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The Use of Offsets to Reduce Greenhouse Gases

Discussions about reducing greenhouse gases often focus on limiting the use of fossil fuels to generate electricity or power cars and trucks, yet a variety of other actions—including disposing of waste in different ways, changing methods of farming, and lessening deforestation—could also reduce the concentration of greenhouse gases (GHGs) in the atmosphere. Both existing climate policies, such as the European Union's Emission Trading System, and policies under consideration, such as the American Clean Energy and Security Act (ACESA) of 2009, which was recently passed by the House of Representatives, have recognized the potential for such actions to "offset" the extent to which the use of fossil fuels must be reduced to meet a chosen target for total GHG emissions. If such offsets—which can be defined as reductions in GHGs from activities *not* subject to limits on emissions—are less expensive than reductions from limiting the use of fossil fuels, they can reduce the overall economic cost of meeting a target for emissions. Yet the difficulty of verifying offset activities raises concerns about whether the specified target will actually be met; those concerns may be especially acute when, as under ACESA, allowable offsets include actions taken outside of the country setting the target for emissions.

Although experience with offsets is not extensive, preliminary evidence suggests that they can significantly lower the economic cost of a cap-and-trade program, even after accounting for the costs of steps taken to increase confidence that offsets represent true incremental reductions in GHGs. However, estimates of the savings that would result from including offsets in a cap-and-trade program are imprecise and depend importantly on policy design.

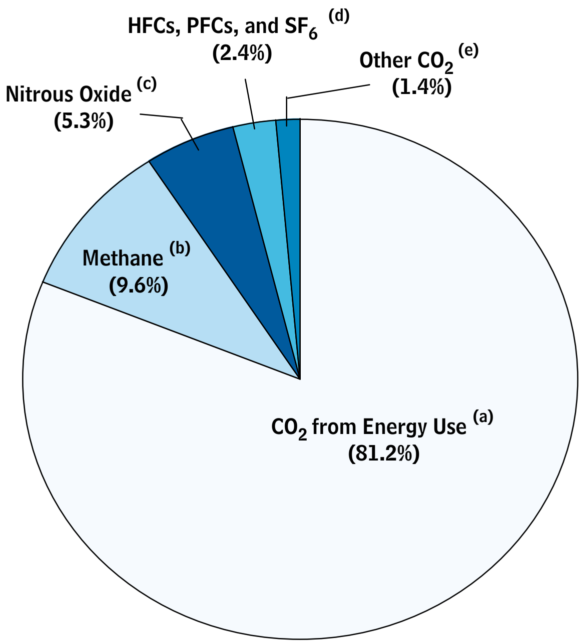
Potential Benefits of Offsets

The cap-and-trade program established by ACESA would set an annual limit, or cap, on emissions for each year between 2012 and 2050 and would distribute "allowances," or rights to produce emissions. After the allowances were distributed, regulated entities—those that generate electricity or refine petroleum products, for example—would be free to trade them, so entities that could reduce their emissions at lower costs could sell allowances to others facing higher costs. The legislation would also allow a regulated entity to meet a portion of its compliance obligation by purchasing domestic and international offsets instead of using allowances. Those offsets have the potential to reduce the total cost of capping GHG emissions by substituting less expensive emission reductions from entities not subject to the cap for more expensive reductions from entities subject to the cap. More generally, including offsets in a cap-and-trade program need not affect the total amount by which greenhouse gases were reduced but would change the mix of activities undertaken to achieve a specified reduction.

In principle, a comprehensive cap could apply to all sources of GHGs. In practice, however, policies currently in effect and being considered by the Congress cap only emissions from significant sources of GHGs that can be easily and reliably measured. The electric power industry, for example, which produces over one-third of all U.S. GHGs, can use systems that continuously monitor emissions (such as methods currently required under the Acid Rain program) to accurately measure the release of carbon dioxide (CO_2). In contrast, entities whose emissions are much less significant or more difficult to monitor systematically are generally excluded from existing and proposed caps. Nonetheless, some of those entities may be able to reduce GHGs more cheaply than the electric power industry or other industries whose emissions are subject to the cap. Owners of livestock are one example. When livestock waste decomposes, methane (which is more damaging to the climate on a per-ton basis than CO_2) is produced. However, manure can be collected and processed with special bacteria in airtight holding tanks or covered lagoons that allow operators to trap and recover methane. If capturing methane was cheaper than reducing CO_2 emissions from other sources by an

Figure 1.

U.S. Greenhouse-Gas Emissions, 2007



Source: Congressional Budget Office based on Department of Energy, Energy Information Administration, *Emissions of Greenhouse Gases in the United States*, 2007 (December 2008); and Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2007* (April 2009).

Notes: HFCs = hydrofluorocarbons; PFCs = perfluorocarbons; SF_6 = sulfur hexafluoride.

Emissions are represented in terms of carbon dioxide equivalent (CO_2e). A metric ton of CO_2e is the amount of a given greenhouse gas (for example, methane or nitrous oxide) that makes the same contribution to global warming as a metric ton of carbon dioxide.

The figure excludes CO_2 emissions in agriculture and forestry that are not from fossil fuels.

Emissions from:

a. Fossil Fuels (Combustion and other uses)

b. Landfills; Coal Mines; Agriculture; Oil and Gas Systems; Wastewater Treatment; Combustion; Iron, Steel, and Metallurgical Coke Production; and Petrochemical Production

c. Agriculture, Combustion, Adipic and Nitric Acid Production, Wastewater Treatment, Product Uses (Primarily as an anesthetic or propellant), and Waste Incineration

d. Solvents, Refrigerants, Firefighting Agents, Aerosols, Electrical Transmission and Distribution, Aluminum Production, Magnesium Production and Processing, and Semiconductor Manufacturing

e. Manufacturing of Cement, Use of Limestone, Natural Gas Production, Manufacturing of Aluminum, Soda Ash, and Waste Combustion

amount that would have an equivalent impact on the climate, then doing so would reduce the cost of meeting a specified cap on GHGs. In another example, emissions might be reduced at relatively low cost in the industrial sector in developing countries.

The potential for reducing costs in a cap-and-trade system through the use of offsets would depend on the stringency of the cap over time and on the scope and amount of allowed offsets:

- The more stringent the cap, the greater the opportunity to reduce costs by using offsets.
- The sooner that significant emission reductions were required under the cap, the more expensive that compliance would be (because there would be less time to develop and adopt new lower-emission technologies), and the greater the opportunity to reduce costs by using offsets.
- The greater the number of sectors and countries from which offsets could be used, and the greater the proportion of compliance for which they could be used, the greater the opportunity to reduce costs by using offsets.

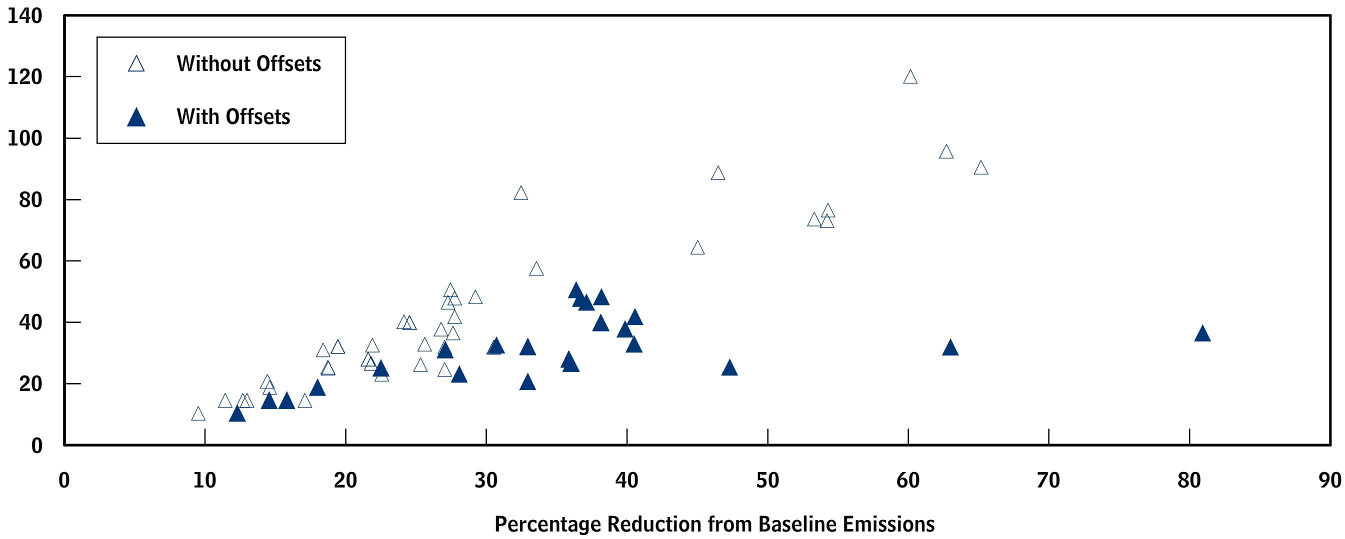
There are many potential sources of offsets: Within the United States, a broad range of activities generate GHGs (see Figure 1), and various land management practices can reduce the amount of CO_2 in the atmosphere by storing it in soil and plants. In addition, offsets could arise from activities in other countries, and especially in developing countries, that could substantially reduce emissions in the agriculture sector and store large quantities of carbon in forests. Because each ton of emissions from any point on the globe has the same effect on the concentration of those gases in the atmosphere, reductions in emissions have equal benefit regardless of where they occur.

To illustrate the potential savings from reducing GHGs partly through offsets rather than exclusively through less use of carbon-intensive fuels, one can compare the estimated cost of emission reductions for cap-and-trade proposals that would allow the use of offsets and proposals that would not. Different researchers, using a number of different modeling approaches, have analyzed a variety of proposals and developed a range of estimated costs (see Figure 2). The pattern of the estimates is clear: When offsets are allowed, the costs of achieving a given reduction

Figure 2.

Various Estimates of the Costs of Reducing Greenhouse-Gas Emissions Under Cap-and-Trade Programs With and Without Offsets

(Allowance price in 2007 dollars per metric ton of CO_2e)



Source: Congressional Budget Office based on estimates from the National Commission on Energy Policy, the Environmental Protection Agency, the Energy Information Administration, the Nicholas Institute for Environmental Policy Solutions, and the Massachusetts Institute of Technology.

Notes: The figure shows, for 2030, the allowance prices and emission reductions under various cap-and-trade proposals, including variations on S. 280, the Climate Stewardship and Innovation Act of 2007, and S. 2191, America's Climate Security Act of 2007. Costs are reported in terms of the price per metric ton of carbon dioxide equivalent (CO_2e) emissions associated with achieving a given reduction in greenhouse gases. A metric ton of CO_2e is the amount of a given greenhouse gas (for example, methane or nitrous oxide) that makes the same contribution to global warming as a metric ton of carbon dioxide.

The estimates do not account for the costs of measures to address concerns about the credibility of offsets.

in GHGs are lower—substantially so for large reductions in GHGs.

Potential Limitations of Offsets

Despite the large cost savings that may be realized from including offsets in a cap-and-trade program, some observers are concerned that the use of offsets can undermine the environmental goals of the program. Those concerns arise because the reductions in GHGs from offsets may be more difficult to verify than the reductions from sources whose emissions are subject to the cap. Moreover, some types of offsets may be more difficult to verify than others. For example, although it might be relatively easy to measure the amount of methane captured in the United States from using special processes to treat animal waste, it might be quite difficult to measure the amount of carbon removed from the atmosphere because of efforts to plant trees or avoid deforestation in developing countries.

Verifying the reduction in GHGs from offsets generally would involve four components:

- Offsets would need to bring about *additional* reductions in GHGs. That is, they would need to result in reductions that would not have occurred in the absence of the program that grants credit for offsets.
- Offsets would need to be *quantifiable* so that any reductions in GHGs could be reliably measured.
- Offsets would need to be *permanent* rather than simply delay the release of GHGs into the atmosphere.

- Offsets would need to be credited in a way that accounted for *leakage* in the form of higher emissions in other locations or sectors of the economy as a result of the offset activity.[1]

Offsets are used by a number of existing climate programs, including the United Nations Clean Development Mechanism (CDM), the Regional Greenhouse Gas Initiative (RGGI) in the United States, the Chicago Climate Exchange, and the Voluntary Carbon Standard (see Box 1). Those programs use a variety of strategies—which vary in rigor and cost—for verifying the intended reductions in GHGs.

"Additionality"

Different climate programs use a variety to strategies to ensure that offsets credited in a cap-and-trade program satisfy "additionality"—that is, that they effect reductions in GHGs that would not have occurred otherwise. Simple strategies include accepting only activities that are not mandated by other laws, activities that reduce GHGs after a specified date, and activities that are not common practice. Further strategies involve judging additionality on the basis of performance standards or the use of specific technology. Still more complex assurances can be sought through demonstrations that the production of offsets—such as reforesting land—would constrain an alternative use of the resources that would be more profitable (apart from the value of the credit for offsets)—such as using that cleared land as pasture for livestock.

The CDM, for example, employs all three of the simple checks. In addition, the providers of offsets must either document that their projects—such as reforestation or the reduction of leaks from natural gas systems—could not be implemented without the program's support or demonstrate that the projects are not prompted by intrinsic financial gains. To document the need for the program's support, offset providers must provide evidence of barriers to implementation. Those barriers may relate to investment (such as limited access to capital markets), technology (such as a lack of skilled labor or of access to materials and equipment), institutions (such as uncertain land ownership and tenure), or other factors. As evidence, the CDM accepts market and statistical data, sectoral studies, legislative and regulatory information, and assessments by independent experts. Alternatively, offset providers can show that the financial benefits of producing the offsets (aside from selling them to regulated entities) are lower than the benefits available through alternative uses of the resources. Evidence must be based on standard market measures that are not linked to subjective expectations of profitability, and they must be bolstered by an analysis showing how the conclusions would vary with reasonable changes to key assumptions.

Quantification

Processes for quantifying reductions of GHGs produced by offset activities vary in their level of detail, degree of transparency, and procedures for external verification. Depending on the activity, effects on GHGs may be estimated on the basis of general relationships (for example, the amount of carbon storage expected when minimizing the extent to which soil is disturbed by agriculture in different geographic regions) or measured directly (for example, the amount of methane that can be captured from the decomposition of animal waste in holding tanks); direct measurement may provide greater certainty but often comes at greater cost. Quantification processes that are more transparent promote oversight by interested parties. Many programs require that third parties verify the GHG reductions reported by the providers of offsets.

RGGI, for instance, requires that providers of offsets use preapproved, publicly available methodologies for calculating offsets, have quality control programs, and hire third parties accredited by RGGI to validate the calculations. RGGI then follows those steps with a separate determination to award credit for offsets.

Permanence

Concerns about the permanence of reductions in GHGs brought about by offsets are heightened if no one is liable for unintended or unforeseen releases of GHGs. Ascertaining permanence is a particular challenge for offsets generated from land use, because carbon stored in plants and soils can be released to the atmosphere by environmental changes such as forest fires and pest infestations as well as by human activities such as logging and plowing.

1. Leakage is not unique to offset activities. It would also occur if sources subject to emission limits could relocate abroad to escape the limits or if they lost market share to competitors not subject to the limits.

Box 1.

Offset Programs

Some existing climate programs have been established by governments to mandate limits on greenhouses gases; others have been established by governments or other entities to encourage voluntary actions to reduce greenhouse gases. Many of the existing programs include offsets in some form.

The Clean Development Mechanism (CDM) was created in December 1997 under the United Nations Framework Convention on Climate Change, and its main operational guidelines were established in November 2001. The CDM is used to assist countries in meeting the collective goal under the Kyoto Protocol of reducing emissions by 5.4 percent from 1990 levels by 2012. Industrialized countries can purchase offsets from developing countries and use them to meet a portion of their commitment to reduce greenhouse gases.

The Regional Greenhouse Gas Initiative (RGGI) in the United States, established in 2005, requires power plants that rely on fossil fuels and are located in 10 Northeastern member states to maintain current emission levels from 2009 to 2014. Thereafter, they must reduce emissions by 2.5 percent annually, achieving a total reduction of 10 percent by 2019. Members can purchase offsets generated in participating states and, under certain circumstances, elsewhere in the United States and internationally to meet a portion of their compliance obligation.

The Chicago Climate Exchange was established in 2003. Members—which include companies operating in various sectors of the economy, universities, municipalities, counties, and states—have made voluntary, but legally binding, commitments to, by 2010, reduce their greenhouse gases 6 percent below their average level from 1998 to 2001 or their level in 2000. Members can use domestic and international offsets to help meet those commitments.

The Voluntary Carbon Standard was developed in 2007 to establish uniform and transparent standards for a voluntary market. That market is made up of a number of mechanisms through which buyers from the public and private spheres can achieve self-defined objectives by funding activities that reduce greenhouse gases. Projects that reduce greenhouse gases can have their offsets certified by adhering to the standards.

Climate programs address permanence in various ways. Some programs require legal assurances that carbon will remain stored. Others assign expiration dates to offsets, and once those dates have passed, sources whose emissions are subject to limits can no longer use those offsets to meet compliance obligations and must replace them. Some programs hold in reserve a portion of the credits earned by each offset activity and use that pooled reserve to compensate for any reversals of carbon storage. For example, the Voluntary Carbon Standard calls for holding in reserve between 10 percent and 60 percent of the offsets produced by an agriculture or forestry project depending on the project's risk of reversal. That risk is regularly reevaluated and the reserve amount adjusted as needed to account for changes in a project's financial, technical, and management situation; the economic risk of changing land values; the risk posed by regulatory and social instability; and the risk of natural disturbances.

Leakage

Leakage reduces the net effect of offset activities on GHGs, but it can be difficult to identify and quantify—which makes it an extremely difficult concern to address. For example, preserving a growing forest to generate offsets would reduce the overall supply of timber, raise timber prices, and provide an incentive for increased harvests of trees in other locations.

The smaller the scope of leakage—within the holdings of the offset provider, for example—the easier it is to account for, but when leakage occurs on a national or international level or in economic sectors other than the one generating the offset, it is very hard to address. For instance, offsets produced by capturing methane emissions from livestock waste would probably not result in increased emissions elsewhere; however, preserving trees in one location could result in an increase of the supply of lumber from other places that would be difficult to prevent or measure.

Programs try to deal with leakage in two ways—by requiring certain design features that minimize leakage and by applying discounts to offset activities when issuing credits to account for leakage that cannot be avoided. The Chicago Climate Exchange, for example, requires offset providers to manage their forestry holdings in a sustainable way. The program also requires projects to quantify leakage, but only within a developer's own land holdings. However, that approach ignores the impact of changes in land use that are less proximate to the offset but nonetheless attributable to the offset project.

The Costs of Verifying the Reduction in Greenhouse Gases from Offsets

The costs of verifying that offsets are additional, quantifiable, permanent, and not neutralized by leakage depend on the level of assurance that is required. In general, the higher the level of assurance about the credibility of offsets that is required, the more rigorous the verification needs to be and the more costly it will be.

Aiming for complete assurance would be prohibitively costly—particularly for international offsets generated in developing countries where a lack of institutional and technical capacity would come into play. Therefore, climate programs could use some combination of two approaches: First, they could discount the value of offsets by requiring more than 1 ton of claimed reduction in GHGs through offset activities to substitute for each ton of forgone reduction by entities subject to the cap. Second, they could limit the proportion of total emission reductions by regulated entities that could be achieved through offsets; in the European Union's Emission Trading System, for example, less than 20 percent of emission reductions in 2012 can be achieved through offsets from the CDM.

To evaluate the cost of verification, the Congressional Budget Office reviewed the relatively few studies that analyze the transaction costs of offsets—costs beyond the direct costs of achieving GHG reductions—in a range of pilot projects and projects associated with the United Nations Framework Convention on Climate Change in the agriculture, forestry, waste, and energy sectors. Such transaction costs include those for feasibility studies; technical assistance; administration; efforts to locate offset buyers and sellers and negotiate transactions; and, primarily, measures taken to address concerns about additionality, quantification, permanence, and leakage.

No standard definition of transaction costs is widely accepted, and no consensus has emerged on how to quantify or predict them. Nevertheless, in the studies that analyze transaction costs, they were less than $5 per metric ton of carbon dioxide equivalent (CO_2e)—which is the amount of a given GHG (for example, methane or nitrous oxide) that makes the same contribution to global warming as a metric ton of CO_2. As a general rule, the transaction costs per ton would be expected to be higher for smaller offset projects, as some of those costs do not vary with the number of offsets produced, and in a smaller project, they are spread over fewer offsets.

That estimate provides insight into the cost of measures undertaken to increase confidence that offsets represent true incremental reductions in GHGs. For example, it encompasses the estimated transaction costs for a reforestation project under the CDM, which employs relatively rigorous measures to address additionality, quantification, permanence, and leakage. However, the estimate does not provide insight into the ultimate degree of confidence provided. That remains an open question in the research and a source of uncertainty about the impact of allowing offsets to substitute for reductions in capped emissions. If offsets fell short of actually providing the full reduction in GHGs for which they were credited in a cap-and-trade program, the actual climate impact would fall short of the intended one.

Offsets in the American Clean Energy and Security Act

The use of offsets reduces the net economic cost of achieving a given cap on GHGs if the offsets represent true incremental GHG reductions, but the magnitude of the savings depends on the costs of verifying the offsets and on the amount and types of offsets allowed.

Table 1.

Effects of the American Clean Energy Security Act With and Without Offsets, 2030

	With Offsets	Without Offsets
	Billions of 2007 Dollars	
Net Cost[a]	101	248
	Million Metric Tons CO_2e	
Net Cap on Greenhouse Gases	3,427	3,427
Emissions from Sources Subject to Limits	5,031	3,555
Allowances Banked[b]	186	-128 [c]
Emissions Covered by Offsets	1,790	0
	Billions of 2007 Dollars	
Auction Revenues	136	474
	Dollars/Metric Ton CO_2e	
Allowance Price	40	138

Source: Congressional Budget Office.

Notes: Emissions are represented in terms of carbon dioxide equivalent (CO_2e). A metric ton of CO_2e is the amount of a given greenhouse gas (for example, methane or nitrous oxide) that makes the same contribution to global warming as a metric ton of carbon dioxide.

Whereas the dollar figures in this table (as well as the text) are reported in constant 2007 dollars, those in CBO's cost estimates, including the one for H.R. 2454, the American Clean Energy and Security Act of 2009, as reported by the House Committee on Energy and Commerce on May 21, 2009 (June 5, 2009), are in nominal dollars.

a. As measured here, the United States' net cost includes the gross cost of complying with the cap minus the sum of the allowance value that would be returned to U.S. households under the provisions of the American Clean Energy and Security Act (ACESA) and the net revenues resulting from the domestic production of offsets. Equivalently, the net cost includes the resource costs associated with reducing emissions-which would include the value of the resources (including nonmonetized resources, such as time) required to reduce emissions, the cost of purchasing international offsets, the cost of producing domestic offsets, and the allowance value that ACESA would direct overseas to support other countries' activities to reduce greenhouse gases and adapt to climate change. The net cost as measured here does not include the costs that some current investors and workers in sectors of the economy that produce energy and energy-intensive goods and services would incur as the economy moved away from the use of fossil fuels or the full range of effects on the economy, nor does it include the benefits of the reduction in greenhouse gases and the associated slowing of climate change.

In a previous analysis of the distributional effects associated with ACESA (*The Estimated Costs to Households from the Cap-and-Trade Provisions of H.R. 2454*, letter to the Honorable Dave Camp [June 19, 2009]), CBO scaled the net cost of the policy in 2020 to the size of the current economy. If the same scaling was done here, the net cost would be $68 billion with offsets and $168 billion without offsets.

b. Under ACESA, allowances could be banked and used to cover future emissions. (Borrowing future allowances for current use could also occur for up to five years, with certain restrictions.)

c. The negative amount indicates that entities would be using allowances that they banked in previous years.

The Environmental Protection Agency and the Department of Agriculture would be largely responsible for establishing the procedures through which offset projects addressed the issues of additionality, quantification, permanence, and leakage. To estimate the effect of offsets under ACESA, CBO incorporated transaction costs of $5 per ton of CO_2e. By way of comparison, that is less than 10 percent of CBO's estimate of what the allowance price would be in 2012 *without* offsets. In recognition of the greater challenge of verifying international offsets, after 2017 the program would require 1.25 tons of reductions in CO_2e from international offsets to substitute for a reduction of 1 ton by an entity subject to the cap—thus discounting international offsets by 20 percent. Moreover, under ACESA, international offsets could come only from developing countries that negotiated a related agreement or arrangement with the United States. ACESA would allow offsets to substitute for up to 2 billion metric tons of emission reductions annually at entities subject to the cap; even so, by 2030, CBO estimates that 52 percent of the required reduction in emissions could be achieved through domestic and international offsets.[2]

The effect of offsets on the cost of achieving the emission reductions specified in ACESA can be illustrated with reference to a specific year (see Table 1). The legislation would establish a cap on GHG emissions in 2030 of 3,427 million tons of CO_2e, so the government would distribute 3,427 million allowances in that year.

Without offsets, 3,555 million tons of emissions would occur in 2030, CBO estimates, which would be equal to the number of allowances distributed that year plus 128 million allowances that entities subject to the cap had banked in previous years and chose to use in 2030. The net cost in the United States for the program would be $248 billion in that year. (The net cost includes the value of the resources required to reduce emissions, the cost of purchasing international offsets, the cost of producing domestic offsets, and the allowance value that ACESA would direct overseas.)

With offsets, as allowed for in the bill, sources subject to the cap would emit 5,031 million tons and purchase offsets for 1,790 million tons, CBO estimates. On the domestic front, those offsets would come primarily from changes in agriculture and forestry and from capturing methane at landfills. On the international front, they would come primarily from changes in agriculture. If the offsets represented true incremental reductions, then net emissions would be 3,241 million tons (5,031 minus 1,790). The sources subject to the cap would use 3,241 million allowances to cover their net emissions and would bank 186 million allowances (3,427 distributed minus 3,241 used) to cover future emissions. In 2030, the net cost in the United States for the program would be $101 billion—about 60 percent less than if offsets were not allowed. With offsets, the greater amount of emissions that would be allowed from sources subject to the cap would make allowances less valuable. Without offsets, the price of an allowance would be $138 per ton, and auction revenues would be $474 billion; whereas with offsets, the allowance price would be only $40 per ton and auction revenues, $136 billion.

The cost savings to the economy generated by offsets could be substantial. CBO estimates that between 2012 and 2050 average annual savings from offsets could be about 70 percent under ACESA. Of course, the intended environmental benefit would be fully realized only if the offsets provided the full reduction in GHGs for which they were credited.

2. Domestic offsets could substitute for up to 1 billion allowances, and international offsets could substitute for up to 1.5 billion allowances (but exceed 1 billion only when compensating for a shortfall in the availability of domestic offsets).

This brief was prepared by Natalie Tawil. It, along with CBO's other work on climate change, appears on the agency's Web site at www.cbo.gov/link/cc.

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