STATEMENT OF

JOSEPH ROMM

SENIOR FELLOW

CENTER FOR AMERICAN PROGRESS

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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.
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> 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.
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> 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….
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> 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.
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> 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.
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> 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.
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> 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….
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> 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.