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How Realistic Are Expectations for the Role of Greenhouse Gas Offsets in U.S. Climate Policy?

An Examination of Offset Supply Analyses

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A sound understanding of the economics of offsets-in particular, of the potential supply of offsets under future policy scenarios and market conditions-is critically important for policymakers as they address major design decisions in crafting climate policy. This analysis will evaluate offset supply analyses completed to date, with a particular focus on identification of the assumptions and discrepancies of these efforts. This work will inform a subsequent, detailed analysis of domestic offset supply potential.

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EXECUTIVE SUMMARY

A sound understanding of the economics of offsets – in particular, of the potential supply of offsets under future market conditions – is critically important for policymakers as they address major design decisions in crafting climate policy. The World Resources Institute, in conjunction with the Stockholm Environmental Institute (SEI), is conducting a study to examine potential supplies of GHG offsets in a domestic cap and trade system.

This analysis will first identify key findings and clarify some of the assumptions, discrepancies, and shortcomings of the various efforts to quantify potential offset supply completed to date. Based on that analysis, the WRI-SEI study will summarize existing data on the potential volume of GHG reductions that could be achieved from these sources, and present cost curves for those reductions taking into account various assumptions about key offset policy design decisions.

INTRODUCTION

Greenhouse gas offsets are a central feature of nearly every major cap-and-trade system designed or proposed to date. A sound understanding of the economics of offsets – in particular, of the potential supply of offsets under future market conditions – is critically important for policymakers as they address major design decisions in crafting climate policy. These decisions include, among others, whether to place limits on the use or supply of offsets (and if so, at what level), whether to expedite or favor certain types of offset activities, and whether mechanisms in addition to offsets should be considered for some types of emission reduction or sequestration activities. Such decisions will need to consider many objectives, perhaps most prominently the management of cost impacts for emitters and consumers and the achievement of an adequately deep and rapid emission reduction pathway.

WRI/SEI are conducting a joint study to collect and provide insights into the economics of offsets. Our study includes a review of the current literature and models for assessing the economics of offsets (with a particular focus on domestic offsets that could be candidates for inclusion in mandatory cap-and-trade programs currently under consideration in the US) and conversations with leading analysts of mitigation opportunities and offset markets. In doing so, we are identifying key findings and clarifying some of the assumptions, discrepancies, and shortcomings of the various efforts to quantify potential offset supply. Our analysis will summarize existing data on the potential volume of GHG reductions that could be achieved from various sources, and present cost curves for those reductions taking into account various assumptions about quantification, additionality, and crediting protocols.

This paper provides a preliminary summary of insights gleaned from an initial review of offset estimation studies and methods, as well as from interviews with leading analysts. It also identifies the key additional variables that will be modeled to augment work already conducted in this area by other researchers.

INITIAL FINDINGS AND KEY QUESTIONS

We have conducted a preliminary review of what we believe to be the leading US studies that either generate offset supply analyses or utilize and adapt such analyses to the economic evaluation of climate policy proposals (See Tables 1 and 2). This analysis focuses on U.S. domestic offset supply potential.

Based on this initial review, we find that:

1. **Offset supply analyses tend to be of two varieties**: those prepared for policy studies (public sector market) and those prepared largely for the private sector. The former studies, of which the EPA and EIA's assessment of national cap and trade legislative proposals tend to be the most prominent, are generally performed by academic or government institutions and their consultants. They tend to be well documented, available in the public domain, and emphasize the broad techno-economic potential of a set of possible offset activities. The latter studies, performed by consulting and brokerage businesses (such as Ecosecurities, ICF, and PointCarbon) for their private sector clients, tend to pay closer attention to "real-world" market experience with offsets and how the potential rules and methods might determine offset project feasibility and the quantity of credits ultimately generated. Since these studies are generally proprietary, we will rely more on the "public sector" or policy studies; however, the "private sector" studies, or more specifically their purveyors, have provided us with helpful insights.
2. **Highly optimistic** is the best term to describe the speed and extent that domestic offsets become available in widely reported EPA, EIA, and related studies. EPA studies of the Lieberman-Warner bill (S.2191) suggest, with a few minor caveats, that most if not all of the economic potential of offset-eligible activities can be realized — i.e. projects implemented and credits generated and issued — immediately, once an emissions trading system is established (e.g. 2012).[1] While some experts are quick to note that the actors with the greatest potential to create offsets under most scenarios – farmers, ranchers, and forest owners – react quickly to economic signals, experience suggests that offset markets present barriers, risks, and transaction costs that could significantly increase cost and restrict supply in a manner acknowledged but not reflected in EPA studies.[2] Some analysts have sought to incorporate these factors into their analyses, by applying penetration rate curves (EIA, 2008), quantity discounts (EIA, 2008), or transaction costs (CRA, in Montgomery and Smith, 2008). These adjustments tend to be relatively subjective and play a greater role in private sector supply curves, based on conversations with their purveyors.

Analysts in the US rely almost exclusively on EPA marginal abatement cost studies and model results as the basis for their offset supply curves. Analysts then apply differing assumptions regarding eligibility, achievability, transaction costs, and program stringency, as illustrated in Table 2.

While additionality, baselines, and leakage are implicitly and systematically accounted in most offset curves analyses (e.g. those based on FASOM/EPA marginal abatement curves), offset supply analyses and the modeling studies that utilize them, do not directly reflect how offset programs would address these issues, nor how offset suppliers would respond to offset program rules and protocols.[3]

Since offset supply estimates are based on marginal abatement curves, and these curves estimate abatement quantity and cost

TABLE 1 Summary of Recent U.S. Cap-And-Trade Modeling Analyses

INSTITUTION	BILL ANALYZED AND CITATION	PRIMARY ECONOMIC MODEL USED	OFFSET LIMITS ASSUMED	APPROACH TO MODELING DOMESTIC OFFSETS SUPPLY	APPROACH TO MODELING INTERNATIONAL OFFSET SUPPLY	BANKING ALLOWED?	DATA AVAILABLE?
ACCF/NAM	S.2191 (ACCF and NAM, 2008)	• NEMS	• 15-20% in ***High Cost*** scenario • >20% in ***Low Cost*** scenario	• Unknown, but reference is made to changing supply and cost	• Not specified	No	No
Clean Air Task Force (CATF)	S.2191 (Banks, (2008)	• NEMS, run by OnLocation Inc.	• 15% domestic • 15% int'l	• Adapted EPA's cost curves (EPA, 2005a) with unspecified modifications	• Not specified	Yes	No (assumed)
Congressional Budget Office	S.2191 (CBO,2008)		• 15% domestic • No international offsets used	• Adapted EPA's cost curves (EPA, 2005a) with assumptions regarding market uptake	• None – international offsets excluded	Yes, up to standard discount rate of 5.8%	No
CRA	S.2191 (Montgomery and Smith, 2008)	• MRN/ NEEM	• 15% domestic • No international offsets used	• Adapted EPA's supply curves with tiered cost "tranches" meant to address both transactions costs and risk parameters • Excluded natural gas and oil-sector methane projects because assumed under the cap	• None - international offsets excluded due to author's reading of bill language as well as assumption that "comparable stringency" in other countries translates to same market price, removing any economic incentive for use of international offsets	Some scenarios allowed banking, some did not	No
EIA	S.2191, (EIA, 2008)	• NEMS	• 15% domestic • 15% international	• Adapted EPA's cost curves with assumptions regarding market penetration	• Adapted EPA's cost curves with assumptions regarding market penetration; ramp up to 15% binding limit in 2016	Yes	Yes, some
EPA	S.2191 (EPA, 2008)	• ADAGE IGEM	• 15% domestic • 15% int'l	• Modeled using FASOM-GHG and NCGM	• Modeled using GTM and MiniCAM	Yes	Yes, some
MIT	S.2191 (Paltsev et al, 2007 – Appendix D)	• EPPA	• 15% domestic • No international offsets used • Note S.2191 analysis is Appendix D	• No supply curves used – instead assumed (as a bounding case) that offsets available at zero cost up to 15% limit	• None because assumes international competition eliminates any price advantage	Yes	No
Nicholas Institute /RTI	S.2191 (Murray and Ross, 2007)	• NEMS (NI-NEMS)	• 15% domestic • 15% int'l	• Used EPA's cost curves with unspecified modifications	• Used EPA's cost curves with unspecified modifications	Yes	No

relative to a Business-as-usual (BAU) projection, by definition, BAU activities cannot generate abatement tons in these analyses. In principle, in these analyses, all additional activities are assumed to be credited; similarly, no non-additional activities are credited: in other words, there are neither false-negatives nor false-positives. Unfortunately, it is impossible to design an offset program with the omniscience and determinism of a modeling exercise. Real-world programs utilize additionality rules that inevitably result in both false positives and false negatives. In particular:

- To the extent that actual offset protocols err on the side of assessing BAU activities as additional — or overstating baseline emissions or underestimating leakage — potential offset supply would be higher than projected by EPA/FASOM modeling. Such non-additional tons do not tend to show up in typical offset supply curves or model analyses, though they do show up in real offset programs.

- Conversely if actual offset protocols err on the side of conservatism and stringency — overestimating leakage, assessing additional activities as non-additional, or understating baseline emissions — potential offset supply would be lower than projected by typical offset supply curves. Some, but not all, modelers account for this possibility through discount factors.

While it is impossible to accurately judge the extent of such errors, methods can be devised to inform their potential scale.[4] In Phase 2 of this study we will examine some project types and protocols more closely to inform estimates of how models can better reflect the potential for both under and overestimation.

Agriculture and forestry activities are projected to be the predominant source of domestic offsets. These projections are generally based on the output of the Forestry and Agricultural Sector Optimization Model (FASOM), (built by Bruce McCarl at Texas A&M and Darrius Adams at Oregon State University, among others), which EPA uses for their analyses, and from which others borrow results extensively. Therefore, understanding the assumptions, workings, and limitations of this model is critically important to deciphering offset supply estimates. We plan to examine the FASOM model more closely in Phase 2 of this analysis.

Recent FASOM runs, designed to reflect higher energy and crop prices over the longer term – as well as updates to baseline agricultural practices -- have found lower abatement potential from ag and forestry activities than estimates found in studies released in 2008 (e.g. those for S.2191 and prior studies). These new results should be released soon,[5] and are expected, as a consequence, to suggest that significantly fewer domestic offsets are likely to be available at a given price.

We anticipate that further work in Phase 2 of this project, incorporating many of the real-world offset issues missing from offset supply curves, will lead to a much wider range of potential offset supply curves.

The manner in which offset programs are designed and implemented, how robust and stringent their protocols are, and how strong and clear a price signal they can send to offset project developers, remain a major unknown. As a result, the uncertainties in projecting offset supply and cost — and the broader benefits offsets can provide — are very large. There are a number of policy design parameters that will be incorporated into the SEI-WRI offset supply curve modeling. These include:

- **Offset Project Type Eligibility** — EPA assumptions will be used, with the addition of possible future ineligibilities (e.g., large landfills) based on potential expansion of the cap.
- **Crediting Period Limits** — In most systems, like CDM and JI, there are limits to how long an offset project can ultimately gain offset credit (10 or 21 years). Crediting periods will be incorporated into the modeling for specific project types.
- **Scale Up Time** — This variable addresses the amount of time necessary for offset projects to be implemented and for the credits to be certified and issued across all sectors.
- **Transaction Costs** — The analysis will include estimates of transaction costs for various project types.
- **Quantitative limits** — Potential quantitative limits on the use of offsets to meet emission reduction compliance obligations in capped sectors will be included.
- **Leakage** — For each relevant project type, how leakage is likely to be accounted for in offset protocols specific to project types will be compared with estimates of leakage implicit in marginal abatement curves (e.g. FASOM modeling).
- **Baseline Error and Additionality** — The model will reflect the possibility that some false-positives (non-additional offset projects) make it into the system, as well as the possibility for false-negatives (projects that were excluded but should not have been).
- **Under and Over Performance Relative to Marginal Abatement Curves** — A parameter will be introduced to reflect potential bias in assessments of abatement potential for given project types, based on available critiques or expert judgment. Experience has shown that for some project types, offset projects have yielded considerably more or fewer emission reductions than originally anticipated.
- **Permanence** — A discount factor will be included to address how offset markets might address the risk of reversal of sequestered carbon in biologically based offset projects.

TABLE 2. Domestic Offset Supply Curves and Offset Dynamics – Modeling Approaches

		AVAILABILITY		TRANSACTION HURDLES	STRINGENCY / QUALITY		
INSTITUTION	**MAC CURVES USED**	**ELIGIBILITY**	**ACHIEVABILITY**	**TRANSACTION COSTS**	**ADDITIONALITY**	**PERMANENCE**	**OTHER STRINGENCY / QUALITY**
ACCF/NAM	Unspecified						
Clean Air Task Force (CATF)	EPA (2005a) and EPA (2006)	Unspecified – presumably same as in EPA (2007)	Unspecified	Unspecified	Unspecified	Unspecified	Unspecified
Congressional Budget Office	EPA (2005a) and EPA (2006)	Unspecified – presumably same as in EPA (2007)	Modified EPA's MAC curves to restrain the rate at which offset projects entered the market	Unspecified	Unspecified	Unspecified	Unspecified
CRA	EPA (2005a)	Same as in EPA (2007) except excluded oil and natural gas sector methane	Applied project-type-specific distribution function of transaction costs to EPA curves but did not use across-the-board discounting; also applied project-specific lag times (especially for afforestation)	Used project-type-specific distribution function of transaction costs	Unspecified	Applied cost function to incorporate some permanence considerations, such as reversal risk management in ag soil sequestration. Also discounted soil sequestration projects 20% to further account for permanence risk.	Applied cost function to incorporate some quality risks, e.g., due to need to prevent leakage from forest management
EIA	EPA, 2005a and EPA, 2006 as in EPA, 2007	Same as in EPA (2007)	Discounted EPA's MAC curves by 25% for most project types to account for achievability and applied energy technology market penetration curve	Discounts most project types by 25% to account for achievability and transaction hurdles	Unspecified	Does not address loss of permanence of sequestration lands to biofuels, as sequestration is modeled exogenously with little interaction with biofuel land (modeled endogenously) [NEED TO VERIFY]	Did not account for crediting periods or international leakage
EPA	EPA (2005a) and EPA (2006)	Assesses eligibility by project type, documented in both EPA, 2007 and EPA, 2008a	Little discounting applied except for select project types (e.g., 50% discounting of methane from oil and natural gas sectors). Otherwise assumes full credit and implementation of agriculture and forestry projects in 2012.	Transaction costs are not included.	Unspecified	EPA does account, in its FASOM model, for emissions associated with land use change from forest or agriculture to biofuels; others that use EPA's curves may also therefore indirectly account for this	FASOM implicitly accounts for (only) domestic leakage; EPA did not directly consider how markets would account for leakage. No accounting for uncertainty or crediting periods
Nicholas Institute /RTI	EPA (2005a) and EPA (2006)	Unspecified	Unspecified	Unspecified	Unspecified	Unspecified	Unspecified
EcoSecurities Consulting	MACs based on IPCC (2001), by global region	Assesses eligibility based on IPCC (2001) and internal estimates	Appears to use a "deployment rate"	Uses proprietary, internal, empirical cost data and financial analyses	Uses additionality stringency factor and distribution function	Unspecified	Unspecified

TABLE 3. Models Used to Assess Supply and Utilization of Offsets in U.S. Climate Policy

MODEL	FULL NAME	LEAD DEVELOPER	SECTOR FOCUS	GEOGRAPHY FOCUS	MODEL TYPE	ADDITIONAL MODEL ATTRIBUTES	LEADING STUDIES
GENERAL EQUILIBRIUM (CGE)							
ADAGE	Applied Economic Analysis of the Global Economy	RTI	All	World with U.S. region and U.S. states	• General equilibrium, top-down	• Runs through 2050 in 5-year steps • Perfect foresight • Better treatment of energy sector than some other CGE models	• EPA (2008) • Murray and Ross (2007)
IGEM	Intertemporal General Equilibrium Model	Harvard	All	U.S.	• General equilibrium, top-down	• Runs through 2050 • Inter-temporal • Perfect foresight	EPA (2008)
IGSM/EPPA	Integrated Global System Model / Emissions Prediction and Policy Analysis	MIT	All	World, with U.S. region	• General equilibrium, top-down	• Runs through 2050 • Dynamic-Recursive (myopic) • Also have new dynamic version (perfect foresight)	• Paltsev et al (2007) • Reilly et al (2004)
MRN-NEEM	Multi-Region National – North America Electricity and Environment Model	CRA	All	U.S.	• MRN is a top-down model, run in combination with the bottom-up NEEM	• Runs through 2050 • Perfect foresight	• Montgomery and Smith (2008)
SGM	Second Generation Model	PNNL / U Maryland	Multi-sector	Global, incl. US	• Set of 14 CGE models • Dynamic-recursive (myopic)	• Through 2050 in 5-year steps	EPA (2005b)
OTHER							
FASOMGHG	Forestry and Agricultural Sector Optimization Model	McCarl	Ag & Forestry	U.S.	• Spatial and market equilibrium • Mathematical programming	• Intertemporal • Price endogenous • Perfect foresight • Runs over 100-year in 10-year steps	• EPA (2008) • EPA (2005) • McCarl (2007)
NEMS	National Energy Modeling System	US DOE	Energy	U.S.	• Integrated supply-demand linear programming model • Bottom-up	• Runs 1990-2030 , single-year steps • Nicholas version (NI-NEMS) has "exogenous offset supply curves that are responsive to allowance price"	• Murray and Ross (2007) • CATF • ACCF/NAM
GTM	Global Timber Model	Sohngen	Timber	Global			EPA (2008)
NCGM		EPA	Non-CO2	World with U.S. as region	• Spreadsheet • Bottom-up • Engineering-economic model	• Time periods: 2010,2015,2020 • Includes only commercial technologies	EPA (2008)
MiniCAM	Mini Climate Assessment Model	PNNL / U Maryland	Buildings, industry, transit	Global, incl. US	• Partial equilibrium • Integrated assessment model	• Balances supply and demand • Through 2095 in 15-year time steps	EPA (2008)
TAMM	Timber Assessment Market Model	Darrius Adams	Forest	U.S.	• Included as module in FASOM-GHG		EPA (2008)
USMP		USDA	Ag	U.S.	• Spatial and market equilibrium • Mathematical programming		USDA (2004)

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NOTES

1. In the words of the EPA analysts, "we assume full credit and implementation when the policy begins for all agriculture and forestry offsets."
2. Furthermore, market actors may respond more slowly to *unfamiliar* market risks and opportunities (e.g. offset markets in comparison with high grain prices), especially those that may impose restrictions or consequences on future changes in land use (e.g. changes that might release sequestered carbon).
3. FASOM does not directly account for international leakage in its abatement results, though the underlying economic model does capture leakage of activity across borders. In addition, EPA analyses do not account for leakage in the case of estimates for activities not covered in the ag/forestry models such as FASOM; however, the potential for leakage for these activities may be relatively small in many cases.
4. See for example, Bernow et al (2001), who used International Energy Agency BAU projections of new renewable energy and natural gas projects to estimate the potential scale of free-riders (non-additional projects) in the CDM.
5. Some preliminary revised FASOM results were presented by Steven Rose of EPRI at the February, 2009 Offset Policy Dialogue Workshop in Washington, D.C. EPA is also planning to release an analysis of S.3036 – the Boxer amendment of the Lieberman-Warner bill, which will include the revised FASOM results, in March.