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Potential Offset Supply in a Cap-and-Trade Program

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Potential Offset Supply in a Cap-and-Trade Program

Summary

If allowed as a compliance option in a greenhouse gas (GHG) emission reduction program (e.g., a cap-and-trade system), offsets have the potential to provide considerable cost savings and other benefits. However, offsets have generated considerable controversy, primarily over the concern that illegitimate offsets could undermine the ultimate objective of a cap-and-trade program: emission reduction.

An offset is a measurable reduction, avoidance, or sequestration of GHG emissions from a source *not covered* by an emission reduction program. An estimate of the quantity and type of offset projects that might be available as a compliance option would provide for a more informed debate over the design elements of a cap-and-trade program. It is difficult to estimate the supply of offsets that might be available in a cap-and-trade system, because the supply is determined by many variables, including:

Mitigation potential. Mitigation potential estimates are the raw data that feed into models estimating offset use in a cap-and-trade program. Recent estimates contain considerable uncertainty.

Policy choices. The design of the cap-and-trade system would be critical to offset supply. Particularly relevant design choices include which sources are covered; which types of offset projects are allowed; whether or not offset use is limited; and the degree to which set-aside allowances are allotted to activities that may otherwise qualify as offsets. Policymakers' treatment of international offsets would play a major role.

Economic factors. The development and market penetration of low- and/or zero-carbon technologies would likely have substantial effects. These technologies could lower the costs of the cap-and-trade program, making fewer offset projects cost effective.

Emission allowance price. The allowance price would determine the supply and type of offsets that would be economically competitive in a cap-and-trade system. As the price increases, more (and different types of) projects would become cost effective. Allowance price estimates are difficult to predict, as they are dependent on numerous variables, including offset treatment.

Other factors. Non-market factors, such as social acceptance, may influence offset use. In addition, information dissemination would likely be an issue, because some of the offset opportunities exist at smaller operations, such as family farms.

Several studies have generated estimates of offset use within a defined policy framework. Although the studies' absolute values should be viewed with skepticism, *relative* differences generated by varied offset scenarios may be instructive to policymakers. For instance, the results indicate that international offset treatment — i.e., whether or not they are allowed (and to what degree) — would have substantial impact on domestic offset use and availability.

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Introduction

If Congress enacts a greenhouse gas (GHG) emission reduction program, such as a cap-and-trade system, the treatment of offsets would be a critical design element. For example, EPA found that different offset scenarios — e.g., unlimited offsets versus no offsets — generated significant variances in cap-and-trade program costs.[1] However, offsets have generated considerable controversy, primarily for the concern that illegitimate offsets could undermine the ultimate objective of a cap-and-trade program: emission reduction.[2]

An estimate of the quantity and type of offset projects that might be available would provide for a more informed debate over the design elements of a cap-and-trade program.

An offset is a measurable reduction, avoidance, or sequestration of GHG emissions from a source *not covered* by an emission reduction program. From a climate change perspective, the location of the reduction, avoidance, or sequestration does not matter: a ton of CO_2 (or its equivalent in another GHG) reduced in the United States and a ton sequestered in another nation would have the same result on the atmospheric concentration of GHGs. If a cap-and-trade program includes offsets, covered sources would have the opportunity to purchase them to help meet compliance obligations.[3]

Offset projects vary by the quantity of emission credits they could generate and the implementation complexity they present. In general, agriculture and forestry activities offer the most potential, but these projects often pose multiple

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[1] This assessment comes from EPA's sensitivity analysis of the Lieberman-Warner Climate Security Act of 2008 (S. 2191). Compared to the core scenario (S. 2191 as written), unlimited offset use would lower the emission allowance price by 71%; a scenario with no offsets use would raise the price 93% compared to the core scenario. EPA, *EPA Analysis of the Lieberman-Warner Climate Security Act of 2008* (2008).

[2] For a discussion of these issues, see CRS Report RL34436, *The Role of Offsets in a Greenhouse Gas Emissions Cap-and-Trade Program: Potential Benefits and Concerns*, by Jonathan L. Ramseur.

[3] In this way, offsets would complement the more traditional emissions trading that can occur between two covered sources. For example, a covered source (e.g., power plant) can make reductions beyond its compliance obligations and then sell these reductions as credits to other covered sources. This type of transaction represents the "trade" component of a cap-and-trade program.

implementation challenges. This may create a tension for policymakers, who might want to include the offset projects that provide the most emission reduction opportunities, while minimizing the use of offset projects that pose more implementation complications, or have the potential to be invalid.

What Is a Cap-and-Trade System?

A cap-and-trade system would create an overall limit (i.e., a cap) on GHG emissions from the emission sources covered by the program. Covered sources may vary, but are likely to include major emitting sectors (e.g., power plants and carbon-intensive industries), fuel producers/processors (e.g., coal mines or petroleum refineries), or some combination of both. Covered entities that face relatively low emission-reduction costs would have an incentive to make reductions beyond what is required, because these further reductions could be sold (i.e., traded) as emission credits to entities that face higher emission-reduction costs. Instead of making internal reductions or purchasing credits from other covered sources, a cap-and-trade program may allow parties to purchase offsets as a compliance option.

The emissions cap is partitioned into emission allowances. Typically, one emission allowance represents the authority to emit one (metric) ton of carbon dioxide-equivalent (tCO_2-e). In general, policymakers may decide to distribute the emission allowances to covered entities at no cost (based on, for example, previous years' emissions), sell the allowances through an auction, or use some combination of these strategies. At the end of each established compliance period (e.g., a calendar year), covered sources would be required to surrender emission allowances to cover the number of tons emitted. If a source did not have enough allowances to cover its emissions, the source would be subject to penalties.

How many offsets would be available as a compliance option if Congress enacted a cap-and-trade program? The first section of this report addresses this question by discussing the multiple variables that help shape offset supply. The second section discusses estimates of offset use within the policy framework of the Lieberman-Warner Climate Security Act of 2008 (S. 2191).[4]

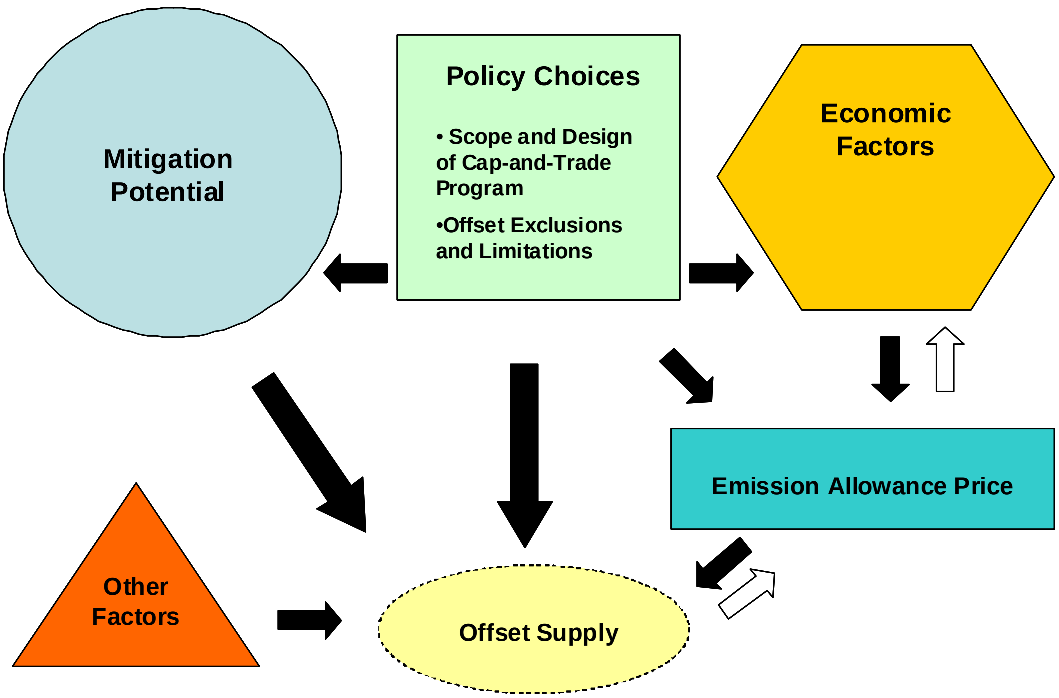
Factors Affecting Offset Supply

It is difficult to estimate the supply of offsets that might be available in a cap-and-trade system, because the supply is determined by many variables, including policy choices. **Figure 1** illustrates the various inputs and variables that would affect the potential supply of offsets in a cap-and-trade program. These factors — mitigation potential, policy choices, economic factors, emission allowance price, and

[4] S. 2191 was reported out of the Senate Committee on Environment and Public Works December 5, 2007. Several agencies and other interested stakeholder groups conducted economic modeling of the legislation. Some of these studies are used in this report, because they represent the most recent analysis of effects from a federal cap-and-trade program.

other factors — are each discussed below. As **Figure 1** indicates, the factors do not act in isolation, but interact in a complex manner.

Figure 1. Illustration of Inputs and Variables That Affect Potential Offset Supply



Source: Prepared by CRS.

Mitigation Potential

Mitigation potential is not synonymous with potential offsets supply (**Figure 1**). Some of the activities included in mitigation potential estimates would not qualify as offsets in a cap-and-trade system. A striking example is biofuel production, which is projected by some studies to play a substantial role in GHG mitigation in later years. A cap-and-trade program's emission allowance price is expected to increase biofuel and biomass production. For example, if a power plant substitutes a carbon-intensive fuel (e.g., coal) with a less carbon-intensive fuel (e.g., biomass, such as switchgrass), the plant's GHG emissions would decrease. These emission reductions would be counted directly by the power plant. The increased biofuel use would mitigate GHG emissions, but would not count as an offset in a cap-and-trade program, because the reductions (from the fuel substitution) would be made directly by covered sources.

Mitigation potential estimates are often used as inputs for other economic models. For example, EPA's 2005 mitigation potential estimates were used in the EPA and Energy Information Administration's (EIA) analyses of S. 2191

(Lieberman-Warner Climate Security Act of 2008).[5] Both of these analyses generated estimates of the number and type of offsets that would be used by covered sources for compliance purposes. However, these offset supply estimates are potentially flawed, because the underlying data — mitigation potential estimates — are rife with uncertainty.

Elements of Uncertainty. Estimates of mitigation potential are derived by assigning a price for GHG emissions and sequestration. Under an EPA 2005 model,[6] for example, landowners would "receive payments for increasing sequestration and reducing emissions *and would make payments* for increasing emissions or reducing sequestration." As with all models, the mitigation potential simulations include numerous assumptions, including behavioral responses to economic incentives and disincentives. For example, actors (e.g., farmers) in the 2005 EPA model are assumed to have "perfect foresight." Perfect foresight assumes that "agents, when making decisions that allocate resources over time (e.g., investments), know with certainty the consequences of those actions in present and future time periods."[7] EPA recognizes that this assumption, which the agency states is used by most of the climate economic modeling community, does not reflect reality. The use of this assumption likely yields an overestimation of mitigation potential: in reality, market participants make imperfect judgements and leave some financial opportunities on the table.

Mitigation potential models must necessarily include certain technical assumptions, such as land availability and sequestration rates of various activities. Different models often use different underlying assumptions to generate results. Indeed, there is often disagreement within the modeling community, particularly for forestry sequestration simulations, over the use of various modeling inputs.

In addition to the above limitations — which are generally inherent to some degree with all economic modeling — the next two sub-sections discuss elements of uncertainty that are particular to agriculture and forestry activities.

Competition for Land Use. A critical factor for agriculture and forestry mitigation opportunities is land availability. More projects would become economically competitive as the emission allowance price rises. At certain price levels, one mitigation activity may replace another. For example, agricultural soil sequestration projects (e.g., conservation tillage practices) are expected to present cost-effective opportunities at relatively low prices. As the allowance price rises, afforestation projects are expected to become (1) cost effective in more places and

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[5] EPA, *EPA Analysis of the Lieberman-Warner Climate Security Act of 2008* (2008); EIA, *Energy Market and Economic Impacts of S. 2191, the Lieberman-Warner Climate Security Act of 2007* (2008).

[6] EPA, *Greenhouse Gas Mitigation Potential in U.S. Forestry and Agriculture* (2005), at [http://www.epa.gov/sequestration/green house_gas.html].

[7] EPA, *Greenhouse Gas Mitigation Potential in U.S. Forestry and Agriculture* (2005).

(2) more cost effective than ongoing soil sequestration activities.[8] Thus, lands that once generated soil sequestration, while growing traditional commodities, may be replaced with afforestation projects (tree farms).

Other activities — preservation, recreation, fuel production — may compete for limited land resources. Some activities (e.g., biofuel production, discussed further below) may preclude options for resource use, such as traditional crop production or afforestation. In other cases, more than one practice that reduces or sequesters CO_2 may be possible. For example, conservation tillage may be conducted in concert with biofuel production.

It is very difficult for most modeling tools to keep track of these competing or compatible activities, although some models may have the capability to account for some of these interactions. Thus, different analyses will produce varying results.

A related factor is that land uses change over time. For example, changes in product demand, seed use, cultivation technologies, and — importantly — regulatory or financial incentives can influence land use and/or crop choice. As discussed in the following sub-section, biofuel policies provide a striking example of this type of development.

Biofuel Production. In this discussion, biofuels include alternative energy sources in both the transportation sector — e.g., ethanol (corn-based or cellulosic) and biodiesel — and the electricity sector — e.g., biomass, such as switchgrass. Biofuels are likely to play a substantial role in determining the mitigation potential of other agriculture and forestry projects, because biofuel production is expected to strongly compete with other mitigation activities for land resources. Indeed, the 2005 EPA study projected that biofuels would out-compete other GHG mitigation options in later years (around 2030) and at higher carbon prices. By contrast, in 2015, EPA estimated that biofuels would account for 1%-2% of the mitigation portfolio, and only at prices above $30.

However, the 2005 EPA mitigation model did not include the most recent federal policies that currently influence biofuel production and the land base it uses.[9] In 2005, Congress established a renewable fuels standard (RFS) under the Energy Policy Act of 2005 (P.L. 109-58). The RFS mandated a specific level of biofuels use

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[8] This is because afforestation can generate more CO2 sequestration per acre than soil sequestration.

[9] The federal government promotes biofuel production through a range of mandated fuel use, tax incentives, loan and grant programs, and certain regulatory requirements. Arguably, the most significant federal programs for biofuels have been tax credits for the production or sale of ethanol and biodiesel. However, with the establishment of the renewable fuels standard (RFS) under the Energy Policy Act of 2005 (P.L. 109-58), Congress has mandated a specific level of biofuels use. This level was significantly increased with the Energy Independence and Security Act of 2007 (P.L. 110-140). For more on these incentives and other policies see CRS Report RL33572, *Biofuels Incentives: A Summary of Federal Programs*, by Brent D. Yacobucci.

in transportation fuels. This level was significantly increased with the Energy Independence and Security Act of 2007 (P.L. 110-140).

These new policies may affect mitigation potential in several ways. First, the mandatory biofuel production levels may require land resources that could be used for other mitigation activities, such as soil sequestration or afforestation. Second, the required production levels may stimulate growth in infrastructure relating to biofuel use in the transportation sector. This may increase demand, which could lead to increased production (above the required threshold) of biofuels for the transportation sector.

It is unclear how the new federal policies would affect the mitigation potential for biomass in the electricity sector. With mandatory thresholds in place, biofuels for transportation could reduce the acreage available for biomass production. However, a federal renewable portfolio standard (RPS), requiring a percentage of electricity generation from renewable energy,[10] could alter the calculus.

Estimates from Agriculture and Forestry Activities. In recent years, several studies, including separate reports from EPA (2005) and USDA (2004),[11] have produced estimates of *mitigation potential* from agriculture and forestry activities. These study results vary. As EPA stated, the "differences can be expected based on differences in the models and assumptions embedded in the estimates. In some cases, estimates of comparable categories vary substantially (**Table 1)**. For example, EPA estimates a dramatically greater mitigation potential for soil sequestration activities. USDA's lower overall estimate for soil management activities is comparable to a more recent estimate that was produced by McCarl in 2007.[12]

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[10] See CRS Report RL34162, *Renewable Energy: Background and Issues for the 110th Congress*, by Fred Sissine.

[11] EPA, *Greenhouse Gas Mitigation Potential in U.S. Forestry and Agriculture*, November 2005, at [http://www.epa.gov/sequestration/green house_gas.html]; USDA, *Economics of Sequestering Carbon in the U.S. Agricultural Sector*, April 2004, at [http://www.ers.usda.gov/publications/tb1909/].

[12] The 2007 McCarl estimate is significant, because McCarl was a co-author in EPA's 2005 study, and it was his model that provided the underpinnings for the 2005 estimates. See Bruce McCarl, "Agriculture in the Climate Change and Energy Price Squeeze: Part 2: Mitigation Opportunities," February 2007, at [http://www-agecon.ag.ohio-state.edu/resources/docs/BruceMcCarlPaper.pdf].

Mitigation Potential Estimates in Context

It may be instructive to compare the mitigation potential estimates with current sequestration levels, emissions caps, and offset quantity limits from recent legislative proposals.

— The agriculture and forestry sectors currently sequester approximately 810 mtCO_2-e per year (EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2005* (2007)).

— In 2015, the emissions cap in S. 2191 would be 5,456 million emission allowances: each allowance equals 1 mtCO_2-e.

Several of the proposals would limit the use of domestic offsets in some fashion. S. 2191, for example, would allow covered sources to use domestic offsets to satisfy up to 15% of the covered source's allowance submission. However, the calculation is not simply 15% of 5,456 mtCO2-e. By allowing domestic offsets and international credits to satisfy separate 15% blocks of the allowance submission, the cap could effectively represent 70% of actual emissions permitted at covered sources. For instance, if there was only one covered facility in the United States and it emitted 7,794 mtCO2-e in 2015, the facility could be in compliance with the cap by submitting 5,456 million allowances, 1,169 million tons of domestic offsets, and 1,169 million tons of international credits. However, if the covered source does not use either compliance option to the maximum level (i.e., less than 15%), the calculation is altered. For example, if a covered source does not use any international credits, domestic offsets would be limited to 963 million tons. The calculation is further complicated by a covered source's ability to bank emission allowances for submission in subsequent years.

Although the estimates include a high degree of uncertainty and are outdated for various reasons (discussed above), the estimates may be informative in some capacity. For instance, the estimates indicate the *relative differences* between offset supply and offset type by price and time. Regardless of the differences in absolute values between the EPA and USDA models, both agencies' results demonstrate the influence of price. Moreover, both models indicate that afforestation activities may provide more mitigation potential than carbon soil sequestration (**Table 1**).

Table 1. EPA and USDA Estimates of Mitigation Potential for Afforestation and Soil Sequestration (in 2025)

Source and Mitigation Activity	$3-5 / $mtCO_2$-e	$13-15 / $mtCO_2$-e	$30-34 / $mtCO_2$-e
	($mtCO_2$-e)		
USDA Model			
Afforestation	0 - 31	105 - 264	224 - 489
Agriculture Soil Carbon	0 - 4	3 - 30	13 - 95
EPA Model			
Afforestation	12	228	806
Agriculture Soil Carbon	149	204	187

Source: EPA, *Greenhouse Gas Mitigation Potential in U.S. Forestry and Agriculture* (2005), Table 4-10, citing USDA, *Economics of Sequestering Carbon in the U.S. Agricultural Sector* (2004).

Note: USDA's study presents estimates as a range of outcomes under different parameters. USDA estimates are *average annual* mitigation for a 15-year program (2010-2025); it is unclear whether EPA estimates are for the year 2025 (as indicated in Table 4-10), or whether the estimates represent annual average values for the decade 2020-2029 (as described on page 4-3). The prices in the table are in constant dollars, adjusted for inflation.

EPA's study also generated mitigation potential estimates for four other agriculture and forestry activities. These estimates are provided in **Table 2** to demonstrate the range of potential for different activities.

Table 2. EPA Estimates of Mitigation Potential for Other Agriculture and Forestry Activities (in 2025)

Mitigation Activity	$5 / $mtCO_2$-e	$15 / $mtCO_2$-e	$30 / $mtCO_2$-e
	($mtCO_2$-e)		
Forest Management	89	156	250
Fossil Fuel Reduction from Crop Production	18	32	49
Agriculture Methane (CH_4) and Nitrous Oxide (N_2O) Mitigation	17	36	76
Biofuel Production	0	0	21

Source: EPA, *Greenhouse Gas Mitigation Potential in U.S. Forestry and Agriculture* (2005), Table 4.A.1.

Note: It is unclear whether EPA estimates are for the year 2025 (as suggested by Table 4.A.1), or whether the estimates represent annual average values for the decade 2020-2029 (as described on page 4-3). The prices in the table are in constant dollars, adjusted for inflation.

Estimates from Other Activities. Other potential mitigation activities — e.g., methane abatement from landfills or the natural gas sector — are generally considered to be less complicated in terms of measurement than agriculture and forestry projects. These types of mitigation projects are typically not subject to competition for land resources. However, these estimates are only mitigation potential, not potential offset supply. Other factors, identified in **Figure 1** and discussed below, would likely constrain or exclude their development as offsets. For instance, some of the activities identified below would be covered under the cap of some legislative proposals.

Table 3. EPA Estimates of Mitigation Potential from Other Activities (in 2010)

Mitigation Activity	$0 / mtCO$_2$-e	$15 / mtCO$_2$-e	$30 / mtCO$_2$-e
	(mtCO$_2$-e)		
CH_4 from Landfills	13	53	53
CH_4 from Natural Gas Sector	20	27	39
CH_4 from Coal Mines	25	44	44
N_2O from Adipic Acid Production	0	8	8
N_2O from Nitric Acid Production	0	14	14

Source: EPA, *Global Mitigation of Non-CO2 Greenhouse Gases* (2006), Data Annexes, at [http://www.epa.gov/climatechange/economics/international.html].

Note: The emission allowance price values and the year (2010) are different from previous tables, because the data are from a different source. The data source (EPA, 2006) also provided estimates for 2020. For the most part, these estimates are similar to the 2010 values. The prices in the table are in constant dollars, adjusted for inflation.

Several of the mitigation activities in **Table 3** are projected to occur at \$0/mtCO$_2$-e.[13] EPA states that these figures "represent mitigation options that are already cost-effective given the costs and benefits considered (and are sometimes referred to as "no-regret" options) yet have not been implemented because of the existence of nonmonetary barriers."[14] These are discussed below in "Other Factors."

[13] The lowest emission allowance price ($0/mtCO2-e) in **Table 3** is different from previous tables, which began at or about $5/mtCO2-e. The data from **Table 3** are from a different EPA study than was used in previous tables.

[14] EPA, Global Mitigation of Non-CO2 Greenhouse Gases (2006), p. I-14.

The fact that parties are not acting in the most economically efficient manner at \$0/mtCO_2-e, calls into question the estimates for higher emission allowance prices. This demonstrates the uncertainty contained in mitigation potential estimates.

Policy Choices

Policy decisions from Congress, U.S. states, and foreign governments would directly and indirectly affect the supply of offsets in a cap-and-trade program. The primary factor would be the design of the cap-and-trade system. Other policies would also help shape the pool of offsets that could be used for compliance purposes. These policy choices are discussed below.

Design of the Cap-and-Trade Program. Programmatic design elements could affect offset supply in several ways, from the overall structure of the cap (e.g., which sources are covered) to specific logistical details (e.g., monitoring and measuring protocols). Another critical element would be the program's use of set-aside allowances.

Scope of the Cap. The wider the scope of the cap, the smaller the offset universe. In other words, as more source categories are subject to the cap, the fewer the number of uncapped sources, thus the number of eligible offset project types decreases. For example, S. 2191 would not cover N_2O emissions from adipic or nitric acid production, whereas S. 1766 (Bingaman-Specter) would include these emissions under its cap.[15]

Eligible Offset Types. Policymakers may choose to restrict the types and locations (domestic versus international) of offsets eligible for use by a regulated entity. For example, some cap-and-trade proposals in the 110th Congress would allow a wider range of biological sequestration activities than other proposals. Biological sequestration generally offers the most potential, but these projects present substantial challenges. In addition, the degree to which international offsets are allowed would have considerable impact on domestic offsets.

Offset Protocols. The protocol established for measuring and verifying offsets would affect supply. A more stringent protocol would likely reduce supply. Offsets that are questionable — for instance, in terms of their additionality — would likely be excluded or discounted (also reducing supply). Additionality determinations (i.e., would the project have happened anyway) typically require some subjectivity in the decision process. A protocol with more constraints could remove some of the subjectivity, which, if left in place, could lead to an influx of questionable offsets.

Some protocols may include more conservative parameters for measuring tons of CO_2 sequestered for a particular project type. For example, one protocol may stipulate that carbon saturation for a given plant or tree species occurs in a shorter time frame, thus fewer offsets would be produced through the project.

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[15] For a comparison of cap-and-trade proposals, see CRS Report RL33846, *Greenhouse Gas Reduction: Cap-and-Trade Bills in the 110th Congress*, by Larry Parker, Brent D. Yacobucci, and Jonathan L. Ramseur.

Moreover, the stringency of the protocols would likely affect the costs of developing, implementing, and verifying an offset project. These costs might be described as transaction costs. For example, a protocol that required independent, third-party verification would entail higher costs for offset projects. If transaction costs increase, the number of cost-effective offset projects would decrease.

The proposed (and enacted) systems of measurement and verification vary. In many cases, legislative proposals direct various agencies to develop the protocols. In these cases, the level of protocol stringency would be uncertain at the bill's passage.

Set-Asides. If the cap-and-trade program provides set-aside allowances for specific activities, these activities would be removed from the potential supply of offsets. Several of the cap-and-trade proposals from the 110th Congress would give emission allowances (set-asides) to non-covered entities to promote various objectives, including biological sequestration.[16] Set-aside allowances are taken from within the cap, so if the set-aside allowances do not lead to further emission reductions, abatement, or sequestration, the cap remains intact. Indeed, one strategy for policymakers is to allot set-asides for activities whose emission reductions, abatement, or sequestration may carry more uncertainty than other potential offset activities.[17] However, a project that receives a set-aside cannot also qualify as an offset. Thus, set-aside allowances would reduce the pool of offsets available for compliance with the cap.

In some of the recent proposals, set-asides would substantially reduce the offset pool. For example, S. 2191 (as reported)[18] would set aside the following emission allowances in 2012:

- 289 mtCO_2-e (5% of total allowances) for domestic agriculture and forestry emission reduction/sequestration projects, and
- 58 mtCO_2-e (1% of total allowances) for landfill and coal mine methane projects.

Actions in Other Nations or U.S. States. As other nations or U.S. states establish emission controls or climate-related policies, the pool of offsets would shrink. International offsets, particularly in the developing nations, are projected in models to provide numerous opportunities for compliance.[19] However, these projections assume that these nations are decades away from requiring GHG emission reductions or other regulations (e.g., technology standards) that would exclude these projects as offsets.

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[16] For more information, see CRS Report RL34502, *Emission Allowance Allocation in a Cap-and-Trade Program: Options and Considerations*, by Jonathan L. Ramseur.

[17] For example, methane reduction from landfills is generally considered a more certain offset than methane reduction from rice cultivation. See Lydia Olander, *Designing Offsets Policy for the U.S.* (2008), Nicholas Institute for Environmental Policy Solutions.

[18] The number of set-asides in the as-reported version of S. 2191 is different from the version (S. 3036) that included the revenue neutral amendment.

[19] EPA, *EPA Analysis of the Lieberman-Warner Climate Security Act of 2008* (2008).

Climate-related policies in U.S. states may also affect offset supply. A number of states have taken actions that directly address GHG emissions.[20] For example, 23 states have joined 1 of the 3 regional partnerships that would require GHG (or just CO_2) emission reductions. A state or regional emissions cap might cover more sources than a federal program, thus disqualifying emissions from these sources as potential offset opportunities. However, it is uncertain how these state actions would interact — e.g., whether or not they would be pre-empted — with a federal ap-and-trade program.

Regardless of whether state and regional emission caps are subsumed into a federal cap-and-trade program, other state policies could play a role. For example, California is developing methane emission performance standards for landfills.[21] If this policy is finalized, methane capture from California landfills would not be available to qualify as offsets in a federal program.

Other Policy Influences. Policies not directly related to a cap-and-trade program could also affect the potential supply of offsets. A comprehensive review of policies that could affect offset supply is beyond the scope of this report. However, several federal policy options stand out. As mentioned above, Congress has enacted energy legislation requiring certain levels of biofuel use in transportation sector. This policy affects the amount of land potentially available for agriculture and forestry offset projects.

If enacted by Congress, a federal renewable portfolio standard (RPS) may affect offset supply. A federal RPS would stimulate the production of biomass for electricity generation. As discussed above, biomass for electricity generation would not qualify as an offset, but would instead compete with other offset projects for land resources.

Economic Factors

The potential supply of offsets would ultimately be affected by how the economy responds to a federal cap-and-trade program. Such a complex analysis is beyond the scope of this report.[22] A critical factor is the development and market penetration of low- and/or zero-carbon technologies. These technologies could lower the costs of the cap-and-trade program. Federal policies — e.g., funding or tax incentives — could stimulate these technologies. If these technologies are available earlier than predicted (by models), the emission allowance price (discussed below) would likely decrease, making fewer offset projects cost effective.

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[20] See CRS Report RL33812, *Climate Change: Action by States To Address Greenhouse Gas Emissions*, by Jonathan L. Ramseur.

[21] See [http://www.arb.ca.gov/cc/landfills/landfills.htm].

[22] For information on these matters, see CRS Report RL34489, *Climate Change: Costs and Benefits of S. 2191/S. 3036*, by Larry Parker and Brent D. Yacobucci.

Emission Allowance Price

The supply and type of offsets available would be largely dependent on the emission allowance price in a cap-and-trade system.[23] The market price — sometimes referred to as the price of carbon — of a tradeable emission allowance would be influenced by several factors, discussed above. The central factor would be the structure of the emission reduction program, particularly the program's scope (which sources are covered) and stringency (the amount and timing of required emission reductions).

In addition to the core structural design of the cap-and-trade program, the allowance price would be dependent on the program's treatment of offsets: which types would be allowed; whether international offsets could be used; whether covered sources would be limited (e.g., as a percentage of their allowance submission) in their use of offsets. Indeed, EPA's analysis of S. 2191 (as reported) indicates that different offset treatments yield the greatest range in emission allowance prices. For example, if the use of domestic and international offsets are unlimited, the emission allowance price would be 71% lower than under the as-written conditions of the bill.[24]

The supply of offsets would fluctuate as the allowance price changes. If the allowance price is relatively low — i.e., \$1 to \$5/mtCO_2-e — only the "low-hanging fruit" projects would be financially viable. If the allowance price is higher, more offset projects would become economically competitive.

It is impossible to predict with confidence what an allowance price would be in a cap-and-trade system. Although multiple studies have provided — through economic modeling — estimates of allowance prices under the proposed cap-and-trade regime that would be created by S. 2191 (the Lieberman-Warner Climate Security Act of 2008), the results vary considerably among studies. For more information on these issues, see CRS Report RL34489, *Climate Change: Costs and Benefits of S. 2191/S. 3036*, by Larry Parker and Brent Yacobucci.

Other Factors

An EPA study stated that "[o]ther nonprice factors, such as social acceptance, tend to inhibit mitigation option installation in many sectors."[25] For example, farmers engaged in dairy operations for many generations may be hesitant to convert their land to forests, even if this would be the most profitable use of the land. In addition, institutional factors have been observed in the forestry sector, which was initially expected to play a much larger role in the CDM. A report from the Intergovernmental Panel on Climate Change (IPCC) stated that although the forestry sector can make a "very significant contribution to a low-cost mitigation portfolio ... this opportunity is being lost in the current institutional context and lack of political

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[23] Offsets could potentially be a design element of a carbon tax regime as well.

[24] EPA, *EPA Analysis of the Lieberman-Warner Climate Security Act of 2008* (2008).

[25] EPA, *Global Mitigation of Non-CO_2 Greenhouse Gases*, p. 1-23 (2006).

will to implement and has resulted in only a small portion of this potential being realized at present."[26]

Two other factors that may limit or slow offset supply are information dissemination and transaction costs (discussed in a subsequent section). Many of the emission abatement and sequestration opportunities, particularly in the agricultural sectors, may be widely dispersed and under the control of relatively small operations (e.g., family farms). Similarly, many of the agriculture and forestry offset projects may present technical challenges, depending on requirements to measure emissions and verify projects. To generate offsets at these locations, parties would need to know that opportunities exist and are financially viable (based on the carbon price). In addition, the smaller operations may need technical support in order to initiate, measure, and verify the projects.

Offset Use in a Cap-and-Trade Program

Several studies, including separate reports from EPA and EIA,[27] have generated estimates of offset use within a defined policy framework — the cap-and-trade program that would be established by S. 2191.[28] Although the absolute values should be viewed with skepticism, *relative* differences generated by varied offset scenarios may be instructive to policymakers.

The absolute estimates of offset use in the EPA and EIA models are inherently flawed — at least for the agriculture and forestry sectors — because both models used EPA's 2005 mitigation potential estimates as underlying data. As discussed above, this underlying data is outdated and embedded with its own uncertainty.[29]

EPA and EIA use different economic models, with different underlying assumptions, in their S. 2191 studies. For example, EPA and EIA make different adjustments to the mitigation potential data, which provide the foundation for offset estimates. For its model of S. 2191, EIA reduced EPA's mitigation potential estimates by 25%.[30] Arguably, the value of the adjustment factor is somewhat

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[26] Intergovernmental Panel on Climate Change, *Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report*, p. 543 (2007).

[27] EPA, *EPA Analysis of the Lieberman-Warner Climate Security Act of 2008* (2008); EIA, *Energy Market and Economic Impacts of S. 2191, the Lieberman-Warner Climate Security Act of 2007* (2008).

[28] A number of studies provided economic analysis of S. 2191. For more information on these studies see CRS Report RL34489, *Climate Change: Costs and Benefits of S. 2191/S. 3036*, by Larry Parker and Brent D. Yacobucci.

[29] In particular, the soil sequestration estimates in EPA's 2005 study are dramatically higher than estimates produced by USDA in 2004 and more recent analysis in 2007 (McCarl, Bruce, "Agriculture in the Climate Change and Energy Price Squeeze: Part 2: Mitigation Opportunities," (2007)).

[30] EIA stated in its analysis of S. 2191 that it "applied the same methodologies and data

(continued...)

arbitrary, but EIA explained that it accounts for various obstacles — e.g., unidentified costs, information diffusion, and social acceptance — that were not reflected in the mitigation potential data. EPA did not make similar adjustments.

In the studies' core scenarios, the agencies' models yielded different estimates for emission allowance prices. Emission allowance price is a key factor in determining offset supply. In 2015, EPA estimated an emission allowance price range of \$29-\$40; EIA estimated a price of approximately \$21.[31]

As one may expect, the different models and underlying assumptions led to different estimates of offset use and, in particular, when the 15% offset limitation (imposed by the bill) would be binding. EPA estimated that the separate 15% thresholds on domestic offsets would be binding almost immediately: in 2015 or 2017.[32] The EIA model estimated that the 15% limitation would not be binding until 2025.

Although the absolute values provided by the studies of S. 2191 contain a large amount of uncertainty, the *relative differences* yield some insights. Because the EPA and EIA analyses of S. 2191 both use EPA's 2005 mitigation potential estimates, the *relative* differences — e.g., relationships between emission allowance price and offset quantity and type — that were observed in mitigation potential are also seen in the S. 2191 analyses. For example, higher allowance prices make more offset projects and different types of offset projects economically competitive. However, higher allowance prices may make other mitigation activities — such as biofuels for electricity — more competitive as well.

An additional insight provided by the S. 2191 analyses is the impact that international offsets have on domestic supply. EPA modeled scenarios with different quantity limitations for domestic and international offsets. In the core scenario, which matches the 15% limitations in the bill, both international and domestic offsets are restricted to 15% of emission allowance submissions almost immediately (**Figure 2**). One may expect the combined offset use columns to demonstrate more of a decline, to coincide with a declining emissions cap. This is not observed in the model, primarily due to the bill's application of the 15% limitation for offset use. In S. 2191, the 15% limit would apply to each covered source's annual allowance submission, in which a covered source must provide (or surrender) to EPA an emission allowance for each unit of GHG emissions (mtCO_2-e) generated in the

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[30] (...continued)
sources described in its evaluation of S. 280, the Climate Stewardship and Innovation Act of 2007." The 25% adjustments are described in EIA, *Energy Market and Economic Impacts of S. 280, the Climate Stewardship and Innovation Act of 2007* (2007).

[31] The relationship between allowance price and offset supply is complicated, because they are interrelated. EIA's lower allowance prices may be partially explained by the agency's treatment of the underlying mitigation potential data.

[32] In its study EPA used two separate computable general equilibrium models: Applied Dynamic Analysis of the Global Economy (ADAGE) and Intertemporal General Equilibrium Model (IGEM). The 15% offset threshold was reach in 2015 with ADAGE and 2017 with IGEM.

previous year.[33] Although the emissions cap would decline under S. 2191, EPA projects annual allowance submissions to remain fairly constant until 2030, largely due to the opportunity for covered sources to bank emission allowances and submit them for compliance in later years.

In an alternate scenario, the use of domestic and international offsets is unlimited. Under this policy framework, international offsets dominate, and total offset use is considerably greater than under the core scenario. However, domestic offset use is substantially less than under the core scenario (**Figure 3**). Although domestic offset use is unlimited, fewer projects are developed because the emission allowance price increases at a much slower rate under this scenario. For example, in the core scenario the allowance price is $83 in 2030, but only $24 in the unlimited offsets alternative.[34] The influx of unlimited international offsets keeps the allowance price relatively low, thus fewer domestic offset projects are cost effective.

In a third scenario (**Figure 4**), domestic offset use is unlimited, while international offsets are restricted to 15% of allowance submission. In this situation, domestic offset use, not surprisingly, is greatest, but total offset use is well below the estimates in **Figure 3**.

As Congress continues to discuss ways to address GHG emissions and the complex array of alternative approaches, understanding the potential effects of offsets will provide for a more informed debate. The treatment of offsets is one of the more critical design elements for policymakers to consider when developing a GHG emission reduction program, such as a cap-and-trade system.

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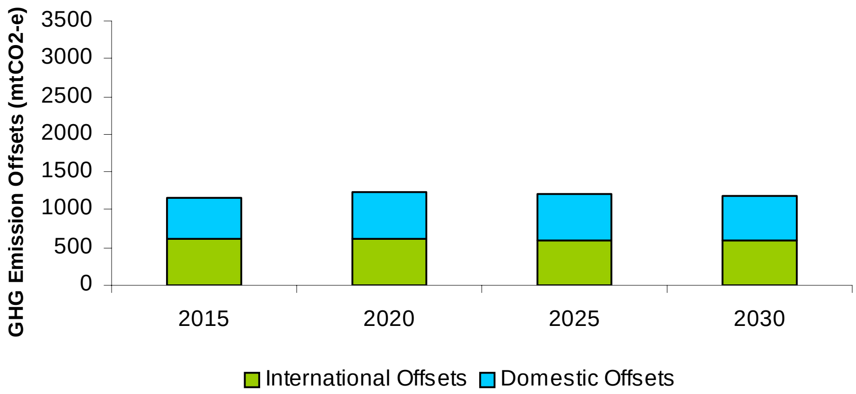
[33] In contrast, the so-called "Boxer Amendment" (S.Amdt. 4825) would limit offsets to a percentage (e.g., 15% for domestic offsets) of the aggregate quantity of allowances under the cap in a given year.

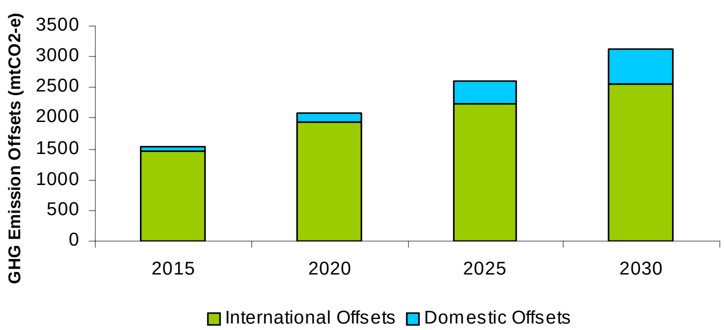
[34] By comparison, in the "no offsets" scenario, the allowance price is $160 in 2030.

Figure 2. Estimated Offset Use Under S. 2191 If International and Domestic Offsets Limited to 15% of Allowance Submission



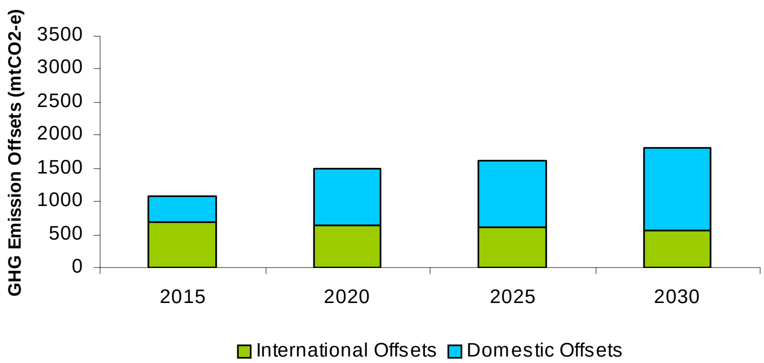
Source: Prepared by CRS with data from EPA, *EPA Analysis of the Lieberman-Warner Climate Security Act of 2008* (2008), data annex.

Figure 3. Estimated Offset Use Under S. 2191 If Domestic and International Offset Use Unlimited



Source: Prepared by CRS with data from EPA, *EPA Analysis of the Lieberman-Warner Climate Security Act of 2008* (2008), data annex.

Figure 4. Estimated Offset Use Under S. 2191 If Domestic Offset Use Unlimited and International Offset Use Limited to 15%



Source: Prepared by CRS with data from EPA, *EPA Analysis of the Lieberman-Warner Climate Security Act of 2008* (2008), data annex.