ISSUE BRIEF 15

OFFSETS: INCENTIVIZING REDUCTIONS WHILE MANAGING UNCERTAINTY AND ENSURING INTEGRITY

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Summary

Most market-based regulatory proposals to limit greenhouse gas (GHG) emissions include provisions that allow market participants to seek reductions outside the regulated system. These reductions are typically referred to as offsets. Offsets are attractive because they can expand the available pool of low-cost reduction options, particularly in the near future. Many potential offset projects, however, present challenges because the emissions reductions they generate are difficult to measure or carry risks of impermanence. How can an offset program be designed to incentivize reductions while also ensuring their integrity?

- This memo briefly describes what offsets are, which sectors they are in, and how they have been used in other regulatory programs. We then discuss policy design features and options for addressing risks and uncertainties associated with low-quality offsets. In broad terms, the results of this exploration suggest that an offset program can be used to generate incentives for reductions that would be difficult to motivate or mandate in other ways, but creative approaches will be needed to manage offsets with uncertain environmental benefits.

- Offsets should be real, additional (beyond what would have happened anyway), permanent, and verifiable. These are the commonly accepted criteria for determining the quality and eligibility of offset projects.

- Offsets can be used to achieve emissions reductions in some sectors and for some activities that are difficult to regulate directly. Examples include biological sequestration of carbon; destruction of fugitive methane emissions from sources such as landfills or coal mines; or changes in agricultural soil management practices to reduce nitrous oxide emissions. Offsets can also enhance the dissemination of advanced technologies for reducing carbon dioxide (CO_2) emissions, particularly in developing countries.

- There is a fundamental tension between generating a large supply of low-cost offsets and ensuring they are high quality. Broadly speaking, two approaches can be used to mitigate—but not eliminate—this tension. The first is to simplify registration and crediting procedures for offset projects that generate emissions reductions which can be verified with a high degree of confidence. The second, complementary approach is to design offset programs that limit the consequences of potentially over-crediting projects in cases where the environmental benefits are less certain. Policymakers will have to decide how to balance trade-offs between minimizing transaction costs and ensuring the environmental integrity of offsets.

- Mechanisms that can minimize the administrative complexity and cost of offset programs include two-step registration procedures that determine project eligibility before developers commence projects, positive lists of pre-approved

offset project types, and tiered systems that use defined crediting levels for different types of projects.

- Policies to address projects with uncertain environmental benefits include credit limits and set-asides that specify a maximum aggregate level of offsetting reductions that can be used for compliance. These effectively place an upper bound on the risk from uncertain or difficult-to-verify projects. Non-uniform crediting can be used to discount certain project types, presumably on a risk basis. Rental credits can be used to limit exposure to offsets from projects that may not produce permanent emissions reductions.

- Policy choices for offset programs must be evaluated holistically. In designing such programs, policymakers should decide first what the overarching goal of the offset program is: generating the maximum number of offsets, minimizing transaction costs for project developers, ensuring environmental benefits, or some combination of these objectives. Designing an offset program will entail making choices about which suite of policy tools will function together to accomplish the goal.

What Are Offsets?

Offsets do what their name implies: they allow emissions reductions outside of a regulated system to 'off-set' emissions-reduction requirements inside the system.[1] The use of offsetting reductions is not required by law; rather, regulations set rules for which emissions-reduction activities can qualify as offsets. Private agents are motivated to pursue these offsets by their value as an alternative compliance option within the regulated system. Under a cap-and-trade program with offsets, for example, regulated entities could have four compliance options: (1) reducing emissions, (2) buying emissions allowances, (3) purchasing offset credits from unregulated entities that have reduced emissions, or (4) undertaking emissions-reduction projects that qualify as offsets within unregulated portions of their own operations.[2]

Although most commonly associated with cap-and-trade proposals, offsets can also be used under a mandatory emission tax as a way to offset the tax. Offset credits would reduce the tax liability of sources (as well as tax revenues to the government).

> Offsets come with a fundamental tension: how can the quality of offsets be assured at a low cost?

Offsets can be a valuable addition to regulatory programs because they expand the available pool of emissions reductions, presumably to include more low-cost options in sectors of the economy that are not regulated or across a wider geographical area. In other words, incorporating offsets can reduce the cost of meeting a given emissions target, make a more stringent target achievable at the same cost, or some combination of both (that is, reduce costs *and* allow for a more stringent target). By increasing the supply of available allowances, offsets can also increase the liquidity and flexibility of allowance markets, and reduce price volatility.

Offsets come with a fundamental tension, however: How can the quality of offsets be assured at a low cost? Performance criteria commonly applied to offsets require that emissions reductions are real, additional, and permanent. That is, offsets should be credited only to activities that actually reduce emissions, are additional to what would have happened anyway,[3] and do not merely shift emissions to another time or place. Ensuring that this is the case requires measurement, monitoring, and verification procedures. Ideally, such procedures would verify high-quality offsets while remaining transparent, streamlined, and administratively simple. In reality, there are trade-offs between ensuring environmental integrity and minimizing transaction costs.

1 In addition to regulatory offsets, there are voluntary or "retail" offsets. These are typically marketed to individual consumers and public awareness of their existence has been increasing. (Witness the New Oxford American Dictionary's selection of the term "Carbon Neutral" as the 2006 Word of the Year.) The voluntary market has grown significantly in the last three years, but remains a small part of the overall market. According to a World Bank report on the carbon market (K. Capoor and P. Ambrosi, 2007. *State and Trends of the Carbon Market 2007*, World Bank: Washington, DC.), compliance offsets—those used to meet regulatory requirements—accounted for more than 98 percent of the transactions in offset markets in both 2005 and 2006. This paper focuses on compliance offsets.

2 This last option would be particularly pertinent for multinational companies whose operations were regulated in some countries but not in others.

3 Additionality can be a challenging concept to define and establish, particularly since it is hard to know what would have happened in a "business-as-usual" world where there was not an incentive to generate offsets. The Clean Development Mechanism (CDM) of the Kyoto Protocol, an offset program discussed at length in the text box in this issue brief, has established a methodology for demonstrating additionality. It requires projects to show that some barrier to emissions reductions exists, that the project would not occur without CDM investment, and that the activity is not already a common practice. Source: CDM – Executive Board, "Combined tool to identify the baseline scenario and demonstrate additionality" Version 02.1. Available at http://cdm.unfccc.int/methodologies/Tools/EB28_repan14_Combined_tool_rev_2.1.pdf Accessed September 10, 2007.

Where Will Offsets Come From?

This section explores potential types of offset projects. What are some key sectors for offsets? What types of offset projects might be undertaken? What implementation challenges might they face? What regulatory concerns do they raise?

Offset opportunities are frequently concentrated in sectors or among activities that may be difficult to regulate directly, such as reducing fugitive emissions or lowering emissions associated with land-use practices. In some cases these emissions cannot be easily or reliably measured—as with soil carbon emissions (or sequestration)—and so are not good candidates for inclusion in a mandatory regulatory system such as a cap-and-trade program or carbon tax. In other cases, it may be difficult to determine, and hence regulate, emissions ex ante, but once an offset project is performed—for example, the capture and destruction of methane from landfills—determining the emissions reduction is straightforward.

One distinction among offsets projects is whether they are domestic or international in nature. To avoid double counting, domestic offsets would be limited to activities that are not already included in a mandatory program. For example, eligible domestic offset projects might address small-source emissions (if these are unregulated), biological sequestration, agricultural emissions, or other fugitive emissions; they typically would not include emissions at large point sources likely to fall under a mandatory program.[4] International offsets in countries without binding emissions caps, on the other hand, could involve a much wider range of projects including, in addition to the types of domestic offset projects noted above, projects that reduce energy- or industrial-sector emissions in developing countries through the transfer of advanced technologies. International offsets may face additional implementation and financing hurdles, however, depending on the strength of market institutions and legal frameworks in host countries.

Some of the projects and activities commonly considered for inclusion in a domestic offsets program are briefly reviewed below. The list is not intended to be exhaustive—rather it is based on projects that have been recognized so far under the Clean Development Mechanism (CDM) of the Kyoto Protocol and on the general disposition of U.S. GHG emissions, particularly fugitive emissions.[5] For each category of emissions, we discuss a few representative project types and identify potential problems in demonstrating that reductions are real, additional, and/or permanent. The information is also summarized in Table 1.

Biological Sequestration of Carbon

Biological sequestration projects focus on two distinct types of carbon reservoirs: forests and soils. Both contain large quantities of carbon with annual fluxes—changes in stored carbon—that significantly influence net CO_2 emissions to the atmosphere. Forestation projects involve either protecting existing forest that is threatened, or creating and sustaining new forests. These projects can raise significant permanence concerns; namely, how long will a stand of trees be preserved? Leakage problems can also be problematic, since protecting one stand of trees may just lead to another stand elsewhere being exploited. Soil carbon sequestration involves changing land-use or land-management practices (for example, in agriculture) such that additional carbon is sequestered in the soil. Net sequestration from soil carbon projects is often difficult to measure and these projects also raise concerns about permanence.

Non-CO_2 Agricultural Emissions

A few key activities generate most fugitive non-CO_2 GHG emissions in the agriculture sector (further discussion of sources and emission-reduction opportunities in this sector can be found in Issue Brief #13). The first category of activities involves methane (CH_4) emissions, primarily from large concentrations of animal waste (for example, manure) and ruminant animals, such as cows, whose digestive processes produce methane. Potential offset projects to address this category of emissions include capturing the methane from animal waste and either flaring it or using it to generate power or heat; options for reducing digestive emissions from ruminant animals are more limited but could involve changes in feed and grazing practices or the use of nutritional supplements. A second important category of agricultural emissions involves the release of nitrous oxide (N_2O) from soils. Nitrous oxide emissions can be reduced using soil management practices such as changing the application method and amount of fertilizer used, the types of crops grown, and irrigation practices. Quantifying these emissions and documenting reductions, however, is difficult.

4 Eligibility could also be influenced by other regulations; for example, an offset program might generally allow soil sequestration projects to receive offset credits, but exclude sequestration projects on land enrolled in the Conservation Reserve Program. Since these areas are already being compensated for environmental benefits associated GHG reductions might not be considered sufficiently "additional."

5 For more information on U.S. GHG emissions see Issue Brief #1.

Other Fugitive Emissions

Fugitive emissions are not released from a concentrated source, like a smokestack or tailpipe, but often involve leaks or evaporative processes. Potential offset projects include capturing fugitive methane emissions from landfills or coal mines, detecting and repairing leaks in natural gas pipelines, and reducing emissions of sulfur hexafluoride (SF_6) from electrical transformers.[6] In some cases it can be difficult to demonstrate that emissions reductions are in addition to the reductions that would have happened anyway, since there are private incentives to reduce many types of fugitive emissions.

Energy Systems

Domestic energy systems would likely be included in any domestic regulation,[7] but energy-system offsets could still be created through projects in other countries that lack binding emissions constraints. Examples include renewable energy projects, such as installing wind or hydroelectric generators, in other countries; generating power using methane emissions from waste treatment facilities overseas, thus both eliminating methane emissions and displacing some power generation; and energy-efficiency or fuel-switching projects that reduce CO_2 emissions outside the United States. Verifying benefits from these types of projects is usually relatively straightforward, although in some cases additionality could be a concern.

Industrial Gases

Although domestic industrial emissions, including emissions of non-CO_2 gases, would likely be included in any domestic regulation, offsets could be created by reducing emissions from industrial sources overseas. These types of offset projects have represented the majority of CDM projects undertaken so far. Examples include destroying hydrofluorocarbon (HFC) emissions associated with refrigerant production, reducing nitrous oxide emissions from the production of adipic or nitric acid, or reducing non-energy CO_2 emissions from industrial processes such as cement manufacture. These projects have proved popular under the CDM because there are abundant opportunities for low-cost reductions. Concern is growing, however, that some of these projects may be creating perverse incentives to continue or even expand activities that create other environmental problems.

Table 1 Overview of Offset Project Categories

Category	Representative Projects	Concerns
Biosequestration	Forest/soil sequestration	Additionality, permanence, MM&V*
Agricultural projects	Manure methane capture, soil management practices (N_2O)	MM&V
Fugitive gases	Landfill methane, coal-mine methane	Additionality
Energy systems (international)	Renewable energy, energy efficiency, fuel switching	Additionality
Industrial gases (international)	HFC-23, N_2O, industrial CO_2	Perverse incentives? (See discussion of CDM at end.)

*MM&V: measurement, monitoring, and verification

Primary Challenges in Designing an Offset Program

This section explores the design features and options that policymakers should consider when creating offset programs. Two sets of issues must be decided. The first concerns the broad design of the offset system, including defining the overall universe of potential projects. Ideally the approach used to determine eligibility for offset projects would minimize administrative complexity and uncertainty for offset developers. The second set of issues involves striking a balance between encouraging as much inexpensive, offset-based emissions mitigation as possible and protecting the integrity of the overall regulatory program in terms of its ability to meet defined environmental objectives. This challenge, not unrelated to the first, largely comes down to deciding how to deal with lower quality offsets.

Options for Determining Project Eligibility

Rather than deciding project eligibility on a case-by-case basis, which can be time consuming and impose high transaction costs, alternative mechanisms can facilitate quicker and cheaper review and measurement of offsets.

Positive list

A "positive list" identifies activities that are eligible to create

6 Fugitive emissions of synthetic gases, like SF_6, could potentially be regulated directly under a mandatory domestic GHG program, either by including industrial gas production sources in the cap (or tax), or by using a deposit-refund system in which permits are required for producing a gas and credited back when the gas is destroyed. See Issue Brief #14 on non-CO_2 gases for further disucssion of regulatory options for industrial gases.

7 Domestic energy systems would not qualify for offsets when covered by mandatory regulation because projects that reduced emissions (for example, energy efficiency projects) would reduce regulatory obligations in the program (whether the obligation is to submit allowances under a cap-and-trade program or to pay a tax on GHG emissions). In other words, the regulation itself would create direct incentives for reductions at covered sources. Under some mandatory programs—upstream cap-and-trade or carbon taxes on fossil-fuel production, for example—provisions would be needed to credit activities that trap and sequester post-combustion emissions, such as carbon capture and storage (CCS) projects. However, these provisions should be thought of as a refund (of allowances or taxes) rather than an offset. They are analogous to the emitter never bearing any regulatory obligation in the first place (as would likely be the case for an emitter that employed CCS under a downstream cap-and-trade program or carbon tax).

offsets; it can also define a fixed crediting level for these activities. This approach has been adopted in the Regional Greenhouse Gas Initiative (RGGI), a cap-and-trade program for limiting electric-sector GHG emissions being developed by several northeastern U.S. states. A positive list can ease administrative burdens and reduce uncertainty for project managers, particularly when dealing with common and well-understood project types.

Two-step process

For projects that require individual review, a two-step process may be appropriate in which offset developers submit a proposal and receive a determination of eligibility prior to beginning work. The second step occurs upon project completion when offsets are verified and credits issued. The CDM currently uses a two-step process—however, the fact that the first step can take a year or longer may discourage participation and investment in offset projects under this program.[8]

Tiered offset systems

Tiered systems are similar to positive lists in that they create standard eligibility and crediting rules. Various offset activities are grouped in specific tiers. "Top-tier" projects—those that are well-understood and easily verified—would have the simplest approval, verification, and crediting procedures. Tiered systems can increase the transparency of the offset approval process.

International offsets

While almost all proposals for offset programs allow domestic offsets, they may also incorporate international offsets. International offsets can expand the pool of available projects, but they may be more difficult to evaluate and administer. They may also enjoy less political support, as there would likely be greater political enthusiasm for generating reductions at home rather than abroad.

Offsets from other programs

As other national and international institutions create offset programs, there is the possibility that the United States could make these offsets fungible with its own. For example, certified emissions reductions (CERs) generated under the CDM program could be eligible for use as a domestic compliance option within a U.S.-based program, as has been proposed for RGGI.

Options for Dealing with Low-quality Offsets

Some types of offsets are well understood and easy to measure and verify. For example, measuring the capture and destruction of landfill methane or industrial gases is relatively straightforward. Inevitably, however, offset programs will have to handle activities that present measurement and verification challenges. There may be uncertainties in quantifying reductions (e.g., for soil carbon sequestration). There may be concerns about permanence or leakage (e.g., in the case of reforestation projects). It may be difficult to demonstrate additionality for some types of projects (e.g., showing that a project to capture methane for use or sale would not happen absent offset credits).

The challenge for an offset program is to balance the need to achieve real reductions against the desire to encourage widespread use of cost-effective mitigation options among otherwise unreachable sectors or activities. If the latter were not an objective, an offset program could simply apply strict eligibility rules—high standards for verifying additionality, permanence, and lack of leakage would ensure that (virtually) all offsetting reductions were real.[9] This approach would ensure high-quality offsets, but has disadvantages: large administrative costs and substantial burdens for offset-project developers could discourage investment. If an offset program is going to produce a reasonable supply of high-quality, low-cost reductions from unregulated sources it will need to incorporate creative and suitable approaches to crediting projects with uncertain environmental value.

Set-asides

An option that may be attractive for incentivizing particularly "high-risk" projects in the context of an emissions trading program is to carve out a portion of allowances under the overall cap and set it aside for these activities. For example, one Congressional proposal calls for 5 percent of the total allowance pool to be set aside for agricultural soil sequestration projects.[10] Set-asides can incentivize particular projects while guaranteeing the integrity of the cap in a cap-and-trade system. If five percent of allowances are credited to agricultural sequestration activities under a set-aside, capped and uncapped emissions will be five percent lower than they would otherwise be if these activities generate real reductions. If they do not generate real reductions, total emissions will still stay within the cap.

8 Natsource LLC, 2007. *Realizing the Benefits of Greenhouse Gas Offsets: Design Options to Stimulate Project Development and Ensure Environmental Integrity,* National Commission on Energy Policy: Washington, DC.

9 The CDM has essentially taken this approach. Despite high administrative costs, the program looks poised to produce a substantial volume of offsets over the compliance period of the Kyoto Protocol. (See further discssion in CDM text box.)

10 Bingaman-Specter "Low Carbon Economy Act of 2007", S. 1766, 110th Congress, section 201(a)(1) and section 205.

Credit limits

Another regulatory option for handling low-quality offsets is to limit the absolute number of credits available for certain types of activities. For example, another Congressional proposal limits the use of offset credits to a maximum of 30 percent of a covered entity's total compliance obligation.[11] The difference between this approach and a set-aside is that crediting projects that do not produce real emissions reductions will result in total emissions above the cap level. Essentially identical results can be achieved, however, by adjusting the cap level to account for this possibility. To illustrate this, consider two hypothetical cap-and-trade proposals. The first establishes a cap level of 100 tons and a set-aside of 10 allowances from the 100 allowances available under the cap (each allowance represents 1 ton of emissions). The second program establishes a cap level of 90 tons and limits offset credits to 10 tons. Assuming the same types of projects are eligible under both proposals, thus introducing exactly the same risks (of permanence, leakage, etc.), and assuming the set-aside and offset limits are exhausted in each case, the two proposals have identical consequences. If emissions reductions from credited projects are real and permanent, overall emissions will total 90 tons under both proposals. If, on the other hand, credits are claimed for projects that turn out to have no real environmental benefit, actual emissions will total 100 tons in both cases.[12] The lesson for policymakers is that the choice of which approach to use is less important than the size of the set-aside or credit limit in the context of the overall cap and the rules used to verify quality (with all the same trade-offs noted above).

Credit limits (and set-asides) do raise a critical issue, however, in terms of their potential to distort investment incentives for offset projects. With either limits or set-asides, the question arises: how will offset credits be distributed when there are more applicants than available credits? Credits could be awarded on a first come, first serve basis or prorated to individual projects such that the total awarded does not exceed the limit or set-aside amount (in that case, project developers would be credited for something less than the emissions reductions they achieve). In either case, uncertainty about how—or whether—their project will be credited could discourage developers from investing in offset activities.

Non-uniform crediting

While credit limits and set-asides are essentially quantity-based instruments for handling risky offset projects, non-uniform crediting is analogous to a price-based approach. The idea is that offset projects receive either more or less than one-to-one crediting: uncertain or risky offset projects receive offset credits at a discounted rate, while other projects receive full or even extra credits. For example, soil carbon sequestration projects might receive credits worth 80 percent of the current best estimate of sequestration.[13] The proposed Lieberman-McCain legislation uses discounted crediting for sequestration projects based on the uncertainty in estimating net emissions benefits: if the range of estimates for a class of projects is broad, the offsets awarded for such projects are near the bottom (low) end of the range.[14] A discounting approach helps address areas where benefits are likely but uncertainties (in measurement, permanence, etc.) remain large. By allowing projects that involve nascent or difficult emissions-reduction opportunities to receive some credit, this approach could promote some near-term investment in developing new abatement options while holding out hope that increased experience and improvements in measurement capabilities would allow crediting levels to be adjusted closer to projects' true value at some point in the future.

As noted previously, non-uniform crediting can also allow greater than one-to-one crediting. If there are certain offset activities that regulators particularly wish to encourage or reward, then awarding additional credit (beyond the best estimate of actual project reductions) will provide even stronger incentives. The Bingaman-Specter legislation uses this approach to encourage investment in carbon capture and sequestration (CCS): eligible geologic sequestration projects receive allowances at a greater than one-to-one rate from 2012 to 2029 (starting at 3.5 times the amount sequestered from 2012 to 2017).[15] Policymakers must recognize, however, that bonus credits represent an additional subsidy and will thus encourage a level of investment in eligible activities that is likely to be inefficient unless it can be justified on some other (non-climate) grounds.

Rental credit

Offset projects characterized by high risks of impermanence (for example, biological sequestration) could also be dealt with through credits that are "rented" rather than transacted once and for all. The Lieberman-McCain proposal uses a version of this approach: any sequestration projects that are

11 Lieberman-McCain "Climate Stewardship and Innovation Act of 2007", S. 280, 110th Congress, section 144(a).

12 If no offset activities are performed and hence no offset credits are claimed, emissions will total 90 tons.

13 This is effectively the approach used for soil sequestration projects within the offset program of the Chicago Climate Exchange (CCX). (The CCX is a North American-based GHG emission trading system that companies can join voluntarily by committing to reduce their emissions. The CCX manages its own offset program.) Each year 20 percent of CCX-eligible offsets that are generated through soil sequestration are placed into a reserve pool to hedge against future reversals in carbon storage. Source: Chicago Climate Exchange, "Soil Carbon Management Offsets" Available at http://www.chicagoclimatex.com/docs/offsets/CCX_Soil_Carbon_Offsets.pdf Accessed September 7, 2007.

14 "Climate Stewardship and Innovation Act of 2007", S. 280, 110th Congress, section 144(c)(3)(B).

15 Bingaman-Specter "Low Carbon Economy Act of 2007", S. 1766, 110th Congress, section 207(a)(3).

submitted for credit must be reevaluated every five years and if the net benefits claimed previously have declined (for example, a forest fire destroys a strand of trees that had been claimed), then covered entities must submit new allowances or credits to cover the shortfall.[16] An important political question in designing a credit rental proposal is deciding which party will be liable if previously rented offsets disappear or diminish in value: the covered entity that surrendered the offset credit to meet its compliance obligation or the unregulated entity that generated the offset in the first place. In either case, the idea of rental credits is attractive from an economic perspective because—assuming offset providers and buyers have good information about the likely permanence of emissions reductions from particular projects—they could account for these risks in managing their use of offsets. Problems could arise, however, if private actors expect the government to be the insurer of last resort: for example, if there were an expectation that in the wake of a forest fire which wiped out a large number of offsets the government would merely forgive resulting emissions. Such expectations would encourage overinvestment in high-risk projects, which could then have the perverse effect of increasing political pressure on the government to be the insurer of last resort in the case of a catastrophic event.

Conclusion

The design options discussed above reflect lessons learned from early offset programs, particularly the CDM. Many of these design option can be used in conjunction with each other. Indeed, policymakers must make decisions about most of the issues reviewed here, even if only implicitly. Finally, it is helpful to evaluate the various choices and options as a package, and to consider the overall implications of a given set of design choices.

For example, policymakers may choose to create an offset program that is outside the cap, consists only of domestic offsets, uses a tiered system with a positive list to determine project eligibility and crediting levels, and utilizes risk-based discounting to credit different project tiers. Such a program would be set up to minimize administrative burden. It would hedge environmental risk through a market mechanism, like discounting, rather than through regulation by offset quotas or caps. On the other hand, policymakers may prefer a tiered system that uses either set-asides or credit limits for certain tiers of activities, and utilizes rental credits with strict liability rules for other tiers. Such a system would be set up to maximize environmental integrity by reducing the risk that awarding credit to low-quality offsets results in emissions above the cap. Or, again, policymakers may opt for a very open system that allows unlimited offset credits from all sectors, recognizes international offsets, and uses uniform crediting, even from riskier projects. This system would be designed to minimize the overall costs of compliance, albeit at some risk to the environmental integrity of the program. All these design choices will have a substantial impact on the degree to which offsets can, on the one hand, expand the pool of low-cost mitigation options while on the other hand potentially compromising, or at least introducing uncertainty about, the overall environmental benefit achieved by the regulatory program.

The Clean Development Mechanism

Created under the Kyoto Protocol, the CDM represents the largest offset program in the world.[17] Under the CDM, credits are awarded for specific project activities in developing countries that reduce GHG emissions.[18] Developed countries with binding emissions targets under Kyoto can then purchase these credits to count towards their own compliance. The use of CDM credits to meet domestic regulatory obligations has also been proposed in countries that have not accepted emissions-reduction targets under Kyoto.[19]

The CDM process has stringent requirements. It requires project design documents to be independently evaluated (a process called validation), approved by a host country, and then reviewed and registered by the CDM Executive Board. There are high standards for demonstrating that reductions are additional and permanent. Once a project is registered and activities are underway, all emissions reductions must be measured and verified by an independent party before any offset credits, called Certified Emissions Reductions (CERs), are issued.

Each CER represents one metric ton of reduced carbon dioxide-equivalent (CO_2e) emissions. CERs can be purchased

16 "Climate Stewardship and Innovation Act of 2007", S. 280, 110th Congress, section 144(c)(1).

17 A smaller offset program has also emerged under the Chicago Climate Exchange (CCX), a private North American-based GHG emissions trading system that companies can join voluntarily by committing to reduce their emissions. The CCX manages its own offset program. As of August 2007 the CCX had issued offset credits to 34 projects—25 in the United States, 9 overseas—totaling almost 15 million metric tons CO_2e of reduced emissions. More than half of the emission reductions were from soil carbon sequestration projects. (Chicago Climate Exchange, "CCX Registery Offsets Report, Offsets and Early Actions Credits Issued as of 08/28/2007." Available at http://www.chicagoclimatex.com/offsets/projectReport.jsf Accessed August 28, 2007.) The CCX offset program has been criticized for having insufficient standards for ensuring that reductions—particularly from soil projects—are real and additional. Further, the CCX itself has faced criticisms for being too industry-friendly and lacking public transparency. (Goodall, J., 2006. "Capital Pollution Solution?", *The New York Times Magazine*, June 30, 2006.)

18 The Kyoto Protocol also created a separate category of offset activities called Joint Implementation projects, which are projects conducted within Annex 1 (developed world) countries. To date there has been much less activity in JI than in CDM.

19 For example, the Northeast and mid-Atlantic states have proposed to recognize CDM credits under their Regional Greenhouse Gas Initiative (RGGI) for limiting power-sector carbon emissions if the price of RGGI allowances rises above some defined threshold.

by countries to meet Kyoto obligations; they can also be purchased by firms—for example, as a means to comply with the European Union's Emission Trading System (EU ETS) (which in turn is being used by EU countries to help meet their Kyoto obligations).

As of July 2007, more than 700 CDM projects had been registered and another 1,500 applicants had submitted project design documents for validation. Altogether these projects in the CDM pipeline represent cumulative emissions reductions totaling approximately 2.2 billion metric tons CO_2-e through 2012.[20] For comparison, the projected compliance shortfall among Kyoto participants (including the EU, Japan, and New Zealand, but excluding Canada) from 2008 to 2012 is 2.0 billion metric tons CO_2e.[21] To date, few CERs have been issued, as most CDM projects are still relatively recent.

Figures 1 and 2 show the distribution of CERs from various project types, first for the 700 currently registered projects and then for all 2,200 proposed projects, including those now in the CDM pipeline.[22] As is evident from the figures, projects involving non-CO_2 GHG emissions account for the majority of emissions reductions. The single largest share of reductions comes from projects that reduce HFC-23 emissions from HCFC-22 production. These projects accounted for an even larger portion of early CDM entrants, as they represented some of the lowest-cost emissions-reduction options available internationally, but their share has fallen as the opportunities for HFC-23 control have been nearly exhausted.[23] Projects to generate nitrous oxide (N_2O) reductions have mostly involved controlling emissions from adipic acid production. By contrast, methane (CH_4) reduction projects have been implemented in a variety of sectors, including coal mines, oil and natural gas production and processing, and various waste management industries, including landfills, wastewater, and animal wastes.

Projects that focus on energy systems, whether they involve energy efficiency, fuel switching (typically to natural gas), or renewable generation, account for a small but growing

Figure 1 Currently registered CDM projects (July 2007); expected volume of 1,015 million CERs by 2012

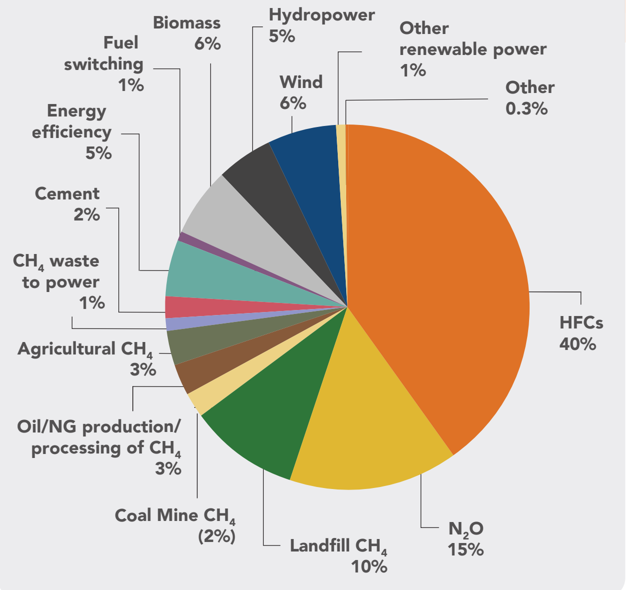
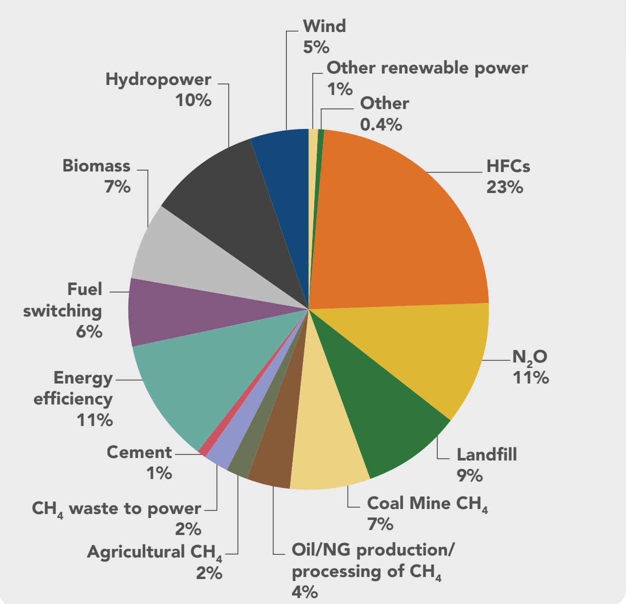


Figure 2 All CDM projects "in the pipeline" (July 2007); expected volume of 2,180 million CERs by 2012



20 The actual yield of delivered CERs will almost certainly be less. The World Bank report mentioned previously (Kapoor and Ambrosi 2007. *State and Trends of the Carbon Market 2007,* World Bank: Washington, DC.) estimates a likely CDM yield over the Kyoto compliance period (2008–2012) of 1.5 billion tCO_2e. The current issuance success rate among the few projects that have already been issued CERs is about 85 percent *(UNEP Riseo CDM/JI Pipeline Analysis and Database, July 2007),* which extrapolates to a little less than 1.9 billion tCO_2e.

21 Kapoor and Ambrosi 2007. *State and Trends of the Carbon Market 2007,* World Bank: Washington, DC. Canada is projected to have a large Kyoto compliance shortfall (perhaps 1.3 billion tCO_2e). Whether this will translate to increased demand for CDM credits is uncertain, however, because the Canadian government has published a report stating that the country will fail to meet its emissions reduction target under the Protocol. (Point Carbon, "Canadian government submits Kyoto compliance plan, without compliance", *Carbon Market North America,* August 29, 2007.)

22 *UNEP Riseo CDM/JI Pipeline Analysis and Database,* July 2007. Available at http://cdmpipeline.org/ Accessed August 2, 2007.

23 Wara, Michael, 2006. *Measuring the Clean Development Mechanism's Performance and Potential,* Program on Energy and Sustainable Development Working Paper #56, Stanford: Palo Alto, CA, and Wara, M., 2007. "Is the global carbon market working?", *Nature*, 445 (7128): 595-596. Compare the pipeline analyses from these papers (April 2006 and January 2007) with the July 2007 analysis in this paper and with the calculations of the total potential volume of HFC-23 reductions in Wara 2006.

portion of CDM reductions. They represent less than one-quarter of reductions from the 700 currently registered projects but are the fastest-growing category of activity for CDM projects. If all projects in the CDM pipeline are credited with currently projected reductions, energy projects in developing countries will account for more than 40 percent of all CERs generated by 2012.

Prices for CERs are driven by demand, particularly from Europe and the EU ETS, and so are linked to the price of allowances in the EU ETS. Prices in July 2007 for CERs delivered during the Kyoto compliance period (2008–2012) were \$12–\$18 per metric ton CO_2-e when purchase agreements were arranged directly between buyers and project developers. Prices for credits purchased in a secondary market have tended to be around 70 percent of the EU allowance price; thus CERs in the secondary market were selling for about \$20 per metric ton CO_2e in July 2007.[24]

Criticism of the CDM

The CDM process has drawn criticism for having an administratively complex and time-consuming approval and verification process.[25] Multiple approvals must be obtained and even after registration the quantity of credits to be generated is not certain until reductions are verified. The program's stringent eligibility standards are designed to ensure the integrity of emissions-reduction projects but they have the disadvantage of increasing transaction costs for project developers and reducing the universe of projects that can be profitably undertaken.

The CDM program includes some features designed to mitigate these burdens. For example, there is a list of acceptable methodologies with published guidelines for quantifying emissions for common types of projects, which can help reduce the length of the approval process for many applicants. Further, the existence of the registration process allows project developers to confirm that credits will be generated prior to undertaking projects (even if the exact quantity remains uncertain). Despite these features, however, bureaucratic delays and bottlenecks in the project review and emissions verification steps have led to a growing lag between project application and registration, and then between registration and the issuance of credits.[26]

The CDM program has also drawn criticism on grounds that payments for some projects that target certain non-CO_2 gases, particularly HFCs, essentially function as subsidies and thus create incentives to sustain—or even expand—activities that exacerbate other environmental problems. There is particular concern that the program creates perverse incentives for firms in developing countries to continue producing HCFC-22, an ozone depleting substance, so that they can receive CDM credits for destroying HFC-23, a by-product of the HCFC-22 production process.[27] Accordingly, some argue that non-CO_2 gases would be better dealt with by side agreements than in conjunction with CO_2.[28] Critics of the CDM further argue that many of the projects being credited, or those likely to be credited, under the program—particularly where they involve industrial gases like HFCs—are neither promoting technology transfer to less developed countries nor supporting sustainable development for the poor[29]—one of the primary goals of the CDM program as originally conceived under the Kyoto Protocol.[30] Others counter that the value of a multi-gas strategy is that it finds the lowest-cost reductions, wherever they occur, and that an offset market at least ensures that reductions in certain industrial-gas emissions are taking place. One potential strategy for addressing concerns about these gases would be to adjust the crediting rate for projects so that the incentive to reduce emissions is balanced against the perverse incentive to expand opportunities for reducing emissions in the future.[31] In addition, a credible long-term decision about which new emission sources will (or will not) be eligible for offsets would help to eliminate incentives for strategically expanding production.

The CDM is significant for creating the first large-scale market for offset credits in the context of greenhouse gas regulation. It has demonstrated that a market-based system of offset credits can be used to link international emissions reductions, particularly in developing countries, to compliance obligations under a domestic or regional cap. The criticisms that have been leveled at certain aspects of the CDM may offer lessons for policymakers and regulators as countries consider setting up their own offset programs.

24 PointCarbon, 2007. "CDM market comment", *CDM & JI Monitor*, July 11, 2007.

25 *Natsource LLC, 2007. Realizing the Benefits of Greenhouse Gas Offsets: Design Options to Stimulate Project Development and Ensure Environmental Integrity,* National Commission on Energy Policy: Washington, DC.

26 PointCarbon, 2007. "Bureaucratic delays, lack of auditors clog up CDM process", *CDM/JI Monitor,* August 22, 2007.

27 The concern arises because, given current prices for CDM credits and low abatement costs for HFC-23, the profits from destroying HFC-23 byproduct and selling the CDM credits are greater than the value of the HCFC-22 production itself. Similar concerns have been raised regarding the relative costs of N_2O destruction from adipic acid production. (Wara, Michael, 2006. *Measuring the Clean Development Mechanism's Performance and Potential,* Program on Energy and Sustainable Development Working Paper #56, Stanford: Palo Alto, CA.) HCFC-22 is used both as a chemical feedstock for synthetic polymers—a process which sequesters the gas without emissions—and in a variety of end-use applications, including as a refrigerant, that result in fugitive emissions. The production of HCFC-22 for non-feedstock purposes is already being phased out by developed countries under the Montreal Protocol, but production in developing countries is allowed to continue without restriction until 2016, at which point a production freeze will go into effect until 2040. After 2040, all production of HCFC-22 worldwide is supposed to cease under the Montreal Protocol (Bradsher, K., 2007. "Push to Fix Ozone Layer and Slow Global Warming", New York Times, March 15, 2007.)

28 Wara 2007. "Is the global carbon market working?", *Nature*, 445 (7128): 595-596.

29 Bradsher, K., 2006. "Outsize Profits, and Questions, In Effort to Cut Warming Gases", *New York Times*, December 21, 2006.

30 Article 12 of the Kyoto Protocol.

31 For more information see the discussion on non-uniform crediting in the section of the main text that discusses design challenges for offset programs