tests can be effective, but the interpretation of their results is always somewhat subjective.

Standardized tests seek to determine additionality by establishing objective criteria that non-additional projects are not likely to meet. For example, a standardized test may count as "additional" any project that:

- Is not mandated by law
- Is not a least-cost option
- Is not common practice
- Involves a particular type of technology
- Is of a certain size
- Is initiated after a certain date
- Has an emission rate lower than most others in its class

The advantage of standardized tests is that little subjectivity is required to interpret their results – projects are either in or out. Subjectivity is still unavoidable, however, in deciding the right set of tests. Furthermore, standardized tests must still be tailored to specific categories of projects. For methane flaring projects like the one described above, it may be sufficient simply to exclude projects not required by law. For renewable energy projects, it may be necessary to develop a whole set of criteria to confidently "zero in" on the set of additional projects. There is no "one size fits all" test for additionality.

Finally, no set of additionality tests – project-specific or standardized – is ever perfect. Some non-additional projects will be mistakenly credited with offsets, while some additional projects will be mistakenly excluded. As suggested in answer to Question 3, one way that government can assist voluntary offset markets is to provide guidance on the extent to which additionality tests should err on one side or the other.[11]

7) **On page 10 of your written statement, you mention the concern that there are not many credible verifiers for the data on carbon offsets, which is true for emissions accounting also, isn't it? Do you recognize that before any mandatory requirements are put in place, should we go down that path, that we should be certain that the integrity of data for both emissions and offsets be well documented and validated?**

Institutional structures for the accurate monitoring and verification of emissions are a critical component of any emissions trading system, whether such systems involve carbon offsets or tradable permits under a "cap-and-trade" program. Although there are few U.S.-based organizations with extensive experience in validating and verifying voluntary carbon offset projects, the United States has unparalleled experience with the design of

[11] For further discussion of this idea, see Trexler, M., D. Broekhoff, and L. Kosloff, 2006. "A Statistically-Driven Approach to Offset-Based GHG Additionality Determinations: What Can We Learn?" in *Sustainable Development Law & Policy,* Volume VI, Issue 2, Winter 2006.

systems to monitor, report, and verify emissions as a basis for cap-and-trade programs.[12]

8) Also on page 10 of your testimony, when you discuss registration and enforcement, you mention serial numbers for offsets. I am being a little facetious here, but how do you expect to assign serial numbers to something that is often so intangible? My point is, because of the nature of offsets, I think we need to be realistic about how difficult this may be to achieve. Do you agree that it is a difficult task with many types of offsets?

In an offset registry system, serial numbers are assigned to each verified ton of CO_2-equivalent emission reductions that has been quantified against a validly reported baseline. When an offset reduction is sold, the serial number and "credit" for the reduction is transferred from the account of the seller to an account for the buyer. If they buyer "uses" the credit by claiming it as an offset against their own emissions, the registry retires the serial number so that the credit cannot be resold.

There will always be some uncertainty involved in quantifying carbon offset reductions (as described in answer to Question 2). The point of assigning serial numbers to reductions after they are quantified, however, is to give them a unique identifier so that buyers will know that the same verified reductions have not been sold to multiple parties. (Serial numbers should also allow buyers to know precisely which project generated the reduction.)

There are still risks. Offset suppliers could potentially register the same verified reductions in multiple registries. Buyers may announce they have used offset credits without informing the registry to retire them – and then resell the credits to an unwitting third party. Government oversight of the voluntary market may be necessary to fully allay concerns about these potential fraudulent practices. The assigning of serial numbers for every officially verified emission reduction, however, is not complicated. A registry for this purpose has already been established, for example, under the CDM.[13]

9) On the issues of potential environmental impacts of offset projects – would you say that Wind energy is a good offset even though the wind turbines have the potential to harm birds? And would you support hydro power which has the potential to harm fish habitat?

These are issues that need to be carefully considered in designing eligibility rules for offset projects. In the voluntary market, offset buyers generally will not want to support projects that are seen to have adverse local environmental,

[12] See, for example, J. Schakenbach, R. Vollaro, and R. Forte, 2006. "Fundamentals of Successful Monitoring, Reporting, and Verification under a Cap-and-Trade Program," in *Journal of the Air and Waste Management Association*, 56:1576-1583, November 2006.

[13] http://cdm.unfccc.int/Issuance/IssuanceCERs.html.

social, and economic effects. Nevertheless, there may be circumstances where explicit prohibitions are warranted where matters of public interest are at stake and where existing laws and regulations are insufficient to address them. Not all wind and hydro projects have the adverse effects described, so it would probably not make sense to categorically exclude such projects from voluntary offset markets.

10) In your opinion, doesn't the Gold Standard certification also meet all three required standards that you stated in your testimony?

The Gold Standard, primarily by reference to the CDM, has clear standards for GHG reduction accounting and for monitoring and verification. It does not yet have an established registry to provide publicly reviewable information on projects and to track the transfer and sale of carbon offset credits. The Gold Standard recently issued a request for proposals to establish such a registry.

It should be noted that the Gold Standard only recognizes offset reductions from renewable energy and energy efficiency projects. If the United States were to implement a cap-and-trade program covering the electricity generation sector, domestic offsets from these types of projects would not be valid because they would only free up allowances to be used at a later time, not result in permanent emission reductions.[14]

11) If the goal of carbon offsets is to achieve emission reduction at the lowest cost, why not include nuclear technology which, other than hydro, is the only proven CO2 emissions-free power source?

If the only goal of carbon offsets were to achieve emission reductions at lowest cost, then there would be no reason in principle to exclude nuclear energy projects. Most offset programs, however – and a large number of voluntary offset buyers – want to encourage more than just low cost emissions reductions. Other objectives for carbon offsets include:

- Promoting reduction opportunities involving new and innovative technologies and practices;
- Promoting secondary social, economic, and environmental objectives (e.g., "sustainable development");
- Generating public relations benefits.

Against these objectives, nuclear energy projects may not fare as well as some other potential project categories.

[14] See page 13 of my original testimony.



www.terrapass.com

September 11, 2007

Ms. Ali Brodsky
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Dear Ms. Brodsky:

I appreciated the opportunity to testify before the Select Committee on July 18. Now I am pleased to respond to additional questions submitted by Committee members (see attached). TerraPass looks forward to participating in further discussions about the voluntary carbon offset market and related climate change issues.

Sincerely,

Erik Blachford
CEO
TerraPass Inc.



www.terrapass.com

1) What percentage of funds that folks pay for your offsets go to your administrative costs versus the actual offset that you provide?

As a retailer, we charge our customers a competitive price per metric ton of carbon offset, and then buy the appropriate amount of carbon credits at the then-current market rate to ensure that we fulfill our customer promise. We charge customers approximately $9/ton, which is at the low end of a market that ranges from $0.45/ton to $45/ton according to a recent industry survey. Our price includes the customer service and fulfillment costs of a consumer retail organization. Other companies selling primarily to corporations or acting as wholesalers charge lower rates, but these are not generally available to individual consumers.

In line with industry practice, we do not release our gross margin for competitive reasons. The mix of for-profit and nonprofit enterprises in our industry, and their heterogeneous accounting practices, make comparisons across organizations difficult. Although we are a for-profit company, to simplify comparison we estimate that, according to standard nonprofit accounting techniques, over 90% of our total income goes to offset programs and related educational activities.

2) How do you come up with your baseline measurements for the amount of carbon reduction benefit you provide?

Our projects use baselines established by the best standards available in the marketplace. The baseline for wind is established by guidance from the nonprofit Center for Resource Solutions (CRS) and uses a regional grid emissions factor consistent with international treatment of renewable-based offset claims. For anaerobic digestion and landfill gas projects, we use the baselines required in the Chicago Climate Exchange protocols against which projects are verified.

On a sales level, our customers calculate their carbon impacts using calculators on our web site. We use a variety of industry-standard protocols in our calculations, including those developed by the World Resources Institute and the World Business Council for Sustainable Development. We also rely on data from the U.S. Environmental Protection Agency and the U.S. Department of Energy.

3) Besides the standards assessment, what else goes into choosing the projects that you fund?

Selling offsets based on standards is a core focus of our selection process. Our wind projects are certified under the Green-e program of the CRS. Projects involving anaerobic digestion of methane at dairies and landfill gas flaring are verified by SES, Inc. or First Environment, Inc. following procedures approved by the Chicago Climate Exchange offset committee.

Additionally, for all projects, we adhere to a matched-maturity principle, i.e., the offsets we sell are generated in the same year that customers purchase them. This functionally precludes tree-planting initiatives, which don't produce substantial carbon reductions until well into the future. We also examine all projects through a separate additionality screen (see Q. 5).

4) Do your offsets result from specific emissions reductions or from sequestration?

At present, all of our offsets result from specific emission reductions. We may consider sequestration projects when project results and the science underlying them are more widely accepted.

5) Are there any projects in your portfolio that would not have happened without a greenhouse gas offset market?

We apply a set of additionality tests to 100% of the projects in our portfolio to ensure that our customers' purchases have the intended environmental benefit. At present, our additionality test methodology is based on processes informed by emerging and established standards in the U.S. and tests developed for the international carbon markets. TerraPass also actively contributes to the development of industry offset standards, and we anticipate refining our project portfolio to meet such standards as soon as they are ready for retail adoption.

6) Do you provide any guarantees to your clients? What sort of follow-up information does your company provide?

Yes. We provide a money-back guarantee if a customer is unsatisfied for any reason. We also provide a Product Content Label that includes a detailed specification of the amount and source of offsets a customer has paid for, as well as the phone number of our third-party auditor (example attached). The Product Content Label is a requirement of our third-party verification process and the language has been inspected and approved by our outside auditor to meet consumer protection standards.

7) Is there a correlation between the cost of the offset and the quality of it?

The relationship between offset cost and quality is complex. We follow these rules: a) diligence is required with any offset purchase; and b) if something appears too good to be true, it probably is. At the low end of the market, such a correlation definitely exists. Carbon at $0.45/ton won't include the minimal oversight necessary to ensure quality. Carbon at $45/ton, on the other hand, generally comes from "boutique" projects that don't necessarily have greater environmental quality, but instead offer special value to particular buyers because of their secondary characteristics.

In the broad middle, offset prices are driven by a combination of quality measures, underlying project costs, and demand. In the present market, purchasers either conduct a diligence process or use a trusted intermediary.

8) What kind of transparency do you adhere to for projects, their validation, the costs of the offset and the like?

We list all of our projects on our web site and identify each carbon transaction (date, source, and amount). As reported above, we include a Product Content Label specifying the source and amount of offsets with every product we sell. In addition, CRS audits our transactions to insure that our carbon purchases equal the obligations to our customers. We publish an annual verification report on our web site. Finally, CRS also reviews the claims made in our marketing and communication materials.

9) What entity serves as your third-party validation firm? Do you find that there are a growing number of validation firms to choose from?

SES, Inc. and First Environment, Inc. are two firms we currently use. All major international verifiers, and especially U.N. Designated Operational Entities (DOEs) are currently seeking to expand in the United States in anticipation of a compliance carbon market.

10) Do you have any concerns about wind power's potential to harm birds?

No. Historically, a few wind projects have had an unacceptable impact on local wildlife. Fortunately, we now have a long history with wind development in the United States, resulting in technological and siting improvements that help to minimize threats to birds, especially during migration seasons. New wind projects undergo extensive environmental impact assessments prior to construction. Of course, it is essential to consider the environmental impact of any renewable energy project, but we note that energy generated

from fossil fuel also has a severe wildlife impact. In short, we believe that wind power's benefits outweigh its potential for harm.

11) How do you validate the emissions reductions that you purchase from corporations and municipalities?

We don't currently purchase any such reductions that are not governed by the established protocols mentioned in questions 2 and 3.

12) On the issue of tree planting – do you preclude tree planting as on offset because it doesn't fit in your business model or because you don't think tree planting is ever a valid carbon offset?

At this time, tree-planting projects do not meet the quality criteria we adhere to in our carbon portfolio nor the brand attributes of TerraPass. However, forestry projects are not in conflict with our business model and we continue to monitor the evolving science and policy framework around trees.

13) On page 10 of your written statement you note that "the voluntary market is a useful laboratory for policy innovation and experimentation that can eventually be incorporated into formal legislation." Do you have concerns that government regulations might serve to stifle innovations by forcing possible entrepreneurs to jump through too many regulatory hoops?

Such concerns are valid. A successful set of regulations will have four properties: 1) sufficiently low transaction costs to ensure adequate supply of projects; 2) clear and timely project approval methodologies so that project entrepreneurs don't face unnecessary capital risk; 3) a flexible mechanism for approving new project types to encourage innovation in the market; and 4) stringent criteria to ensure environmental integrity and consumer protection.

These four properties -- and particularly the last one -- are not necessarily in perfect alignment, and it would be possible to design regulations that stifle the market. Nevertheless, we believe the benefits of government oversight over clear quality standards and consumer protection standards in our industry will outweigh any potential operational inefficiencies that result from that oversight.

Product content label: Cross Towner TerraPass

TerraPass is a Carbon Dioxide (CO2) offset product for vehicles. CO2 is a greenhouse gas (GHG) that contributes to global warming. According to the U.S. Environmental Protection Agency, vehicles release about 10,000 pounds of CO2 to the atmosphere per year on average. However, more efficient vehicles emit fewer pounds of CO2 and less efficient vehicles emit more. For each Cross Towner TerraPass purchased, 8,000 lbs of CO2 reductions are purchased and retired on your behalf. TerraPass does not actually reduce the CO2 emissions from your vehicle, but offsets the release of 8,000 lbs of CO2 emissions elsewhere. TerraPass will not prevent the release of or offset the emissions of other harmful pollutants from your vehicle, such as particulate matter, lead and nitrous oxide (NOx). This product matches 100% of your vehicle's estimated CO2 annual emissions.

This product is comprised of the following mix of RECs and carbon credits:

Renewable Energy Certificates

An REC represents the environmental attributes associated with a unit of renewable electricity. For every unit of renewable electricity generated, an equivalent amount of RECs are created. The purchase of RECs supports renewable electricity generation, which helps offset conventional electricity in the region where the renewable generator is located. RECs can be quantified in tons of CO2 based on regional data provided by the Department of Energy's E-GRID program.

Percentage	Total kWh	Pounds of CO_2
33.3%	1411 - 3313	2,667

Renewable Resources	General Location
Wind	Nationwide

The Green-e Program certifies that the RECs used in this product meet the minimum environmental and consumer protection standards established by the non-profit Center for Resource Solutions. For more information on Green-e certification requirements, call 1-888-63-GREEN or log onto www.green-e.org.



33% Renewable

Carbon credit offsets

A Carbon Credit Offset represents the reduction of one unit of carbon (typically a metric ton) from a baseline scenario or regulatory requirement by an emitting entity. A lynchpin feature of the Kyoto Protocol, Carbon Credits rely on the concept of flexible trading to allow that a market based system directs funding to the lowest marginal cost project areas.

Carbon Credits can be generated when a corporation or organization makes a reduction of carbon beyond a baseline scenario. The purchase of Carbon Credits helps support carbon reduction by giving a payment for each unit of carbon reduced beyond a baseline scenario. Where a protocol is available, TerraPass Carbon Credit Offsets are registered, and retired on the Chicago Climate Exchange.

Percentage	Purchasing Market	Pounds of CO_2
66.7%	CCX or bilateral contracts adhering to CCX protocols	5,333

Carbon Credit Resources	General Location
Biomass (including agricultural and landfill methane abatement and biofuels)	Nationwide
Industrial efficiency	Nationwide

For specific information about this product, you may contact TerraPass toll free at



September 12, 2007

Ms. Ali Brodsky
Chief Clerk
Select Committee on Energy Independence and Global Warming
(202) 225-4012

By email: Aliya.Brodsky@mail.house.gov

Dear Ms. Brodsky:

As a follow-up to our letter of September 11, please be advised that we have confirmed the actual amount of the U.S. Dept. of Energy grant to the Three Affiliated Tribes Single Turbine Project was $230,824. We also understand that the Essex Junction Wastewater Treatment Plant project received a U.S. Dept. of Energy grant that covered approximately 2% of the project cost. Should the committee have any more questions or issues you would like to have addressed, please contact me at your convenience.

Very truly yours,

Tom Boucher
President & CEO