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TESTIMONY BEFORE THE SENATE SUBCOMMITTEE ON RURAL REVITALIZATION, CONSERVATION, FORESTRY, AND CREDIT OF THE UNITED STATES SENATE COMMITTEE ON AGRICULTURE, NUTRITION, AND FORESTRY

"CREATING JOBS WITH CLIMATE SOLUTIONS: HOW AGRICULTURE AND FORESTRY CAN HELP LOWER COSTS IN A LOW-CARBON ECONOMY"
MAY 21, 2008

Executive Summary

Carbon offsets can be an effective tool for lowering the costs of compliance in a cap-and-trade program, and are already being widely used internationally to comply with greenhouse gas emissions targets. To function well and maintain the integrity of a cap-and-trade system, carbon offsets must adhere to certain basic criteria and standards defining how they are quantified and certified. A number of programs around the world have begun developing such standards, but these standards would have to be carefully evaluated before being adopted under a U.S. regulatory program. Carbon offsets can come from many types of projects that reduce or sequester emissions. Some types of projects face higher quantification uncertainties than others, however, necessitating higher transaction costs in certifying the offsets they generate. These projects include certain types of forestry and agriculture carbon sequestration projects, which are subject to greater measurement and baseline uncertainties, reversibility, and leakage compared to other projects. It may be preferable in some cases fund these projects using direct payments rather than an offset market, in order to avoid costs of reducing uncertainties and lower the total cost of achieving emission reductions.

What are carbon offsets?

A "carbon offset" is a reduction in greenhouse gas (GHG) emissions that is achieved to compensate for, or "offset," GHG emissions occurring at other sources.[1] In a cap-and-trade system, carbon offsets allow emissions from regulated sources to increase above levels set by the cap, on the premise that those increases are compensated by reductions achieved at unregulated sources. Because reducing emissions at unregulated sources is often less costly, carbon offsets can lower the total cost of achieving an overall net emissions goal.

In an emissions market, carbon offsets can be traded in the form of certified "credits" or "offset allowances." One credit usually denotes a reduction in GHG emissions equivalent to one metric ton of carbon dioxide (CO_2). The terms "offset credit," "offset allowance," and "carbon offset"

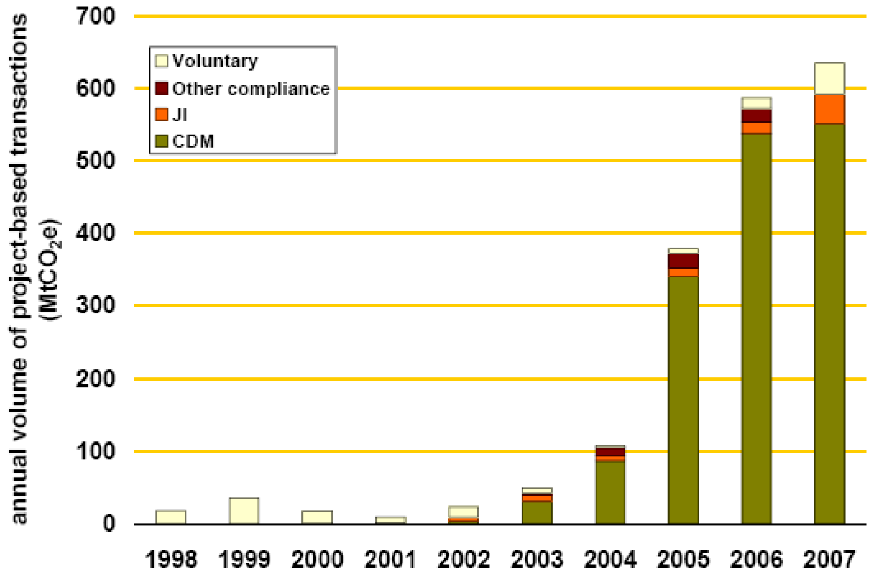
[1] Because the effect of greenhouse gases is global, it does not matter where they are reduced. Carbon offsets can also involve the removal of CO_2 (the primary GHG responsible for climate change) from the atmosphere by activities that sequester carbon, including tree planting.

are often used interchangeably. In most cases, offset credits are issued for reductions achieved by specific projects, i.e., “offset projects”. In order to receive credits, the project owners must demonstrate that they have reduced emissions according to predefined rules and procedures. In principle, a wide variety of projects can generate carbon offsets. Examples include, but are not limited to:

- Capturing methane created by landfills and flaring it or using it to produce energy (thus displacing fossil fuel combustion);
- Installing equipment at chemical factories to capture and destroy industrial GHGs, such as HFCs or N_2O.
- Switching from high carbon-intensity fuels (e.g., coal) to fuels with low or zero net carbon emissions (e.g., biofuels) for energy production or transportation.
- Improving the efficiency of energy production from fossil fuels, e.g., by upgrading commercial or industrial boilers, or exploiting opportunities to combine the production of heat and power.
- Deploying equipment or appliances that use less energy (e.g., high-efficiency air conditioners or fluorescent light bulbs) and reduce demand for fossil fuels.
- Planting trees or adopting forestry or land management practices that remove carbon dioxide from the atmosphere and sequester it.

Globally, markets for carbon offsets have grown rapidly over the last five years (Figure 1). The largest of these markets was created by the “Clean Development Mechanism” (CDM) established under the Kyoto Protocol. Through the CDM, emission reductions in developing countries can be used to offset emissions in industrialized countries, whose total emissions are capped by the Kyoto Protocol. The CDM effectively allows industrialized countries to achieve their emissions targets through a combination of domestic and foreign reductions. 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.

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



A separate global market for carbon offsets has arisen to meet voluntary demand for GHG emission reductions. The voluntary offset market is driven by companies and individuals seeking to help avert climate change outside any regulatory obligation to do so.[2] Although this market is growing rapidly, it has struggled with a proliferation of different standards and lack of consistent guidance on what constitutes a credible offset.[3]

What are the basic requirements for carbon offsets?

To have a functioning market for carbon offsets, clear rules and procedures are required defining their creation and certification. Although these rules and procedures can differ from program to program, most of the literature on carbon offsets refers to a core set of basic criteria, derived from criteria established under the 1977 Clean Air Act. Specifically, offsets must be "real, surplus (or additional), verifiable, permanent, and enforceable" in order to maintain the integrity of an emissions trading system.[4] Interpretations of these criteria vary, but their essence can be summed up as follows:

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[2] Hamilton, K., *et al.*, 2008. *Forging a Frontier: State of the Voluntary Carbon Markets 2008*. Ecosystem Marketplace and New Carbon Finance. http://ecosystemmarketplace.com/

[3] Ibid.; Kollmuss, A., *et al.*, 2008. *Making Sense of the Voluntary Carbon Market: A Comparison of Carbon Offset Standards*. World Wildlife Fund, Germany.

[4] The concept of air 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. Current carbon offset programs (including for example, the one established by the Regional Greenhouse Gas Initiative in the Northeastern United States) generally require that offsets must be "real, surplus, verifiable, permanent, and enforceable" or some close variation

Real

An offset credit must represent an actual net emission reduction, and should not be an artifact of incomplete or inaccurate emissions accounting. In practice, this means methods for quantifying emission reductions should be conservative to avoid overstating a project's effects. It also means that the effects of a project on GHG emissions must be comprehensively accounted for.[5] Some projects may reduce GHG emissions at one source, for example, only to cause emissions to increase at other sources. A frequently cited example would be a forest protection project that simply shifts logging activities to other forest land, causing little net decrease in carbon emissions. Unintended increases in GHG emissions caused by a project are often referred to as "leakage." For carbon offsets to be real, they must be quantified in ways that account for leakage.

Additional

Only emission reductions that are a response to the incentives created a carbon offset market should be certified as offsets. Reductions that would occur regardless of an offset market (e.g., those that result from "business as usual" practices) should not be counted. The rationale for this is straightforward. The basic premise of carbon offsets is that they maintain net GHG emissions at a level set by a trading system's cap. Total emissions should be the same with or without an offset program. Since offset credits allow regulated sources in a cap-and-trade system to increase their emissions, offset reductions must be "additional" in order to maintain net emission levels. Crediting reductions that would happen anyway will result in higher total emissions than a cap-and-trade program without offsets.

Although this general concept (called "additionality") is straightforward, it is vexingly difficult to put into practice. Determining which projects (and therefore which reductions) would not have occurred in the absence of an offset market is frequently challenging and always subjective. Within existing carbon offset programs, there are two basic approaches to determining "additionality": project-specific and standardized.[6]

Project-specific approaches seek to assess, by weighing certain kinds of evidence, whether a project in fact differs from an imagined baseline scenario where there is no carbon offset market. Generally, a project and its possible 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 baseline scenario, the project is considered additional. The Kyoto Protocol's CDM requires project-specific additionality tests.

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thereof. See, for example, Liepa, I., 2002. *Greenhouse Gas Offsets: An Introduction to Core Elements of an Offset Rule*. Climate Change Central, Alberta, Canada.

[5] For a full elaboration of quantification and accounting principles for offset projects, see World Resources Institute and World Business Council for Sustainable Development, 2005. *The Greenhouse Gas Protocol for Project Accounting*. Washington, D.C. / Geneva, Chapter 4. Available at http://www.ghgprotocol.org.

[6] International Emissions Trading Association, 2007. *Expanding Global Emissions Trading: Prospects for Standardized Carbon Offset Crediting*. Prepared by World Resources Institute, Washington, DC. http://www.ieta.org/ieta/www/pages/getfile.php?docID=2730

Standardized approaches evaluate projects against objective criteria designed to exclude non-additional projects and include additional ones. For example, a standardized test may count as "additional" any project that:

- Is not mandated by law
- Is not a "least-cost" option (objectively defined)
- Is not common practice (objectively defined)
- 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 (e.g., relative to a performance standard)

Several U.S.-based carbon offset programs (including the California Climate Action Registry, the Chicago Climate Exchange, and the Regional Greenhouse Gas Initiative) have adopted standardized additionality tests. It is also possible to combine project-specific and standardized approaches.

Verifiable

Carbon offsets should result from projects whose performance and effects can be readily monitored and verified. Verification is necessary to demonstrate that emission reductions have actually occurred and can therefore be used to offset emission increases at regulated sources. Verification helps ensure that offset reductions are "real" and not overestimated. Because of the importance of maintaining net emissions levels within a trading system, projects whose effects are difficult to verify – or whose effects cannot be measured with reasonable precision – may not be suitable for generating carbon offsets.

Permanent

Since emission increases are effectively permanent (e.g., fossil fuel emissions cannot be put back in the ground), offsetting emission reductions should be permanent as well. Permanence is only an issue where the effects of a project can be reversed, such as forestry projects where carbon stored in trees or soils can be released to the atmosphere due to fires, harvesting, or other disturbances. In these cases, a mechanism is required to make reversible reductions/removals functionally equivalent to permanent reductions for the purpose of issuing offset credits. There are at least three possible ways to do this:

1. *Issuing credits on a discounted basis*. For example, only one credit is issued for every two tons of CO_2 sequestered in trees or soils.[7] Although this approach has been proposed in the literature,[8] it has not been put into practice within existing offset programs.
2. *Issuing temporary or expiring credits*. Credits for reversible reductions can be made to expire at a predefined date, or canceled if verification indicates that a reversal has occurred. In both cases, the holder of the credits would have to procure other credits or allowances in order to remain in compliance with the cap-and-trade system. This approach has been adopted by the CDM for reforestation and afforestation projects.

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[7] There are different ways to calculate the discount. Under most proposals, a discount would be given based on how long carbon is expected to be sequestered relative to its average residence time in the atmosphere (e.g., 100 years).

[8] For example, see Fearnside, P.M., 2002. "Why a 100-year time horizon should be used for global warming mitigation calculations." *Mitigation and Adaptation Strategies for Global Change* 7(1): 19-30.

3. *Establishing an insurance or buffer system*. Buyers or sellers of reversible reductions could be required to buy "insurance" in some form to compensate for reversals, or establish carbon sequestration buffers that serve the same function. There are many ways these mechanisms can be structured, and they may be combined with requirements for landowners to commit to maintaining carbon stocks over the long term (e.g., through easements). The U.S. Regional Greenhouse Gas Initiative has adopted this approach for reforestation projects.

It is worth noting that all of these mechanisms have the effect of either increasing costs for project developers or reducing the amount of compensation they receive per ton of emissions reduced or removed from the atmosphere.

Enforceable
Carbon offsets should be backed by regulations and tracking systems that define their creation and ownership, and provide for transparency. Clear definitions of ownership are essential for enforceability. For example, both the manufacturer and the installer of energy efficient light bulbs might want to claim the emission reductions caused by the light bulbs – as might the owners of the power plants where the reductions actually occur. Regulatory rules must establish who has claim to emission reductions, who is ultimately responsible for ensuring project performance, who is responsible for project verification, and who is liable in the case of reversals.

How can these requirements be realized?

To create a functioning market for carbon offsets, the criteria outlined above must be elaborated in set of standards and those standards administered by a regulatory body responsible for certifying and issuing offset credits. Standards are required to create a carbon offset "commodity" that is as uniform as possible, i.e., one offset credit equal to one ton of CO_2-equivalent emission reductions regardless of where it is sourced. Three related sets of standards are necessary to fully define a carbon offset commodity:[9]

1. **Procedural and technical standards.** These are standards related to the validation, monitoring, and verification of offset projects, as well as the certification and crediting of GHG reductions. Procedural and technical standards ensure that offsets are ***verifiable***.
2. **Contractual standards**. These are standards for the establishment and transfer of property rights related to carbon offsets, for information disclosure, and for the assignment of liability. They can include terms for payment and delivery, allocation of risk, and compensation where emission reductions are reversed or not realized.

[9] In addition to establishing these standards, many carbon offset programs will impose eligibility criteria for offset projects intended to ensure that they are compatible with goals beyond simply reducing GHG emissions. Eligibility criteria may exclude certain types of projects based on secondary environmental or social concerns (e.g., nuclear waste, or community displacement caused by hydro reservoirs), or they may ensure that projects contribute to additional social, economic, and environmental objectives (e.g., "sustainable development"). While these criteria are ancillary to defining a carbon offset with respect to climate change impacts, they nevertheless help to define the "commodity" within a particular program and may be particularly important in the context of linking to other trading systems.

Contractual standards are necessary to avoid double-counting of reductions and double-issuance of credits, and ensure that offsets are ***enforceable***.

3. **Accounting standards.** These are standards related to the actual quantification of carbon offsets. Accounting standards specify methods for defining quantification boundaries, estimating baseline emissions, and correcting for unintended changes in emissions (i.e., "leakage"). Accounting standards also cover methods for demonstrating "additionality." Finally, they may specify methods for treating reversible GHG reductions on an equal footing with permanent reductions. Accounting standards are a first-order requirement for ensuring that "a ton is a ton" and ensure that offsets are ***real, surplus, and permanent***.

Are there existing standards for carbon offsets?

Yes, in fact there are quite a number. The challenge is deciding which ones might be sufficiently stringent and credible for a U.S. regulatory offset program. Current offset programs (both mandatory and voluntary) are probably most diverse in terms of accounting standards.

Internationally, an extensive amount of work has been done to clarify the basic requirements of carbon offset accounting. Two salient examples of this work are the *Greenhouse Gas Protocol for Project Accounting* ("Project Protocol"), developed by the World Resources Institute (WRI) and World Business Council for Sustainable Development (WBCSD), and the ISO 14064 (Part 2) standard developed by the International Organization for Standardization – both of which provide a general framework for quantifying emission reductions from offset projects.[10] To specify a truly standardized commodity for carbon offsets, however, requires elaborating these general requirements into "methodologies" or protocols aimed at specific types of projects. Such protocols streamline the quantification process, taking into account data requirements and analysis relevant to a particular project type.

WRI/WBCSD *Project Protocol* includes two sector-specific supplements, aimed at grid-connected electricity projects and land-use and forestry projects.[11, 12] Even these guidance documents, however, are too broadly specified to guarantee a true standard for carbon offsets. The task of developing standardized protocols has fallen to a number of individual programs that verify and certify offsets. The largest of these is the CDM. Table 1 summarizes the types of publicly available protocols and methodologies developed by the CDM and other programs around the world.

Table 1. Offset Protocols and Methodologies Developed Under Existing Programs

Program	Description	Types of Protocols
The Clean Development Mechanism (CDM)	The CDM is the largest offset program established under the Kyoto Protocol, and is currently the largest	Well over 100 methodologies covering renewable energy, energy efficiency, fuel

[10] WRI and WBCSD, 2005. *The Greenhouse Gas Protocol for Project Accounting*. Washington, D.C. / Geneva; and ISO 14064, International Organization for Standardization, Geneva, Switzerland, 2006.

[11] 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.

[12] Broekhoff, D., 2007. *Guidelines for Quantifying GHG Reductions from Grid-Connected Electricity Projects*. World Resources Institute and World Business Council for Sustainable Development, Washington, D.C. / Geneva.

http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html	such program in the world. CDM offset credits may be used for compliance with emissions targets set under the Kyoto Protocol.	switching, methane destruction, industrial gas destruction, and reforestation/afforestation in a wide range of applications and sectors.
The Regional Greenhouse Gas Initiative (RGGI) http://www.rggi.org	RGGI is a mandatory cap-and-trade program in the Northeastern United States due to begin operation in 2009.	• Landfill methane capture and destruction • Reduction in emissions of sulfur hexafluoride (SF_6) • Sequestration of carbon due to afforestation • Avoided/reduced natural gas or oil combustion due to end use energy efficiency • Agricultural manure management operations
The U.S. EPA *Climate Leaders* Program http://www.epa.gov/climateleaders/index.html	*Climate Leaders* is an EPA industry-government partnership that works with companies to develop comprehensive climate change strategies, and has developed several offset methodologies in line with the WRI/WBCSD Project Protocol.	• Reforestation/afforestation • Commercial boilers • Industrial boilers • Landfill methane • Manure management (anaerobic digesters) • Bus fleet upgrades
The California Climate Action Registry (CCAR) http://www.climateregistry.org/offsets.html	CCAR is a non-profit, voluntary registry for GHG emissions originally formed by the State of California. It is developing a series of carbon offset protocols under its Climate Action Reserve program.	• Forestry conservation • Conservation-based forest management • Reforestation • Manure management • Landfill methane
The Chicago Climate Exchange (CCX) http://www.chicagoclimateexchange.com/	The CCX is a U.S.-based voluntary emissions trading system for GHGs. Participants take legally binding commitments to reduce their emissions and can do so through the purchase of carbon offsets certified under CCX protocols.	• Agricultural methane (manure management) • Agricultural soil carbon • Energy efficiency and fuel switching • Forestry carbon • Landfill methane • Renewable energy • Coal mine methane • Rangeland soil carbon • Ozone depleting substance destruction
The New South Wales Greenhouse Gas Abatement Scheme (GGAS) http://www.greenhousegas.nsw.gov.au/default.asp	The GGAS is one of the first mandatory GHG trading systems and bases compliance on credits issued for a variety of project types.	• Low-emission electricity generation • End-use energy efficiency • Forestry sequestration • GHG reductions at industrial facilities
The Alberta Offset System http://www.carbonoffsetsolutio	The Alberta Offset System in Canada was established to facilitate compliance with provincial	Sixteen protocols completed, including: • Livestock methane

ns.ca/policyandregulation/abOffsetSystem.html	legislation requiring large industrial facilities to reduce their GHG emissions. A variety of offset protocols have been adopted under the program.	emissions • Soil carbon sequestration • Methane reductions from organic waste • Biofuels • Enhanced oil recovery • Waste-heat recovery • Energy efficiency • Afforestation • Others

A thorough evaluation would be required to decide whether the protocols developed under these programs are suitable for a national U.S. regulatory offsets program. One of the challenges in designing offset protocols is that they require balancing tradeoffs. Protocols that are too stringent (e.g., with respect to additionality) may end up excluding good offset projects and raising overall compliance costs. Lenient protocols may allow too many reductions to be credited and therefore undermine the integrity of an emissions cap. Ideally, protocols should be developed and adopted according to how well they achieve desired policy outcomes for an emissions trading system, including objectives for environmental integrity, transaction costs, and administrative costs.[13] Protocols developed under other programs may or may not fit the bill for a U.S. national GHG trading system.

What types of projects should be included in a carbon offset program?

Only emission reductions at sources not covered by an emissions cap can truly qualify as offsets. While it may be desirable to encourage reductions at covered sources, "crediting" such reductions must be done through some form of allowance allocation rather than the creation of offset credits.[14] Only projects that affect sources (or sinks) of GHG emissions not covered by the cap should be included in an offset program. Under Senate Bill 2191 as currently drafted, for example, the following types of projects might be included in a domestic offset program:

- Agricultural and rangeland management
- Manure and livestock management
- Forest, agricultural, and rangeland land-use change
- Forest management practices
- Fossil fuel (oil, gas, and coal) production, processing, and delivery[15]
- Landfill gas and waste management

[13] See, for example, 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; and WRI and WBCSD, 2005. *The Greenhouse Gas Protocol for Project Accounting*. Washington, D.C. / Geneva, Chapter 3.

[14] Under cap-and-trade, reductions at covered sources (even if they are covered "upstream" from the actual point of emissions, e.g., at fossil fuel processing or distribution facilities) will simply free up allowances that can be used to emit more at a later time. Total emissions will not change and no "offset" will occur. Issuing offset credits for such reductions would therefore result in double-counting and cause total emissions to rise.

[15] For projects involving emissions not covered by the emissions cap, e.g., coalmine methane emissions, vented emissions in oil and gas operations, fugitive emissions from natural gas transmission and distribution, etc.

In addition, it makes sense to exclude any projects that are likely to have adverse social, economic, or environmental effects. This is probably best accomplished through general eligibility criteria applied to projects, rather than the exclusion of project types.

Beyond these considerations, there is in theory no reason to limit the types of projects allowed in an offset program as long as they can meet the basic criteria outlined above (i.e., real, additional, verifiable, permanent, and enforceable). However, some types of projects will face greater risks and uncertainties relative to these criteria than others. The question becomes whether it makes sense to exclude some types of offsets on the basis of higher uncertainties and associated costs.

Are there differences in the credibility of offsets from different project types?

The "credibility" of a carbon offset largely depends on the level of confidence one has in its quantification, additionality, verification, permanence, and ownership. Broadly speaking, the risks and uncertainties for carbon offsets fall into four categories:

1. *Measurement uncertainty*. Accurately quantifying emission reductions requires being able to accurately monitor and verify the performance of a project and its effect(s) on emissions or sequestration. Accurate measurement is easier for some types of projects than others.
2. *Baseline uncertainty*. Accurately quantifying emission reductions also requires reasonable certainty about a project's baseline emissions and its additionality.[16] Baseline uncertainty will be higher for projects that have numerous possible alternatives, and for projects that provide significant compensation or revenue aside from their emission reductions.
3. *Leakage potential*. Accurately quantifying emission reductions requires accounting for any unintended increases in emissions caused by a project. Leakage can add significant uncertainty to a project because it often difficult to monitor and quantify. Some types of projects are more prone to leakage than others.
4. *Reversibility risk*. The potential for reversal of a project's emission reductions creates uncertainty about its value as an offset. Reversibility is only a concern for projects whose emissions benefits result from sequestration.

In general, many types of forestry and agriculture carbon sequestration projects will face higher quantification uncertainty, because they are subject to greater relative measurement uncertainties, baseline uncertainties, reversibility, and leakage. Table 2 illustrates how some different types of offset project compare against these categories of uncertainty, based on qualitative analysis and a preliminary survey of carbon offset quantification literature. Further studies are needed to

[16] A project's baseline and additionality are intimately related. Because the goal is to maintain net emissions at capped levels, the baseline for a project should in theory represent the emissions that would occur at the sources it affects in the absence of a carbon offset market. If the project is not additional, baseline and project emissions will be identical.

develop a full quantitative comparison for different project types, but there are generally clear differences between projects that avoid GHG emissions and those that sequester carbon.

Table 2. Illustrative Project Types and Their Associated Uncertainties

Project Type	Measurement Uncertainty	Baseline Uncertainty	Leakage Potential	Reversibility Risk
Landfill methane flaring	Low[a] <1%	Low[b] <1%	None	No
Boiler efficiency improvement	Low[c]	Medium/High[d] 45%	Low	No
Soil carbon sequestration	Medium to High[e] 6% to >100%	Medium[f]	Low/Medium?[g]	Yes
Avoided deforestation	Medium to High[h]	High[i] >50%	High[j] Up to 90%	Yes

Notes:

a: Captured methane can be measured accurately with flow meters, whose uncertainty range is typically much less than 1%.[17]

b: There are few other reasons for undertaking this kind of project (e.g., unless required by regulation), so there is little uncertainty about additionality. Landfill methane projects have a relatively high likelihood of generating “real” (additional) emission reductions compared to other project types, even where captured gas is used to supply energy.[18]

c: Boiler fuel consumption can be easily tracked and accurately measured.

d: In one study of boiler projects involving district heating, uncertainty was estimated at +/- 45% for baseline CO_2 emissions.[19]

e: Measurement uncertainties for soil carbon have been estimated at up to 100%, but may be as low as 6% (single standard deviation).[20] The uncertainty range depends greatly on the spatial scale considered.[21]

f: There may be multiple reasons for undertaking activities that sequester carbon, such as no-tillage practices. In some areas no-tillage is common practice.

g: Depends on how tillage practices affect crop yields and whether there are associated shifts in crop production on other lands.

h: As with soil carbon stocks, carbon stocks in forests may be subject to medium-to-high uncertainty depending on methods, spatial scales, and forest types.[22]

i: Forestry and land use baselines can be very difficult to predict. Uncertainty ranges for baseline carbon may be well over 50% in some areas.[23]

j: Leakage for avoided deforestation projects in the Untied States may range as high as 90%, depending on the region.[24]

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[17] For example, see http://ts.nist.gov/MeasurementServices/Calibrations/flow.cfm.

[18] Sutter, C., and J.C. Parreno, 2007. “Does the Current Clean Development Mechanism (CDM) Deliver Its Sustainable Development Claim? An Analysis of Officially Registered CDM Projects.” *Climatic Change* 84: 75-90.

[19] Joint Implementation Network, et al., 2003. *Procedures for Accounting and Baselines of JI and CDM Projects (PROBASE): Final Report*. The European Commission, Fifth Framework Programme, p. 33. Available at: http://www.jiqweb.org/probase/. Baseline uncertainty can be high because there may be multiple alternatives for a boiler upgrade, there is uncertainty about baseline operating conditions, and there may be other reasons for undertaking these projects (e.g., an old boiler may have been due for replacement anyway).

[20] Kim, M., et al., ??. *Management Response Curves: Estimates of Temporal Soil Carbon Dynamics.* http://agecon2.tamu.edu/people/faculty/mccarl-bruce/papers/1121.pdf

[21] Ibid; and http://www.envtn.org/LBcreditsworkshop/Uncertainty_Intro.pdf

[22] Kerr, S., et al., 2004. *Tropical Forest Protection, Uncertainty, and the Environmental Integrity of Carbon Mitigation Policies*. Motu Working Paper 04-03. http://motu-www.motu.org.nz/wpapers/04_03.pdf.

[23] Ibid.; baseline carbon uncertainty ranges for forest protection in Costa Rica range up to 54% for a single standard deviation.

Can the risks and uncertainties for some project types be addressed?

In most cases, yes. There is no reason in principle why projects with relatively high quantification uncertainty cannot yield credible offsets. The only challenge is that methods to compensate for the uncertainty will tend to raise costs. For example:

- Compensating for measurement uncertainties may require more costly measurement and verification practices, or the use of conservative estimates or discounts for quantified reductions. Both methods will increase the cost per ton of creditable emission reductions.
- Compensating for baseline uncertainties may require more rigorous analysis and additionality tests (raising costs for project developers and/or program administrators), or similar application of conservative estimates that err on the side of under-counting emission reductions.
- Compensating for leakage generally requires the incorporation of project elements designed to mitigate it,[25] or the application of conservative methods to estimate its impact, both of which may increase costs relative to other types of projects.
- Compensating for reversibility requires the adoption of one of the methods already described in this testimony (above), which will tend to either increase costs or reduce compensation to project owners.

The bottom line is project types with higher levels of quantification risk and uncertainty are likely to incur significantly higher costs for every ton of CO_2 they reduce in order to have their reductions certified as offsets. Unfortunately, no studies have yet tried to quantify the likely size of this cost differential under a strict regulatory program.[26] The added costs may have important consequences for how these types of projects fare in a broader market for GHG reductions. Furthermore, it may take time to develop protocols for some types of projects in ways that effectively mitigate uncertainty. This could lead to delays in how soon those projects can enter the market. Finally, even where the added costs amount to less than a dollar per ton of CO_2, this could mean many millions of dollars of added investment burden across the entire market for carbon offsets.

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[24] Murray, B.C., McCarl, B.A., Lee, H., 2004. "Estimating Leakage from Forest Carbon Sequestration Programs." *Land Econ.* 80(1), 109-124.

[25] See, for example, WRI and WBCSD, 2005. *The Greenhouse Gas Protocol for Project Accounting*. Washington, D.C. / Geneva, Chapter 5.

[26] The most extensive study of "transaction costs" for carbon offset projects indicates that existing forestry offset projects (almost exclusively serving the voluntary market), have faced higher monitoring and verification costs than other projects, and may face higher costs under a regulatory program to address permanence and leakage concerns. Total transaction costs for forestry projects have ranged from one to 19 percent of total project costs, and have amounted to around \$0.30 to \$0.70 per ton of CO_2. The study notes that "insurance costs" to compensate for reversibility could significantly increase costs for forestry projects. See Antorini, C. and J. Sathaye, 2007. *Assessing Transaction Costs of Project-based Greenhouse Gas Emissions Trading*. Lawrence Berkeley National Laboratory, LBNL-57315.

Are there alternatives?

It may be worth asking whether some types of GHG emission reductions are best achieved through carbon offset markets or through other policy mechanisms. If the added costs associated with reducing uncertainties for sequestration projects could be avoided, for example, then greater reductions could in principle be achieved for the same total expenditure of resources.

One way to do this would be to fund these and other projects with high quantification uncertainties through a separate program of direct payments, or allowance set-asides.[27] Unlike offsets, reductions achieved through direct payments would not be have to be used to compensate for increased emissions from capped sources, and therefore would not have to be subject to the same levels of scrutiny in terms of measurement, additionality, leakage, and reversibility. While it may still be desirable to fund reductions that are "real, additional, verifiable, permanent, and enforceable," the application of these criteria would not have to be as stringent. For example:

- Measurement of the effects of funded activities would be primarily for information purposes, and would not have to meet the same degree of accuracy needed to ensure that quantified reductions are truly offsetting emissions on a ton-for-ton basis. Avoiding and mitigating leakage from funded activities would be desirable, but the extent of leakage would not have to be rigorously quantified.
- While it may be desirable to fund "additional" activities, demonstrating additionality on a project-by-project basis would not be necessary. Avoiding the need to develop and apply complicated additionality tests could reduce costs significantly.[28]
- Verification of funded activities would still be necessary, but could be limited to a simple confirmation that activities are being undertaken rather than checking their performance in ways that are necessary for precise quantification.
- Long-term carbon storage for sequestration projects would be desirable and could be encouraged, but designing complicated insurance mechanisms to put carbon sequestration on equal footing with permanent emission reductions would not be necessary.
- Enforcement of a direct payment program would consist of ensuring that project owners follow through on their commitments, and would not require tracking systems or legal rules for establishing ownership of emission reductions.

Whether or not a direct payment system would make sense as an alternative greatly depends on how various other elements of a cap-and-trade system and offset program are designed. Total demand for reductions (determined by cap levels), the types offset projects allowed, and limits on the use of offsets will all play a role in determining price levels and whether "high transaction cost" projects can succeed in the market. The stringency required of offset protocols (based on

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[27] For further discussion of this approach, see Hayes, D., 2008. *Getting Credit for Going Green: Making Sense of Carbon "Offsets" in a Carbon-Constrained World*. Center for American Progress, Washington, DC.

[28] Rebate programs for energy efficient appliances, for example, operate under the assumption that some rebate recipients would buy high-efficiency appliances even without a rebate. Because screening out these "free riders" would be costly and difficult, it is generally not attempted. Instead, rebates are given without restriction, and the funding of some "non-additional" purchases is tolerated as a cost of running the program. Because the purchases are not being used to offset energy consumption elsewhere, it does not matter that buyers are not screened for additionality.

policy objectives, as described above) will also play a role. Further study is needed to determine which types of projects might best be encouraged through an offset program and which might be better achieved through direct payments. In the meantime, it makes sense to design policies that keep both options open for a variety of project opportunities in “uncapped” sectors.