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# Outside the Cap: *Opportunities and Limitations of Greenhouse Gas Offsets*

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## EXECUTIVE SUMMARY

Carbon offset programs require the application of rigorous quantification, verification, and enforcement criteria in order to ensure that the integrity of greenhouse gas (GHG) caps is not compromised. Some types of climate change mitigation activities—especially those involving soil or forest carbon sequestration—are less likely to meet these criteria than others. It is possible to overcome these challenges, but doing so entails costs that might be avoided if these GHG reductions were achieved through other policies and measures. Deciding which types of GHG reductions to include in a carbon offset program should therefore be part of a broader strategy to achieve economy-wide GHG reductions at the lowest overall cost.


## Introduction

A comprehensive cap-and-trade program requires a number of policy design decisions. These involve setting emissions targets, determining which sources will be regulated under the cap, how pollution permits will be assigned or auctioned, and how to generate emissions reductions from GHG pollution sources not included in the cap. Carbon offsets are reductions from uncapped sectors or sources that are used for compliance with the cap. Offsets are likely to play a crucial role in the design of a U.S. cap-and-trade program for limiting GHG emissions because they can help contain costs and expand compliance options. However, offsets are only one mechanism for achieving reductions at uncapped sources, and should be considered alongside other measures, such as complementary regulations (including GHG performance standards) or subsidies.

In principle, any GHG reductions (or increases in carbon sequestration) that occur at sources or sinks "outside the cap" can be used as offsets within a cap-and-trade system.[1] However, not all GHG reductions are easy to certify as offsets. These include GHG reductions from forestry and agriculture activities, which face larger challenges in meeting basic offset certification criteria than activities in other sectors (e.g., projects involving methane capture and destruction). Overcoming these challenges may add costs that could be avoided by using other policies and mechanisms.

Policymakers must therefore confront a tradeoff in deciding whether certain kinds of GHG reductions should count as carbon offsets. Should they seek maximal inclusion of offset options as part of a cap-and-trade package in order to provide the greatest amount of flexibility and cost-containment for capped entities? Or should they think about the most efficient means to achieve GHG reductions, and exclude from an offset program those reductions that could be more cost-effectively achieved through other policy mechanisms? This brief argues the latter. Carbon offsets should be considered as an important element of an overall strategy to achieve national GHG reductions at the lowest cost to the economy, but cost containment should not be viewed only from the perspective of capped entities. The authors review some of the decisions policymakers will need to make as they consider designing the offsets component as part of a cap and trade program. Section I describes the basic criteria for certifying carbon offsets. Section II assesses differences in the ease with which various project types can satisfy these criteria. Section III discusses the implications of these differences for decisions about whether to include certain types of activities in a carbon offset program or address them through other policies. Section IV provides conclusions and recommendations.

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## Section I – Carbon Offset Criteria

### What are carbon offsets?

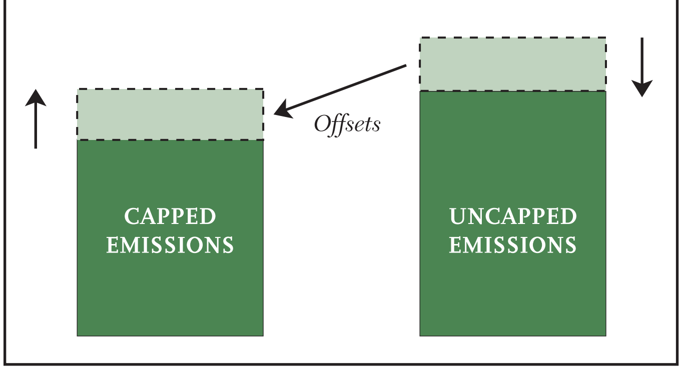
A "carbon offset" is a reduction in GHG emissions or an increase in carbon sequestration[2] that is achieved to compensate for, or "offset," GHG emissions occurring at other sources.[3] In a cap-and-trade system, carbon offsets allow emissions from regulated ("capped") sources to increase above levels set by the cap, on the premise that those increases are compensated by reductions achieved at unregulated ("uncapped") sources (Figure 1). Because reducing emissions at unregulated sources can be less costly than at capped sources, carbon offsets can lower the cost of achieving the cap's overall net emissions goal.[4]

In an emissions market, carbon offsets can be traded in the form of certified "credits."[5] One credit usually denotes a GHG reduction equivalent to one metric ton of carbon dioxide ($CO_2$). 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 a project has reduced emissions according to predefined rules and procedures. These procedures are designed to ensure that an offset represents a real reduction, thereby preserving the integrity of the cap. In principle, a wide variety of projects can generate carbon offsets, although the list will vary depending on which sources are covered by the cap and are therefore ineligible as offsets.[6]

Examples of offset projects include, but are not limited to:

- Capturing methane created by landfills and flaring it (methane emitted from landfills is a potent gas in the atmosphere) 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., wind power) for small-scale energy production or transportation.
- Improving the efficiency of energy production from fossil fuels, e.g., by upgrading commercial or industrial boilers, or utilizing 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 fuel-based energy.
- Planting trees or adopting forestry or land management practices (such as extending the length of time until harvest, or switching to no-tillage agriculture) that remove carbon dioxide from the atmosphere and sequester it.

**FIGURE 1 Use of Offsets in a Cap-and-Trade System**




### Criteria for carbon offsets

To have a functioning market for carbon offsets, clear rules and procedures are required to define 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 criteria derived from guidelines established under the federal 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.[7] Interpretations of these criteria vary, but their essence can be summarized as follows:

#### *Real*

An offset credit must represent an actual net GHG reduction, and should not be an artifact of incomplete or inaccurate emissions accounting. In practice, this means methods for quantifying reductions should be conservative in order to avoid overstating them. It also means that the accounting of a project's effect on GHG emissions must be comprehensive.[8] For example, some projects may reduce GHGs at one source, only to cause emissions to increase at other sources. A frequently cited example is a forest protection project that simply shifts logging activities to other forest land, causing little or even no net decrease in carbon emitted from logging. Unintended increases in GHG emissions that occur outside of a project's boundaries, but are caused by that 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 GHG reductions that are a response to the incentives created by a carbon offset market should be certified as offsets. Activities 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. Because offset credits allow regulated sources in a cap-and-trade system to increase their emissions by a corresponding amount (as in Figure 1), offset reductions must be "additional" in order to maintain net emission levels. Crediting reductions that would occur in the absence of a cap would result in higher total emissions, as capped emissions would increase without a corresponding reduction in uncapped emissions.

Although the premise behind this general concept (called "additionality") is straightforward, it is 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.[9]

1. *Project-specific* approaches seek to assess whether a project differs from a hypothetical baseline scenario in which 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 business-as-usual (or "baseline") scenario, the project is considered additional. The Kyoto Protocol's Clean Development Mechanism (CDM), a global carbon offset program for projects in developing countries, requires project-specific additionality tests.

2. *Standardized* approaches evaluate projects against consistent criteria designed to exclude non-additional projects and include additional ones. For example, standardized tests could involve determinations that a project:
   - Is not mandated by law;
   - Is not a "least-cost" option (as defined by regulators);
   - Is not common practice (as defined by regulators);
   - Involves a particular type of technology;
   - Is of a certain size;
   - Is initiated after a certain date; or
   - Has an emission rate lower than most others in its class (e.g., relative to a performance standard)

From a regulatory perspective, standardized additionality tests are advantageous. Relative to project-specific tests, they can reduce transaction costs for project developers, alleviate uncertainties for investors, and increase the transparency and consistency of regulatory decisions.[10] Several U.S.-based carbon offset programs–including the California Climate Action Registry, the Chicago Climate Exchange, the Regional Greenhouse Gas Initiative in the northeastern United States, and U.S. EPA's Climate Leaders program–have adopted standardized additionality tests.

Standardized tests are not always easy to devise, however. They are particularly difficult to implement when there is high uncertainty about baseline conditions, e.g., when it is not clear in most cases whether a certain type of project or its alternatives would be implemented in the absence of an offset market. For projects that extend harvesting rotations on managed forest land, for example, it may be difficult to consistently distinguish business-as-usual from "additional" activities using standard criteria because of the wide range of circumstances under which these projects can occur. This could be a factor in deciding whether such projects should be included in a carbon offset program or supported instead by some other policy or incentive.[11]

### *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 measure or verify may not be suitable for generating carbon offsets.

### *Permanent*

Once GHGs are emitted into the atmosphere, they reside there more or less permanently.[12] Accordingly, the offset emissions reduction must also be permanent. Permanence is usually only an issue for GHG sequestration or storage projects, as their effects can be reversed over time. For example, in forestry or agricultural carbon sequestration projects, carbon stored in trees or soils can be released to the atmosphere due to fires, harvesting, land-use changes, or other disturbances. In these cases, a mechanism is required to make reversible reductions or removals functionally equivalent to permanent reductions for the purpose of issuing offset credits. There are at least three possible ways to acheive this goal:

1. *Issuing credits on a "discounted" basis*. With this approach, less than a full credit is awarded for each ton of GHG reduction. For example, credits might be discounted to take into account expected future losses of sequestered or stored carbon over a certain time period.

**TABLE 1 Climate Change Programs with Offset Quantification Protocols**

| Program | Description | Types of Offset Protocols | Notes |
|---|---|---|---|
| **The Clean Development Mechanism (CDM)**[a] | The CDM is the largest offset program established under the Kyoto Protocol, and is currently the largest offset program in the world in terms of volume market value. CDM offset credits may be used for compliance with emissions targets set under the Kyoto Protocol. | Well over 100 methodologies covering renewable energy, energy efficiency, fuel switching, methane destruction, industrial gas destruction, and reforestation/ afforestation in a wide range of applications and sectors. | Protocols have been designed to apply across a wide range of circumstances in developing countries; these could be adopted and possibly standardized in a U.S. context. The CDM's project-specific approach to additionality has come under scrutiny recently for being difficult to enforce consistently.[b] |
| **The Regional Greenhouse Gas Initiative (RGGI)**[c] | RGGI is a mandatory cap-and-trade program in the Northeastern United States due to begin operation in 2009. | • Landfill methane capture and destruction<br>• Reduction in emissions of sulfur hexafluoride ($SF_6$)<br>• Sequestration of carbon due to afforestation<br>• Avoided/reduced natural gas or oil combustion due to end use energy efficiency<br>• Agricultural manure management operations | Protocols are highly standardized; some parties have complained that they are too restrictive.[d] The protocols do not explicitly address leakage. Additionality rules only exclude projects required by law, that receive public subsidies, or that are double-counted under other programs. These criteria may be more effective for some project categories (e.g., methane destruction) than others (e.g., afforestation). Permanence is addressed by requiring long-term easements on forest land, but there is no insurance mechanism for reversals. |
| **The U.S. EPA *Climate Leaders* Program**[e] | *Climate Leaders* is an EPA industry-government partnership that works with companies to develop comprehensive climate change strategies and has developed several offset methodologies based on the WRI/WBCSD Project Protocol. | • Reforestation/ afforestation<br>• Commercial boilers<br>• Industrial boilers<br>• Landfill methane<br>• Manure management (anaerobic digesters)<br>• Bus fleet upgrades | The offsets component of the Climate Leaders program is new and still under development. Protocols have explicitly adopted a "performance standard" approach to determining project additionality, and project types were selected according to their suitability for this approach. Rules to address leakage and permanence are still under development. |
| **The California Climate Action Registry (CCAR)**[f] | 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<br>• Conservation-based forest management<br>• Reforestation<br>• Manure management<br>• Landfill methane | CCAR has emphasized the development of protocols with standardized baseline and additionality criteria. CCAR's forestry protocols are currently being updated to expand their applicability, address permanence, and account for leakage effects. |

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 (rather than the project developer) would have to procure replacement 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.
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 Regional Greenhouse Gas Initiative in the U.S. has adopted this approach for reforestation projects.

It is worth noting that all of these methods for addressing reversible reductions have the effect of either increasing costs for project developers (insurance and buffer systems) or reducing the amount of compensation they receive per ton of $CO_2$ reduced (discounting and expiring credits), and therefore lessen the cost-reduction benefit of the offsets. But addressing reversibility is critical if carbon sequestration offsets are to be credited on the same basis as offsets involving permanent emission reductions.

TABLE 1 *continued*

| Program | Description | Types of Offset Protocols | Notes |
|---|---|---|---|
| **The Chicago Climate Exchange (CCX)**[g] | 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)<br>• Agricultural soil carbon<br>• Energy efficiency and fuel switching<br>• Forestry carbon<br>• Landfill methane<br>• Renewable energy<br>• Coal mine methane<br>• Rangeland soil carbon<br>• Ozone depleting substance destruction | Most of the CCX's protocols are highly standardized. For example, there are pre-specified crediting rates for eligible projects. Permanence for forestry projects is addressed by requiring a commitment to "long-term maintenance" of carbon stocks, as well as setting aside a 20 percent buffer to compensate for reversals. A similar insurance buffer is required for soil carbon projects, but project owners need only commit to maintaining carbon stocks for 5 years. Anecdotal evidence suggests the CCX's additionality criteria have not worked well for soil carbon projects.[h] Leakage effects are not explicitly accounted for. |
| **The New South Wales Greenhouse Gas Abatement Scheme (GGAS)**[i] | The GGAS in Australia 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<br>• End-use energy efficiency<br>• Forestry sequestration<br>• GHG reductions at industrial facilities | The GGAS protocols are all highly standardized, but largely tailored to circumstances in New South Wales; they may be difficult to apply elsewhere. Forestry project landowners are required to maintain average carbon stocks at a constant level for 100 years but GGAS has no explicit provisions to address reversals or account for leakage. |
| **The Alberta Offset System**[j] | The Alberta Offset System in Canada was established to facilitate compliance with provincial legislation requiring large industrial facilities to reduce their GHG emissions. A variety of offset protocols have been adopted under the program. | Sixteen protocols completed, including:<br>• Livestock methane emissions<br>• Soil carbon sequestration<br>• Methane reductions from organic waste<br>• Biofuels<br>• Enhanced oil recovery<br>• Waste-heat recovery<br>• Energy efficiency<br>• Afforestation<br>• Others | Protocols have been developed via public-private partnership, and contain both standardized and project-specific elements. There are no explicit additionality tests or criteria (although projects required by law are not eligible).<br>Leakage effects are addressed through the identification of sources and sinks affected by project. Permanence is addressed through discounting. |

**Notes**

a. http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html

b. Schneider, L., 2007. *Is The CDM Fulfilling Its Environmental And Sustainable Development Objectives? An Evaluation Of The CDM And Options For Improvement*. World Wildlife Fund / Oeko Institut.

c. http://www.rggi.org

d. Lee, C., *et al*. (forthcoming). *Domestic and International Offset Programs: A Review and Assessment*. Stockholm Environment Institute.

e. http://www.epa.gov/climateleaders/index.html

f. http://www.climateregistry.org/offsets.html

g. http://www.chicagoclimateexchange.com/

h. Goodell, J., 2006. "Capital Pollution Solution?" in *New York Times Magazine*, July 30, 2006; Samuelsohn, D., 2006. "Farmers Find NewCash Crop in Emissions Trading Schemes," *Greenwire*, June 22, 2006.

i. http://www.greenhousegas.nsw.gov.au/default.asp

j. http://www.carbonoffsetsolutions.ca/policyandregulation/abOffsetSystem.html

### *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 and to avoid double counting. For example, a forest owner and a mill owner might both want to claim the emissions sequestered in forest products–as might the owners of the products themselves. Regulatory rules must establish who may claim the 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.

### Writing the rules for offsets

To create a functioning market for carbon offsets, the criteria outlined above must be defined in a set of operational standards, and administered by a credible regulatory body responsible for certifying and issuing offset credits. Standards are required in order to create a carbon offset "commodity" that is as uniform as possible, i.e., a high degree of certainty that one offset credit reflects one ton of $CO_2$-equivalent emission reductions or sequestration. There are several existing "standards" for carbon offsets. The challenge is deciding which ones, if any, may be sufficiently stringent and credible for a U.S. cap-and-trade program.

Internationally, an extensive amount of work has been done to clarify the basic requirements of carbon offset accounting. In particular, 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 provide a general framework for quantifying emission reductions from offset projects.[13] 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.

The task of developing 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 indicates potential shortcomings in the protocols developed by other programs to date. In the context of a U.S. cap-and-trade system, federal regulators would need to thoroughly evaluate whether the protocols developed under these programs are suitable for a regulatory offsets program. Such an evaluation would need to take into account the accuracy of their quantification methods, as well as their sufficiency in addressing additionality, leakage, and permanence. One of the challenges in designing offset protocols is that they require balancing different policy goals. Protocols that are too stringent may end up excluding good offset projects and raising overall compliance costs. Lenient protocols may result in an overestimation of GHG reductions 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.[14] Federal regulators will need to carefully decide whether existing protocols strike the right balance, and adopt or modify them accordingly.

## Section II – How Different Project Types Fare

### Which reductions to include in an offset program?

Only emission reductions at sources outside the emissions cap can truly qualify as offsets. While it may be desirable to provide an extra incentive for reductions at some covered sources, "credit" for such reductions must be given, if at all, through some form of allowance allocation rather than the creation of offset credits.[15]

In addition, it may be desirable to exclude reductions from activities that are likely to have adverse social, economic, or environmental effects (e.g., activities that spread invasive species or increase the use of harmful herbicides). This is probably best accomplished through general eligibility criteria applied to individual offset projects (such as requiring that they undergo an environmental impact review), rather than the exclusion of whole categories of projects because, in most cases, projects can be individually designed to avoid adverse consequences.

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).[16] 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 projects when the cost of overcoming these uncertainties is high.

### Not all project types are equal

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

1. *Measurement uncertainty*: uncertainty associated with monitoring and verifying a project's performance and its effect on GHG emissions or sequestration. Accurate measurement is easier for some types of projects than others. Measuring methane captured from a landfill, for example, can be done very accurately using gas flow meters. Measuring automobile emissions affected by a public transportation project, on the other hand, would be nearly impossible; such emissions would have to be estimated using surveys and models, with a much higher range of uncertainty.

2. *Baseline uncertainty*: uncertainty about a project's business-as-usual (baseline) emissions and its additionality.[17] 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*: the likelihood of unintended increases in emissions caused by a project. Leakage can add significant uncertainty to a project because it is often difficult to monitor and quantify. Some types of projects are more prone to leakage than others. (See Table 2.)
4. *Reversibility risk:* the potential for reversal of a project's emission reductions (which raises concerns about permanence). Reversibility is only a concern for projects whose emissions benefits result from carbon sequestration.

Different types of offset projects will face different intrinsic levels of uncertainty and risk in each of these four categories. Table 2 illustrates how some different types of projects compare, based on qualitative analysis and a preliminary survey of carbon offset quantification literature. Further studies are needed to develop a full quantitative comparison for different project types, but there are generally discernible differences. In particular, many types of forestry and agriculture carbon sequestration projects will face greater measurement difficulty, baseline uncertainty, leakage potential, and reversibility risk, making these types of projects much harder to credit as offsets. However, these are also categories of great interest in the political debate, given their potential to provide a relatively large supply of reductions as well as income for their sectors. There is therefore significant interest in further research and attention to the development of viable protocols for these project types.

### Addressing risks and uncertainties can raise costs

Projects with relatively high intrinsic quantification difficulties can yield credible offsets if the issues are adequately addressed. However, doing so will usually raise costs (and therefore lessen the cost-reduction benefit) of offset projects. For example:

**TABLE 2** Examples of Project Types and Uncertainties

| Project Type | Measurement Difficulty | Baseline Uncertainty | Leakage Potential | Reversibility Risk | Total Relative Uncertainty & Risk |
|---|---|---|---|---|---|
| Landfill methane flaring | Low[a] | Low[b] | None | No | Low |
| Boiler efficiency improvement | Low[c] | Medium/High[d] | Low | No | Medium-Low |
| Afforestation | Medium[e] | Low/Medium | Medium[f] | Yes | Medium |
| Soil carbon sequestration | Medium to Very High[g] | Medium[h] | Low/Medium?[i] | Yes | Medium-High |
| Avoided deforestation | Medium/High[e] | High[j] | High[k] | Yes | High |
| Bus rapid transit system | Medium/High | High[l] | Low[m] | No | Medium-High |

Notes

a. Captured methane can be measured accurately with flow meters, whose uncertainty range is typically much less than 1%.[18]
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 and additional emission reductions compared to other project types, even where captured gas is used to supply energy.[19]
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.[20]
e. Carbon stocks in forests may be subject to medium-to-high uncertainty depending on methods, spatial scales, and forest types.[21]
f. Leakage for afforestation projects in the United States may range as high as 42%, depending on the region.[22]
g. Measurement uncertainties for soil carbon have been estimated at up to 100%, but may be as low as 6% (single standard deviation).[23] The uncertainty range depends greatly on the spatial scale considered.[24]
h. There may be multiple reasons for undertaking activities that sequester carbon, such as no-tillage practices. In some areas no-tillage is common practice.
i. Depends on how tillage practices affect crop yields and whether there are associated shifts in crop production on other lands.
j. Forestry and land use baselines can be very difficult to predict. Uncertainty ranges for baseline carbon may be well over 50% in some areas.[25]
k. Leakage for avoided deforestation projects in the Untied States may be as high as 90%, depending on the region.[26]
l. Emissions from urban vehicle traffic must be modeled; typical uncertainty ranges for simple models are around +/- 30%.[27] Many variables must be taken into account and modeled to produce accurate estimates of baseline emissions.[28]
m. Depends on specific project. Estimates for existing projects are low (e.g., 3%).[29]

- Addressing measurement uncertainties may require more costly measurement and verification practices or the use of conservative estimates or discounts for quantified reductions (which raise the cost per ton of creditable reductions).
- Addressing baseline uncertainties may require more rigorous analysis and additionality tests (raising costs for project developers and/or program administrators), or application of conservative estimates that err on the side of under-counting emission reductions.
- Addressing leakage generally requires the incorporation of project elements designed to mitigate it,[30] or the application of conservative methods to estimate its impact.
- Addressing reversibility requires the adoption of mechanisms (e.g., discounted or temporary credits) that will either increase costs or reduce compensation to project owners.

Project types with higher levels of quantification risk and uncertainty are likely to incur higher transaction costs for every ton of $CO_2$ reduced. No studies have yet attempted to quantify the size of these costs under a strict regulatory program.[31] However, they may have important consequences for how these projects fare in a GHG market. Furthermore, it may take time to develop protocols that effectively mitigate uncertainty, which may delay projects' entry into the market. Finally, even when the added costs amount to less than a dollar per ton of $CO_2$, they could create many millions of dollars of added investment burden across the entire market for carbon offsets. Modeling estimates of the cost-reduction benefits of including offsets in a cap-and-trade program do not typically factor in these transaction costs.

## Section III – A Comprehensive Approach to Targeting Emission Reductions

### Alternative Policies for Reducing Uncapped Emissions

For some types of climate change mitigation activities, the cost of rigorously quantifying and verifying GHG reductions may be significant. Viewed strictly from the standpoint of an offset market, this may not seem to be a major obstacle. If the market can bear the costs and pay project owners enough to make a profit, why should they matter? These costs do matter, however, if lower cost options exist for controlling the same emissions. Where costs can be avoided, as in the examples below, more reductions can be achieved for the same total expenditure of resources.

There are at least three options for achieving GHG reductions at uncapped sources that could potentially avoid the costs associated with quantifying and certifying carbon offsets. The first is to include these sources under the cap; however, the quantification challenges described in this paper (as well as other considerations) often make coverage under the cap infeasible. The second option is traditional regulation. In some cases, it may make sense for federal, state, or local governments to simply require the implementation of emission-reducing activities. For example, producers of industrial waste gases could simply be required to capture and destroy them. The advantage of this approach is that it can be comprehensive (covering all relevant facilities or installations), and it does not require complex emissions accounting. Regulators would still have to verify and enforce activities, and would want to consider whether regulations could result in emissions leakage, but administrative and overhead costs could be much lower than for certifying carbon offsets.

The third broad policy option is the use of incentive payments to fund emission reductions.[32] Incentive payments could take numerous forms, including the allocation of tradable allowances from a cap-and-trade program, allocation of revenue from auctioning allowances, general subsidies, or even tax credits. Why would using incentive payments reduce costs? Because unlike offsets, reductions achieved through incentive payments would not be used to compensate for increased emissions from capped sources, and therefore would not have to be subject to the same scrutiny in terms of measurement, additionality, leakage, and reversibility.

For example:

- Measurements of the effects of funded activities would be primarily for informational 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.
- While it would be desirable to fund "additional" activities, developing and applying complicated additionality tests would not be necessary from an environmental standpoint.
- Verification of funded activities would still be necessary, but could be limited to a simple confirmation that activities are being undertaken rather than precise quantification.
- Long-term carbon sequestration 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 an incentive 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.

The scrutiny required for incentive payment programs would differ from offset programs in degree, not in kind. Quantifying the effects of an incentive program–and making sure that mostly "additional" reductions were being funded–would be important in order to ensure that funds are not wasted. The consequences of any errors, however, would be no different from those of any subsidy program designed to achieve a public benefit, such as programs to promote energy efficiency or soil conservation.[33] Unlike carbon offsets, errors in quantification would not undermine the achievement of net GHG reductions, the primary goal of a cap-and-trade system.

### Finding an Optimal Approach

Offset projects are often sought as opportunities to lower capped entities' cost of complying with a cap-and-trade program. If emission reductions outside the cap are cheaper than reductions inside the cap, offsets allow the same overall emissions to be achieved at lower cost. Unfortunately, the setting of overall emissions reductions goals is often considered separately from the identification of offset project opportunities – and without consideration for what an optimal approach to emission reductions might look like across both capped and uncapped sectors of the economy.

Rather than pursuing a piecemeal approach, policymakers should consider a cap-and-trade program and other policy mechanisms for reducing emissions together, such that the overall package of policies is as environmentally effective and economically efficient as possible. As described above, some categories of uncapped reductions may be better served through policy mechanisms other than offsets. The downside to excluding some types of activities from an offset program is that doing so may raise the cost of compliance with an emissions cap. However, if setting emissions goals, identifying eligible offset project types, and designing other policy mechanisms to address uncapped emissions are considered in tandem, the overall cost to society of addressing climate change could be reduced.

## Section IV - Conclusions and Recommendations

The analysis presented in this brief is not intended to suggest that entire categories of activities, such as carbon sequestration activities, should be categorically excluded from a U.S. carbon offset program. It does suggest, however, that U.S. policymakers need to carefully consider the various options for achieving GHG emission reductions in "uncapped" sectors of the economy. Carbon offset programs are attractive for many reasons, but they require the application of rigorous quantification, verification, and enforcement criteria. Some types of activities are less likely to meet these criteria than others, and many activities involving soil or forest carbon sequestration are at an inherent disadvantage. Policymakers should look holistically at the range of options for reducing emissions at uncapped sources, and set targets for capped sources as part of an overall suite of climate change policies.

In designing a U.S. carbon offset program, policymakers should:

- Identify how much uncertainty is acceptable in quantifying the emission reductions (or net sequestration) from offset projects, taking into account measurement uncertainty, baseline uncertainty, and leakage. Although there will be no quantitatively "right" answer, policymakers should decide the maximum level of allowable risk of overstating real, additional emission reductions.
- Evaluate whether emission reductions (or net sequestration) from specific kinds of projects can be reliably quantified within the acceptable range of uncertainty, taking into account existing protocols.
- Decide on an appropriate mechanism for insuring against, and compensating for, reversals in carbon sequestration.
- Evaluate the transaction costs for different kinds of projects associated with meeting acceptable levels of quantification uncertainty, and with insuring against reversals.
- Decide whether specific types of projects can cost-effectively meet the requirements of a carbon offset program, or whether they should instead be realized through regulations or incentive programs.
- Consider the level of emissions caps in light of an overall package of policies aimed at both capped and uncapped sources.

## About the Authors

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Before coming to the Registry, Derik was a Senior Associate at the World Resources Institute (WRI) in Washington, DC where he led work on the Greenhouse Gas Protocol Initiative (an internationally recognized standard for greenhouse gas emissions accounting), and managed WRI's work on the design of greenhouse gas emissions trading programs, registry systems, and standards for carbon offsets. He is a primary author of the WRI/WBCSD GHG Protocol for Project Accounting, has advised numerous regulatory and voluntary programs on the development of carbon offset policies and standards, and has testified twice before Congress on carbon offset regulation and standard development.

Prior to joining WRI, Derik worked for eight years in the fields of energy and climate change consulting, including five years with Trexler Climate + Energy Services, Inc. in Portland, Oregon, where he developed financial and economic analytical tools for carbon market forecasting, risk management, project evaluation and business strategy development for a wide range of private and public sector clients. Derik holds a Masters degree in Public Policy (MPP) from the University of California at Berkeley, and a Bachelors degree in International Relations from Stanford University.

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## Notes

1. Although the focus of this brief is on U.S. domestic offsets, the same technical issues presented here will arise in the context of certifying international carbon offsets. Quantification uncertainties and risks may be even greater for projects undertaken in developing countries, and similar question may arise about the most effective policy approaches for different types of activities. See, for example, Kanninen, M., *et al.*, 2007. *Do Trees Grow on Money? The Implications of Deforestation Research for Policies to Promote REDD*. Center for International Forestry Research (CIFOR), Jakarta.
2. This paper uses the term "GHG reductions" to refer to both reductions in GHG emissions as well as increased removal and sequestration of GHGs (mainly $CO_2$) from the atmosphere.
3. 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.
4. The U.S. Environmental Protection Agency's (EPA) analysis of the Climate Security Act of 2008 found that the use of offsets would have a significant effect on the cost of the program. The report concluded that if domestic offsets and international credits were not allowed, allowance prices would increase by 93% compared to the bill as written. *EPA Analysis of the Lieberman-Warner Climate Security Act of 2008*, March 14, 2008. http://www.epa.gov/climatechange/downloads/s2191_EPA_Analysis.pdf.
5. The terms "offset credit," "offset allowance," and "carbon offset" are often used interchangeably.
6. Some reduction categories that are covered by a domestic cap (and therefore ineligible as domestic offsets) may still qualify as international offsets if the reductions occur at uncapped sources outside the U.S.
7. The concept of air emission offsets originated under the "New Source Review" program established by the United States' Clean Air Act. Under this program, offsets are required to be "real, creditable, quantifiable, permanent, and federally enforceable." These basic criteria have been modified and adopted in a 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 thereof. See, for example, Liepa, I., 2002. *Greenhouse Gas Offsets: An Introduction to Core Elements of an Offset Rule.* Climate Change Central, Alberta, Canada.

8. 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.
9. 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.
10. Ibid.
11. One option to accommodate these kinds of projects would be to allow limited use of project-specific additionality tests. For example, regulators could decide to treat methane capture projects at small landfills as automatically additional, but allow a project-specific analysis for projects at large landfills (where methane capture is often required and therefore baselines are more uncertain) rather than automatically rejecting them.
12. The average residence time of $CO_2$ in the atmosphere is around 100 years. U.S. EPA. http://yosemite.epa.gov/oar/globalwarming.nsf/content/Glossary.html#Lifetime.
13. 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.
14. See, for example, WRI and WBCSD, 2005. *The Greenhouse Gas Protocol for Project Accounting*. Washington, D.C. / Geneva, Chapter 3; and 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.
15. Under a cap-and-trade program, 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 allowances that can be used to emit more elsewhere. 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.
16. There may be a reason to rule out categories that will soon be covered by the emissions cap, as the benefits of capturing early reductions through offsets should be weighed against the administrative effort of developing rules for a category that will soon become obsolete.
17. 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. Additionality represents the extent to which project emissions are lower than the baseline.
18. For example, see http://ts.nist.gov/MeasurementServices/Calibrations/flow.cfm.
19. 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.
20. 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).
21. For example, see Brown, S., 2002. "Measuring, Monitoring, and Verification of Carbon Benefits for Forest-Based Projects." Philosophical Transactions: Mathematical, Physical and Engineering Sciences, Vol. 360, No. 1797, Carbon, Biodiversity, Conservation and Income: An Analysis of a Free-Market Approach to Land-Use Change and Forestry in Developing and Developed Countries (Aug. 15, 2002), pp. 1669-1683; and 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.
22. Murray, B.C., McCarl, B.A., Lee, H., 2004. "Estimating Leakage from Forest Carbon Sequestration Programs." *Land Econ.* 80(1), 109-124.
23. Kim, M., B. McCarl, T. Butt, 2005. *Uncertainty Discounting for Land-Based Carbon Sequestration.* http://agecon2.tamu.edu/people/faculty/mccarl-bruce/papers/1121.pdf
24. Ibid; and http://www.envtn.org/LBcreditsworkshop/Uncertainty_Intro.pdf
25. http://www.envtn.org/LBcreditsworkshop/Uncertainty_Intro.pdf; baseline carbon uncertainties for forest protection in Costa Rica range up to 54% for a single standard deviation.
26. Murray, B.C., B.A. McCarl, H. Lee, 2004. "Estimating Leakage from Forest Carbon Sequestration Programs." Land Econ. 80(1), 109-124. See also Murray, B., 2008. *Leakage from an Avoided Deforestation Compensation Policy: Concepts, Empirical Evidence, and Corrective Policy Options*, Nicholas School for Environmental Policy Solutions, Duke University. http://www.env.duke.edu/institute/wp-leakage.pdf
27. Cordeiro, M., and L. Schipper, 2008 (forthcoming). *Measuring the Invisible: Quantifying Emission Reductions From Transport Solutions.* EMBARQ / World Resources Institute, Washington, D.C.
28. Ibid.
29. Ibid.
30. See, for example, WRI and WBCSD, 2005. *The Greenhouse Gas Protocol for Project Accounting*. Washington, D.C. / Geneva, Chapter 5.
31. 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.
32. 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.
33. For a discussion of incentive program evaluation issues, see (for example): National Action Plan for Energy Efficiency, 2007. *Model Energy Efficiency Program Impact Evaluation Guide*. Prepared by Steven R. Schiller, Schiller Consulting, Inc.; and Heimlich, R., 2000. "Establishing Effective Incentives in Practice: the Role of Valuation and Influence of Other Factors" in *Valuing Rural Amenities*, OECD, Paris, pp.129-160.

## About WRI

The World Resources Institute is an environmental think tank that goes beyond research to create practical ways to protect the Earth and improve people's lives. Our mission is to move human society to live in ways that protect Earth's environment for current and future generations.

Our programs meet global challenges by using knowledge to catalyze public and private action:

- To reverse damage to ecosystems. We protect the capacity of ecosystems to sustain life and prosperity.
- To expand participation in environmental decisions. We collaborate with partners worldwide to increase people's access to information and influence over decisions about natural resources.
- To avert dangerous climate change. We promote public and private action to ensure a safe climate and a sound world economy.
- To increase prosperity while improving the environment.

We challenge the private sector to grow by improving environmental and community well-being.

In all its policy research and work with institutions, WRI tries to build bridges between ideas and actions, meshing the insights of scientific research, economic and institutional analyses, and practical experience with the need for open and participatory decision making.