Estimating Offset Supply in a Cap-and-Trade Program

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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.

Although economic models have generated estimates of offsets that would be developed and used in a cap-and-trade system, the estimates are rife with uncertainty. This report examines the multiple variables that would help shape offset supply.

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Introduction

An estimate of the quantity and type of offset projects that might be available in a cap-and-trade system would provide for a more informed debate over the design elements of a cap-and-trade system. (See text box below, "What is a Cap-and-Trade System?") 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 to submit offsets (in lieu of emission allowances) to meet compliance obligations.[1]

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 implementation challenges. These contrasting attributes 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.

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. Economic models of cap-and-trade legislation have generally demonstrated that different offset scenarios—for example, unlimited offsets versus no offsets allowed—lead to significant variances in program costs.[2] However, offsets have fueled considerable debate, primarily for the concern that illegitimate offsets could undermine the ultimate objective of a cap-and-trade program: emission reduction.[3]

How many offsets would be available as a compliance option if Congress enacted a cap-and-trade program? Although economic models have generated estimates of offsets developed and used in a cap-and-trade system, the estimates are rife with uncertainty. This report examines the multiple variables that help shape offset supply.

[1] 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.

[2] For example, in EPA's sensitivity analysis of H.R. 2454 (Waxman-Markey), the agency found that a scenario prohibiting offset use (Scenario 9e) would increase the emission allowance price by approximately 65% in 2016, compared to the core scenario (Scenario 8), which represented the bill as passed by the House. See EPA's "Data Annex" to the agency's most recent analysis of H.R. 2454, available on EPA's website at http://www.epa.gov/climatechange/economics/economicanalyses.html. Another analysis that prohibited all offset projects (domestic and international) found a price increase of 250%. For a discussion of other modeling results, see CRS Report R40809, *Climate Change: Costs and Benefits of the Cap-and-Trade Provisions of H.R. 2454*, by Larry Parker and Brent D. Yacobucci.

[3] 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.

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. Cap-and-trade programs can vary by the sources covered. The covered sources, also referred to as covered entities, 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.

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). This term of measure is used because GHGs vary by global warming potential (GWP). GWP is an index of how much a GHG may contribute to global warming over a period of time, typically 100 years. GWPs are used to compare gases to carbon dioxide, which has a GWP of 1. For example, methane's GWP is 25, and thus a ton of methane is 25 times more potent a GHG than a ton of carbon dioxide.

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. These decisions are typically a source of intense debate.

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. Likewise, entities who face higher reduction costs could purchase allowances on the market. 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.

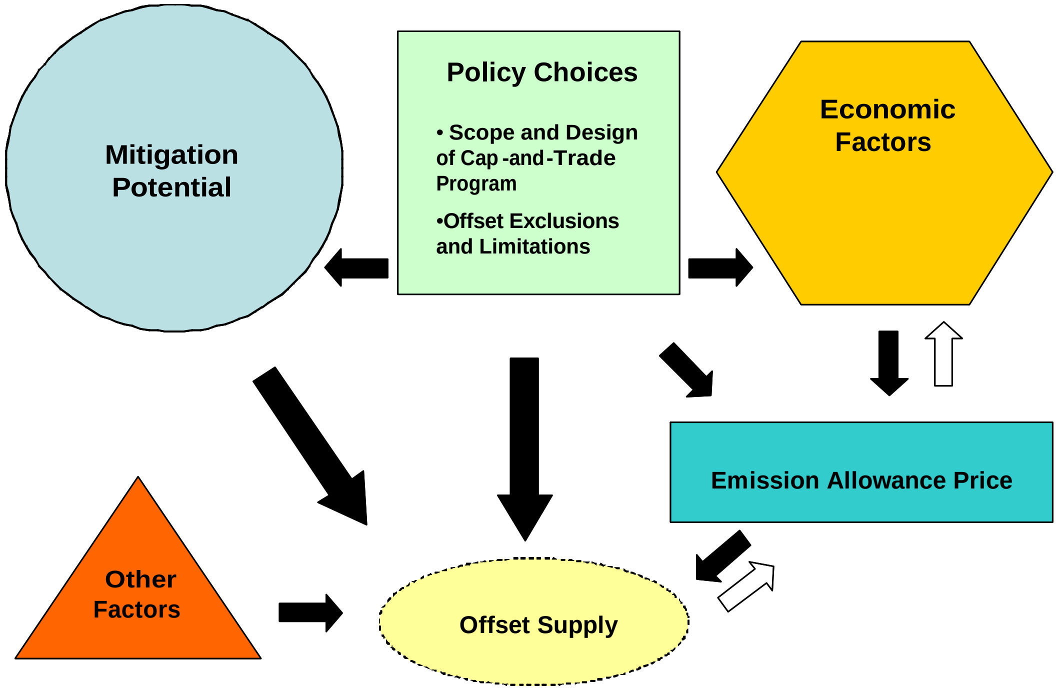
Mechanisms, such as banking or offsets, may be included to increase the flexibility of the program.

For more information, see U.S. Environmental Protection Agency (EPA), Office of Air and Radiation, *Tools of the Trade: A Guide To Designing and Operating a Cap and Trade Program For Pollution Control* (2003); CRS Report RL33799, *Climate Change: Design Approaches for a Greenhouse Gas Reduction Program*, by Larry Parker; and CRS Report RL34502, *Emission Allowance Allocation in a Cap-and-Trade Program: Options and Considerations*, by Jonathan L. Ramseur.

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 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 offset supply potential (**Figure 1**). Some of the activities included in mitigation potential estimates would likely not qualify as offsets in a cap-and-trade system. A striking example is biofuel production, which has been projected by some studies to play a substantial role in GHG mitigation in later years. By placing a price on carbon, a cap-and-trade program is expected to increase biofuel and biomass production. 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 economic models of cap-and-trade legislation. For example, EPA's 2009 mitigation potential estimates were used in the EPA and Energy Information Administration's (EIA) analyses of H.R. 2454.[4] 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 imperfect, because the underlying data—mitigation potential estimates—contain considerable uncertainty.

[4] See EPA's Analysis of H.R. 2454 in the 111th Congress, the American Clean Energy and Security Act of 2009 (most recent version from January 2010); EIA, *Energy Market and Economic Impacts of H.R. 2454, the American Clean Energy and Security Act of 2009* (August 2009).

Elements of Uncertainty

Modelers derive estimates of mitigation potential by assigning a price for GHG emissions and sequestration. Under the widely used Forest and Agriculture Sector Optimization Model (FASOM), for example, "landowners would receive annual payments for increasing sequestration and reducing emissions relative to their base case (additionality), but face the cost of having to make payments for increasing emissions or reducing sequestration."[5] 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) 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."[6] 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 judgments and leave some financial opportunities on the table.

Mitigation potential models must necessarily include certain technical assumptions, such as 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.[7]

In addition to the above limitations—which are generally inherent to some degree with all economic modeling—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 (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 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.

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[5] EPA, memorandum describing the results from the Forest and Agriculture Sector Optimization Model with Greenhouse Gases (FASOMGHG), April 13, 2009.

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

[7] For a comparison between assumptions used by EPA and the United States Department of Agriculture (USDA), see CRS Report R40236, *Estimates of Carbon Mitigation Potential from Agricultural and Forestry Activities*, by Renée Johnson, Jonathan L. Ramseur, and Ross W. Gorte.

[8] This is because afforestation can generate more CO_2 sequestration per acre than soil sequestration. Indeed, the range of estimates between these project types may vary by an order of magnitude. See CRS Report R40236, *Estimates of Carbon Mitigation Potential from Agricultural and Forestry Activities*, by Renée Johnson, Jonathan L. Ramseur, and Ross W. Gorte.

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.

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 sequestered (net of emissions) approximately 940 $mtCO_2$-e in 2008 (EPA, *Draft Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2008* (March 2010)).

—In 2016, the emissions cap in H.R. 2454 would be 5,482 million emission allowances: each allowance equals 1 $mtCO_2$-e.

Recent cap-and-trade proposals would limit the use of domestic offsets in some fashion. For example, H.R. 2454 would allow covered entities, in aggregate, to annually submit 1 billion metric tons of *domestic* offset credits in lieu of emission allowances. However, each covered entity's compliance obligation would be limited: in 2016, 13.5% of the compliance obligation could be satisfied with domestic offsets; 18% in 2030; 33% in 2050. Based on EPA estimates of covered entity emissions under H.R. 2454, these percentages would allow (if used to the fullest extent) for approximately 615 $mtCO_2$-e of domestic offsets in 2016, 850 $mtCO_2$-e in 2030, and 1,275 $mtCO_2$-e in 2050.

Estimates from Agriculture and Forestry Activities

Over the past decade, several studies, including reports from EPA (2005 and 2009) and USDA (2004),[9] have produced estimates of *mitigation potential* from agriculture and forestry activities. The estimates from these studies vary, in some cases considerably. For example, **Table 1** lists the different results between EPA's 2005 and 2009 models. As the table indicates, the estimates of mitigation potential from the agriculture and forestry sectors decreased substantially in the 2009 model. In particular, estimates of agricultural soil sequestration activities decreased by 100% (or almost 100%) at several price scenarios. The explanation for these varied estimates is complex and beyond the scope of this report: for a comprehensive discussion of these estimates, see CRS Report R40236, *Estimates of Carbon Mitigation Potential from Agricultural and Forestry Activities*, by Renée Johnson, Jonathan L. Ramseur, and Ross W. Gorte. In short, the different estimates reflect different modeling assumptions, such as emission/sequestration baselines (or business-as-usual scenarios).

The dramatic differences between the 2005 and 2009 estimates (**Table 1**) highlight the uncertainty that pervades mitigation estimates. Regardless, both models demonstrate the influence of price. And both models indicate *relative* differences between the project types, with forestry projects providing much of the potential, particularly at higher price scenarios.

9 EPA, *Greenhouse Gas Mitigation Potential in U.S. Forestry and Agriculture*, November 2005, at http://www.epa.gov/sequestration/greenhouse_gas.html; EPA, *Updated Forestry and Agriculture Marginal Abatement Cost Curves*, March 2009, available with data annex to EPA's analysis of H.R. 2454; USDA, *Economics of Sequestering Carbon in the U.S. Agricultural Sector*, April 2004, at http://www.ers.usda.gov/publications/tb1909/.

Table 1. Mitigation Estimates from EPA's 2005 and 2009 Models

Constant Price Scenarios (2025 Timeframe)

Mitigation Activity	Prices ($/mtCO2-e)					
	$5		$15		$30	
	EPA-2005	EPA-2009	EPA-2005	EPA-2009	EPA-2005	EPA-2009
Afforestation	12	21	228	81	806	221
Forest management	89	114	156	243	250	313
Agriculture soil sequestration	149	17	204	2	187	0
Agriculture CH_4 and N_2O mitigation	17	4	36	12	76	27
Total	267	156	624	338	1319	561

Source: Prepared by CRS; EPA 2005 data from EPA, *Greenhouse Gas Mitigation Potential in U.S. Forestry and Agriculture* (2005), Table 4-10; EPA 2009 data from EPA, Updated Forestry and Agriculture Marginal Abatement Cost Curves, March 2009, available with data annex to EPA's analysis of H.R. 2454.

Notes: The prices in the table are in constant dollars, adjusted for inflation (per EPA (2005), p. 4-2). The 2005 figures represent estimates for the year 2025; the 2009 figures represent the net annual average mitigation for the decade 2020-2029. For further discussion of these estimates, see CRS Report R40236, *Estimates of Carbon Mitigation Potential from Agricultural and Forestry Activities*, by Renée Johnson, Jonathan L. Ramseur, and Ross W. Gorte.

Estimates from Other Activities

Other potential mitigation activities—for example, methane abatement from landfills or the natural gas sector—are generally considered less complicated in terms of measurement than agriculture and forestry projects. In addition, 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 2. EPA Estimates of Mitigation Potential from Other Select Activities

Constant Price Scenarios in 2020

Mitigation Activity	Prices ($/mtCO2-e) in $2007		
	$4	$17	$32
CH_4 from Landfills	54	73	91
CH_4 from Natural Gas Sector	16	16	31
CH_4 from Coal Mines	40	40	40
N_2O from Adipic Acid Production	9	9	9
N_2O from Nitric Acid Production	16	16	16
Total	$139.00	$171.00	$219.00

Source: EPA, *EPA Analysis of the American Clean Energy and Security Act of 2009 H.R. 2454 in the 111th Congress*, Data Annex, at http://epa.gov/climatechange/economics/economicanalyses.html#hr2452.

Note: The price scenarios in this table differ from the previous table, because the underlying data come from a different source.

Several of the mitigation activities in **Table 2** are projected to occur at $0/mt$CO_2$-e. 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."[10] These are discussed below in "Other Factors."

The fact that parties are not acting in the most economically efficient manner at $0/mt$CO_2$-e, calls into question the estimates for higher prices and further 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), including which agency or agencies would be responsible for developing the logistical details. 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. Similarly, H.R. 2454 would set emission performance standards for CH_4 emissions from landfills and coal mines, reducing the opportunities for offsets from these categories.[11]

Eligible Offset Types

Policymakers may choose to restrict the types and locations (domestic versus international) of offsets eligible for use by a regulated entity. Biological sequestration generally offers the most potential, but these projects present substantial challenges. In some legislative proposals, the project types allowed are not specified in the text, but would be subsequently determined by an

[10] EPA, Global Mitigation of Non-CO_2 Greenhouse Gases (2006), p. I-14.

[11] See CRS Report R40556, *Market-Based Greenhouse Gas Control: Selected Proposals in the 111th Congress*, by Jonathan L. Ramseur, Larry Parker, and Brent D. Yacobucci.

implementing agency.[12] 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.

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 a cap-and-trade program provides set-aside allowances for specific activities,[13] these activities would impact the potential supply of offsets. Recent cap-and-trade proposals would give emission allowances (set-asides) to non-covered entities to promote various objectives, including biological sequestration. 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. 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.

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[12] CRS Report R40896, *Climate Change: Comparison of the Cap-and-Trade Provisions in H.R. 2454 and S. 1733*, by Brent D. Yacobucci, Jonathan L. Ramseur, and Larry Parker.

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

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. 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.

Climate-related policies in U.S. states may also affect offset supply. A number of states have taken actions that directly address GHG emissions.[14] 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—for example, whether or not they would be pre-empted—with a federal cap-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 recently developed methane emission performance standards for landfills.[15] Methane captured from California landfills in response to this standard 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) or a renewable electricity standard (RES) would affect offset supply. Such a federal standard 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. 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—for example, funding or tax incentives—could stimulate these technologies. If these technologies are

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

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

available earlier than predicted (by models), the "Emission Allowance Price" (discussed below) would likely decrease, making fewer offset projects cost effective.

Emission Allowance Price

The supply and type of offsets available would largely depend on the emission allowance price in a cap-and-trade system. 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. As mentioned above, multiple analyses indicate that different offset treatments yield a substantial range in emission allowance prices.

The supply of offsets would fluctuate as the allowance price changes. If the allowance price is relatively low—that is, \$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 cap-and-trade proposals, the results vary considerably among studies. For more information on these issues, see CRS Report R40809, *Climate Change: Costs and Benefits of the Cap-and-Trade Provisions of H.R. 2454*, by Larry Parker and Brent D. Yacobucci.

Other Factors

An EPA study stated that "other non-price factors, such as social acceptance, tend to inhibit mitigation option installation in many sectors."[16] 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 will to implement and has resulted in only a small portion of this potential being realized at present."[17]

Information dissemination may play a role. Many of the emission abatement and sequestration opportunities, particularly in the agricultural sectors, may be widely dispersed and under the

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

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

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.

In addition, transaction costs may impact offset development. The definition of transaction costs can vary widely, but in general transaction costs would likely include (1) administrative costs, such as project registration or document preparation (e.g., project petitions) needed for compliance; and (2) measuring, monitoring, and verifying costs. Transaction costs would likely involve upfront, one-time costs to get the project up and running as well as annual or periodic costs to assure the project is performing as intended.

Different offset project types could have radically different transaction costs. These differences could affect the types and quantity of offsets developed in a cap-and-trade system. For example, agricultural soil sequestration projects would likely require annual monitoring, possibly at several sites, depending on the size of the project. In contrast, afforestation might need only periodic monitoring, perhaps every five years, to assure that carbon sequestration is occurring. In addition, afforestation carbon is above ground and can be estimated rather simply, with measurements of tree height and diameter. Soil carbon would likely require soil samples to be taken and analyzed, with the number of samples depending on the heterogeneity of the soils on the site.

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