HEARING TO REVIEW THE COSTS AND BENEFITS OF AGRICULTURE OFFSETS

HEARING

BEFORE THE

SUBCOMMITTEE ON CONSERVATION, CREDIT, ENERGY, AND RESEARCH

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HOUSE OF REPRESENTATIVES

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HEARING TO REVIEW THE COSTS AND BENEFITS OF AGRICULTURE OFFSETS

THURSDAY, DECEMBER 3, 2009

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON CONSERVATION, CREDIT, ENERGY, AND RESEARCH,
COMMITTEE ON AGRICULTURE,
Washington, D.C.

The Subcommittee met, pursuant to call, at 10:00 a.m., in Room 1300 of the Longworth House Office Building, Hon. Tim Holden [Chairman of the Subcommittee] presiding.

Members present: Representatives Holden, Peterson (*ex officio*), Herseth Sandlin, Dahlkemper, Markey, Schauer, Boccieri, Walz, Massa, Murphy, Minnick, Goodlatte, Moran, Schmidt, Smith, Luetkemeyer, Thompson, and Cassidy.

Staff present: Nona Darrell, Craig Jagger, John Konya, Scott Kuschmider, James Ryder, Anne Simmons, Debbie Smith, Rebekah Solem, Patricia Barr, Tamara Hinton, Josh Maxwell, and Sangina Wright.

OPENING STATEMENT OF HON. TIM HOLDEN, A REPRESENTATIVE IN CONGRESS FROM PENNSYLVANIA

The CHAIRMAN. This hearing of the Subcommittee on Conservation, Credit, Energy, and Research to review the costs and benefits of agriculture offsets will come to order.

Welcome to the second of two hearings on the topic of climate change in agriculture. Today our witnesses will provide testimony on the costs and benefits of agriculture offsets. The implications of the 2007 Supreme Court decision regulating greenhouse gas emissions are still unknown, and the extent to which agriculture will need to participate in an offset and allowance program is still under debate. The efforts of Chairman Peterson to prevent EPA regulation of agriculture during consideration of the climate change bill would ensure that the writing of any offset rules will remain in the hands of those who understand agriculture and rural America. However, as I mentioned yesterday, the bill passed by the House is a long way from the President's desk.

Yesterday, we heard from witnesses about the impacts that regulation and legislation addressing greenhouse gas emissions will have on our farms. At the same time, the witnesses discussed the effects of a changing climate on our cropland and livestock. What was clear from their testimony is that both action and inaction come with a price tag.

The intent of this second hearing is to gather more information from those who have the knowledge and expertise on the use of offsets to counter these new costs. The researchers, economists, educators and analysts of our panel today are part of this wide and growing debate about whether or not these programs are viable, verifiable and profitable. Regardless of which side of the debate we are on, we all agree that there is much more work to be done.

I look forward to today's expert testimony and the opportunity to listen, learn and question those on the forefront of this issue.

[The prepared statement of Mr. Holden follows:]

PREPARED STATEMENT OF HON. TIM HOLDEN, A REPRESENTATIVE IN CONGRESS FROM PENNSYLVANIA

Welcome to the second of two hearings on the topic of climate change and agriculture. Today, our witnesses will provide testimony on the costs and benefits of agriculture offsets.

The implications of the 2007 Supreme Court decision regulating greenhouse gas emissions are still unknown, and the extent to which agriculture will need to participate in an offset and allowance program is still under debate. The efforts of Chairman Peterson to prevent EPA regulation of agriculture during consideration of the climate change bill would ensure that the writing of any offset rules will remain in the hands of those who understand agriculture and profitable. Regardless of which side of the debate we are on, we all agree there is much more work to be done. I look forward to today's expert testimony and the opportunity to listen, learn and question those on the forefront of this issue.

The CHAIRMAN. I now recognize the Ranking Member, Mr. Goodlatte.

OPENING STATEMENT OF HON. BOB GOODLATTE, A REPRESENTATIVE IN CONGRESS FROM VIRGINIA

Mr. GOODLATTE. Thank you, Mr. Chairman. I appreciate you holding this series of hearings.

Dr. Glauber, welcome again. This is getting to be a regular thing. I want to thank the witnesses for their participation today.

Yesterday's witnesses demonstrated that cap-and-trade will have serious economic consequences for agriculture. H.R. 2454, the American Clean Energy and Security Act (ACES), or as I like to call it, the Agriculture Can't Exist Standards, creates a cap-and-tax program that will drive up energy and input costs for our farmers and ranchers and drive down farm income, ultimately putting many producers out of business. Proponents of cap-and-trade will point to the agriculture offsets provision in ACES and claim that they create potential for added farm revenue to mitigate the increase in production costs. But this provision also producers winners and losers. While every commodity will be hit with increased costs, only select producers will be able to take advantage of revenue-raising offset projects. Meanwhile, entire regions of the country will be ignored and placed at an economic disadvantage because producers are not able to participate in offsets or projects that are economically feasible. Secretary Vilsack has often claimed that an offset program will be a major source of revenue for farmers, but has yet to produce evidence to back this claim except for the example of a producer who stops farming and converts cropland to trees. According to the EPA, this conversion could potentially be as high as 60 million acres, nearly twice the amount of land eligible under CRP.

Now, let me be clear. In many cases the decision to take farmland out of production will not be made by farmers but rather it will be made by landowners. Converting this farmland would be devastating to agriculture and to rural America. Fewer acres would mean, potentially, more expensive feed for livestock producers and less revenue for agribusiness. Additionally, rural towns and communities will see a decrease in tax revenue that is necessary for essential community services.

Rural America is facing an economic crisis and farm income is projected to decrease nearly 35 percent in 2009. This is no time to further cripple our farm economy with a burdensome cap-and-tax policy.

Mr. Chairman, I thank you for holding the hearings this week. I thank the Chairman of the full Committee, Mr. Peterson, for his efforts in trying to make the cap-and-trade legislation better, and certainly in the areas in which this Committee has jurisdiction he was successful in doing so, but there are wider, larger ramifications of this legislation that I think make it a very bad idea and very harmful to American agriculture. I look forward to today's testimony and hope the Committee will continue to review issues related to cap-and-trade.

[The prepared statement of Mr. Goodlatte follows:]

PREPARED STATEMENT OF HON. BOB GOODLATTE, A REPRESENTATIVE IN CONGRESS FROM VIRGINIA

Mr. Chairman, thank you for holding today's hearing to review the costs and benefits of agriculture offsets.

Yesterday's witnesses demonstrated that cap-and-trade will have serious economic consequences for agriculture. H.R. 2454, the American Clean Energy and Security Act (ACES) or as I like to call it, the Agriculture Can't Exist Standards, creates a cap-and-tax program that will drive up energy and input costs for our farmers and ranchers and drive down farm income; ultimately putting many producers out of business.

Proponents of cap-and-trade will point to the agriculture offsets provision in ACES and claim that they create potential for added farm revenue to mitigate the increase in production costs. But this provision also produces winners and losers. While every commodity will be hit with increased costs, only select producers will be able to take advantage of revenue-raising offset projects. Meanwhile, entire regions of the country will be ignored and placed at an economic disadvantage because producers are not able to participate in offsets or projects that are economically feasible.

Secretary Vilsack has often claimed that an offset program will be a major source of revenue for farmers, but has yet to produce evidence to back this claim except for the example of a producer who stops farming and converts crop land to trees. According to the EPA, this conversion could potentially be as high as 60 million acres, nearly twice the amount of land eligible under CRP. Now let me be clear—in many cases, the decision to take farm land out of production will not be the farmers—it will be with the landowners.

Converting this farm land would be devastating to agriculture and to rural America. Fewer acres would potentially mean more expensive feed for livestock producers and less revenue for agribusiness. Additionally, rural towns and communities will see a decrease in tax revenue that are necessary for essential community services.

Rural America is facing an economic crisis and farm income is projected to decrease nearly 35% in 2009. This is no time to further cripple our farm economy with the burdens of a cap-and-tax policy.

Mr. Chairman, I again thank you for holding the hearings this week. I look forward to today's testimony and I hope the Committee will continue to review issues related to cap-and-trade.

The CHAIRMAN. The chair thanks the gentleman, and asks all other Members of the Subcommittee to submit their statements for the record.

[The prepared statement of Mr. Peterson follows:]

PREPARED STATEMENT OF HON. COLLIN C. PETERSON, A REPRESENTATIVE IN CONGRESS FROM MINNESOTA

Thank you, Chairman Holden, for your leadership in calling this week's hearings. Once again, I will be brief because we have a lot of witnesses and a lot of substance to get into regarding the costs and benefits of agriculture offsets.

The agriculture and forestry offset program that was included in the House-passed climate change legislation was a prime example of why the House Agriculture Committee needed to be at the table if the EPA was going to act on climate change without Congress's input.

Agricultural producers have been leaders when it comes to reducing emissions. Many farmers, ranchers, and forest landowners are storing carbon, improving their energy efficiency and reducing greenhouse gas emissions through no-till, renewable energy production, forest management and other methods. Offset provisions in climate change legislation should recognize and reward this work, not hold it responsible for ideological reasons not based on sound science.

If Congress fails to act, and if EPA is left in charge of writing carbon offset rules, there is no reason to think that agriculture and rural America will be fairly included in the process. Unlike USDA, EPA doesn't know agriculture, they aren't in the field dealing with producers, and they don't have the researchers or soil scientists to form a base of knowledge that would help in establishing and administering an offset program that credits real emissions reduction.

That's why we ensured the House bill contains a workable, common-sense offset option for farmers, ranchers, and private forest landowners with USDA in charge. While the bill as a whole is far from perfect, I believe the carbon offset provisions we included are the foundation for the kind of program farmers, ranchers, and foresters can ultimately get behind. And most agricultural groups have agreed. We are watching the Senate and hoping they can build on that.

With that said, we are here today to learn more about the role of offsets in recent economic studies of climate legislation, how these programs could work, and what it could mean for producers in the long run, whether or not Congress decides to act. I look forward to that discussion and I yield back my time.

The CHAIRMAN. We would like to welcome our first panel of witnesses today. Dr. Glauber, thank you very much for being with us again today. As well, we would like to welcome Dr. Joseph Kile, Assistant Director of Microeconomic Studies from the Congressional Budget Office.

Dr. Glauber, you may begin when you are ready.

STATEMENT OF JOSEPH GLAUBER, PH.D., CHIEF ECONOMIST, U.S. DEPARTMENT OF AGRICULTURE, WASHINGTON, D.C.

Dr. GLAUBER. Thanks very much. Chairman Holden, Congressman Goodlatte, Chairman Peterson and other Members of the Committee, again, thank you for the opportunity to discuss the effect of greenhouse gas offsets on U.S. agriculture.

In yesterday's testimony, I summarized the Department's analysis of how the American Clean Energy and Security Act would likely affect production costs for U.S. farmers and ranchers across a wide range of commodities and regions. Today I will address how farmers and ranchers can potentially gain through the greenhouse gas offset program provided for in H.R. 2454.

The role of offsets is important for agriculture as well as for the rest of the economy. First, offsets provide a potential low-cost option for compliance to greenhouse gas emissions reductions for covered sectors under a cap-and-trade system. Offsets reduce the cost of compliance for covered entities which results in small increases in allowance prices that are then passed on to consumers, including farmers, as increased energy prices. Conversely, limited offset availability could result in higher cost to the economy. In its analysis of H.R. 2454, the Environmental Protection Agency estimates that allowance prices would almost be 90 percent higher if international offset markets were not allowed. In a similar analysis, the Energy Information Administration estimates that allowance prices would be 64 percent higher with no international offset market.

Second, offsets are a potential income source for agricultural producers and forest landowners through changes in land management practices, for example, reduced tillage, increased fertilizer efficiency, afforestation through animal management such as dietary modification, and manure management such as biogas capture. And while the profitability of management practices and the carbon storage that is attainable varies widely by region, net revenues from agricultural offsets can help mitigate the effects of higher production costs due to higher energy costs.

Last, a domestic carbon offset program could affect land use and agricultural production and prices. If afforestation is the primary source of carbon offsets, cropland and pastureland would be converted to forest, which would raise farm prices and increase farm income, but also potentially result in higher food prices for both domestic and foreign consumers. Other sources of possible offsets such as conservation tillage and other agricultural management practices could have potentially smaller effect on land use and agricultural production and prices.

Mr. Chairman, as I said in my testimony yesterday, we found that farm-level price and income effects due to higher production costs under H.R. 2454 will be relatively small, particularly over the short run. However, I believe a far more significant factor will be the effects of carbon offsets. There is no question that offsets will provide producers with potential means to enhance farm income and more than compensate the effects of higher production costs. The bigger issue, I believe, will be the source of the offsets. If too much cropland is diverted to afforestation, higher prices will result. This will put pressure on the livestock sector and ultimately food prices.

In today's testimony, I review a number of recent studies that have focused on how ranchers, farmers and forest landowners would respond to various incentives designed to increase the use of production practices and land uses that increase carbon sequestration or reduce emissions associated with commodity production. To estimate the economic potential for agriculture and forestry to supply offsets, we relied on EPA allowance prices and detailed model analysis provided by the EPA using the so-called FASOM model developed at Texas A&M by Dr. Bruce McCarl, who you are fortunate to have on the next panel. Based on the FASOM results, we estimate the total amount of offsets that would be supplied by the agriculture sector would be 59 million metric tons of carbon equivalent in 2015, rising to over 420 million tons by 2050. The gross value of offsets increases from $800 million per year in 2015 to almost $30 billion per year in 2050.

Providing offsets through afforestation has clear land use implications. As the value of carbon allowances increases, the FASOM estimates show that afforestation occur on large amounts of crop and pastureland. Afforestation of cropland and pastureland will have production and price impacts. The impact of less land in agriculture production leads to higher overall returns to agricultural producers with the results suggesting net returns to agricultural producers would be 12 percent higher than under baseline levels. However, the impact of less land also leads to higher commodity prices and ultimately higher food prices.

It is important to point out two *caveats* about the model, and these are quite important. In the FASOM results that were provided to us from EPA, the Conservation Reserve Program was assumed to be fixed at 32 million acres. Planting trees on CRP acreage would provide additional offsets without causing loss of cropland. Alternatively, allowing some CRP acreage to come out and go into cropland would also help mitigate the price impacts while providing potential offset income to producers.

Second, the FASOM model only evaluates no-till adoption relative to baseline levels. Under H.R. 2454, there would be potential offsets to early adopters and particularly for those adopters using permanent no-till practices. These are not accounted for in the model, and in fact the model shows no potential offsets coming from no-till. But again, this is a function of one of the underlying model assumptions. What these results suggest is that it is important to get the offsets program right, to provide sufficient income incentives to producers to reduce greenhouse gas emissions or sequester carbon, but in a way that does not turn an offsets program into a food *versus* fuel *versus* carbon debate.

That completes my testimony and I would be happy to take any questions.

[The prepared statement of Dr. Glauber follows:]

PREPARED STATEMENT OF JOSEPH GLAUBER, PH.D., CHIEF ECONOMIST, U.S. DEPARTMENT OF AGRICULTURE, WASHINGTON, D.C.

Mr. Chairman, Members of the Subcommittee, thank you for the opportunity to discuss the effects of greenhouse gas (GHG) offset programs on U.S. agriculture. In previous testimony I have summarized the Department's analysis of how the American Clean Energy and Security Act (H.R. 2454) would likely affect production costs for U.S. farmers and ranchers across a wide range of commodities and regions. Today I will address how farmers and ranchers can potentially gain through the GHG offset program provided for in H.R. 2454.

The role of offsets is important for agriculture as well as to the rest of the economy. First, offsets provide a potential low-cost option for compliance to GHG emissions reduction targets for covered sectors under a cap-and-trade system. Offsets reduce the costs of compliance for covered entities which results in smaller increases in allowance prices that are then passed on to consumers—including farmers—as increased energy prices. Conversely, limited offset availability could result in higher costs to the economy. In its analysis of H.R. 2454, the Environmental Protection Agency (EPA) estimates that allowance prices would be almost 90 percent higher if international offset markets were not allowed.[1] In a similar analysis, the Energy Information Administration (EIA) estimates that allowance prices would be 64 percent higher with no international offsets market.[2] The Congressional Budget Office

[1] The EPA analysis of H.R. 2454 can be found at *http://www.epa.gov/climatechange/economics/economicanalyses.html.*

[2] The EIA analysis of H.R. 2454 can be found at: *http://www.eia.doe.gov/oiaf/servicerpt/hr2454/index.html.*

estimates that if no offsets were allowed, allowance prices would more than triple.[3] These analyses do not consider how allowance prices would change if both international and domestic offsets were not available, but the effect would likely be magnified. This is because when international offsets are not available, demand for domestic offsets increases substantially and acts as a limiting factor on allowance price increase.

Second, offsets are a potential income source for agricultural producers and forest landowners through changes in land management practices (*e.g.,* reduced tillage, increased fertilizer efficiency, afforestation/tree planting), animal management (*e.g.,* dietary modifications), and manure management (*e.g.,* biogas capture). And while the profitability of management practices varies widely by region, as does the amount of carbon storage attainable, net revenues from agricultural offsets can mitigate the effects of higher production costs due to higher energy costs.

Last, a carbon offsets program could affect land use and agricultural production and prices. If afforestation is the primary source of carbon offsets, for example, cropland and pastureland would be converted to forests which would raise farm prices and increase farm income, but also result in higher food prices for both domestic and foreign consumers. Other sources of possible offsets such as conservation tillage and other agricultural management practices that reduce nitrous oxide and methane emissions could have potentially smaller effects on land use and agricultural production and prices but would be more difficult to monitor and verify.

Note that the analysis presented here does not examine the impacts of international offsets on the U.S. farm sector. International offsets, particularly reduced deforestation offsets that limit agricultural expansion globally can also affect U.S. farmers by raising farm prices. As found in the EPA and EIA analyses, international offsets are important for avoiding high allowance prices, which will lead to more moderate energy price increases but also result in lower prices for domestic offsets.

The Role of Offsets

Agriculture and forestry have a wide variety of production and land management practices that can lower GHG emissions and/or increase the quantity of carbon stored in soils and vegetation. These include shifting cropland into trees or permanent grasses, managing existing forests to store additional carbon, adopting no-till or reduced tillage systems on a long-term basis, eliminating fallow periods, planting cover crops, changing nitrogen fertilizer management practices (including rates, application method, timing, and use of inhibitors), altering livestock feed mixes, and changing manure management practices.

A number of recent economic studies have focused on how farmers and forest land owners would respond to various incentives designed to increase the use of production practices and land uses that increase carbon sequestration and/or reduce emissions associated with commodity production. For six of these studies, *table 1* details the types of mitigation activities assessed, the regional and sector coverage, and the quantity of GHG mitigation achieved by specific activities at selected prices.

The studies summarized in *table 1* employ different methodologies and make alternative assumptions regarding key underlying variables, trends, and other factors. Additionally, the studies were designed to look at different research questions and so differ with respect to geographic focus, sector coverage, activity coverage, inclusion of relevant Federal policies and measures and time period considered. When viewed collectively, however, several overall conclusions emerge regarding the potential of the U.S. agriculture and forestry sectors to supply greenhouse gas mitigation within the context of a cap-and-trade system.

Collectively, the studies found, depending on the CO_2 price, farmers and forest land owners generate measurable amounts of greenhouse gas mitigation through changes in tillage practices, crop rotations, elimination of fallow periods, switching marginal cropland to permanent grassland, reducing methane (CH_4) and nitrous oxide (N_2O) emissions from agricultural sources, making changes in forest management, and afforestation.

The offset supply curves from these studies indicate than even at low CO_2 prices, the domestic agriculture and forestry sectors could supply a significant amount of GHG offsets to entities covered under a cap-and-trade system. At very low CO_2 prices (*e.g.,* under $10 per ton), these offsets would be generated mostly by changes in agricultural production practices. Lewandrowski *et al.* (2004), EPA (2005), and Antle *et al.* (2001, 2007) found some shifting to less GHG intense production practices (such as increased adoption of no-till, elimination of fallow periods, and shifts

[3] Congressional Budget Office. *CBO Cost Estimate: H.R. 2454 American Clean Energy and Security Act of 2009,* June 5, 2009. p. 18.

to less energy intensive rotations) at CO_2 prices of $5 per ton or less. In many areas no-till, conservation tillage, and conventional tillage systems are practiced in relatively close geographic proximity. This suggests the economic returns to different tillage systems are often relatively similar. Where this is the case, a relatively small economic incentive favoring one system over another—such as a carbon market could provide for no-till, would be sufficient to induce some farmers to change tillage systems. Similar reasoning applies to increases in the use of other less GHG intense production practices and rotations.

Results in the two studies that include forest management as a mitigation option (EPA 2005, 2006) suggest these activities would also start generating significant offsets at a CO_2 price as low as $5 per ton. At a CO_2 price of about $10 per ton, afforestation becomes economically attractive and dominates mitigation activities in the agricultural sector. Although explicitly accounted for only in the EPA (2005) study, changes in forest management dominate mitigation activity in the forest sector. Across studies, afforestation accounts for an increasing share of total offsets as CO_2 prices rise—at least through the price ranges considered ($33.1 per ton in Lewandrowski *et al.*, $50 per ton in EPA (2005), and $54.4 per ton in Lubowski *et al.*). Opportunities to generate offsets from reducing N_2O and CH_4 emissions from agricultural sources appear positive but relatively modest through the range of CO_2 prices considered (EPA, 2005 and 2006). Results in the one study that looks at farms and forests as suppliers of biofuel feedstocks for electricity generation suggest this activity could be important source of offsets at CO_2 prices above $30 per ton (EPA 2005).

Finally, the studies by Lewandrowski *et al.* and EPA (2005) discuss the difference between the technical and economic potentials of the agriculture and forestry sectors to mitigate GHG emissions through changes in production and land management practices. As with the empirical results, these discussions are not directly comparable. Lewandrowski *et al.* combine published technical assessments of the carbon sequestering potential of various crop and livestock activities with published estimates of the total land suitable for each practice to develop a table describing the aggregate technical potential of specific farm sector activities to sequester carbon (see Lewandrowski *et al.*, table 2.2, page 5). The discussion in EPA (2005) is conceptual and drawn from an earlier paper McCarl and Schneider (2001). Also, the studies differ in terms of evaluation period, as the EPA 2005 results are from 2010–2100 while the Lewandrowski *et al.* study evaluates a shorter, 15 year time period.

It is also important to understand the regional economic implications of a national cap-and-trade framework such as contained in H.R. 2454. Insights regarding these impacts can be developed from the studies by Lewandrowski *et al.* (2004) and EPA (2005). Although the studies vary significantly in timeframe and other underlying assumptions, this brief synopsis highlights the regional difference in adoption rates of offset options, using afforestation as an example.

Regional results of offset potential by source from Lewandrowski *et al.* with GHG mitigation priced at $34 per ton CO_2, and, EPA (2005) with GHG mitigation priced at $30 per ton CO_2 are shown in *figures 1a* and *1b*. In both cases, afforestation is the largest potential source of offsets.[4] In the EPA (2005) study, 90 percent of the 434.9 MMT of CO_2 sequestered by afforestation occurs in the Corn Belt and South Central regions. The remainder occurs in Southeast, Lake States, and Rock Mountain regions. In the Lewandrowski *et al.* study, over 60 percent of the CO_2 sequestered by afforestation occurs in Appalachia, the Southeast, Delta States, Lake States, and Corn Belt. One region where the afforestation results differ significantly between the two studies is the Pacific Northwest and California. In Lewandrowski *et al.*, these areas sequester 160 MMT CO_2 via afforestation (all from conversion of pasture to trees). It is worth noting that in this study, afforestation in the PNW region requires a relatively high price for CO_2 before it is economically attractive. At prices below $15 per ton CO_2 virtually no afforestation occurs. In the EPA (2005) analysis the PNW and California sequester only 4.7 MMT CO_2 from afforestation.

Agricultural Offsets in H.R. 2454

The economic profitability to supply offsets depends on the price that industries in covered sectors are willing to pay for offsets. The June EPA analysis of H.R. 2454 (2009) estimates the real ($2005) price of allowances to increase from about $13 per ton of carbon dioxide equivalent (CO_2eq) in 2015 to over $70 per ton CO_2eq by 2050; an increase of five percent per year[5] (*table 2*).

[4] In the Lewandrowski *et al.* study, afforestation was assumed to be zero in the North Plains, South Plains and Mountain regions.

[5] For the June EPA H.R. 2454 analysis, scenario 2 was used. The EPA analysis of H.R. 2454 can be found at: *http://www.epa.gov/climatechange/economics/economicanalyses.html.*

To estimate the economic potential for agriculture and forestry to supply offsets we rely on EPA allowance prices and detailed modeling analysis provided by EPA.[6] The results presented are similar to but not identical to the results provided in the EPA (2009) analysis of H.R. 2454 or our preliminary analysis of H.R. 2454 (USDA, OCE, 2009). The results presented in this analysis reflect the estimates from FASOM based on an average of two scenarios: an inflation adjusted carbon allowance price of $5 per ton in 2010 and increasing at five percent per year over time and an inflation adjusted carbon allowance price of $15 per ton in 2010 and increasing at five percent per year over time. The average of these carbon prices paths generates a carbon price path that approximates the carbon price allowance path estimated by EPA. In addition, in this paper we focus exclusively on agricultural activities and include afforestation as an agricultural activity.

The FASOM modeling did not account for several categories of GHG reductions, including: improvements in organic soil management; advances in feed management of ruminants; changes in the timing, form, and method of fertilizer application; and alternative manure management systems other than anaerobic digesters.[7] The model only evaluates additional no-till adoption relative to a historic baseline. To the extent legislation awards offsets to no-till prior to the start of the program, it is not accounted for here. It is important to note that these emissions reductions would not be additional relative to the baseline.

It is also important to note that, as with any economic model, predictions far out into the future are inherently more uncertain than nearer term estimates. USDA typically only forecasts agricultural prices and incomes a handful of years into the future. As such, results—particularly for 2030 and 2050—should not be interpreted as precise estimates but rather as indications of the direction and magnitude of the expected effect.

From 2015 to 2050, the total amount of offsets that would be supplied by the agricultural sector increases from 59 million metric tons of carbon equivalent ($MMTCO_2eq$) per year to over 420 $MMTCO_2eq$ by 2050 (*table 3*). With allowance prices increasing over time, the real gross revenues resulting from agricultural offsets increases from about $800 million per year in 2015 to almost $30 billion per year by 2050.

The primary source of agricultural offsets would be increased carbon sequestration through afforestation of crop and pastureland.[8] The gross revenues—before accounting for the cost of the offset-generating activity—associated with offsets from afforestation account for about 85 percent of the total agricultural offset revenues from 2015 to 2050 (*table 3*). Reductions in methane (CH_4) and nitrous oxide (N_2O) emissions account for second largest share of agricultural offsets. These offsets total about 11 MMT CO_2eq in 2015 and 78 MMT CO_2eq in 2050. Many of the opportunities to generate these offsets would be concentrated among specific groups of producers. Examples include changes in manure management practices for confined dairy, hog, and poultry operations, changes in diet for confined cattle operations, changes in fertilizer management for nitrogen intensive commodities such as corn and cotton, and, changes in rice production practices.

Regionally, the Corn Belt region is the largest supplier of GHG offsets across time periods and the Lake States region is the second largest supplier (*table 4*).[9] In each 5 year period between 2015 and 2050, the Corn Belt region accounts for between 30 and 50 percent of all agricultural sector offsets supplied while the Lake States region account for between 20 and 30 percent of the total supply of agricultural offsets. The South Central, Northeast, and Rocky Mountain regions account for, on average and respectively, 11, 8, and 6 percent of all agricultural offsets supplied between 2015 and 2050.

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[6] To estimate the economic potential of the agriculture and forestry sectors in the United States to provide carbon offsets, EPA (2009) used an economic model, the Forest and Agricultural Sector Optimization Model (FASOM), developed by Bruce McCarl at the Texas A&M University. The results presented in this paper reflect simulations during March 2009. A more complete description of FASOM modeling framework and a complete list of commodities can be found at: *http://agecon2.tamu.edu/people/faculty/mccarl-bruce/FASOM.html.*

[7] Because of how it is handled in the FASOM model, agricultural soil sequestration does not show significant supply. However, detailed FASOM output indicates a 50 percent increase in the percent of cropland using conservation tillage and no-till by 202 in response to a $15/ton CO_2 incentive payment. Because overall land area in crops declines due to afforestation, the modeling indicates a net decrease in total agricultural soil carbon storage as carbon is transferred from the agricultural soils pool to the afforestation carbon pool.

[8] This includes soil carbon sequestration on afforested agricultural lands, in addition to carbon sequestered from new trees.

[8] FASOM regions are presented in *Figure 1.*

Implications for Land Use

Providing offsets through afforestation has clear land use implications. As the value of carbon allowances increase, FASOM estimates show that afforestation occurs on larger amounts of crop and pastureland (*table 5*). In 2015, when the price of carbon allowances is about $13 per ton of CO_2eq, additional afforestation occurs on about 8 million acres. This represents a three percent increase in forestland against the projected baseline. By 2030, when the price of carbon allowances increases to almost $27 per ton of CO_2eq, additional afforestation occurs on almost 27 million of acres. By 2050, when the price of carbon allowances increases to $70 per ton of CO_2eq, additional afforestation occurs on almost 60 million acres, 35 million acres of which comes from cropland (14 percent decline from baseline) and 24 million acres from pasture (almost nine percent decline from baseline).

As the value of carbon allowances increase, the share of cropland used for afforestation also increases. For example, in 2015, when the price of carbon allowances is relatively low, almost all the afforestation occurs on pastureland. By 2030, when price of carbon allowances rises to about twice the price in 2015, slightly more than half of the additional afforestation occurs on cropland. The source of land being used for afforestation matters as well. In the early periods, more pastureland is converted to forests than cropland. By 2050, when the price of carbon allowances increases to over $70 per ton of CO_2eq, about 60 percent of the afforestation occurs on cropland compared to about 40 percent for pastureland. Studies that have shown a greater portion of mitigation coming from pasturelands have shown smaller aggregate impacts on commodity production and food prices (de la Torre Ugarte *et al.* 2009).

The amount of land where additional afforestation occurs also varies by region. As shown in *table 6,* in 2015, almost all of the additional afforestation occurs in four regions of the country: the Corn Belt, Lake States, Rocky Mountains, and South Central. While most of the additional afforestation occurs in the Corn Belt, there is also a growing concentration of afforestation over time. In 2015, for example, about 55 percent of the afforestation occurs in the Corn Belt and Lake States. By 2050, almost 65 percent of the additional afforestation in the United States occurs in those two regions.

Impacts on Crop Production and Prices

Afforestation of cropland will have production and price impacts. As carbon allowance prices increase, the magnitude of the impact compared to baseline production and prices grows. In 2015, the commodity production impacts are relatively modest except for rice (*table 7*). Corn and soybean production are 3.5 and 1.4 percent lower, respectively, compared to baseline production levels. By 2030, corn and soybean production are about seven and nine percent lower, respectively, when compared to baseline levels of production in 2030. By 2050, corn and soybean production are 22 and 29 percent lower than baseline levels.

It is important to note that under the FASOM baseline, crop production generally increases over time due to yield growth. Thus, the impacts of higher carbon allowance prices on future production relative to current levels are less than the impacts compared to baseline levels. For example, while corn production is 22 percent less than baseline production levels for 2050, this lower level of production is 13 percent higher than baseline levels of production in 2015. Only for soybeans and sorghum are 2050 levels of production under cap-and-trade less than baseline levels of production in 2015.

Lower levels of production relative to baseline levels translate into higher real prices. As shown in *table 8,* by 2030, corn, rice, and wheat prices are 15, 5.5, and three percent higher compared to baseline prices. By 2050 corn, rice, wheat prices are 28, 8, and 13 percent higher, respectively, compared to baseline prices. In addition, soybean, cotton, sorghum, and barley prices are 21, 25, 40, and 57 percent higher compared to baseline prices. While baseline corn yield growth mitigates increases in corn, wheat, rice and oat prices over time, crop prices in real terms are higher in 2050 compared to current prices for sorghum, barley, cotton and soybeans.

Lower domestic crop production and higher prices could spur increases in agricultural production abroad as producers make up for reductions in U.S. crop exports relative to the baseline. These trade impacts could moderate the anticipated rise in crop prices over the baseline. At the same time, expansion of agricultural production abroad could lead to emissions leakage if forests and grasslands are cleared to produce crops. However, international offset programs, such as reducing deforestation, could limit this effect.

Implications for Livestock

Higher real commodity prices also affect livestock production and prices through higher production costs. Hog slaughter is estimated to fall by about seven percent in 2030 and fed beef slaughter is estimated to fall by about three percent compared to 2030 baseline production levels (*table 9*). As greater and greater amounts of cropland are afforested and crop prices rise, the impacts on livestock producers increase. By 2050, hog slaughter is 23 percent lower compared to baseline levels while fed beef slaughter is estimated to fall by almost ten percent compared to baseline levels. Milk production is estimated to fall by about 7 and 17 percent compared to baseline levels in 2030 and 2050, respectively. Chicken, turkey, and egg production appear to be relatively less impacted.

Lower livestock supplies will cause real prices to increase relative to baseline levels (*table 9*). Those livestock categories which showed the largest production impacts translate into the smallest price changes. For example, for 2030, the seven and three percent declines in hog and fed beef slaughter result in price increases of 12 and 4 percent, respectively; by 2050, the decline in hog and fed beef slaughter result in price increases of 27 and 14 percent, respectively. However, while egg, broiler, and turkey production are only two, seven, and eight percent lower than baseline production levels in 2050, respectively; egg, broiler, and turkey prices are 20, 16, and 15 percent higher, respectively. The prices for eggs, broilers, and turkeys are far more responsive to a change in production relative to the prices for beef and hogs. Similarly, milk prices are expected to increase by 33 percent in 2050 compared to the baseline in response to the 17 percent decline in production. The relatively larger price impacts for eggs, broilers, turkeys, and milk compared to beef and pork reflects the availability of alternatives in consumers food spending. Price increases for beef and pork are limited because consumers can switch to relatively lower priced alternatives such as chicken and turkey. However, there are few alternatives in the consumer food basket to chicken, turkey, and milk.

Price increases in livestock due to cap-and-trade could be mitigated in part if foreign producers increase their production of livestock beyond baseline levels in response to higher prices. Similar to the trade impacts associated with changes in crop production, increase in foreign livestock production could lead to increases in GHG emissions abroad if producers clear native ecosystems to expand pastureland. As with crop production, well designed international offset programs could limit this effect.

Implications for Farm Income/Producer Surplus

Higher real commodity prices coupled with lower production, changes in input costs and offset net revenues will have an impact on net farm income or producer surplus. FASOM modeling results provided by EPA show the annuity value of changes in producer surplus over the entire simulation period.[10] As was presented in my December 2 testimony, the annuity value of the change in producer surplus is expected to be almost $22 billion higher; an increase of 12 percent compared to baseline producer surplus (*table 9*). About 78 percent of this increase is due to higher commodity prices as a result of the afforestation of cropland. Only about 22 percent of the increase in producer surplus is due to GHG related payments. Almost 30 percent of the gains would occur in the Corn Belt followed by the South East region (16 percent of the gains), Great Plains region (13 percent), and South Central region (10 percent).

The producer surplus impacts exclude earnings from the sale of carbon from afforestation. USDA estimates the annuity value of the gross revenues associated with the sale of afforestation offsets would result in approximately $3 billion of additional farm revenue.[11] About 90 percent of that additional revenue would be generated in four regions of the country: the Corn Belt (40 percent), Lake States (25 percent), South Central (14 percent), and Northeast (11 percent). However, part of that increase in revenue will be offset by the continued costs associated with maintaining afforestation projects.

[10] FASOM estimates the impact on producer surplus, a measure of farm income. The annuity value is calculated over the period 2015–2075.

[11] The annuity value of afforestation offsets were not directly taken from model results but estimated based on the EPA allowance prices, the amount of offsets in each region, and a real discount rate of five percent.

Impacts on Consumer Food Prices

Higher commodity prices will also affect the prices consumers pay for food.[12] The predicted effect on the overall Food CPI is dependent upon the assumed relationship between the Food at Home (FAH) and Food Away from Home (FAFH) price indices. An upper and lower bound estimate is presented based on the following two possible assumptions: a lower bound estimate which assumes the FAFH index is not changed by higher costs and an upper bound estimate which assumes that FAFH effects are the same as the FAH effects. Combining the FAH and FAFH results to the overall CPI for Food implies that the changes in food costs due to higher commodity prices will increase the Food CPI by 0.1 to 0.2 percentage points above the expected inflation trend in 2015 and 1.2 to 2.1 percentage points in 2050. In comparison, the average annual food inflation rate has been 3.1 percent over the past 20 years. Adding the impact of higher energy costs could add an additional 0.4 to 0.8 percentage points to the Food CPI in 2015 and an additional 1.4 to 2.5 percentage point to the Food CPI by 2050. Thus, the total increase to the food CPI from both higher commodity and energy prices is expected to be 0.5 to 1.0 percentage points in 2015 and 2.6 to 4.6 percentage points in 2050.

Conclusions

The ability to generate and sell offsets provides an additional source of farm income which can more than compensate for any loss in income due to higher energy costs, in addition to increased revenues from higher commodity prices. The agricultural sector is estimated to supply 59 to 150 MMT CO_2eq. in offsets annually between 2015 and 2020 at a carbon price starting around $10 per ton and rising at five percent per year (assuming they are all additional reductions relative to the baseline). With the real (inflation adjusted) price of carbon allowances estimated at about $13 per ton CO_2eq in 2015 and $16 per ton CO_2eq in 2020, potential gross offset revenue to farmers is between $0.8 and $2.4 billion annually in the early years of the program. Between 2025 and 2035, agriculture is estimated to supply 167 to 342 MMT CO_2eq per year, generating $3.5 to $11.6 billion per year. In the longer-term, from 2040 to 2050, agriculture is estimated to supply over 400 MMT CO_2eq per year, which generates $18 to $30 billion per year in gross revenue at carbon allowance prices of $43 to $70 per ton CO_2eq.

Providing offsets through afforestation will also take land out of agricultural production. The impact of less land in agricultural production leads to higher overall returns to agricultural producers. The effect of higher prices outweighs the effect of less production and, on average, net returns to agricultural producers are about 12 percent higher, with an annuity value in excess of $20 billion.

Consumers will feel the effect of higher commodity prices through increases in the prices paid for food. The overall impact on the Food CPI is estimated to be an increase of about 0.1 to 0.2 percentage points above the expected historical trend in the Food CPI in 2015 and 1.2 to 2.1 percentage points above the expected historical trend in the Food CPI in 2050 with the years in between showing steady increases in the index.

Allowing domestic agriculture and forest offsets into a regulatory cap-and-trade system has a significant effect on the costs of allowance prices. By allowing agriculture and forestry to provide offsets to regulated entities, the cost associated with meeting GHG reduction goals can be greatly reduced and, if implemented correctly, provide the same environmental benefits.

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[12] FASOM does not estimate the impact of changes in primary and secondary commodity prices on the consumer prices index (CPI). To estimate the impacts on the CPI, USDA's Economic Research Service matched the FASOM results to analogous categories of Producer Price Index (PPI) food items. The analysis assumes that consumer spending patterns remain relative constant over time. To the degree to which there may be shifts in consumption patterns due changes in tastes and preferences, the effects may be overstated or understated.

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TABLES

Table 1: GHG Offset Potential for Selected Practices and CO_2 Prices From Recent Studies *

GHG Mitigation Practice	Study	Coverage	Potential GHG mitigation ($MMTCO_2e$/yr @ $ per ton CO_2)
	Tillage		
Conservation tillage (primarily no-till)	Lewandrowski *et al.* (2004)	U.S. agriculture sector	31 @ $13.62 101 @ $34.06
	EPA (2005)	U.S. agriculture and forestry sectors	In 2015: 194 @ $15.00 191 @ $30.00 In 2025: 204 @ $15.00 187 @ $30.00
	Antle *et al.* (2007)	Central U.S. cropland	No-till corn-soy-feed systems 14.6 @ $16.4 18.6 @ $27.3 No-till wheat systems 1.9 @ $16.4 2.2 @ $27.3
	Other Agricultural Management Practices		
All Agricultural CH_4 and N_2O	EPA (2005)	U.S. agriculture and forestry sectors	In 2015: 28 @ $15.00 48 @ $30.00 In 2025: 36 @ $15.00 76 @ $30.00
	EPA (2006)	Global Agriculture U.S. Cropland sources	In 2020 (Base = 200 MMT CO_2) 21% Reduction @ $15 26 % Reduction @ $30
		U.S. Livestock sources	In 2020 (Base = 171 MMT CO_2) 11.8% Reduction @ $15 19.8% Reduction @ $30

Table 1: GHG Offset Potential for Selected Practices and CO_2 Prices From Recent Studies *—Continued

GHG Mitigation Practice	Study	Coverage	Potential GHG mitigation ($MMTCO_2e$/yr @ $ per ton CO_2)
Reduced fossil fuel use	EPA (2005)	U.S. agriculture and forestry sectors	In 2015: 35 @ $15.00 46 @ $30.00 In 2025: 32 @ $15.00 49 @ $30.00
Biofuel Offsets (primarily biomass for power generation)	EPA (2005)	U.S. agriculture and forestry sectors	In 2015: 0 @ $15.00 16 @ $30.00 In 2025: 0 @ $15.00 21 @ $30.00
Cropland to permanent grass	Antle *et al.* (2001)	Northern U.S. Great Plains	8.7 @ $24.9 13.6 @ $49.2
Continuous cropping (reducing fallow)	Antle *et al.* (2001)	Northern U.S. Great Plains	44.9 @ $14.4 63.4 @ $28.7
	Antle *et al.* (2007)	Central U.S.	2.23 @ $16.35 2.85 @ $27.25
Afforestation			
Afforestation	Lewandrowski *et al.* (2004)	U.S. agriculture sector	265.7 @ $13.62 74.1 from cropland 191.6 from grassland 488.8 @ $34.06 147.2 from cropland 341.7 from grassland
	EPA (2005)	U.S. agriculture and forestry sectors	In 2015: 145 @ $15.00 557 @ $30.00 In 2025: 228 @ $15.00 806 @ $30.00
	Lubowski *et al.* (2006)	U.S. land base	734–917 @ $13 2,110–2,899 @ $27.2 (range shows with & without harvests)
Forest Management			
Forest management (*e.g.,* extend rotations, thin, and fertilize)	EPA (2005)	U.S. agriculture and forestry sectors	In 2015: 227 @ $15.00 271 @ $30.00 In 2025: 156 @ $15.00 250 @ $30.00

* Some values have been derived from numerical results or interpreted off of graphs in associated publications. Some studies report results in units of carbon. In this table, all GHG values have been converted to metric tons of CO_2.

Table 2. EPA Estimated Allowance Prices

Year	2015	2020	2025	2030	2035	2040	2045	2050
Allowance Price ($2005 per ton CO_2eq)								
	$12.64	$16.31	$20.78	$26.54	$33.92	$43.37	$55.27	$70.40

Source: USEPA. *EPA Analysis of the American Clean Energy and Security Act of 2009 H.R. 2454 in the 111th Congress.* June 23, 2009.

Table 3. Agricultural Offsets—by Source, Quantity, and Gross Offset Revenue

	2015	2020	2025	2030	2035	2040	2045	2050
Allowance Price ($2005 per ton CO_2eq)								
Afforestation	48	132	146	170	307	372	368	344
Animal Wastes CH_4	3	4	6	8	10	12	17	25
Other Ag CH_4 & N_2O	8	12	15	19	26	35	44	53

Table 3. Agricultural Offsets—by Source, Quantity, and Gross Offset Revenue—Continued

	2015	2020	2025	2030	2035	2040	2045	2050
Ag Soils	0	0	0	0	0	0	0	0
Total	**59**	**148**	**167**	**197**	**342**	**419**	**429**	**422**
Annual Gross Offset Revenue ($2004 billion)								
Afforestation	0.6	2.1	3.0	4.5	10.4	16.1	20.3	24.2
Animal Wastes CH_4	0.0	0.1	0.1	0.2	0.3	0.5	1.0	1.8
Other Ag CH_4 & N_2O	0.1	0.2	0.3	0.5	0.9	1.5	2.4	3.8
Ag Soils	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**0.8**	**2.4**	**3.5**	**5.2**	**11.6**	**18.1**	**23.7**	**29.7**

USDA analysis based on FASOM simulations provided by EPA.

Table 4. Annual Agricultural Offsets and Gross Offset Revenue by Region

Year	2015	2020	2025	2030	2035	2040	2045	2050
Agricultural Offsets (MMT CO_2eq per year)								
U.S. Total	59.0	148.4	167.5	197.4	342.4	419.0	429.0	422.0
Corn Belt	26.5	70.8	82.4	79.3	109.0	138.0	127.1	141.7
Great Plains	5.4	7.5	8.5	8.8	10.3	20.0	28.6	37.0
Lake States	16.8	36.4	48.5	47.7	70.4	96.0	92.0	108.9
Northeast	1.5	6.4	10.4	15.0	35.7	53.0	49.4	45.0
Rocky Mountains	4.9	6.2	9.6	10.0	13.5	19.6	24.2	39.2
Pacific Southwest	1.9	2.1	3.4	1.3	2.1	2.2	1.6	2.4
Pacific Northwest	0.7	0.8	0.7	0.7	1.0	1.3	1.2	3.0
South Central	0.1	15.9	0.9	24.4	86.0	68.7	69.9	15.4
Southeast	0.0	0.9	1.0	7.7	9.9	17.1	32.1	25.0
South West	1.3	1.4	2.0	2.5	4.3	3.1	3.0	4.4
Annual Gross Offset Revenue ($2004 billion)								
U.S. Total	$0.8	$2.4	$3.5	$5.2	$11.6	$18.1	$23.7	$29.7
Corn Belt	0.3	1.2	1.7	2.1	3.7	6.0	7.0	10.0
Great Plains	0.1	0.1	0.2	0.2	0.4	0.8	1.6	2.6
Lake States	0.2	0.6	1.0	1.3	2.4	4.1	5.1	7.7
Northeast	0.0	0.1	0.2	0.4	1.2	2.3	2.7	3.2
Rocky Mountains	0.1	0.1	0.2	0.3	0.5	0.9	1.3	2.8
Pacific Southwest	0.0	0.0	0.1	0.0	0.1	0.1	0.1	0.2
Pacific Northwest	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2
South Central	0.0	0.3	0.0	0.7	2.9	3.0	3.9	1.1
Southeast	0.0	0.0	0.0	0.2	0.3	0.7	1.8	1.8
South West	0.0	0.0	0.0	0.1	0.2	0.1	0.2	0.3

USDA analysis based on FASOM simulations provided by EPA.
Totals may not add due to rounding.

Table 5. National Changes in Land Use.

	2015	2020	2025	2030	2035	2040	2045	2050
Million Acres								
Forest	8.3	16.6	20.3	26.6	34.4	43.6	55.4	59.0
Cropland	0.1	−6.0	−10.2	−14.6	−21.0	−28.3	−32.5	−35.0
Pasture	−6.7	−8.5	−9.7	−12.0	−13.3	−15.3	−22.8	−24.0

USDA analysis based on FASOM simulations provided by EPA.

Table 6. Regional Changes in Acres.

	2015	2020	2025	2030	2035	2040	2045	2050
Forest (million acres)								
Corn Belt	2.9	4.9	6.9	9.7	13.5	16.3	20.1	22.5
Great Plains	—	—	—	—	—	—	—	—
Lake States	1.7	3.1	4.9	4.9	8.7	10.6	13.4	15.1
Northeast	−0.1	1.1	1.9	2.5	3.2	3.2	3.2	2.4
Rocky Mountains	2.3	3.4	4.0	4.7	5.5	6.2	7.0	7.7

Table 6. Regional Changes in Acres.—Continued

	2015	2020	2025	2030	2035	2040	2045	2050
Pacific Southwest	0.2	0.2	0.2	0.2	0.2	0.0	0.0	0.0
Pacific Northwest	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
South Central	1.2	3.3	2.1	2.0	2.8	6.0	10.4	10.0
Southeast	−0.1	0.4	0.2	0.3	0.4	1.2	1.2	1.1
South West	—	—	—	—	—	—	—	—
Cropland (million acres)								
Corn Belt	−2.3	−4.2	−6.3	−8.5	−12.2	−15.5	−18.1	−20.6
Great Plains	−0.2	−0.2	−0.2	−0.2	−0.2	−0.2	1.7	1.7
Lake States	−1.2	−2.2	−4.0	−5.2	−6.9	−8.7	−10.5	−12.1
Northeast	0.6	0.0	−0.7	−1.2	−1.5	−1.5	−1.5	−1.9
Rocky Mountains	−0.4	−1.0	−1.6	−2.3	−3.1	−3.8	−4.6	−5.3
Pacific Southwest	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pacific Northwest	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2
South Central	−0.2	−2.0	−2.1	−2.1	−2.1	−3.1	−7.0	−6.4
Southeast	0.6	0.3	1.4	1.7	1.7	1.1	1.2	1.2
South West	3.1	3.1	3.1	3.1	3.1	3.1	6.0	8.2
Pasture (million acres)								
Corn Belt	−0.5	−0.4	−0.4	−1.1	−1.0	−0.6	−1.8	−1.8
Great Plains	−1.9	−1.9	−1.9	−1.9	−1.9	−1.9	−3.8	−3.8
Lake States	0.0	−0.2	−0.2	−1.1	−1.1	−1.2	−2.2	−2.2
Northeast	−0.5	−1.1	−1.2	−1.2	−1.7	−1.7	−1.7	−0.5
Rocky Mountains	−1.2	−1.7	−1.7	−1.7	−1.7	−1.7	−1.7	−1.7
Pacific Southwest	−0.2	−0.2	−0.2	−0.2	−0.2	0.0	0.0	0.0
Pacific Northwest	−0.2	−0.2	−0.2	−0.2	−0.2	−0.2	−0.2	−0.2
South Central	0.7	0.4	0.4	0.2	−0.7	−3.0	−3.4	−3.6
Southeast	0.3	0.1	−1.1	−1.6	−1.7	−1.9	−2.0	−1.9
South West	−3.1	−3.1	−3.1	−3.1	−3.1	−3.1	−6.0	−8.2

USDA analysis based on FASOM simulations provided by EPA.

Note: FASOM does not allow afforestation in the Great Plains and Southwest regions and does not allow agriculture in the west side of the Pacific Northwest region.

Table 7. Crop Production Impacts

Crop (unit)	2015	2020	2025	2030	2035	2040	2045	2050
millions								
Cotton (bales)								
Baseline	16.1	18.0	18.6	18.6	19.6	19.9	20.6	20.8
Scenario	16.3	17.3	17.9	18.3	19.1	18.8	17.7	18.2
% Change	1.2	−3.9	−3.6	−1.5	−2.7	−5.3	−14.1	−12.5
Corn (bushels)								
Baseline	14,222	14,619	15,585	16,520	17,536	17,547	18,274	20,627
Scenario	14,022	14,212	14,735	15,326	15,852	16,003	15,794	16,109
% Change	−1.4	−2.8	−5.5	−7.2	−9.6	−8.8	−13.6	−21.9
Soybeans (bushels)								
Baseline	2,609	2,671	2,734	2,777	2,888	2,818	2,861	2,848
Scenario	2,518	2,539	2,534	2,527	2,481	2,319	2,126	2,028
% Change	−3.5	−5.0	−7.3	−9.0	−14.1	−17.7	−25.7	−28.8
Wheat (bushels)								
Baseline	2,433	2,509	2,601	2,660	2,795	3,108	3,212	3,412
Scenario	2,433	2,498	2,563	2,611	2,724	2,988	3,059	3,065
% Change	0.0	−0.4	−1.5	−1.8	−2.6	−3.8	−4.8	−10.2
Sorghum (bushels)								
Baseline	522	317	300	289	307	304	315	333
Scenario	588	325	304	297	303	262	262	251
% Change	12.7	2.6	1.3	2.8	−1.4	−13.7	−16.9	−24.5
Rice (cwt)								
Baseline	273	346	391	444	484	536	590	632
Scenario	237	306	334	359	397	419	440	474
% Change	−13.1	−11.4	−14.5	−19.2	−18.0	−21.7	−25.3	−25.1
Oats (bushels)								
Baseline	114	96	104	114	134	190	212	217
Scenario	127	102	100	108	110	140	154	149
% Change	11.4	6.0	−3.8	−5.1	−18.1	−26.1	−27.2	−31.5
Barley (bushels)								
Baseline	310	283	296	312	342	398	400	428
Scenario	324	285	293	309	314	358	375	363

Table 7. Crop Production Impacts—Continued

Crop (unit)	2015	2020	2025	2030	2035	2040	2045	2050
millions								
% Change	4.8	0.8	−1.1	−1.0	−8.4	−10.1	−6.2	−15.2

USDA analysis based on FASOM simulations provided by EPA.

Table 8. Crop Price Impacts

	2015	2020	2025	2030	2035	2040	2045	2050
$2004 per unit								
Cotton ($/bale)								
Baseline	273.45	241.60	241.60	258.62	249.79	263.67	267.94	278.53
Scenario	267.71	259.38	260.11	264.20	264.20	287.80	339.60	347.10
% Change	−2.1	7.4	7.7	2.1	5.8	9.2	26.8	24.6
Corn ($/bu)								
Baseline	4.03	4.03	3.63	3.26	2.97	2.72	2.61	2.50
Scenario	4.32	4.50	4.05	3.77	3.53	3.19	3.14	3.21
% Change	7.2	11.5	11.4	15.4	19.0	17.3	20.6	28.1
Soybeans ($/bu)								
Baseline	9.04	9.03	9.01	9.00	8.85	8.83	8.71	8.79
Scenario	9.04	9.03	9.02	9.06	9.07	9.06	9.81	10.63
% Change	0.0	0.0	0.1	0.7	2.5	2.6	12.7	20.9
Wheat ($/bu)								
Baseline	5.40	5.10	5.03	4.80	4.59	4.50	4.31	4.11
Scenario	5.35	4.85	4.95	4.94	4.76	4.94	4.78	4.66
% Change	−0.9	−4.9	−1.6	3.0	3.7	9.8	10.9	13.4
Sorghum ($/bu)								
Baseline	7.73	5.99	6.27	5.98	5.92	7.39	7.97	8.12
Scenario	7.77	5.96	6.01	6.17	6.02	8.13	9.68	11.35
% Change	0.5	−0.5	−4.2	3.2	1.6	10.0	21.4	39.8
Rice ($/cwt)								
Baseline	7.30	6.87	6.51	6.24	5.97	5.80	5.57	5.29
Scenario	7.42	6.97	6.77	6.58	6.29	6.14	5.89	5.72
% Change	1.6	1.5	4.0	5.5	5.3	5.9	5.8	8.1
Oats ($/bu)								
Baseline	1.35	1.96	1.41	1.01	0.47	1.15	0.47	0.72
Scenario	1.42	1.43	1.49	1.10	0.95	1.44	1.04	1.04
% Change	5.5	−27.1	5.9	8.9	100.5	25.3	120.0	45.1
Barley ($/bu)								
Baseline	2.92	3.24	3.32	3.53	3.76	3.36	4.78	5.50
Scenario	2.99	2.80	3.28	3.53	4.33	4.51	5.32	8.61
% Change	2.5	−13.6	−1.1	0.0	15.0	34.2	11.3	56.5

USDA analysis based on FASOM simulations provided by EPA.

Table 9. Livestock Production Impacts

	2015	2020	2025	2030	2035	2040	2045	2050
Million cwt except eggs (million dozen)								
Fed Beef								
Baseline	510	525	547	555	560	614	640	649
Scenario	508	507	523	536	546	576	591	587
% Change	−0.4	−3.5	−4.4	−3.4	−2.6	−6.1	−7.7	−9.6
Hogs								
Baseline	453	474	518	555	615	647	674	699
Scenario	427	437	481	500	525	547	557	541
% Change	−5.7	−7.9	−7.2	−9.9	−14.6	−15.3	−17.3	−22.7
Milk								
Baseline	2,017	2,153	2,243	2,420	2,547	2,654	2,773	2,911
Scenario	2,005	2,095	2,181	2,255	2,329	2,427	2,410	2,418
% Change	−0.6	−2.7	−2.8	−6.8	−8.6	−8.6	−13.1	−16.9
Eggs								
Baseline	7,506	7,749	8,000	8,259	8,615	8,803	9,088	9,480
Scenario	7,467	7,629	7,945	8,212	8,483	8,696	8,994	9,285
% Change	−0.5	−1.6	−0.7	−0.6	−1.5	−1.2	−1.0	−2.1
Broilers								
Baseline	471	484	514	540	568	596	618	643
Scenario	466	481	506	531	557	579	593	596
% Change	−1.0	−0.7	−1.6	−1.6	−1.8	−2.8	−4.1	−7.3
Turkeys								

Table 9. Livestock Production Impacts—Continued

	2015	2020	2025	2030	2035	2040	2045	2050
Million cwt except eggs (million dozen)								
Baseline	92	105	111	124	130	137	146	154
Scenario	92	102	109	114	122	133	136	142
% Change	0.1	−3.1	−2.1	−8.2	−6.3	−2.7	−6.9	−7.6

USDA analysis based on FASOM simulations provided by EPA.

Table 10. Livestock Price Impacts

	2015	2020	2025	2030	2035	2040	2045	2050
$2004 per unit								
Fed Beef ($/cwt)								
Baseline	57.60	58.57	57.91	60.24	62.07	58.12	58.10	60.17
Scenario	58.29	61.07	61.53	62.58	64.30	63.45	65.04	68.79
% Change	1.2	4.3	6.3	3.9	3.6	9.2	11.9	14.3
Hogs ($/cwt)								
Baseline	41.77	40.42	38.73	37.43	36.44	36.97	35.29	36.19
Scenario	43.60	44.08	42.38	41.96	41.64	41.29	43.13	45.94
% Change	4.4	9.0	9.4	12.1	14.3	14.8	22.2	26.9
Milk ($/cwt)								
Baseline	15.51	14.78	14.65	13.90	13.45	13.41	12.98	12.98
Scenario	15.72	15.49	15.44	15.51	15.68	15.58	16.21	17.27
% Change	1.4	4.8	5.4	11.5	16.6	16.2	24.9	33.1
Eggs ($/dz)								
Baseline	0.92	0.96	0.90	0.94	0.88	0.92	0.89	0.87
Scenario	0.96	1.02	1.01	0.97	0.97	1.03	1.03	1.05
% Change	4.2	6.3	12.1	2.6	10.8	12.5	15.3	19.9
Broilers ($/cwt)								
Baseline	49.01	49.23	47.63	46.56	45.16	44.56	44.65	44.06
Scenario	49.65	50.30	48.88	47.79	47.05	46.77	48.54	51.09
% Change	1.3	2.2	2.6	2.6	4.2	5.0	8.7	16.0
Turkeys ($/cwt)								
Baseline	46.03	39.21	38.96	33.40	32.56	31.00	31.00	28.96
Scenario	46.03	41.28	39.25	38.21	36.14	33.46	33.85	33.29
% Change	0.0	5.3	3.4	14.4	11.0	8.0	9.2	14.9

USDA analysis based on FASOM simulations provided by EPA.

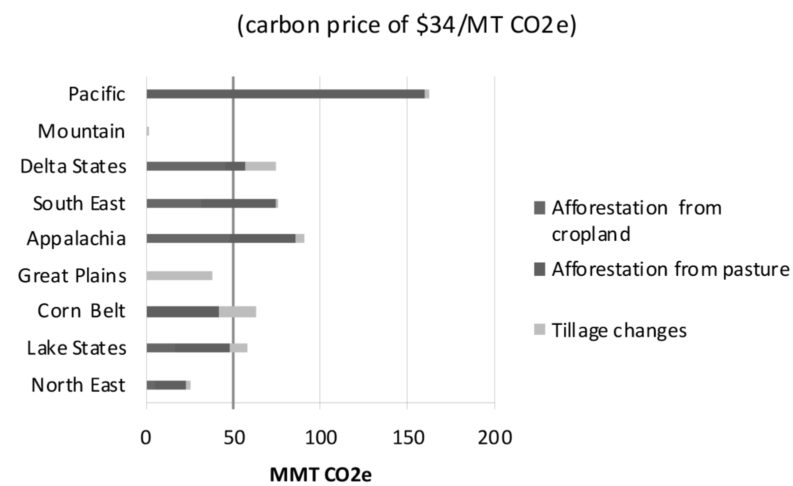
Table 11. Annuity Impacts on Producer Surplus/Farm Income, by Region.

	$2004 billion annualized annuity value	% of total
Corn Belt	6.4	29.3
Great Plains (no forestry)	2.9	13.3
Lake States	1.6	7.3
Northeast	0.4	1.8
Rocky Mountains	1.5	6.7
Pacific Southwest	0.7	3.3
Pacific Northwest	0.7	3.3
South Central	2.3	10.4
Southeast	3.4	15.6
South West (no forestry)	1.9	8.9
U.S. Total	22	100

USDA analysis based on FASOM simulations provided by EPA.

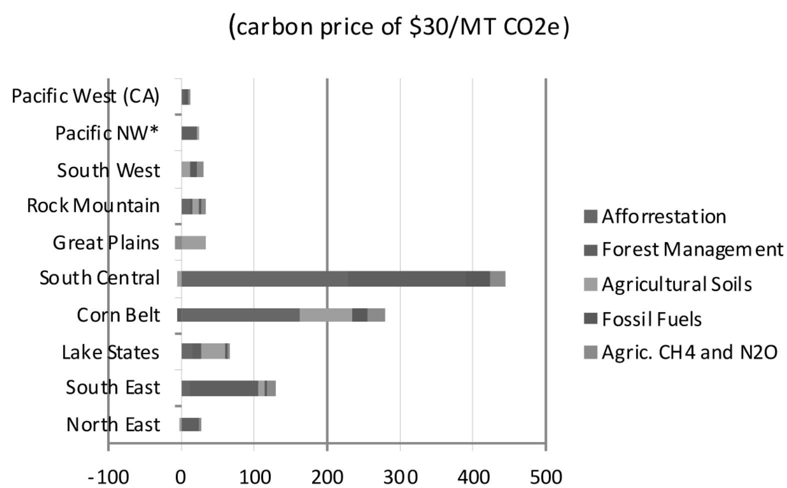
FIGURES

Figure 1a—Regional Potential



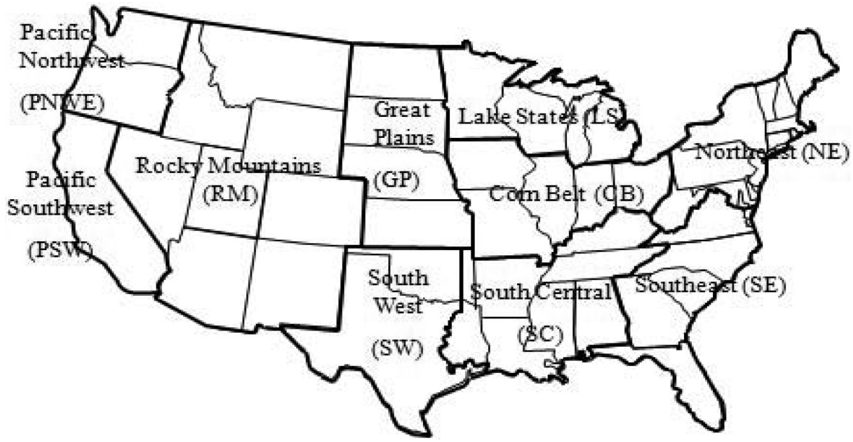
Source: USDA, ERS, 2004.

Figure 1b—Regional Potential



Source: EPA 2005.

Figure 2. FASOM Regional Map



The CHAIRMAN. Thank you, Dr. Glauber.
Dr. Kile.

STATEMENT OF JOSEPH KILE, PH.D., ASSISTANT DIRECTOR FOR MICROECONOMIC STUDIES, CONGRESSIONAL BUDGET OFFICE, WASHINGTON, D.C.

Dr. KILE. Chairman Holden, Congressman Goodlatte, Members of the Subcommittee, Chairman Peterson, I am pleased to be here today to discuss the role of agricultural offsets as part of a cap-and-trade program for reducing greenhouse gas emissions.

The buildup of greenhouse gases in the atmosphere poses risks for the United States from climate change. Reducing emissions of those gases would decrease that risk, but as you heard yesterday, it would also impose costs on the U.S. economy including the agricultural sector. H.R. 2454 would reduce emissions of greenhouse gases and it would also allow for the use of offsets to limit the costs of those reductions. Offsets replace reductions of greenhouse gases that are expensive to achieve with reductions that are less expensive, but from sources that are not subject to the cap. For example, a farmer might change land-use practices or capture methane emissions from animal wastes more cheaply than an electric utility could replace use of fossil fuels.

Under a wide range of scenarios, researchers have concluded that the use of offsets could reduce the cost of controlling greenhouse gas emissions. As a general rule, the more stringent a cap on greenhouse gases might be, the greater the opportunity to reduce the cost by including offsets. In practice, reducing the concentration of such gases in the atmosphere would depend on whether the activities that produce the offsets result in actual reductions in greenhouse gases, and ensuring that would entail addressing four challenges with offsets.

First, offsets would need to bring about additional reductions in greenhouse gases that otherwise would not have occurred. Second, the offsets would need to be quantifiable so that any reductions in greenhouse gases could be reliably measured. Third, offsets would need to be permanent rather than simply delaying the release of greenhouse gases into the atmosphere. And finally, offsets would need to be created in a way that accounted for leakage in the form of higher emissions elsewhere in the economy.

Those challenges can be daunting and may be more difficult to resolve in some areas than in others. For example, it might be relatively easy to establish criteria to address those challenges in the context of a system to capture methane from animal waste. In contrast, reducing the use of fertilizer to avoid emissions of nitrous oxide might simply reduce crop yields and thereby increase the price of those crops. In turn, the higher prices would encourage the production of those crops elsewhere and potentially undermine the environmental goal.

Using the projections from EPA on the likely sources of offsets, CBO's analysis of H.R. 2454 concluded that offsets would reduce the price of allowances and the net cost of limiting greenhouse gas emissions by about 70 percent. Over the course of the program, CBO expects the regulated entities would substitute offsets for about 45 percent of the total emission reductions that they otherwise would be required to make.

Let me illustrate with an example. A cap in 2030 would allow for about 3.4 billion tons of emissions from regulated entities. CBO expects that actual emissions from those entities would be about 5 billion tons during that year. The additional emissions would be offset by reductions of about 1.8 billion tons of emissions from other sources. The effect of those offsets would be to reduce the cost of meeting the cap in that year by about 60 percent. Most of the offsets would come from changes in agriculture and forestry. Of the offsets from those sectors, fewer than half would be produced domestically. Most of those would come from the forestry sector. Offsets from changes in agricultural practices are expected to account for only about ten percent of the offsets from those sectors. In addition, however, the remaining 90 percent would include planting trees on some crop and grazing land. Internationally, the source of offsets is likely to be more evenly split between those sectors than in the United States.

Finally, I want to close by noting the uncertainty around those estimates. Like any estimate of the supply of offsets and the effect of those offsets on containing costs, CBO's estimates should be interpreted cautiously. It is likely that the qualitative conclusions are correct, but the specific quantitative projections are subject to several sources of uncertainty. For example, the decisions that would be made by regulatory authorities such as EPA and the Department of Agriculture could be different than those anticipated in CBO's analysis. Similarly, the models used to project the supply of offsets are subject to uncertainty themselves, and it is difficult to anticipate how quickly the United States would enter into agreements for international offsets.

Thank you again for the invitation. I would be delighted to take any questions that you might have.

[The prepared statement of Dr. Kile follows:]

PREPARED STATEMENT OF JOSEPH KILE, PH.D., ASSISTANT DIRECTOR FOR MICROECONOMIC STUDIES, CONGRESSIONAL BUDGET OFFICE, WASHINGTON, D.C.

Chairman Holden, Congressman Goodlatte, and Members of the Subcommittee, thank you for the invitation to testify on the use of agricultural offsets as part of a cap-and-trade program for reducing greenhouse gases.

H.R. 2454, the American Clean Energy and Security Act of 2009, which was passed by the House of Representatives, would set an annual limit, or cap, on greenhouse-gas emissions for each year between 2012 and 2050 and would distribute "allowances," or rights to produce those emissions. After the allowances were distributed, regulated entities—those that generate electricity or refine petroleum products, for example—would be free to trade them, so entities that could reduce their emissions at lower costs would sell allowances to others facing higher costs.

The provisions of H.R. 2454 reflect the fact that a variety of other actions—including changing agricultural practices and reducing deforestation—can also reduce the concentration of greenhouse gases in the atmosphere. Those actions have the potential to "offset" the extent to which more costly actions, such as reducing the use of fossil fuels, would have to be undertaken to meet a chosen target for total greenhouse-gas emissions. Under the bill, regulated entities would be allowed to use offsets—meaning reductions in greenhouse gases from activities *not* subject to limits on emissions—*in lieu of* reducing their emissions or purchasing allowances. Yet the difficulty of verifying offsets raises concerns about whether the specified overall limit would actually be met. Such concerns may be especially acute when, as under H.R. 2454, allowable offsets include actions taken outside the United States.

My testimony makes the following key points:

- Researchers have concluded that a cap-and-trade program that allowed for offsets—such as those that might be generated by changes in agricultural practices and forestry—could reduce greenhouse gases more cheaply than a cap-and-trade program that did not include offsets, but instead relied entirely on reducing the consumption of fossil fuels.
- Because of concerns that the use of offsets could undermine the environmental goals of a cap-and-trade program, four challenges would have to be addressed if offsets are to play a meaningful role in reducing the concentration of greenhouse gases in the atmosphere. In particular, offsets would have to bring about reductions in greenhouse gases that (1) would not have otherwise occurred; (2) could be quantified; (3) were permanent rather than merely a delay in the release of greenhouse gases into the atmosphere; and (4) accounted for "leakage," that is, higher emissions elsewhere or in different sectors of the economy as a result of the activities producing the offsets.
- On the basis of data from the Environmental Protection Agency (EPA), the Congressional Budget Office (CBO) expects that, under the provisions of H.R. 2454, most offsets would be generated by changes in forestry and agricultural practices. Of the offsets from those sectors, fewer than half would be produced domestically in most years, and only about ten percent of the domestically produced offsets would be from changes in agricultural practices. The remaining offsets from those sectors would come from international sources and would be more evenly split between agriculture and forestry.
- CBO estimates that the savings generated by offsets under H.R. 2454 would be substantial—reducing the price of allowances and the net cost of the program to the economy by about 70 percent. By CBO's estimates, regulated entities would use offsets for about 45 percent of the total emission reductions that they would be required to make over the 2012–2050 period covered by the policy.
- Any assessment of the use of offsets is subject to many uncertainties, which are inherent in the models used, about such things as the types of activities that would be eligible to generate offsets and the amount supplied by those activities, the prospects for concluding agreements with other nations to allow the use of international offsets, and the cost of ensuring that activities generating offsets actually reduce greenhouse gases.

Potential Benefits of Offsets in Reducing the Cost of Meeting a Target for Emissions

Offsets used as a part of a cap-and-trade program for greenhouse-gas emissions have the potential to reduce the cost of meeting the cap by substituting cheaper reductions in greenhouse gases for more expensive ones. The effect of greenhouse gases on the climate does not depend on where and how those gases are produced, but rather on the concentration of those gases in the atmosphere. Consequently, the cheapest way to reduce greenhouse gases by a chosen amount is to create a system that encourages reductions wherever and however they are least costly to make.

In principle, a comprehensive cap could apply to all sources of greenhouse gases. In practice, however, policies currently in effect in parts of the United States and in other countries, as well as those being considered by the Congress, cap only emissions from significant sources of greenhouse gases that can be easily and reliably measured.

The electric power industry, for instance, which produces over ⅓ of all greenhouse gases in the United States, can use systems that continuously monitor emissions (such as methods currently required under the Acid Rain program) to accurately measure the release of carbon dioxide. In contrast, entities whose emissions are much less significant or more difficult to monitor systematically are generally excluded from existing and proposed caps. Nonetheless, some of those entities may be able to reduce greenhouse gases more cheaply than the electric power industry or other industries subject to a cap. Owners of livestock are one example. When livestock waste decomposes, methane (which is more damaging to the climate on a per-ton basis than carbon dioxide) is produced, but manure can be collected and processed with special bacteria in airtight holding tanks or covered lagoons that allow operators to trap and recover methane. If capturing methane was cheaper than reducing carbon dioxide emissions from other sources by an amount that would have an equivalent impact on the climate, then taking steps to capture methane would reduce the cost of meeting a specified cap on greenhouse gases. As another example, greenhouse gases might be reduced at relatively low cost in developing countries through practices that would preserve existing forests and encourage reforestation.

The potential for reducing costs in a cap-and-trade program through the use of offsets would depend on the stringency of the cap over time and on the scope and amount of allowed offsets. The more stringent the cap, the greater the opportunity to reduce costs by using offsets. The sooner that significant emission reductions were required under the cap, the more expensive compliance would be (because there would be less time to develop and adopt new lower-emission technologies)—and the greater the opportunity to reduce costs by using offsets. Similarly, that opportunity grows with increases in the types of allowable offsets, the number of potential providers, and the proportion of compliance for which offsets could be used.

There are many potential types of offsets. Within the United States, offsets can be generated by changing forest management practices and planting trees to increase carbon storage or changing livestock management and crop production, among other methods. For example, farmers can alter various crop management practices to reduce the amount of nitrous oxide produced and released by soils through decreasing the use of fertilizers or adopting practices involving little or no tilling. Outside of the United States, in developing countries, important potential sources of offsets include reducing deforestation and changing forest management practices, planting trees, and reducing methane and nitrous oxide emissions from livestock, cropland, and rice paddies.

To illustrate the potential savings from reducing greenhouse gases partly through using offsets rather than exclusively through reducing emissions from carbon-intensive fuels, one can compare the estimated cost of emission reductions for cap-and-trade proposals that would allow the use of offsets and proposals that would not. Different researchers, using a number of different modeling approaches, have analyzed a variety of proposals and developed a range of estimated costs (see *Figure 1*). The pattern of the estimates is clear: When offsets are allowed, the costs of achieving a given reduction in greenhouse gases are lower—substantially so for large reductions.

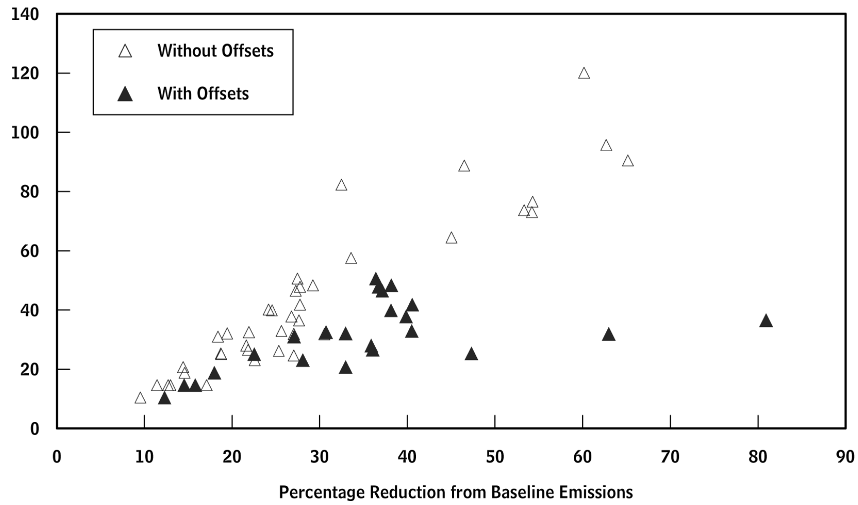
Potential Limitations of Offsets

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

Figure 1.

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

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



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

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

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

Offsets are used by a number of existing climate programs, which employ a variety of strategies, varying in rigor and cost, for verifying the reductions in greenhouse gases claimed by an entity offering an offset.[1]

The Clean Development Mechanism was created in December 1997 under the United Nations Framework Convention on Climate Change, to assist countries in meeting the goal for reducing emissions under the Kyoto Protocol. Industrialized countries can purchase offsets from developing countries and use them to meet a portion of their commitment to reduce greenhouse gases.

The Regional Greenhouse Gas Initiative in the United States, established in 2005, requires power plants that rely on fossil fuels and are located in ten Northeastern member states to reduce emissions. Members can purchase offsets generated in participating states and, under certain circumstances, elsewhere in the United States and internationally to meet a portion of their compliance obligation.

The Chicago Climate Exchange was established in 2003. Members have made voluntary, but legally binding, commitments to reduce their greenhouse gases. Members can use domestic and international offsets to help meet those commitments.

The Voluntary Carbon Standard was developed in 2007 to establish uniform and transparent standards for a worldwide voluntary market made up of a number of mechanisms through which buyers from the public and private spheres can achieve

[1] See Congressional Budget Office, *The Use of Offsets to Reduce Greenhouse Gases, Issue Brief* (*http://www.cbo.gov/doc.cfm?index=10497*) (August 3, 2009).

self-defined objectives by funding activities that reduce greenhouse gases. Projects that do so can have their offsets certified by adhering to the standards.

Verifying that offsets actually reduce greenhouse-gas emissions generally involves addressing four issues:

- Offsets would need to bring about *additional* reductions in greenhouse gases. That is, they would need to result in reductions that would not have occurred in the absence of the program that grants credit for offsets.
- Offsets would need to be *quantifiable* so that any reductions in greenhouse gases could be reliably measured.
- Offsets would need to be *permanent* rather than simply delay the release of greenhouse gases into the atmosphere.
- Offsets would need to be credited in a way that accounted for *leakage* in the form of higher emissions elsewhere or in different sectors of the economy as a result of the offset activity.

Identifying Additional Reductions Attributable to the Policy

Different climate programs use a variety to strategies to ensure that offsets credited in a cap-and-trade program satisfy "additionality"—that is, that they effect reductions in greenhouse gases that would not have occurred otherwise. Simple strategies for identifying reductions attributable to offset policies include accepting only activities that are not mandated by other laws, activities that reduce greenhouse gases after a specified date, and activities that are not common practice. Other possible strategies involve performance standards or the use of specific technologies. Still more complex assurances can be sought through demonstrations that the production of offsets—by planting trees, for example—would constrain an alternative use of resources that (apart from the value of the offsets) would be more profitable—such as using that land as pasture for livestock.

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

Quantifying Reductions

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

The Regional Greenhouse Gas Initiative, for instance, requires that offset providers use pre-approved, publicly available methodologies for calculating offsets, have quality control programs, and hire accredited third parties to validate the calculations. The initiative then follows those steps with a separate determination to award credit for offsets.

Ensuring That Reductions Are Permanent

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

Climate programs address concerns about permanence in various ways. Some programs require legal assurances that carbon will remain stored. Others assign expiration dates to offsets, and once those dates have passed, entities subject to the cap can no longer use those offsets to meet compliance obligations and must replace them.[2] Some programs hold in reserve a portion of the credits earned by each offset activity and use that pooled reserve to compensate for any reversals of carbon storage.[3] For example, the Voluntary Carbon Standard calls for holding in reserve between ten percent and 60 percent of the offsets produced by an agriculture or forestry project, depending on the project's risk of reversal. That risk is regularly reevaluated and the reserve amount adjusted as needed to account for changes in the project's financial, technical, and management situation; the economic risk of changing land values; the risk posed by regulatory and social instability; and the risk of natural disturbances.

Accounting for "Leakage," or Related Increases in Emissions

Leakage—increases in emissions elsewhere that stem from the activities producing offsets—diminishes the net effect of offsets in reducing greenhouse gases, but it can be hard to identify and quantify, which makes it extremely difficult to address. The smaller the scope of leakage—within the holdings of the offset provider, for example—the easier it is to account for, but when leakage occurs on a national or international level or in economic sectors other than the one generating the offset, accounting for it is a bigger challenge. For instance, offsets produced by capturing methane emissions from livestock waste may not result in increased emissions elsewhere; however, preserving trees in one location would reduce the supply of timber on the world market, thereby raising its price and encouraging increased production elsewhere, which would be difficult to prevent or measure.

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

The Effect of Offsets on the Cost of H.R. 2454

In analyzing the cap-and-trade program in H.R. 2454, the American Clean Energy and Security Act of 2009, which was passed by the House of Representatives, CBO estimates that the availability and use of offsets would reduce the net cost of complying with the cap by about 70 percent between 2012 and 2050. The net cost includes the gross cost of complying with the cap minus the sum of the allowance value that would be returned to U.S. households and the net revenues resulting from the domestic production of offsets.[4]

H.R. 2454 would allow regulated entities to substitute offsets *in lieu of* up to two billion greenhouse-gas allowances each year. By comparison, total greenhouse-gas emissions in the United States were about 7 billion tons in 2007. Under the bill, domestic offsets could be used in place of up to one billion allowances per year and international offsets, in place of an additional one billion allowances. In recognition of the greater challenge of verifying international offsets, after 2017 the legislation would require 1.25 tons of reductions from international offsets to substitute for an allowance representing 1 ton of emissions—thus discounting international offsets by 20 percent. If fewer than 900 million domestic offsets were used, the use of international offsets could be increased to make up the shortfall but could never substitute for more than 1.5 billion allowances in a given year. In no case could domestic and international offsets together substitute for more than two billion allowances.

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[2] In addition to providing for the use of standard offsets, H.R. 2454 also provides for the use of expiring offsets generated by agricultural practices that sequester greenhouse gases.

[3] H.R. 2454 lists that approach as one mechanism that regulators should consider using to address concerns about the permanence of reductions.

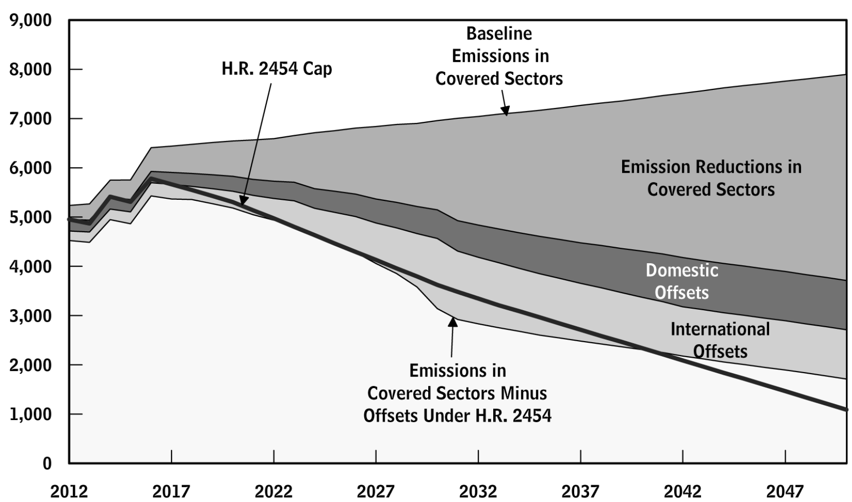
[4] The net cost represents the loss in purchasing power that households would experience as a result of the policy. See Congressional Budget Office, *The Economic Effects of Legislation to Reduce Greenhouse-Gas Emissions* (*http://www.cbo.gov/doc.cfm?index=10561*) (September 2009) for a discussion of how the loss in purchasing power resulting from H.R. 2454 would be distributed among households in different income brackets.

CBO expects that regulated entities would take advantage of those provisions when the costs were less than those for other methods of compliance—such as reducing their own emissions or purchasing allowances. CBO estimates that regulated entities would use domestic offsets in place of about 230 million allowances in 2012 and about 300 million allowances in 2020. Annual use of domestic offsets would probably not reach the limit of 1 billion tons until after 2040. Regulated entities would use international offsets in place of about 190 million allowances in 2012 and about 340 million allowances in 2020. The constraint of 2 billion metric tons on the overall use of offsets would become restrictive for the first time shortly after 2030. Over the 2012–2050 period, by CBO's estimates, offsets would account for about 45 percent of the total emission reductions resulting from the cap, including reductions made by regulated entities as well as those made through offsets. A little fewer than half of those offsets would be produced domestically (see *Figure 2*).

Figure 2.

Estimated U.S. Emissions Under H.R. 2454, the American Clean Energy and Security Act of 2009

(Millions of metric tons of CO_2e)



Source: Congressional Budget Office.

Notes: CO_2e = carbon dioxide equivalent.

The figure includes both cap-and-trade programs specified under H.R. 2454: the one for hydrofluorocarbons and the one for all other greenhouse gases.

By reducing the cost of complying with the cap, the use of offsets would have a significant effect on allowance prices. Together, the provisions allowing the use of domestic and international offsets would decrease the price of greenhouse-gas allowances by about 70 percent over the 2012–2050 period because they would provide a cheaper alternative for reducing greenhouse gases than relying exclusively on reductions from regulated entities.[5]

Domestic offsets would probably come predominantly from the forestry sector, where producers would find it profitable to make changes in forest management and increase the planting of trees to increase carbon storage. Only about ten percent of the offsets generated in the United States would come from agriculture. In the supply of international offsets, ones deriving from agriculture would probably be roughly equal in importance to ones from forestry. Those agricultural offsets would be

[5] Under H.R. 2454, regulated entities would be allowed to hold for later use as many allowances as they chose. Thus, their profit-maximizing behavior would cause the price of an allowance to increase at the same rate as the return they expected to receive on comparable alternative investments. As a result, even though the composition of reductions in greenhouse gases (that is, from regulated entities, from domestic offsets, and from international offsets) would change over time, the use of offsets would lower the price of allowances in any given year by the same amount.

generated primarily through the reduction of methane and nitrous oxide emissions from livestock, cropland, and rice paddies.

Estimating the Supply of Offsets

CBO's approach to estimating the supply of offsets incorporates three factors: the direct costs of an activity that produces an offset, such as the cost of planting trees; the forgone value of other uses of the land; and the costs associated with verifying and bringing offsets to the market.

CBO's analysis drew on data from the Environmental Protection Agency, which are the most comprehensive available.[6] The data incorporate direct costs and the forgone value of other uses of the land. EPA's estimates of the costs of offsets supplied by the agriculture and forestry sectors in the United States and by the forestry sector outside the United States were generated by models that simulate profit-maximizing decisions by landowners and acknowledge, to different degrees, the choices that they face among different land uses (including different strategies for generating offsets) and the market responses associated with those choices. For example, a landowner takes into account information on how the value of the current use of the land compares with that of, say, growing crops for biofuels or growing trees to store carbon if a climate program is in place. EPA's estimates of the number of offsets supplied by the agriculture sector outside the United States came from engineering studies that focus on direct costs—for which the quality of data varies by region and by practice—and are less effective at accounting for alternative uses of resources that may be more profitable to landowners.[7]

CBO adjusted EPA's data for the costs of verifying and bringing offsets to the market, in two ways. First, for both international and domestic offsets, CBO added an estimated verification cost of $5 per metric ton of carbon dioxide equivalent (CO_2e).[8] (By way of comparison, that $5 verification cost is less than ten percent of CBO's estimate of what the allowance price would be in 2012 *without* offsets.) CBO's estimate reflects information from the few available studies that use data from pilot projects involving offsets and projects in the agriculture, forestry, waste, and energy sectors, but there is no consensus on how to define, quantify, and predict such costs.[9] The studies define costs differently and may include expenses for feasibility studies, technical assistance, verification, administration, regulatory approval, and efforts to locate offset buyers and sellers and negotiate transactions.[10] Those costs, which vary by type of project and region, are lower in more mature markets—indicating a potential benefit in adopting verification procedures with which there is some familiarity gained through existing offset markets. Some researchers have found, however, that the apparent influence of a mature market on the costs is actually attributable to economies of scale and that projects generating greater numbers of offsets are simply the ones that have lower per-ton verification costs.

Second, CBO adjusted EPA's projected supplies of international offsets to account for the challenges of bringing offsets to the cap-and-trade market. Under H.R. 2454, developing countries generating international offsets for the market would have to be party to an agreement with the United States. CBO expects that such agreements would address developing countries' institutional and technical capacity to

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[6] See the data annex for EPA's analysis of H.R. 2454 in the 111th Congress, the American Clean Energy and Security Act of 2009, available at *www.epa.gov/climatechange/economics/economicanalyses.html.* The data sources are described in three publications: Environmental Protection Agency, *Greenhouse Gas Mitigation Potential in U.S. Forestry and Agriculture,* EPA 430–R–05–006 (November 2005); Environmental Protection Agency, *Global Mitigation of Non-CO_2 Greenhouse Gases,* EPA 430–R–06–005 (June 2006); and Brent Sohngen and Robert Mendelsohn, "A Sensitivity Analysis of Carbon Sequestration," in *Human-Induced Climate Change: An Interdisciplinary Assessment,* edited by Michael E. Schlesinger and others (Cambridge: Cambridge University Press, 2007).

[7] Estimates of the supply of offsets from outside the agriculture and forestry sectors, both within and outside of the United States, have also been derived from those engineering models.

[8] A metric ton of carbon dioxide equivalent is the amount of a given greenhouse gas, such as methane or nitrous oxide, that makes the same contribution to global warming as a metric ton of carbon dioxide.

[9] See Oscar Cacho and others, *Economic Potential of Land-Use Change and Forestry for Carbon Sequestration and Poverty Reduction,* Technical Report 68 (Australian Center for International Agricultural Research, 2008); Camille Antinori and Jayant Sathaye, *Assessing Transaction Costs of Project-Based Greenhouse Gas Emissions Trading* (Lawrence Berkeley National Laboratory, Environmental Energy Technologies Division, January 25, 2007); Neeff Till and others, *Update on Markets for Forestry Offsets* (Tropical Agricultural Research and Higher Education Center, September 2007); and Axel Michaelowa and Frank Jotzo, "Transaction Costs, Institutional Rigidities, and the Size of the Clean Development Mechanism," *Energy Policy,* vol. 33, no. 4 (March 2005), pp. 511–523.

[10] Verification costs estimated by the four studies range from $0.10 to $4.30 per metric ton of carbon dioxide equivalent.

verify offsets, that negotiating the agreements would take a significant amount of time, and that it would not be possible to reach agreements to produce carbon offsets from the energy sectors of developing countries. CBO concluded that the number of agreements and the scope of their coverage would increase over the 2012–2050 period covered by the legislation but that throughout the period the supply of offsets would be lower than that estimated by EPA.[11] CBO's assessment, which is subject to significant uncertainty, is based on indicators of regulatory bodies' capacity to verify offsets and on information from the Department of State, EPA, and outside experts on negotiating agreements.[12]

The Projected Use of Offsets

To illustrate the role of offsets under H.R. 2454, CBO has estimated their impact in 2030 after making adjustments for the costs of verifying and bringing offsets to the market and taking into account the fact that other developed countries would also wish to purchase international offsets (see *Table 1*). The legislation would establish a cap on greenhouse-gas emissions in 2030 of 3,427 million metric tons of CO_2e, so the government would distribute 3,427 million allowances in that year. Without offsets, 3,555 million metric tons of emissions would occur in 2030, CBO estimates, which would be equal to the number of allowances distributed that year plus 128 million allowances that entities would have banked in previous years and chose to use in 2030.

With offsets, as allowed for in the bill, sources with compliance obligations would emit 5,031 million metric tons and purchase offsets for 1,790 million metric tons—about ⅓ supplied domestically and about ⅔ supplied internationally, CBO estimates. About 60 percent of those domestic offsets would come from forestry and agriculture—the vast majority (roughly 90 percent) from forestry. About 80 percent of those international offsets would come from agriculture and forestry—the majority (roughly 60 percent) from agriculture.

If the offsets represented true incremental reductions, then net emissions would be 3,241 million metric tons (5,031 minus 1,790). The sources subject to the cap would use 3,241 million allowances to cover their net emissions and would bank 186 million allowances (3,427 distributed minus 3,241 used) to cover future emissions.

The Impact of Offsets on Net Costs and the Price of Allowances

The substantial use of offsets would significantly reduce the net cost of the cap-and-trade program that H.R. 2454 would establish. Without offsets, net costs would be an estimated $248 billion in 2030 (expressed in 2007 dollars), or about one percent of gross domestic product in that year. By CBO's estimate, the availability of offsets would reduce those costs by about 60 percent during that year—to an estimated $101 billion. On average during the overall period that the legislation would be in effect, offsets would reduce net costs by about 70 percent.

[11] CBO's adjustment also takes into account provisions for allocations of allowances to support emission reductions from reduced deforestation. Under H.R. 2454, entities receiving such support would be prohibited from generating offsets for direct sale into the U.S. market.

[12] CBO also modified EPA's projected supply of offsets to reflect the judgment that activities producing offsets could not be undertaken at negative cost—that is, there are no extensive opportunities for suppliers to adopt practices that would reduce greenhouse gases while also yielding a profit. In EPA's data, the projected availability of offsets at negative cost, which probably derives from not accounting for some barriers to adoption or from omitting some costs, is particularly significant for the practice of controlling methane and nitrous oxide emissions from livestock and cropland in developing countries.

Table 1.

Effects of H.R. 2454, the American Clean Energy Security Act, With and Without Offsets, 2030

	With Offsets	Without Offsets
	Billions of 2007 Dollars	
Net Cost [a]	101	248
	Million Metric Tons CO_{2e}	
Net Cap on Greenhouse Gases	3,427	3,427
Emissions from Sources Subject to Limits	5,031	3,555
Allowances Banked [b]	186	[c] −128
Emissions Covered by Offsets	1,790	0
	Dollars/Metric Ton CO_{2e}	
Allowance Price	40	138

Source: Congressional Budget Office.

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

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

[a] As measured here, the United States' net cost includes the gross cost of complying with the cap minus the sum of the allowance value that would be returned to U.S. households under H.R. 2454 and the net revenues resulting from the domestic production of offsets. The net cost also represents the loss in purchasing power that households would experience as a result of the policy. As measured here, the net cost does not include the costs that some current investors and workers in sectors of the economy that produce energy and energy-intensive goods and services would incur as the economy moved away from the use of fossil fuels or the full range of effects on the economy, nor does it include the benefits of the reduction in greenhouse gases and the associated slowing of climate change. For more information, see Congressional Budget Office, *The Economic Effects of Legislation to Reduce Greenhouse-Gas Emissions* (*http://www.cbo.gov/doc.cfm?index=10573*) (September 2009).

[b] Under H.R. 2454, allowances could be banked and used to cover future emissions. (Borrowing future allowances for current use could also occur for up to 5 years, with certain restrictions.)

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

With offsets, more emissions would be allowed from sources subject to the cap, thus making allowances less valuable. Without offsets, the price of an allowance in 2030 would be $138 per metric ton (in 2007 dollars), CBO estimates; with offsets, the allowance price would be only $40 per metric ton.

Finally, if international offsets were not available to regulated entities, the use of domestic offsets would expand. Entities subject to the cap would use an estimated 891 million domestic offsets in 2030 (more than the use of domestic offsets projected under H.R. 2454 but not as much as the use of international offsets under the legislation), and the allowance price and the net cost of the policy would be greater than that under the legislation. This alternative would benefit offset producers in the domestic agriculture and forestry sectors, but the program would be less effective at lowering net costs to the economy as a whole.

Sources of Uncertainty

The potential for offsets to reduce net costs depends critically on the types and sources of offsets allowed and on the costs of producing and verifying offsets. H.R. 2454 provides neither detailed specifications for the types and sources of offsets to be included in the cap-and-trade program nor the methodologies necessary to verify those offsets; it assigns primary responsibilities for those determinations to two Federal agencies. For domestic offsets from changes in agriculture and forestry, that responsibility would fall to the Department of Agriculture, which would take into account the recommendations of its Greenhouse Gas Emission Reduction and Sequestration Advisory Committee, established under the legislation. For all other offsets, that responsibility would fall to EPA. That agency would consult with appropriate Federal agencies; take into account the recommendations of the Offsets Integrity Advisory Board, also established by the legislation; and accept international offsets only if the country providing them had negotiated an agreement or arrangement with the United States.

CBO's estimates of the costs to produce offsets are based on data from EPA that take into account a wide range of types and sources of activities that could generate offsets. CBO adjusted those data to reflect its best judgment of how regulators might identify classes of offsets and how methodologies required for verification might affect costs. Actual developments might turn out quite differently.

There are uncertainties inherent in the modeling used to generate initial estimates of the supply of offsets—such as the extent to which they are able to account for competition among different land uses and other market responses.[13] Moreover, the data used in modeling are themselves uncertain. For example, recently revised estimates of past deforestation rates imply lower potential for generating offsets through avoided deforestation. Also, the types and sources of offsets that would ultimately be allowed under a cap-and-trade program in the United States could be different from those envisioned in EPA's data and CBO's estimates. Verification costs, too, are uncertain because of a lack of relevant experience. All of those factors have implications for the ultimate impact of offsets on the net cost of the policy to reduce the concentration of greenhouse gases that would be established by H.R. 2454.

The CHAIRMAN. Thank you, Dr. Kile.

Dr. Glauber, do you agree with Dr. Kile's assessment, only ten percent of offsets would likely come from agriculture practices, and in your opinion, what practices should be eligible for the offsets?

Dr. GLAUBER. Under the modeling results provided by EPA, under those of the 2 billion metric tons of offsets, about 400 million or so were provided by agriculture, so a slightly higher figure obviously than what CBO would estimate. But I would certainly agree with his opening statement of the amount of uncertainty in these estimates, and again, it depends on when you are looking at these. If you look at the path for offsets, and I would have to go back and look at the data here and, again, would be happy to get back to you on this, but if you look over time, early on as the carbon prices are lower, there is very little coming in on the agriculture side. A little bit of pastureland is being converted to forests. But as you move out and carbon prices get higher and higher, that is when you see a lot of the accumulation is in the out-years. So a lot depends on what time period we are talking about. When I say the 400 million, that is in the year 2050.

The CHAIRMAN. Also Dr. Glauber, Chairman Peterson's amendment that was contained in H.R. 2454 gave USDA control of implementing an offset program for agriculture and forestry. Has the Department looked at this language and thought about how to implement such a program, and do you think USDA has the staff and resources to implement such a program? And finally, in your personal opinion, do you think USDA could get a program up and running in 1 year?

Dr. GLAUBER. It certainly is a daunting task, to say the least. One of the big issues will be quantifying these various practices, and I think that is a key part of these offsets. We need to have

[13] One consideration is the potential for concentration of market power in the hands of a limited number of offset providers—if, for instance, a few parties control significant expanses of forests or if requirements for verification significantly limit entry into the offset market.

practices where there are standards established and they are verifiable, and that there is some certainty, at least in terms of the carbon that is being sequestered or the amount of greenhouse gas emissions that are being reduced, so that there is actually a market there and that the full prices are paid for these credits. What USDA has embarked upon, and we are doing a lot of work on this year, is trying to get a very large matrix that outlines agricultural practices with the specific carbon reduction or potential sequestration numbers by region and by practice to outline a whole menu of these sorts of things and develop standards. It is a big part of my own office's program that we are intending to do with the monies that were provided in this most recent budget.

The good thing about USDA, as you well know, is we have a very elaborate field office structure with a lot of NRCS and FSA employees on the ground and I think that is a potential benefit in establishing an offset program.

The CHAIRMAN. Do you think you have enough staff and resources to implement a program?

Dr. GLAUBER. I think that, frankly, I would need a little more time to evaluate the full needs on this. With the monies that have been provided our office, we are embarking on looking at this data. I can't say that all these practices would come online right away, but the important thing is that they are jump started with resources to be looking at this one way or the other.

The CHAIRMAN. Thank you.

Dr. Kile, are you aware of the chain of actions that are leading to the reality that EPA is likely going to be regulating greenhouse gases under existing Clean Air Act authorities? Are you aware of whether anyone is looking at the impacts of that, as opposed to a cap-and-trade system with allowances for offsets?

Dr. KILE. Well, I anticipate that someone is looking at that. That is not something that CBO has looked at. We were charged with estimating the budgetary impact of H.R. 2454 and that was our focus. I am aware that EPA is looking at other possible avenues, but that is not something we have examined carefully.

The CHAIRMAN. You haven't? Thank you.

The gentleman from Virginia.

Mr. GOODLATTE. Thank you, Mr. Chairman.

Gentlemen, welcome. Dr. Glauber, yesterday we talked in more general terms about what the prognosis was for agriculture under cap-and-trade legislation, and I appreciate very much your testimony. We received your testimony for today last night so we have only just recently been able to look at some of the more specific projections that you have given us, but quite frankly, they are stunning. The estimates are that we will have 130 million more people in the United States in 2050 than we have today. Yet, by 2050 you project that hog slaughter is going to be 23 percent lower compared to baseline levels, compared to what it would be if we did not have this legislation taking effect, and I hope it never does take effect. Beef slaughter is estimated to fall by almost ten percent compared to baseline levels, milk production to fall by 7 to 17 percent in 2030 and 2050, respectively. The price increases for beef and pork, you indicate, are limited because consumers can switch to relatively lower priced alternatives such as chicken and turkey.

That will be great news to my poultry farmers in the Shenandoah Valley, but I also have 7,000 small beef cattle operations and they are not going to be happy about that at all. Price increases in livestock due to cap-and-trade could be mitigated in part if foreign producers increase their production of livestock beyond baseline levels in response to higher prices. In other words, we will face greater availability of supply, but that supply will be coming from outside of the United States. And, of course that will be a downward pressure on the prices that farmers will receive for their livestock. So the net effect of this is to make the United States a net importer of agricultural products, and we may be headed that way anyway, but this is going to accelerate that process, and that greatly concerns me.

Dr. Glauber, how are we expected to feed the additional 130 million people in the United States in 2050?

Dr. GLAUBER. Well, thanks. Let me say at the outset that I think it is important to recognize what the model results represent. What we did in this analysis that we put in the testimony here, and again, I apologize for the lateness of this—some things are outside of my control—but what we tried to do is, we took the EPA results in their June 23rd analysis, both their carbon price projections but also their offset projections. What we asked them to provide us was all the output that had been provided that they were able to estimate those things using the FASOM model. We then took that output, approximated the same price path to find out what the agricultural implications were, and there again the big driver here is afforestation. As I said in my opening statement, there are some *caveats* and this is one scenario and one that again overlies the EPA estimates, but it is only one scenario. There are, as I pointed out, some underlying assumptions in this model that if relaxed would mitigate these price impacts. I agree, if you take out 30 million acres of cropland or 35 million acres of cropland, you will have price increases and——

Mr. GOODLATTE. Let me follow up on that point, because—do we know what percentage of crop acres are rented? I am concerned that if a large quantity of cropland would be converted to trees that this decision will be made by landowners, not by farmers, and this would also mean that farmers might not see the benefits of the offset revenue.

Dr. GLAUBER. Congressman, you have raised an interesting point, and we do have, of course, several programs that we operate currently under the farm bill, things like the Conservation Reserve Program that do treat tenants and landlords in certain ways. There are potential ways in establishing these programs where benefits could be shared in one way.

Mr. GOODLATTE. I am also very concerned about what impact converting 60 million acres of land into tree production does for both the crop markets of various kinds, and what it does in forestry as well. I mean, we have right now 191 million acres of national forestland in this country that have been nearly fenced off from any use of those products. Obviously the trend away from carbon-based fuels means that these 60 million new acres of trees available on the market are not going to be very attractive for use in energy production. This is certainly something that I think we ought to be looking at, and ought to be turning to with our existing forestry base, but this legislation is going to make the value of that considerably diminished. Sequestering the carbon will be viewed positively, but what you do with the product once these trees are grown is very much open to a great deal of speculation. There is a whole lot more that we don't know about what this legislation will do than we do know about it. I appreciate both of your efforts to project that, but the fact of the matter is that the law of unintended consequences is going to hit us very, very hard with regard to this legislation, I fear.

Thank you, Mr. Chairman.

The CHAIRMAN. The chair thanks the gentleman and recognizes the Chairman of the full Committee, Mr. Peterson.

Mr. PETERSON. Thank you, Mr. Chairman. I thank you and Ranking Member for your leadership.

Dr. Glauber and Dr. Kile, your analysis is off of the EPA baseline, I assume, because I understand that's really the only baseline that is out there. Is that correct?

Dr. KILE. Yes.

Dr. GLAUBER. That is true for us as well.

Mr. PETERSON. And I am hearing from a lot of—one of the things we are trying to do is to get to the bottom of what, potentially, this legislation would do, and we have a panel of folks from the university coming next. But, as I understand it, everybody is working off of that EPA baseline, whoever they are that are looking at this, and I am being told by people that they don't think that this baseline is right or realistic. So my question is, I guess to you guys and the second panel, Mr. Chairman, I may not be here but the panel that follows, is there anybody out there doing another baseline that would take another shot at trying to have some other place to start to look at this? Is that effort going on anyplace that you are aware of?

Dr. GLAUBER. Mr. Chairman, the answer is yes. I would say part of the problem, and a lot of us are facing this, is that USDA, for example, we have had years of looking at—we do a 10 year baseline. We look out 10 years. We do projections. We use that for forecasting purposes. We use it for budgeting purposes. Any time there is a new bill before Congress, we will look at it in the context of a 10 year baseline. We just—most of the time we don't have to look out 30, 40 years and it is a dangerous thing to do that just because of the great uncertainties there. With something like climate change legislation where you have changes occurring now 20, 30, 40 years out, obviously people have questions about, "What does that mean," so we are all struggling to do that. We have modeling efforts going on right now where we are trying to extend out baselines. We are bringing in forestry models. We have done this in the past, but only for models that will look at any given year. Luckily there is a model, and most of us have drawn on results that have been done at Texas A&M, and you will have an opportunity in the next panel to quiz Dr. McCarl on some of the aspects of it. I would just say there are other efforts—Dr. Hayes from Iowa State—they have been developing a model. There are other models at Purdue, for example. But to get the sort of information that people legitimately want to find out requires a very detailed, well-structured model. The first we have been dealing with this has been in sort of the greenhouse gas indirect land use issues coming out of renewable fuels because all of us were caught off guard by the analysis that was put forward. We have been trying to—my office, now we are supporting research at Iowa State, supporting research at University of Missouri to get a better idea of some of those issues.

Mr. PETERSON. When is that all going to happen or when are you going to have——

Dr. GLAUBER. Well, I hope to have—certainly with both of those contracts, we are hoping for results later in the year. Now, to have a fully well-structured forestry model, I think that is going to take, frankly, a little longer. It is just unfortunate but models are—again, you will have an opportunity to ask some of the gentlemen behind me, they build models over a very long period of time, but we are trying to catch up and I wish today I had my own set of model results to——

Mr. PETERSON. Well, tell me, you said next year, sometime next year?

Dr. GLAUBER. Well, certainly with the research that I have going on with University of Missouri, we will be able to address some of the issues that are being raised in terms of land use, which I think is an important consideration.

Mr. PETERSON. Can you give me a date?

Dr. GLAUBER. Let me consult with my—since it is in the hands of someone who is not here right now, and I am talking about my university collaborator. We can find out and get back with you on that.

Mr. PETERSON. Yes, I would like to know. And you said on the forestry it is going to take a long time?

Dr. GLAUBER. Well, we have—again, I will have to check. The Economic Research Service has some cooperative work going on, trying to build a forestry model, and they have hired an expert on forestry that should be a big benefit to them. I will be happy to get back with you and the Committee on this.

Mr. PETERSON. Are you studying the Indonesian forests and the Brazilian forests in this process, or not?

Dr. GLAUBER. I will have to check with the cooperators. I know, certainly, on the land use issues we have been very much interested in Brazil and looking at Brazilian land use.

Mr. PETERSON. It sounds to me like Indonesia is a bigger problem.

Dr. GLAUBER. Well, it certainly is a large——

Mr. PETERSON. I mean, they deforested that to grow palm oil plants and then it all caught on fire, and I was reading some article where they put four times the amount of carbon that we do into the atmosphere in 1 year because they cut down that forest. It was peat underneath and it caught on fire, and I don't know, apparently they have it somewhat under control, but I don't think agriculture had anything to do with that here in the United States, you know.

Anyway, somebody needs to get some alternative analysis because we have a lot of folks that really question the methodology of EPA, question whether EPA understands what we are doing here in agriculture and we would be more comfortable if we had some other baseline. Thank you, Mr. Chairman.

The CHAIRMAN. The chair recognizes Mr. Luetkemeyer, the gentleman from Missouri.

Mr. LUETKEMEYER. Thank you, Mr. Chairman.

As we discuss the forestry issue here, what is the percentage of forestry involved in the total amount of credits, Dr. Glauber?

Dr. GLAUBER. I am sorry. Could you repeat the question?

Mr. LUETKEMEYER. What is the total amount? Can you give me a fraction or the percentage of afforestation that is involved in the total amounts of credits that you are looking at when you come up with your models?

Dr. GLAUBER. Afforestation is a very, very large part of it. Of the 30+—excuse me. Of the 422+ million metric tons, I would say about 75 percent or so of that is coming from afforestation in this model.

Mr. LUETKEMEYER. Was that about right, Dr. Kile, whenever you do your analysis? Is that, roughly, the figure that you use as well?

Dr. KILE. Yes. What we found was that both domestically and overseas, afforestation accounts for a large portion of the offset credits that would be earned under H.R. 2454.

Mr. LUETKEMEYER. Is there a restriction, are there rules or qualifications on a farmer whenever he uses his land and does plant trees? Are there restrictions on how he can use the land, how he can use the trees? I mean, can he grow them, cut them down eventually? Does he have to plant a certain number of them? Can he use it to hunt on? Can he cut the hay underneath the tree limbs? I mean, are there restrictions on usage of the land that he plants trees on?

Dr. KILE. My understanding of that is that those would ultimately be rules that would be set in place by USDA and others.

Mr. LUETKEMEYER. Okay. Dr. Glauber, do you have any idea what——

Dr. GLAUBER. You are raising good questions about implementation. I think the key part of any of this is the permanence in terms of storing the carbon. That is, if you cut down the trees, you emit carbon, and that is fine, you can emit carbon, but understanding that in doing so that has to be taken into account somewhere, and that will show up as an emission.

Mr. LUETKEMEYER. Well, if you cut one down, you plant a new one. I mean, my question is obviously what kind of restrictions are there going to be placed on the farmer if he goes along with this program and he plants trees to comply to get his credits? Can he use the land for other purposes? And if the tree grows up at a certain point, it is a nice log. If he cuts it down, does he have to replace it with one, two or three? How do you administer that? Are there rules in place at all? I mean——

Dr. GLAUBER. Well, there are no rules in place right now. We would be developing those rules, certainly. I would have to—I am probably best getting back with you with a little more detailed answer on this, but just my off-the-cuff remark would be, for most activities in the forest like hunting and everything, that would be perfectly fine. I think the real issue is cutting down the tree, and because the assumption of a payment, unless you are going to pay on a rental basis—in a rental basis, you could do that. You could pay annually. How much carbon did you sequester this year, and then if you cut down the tree, that is okay, you pay for the rental. But understand a rental payment would be far less than what we are talking about in terms of planting the tree and committing to leaving it as an acre of trees for 60 years or whatever.

Mr. LUETKEMEYER. Okay. As you were developing these models, did you look at what Europe did? I mean, they have this program in place already. Is that not correct?

Dr. GLAUBER. They do have a cap-and-trade system in place.

Mr. LUETKEMEYER. Did you look at their model of how they were administering the afforestation portion of this? Did you come up with your models by using what has happened there to model your stuff?

Dr. GLAUBER. Again, I just want to—in the sense that we—we took our modeling results—these were all outputs that were provided to us from EPA. This is what I was just going through with Chairman Peterson. So in that sense we are using the modeling results that were provided to us, but we certainly are looking at the European system to see how that system has functioned. This would be in one sense because of the amount of emission caps and everything under this bill, I think we are talking about larger reductions with higher carbon prices than what has been seen under the European system.

Mr. LUETKEMEYER. Dr. Kile, before my time runs out, what about your analysis? Were you looking to compare with the European model at all and how things are working over there, how they implemented it, how they managed it, the ramifications? Did you use them as a model at all?

Dr. KILE. Right. So we are certainly—we have been looking at what has been going on in the ETS, the European Trading System, with their Clean Development Mechanism where they do recognize forestry offsets.

Mr. LUETKEMEYER. Do they have a plan like this in place over there?

Dr. KILE. Sorry?

Mr. LUETKEMEYER. Do they have a plan like this, afforestation plan to capture credits, trade credits? Do they have something like this in Europe?

Dr. KILE. They do have a plan that captures forestry credits under their Clean Development Mechanism. I don't know how much that lowers the allowance price in the EU, but as Dr. Glauber noted, I think that the prices that we have seen recently in Europe are below what would be anticipated under H.R. 2454.

Mr. LUETKEMEYER. Okay. Thank you.

Thank you, Mr. Chairman.

The CHAIRMAN. I thank the gentleman and recognize the gentleman from Minnesota, Mr. Walz.

Mr. WALZ. I thank the Chairman, and I thank you both again for testifying. I am very appreciative of you helping us get a handle on this.

I do want to say, Chairman Peterson, the Chairman of the full Committee, brought up a very good point about multiple baselines on this is critically important. I am glad that got brought up. I am looking forward to the next panel, talking a little bit about it because I have been using a recent one from the University of Tennessee that takes USDA's baseline out to 2030, takes EPA's baseline out, takes multiple baselines including RFS standards and those types of things and also includes a baseline of doing nothing. I come back to the issue again, and I thank the Ranking Member. He is an incredible asset for me because he challenges me to look at issues in different ways and he asked yesterday, he said, "I think you are setting up a false dichotomy of, we implement this or we go with EPA." I agree with him on that point, that the possibility is that the EPA doesn't enforce this and we stay the same. I think it is important to draw that baseline of what happens if we don't do anything because quite honestly, coastal areas, your input cost would go up relatively significantly if some of the projections on climate change forces you to pump out the ocean to grow anything on that, so those things are really critical.

So my question to you is, this afforestation issue, is it correct that the afforestation issue really only kicks in in terms of offsetting production land once those carbon prices start at around $80 per metric ton, and at $160 per metric ton which is quite a ways out before you ever see that. Is there any guarantee as you two see it that it will ever reach those numbers? Now, this is the assumption, again, I brought up yesterday is that we are making the assumption that no changes are being made on energy production whether it be nuclear or other types of energy production to offset these costs. Has that been looked at, that we may never reach $160 if you never reach $160 per metric ton in the modeling I am seeing—and it seems like that seems very consistent from what I am hearing—you will never see the afforestation issue to the extent that it will offset agricultural land. Would either of you like to——

Dr. KILE. Over time CBO's expectation is that prices would start around $15 a ton under H.R. 2454 and they would rise over the course of the bill at about 5.8 percent per year under our expectation, and over time that would encourage more and more people to look for offset opportunities. Some of those would obviously—many of them obviously would come in the forestry area and people would go to the least expensive options of those first. By 2030, we had about 600 million domestic tons of offsets from forestry and agricultural sources primarily. Most of those were from forestry practices.

Mr. WALZ. In your modeling, does it account for changes in energy production and energy usage if we are becoming less energy intensive, we are seeing a reduction in the energy-intensive measure in this country as actually dropping? Does that play into that?

Dr. KILE. Right. So CBO's analysis, CBO's modeling draws primarily from EPA and the Energy Information Administration, EIA, and those include the kinds of shifts in energy sources over time.

Mr. WALZ. My other question I guess on this is, and maybe this is for the next panel. Dr. Glauber, you might be able to help me with this one, and I am trying to get a handle on it. I think this modeling question is very good. I think it is a very valid question. The conclusions that came out of this University of Tennessee study using the POLYSYS model, and I guess maybe the folks from A&M can help me with that, was it absolute, and are all the questions that are being asked, the Ranking Member's questions are absolutely correct on the impact and the negative impact it could have. The real question here is, the variables are how you design this. A well-designed, well-constructed, multi-offset model really makes a huge difference. Would you agree with that, Dr. Glauber?

Dr. GLAUBER. Absolutely, and I think you are absolutely correct, and as you pointed out, under the University of Tennessee model, they see most of the carbon credits coming from pastureland going into biofuel production and other sorts of things, which is a very different path than planting trees obviously. The price effects that we see under the model that we have been reporting based on the results out of the EPA that afforestation is the big source of offsets. Under the Tennessee one, it is more in biofuels.

Mr. WALZ. And maybe I will ask the next group, because I am concerned about this, and I will just leave this as a rhetorical for you. What I do want to do is, I don't want to be cherry-picking data to support my ideology but I do want to add it to the discussion to make sure that these things are addressed. So I thank you both for the work you are doing. I yield back.

The CHAIRMAN. The chair thanks the gentleman and recognizes the gentleman from Louisiana, Mr. Cassidy.

Mr. CASSIDY. For either one of you, is there any estimate of how many of these credits will be purchased internationally *versus* domestically?

Dr. KILE. In CBO's analysis, our split varies over time between roughly 30 and 50 percent of offset allowances, and the example that I have——

Mr. CASSIDY. Thirty to 50 percent will be international or——

Dr. KILE. Will be domestic.

Mr. CASSIDY. I am sorry?

Dr. KILE. Will be domestic, so 50 to 70 percent would come from international sources.

Mr. CASSIDY. Next, I have also gathered from this testimony there will be a net increase in the amount of food that we are going to import. I gather that is implied because we are going to have decreased acreage, we are going to have decreased amounts, we are going to have increased costs and we are going to have an expanded population. Is that a fair statement?

Dr. GLAUBER. Frankly, imports don't increase under this, but I tell you what does decrease is exports. So any sort of exportable surplus falls considerably reflecting that, and that is the flip side of it.

Mr. CASSIDY. And my next question, we have a lot of money going out, has there been any estimate in the net decrease in U.S. wealth that will be created by this? Because we are buying 50 to 70 percent of our credits overseas, we are exporting less and perhaps importing more, particularly in the case of rice, for example. We are going to be sending all kinds of—this is going to be like OPEC when it comes to credits and food. Has there been any estimate of our net decrease in U.S. wealth because of these policies?

Dr. KILE. That is not something we have looked at directly, but it is important to remember that offsets are designed as a cost control mechanism in a climate bill. It is the cost of the climate action *versus* the benefits that one might get from that action; and then to look at what is the way of, what is the method of minimizing the cost of whatever policy is taken, offsets are driven by that rather than other factors.

Mr. CASSIDY. But it does seem intuitively that if we are spending a lot of money overseas to buy credits, we are exporting less, and we have decreased acreage under production, that there is going to be a net decrease in U.S. wealth.

Dr. KILE. The policy itself would impose costs on the United States, that is correct, and——

Mr. CASSIDY. Now, do we have any estimate of how many jobs will be lost in the agricultural sector because of this? In the case of rice, page 24 of your testimony, Dr. Glauber, by 2050 there will be a 25 percent decrease in the amount of production and also some corresponding decrease in acreage. How many jobs are going to be lost from this? Any estimates of that?

Dr. GLAUBER. I do not have any job estimates.

Mr. CASSIDY. Intuitively, we know there will be some, correct?

Dr. GLAUBER. It depends on how the activity flows. There is more money in the sector itself and so how that money is spent, *et cetera*. You know, with an income increase you get jobs as well but trying to sort out what shifts in acreage, shifts in production would entail, we have not done that.

Mr. CASSIDY. I will tell you also I am concerned because there seems to be an aggregation of the benefits of offsets *versus* an aggregation of the cost of compliance. If you just look particularly at Louisiana—which I represent and which this bill frankly seems to have a huge bulls eye on my state—on page 23 from your testimony yesterday, Dr. Glauber, it looks like rice has the most increased input cost because it is the most energy intensive, if you will, most carbon intensive. Yet, on page 24 of your testimony today, you speak about there is going to be a 25 percent decrease in rice production. Now, it seems that most of the benefit of the offset goes to the corn-growing states and relatively little goes to the rice-producing states. It just seems like we just got an incredibly tilted table against the rice farmers and those folks in the Mississippi Delta region.

Dr. GLAUBER. The only thing I would caution with drawing too many conclusions from that is the fact that, again, back to the model itself that was used, it is a very elaborate model that includes a lot of various greenhouse gas reduction practices. There are others, and there is certainly a number that could potentially affect rice cultivation, practices like mid-season drainage, shallow flooding; nitrogen inhibitors; upland cultivation; and improved irrigation, water management. There is a lot of research out there that suggests there are greenhouse gas emission reductions connected with these practices and again, what behooves whoever implements this program is to be able to quantify this in a way that allows producers to take advantage of these technologies to gain greenhouse gas offsets.

Mr. CASSIDY. My last comment, just because I am out of time and I know we are sensitive to that, presumably that has been included in these complex models to at least some extent. It appears that if you are in a rice-growing state, the Mississippi Delta region, for example, it is just a bulls eye for economic development. I yield back.

The CHAIRMAN. I thank the gentleman and recognize the gentlewoman from South Dakota.

Ms. HERSETH SANDLIN. Thank you, Mr. Chairman. I thank our witnesses for their testimony today.

I represent the State of South Dakota and there remains a lot of uncertainty and skepticism as to how an offsets program would work for our farmers and ranchers, and whether those already participating in the voluntary offsets market would be able to benefit under a new offsets program established in cap-and-trade legislation. As we heard from some of the questions today and yesterday, how such a program would, perhaps, be expected to increase energy inputs and how an offsets program would offset some of those input costs.

Dr. Glauber, yesterday in your testimony you said that an offsets program done the right way would reduce any projected increases in production costs for agriculture. Is the offsets program setup that was established in the Peterson amendment to the House bill the best way of creating an offsets program and how might it be strengthened, if at all?

Dr. GLAUBER. Well, of course, H.R. 2454 as amended has a lot of very detailed provisions on offsets. We have been going through those. I think one of the key ones of course is for any practice that could be potentially reversed, that there would be an ability to give credits back to 2001 for those producers which brings in a whole lot of carbon that otherwise would not be accounted for in the system, and it, again, benefits the producers. And so it doesn't penalize early adopters or other sorts of things. Again, from USDA's standpoint, we stand by ready to implement any bill or do whatever Congress requires us to do. I do think there is a lot, as I mentioned earlier, a lot of—USDA does have a lot of resources to put on this issue, again because of the extensive field staff, the fact that we already manage a lot of contracts through CRP and other sorts of things. So again, I think there is a lot of potential there.

Ms. HERSETH SANDLIN. Is there anything, though, that USDA can offer more proactively to strengthen an offsets program? In a conversation I had a few months ago with former Secretary of Agriculture Ann Veneman, she indicated to me that for a number of years USDA was doing important research as it relates to climate and opportunities for American agriculture. And so how might we strengthen the offsets program knowing of this Committee's desire that if this type of system were even established, that any offsets program would be administered by USDA, particularly because of that expertise and field presence that we have across the country?

Dr. GLAUBER. Well, two key things. One is the extensive amount of research that is ongoing right now. You have alluded to it, and former Secretary Veneman, I am sure, spoke of it as well because this has been a lot of effort that has been ongoing for many years. We are trying to come up with very well-quantified estimates of sequestration values and greenhouse gas emissions, because these are key. The other thing, as I mentioned earlier, in answer to a question from the Chairman, that we are looking at—one of the things my own office is planning on doing this year is coming up with a very large document for various regions, various practices, trying to standardize these measures. And so we are taking this very seriously, and again, without knowing what the fate of climate legislation will be, the point is when it is enacted we will have to hit the ground running so we are trying to prepare for that.

Ms. HERSETH SANDLIN. Well, in light of that, in light of the uncertainty related to climate change legislation, whether it would be established and when, it is clearly an objective and priority of the Administration as they head to Copenhagen and some other things that they have been looking at in terms of administrative options. Has USDA considered the option of creating supplemental incentives for carbon reduction at USDA separate from an offsets program?

Dr. GLAUBER. There has been—I guess the short answer is no but I will check on that. Yes. My guy told me what I thought I was going to say anyway, so that is always good. We are looking at that, particularly for the Conservation Reserve Program. We have already in the Conservation Reserve Program and throughout a lot of the strategic plan that we are developing that accompanies budget, *et cetera*, we are looking at greenhouse gas reduction as being one of the factors that are looked at.

Ms. HERSETH SANDLIN. Thank you, Dr. Glauber.

Thank you, Mr. Chairman.

The CHAIRMAN. The chair thanks the gentlewoman and recognizes the gentleman from Nebraska, Mr. Smith.

Mr. SMITH. Thank you, Mr. Chairman.

Dr. Kile, I was wondering, have you quantified the transactional cost of carbon credits and how much of that will be going to the brokers and similar folks?

Dr. KILE. So one of the things that we looked at when we were trying to figure out what the supply of international and domestic offsets would be was exactly this issue of transaction cost. It is something that is considered in the literature but not as extensively as one might like. We took what we thought was a fairly cautious approach of including a $5 per-ton transaction cost and that reduced the number of offsets supplied both in the United States and elsewhere, and that was just based on analysis of other offset programs throughout the world.

Mr. SMITH. In arriving at that or using that information, how do you see that as impacting the overall cost of food?

Dr. KILE. I don't have any information on the cost of food. As a general notion, it would reduce somewhat the number of domestic and international offsets supplied. Perhaps Dr. Glauber has some insight as to what that would do to food prices.

Dr. GLAUBER. Well, I think Dr. Kile is absolutely right. Any sort of discount on transaction costs would lower the effect of price that a producer would receive or a forest landowner for embarking on some practice. In that sense, whatever that percent discount would be effectively reduces—would have the effect of reducing those offset activities by some amount. That said, I must say, if I am not mistaken, the results that we were looking at assumed perfect foresight. That is, they assumed that there is perfect foresight for carbon prices throughout the period so no uncertainty built in there, and zero transaction costs. So to the degree that those were included, I think there would be some effect.

Mr. SMITH. I am trying to sift through all of this, the technicalities, and we heard earlier that we really don't have the regulations that would result or that would apply for a lot of the offset opportunities, if one might call them an opportunity or not. But my concern is for consumers and obviously producers. I represent many producers but I also represent consumers, and I am concerned about the impact to consumers not only paying their electricity bill but putting food on the table. When I see the actions and activities of Congress and other entities trying to grapple with the increasing cost of food, it is a bit frustrating, if you will. Can you speak to anything like that?

Dr. KILE. I would go back again to the general notion of the role of offsets in a cap-and-trade program, and the goal with including offsets, or the intention of including offsets, or the effect of including offsets would be to lower the prices of goods and services that have a high carbon content by substituting cheaper emissions from one source for more expensive emissions elsewhere. Obviously those would play through to the prices that consumers pay for food and for electricity, and for other goods and services that have carbon embedded in them. To the extent that that could be done more cheaply, it would have less of an effect on those prices than if offsets were ignored as an opportunity.

Mr. SMITH. So do you see the cost to consumers going down over time if somehow this program is highly successful?

Dr. KILE. By "this program," you mean the offset program?

Mr. SMITH. Well, not necessarily the offset program but the net cost to consumers.

Dr. KILE. The net cost to consumers of a cap-and-trade program would be positive. It would increase the price of goods and services that people pay for goods and services that have a lot of carbon in them, most obviously fossil fuels and electricity, but also other goods and services that require a lot of energy to produce. Those prices would be expected to rise under a cap-and-trade program. An offset portion of that program would limit those price increases, could restrain those price increases.

Mr. SMITH. I understand that, and my time is expired, so thank you, Mr. Chairman.

The CHAIRMAN. The chair thanks the gentleman and recognizes the gentlewoman from Pennsylvania, Mrs. Dahlkemper.

Mrs. DAHLKEMPER. Thank you, Mr. Chairman, and thank you, Dr. Glauber, Dr. Kile, for joining us today, Dr. Glauber again today. Thank you for your time.

Dr. Kile, I wanted to ask you if you could just expand on something in your testimony where you talked about leakage, and if you could just maybe expand on that a little bit for me.

Dr. KILE. The notion of leakage is one of several problems that would need to be addressed by USDA, EPA, or any regulatory authority, to ensure that offsets met the environmental goal that the cap-and-trade would be designed to address. Leakage occurs when reductions in emissions from the creation of offsets are simply replaced by emissions elsewhere in the economy. In some cases that might be fairly easy to protect against. In my example of processing of animal wastes to capture the methane, it is pretty clear that that is not going to cause increased emissions of methane elsewhere. In other instances where the price of a good was changed in the market by, say, limiting the use of fertilizer to capture an offset, that might simply raise the price of crops that would encourage someone to produce them elsewhere, thus potentially offsetting the emission reductions that would be claimed.

Mrs. DAHLKEMPER. So in terms of determining that leakage, how would you go about the methodology for that?

Dr. KILE. So that is something that is a step down in the details that CBO hasn't analyzed, and that would fall ultimately to USDA and EPA.

Mrs. DAHLKEMPER. Dr. Glauber, would you have anything more to say on that in terms of leakage?

Dr. GLAUBER. Well, I would just second that. I think there are certain practices, potential sequestration activities or activities that would lower greenhouse gas emissions where the leakage issues are small. I would agree, the bigger ones are the ones that would big, large increases of activities that would have carbon. Again, the issue for some of this is it is a bigger issue. I mean, it is an issue in the general sense for accounting purposes, and particularly for international accounting, and a lot of the concerns on leakage is of particular concern with overseas projects.

Mrs. DAHLKEMPER. I just have one final question. As we are looking at this entire thing, and we believe in the free market, in your opinion, how can the free market work in a positive way as we are looking at this entire issue?

Dr. GLAUBER. Well, I think one——

Mrs. DAHLKEMPER. Both for the producers and the consumers.

Dr. GLAUBER. Yes. No, I think the one way is through the whole cap-and-trade mechanism, the ability for covered sectors who are having to meet what may be stringent reduction requirements to be able to meet them in a cheaper way than they would otherwise. I think that there—I believe a free market in trading of these permits, or in these offset markets, rather, is the way to sort of try to eliminate the costs and get that down as much as possible. It is, I believe, a more efficient way to do this. And so the government's role is in establishing standards and making sure that enforcement and all that, helping with that, but, ultimately, I at least, personally, would think that a market-based system is the way to do that most efficiently.

Mrs. DAHLKEMPER. Dr. Kile, do you have anything on that?

Dr. KILE. Well, I would second many of the notions, that the purpose of going to a system like a cap-and-trade is to allow the market to figure out what the cheapest way of achieving environmental goals is. One of the roles of offsets is to allow the market to figure out if there are people who are not covered by the cap who could reduce emissions more cheaply in substitute for those who are.

Mrs. DAHLKEMPER. Thank you. I yield back.

The CHAIRMAN. The chair thanks the gentlewoman and recognizes the gentleman from Pennsylvania, Mr. Thompson.

Mr. THOMPSON. Thank you, Mr. Chairman. Dr. Glauber, good to see you again today. Dr. Kile, welcome.

Dr. Glauber, I appreciate the discussions you have had on afforestation, and I want to look at that just a little closer from a standpoint of recommended forest management practices. My district, we have the Allegheny National Forest, 513,000 acres, home of the world's best hardwood cherry and other species, and a significant number of state and private forests. We certainly take forest management very seriously, both for the economic benefits that the management provides, as well as an essential part of keeping our forests healthy. In my experience, we have had too much land in the United States that is under lock and key, areas that we can't manage or access their natural resources. Now, I have concern that there may be effects that this legislation will have on the overall forest management practices. So my question is very simple: Has there been an analysis of how this legislation aligns with the recommended forest management practices of the Forest Service?

Dr. GLAUBER. Thanks. My understanding is the Forest Service is concerned about this and is looking at integrating greenhouse gas targets and emission issues into their current forest management plans. They are looking at greenhouse gas, both emissions and reductions, looking at those as indicators in those plans. These efforts have been underway for 2 or 3 years now where they have been looking at practices and trying to integrate this because this is very important, as you say, and in fact, if I am not mistaken, we don't report them here but are in the broader EPA study. Greenhouse gas reductions or offset credits, rather, from forest management are a significant—provide significant income for forest landowners.

Mr. THOMPSON. And I understand that part of it but I guess my concern is related to that. The fact is that a forest is a living organism, and no matter what we do, it is going to die. So that carbon sink will go away, and in the meantime we create situations where we expedite the death of that forest when the Forest Service is not even—and not just the Forest Service. I am talking of any kind of regulations be driven out or unintended consequences of this legislation that would be imposed upon private owners, state forests where we don't have proper management because we are driven to achieve that dollar. It circumvents proper forest management which involves select cutting, it involves keeping the forest healthy, it involves keeping that forest duff from building up to the point where you have a fire load that results in more forest fires. Frankly, for those who are concerned with carbon emissions, ten percent—one statistic I saw—that ten percent of all carbon emissions come from wildfires annually. I guess I am wondering, are those concerns being looked at? Because by creating these forest carbon sinks that we may not properly manage with all the points that I have made, we may actually be contributing to more carbon emissions at a minimum as we build up fire loads with potential fires.

Dr. GLAUBER. Well, I am glad you asked that question for no other reason so that I can amend a response I gave your colleague from Missouri. When I was speaking about afforestation, the question was asked, well, what happens when you cut down the tree and I said well, it is an emission. Well, it is an emission if you don't use it. If indeed it is going into wood products or whatever, those can be taken into account and that is also sequestering, obviously. Or it can go into bioenergy, which also has a greenhouse gas impact. And so, in answer to your question, there are those potential mitigating effects here. Again, I realize that for thinnings and things like that you are not necessarily talking about wood products, but you could be potentially talking about things like bioenergy.

Mr. THOMPSON. Thank you, Dr. Glauber.

Mr. Chairman, based on my time, I will yield back.

The CHAIRMAN. The chair thanks the gentleman and recognizes the gentleman from Michigan.

Mr. SCHAUER. Thank you, Mr. Chairman. Dr. Glauber, good to see you again. Dr. Kile, thanks for being with us. I appreciate your testimony. Yesterday, Dr. Glauber talked to us about the impact on ag prices and I know today we are primarily talking about offsets. Dr. Glauber's research yesterday didn't really take into account bioenergy production. Obviously that is a key part of offset programs. I wonder if you could talk about whether you feel your testimony really, accurately projects the potential for bioenergy. Several weeks ago we heard from a company in Michigan, as well as a number of other panelists, that talked about because of the unpredictability in terms of credit availability and some other definitions, they felt constrained by their ability to produce bioenergy and biofuel. I wonder if you could talk about that and how it might impact your numbers and your research.

Dr. KILE. The majority of the offsets that we studied under H.R. 2454 do come from forestry and some from agriculture as well. In terms of looking at bioenergy, biofuels as a source of energy in this country, that is actually something that we are studying right now. We haven't completed that analysis at this point.

Mr. SCHAUER. Your report also talks about a variety of other actions including changing agricultural practices and reducing deforestation can also reduce the concentration of greenhouse gases in the atmosphere. I wonder if you have some additional thoughts to share with us about that, or what additional research you could do to help get a handle on that.

Dr. KILE. CBO's primary responsibility is to figure out, of course, the budgetary impact of the bill, and in order to do that, we need to understand the price of emissions and the role that offsets play in determining that price. We have less—and I can break down somewhat between agriculture and forestry and think about where the major pieces come from. We have less detailed modeling of what happens beneath that with different types of crops and exactly where it would come from, from either reduced deforestation or afforestation, and there we really rely on the USDA models of offsets.

Mr. SCHAUER. Thank you.

Dr. Glauber, did you have anything you wanted to add?

Dr. GLAUBER. Yes. We talked about this a little earlier, and that is when there was reference made to the University of Tennessee's study that was done. A lot depends on what your underlying assumptions are under the baseline, and the model results that we received from EPA have a fairly aggressive path in the baseline itself on bioenergy production, so by virtue of that, that doesn't really come into play here. The University of Tennessee, I might add, has less in their baseline and so they get a lot of land going into bioenergy production, and again, with the RES and other sorts of things, you can see where that could be a potential very big source, and so a lot depends on the underlying assumptions of the baseline. It is something that we are looking at in our modeling work now as well.

Mr. SCHAUER. Great. Thank you. I yield back.

The CHAIRMAN. The chair thanks the gentleman.

Mr. Cassidy has asked for a follow-up question. The chair recognizes the gentleman from Louisiana.

Mr. CASSIDY. First, let me apologize, gentlemen. I am not trying to be unpleasant. My back hurts and so I am here kind of grimacing. It is not your testimony. It may be the bill but it is not your testimony.

I would like to return to the topic of leakage. I also read that report, in *The New York Times* or maybe the *Post* about the peat burning in Indonesia. We heard testimony, not long ago, how in Brazil in response to corn-based ethanol production that they are cutting down the Amazon basin trees in order to plant more cropland, resulting in a net increase of carbon production according to both the California environmental agency and the EPA for corn-based ethanol. Now, it occurs to me that not all land is carbon equivalent, so if we are encouraging people in Indonesia to chop down trees and plant on peat, fires start, more carbon is released, we actually have a net negative for carbon emissions if we just turned land into forest in the United States. Is that a fair assumption?

Dr. KILE. It is certainly the case that as forestry land would be taken out of forestry and put into crop production. That releases carbon, as you noted, and particularly Indonesia and Brazil are very large sources of net greenhouse gas emissions, primarily from deforestation. That creates a large increase or potentially a large increase in emissions that might only be very slowly offset. So increases in biofuel would depend very critically on where they came from.

Mr. CASSIDY. But it wouldn't actually have to depend upon increases in biofuels because if we are increasing input costs for, say, corn, we are decreasing acreage, we have an expanding population worldwide, that we are going to have more corn grown someplace. And so if they are cutting down very lush, luxuriant tall trees in the Amazon in order to plant more corn, and we are taking relatively small forests compared to the Amazon and replanting them. We may have a net increase in global carbon dioxide production based upon this policy.

Dr. KILE. Right, and that is the fundamental issue with leakage, does activity for which you might get an offset credit cause increased emissions elsewhere that would either eliminate, or the example that you cited, more than eliminate the reductions from that offset.

Mr. CASSIDY. Now, frankly, it seems almost an inevitability if we base it upon recent history because we know that trees grow taller in the Amazon than they do in, say, Minnesota. So, is it not just an inevitability as much as we can say such things that the more we encourage crop production in places like Indonesia and the Amazon and elsewhere in the tropics that we are going to have relative increases in CO_2 because of this policy?

Dr. KILE. That level of specificity is just something that CBO hasn't analyzed and it is something that would ultimately need to fall to one of the regulatory agencies, but it is a serious issue that——

Mr. CASSIDY. Let me ask, and I don't mean to be rude. Now, EPA has done this and so you have not borrowed from the California environmental agency's methodology to estimate this? Because this seems so important because we may end up worsening the environment because of this bill. We may have more CO_2 production because of this bill. It kind of boggles my mind that it has not been explored more fully.

Dr. KILE. This is obviously an important issue and it is the central issue with leakage, and it is something that we haven't looked at that level of detail. We do take the offset supplies from EPA.

Mr. CASSIDY. Now, tell me, intuitively it seems to me as if it will. Do you agree with that intuition or do you say no, my intuition is that we will have a net decrease in CO_2?

Dr. KILE. From?

Mr. CASSIDY. From basically forcing crop production in the tropics in which we will end up with deforestation, as we have already seen, in places like the Amazon or Indonesia.

Dr. KILE. I don't have a good intuition on any particular example. My sense is that there are examples like that where leakage could be a very serious problem. I think there are other places where leakage could be easier to account for in the creation of offsets.

Mr. CASSIDY. Now, let me also ask, because it seems like we always think of a family farm, but as we know, companies like ADM really are major players in food production and I can imagine, since I understand Australia just rejected such a plan, that ADM would just move wheat production to Australia, another example of leakage, a major trading partner, a developed country, and they have rejected this protocol, this cap-and-trade, whatever. It seems more examples that internationals would move crop production elsewhere, perhaps at the expense of family farms. Does that also make sense?

Dr. KILE. That is at least plausible to the extent that if the United States were to adopt practices and policies that weren't similar to what was going on in the rest of the world, obviously it would create that. Whether or not those incentives were large enough to actually move substantial portions of production, that I don't know.

Mr. CASSIDY. And if I may, one last question. I think bottom line though is we know that the offsets will not entirely increase the cost of the increased input cost. Is that also true?

Dr. KILE. I am sorry. I didn't get the question.

Mr. CASSIDY. The profits from offsets will not offset entirely the increased input costs associated with this legislation.

Dr. KILE. So the—I go back again. The purpose of offsets is to lower the cost of the legislation itself, not to reduce that cost to a negative number, if you will.

Mr. CASSIDY. Thank you. I yield back.

The CHAIRMAN. The chair thanks the gentleman. Does the gentleman from Ohio have any questions? The gentleman is recognized.

Mr. BOCCIERI. Thank you, Mr. Chairman.

I appreciate your testimony today. We had an opportunity to talk to Dr. Glauber yesterday. I want to speak to you, Dr. Kile, if you could and just answer this question for me because I asked the same to Dr. Glauber yesterday. Will the offset provisions that are in the plan, obviously forestry and agriculture exempt under the bill, would the offsets that are on the table right now provide a net income gain for farmers and the agriculture community?

Dr. KILE. That is something that we just haven't looked at that level of granularity. We have the sense that ag and forestry would obviously be important suppliers of offsets. Whether or not the income from those to farmers and ranchers would exceed the cost increases that in the aggregate they paid elsewhere, I don't——

Mr. BOCCIERI. So you are suggesting that the offsets would not exceed a postage stamp for a day, which is the potential cost, if there is a cost? In fact, Ohio is predicting that there may be a net income gain from this but they suggested a postage stamp a day would be the net cost of this bill. Are you suggesting that the offset programs are not going to be the cost of a postage stamp?

Dr. KILE. Well, I certainly heard that figure in——

Mr. BOCCIERI. Those are your figures, I believe, or the CBO's figures, right?

Dr. KILE. The CBO's figures were on the aggregate costs and per household in 2020 and 2050 which were the net costs of the program, which is the cost of reducing emissions and buying allowances and money that would be sent overseas minus the cost of, or the value of, the allowances that would be rebated back to households, and I think that came out to $160 a year in 2020.

Mr. BOCCIERI. So $160. The agriculture community is not going to be able to make up with offsets $160?

Dr. KILE. That is not something that we have looked at *per se,* but again that is a figure that comes—that is a net figure that would include the value of offsets earned by the providers of offsets.

Mr. BOCCIERI. Okay. Well, we will proceed to my next question, if we could, please. The Department of Defense issued a study back in 2003 and said that the risk of abrupt climate change—now, I am not a scientist, I am not into this whole aspect of this. When the Department of Defense and CIA say what they are saying in these studies, I want to know if there is an added cost in this. The 2003 U.S. Department of Defense said that the risk of abrupt climate change should be elevated beyond a scientific debate to a U.S. national security concern. Economic disruptions associated with global climate change are projected by the CIA, and other intelligence experts, to place increased pressure on weak nations that may be unable to provide the basic needs and maintain order for their citizens. Have you factored, has the CBO factored into the cost, the overall cost of doing nothing, the military commitment that would be associated if this were real with respect to what that would mean for the United States?

Dr. KILE. We take under our current baseline—under CBO's baseline we take current law and under current law best expectations and current practices. I would have to get back to you on whether or not that includes specific changes in defense posture.

Mr. BOCCIERI. And our military commitment. I would just add as a comment that it is pretty ironic that last year during the Presidential campaign every candidate running for office last year, from the most conservative to the most liberal, said that this was a threat to our national security. John McCain himself said, "Suppose climate change is real and we have done nothing, what kind of planet are we going to pass on to our next generation of Americans. It is real and we have to address it." He said, "The cap-and-trade portion of this, there will be incentives for people to reduce greenhouse emissions. It is a free market approach. It won't cost the American taxpayers, and we have been doing this in a profit-making business mode." I think Mike Huckabee summed it up best. He said, "A nation that can't feed itself, fuel itself or produce the weapons to fight for itself will be a nation forever enslaved," and I think that we have to be real about what these costs are. In Ohio, we have regulated utilities, we have a renewable energy portfolio. They cannot come and just make arbitrary blanket increases in cost without having to meet the performance indicators that have been put in place. So I hope over this discussion and over this debate that we have about whether this is real or not, and I suggest that we ought to pay attention as Members of Congress to what the DOD and the CIA and our intelligence experts are suggesting. I hope that those are factored into the costs of doing nothing that the CBO purports, but in the long term, this is a debate that transcends party. It is about what our country is going to be faced with here in years to come. With that I will yield back, Mr. Chairman.

The CHAIRMAN. Does the gentleman from New York have any questions? Okay. The chair thanks our witnesses for their testimony, Dr. Glauber for spending 2 days with us. We appreciate it very much. There are three votes on the House floor so the Committee will stand in recess until the votes are concluded.

[Recess.]

The CHAIRMAN. The Committee will come back to order, and we would like to welcome our second panel. Dr. Brian C. Murray, Director for Economic Analysis, Nicholas Institute for Environmental Policy Solutions, Duke University; Dr. Bruce A. McCarl, Distinguished Professor of Agricultural Economics, Texas A&M University; Dr. Brent Sohngen, Professor, Department of Agricultural, Environmental and Developmental Economics, the Ohio State University; Dr. Dermot Hayes, Professor of Economics, Center for Agricultural and Rural Development, Iowa State University; and Dr. Michael Wara, Assistant Professor, Stanford Law School.

Dr. Murray, you may begin when you are ready.

STATEMENT OF BRIAN C. MURRAY, PH.D., DIRECTOR FOR ECONOMIC ANALYSIS, NICHOLAS INSTITUTE FOR ENVIRONMENTAL POLICY SOLUTIONS, DUKE UNIVERSITY, DURHAM, NC

Dr. MURRAY. Mr. Chairman, thank you for inviting me to address the Subcommittee today.

I have worked on land use and environmental policy for 20 years and offsets policy for the last 10 years. Offsets have received much attention, both positive and negative, as a policy option to address greenhouse gases and climate change. In the next 5 minutes I will define *offsets*, why they are proposed, opportunities they present for farmers, challenges and potential solutions to those challenges.

First, I will define an *offset* as an agreement where one party voluntarily reduces its emissions or increases carbon stored in agricultural soils or forests in exchange for a payment. The paying party may represent an entity such as an electric power plant obligated to reduce its emissions either by law or as part of a voluntary program. The seller may be a farmer who has no such obligation. Any action the farmer takes to reduce emissions or increase sequestration can be viewed as a potentially creditable offset action. The power plant can use the offset credits to help meet its compliance obligation rather than rely solely on cutting its own emissions.

There is a precedent for using offsets in environmental policy. All recent cap-and-trade proposals in the U.S. Congress have included offset provisions drawing on examples elsewhere from the Clean Development Mechanism of the Kyoto Protocol to the voluntary market, Chicago Climate Exchange, to the newly emerging regulatory market in the Northeast United States, the Regional Greenhouse Gas Initiative, and from clean water regulations offsets are used as part of wetlands mitigation banking.

Why offsets? The basic rationale for offsets can be summarized as follows: A greenhouse gas reduction delivers the same environmental benefit no matter where it occurs. This situation lends itself to emissions trading where regulated entities buy and sell emissions rights to more cost-effectively achieve their target. It is more economically efficient to achieve the target through trade, and because market forces induce those who can cut emissions cheaper to do so and profit. Emission reductions and sequestration in agriculture and forests are among the least expensive mitigation options. No legislation proposals mandate a cap for agriculture and forest emissions. This leaves the voluntary supply of offsets as the only way to bring these reductions into an economy-wide market-based reduction strategy.

Economic modeling estimates of the cap-and-trade bill such as Waxman-Markey and Kerry-Boxer show that offsets can reduce marginal cost by about half. In addition, agriculture and forest offsets can deliver revenue for rural communities and environmental co-benefits such as soil retention, clean water and habitat retention.

Agriculture accounts for about six percent of all greenhouse gases in the United States. Prominent offset opportunities in agriculture include soil carbon management, nutrient management, manure management, and grazing and grass management. Our nation's forests are a net carbon sink, meaning they absorb more carbon dioxide than they emit. This counters about 13 to 14 percent of our country's emissions at this point in time. Offset activities in forest include afforestation, forest management, and reduced deforestation. There is also tremendous potential for agriculture and forestry and biofuel production from existing energy policies and climate proposals.

Research studies have shown that a properly designed agriculture and forest offset program could generate hundreds of millions of tons of emission reductions in the United States. Internationally, the potentially is even larger for agriculture and forest offsets. Agriculture accounts for 12 to 14 percent of global greenhouse gas emissions and deforestation alone accounts for about 15 percent. Reducing emissions from these sources is even less expensive than reducing them in the United States, but several factors must be overcome and capacity must be built to bring these reductions to the market.

A well-functioning offset system needs to rise above some notable challenges. A critical concern is if offset credits are granted for reductions that do not occur, in which case the integrity of the transaction and the cap is undermined. Three basic issues of concern are: additionality, or whether these reductions produce incremental emission reductions rather than take credit for an emissions profile that would occur anyway under business as usual; leakage, which occurs when emission reductions generated by a project simply lead to emissions being shifted to some other ungoverned source; and permanence, which occurs when carbon that is stored in soils and biomass one period is released in a subsequent period, thus undermining the initial benefit. These problems are tricky but they are real and they must be dealt with to maintain the environmental and economic integrity of an offset program.

There are options to address these challenges. Offset policy has focused on these types of problems in two ways: first, the use of quality standards to account for or adjust for additionality, leakage or permanence, as well as measurement monitoring and verifying transactions. Congressional proposals all recognize the need for quality standards and have processes in place to develop them, drawing on examples from preexisting programs, and quantitative restrictions. Policymakers have tended to couple quality standards with quantitative restrictions on the use of offsets for compliance. For example, the European Union limits the share of compliance commitments that can be met with offset credits to approximately ten percent. The U.S. House bill would have similarly placed compliance limits on offsets of roughly 2 billion tons equally split between domestic and international sources.

In summary, agriculture and forests have a large potential impact on the balance of greenhouse gases. The climate problem would be much harder to solve without involving these sectors. These sectors are not included in the cap. Using them as an offset is a viable option.

[The prepared statement of Dr. Murray follows:]

PREPARED STATEMENT OF BRIAN C. MURRAY, PH.D., DIRECTOR FOR ECONOMIC ANALYSIS, NICHOLAS INSTITUTE FOR ENVIRONMENTAL POLICY SOLUTIONS, DUKE UNIVERSITY, DURHAM, NC

The Role of Agricultural and Forest Offsets in a Cap-and-Trade Policy

Thank you, Mr. Chairman, for inviting me to address the Subcommittee today. I have worked on the economics of land use and environmental policy for more than twenty years, and on various aspects of offsets policy for the last 10 years with colleagues on this panel and others. During that time, offsets have received much attention both positive and negative, as a policy option to address greenhouse gases and climate change. The agricultural community understandably wants to learn more about offsets, how such a system could work, what it could mean for producers, and how concerns about system integrity can be addressed. I will touch on each of those points briefly.

Defining Offsets

An offset is an agreement where one party agrees to reduce its emissions (or increase carbon storage in agricultural soils or forests) in exchange for a payment from another party. The paying party may be an electric power plant or other source obligated to reduce emissions either by law or as part of a voluntary program. For our discussion, the selling party is a farmer or forest owner who has no such obligation. Any action the farmer/forest owner takes to reduce emissions or increase sequestration can be viewed as a potentially creditable *offset*. The power plant can use the generated offset credits to help meet its compliance obligation rather than rely solely on cutting its own emissions. The underlying premise is that the farmer can cut emissions cheaper than the power plant can and will do so if paid more than the action costs.

All recent cap-and-trade proposals in the U.S. Congress have included offset provisions, drawing from examples elsewhere in the world, including the Clean Development Mechanism (CDM) of the Kyoto Protocol, the Regional Greenhouse Gas Initiative regulatory market in the Northeast U.S. states, and the Chicago Climate Exchange voluntary market. There have also been offset provisions in other environmental policies, such as wetlands mitigation.

The Rationale for Offsets

A unique characteristic of greenhouse gases (GHGs) is that they disperse uniformly about the Earth's atmosphere, in contrast to other pollutants that are found in higher concentrations near their sources. As a result, an emission reduction delivers the same benefit no matter where it takes place, whether it is from an electric power plant in the Ohio Valley, a cement plant in India, a soybean farm in Mississippi, or a forest in the Amazon. This uniformity enables emission trading as an approach to control greenhouse gases.

The argument in favor of emissions trading in general and offsets in particular is an economic one. Rather than designate which parties must undertake which reductions to achieve a collective target, it is more efficient to allow parties to contract among themselves to find who can achieve these reductions at the lowest cost, even if those less expensive reductions occur at sources (sectors, countries) not directly capped and thereby participate as offsets. Economic evidence supports this view. A recently published study by EPA of the Waxman-Markey cap-and-trade bill that passed in the House of Representatives this summer found that allowing offsets even subject to quantitative limits on their use reduces marginal compliance costs by about half. Other studies of different cap-and-trade proposals conducted by government agencies and other organizations consistently find large cost reduction from allowing offsets.

In addition to cost containment, offsets are seen as a potential source of economic stimulus for sectors such as agriculture not subject to a cap. Offsets can also produce environmental co-benefits through the deployment of less-polluting technologies and protecting soils, forests and grasslands, though care should be taken to ensure that offsets do not inadvertently damage other ecosystem values. An offset program can also put institutions in place to more effectively include all emission sources into a comprehensive economy-wide reduction program.

Agriculture and Forest Offsets

Agriculture currently accounts for about six percent of all greenhouse gas emissions in the United States. However, none of the cap-and-trade proposals now under consideration include placing a cap on those emissions. This means that any reductions in those sectors can, in principle, be included as offsets. Prominent offset opportunities in agriculture include:

- Soil carbon management (*e.g.,* tillage change to sequester carbon dioxide (CO_2))
- Nutrient management (to reduce nitrous oxide (N_2O) emissions)
- Manure management (to reduce methane (CH_4) emissions)
- Grazing/herd management (sequester carbon, reduce CH_4)

Our nation's forests are a net carbon sink, meaning they absorb more CO_2 from the atmosphere through forest growth than they emit to the atmosphere through forest clearing and other disturbances. Today this sink offsets about 14–15 percent of our country's greenhouse gas emissions, but this situation could be further improved through offset projects in such forestry activities as

- Afforestation.
- Forest management.
- Reduced deforestation.

There is also tremendous potential for agriculture and forestry as a source of biofuels induced by existing energy policies and climate proposals.

Research studies I have been involved in with colleagues at universities and government agencies show that a properly designed agricultural and forestry offsets program could produce emission reductions that counter as much as 1 billion tons of U.S. emissions (about 15% of today's totals) and thereby provide significant revenue potential for producers in those sectors. I believe Dr. McCarl will speak more about this work in his testimony.

Internationally, the potential is even larger for agriculture and forest offsets. Agriculture accounts for 14% of global greenhouse gas emissions and is the main emissions source in many developing countries. Deforestation alone accounts for about 15% of global emissions, or about the same as the global transport sector, and occurs mostly in the developing country tropics. Reducing emissions from agriculture and forests in developing countries is even less expensive than reducing them in the United States, but there are several factors that must be overcome and capacity-building to bring these reductions to market. I believe Dr. Sohngen will have more to say about these international opportunities in his testimony.

Potential Challenges

One common criticism of offsets is that they deflect effort from abatement in the capped sectors. In my view, this criticism is misdirected. Deflecting abatement from the capped sectors is exactly how offsets work to reduce costs. It should be the overall reductions we are interested in, not where they occur.

However, if offset credits are being given for reductions that do not actually occur, the transaction and the cap are illusory, which would be a very real problem. The validity of offset reductions is sometimes called into question because they are generated from sources that do not face an emissions mandate. This makes it difficult to determine how to give credits for emissions reductions—reductions compared to what? The answer typically comes in the form of a baseline that captures what the emissions level would be under a "business as usual" scenario. Reducing emissions below this baseline can be considered additional to reductions that would have occurred anyway.

"Additionality" is a necessary condition for the reductions to be real. Additionality may be more apparent in some cases such as methane capture from livestock manure management or afforestation of cropland because these are not prevalent practices for farmers under business as usual. But in practice it can be difficult to determine additionality because once a project starts, the baseline itself is unobservable. This can become a matter of guesswork that varies in sophistication—from complex data analysis to simply asking the party to provide evidence the project is additional. If a party has too much freedom to set its own baseline, there is legitimate concern about its validity and whether the reductions are therefore truly additional. This is why rules are important to ensure offset validity as I will discuss more below.

Another potential problem with offset transactions is "leakage," which occurs when emissions reductions generated by a project in one location simply lead to emissions being shifted to some ungoverned source elsewhere. An example might be if cropland in one location were retired into permanent grassland or forests, but this simply causes other grassland or forests to be cleared to help fill the supply gap.

A third problem, "permanence," comes specifically from offsets generated by biological sequestration of carbon in forests and agricultural soils. These projects create value by removing CO_2 from the atmosphere and storing it in biomass and soils. The stored carbon, however, can be re-emitted by natural disturbances, such as fire, or intentional management actions. If this occurs, the original benefits of the project have been negated and the offset accounting shortfall needs to be addressed. This so-called *reversal risk* can be addressed with monitoring and clear, enforceable rules designating liability, but this comes with a cost. Another way to deal with liability is through private insurance or a public insurance pool or "buffer" requirement.

Possible Solutions

Offset policy has focused on addressing additionality, leakage, and permanence in two ways.

(1) Quality Standards

Each of the problems identified here can be dealt with by imposing offset quality standards. The Kyoto Protocol's Clean Development Mechanism follows this approach by restricting the activities eligible for offsets and requiring an Executive Board to approve all projects. All CDM projects must meet standards for additionality, address leakage, and address impermanence. This was deemed necessary to get political buy-in from parties who were skeptical of offset integrity. The results have been mixed. Indeed, it has been challenging to get many CDM projects approved, thereby restricting supply. But the logjam is loosening and some projects that have been approved have been criticized for generating questionable reductions despite quality standards being in place. Refinement of standards is an ongoing process.

In the current legislative proposals in Congress, the need for offset quality standards is well-recognized. The lead agency, whether it is USDA or EPA will be responsible for establishing offset rules that address additionality, leakage and permanence and the use of any early offset credits will rely on pre-existing protocols from the voluntary markets that address these issues as well.

(2) Quantitative Restrictions

Policymakers have tended to couple quality standards with quantitative restrictions on the use of offsets for compliance. For example, the EU limits the share of compliance commitments that can be met with offset credits to approximately ten percent (with some variation across countries within the EU). The U.S. House bill would have similarly placed compliance limits on offsets, 2 billion tons per year, which is much larger than ten percent of U.S. compliance. These restrictions implicitly suggest that policymakers are lured by the appeal of offsets, but they only trust them so far.

Summary

Offsets are neither a panacea nor a pox. Agriculture and forests together have a large impact on the global balance of greenhouse gases; solving the climate problem would be much more difficult without involving these sectors. Absent including these sectors under a cap, using them as offsets is an alternate solution. Done well, offsets expand emissions reduction opportunities and lower the cost of achieving reduction targets, and provide income opportunities for farmers, forest owners and other uncapped entities. But offsets can create a number of accounting problems for a cap-and-trade program. Rigorous standards for their inclusion are essential if the system is to have environmental and economic integrity. Nonetheless, some flexibility is necessary to ensure that high-quality offsets are not left out of the system because of overly burdensome requirements. This tradeoff is as much art as science. Quantitatively limiting offsets for compliance is not an ideal solution, but it may be necessary, at least at first when offset quality is highly uncertain. The CDM, warts and all, has shown that offsets can be generated at scale of hundreds of millions of tons globally, but more would be needed if offsets are to remain a critical element of a post-Kyoto global agreement and U.S. climate and energy legislation.

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The CHAIRMAN. Thank you.
Dr. McCarl.

STATEMENT OF BRUCE A. MCCARL, PH.D., DISTINGUISHED PROFESSOR OF AGRICULTURAL ECONOMICS, TEXAS A&M UNIVERSITY, COLLEGE STATION, TX

Dr. MCCARL. I am not as good as reading as Brian so I am just going to over a few things, plus my testimony was a little long as written.

Thank you for having me here. I want to talk through a few major issues. The first I want to talk about is that regardless of what we do in offsets, agriculture is fairly vulnerable to climate change. This vulnerability comes about in three different ways. There are some productivity effects of shifts in climate where, for example, we have seen lowered crop yields in some areas, increases in variability, diminished range carrying capacity and slowing in rates of technological progress where rates are returned to our research. We are also going to need to adapt to this altered climate. Today we see shifts in crops happening throughout the world with alterations in crop mixes, land management practices. We will probably also have to increase research and extension investments in some places, and some of these changes seem to be inevitable. We have passed the point that the European community thought that we should be in terms of atmospheric concentrations to avoid dangerous climate change. And then finally we will have diversion of resources to the extent that agriculture and forestry move to limit climate change.

Now, there are a number of opportunities. I have a note here saying I am leaving them to Brian, but Brian didn't talk about too many of them, but I will still skip that. One thing that is worth mentioning is that agriculture and forestry do provide some attractive alternatives. They are currently implementable as opposed to 80 percent of the emissions coming from the energy sector and things like carbon capture and storage being considerably further in the future. They can also lead to roughly 50 percent reductions in the overall U.S. cost and the contribution can be large.

There are a number of complex implementation issues, some of which Brian mentioned, others of which could be mentioned. Today in my mind, it is difficult to overcome most of these issues and figure out what is going to be a winner or a loser. In general, we need to allow fairly broad participation, establish a careful way of setting the cap and then let the market work to pick out what the winners and the losers are.

If I turn to cap-and-trade effects on agriculture, the principal effect of cap-and-trade is, it offers new markets. If we do not have offsets approved, we would still have a new market in a much bigger bioenergy potential market. If we do have offsets approved, then we have all the participation in the carbon markets. Now, we see that this is competitive with existing markets in that this diverts agricultural resources—land, water, *et cetera*—and that tends to raise prices for existing commodities. It also tends to diminish our ability to export and world food prices go up. This in turn leads to higher agricultural incomes, both with and without the offsets. It also leads to higher consumer and international food costs. In general, I think that the gains exceed the losses. This though, naturally, would have to be balanced off with the environmental benefits of cap-and-trade and the costs of running the program. Finally, the agricultural income effects are not uniformly distributed. Crop producers gain more than livestock and forests don't quite gain as much, and there are regional distributions.

This is an environmentally complex issue in that actions like tillage reductions generate co-benefits, but to the extent we allow the power plants to generate with more coal, we get increased air pollution. So there is a complex set of tradeoffs there.

The final thing, since I noted that research was in the title of this Committee is, one of the biggest strategies is going to be extremely important in this area is, what happens to future technical change. We have been blessed with a rate of corn yield improvements of about 1.7 percent for the last 100 years, but that has been diminishing a little bit in the last 20 years, climate change being one of the factors and a number of others. If we don't have continued investment and continued technological progress, agriculture is going to have to limit its role in these arenas. It won't be able to produce food and fiber plus fuel plus carbon offsets, so that technology is really an important part of this whole story.

With that, this has stopped so I will.

[The prepared statement of Dr. McCarl follows:]

PREPARED STATEMENT OF BRUCE A. MCCARL, PH.D., DISTINGUISHED PROFESSOR OF AGRICULTURAL ECONOMICS, TEXAS A&M UNIVERSITY, COLLEGE STATION, TX

Agriculture, Forestry Climate Change and Offsets

Thank you for inviting me to address the Subcommittee on climate change related issues. I have worked in teams addressing climate change effects, adaptation and emissions limitation for nearly 25 years. This could not have been possible without the U.S. Government funding support that I have received. This arose particularly from EPA but also from USDA, DOE, NOAA and the Congress. I am grateful for the support.

Now let me touch on a few points that have arisen from that work focusing primarily on agriculture and forestry.

1 Climate Change Vulnerability

Agriculture, broadly defined to include forests and fisheries, is highly vulnerable to climate change related developments. Specifically agriculture is vulnerable in three fundamental ways.

- **Productivity effects of shifts in climate** will impact the sector though changes in temperature, precipitation, and extreme climatic events along with other climate attributes. Atmospheric carbon dioxide also will have implications. Here is just a sampling of some findings: work has shown crop yields worsened in the South and Southwest but bettered in the North, pest populations and costs increased, yield variability increasing, range carrying capacity diminished, livestock appetite altered, subtropical developing agriculture negatively affected, tree growth altered and technical progress slowed (Reilly *et al.*, Chen and McCarl, Paustian *et al.*, McCarl *et al.*, Irland *et al.*).
- **Need to adapt to an altered climate and a carbon dioxide enriched atmosphere** will affect the sector. Climate change adaptation will involve alterations in crop and livestock mixes along with land management practices. It will also require added investment capital for facilities, altered production practices, research and extension (McCarl, 2007). Furthermore such actions today appear to be inevitable (Rose and McCarl).
- **Diversion of resources to limit the extent of climate change plus effects of higher energy prices.** Agriculture may face altered energy costs and face pressures/opportunities to limit emissions, produce substitute, lower emitting products (bioenergy) and enhance sequestration (Murray *et al.*).

Collectively these forces mean agriculture will be substantially affected.

2 Limiting Climate Change

Now let me turn to the topic of the day and that is agriculture's role in limiting the future magnitude of climate change by participating in an offsets market.

2.1 Opportunities

As argued by Dr. Murray there are a number of ways agriculture might participate in or be affected by a cap-and-trade market including:

- agriculture generates about 6% of fossil fuel related emissions and would face increased fuel costs and needs to reduce usage (EPA).
- agriculture provides the bulk of the feedstocks for renewable and, in many cases, emissions reducing forms of energy (McCarl, 2008).
- Agriculture may be able to reduce a number of other emissions including those from livestock and manure, and fertilizer (McCarl and Schneider, 2001).
- Agriculture may be able to increase the rate of sequestration by changing tillage, afforesting, forest management, grassland conversion and others (Murray *et al.*).
- Agriculture may be able to preserve existing carbon stocks by avoiding land use change and deforestation as discussed by Dr. Sohngen.

2.2 Attractive Alternatives?

There are a number of reasons why the above opportunities may be attractive meriting current attention including:

- The practices needed to implement the offsets, fossil fuel emissions reductions and renewable fuel feedstocks are generally **known, existing technology** (excepting cellulosic liquid fuels) not needing extended time until deployment (as is the case with for example carbon capture and storage)—Marland *et al.*
- Many of the technologies are currently implementable with low capital costs bridging us to a future with a decarbonized energy.
- The use of agricultural activities has been shown in modeling studies to lead to substantial reductions in the domestic and international costs of limiting atmospheric greenhouse gas content (de la Chesnaye, and Weyant).
- The agricultural contribution can be large. For example, when we were analyzing possible Kyoto Protocol participation 10 years ago we found at higher prices that agriculture and forestry could offset the entire U.S. obligation which was about 6% below 1990 levels plus 24% projected growth by 2012 or a total of 30% below today's levels.
- There are a number of large potential or readily exploitable alternatives including bioelectricity, liquid fuels from cellulose and wastes, feedstocks, afforestation, manure lagoon management, agricultural soils, forest management, and avoided deforestation (Murray *et al.*).

2.3 Implementation Complexity

As Dr. Murray argued there are a number of complex implementation issues including the points he highlighted and more (additionality, uncertainty, permanence, saturation, leakage, transactions costs, measurement/monitoring, climate change interactions and aggregation/brokerage—Smith *et al.*, Morgan *et al.*). Some alternatives will turn out to be impractical in the face of these considerations. Today it is difficult to pick winners and losers. I feel it is desirable in setting up cap-and-trade to allow broad participation and establish a careful way of setting the cap then let the private market evolve to handle the complexity.

3 Cap and Trade Effects on Agriculture

Now let me turn attention to the implications that a cap-and-trade program would have on agriculture addressing the case both with and without the approval of offsets.

3.1 New Markets

Fundamentally, the cap-and-trade program would provide agriculture with new markets and opportunities. If offsets are not broadly approved the market would likely be restricted to an increased demand for biofuel and bioelectricity feedstocks. If offsets are approved then agriculture could enter the carbon (broadly defined to encompass multiple greenhouse gasses) market selling the results of sequestration and emission reduction activities.

3.2 Competitive With Existing Markets

Producing offsets and bioenergy feedstocks on a large scale diverts agriculture from things it is now doing and ultimately is competitive with existing production. As such several things are expected.

- Market prices are likely to go up—with or without offsets (Schneider and McCarl, Murray *et al.*, Baker *et al.*). More with than without.
- Exports are likely to fall and world prices go up.

3.3 Producer Income and Consumer Cost

The higher prices and added markets inevitably lead to higher agricultural incomes along with higher consumer and international food costs. This means reduced consumer and rest of world welfare with the losses therein being greater than the producer income gains. This would naturally have to be balanced off with the environmental benefits of cap-and-trade plus the savings in the rest of the economy of meeting the cap.

Furthermore, the agricultural income effects (Baker *et al.*) are not uniformly distributed with crop producers gaining the most and livestock and forest somewhat less (although one can alter this by allocating afforestation incomes in different ways). There is also substantial gain in rural America from enhanced land based incomes plus distributed energy production under biofeedstock transformation to energy.

3.4 Environmentally Complex

Collectively the use of offsets, fossil fuel use and bioenergy feedstock production generates a complex set of environmental impacts. Actions reducing tillage intensity, afforesting, converting grasslands *etc.* lead to water quality and erosion benefits while higher market prices and increased land demand lead to more land development and intensification possibly increasing chemical use, erosion sequestration releases and water use. In addition, increases in agricultural participation in the cap allows less energy sector reduction and diminishes air quality gains that would occur with less fossil fuel usage (Elbakidze and McCarl). Finally, the international market consequences would stimulate production increase in other areas including the possibility of added deforestation.

4 Key Role of technology

It merits mention that the pressures of an agriculture contributing to expanding demands for energy, limiting greenhouse gasses and food/fiber can only happen if technological progress remains high. Certainly technology investment is a complementary policy and is in fact a substantial way of limiting future greenhouse gas emissions (Schneider *et al.*).

5 Summary

Agriculture will be affected by climate change and will need to adjust. It may be a big player in cap-and-trade if offsets are approved but would benefit from just increased energy prices in the absence of offsets. A complex market will need to evolve to handle agricultural offset characteristics and it appears desirable to allow wide participation.

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The CHAIRMAN. Thank you.

Dr. Sohngen.

STATEMENT OF BRENT L. SOHNGEN, D.F., PROFESSOR, ENVIRONMENTAL ECONOMICS, DEPARTMENT OF AGRICULTURAL, ENVIRONMENTAL, AND DEVELOPMENT ECONOMICS, OHIO STATE UNIVERSITY, COLUMBUS, OH

Dr. SOHNGEN. Mr. Chairman, Members of the Subcommittee, thank you for the opportunity to testify today.

While forests have always been recognized for the benefits they provide to humans including wood for consumption, habitat for wildlife, stores of biodiversity, water regulation services and stream stabilization, society has increasingly recognized the role forests play in mitigating the potential damages from climate change. My research along with that of my colleagues has shown that forests are a low-cost option for reducing net carbon emissions to the atmosphere. In particular, research has shown that the international supply of carbon credits from forestland could be as large as 6 billion tons of carbon dioxide abatement per year by 2030, and carbon prices of $10 to $20 per ton carbon dioxide.

By far, the largest share of credits that could be generated globally arise from reductions in deforestation, followed by improvements in forest management, and finally by afforestation. The carbon credits generated by forestry actions both within the United States and outside of it could provide immense benefits to consumers. Our estimates indicate that if international offsets from forestry are used within a U.S. compliance market, we could reduce the carbon prices in the United States by 20 to 50 percent, depending on the size of the cap implemented and how many offsets are allowed to be imported into the United States. In the context of a cap-and-trade system with fixed target for emissions, this represents a substantial cost reduction function for consumers.

An international carbon sequestration program will also make a U.S. carbon sequestration program more effective. If the United States only allows domestic offsets, commodity price increases will cause carbon emissions or leakage elsewhere. An international offsets program, however, can help limit these losses in other countries. By helping to stabilize land use in other countries, an international offsets program will also limit agricultural commodity supply responses in our competitor countries.

The economic evidence is clearly in favor of international offsets. They reduce cost and they ensure the integrity of a U.S.-based offsets system. But are they also feasible? Many questions and concerns have been raised academically, and in the public discourse, about land-based offsets. In particular, questions have been raised about international offsets, and I would like to address several of those issues now.

First, many parties are worried that there is no way to measure, monitor and verify large expanses of forestland in other countries. Actually, there is little doubt from a physical and scientific standpoint that we can measure, monitor and verify carbon in forests. We already do this in lots of places around the globe. The more important question is, what are the costs? The research on costs suggests that these costs would be $1 to $2 per ton carbon dioxide to measure and monitor carbon in forests. If carbon prices are in the range of $15 to $20 per ton CO_2 and rising, measuring and monitoring and verifying will turn out to be a small proportion of the total transaction cost. Of course, we don't yet have precise measurement and monitoring of forests around the world. The reasons for this are clear. Society has simply never valued the carbon in its forests as a marketable commodity, so no one put time in measuring and monitoring. However, with global carbon reductions in the order suggested by Waxman-Markey, the world's forests could be worth as much as $2 trillion in asset value in carbon abatement services, or $500 per hectare for every forest in the world. Commodities worth this much are simply worth measuring and monitoring and we should put the resources into doing that.

Second, there are vast concerns that forest carbon is volatile and impermanent, *i.e.,* that it will be sold off to the highest bidder or burnt up when lightning strikes. Permanence is a legitimate issue but it can be handled by markets. The fact is, carbon markets do not need carbon to be permanent at all. Temporary storage is valuable, it could be priced and it should be traded on the market. To handle permanence, either the buyers or the sellers need to be contractually liable for the carbon. Then the risks associated with a particular location, for example, the fire and logging characteristics, could be considered and permanence could be worked into the price. Shorter-term storage would be worth less. Risky storage would be worth less. Longer-term storage, less risky storage worth more.

Third, can we handle the land ownership and tenure issues that often plague developing countries? Clearly, carbon purchases from developing regions and individual places where land tenure is under question should be devalued. The United States should limit forest carbon contracts to those countries that have clearly established tenure rights regardless of whether the land is privately, publicly or communally managed. Countries that do not satisfy these criteria should be encouraged to develop equitable tenure arrangements so that they can enter into carbon contracts in the future.

In conclusion, international carbon credits generated from forestry are a cost-effective means of reducing carbon emissions. Further, they enhance the efficiency of the domestic offset program. Some of the concerns that have been raised are important and should not be diminished, but they probably shouldn't be oversold, either. Thank you.

[The prepared statement of Dr. Sohngen follows:]

PREPARED STATEMENT OF BRENT L. SOHNGEN, D.F., PROFESSOR, ENVIRONMENTAL ECONOMICS, DEPARTMENT OF AGRICULTURAL, ENVIRONMENTAL, AND DEVELOPMENT ECONOMICS, OHIO STATE UNIVERSITY, COLUMBUS, OH

Mr Chairman, Members of the Subcommittee, thank you for the opportunity to testify before you on the benefits and costs forest carbon sequestration as a climate mitigation tool.

The global forest estate currently stands at 3.9 billion hectares, with 1 trillion tons of CO_2. [1] More than half of this total forest area is located in temperate regions, including the United States, Canada, Europe, Russia, and China. For the most part, the carbon in these forests is increasing or is relatively stable.

Well more than half of the total carbon in forests is located in tropical countries. Due to human activity, this carbon is not as stable as that in temperate regions. Annually, 10–14 million hectares of forestland are lost as deforestation occurs, causing an estimated 4 billion tons of CO_2 emissions per year. This emission amounts to about 17% of total carbon dioxide emissions into our atmosphere. [2]

Forests have always been recognized for the benefits they provide to humans, including wood for consumption, habitat for wildlife, stores of biodiversity, water regulation services, and stream stabilization. More recently, society has recognized the role forests play in mitigating the potential damages from climate change. My research along with that of my colleagues has shown that forests are a low cost option for reducing net carbon emissions to the atmosphere.

In particular, our research has shown that the international supply of carbon credits from forestland could be as large as 6 billion tons of CO_2 abatement per year by 2030 at carbon prices of $10–$20 per ton CO_2. [3] By far the largest share of credits that could be generated globally arise from reductions in emissions from avoided deforestation, followed by improvements in forest management practices, and finally by planting of forests on old agricultural land.

The carbon credits generated by forestry actions, both within the United States and outside of it, could provide immense benefits to U.S. consumers. Our estimates indicate that international offsets from forestry in particular, could reduce carbon prices in U.S. compliance markets by 25–50%, depending on the size of the cap implemented, and how many offsets are allowed to be imported. [4]

In the context of a cap-and-trade system with a fixed target for emissions, this cost reduction function would leave literally billions of dollars each year in the hands of small businesses, who will have more resources to invest in productive capital, and consumers, who will pay lower energy prices as a consequence.

Beyond these cost savings, an international carbon sequestration program will also make a U.S. carbon sequestration program more effective. If the U.S. only allows domestic offsets, commodity price increases will cause carbon emissions, or leakage, elsewhere. An international offsets program, however, can help to limit these losses in other countries. By helping to stabilize land use in other countries, an international offsets program will also limit agricultural commodity supply responses in competitor countries.

The economic evidence is clearly in favor of international offsets. They reduce costs, and they ensure the integrity of a U.S.-based offset system. But are they also feasible? Many questions and concerns have been raised academically and in the public discourse about land-based offsets. In particular, questions have been raised about international offsets. I would like to address several of those concerns here.

First, many parties are worried that there is no way to measure, monitor, and verify large expanses of forest carbon in other countries. There is little doubt from a physical and scientific standpoint that we can measure, monitor and verify carbon in forests. We already do this in many locations around the globe. The more important question is "what are the costs?" Current studies place costs at $1–$2 per ton CO_2 to measure and monitor carbon in forests. [5] If carbon prices are in the range of $15–$20 per ton CO_2, and rising, measuring, monitoring and verifying will turn out to be a relatively small part of the transaction.

Of course we do not yet have precise and accurate measurements of forest carbon in most tropical countries to date. The reasons are clear: Society has never valued forest carbon as a marketable commodity. The European Trading System declined to fully integrate forests, and voluntary systems that do include forests systematically under-value carbon. However, with global carbon reductions on the order suggested by the current Waxman-Markey bill, the world's forests could be worth as much as $2 trillion in carbon abatement services, or $500 per hectare. [3] Commodities worth this much are worth measuring and monitoring.

Second, there are vast concerns that forest carbon is volatile and impermanent—*i.e.,* that it will be sold off to the highest bidder or burnt up when lightening strikes. Permanence is a legitimate issue, but it can be handled by markets. The fact is that carbon markets do not need forest carbon to be permanent at all. Temporary storage would be valuable, could be priced, and should be traded on a market.

The best way to think about permanence is to begin by asking whether we hold any assets to the same standard in the modern economy. The answer is no. Economic actors recognize that all assets depreciate and that there are risks associated with holding them. Automobiles are not meant to be driven forever. Few of us end up living in the same house or apartment forever, and many of us rent.

To handle permanence, either the buyers or the sellers need to be contractually liable for the carbon. Then the risks associated with the particular location (*e.g.,* fire, illegal logging) can be considered, and permanence is worked into the price: Shorter term storage of carbon, or more risky storage of carbon will be worth less than longer term or less risky storage.

Third, can we handle the land ownership and tenure issues that often plague the developing countries? Clearly, carbon purchased from individuals in regions where land tenure is under question should be devalued. The U.S. should limit forest carbon contracts to those countries that have clearly established tenure rights, regardless of whether the land is publicly, privately, or communally managed. Countries that do not satisfy these criteria should be encouraged to develop equitable tenure arrangements so they can enter into carbon contracts in the future.

In conclusion, international carbon credits generated from forestry are a cost-effective means of reducing carbon emissions. Further, they enhance the efficiency of a domestic offset program. Some of the concerns that have been raised with international carbon offsets are important and should not be diminished, but they also should not be oversold.

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The CHAIRMAN. Thank you.

Dr. Hayes.

STATEMENT OF DERMOT J. HAYES, PH.D., PIONEER HI-BRED INTERNATIONAL CHAIR IN AGRIBUSINESS, PROFESSOR OF FINANCE, AND PROFESSOR OF ECONOMICS, DEPARTMENTS OF ECONOMICS AND FINANCE, IOWA STATE UNIVERSITY, AMES, IA

Dr. HAYES. Thank you. I would like to describe some of our recent research on the impact of domestic offsets on agricultural land use and on crop prices, and then finish with the results of an informal survey of farmers on the subject.

I read reports by the Environmental Protection Agency and the team from Duke and Texas A&M that suggested that with a carbon price of $30 per ton, as many as 50 million crop acres would be converted from crops to trees with commensurate price increases for agricultural commodities. I decided to try and replicate these results, especially as they pertain to the Corn Belt.

I am a Co-Director of FAPRI at Iowa State and I have access to the FAPRI modeling system. I believe that Pat Westhoff described this system yesterday in his remarks to this Committee, so I will not describe the model in detail expect to say that the model is well suited to this type of analysis.

First, we decided to examine the EPA estimate of crop conversion in the Corn Belt. To do this, we compared the offset value of trees grown for purposes of carbon sequestration against the current value of this land in agriculture. To estimate the carbon value of cropland in the Corn Belt, we used data from Lewandrowski on the sequestration rates and metric tons of CO_2 equivalent per acre for different tree types in different regions of the country. We converted these rates to an annual cash rent equivalent by multiplying the average annual sequestration amount in tons by $30. Our results suggest that the Corn Belt land would have an annual offset value in the range of $102 to $132 per acre, and that land in the Lake States would have a value of about $146 per acre. These cropland conversion values are about 50 percent greater than for pasture in the same region because pastureland has more stored carbon to begin with.

Next, we decided to compare the current cash rents in agriculture against the value of this land in an agricultural offset program. We were able to obtain survey data for cash rents on 3,000 Iowa farms for 2009 from Dr. William Edwards at Iowa State, and we used this as the basis for comparison. We also found 2009 cash rental data by county from the USDA National Agricultural Statistics Service. This work suggested that in an offset value of $110 per acre, about 20 percent of Corn Belt land would be converted to trees. At $118 per acre, the number of acres would be about 25 percent of the total. These results are remarkably consistent with the EPA results for cropland conversion in the Corn Belt. We do not have adequate rental data for other regions of the country and we were, therefore, unable to verify the EPA estimates for those regions.

We then took the EPA estimates of regional cropland conversion and ran them through the FAPRI model to estimate the impact on crop prices. The results suggest that by 2023 the price of corn would be about 28 percent higher than in our baseline, and that the price of soybeans would be 20 percent higher. Our corn price results are slightly lower than in the bigger McCarl study and our soybean results are slightly higher, but given the enormous difference in our approach, the results are remarkably consistent. The FAPRI model did suggest that with higher crop prices, about 10 million acres of pasture and CRP would be converted into cropland so that the net price impact described here is for 40 million acres of conversion.

Finally, I would like to describe the reaction that I have had from about 250 farmers that have listened to audio versions of this presentation. About half the participants were livestock producers, and that, as I had expected, they were against the concept because of the increase in feed costs. The other half were specialized crop growers, and to my surprise, they were also against the concept. After some consideration, I was able to come up with a reason for the opposition from crop growers. The key is that the particular individuals I asked were actively involved in growing crops and, as such, they did not wish to reduce the size of their own operation by converting land. Almost all the participants also rent land from investors. These farm operators would see increases in the cost of renting land and this explains their opposition. Crop growers see a big difference between policies that increase crop prices because of demand pull, as was the case for ethanol, and policies that increase crop prices due to cost push, as would be the case here.

I do see a way to make this program beneficial for almost all involved. The answer is to limit conversion of cropland for domestic offsets and combine this activity to pasture, CRP and publicly owned lands. Alternatively, the United States could explore other opportunities to sequester carbon such as that provided by using crop residues and other forms of cellulose to produce biochar and then burying the biochar in the soil. Thank you.

[The prepared statement of Dr. Hayes follows:]

PREPARED STATEMENT OF DERMOT J., HAYES, PH.D., PIONEER HI-BRED INTERNATIONAL CHAIR IN AGRIBUSINESS, PROFESSOR OF FINANCE, AND PROFESSOR OF ECONOMICS, DEPARTMENTS OF ECONOMICS AND FINANCE, IOWA STATE UNIVERSITY, AMES, IA

Thank you, Mr. Chairman, for the opportunity to participate in today's hearing. I would like to describe some of our recent research on the impact of domestic offsets on agricultural land use and on crop prices and then finish with results of an informal survey on the subject where I have attempted to capture the opinions of farmers with whom I have recently interacted.

I first became interested in this subject of domestic offsets when I read a report produced by the Environmental Protection Agency suggesting that with a carbon price of $30 per ton, as many as fifty million crop acres would be converted from crop to woodland nationwide. This early EPA report was followed by a report by a team from Duke and Texas A&M, led by Professors Baker and McCarl, that suggested this amount of acreage conversion would lead to significant price increases for agricultural commodities such as corn. This work caught my attention because a 50 million acre conversion of crop land is greater than that associated with the Conservation Reserve Program or with the recent conversion of corn land used for feed into corn land used for biofuel production. Therefore, I decided to try to replicate these results especially as they pertain to the Corn Belt.

I am a Co-Director of FAPRI at Iowa State and I have access to the FAPRI modeling system. I believe that Pat Westhoff described this system yesterday in his remarks to this Committee, so I will not describe the model in detail except to say that the model is well suited to this type of analysis. In addition, the group of individuals that I work with at the Center for Agricultural and Rural Development and in the Department of Economics at Iowa State University have an excellent understanding of how agricultural markets and agricultural polices interact. I was able to draw on the expertise of a large group of experts as I prepared these remarks.

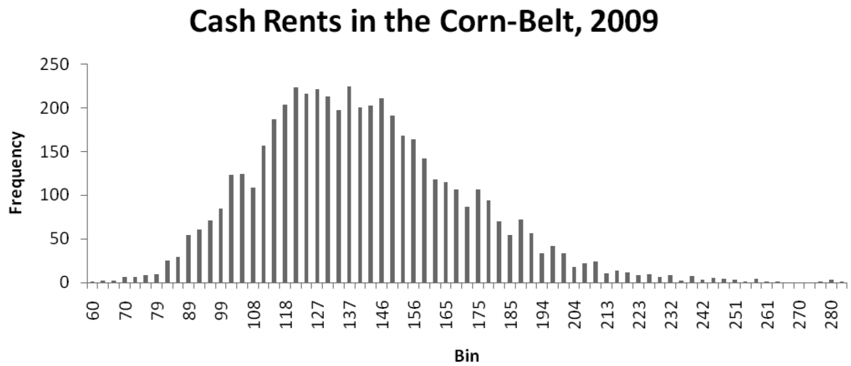
First, we decided to examine the EPA estimate of cropland conversion in the Corn Belt. To do this, we compared the offset value of trees grown for purposes of carbon sequestration against the current value of this land in agriculture. To estimate the carbon value of cropland in the Corn Belt, we used data from Lewandrowski on the sequestration rates in metric tons of CO_2-equivalent per acre for different tree types in different regions of the country. We converted these rates to an annual cash rent equivalent by multiplying the average annual sequestration amount in tons by $30. I realize that there are other ways of examining this issue and we do plan to pursue other more sophisticated methods, but for now this method is as accurate as we can be. Our results suggest that Corn Belt land would have an annual offset value in the range of $102 to $132 per acre and that land in the Lake States would have a value of about $146 per year. These cropland conversion values are about 50% greater than for pasture in the same region because pasture land has more stored carbon to begin with.

Offset Values in U.S.$ per Acre at Carbon Price of $30/metric ton

Region	Tree	Cropland to Forest	Pasture to Forest
Appalachia	Southern Pine	$172.80–$189.30	$102.90–$112.80
Corn Belt	White/Red Pine	$102.90–$132.90	$93.00–$122.70
Delta States	Southern Pine	$189.00	$112.80
Lake States	White/Red Pine	$146.10	$136.20
Northeast	White/Red Pine	$132.90	$122.70
Pacific States	Douglas fir/Ponderosa	$86.10–$89.70	$79.80–$96.30
Southeast	Southern Pine	$172.50	$102.90

Next, we decided to compare the current cash rents in agriculture against the value of this land in an agricultural offset program. For purposes of this comparison, it is important to realize that cash rents vary widely in the Corn Belt because the suitability of the ground for corn and soybean production varies so much from farm to farm and from county to county. This is an important distinction because it seems likely that land owners will enroll the lowest quality ground in an offset program, much as was the case for the CRP program.

We were able to obtain survey data for cash rents on 3,000 Iowa farms for 2009 from Dr. William Edwards at Iowa State University and we used this as the basis for comparison. We also found 2009 cash rental data by county from the USDA National Agricultural Statistics Service. We used the coefficient of variation from the Iowa State University data as a measure of the dispersion of cash rents across farms, and we used the $145 per acre mean of the Corn Belt county data as a measure of the current average farm rent. This distribution suggested that at an offset value of $110 per acre, 20% or 22.5 million acres of Corn Belt land would be converted to trees. At $118 per acre, the number of acres converted would be 25% of the total. These results are remarkably consistent with the EPA results for crop land conversion in the Corn Belt. We did not have adequate rental data for other regions of the country and we were therefore unable to verify the EPA results for those regions, however these other results also make intuitive sense.



Next, we took the EPA estimates of regional cropland conversion and ran them through the FAPRI model to estimate the impact on crop prices. The FAPRI model is an annual model and it can be used for projections as far out as 2023. Therefore, we assumed that the $30 per ton carbon price would be reached by that date and that the rate of increase in carbon process prior to that date is linear.

Region	% of total	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Corn Belt	50%	—	2	4	5	7	9	11	13	14	16	18	20	21	23	25
Delta States	32%	—	1	2	3	5	6	7	8	9	10	11	13	14	15	16
Far West	2%	—	0	0	0	0	0	0	1	1	1	1	1	1	1	1
Lake States	3%	—	0	0	0	0	1	1	1	1	1	1	1	1	1	2
Southeast	3%	—	0	0	0	0	1	1	1	1	1	1	1	1	1	2
South Plains	10%	—	0	1	1	1	2	2	3	3	3	4	4	4	5	5

The results suggest that by 2023, the price of corn would be about 28% higher than in our baseline and that the price of soybeans would be 20% higher. Our corn price results are slightly lower than in the Baker-McCarl study and our soybean results are slightly higher, but given the enormous difference in our approach, the results are remarkably consistent.

The FAPRI model did suggest that with higher crop prices, about 10 million acres of pasture and CRP would be converted into cropland so that the net price impact described here is for 40 million acres of conversion.

Commodity	McCarl ($30/mt)	Our results ($30/mt)
Cotton	+9.77%	+10.10%
Corn	+40.76%	+27.60%
Soybeans	+9.40%	+20.5%
Wheat	+14.23%	+14.60%
Sorghum	+5.50%	+23.40%
Rice	+1.25%	+28.40%

Finally, I would like to describe the reaction that I have had from about 250 farmers that have listened to earlier versions of this presentation. I conducted this survey by presenting the results and then asked the group if they were for or against the concept as described. About half the participants were livestock producers, and as I had expected, they were against the concept because of the increase in feed costs. The other half were specialized crop growers and, to my surprise, they were also against the concept. I had expected that this group would be in favor.

After some consideration, I was able to come up with a reason for the opposition from crop growers. The key is that the particular individuals I asked are actively involved in growing crops and, as such, they did not wish to reduce the size of their own operation by converting land. Almost all participants also rent land from investors, or from landowners who have retired and/or who live out of state. Approximately 60% of the land farmed in Iowa is operated by someone other than the owner and about 80% of the land in Illinois is in this category. Because I conducted my survey among actively involved farmers in Iowa, I simply missed the group of people who own land but do not farm it themselves. I am sure that this second group would be more favorable towards the domestic offsets, because the program would offer them leverage when negotiating cash rents. I should acknowledge here that my wife and I own several hundred acres of crop land in Iowa.

However, the farm operators would see increases in the cost of renting land and this explains their opposition. Crop growers see a big difference between policies that increase crop prices because of demand pull (as was the case for ethanol) and policies that increase crop prices due to cost push as would be the case here.

I have not had a chance to present these results to agribusiness companies, but I would assume that those who provide machinery and seed genetics would prefer to see cropland remain in production, while those who provide equipment for conversion of land into trees would be supportive of the policy. People and businesses involved in the food industry and food security programs are also likely to be opposed to the domestic offsets because of the impact the program would have on food prices.

One last group worth considering is those who live in rural towns but who are not directly involved in production agriculture or land ownership. My sense is that this group would prefer to retain the economic activity associated with crop production, in part because of the negative impact that the CRP program had on some small towns.

I do see a way to make this program beneficial for almost all involved. The answer is to limit the conversion of crop land for domestic offsets and confine this activity to pasture, CRP, and publicly owned lands. Alternatively, the U.S. could explore other opportunities to sequester carbon, such as that provided by using crop residues and other forms of cellulose to produce biochar and burying the biochar in the soil. Such a program might sequester similar amounts of carbon, while creating much smaller discontinuities for agriculture, industry, and rural communities.

Thank you for the opportunity to present this research and these remarks.

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The CHAIRMAN. Thank you.

Dr. Wara.

STATEMENT OF MICHAEL WARA, PH.D., ASSISTANT PROFESSOR OF LAW, STANFORD LAW SCHOOL, STANFORD, CA

Dr. WARA. Mr. Chairman and Members of the Committee, thank you for inviting me to appear. I am honored to talk to you and share my perspective on offsets today.

My research focuses on the Clean Development Mechanism, which is the world's largest offset market. It is the only so-called compliance-grade offset market currently in existence in the world. However, it has little or no ag or forestry in it because of restrictions made in the Kyoto Protocol and the Marrakesh Accords to follow an agreement. Nevertheless, the experience gained in this market, and in particular the implementation of rules to govern offset creation, are very relevant to thinking about how a U.S. agricultural and forestry offsets program might function under ACES or some other cap-and-trade legislation. I take it as a goal for such a program to create a system in which uncapped sources of emissions change their behavior and also captures much of the financial benefit of doing so as possible.

Some lessons from the Clean Development Mechanism that I think are very relevant to this discussion are that there is a fundamental tension between high environmental integrity and transaction costs and risks associated with offset production. Even with excellent resources and intentions, the regulatory problem of creating, managing, and overseeing a large offset market is incredibly difficult. The CDM is a much smaller market than is envisioned for either a United States ag and forestry program, or more broadly, the ACES offset market both when considered domestically and internationally.

Another important consideration that has emerged from the CDM is that carbon markets really value one thing and one thing only, and that is tons of carbon. That being said, agricultural and forestry offsets have the potential to provide important, and in many contexts, valuable contributions in terms of air, water and ecosystem quality. These would be very difficult to value in a strictly carbon offset context. The net of the CDM experience has been that the regulator and the market have struggled to produce very many offsets at all, that is, that the compliance-grade offset market has not served terribly well as a cost-containment mechanism. In addition and at the same time, there have been deep suspicions regarding the quality of the offsets produced. So not only has the market not produced very many credits, but the credits it has been produced have been subject to numerous criticisms.

Because of this result, I would suggest that the United States consider alternatives to offsets for both reducing emissions from uncapped sectors such as agriculture and forestry, and for providing cost containment to the cap-and-trade market to limit the impacts on businesses and consumers. In particular, I believe that rather than putting farmers and forest landowners through the complicated, expensive and risky process necessary to make a compliance-grade offset, it makes far more sense to simply pay them to change their practices in ways that we know will benefit both U.S. greenhouse gas emissions and improve air and water quality.

Rather than financing these changes through the creation of offsets, assuming that we were to have a cap-and-trade program, I believe that it would make far more sense to fund such a conservation incentive program by a large, permanent allocation of allowances from the cap-and-trade. The effects of this would be to lower transaction costs for farmers and forest landowners; simplify the application process, simplify the implementation for USDA and/or EPA of running such a program, and I wouldn't minimize that; to allow farmers and forest landowners to capture a far greater share of the revenue generated by the program; and also to significantly reduce the uncertainty as to the environmental performance of the cap. It is important to emphasize as was mentioned in the earlier panel, and also by members of my panel, that we are talking about a very large number of tons in offsets relative to the total volume of emissions under the cap. To the extent that those offsets are of dubious or uncertain quality, the performance of the program as a whole is called into question.

So in addition, it is worth pointing out that such a program could take advantage of existing USDA programs, be less likely to be subject to legal challenge because they are not linked to the cap, and I will tell you that in interactions with numerous environmental NGOs, that is a major concern, and it does require the development of complicated mechanisms for project-level implementation of offset reductions.

I will conclude with that. Thank you very much.

[The prepared statement of Dr. Wara follows:]

PREPARED STATEMENT OF MICHAEL WARA, PH.D., ASSISTANT PROFESSOR OF LAW, STANFORD LAW SCHOOL, STANFORD, CA

1. Introduction and Summary

Mr. Chairman and Members of the Committee, I am honored to appear before you to testify on the potential role of agricultural and forestry carbon offsets in a U.S. greenhouse gas emissions trading market. Overall, I believe that offsets hold limited promise, both as a cost control mechanism and as a method for reducing emissions beyond the sectors covered by a cap-and-trade scheme. For U.S. farmers, this may translate into higher than anticipated costs for agricultural inputs and lower than anticipated benefits from the sale of offsets.

A superior alternative to the approach taken by the American Clean Energy and Security Act of 2009 (ACES)[1] would be to separate the cost containment function under a U.S. cap-and-trade program from policies aimed at reducing emissions from uncapped sources such as agriculture and forests. In essence, rather than trying to kill two birds with one stone, using two stones. The first would be a price collar for the cap-and-trade program. The second would be a conservation incentives program focused on GHG reductions and funded via allowance allocations and safety valve revenues. Such an approach would provide much greater certainty regarding minimum and maximum costs to be born by firms and consumers affected by the cap on fossil fuel emissions. It would also greatly simplify the implementation and operation of a program aimed at reducing emissions from U.S. farms and forests, thus insuring that farmers and forest land owners receive the expected benefits from reducing and sequestering carbon.

The changes necessary to reduce GHG emissions from U.S. farms and forests will almost certainly also provide substantial co-benefits in the form of reduced impacts to air, water, and ecosystem quality. A carbon offsets-based program for producing reductions has no straightforward way of taking these added benefits into account. In contrast, a more familiar conservation incentives program could easily factor in the extent to which certain practices provide benefits beyond GHG reductions.

A conservation incentives program would also accomplish another important objective—insuring that as much of the revenue devoted to reducing emissions from U.S. farms and forests actually reaches the individuals who change farm and forest practices. Current compliance grade offset programs, such as the Clean Development Mechanism of the Kyoto Protocol, have struggled mightily to produce offsets of high environmental integrity. This struggle has necessarily created high transaction costs and substantial risks for offset developers. In practice, these risks reduce the fraction of offset revenue captured by the owner of a factory or landfill actually producing the GHG reductions. Instead, other elements of the offset value-chain, such as offset development companies, lawyers, consultants, and hedge funds, have captured much of the revenue. The same would likely be true of a U.S. carbon offset market under ACES. In contrast, a conservation incentives program, because of its simplicity, would insure a greater share of benefits for farm and forest owners.

In this testimony, I will address several key lessons learned from the experience to date under the Kyoto Protocol with compliance grade carbon offsets. I will then describe the relevance of these lessons to the agricultural and forestry offsets program contemplated by Title V of ACES. Finally, I will describe an alternative policy for reducing GHG emissions from U.S. farms and forests—a conservation incentive program. Last, I will describe an alternative cost-containment mechanism for a U.S. cap-and-trade system, a symmetric safety valve or price collar. I conclude the following:

(1) **There has been and will continue to be substantial crediting of business-as-usual behavior within the CDM and other large offset programs.** This is particularly true for sectors such as electricity generation that are highly regulated or benefit from substantial public subsidy. This crediting of counterfeit emissions reductions is likely to be a hallmark of any real offset

[1] The American Clean Energy and Security Act, H.R. 2454, 111th Cong. (2009).

program. The crux of the problem is the inability in practice to tell which of the many applicants for carbon offsets are telling a genuine story regarding emissions reductions and which would have changed practices even in the absence of the carbon market.

(2) **The CDM has yet to perform as a reliable cost-containment strategy.** Actual issuance of offsets has been far lower than predicted because of concerns about environmental integrity. These concerns have led of necessity to an elaborate and time consuming regulatory process. The impact of this failure to produce offsets has been largely hidden by the reduction in demand for permits due to the global recession. A U.S. program that sought to have higher standards than the CDM while producing more credits would almost certainly face similar supply problems.

(3) **Real-world implementation of an offset market of the scale contemplated by ACES could not avoid the CDM's pitfalls.** ACES as passed requires an offset market and regulatory structure of between 10 and 50 times the size of the current CDM. While there are process efficiencies that a U.S. system could realize, the potential for crediting business-as-usual behavior, for uncertain offset supply, or both, is substantial. In practice, both effective cost control and certainty as to emissions levels are impossible to achieve under such a system.

(4) **Dedication of a significant fraction of allowances to permanently fund a Conservation Incentive Program for farms and forests is a superior policy for reducing uncapped emissions.** A Conservation Incentive Program could accomplish many of the emission reduction objectives of an offset program and do so more cost-effectively. By allowing for increased flexibility and by reducing and risks of creating GHG emission reductions a Conservation Incentive Program would likely produce greater reductions from uncapped sources than would be possible under a carbon offset system.

(5) **A symmetric safety valve or price collar that includes both a price floor and a price ceiling for emissions allowances is preferable to offsets as a cost-control option.** A price collar would be simple to administer, would not require an elaborate regulatory system, and would produce certainty expost as to the actual level of emissions under the cap. Offsets will deliver none of these benefits. A price-collar would keep costs within the ACES emissions trading market commensurate with expectations. By doing so it would help to ensure the ongoing support of constituencies essential for an enduring and stable climate policy. Finally and most importantly, a price collar would provide a guaranteed minimum return for clean-tech innovators seeking to displace older fossil generation. This guaranteed return would increase the provision of new and innovative technologies to the U.S. economy. By doing so, it would also increase the number of green jobs created by a U.S. climate program, and help to position the U.S. as a leader in the global energy revolution.

2. Crediting of Business-as-Usual Activities in the Clean Development Mechanism

The environmental integrity and cost-effectivenessof a carbon offset system depend on the ability to rapidly, reliably, and cheaply determine how entities seeking carbon offsets would have behaved in the absence of emissions trading. This "business-as-usual" or baseline scenario can then be compared to the proposed offset activity. Any reduction in emissions from the baseline can then be credited with offsets. Offsets must, if they are to be effective, must result in changed behavior. If not, then the result is that emissions do not fall either under the cap (where the offset is used as an alternative compliance tool) or outside the cap (where emissions remain unchanged relative to the baseline scenario). If an offset system performs perfectly, the net of uncapped and capped emissions remain unchanged. For every ton reduced outside the cap, 1 ton is emitted by a covered entity inside the cap. Of course, no offsets market is likely to work perfectly; in practice, a balance must be struck between the over-crediting of business-as-usual behavior and the under-crediting of real reductions. But even evaluating this type-1 *versus* type-2 error requires some ability to objectively determine the counterfactual baseline scenario. In practice, this has proven impossible to do for real offset systems.

The Clean Development Mechanism of the Kyoto Protocol (CDM) is the largest carbon offset market in the world, both in terms of volume of credits and value transacted. The CDM is also the world's first compliance grade carbon offset market. Firms covered by cap-and-trade regimes, most notably the European Union Emissions Trading Scheme (EU ETS), can use CDM offsets *in lieu of* allowances for compliance. The CDM was conceived with the twin goals of lowering compliance costs for parties to the Kyoto Protocol and assisting in the financing of sustainable development. The performance of the CDM holds important lessons for an analogous compliance grade carbon offset system proposed for the U.S. agriculture and forestry.

The CDM has evolved through time as it has both grown in size, from just a few emission reduction projects to more than four thousand, and in complexity, from just a few project types to over one hundred. During this growth process, the regulators of the CDM have learned by doing and have improved practices. These improvements have been made mainly with the intention of insuring greater environmental integrity. **Nevertheless, both anecdotal and systematic evidence suggests that substantial crediting of business-as-usual projects continues to occur. The root cause of the problem appears to be an inability to reliably determine the baseline scenario for a particular project or class of projects.**

The problems in the CDM have been greatest in sectors and countries where government regulation or subsidy plays an important role in economic activity. In China where more than half of all CDM credits originate, this is most evident in the energy sector. The Chinese energy sector, because of its strategic importance, remains largely state controlled and in many cases, state owned. The basic problem for the CDM is that state mandates and subsidy programs, along with a complicated and non-transparent interaction between state owned banks, state owned utilities, and financial and energy regulators, already strongly favor the construction of renewable and natural gas fired energy production. Some small fraction of the new capacity added is no doubt caused by the additional finance provided by CDM. However, in practice, almost all new plants in the wind, hydro, and natural gas sectors apply for and receive credit under the CDM for emissions reductions (see *Figure 1*).[2]

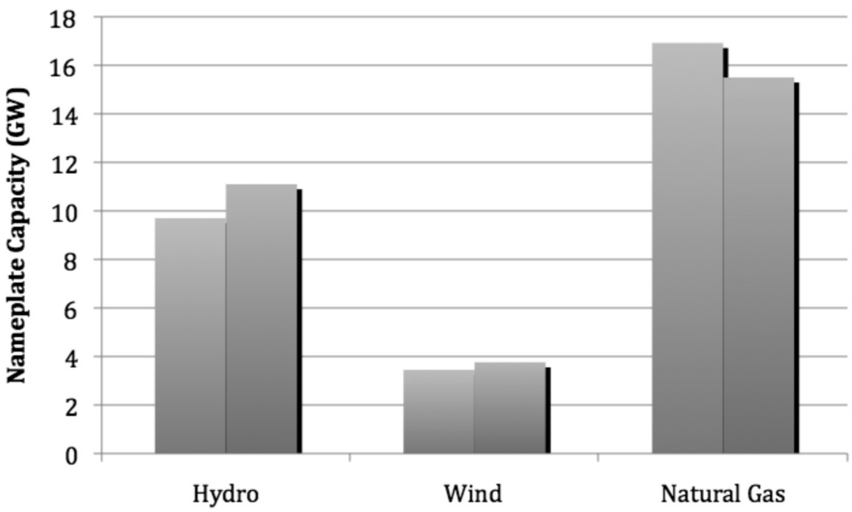

Figure 1: Hydro, wind, and natural gas fired power plants built or under construction in China compared to applications for CDM crediting for these projects. Essentially all new capacity (blue bars) is applying for CDM offset credit (red bars). Issued credits are based on the difference between these new energy sources and the Chinese grid GHG emission intensity. Shown are new capacity and CDM applications for Chinese hydro and wind power in 2007, and for natural gas-fired power in 2005–2008.[3]

The problem for the CDM has been that in practice, there is no straightforward way to determine whose behavior has been altered because of offsets and therefore who should receive them. CDM regulators have been forced

[2] *See,* Michael Wara and David Victor, *A Realistic Policy on International Carbon Offsets,* Stanford Program on Energy and Sustainable Development Working Paper #74 (2008), *at http://pesd.stanford.edu/people/michaelwara.*

[3] Hydro and wind CDM applications exceed new capacity additions in part because some plants applying for credit in 2007 were built earlier and in part because some plants that applying for credit experienced construction delays. Data Sources: National Development and Reform Council; International Gas Union; International Energy Agency; Jørgen Fenhann, UNEP-Risø Centre, CDM–JI Pipeline Database.

to add layers of bureaucracy in an ultimately futile effort to determine which of the many applicants are telling a genuine story regarding emissions reductions and which would have installed cleaner technology even in the absence of the carbon market. As a result, there are lingering uncertainties as to the quality of credits that have been and are being issued by the CDM.

CDM offsets are most often bought for use as alternative compliance in a cap-and-trade system. The impact of their uncertain quality translates into uncertainty as to the quantity of emission reductions produced by the overall program of cap, trade, and offset. The same fate would likely befall a U.S. system. In the EU ETS, this uncertainty has turned out to be less than anticipated because of the global recession. The recession has caused a fall in demand for electric power and hence for allowances and offsets. The fall in demand, combined with free allocation of allowances to emitters has resulted in relatively little use of offsets.[4] Even so, approximately ⅓ of the reduction between the cap in 2007 and the cap in 2008 was covered by CDM offsets. To the extent that these offsets are of doubtful quality, we will never know whether a third of the reductions within covered sectors for the first year of the Kyoto Protocol were real or mere paper reductions. Unless ACES can somehow resolve the lingering uncertainty and criticism that has surrounded determination of baselines and consequent emissions reductions in offset programs, it will suffer the same fate. And ACES if enacted, would rely on offsets to a far greater extent than does the current EU ETS.

3. The Clean Development Mechanism Struggles to Produce a Large Offset Supply

Another surprise of the first 5 years of CDM operation has been the difficulty the system has had in producing large numbers of issued credits. Reliable supply of large volumes of offsets is a necessity for a cost-containment mechanism. The problem for CDM offsets has been that in order to maintain environmental integrity, a complex and time consuming regulatory process is required. The CDM system works by first requiring that a project apply for registration, after which it operates, producing emission reductions. Reductions claimed by a project are then audited by an accredited third-party verifier. Only after this verification can an offset project owner apply for issuance of credits that can be used for compliance purposes. The ACES offset program is designed to operate in a similar fashion.[5]

In the CDM, this process has proven fraught with delay. The number of issued credits is far lower than had been expected or promised in offset project application documents or by early analyses of the market. Estimates vary depending on methodologies used to assess project and country risk, but expected deliveries of CDM credits were on the order of several billion tons. Over the past 5 years, the program has produced just over 300 million offsets (See *Figure 2*). Further, the rate of issuance, which increased through the early phases of the program, has recently stabilized at about 12 million offsets per month (See *Figure 3*). At this rate, the CDM will issue just 800 million offsets by the end of the Kyoto Protocol compliance period in 2012. This slow rate of issuance has been caused largely by the need to carefully check registration and issuance requests because of concerns about environmental integrity. Because each request and audit trail must be checked individually before approval, this is not an area where significant economies of scale have been found. Instead, issuance has emerged as perhaps the most significant bottleneck in the CDM process, followed closely by project registration.

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[4] In 2008, the first year during which covered entities could use CDM offsets as alternative compliance in the EU ETS, just 82 million offsets were surrendered, compared to a maximum allowed usage of 8% of the cap or approximately 150 million offsets. Data obtained from the European Commission Community Independent Transaction Log.

[5] ACES *supra* note 1, §§ 35, 736.

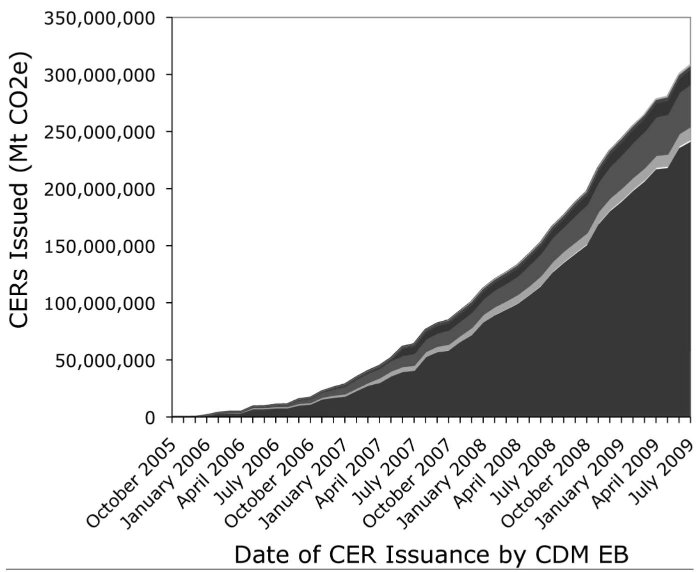


Figure 2: Cumulative issuance of carbon offsets, known in the CDM as Certified Emission Reductions (CERs) by the CDM to July 31, 2009. Total issuance is just over 300 million CERs over almost 5 years. 70% of issued CERs come from large industrial gas projects (Red). The remainder come from a mix of methane capture (Tan), renewable energy (Green), industrial energy efficiency (Blue) and natural gas power plants (Grey).[6]

Furthermore, the composition of the projects generating credits is strongly biased towards those that generate large numbers of credits. This dramatically reduces the number of requests for issuance that must be reviewed by the CDM. Thus the current rate of issuance is unrealistically high relative to the entire universe of offset projects, or a U.S. domestic offset program focused on farms and forests. Shown in red in *Figure 2* are the industrial gas capture projects, which have generated more than 70% of the issued credits to date. These offset projects capture high global warming potential gases at industrial facilities. Because each ton of high GWP gas is worth between 310 and 11,700 times a ton of carbon dioxide, these projects generate enormous volumes of credits. Industrial gas projects greatly simplify the workload for the CDM, since a few large issuances from these projects make up most of the flow of credits. Unfortunately, these are unlikely to be representative of either the future of the CDM or of a U.S. domestic offset system. The remainder of projects in the CDM portfolio or in any other potential offset portfolio will be significantly smaller in scale and so require proportionately more work on the part of regulators to process and approve. Thus because of the project mix in the CDM, the market may be operating more quickly than is likely for a U.S. offset system.

[6] Data compiled by the author from the CDM issuance database, *at http://cdm.unfccc.int/issuance/index.html.*

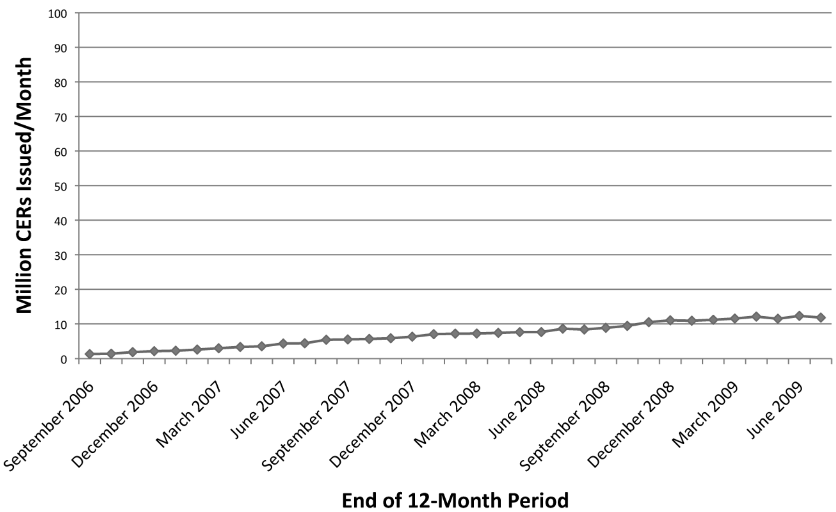


Figure 3: The 12 month running average of CDM offset issuance scaled to reflect the approximate monthly requirement to meet ACES demand for domestic offsets, 100 million tons per month. CDM issuance rates appear to have stabilized at 12 million CERs per month.[7]

Whatever the ultimate issuance rate achieved by the CDM, one thing the system has made clear is that actually producing compliance grade offsets is a complex and time consuming regulatory undertaking. Building the regulatory apparatus for the CDM has proven quite challenging, especially as concerns about quality have caused greater scrutiny to be applied to each project registration and request for issuance. This scrutiny takes time and leads to delays and hence a slower than anticipated production rate of offsets. Luckily for those nations and firms otherwise dependent on the CDM for cost containment, the global recession, by reducing economic activity, has substantially lowered emissions.[8] This in turn has greatly reduced the need for offsets and the costs of not having them, averting what could have been a compliance crisis.

4. Implications of the CDM example for ACES

The CDM is the carbon offset system about which we know the most. But how relevant is experience gained under the Kyoto Protocol to the ACES offset program? I believe that the lessons presented above, of difficulty telling good from bad credits, and of the challenges of producing adequate supplies of credits, are likely to be highly relevant to an offset program of the scale contemplated by ACES.

No offsets system, including the CDM or ACES, can avoid the problem of establishing emissions baselines against which actual emissions are judged. The CDM has illustrated the difficulty of this task. By 2020, the ACES offset program would likely be approximately 20 times the size of the current CDM, if measured in terms of issuance rate (See *figure 3*).[9] Extrapolating from the relatively small size of the CDM to the much larger ACES program is necessarily uncertain. This is especially the case because ACES contains provisions for both a large international forestry offsets program[10] as well as a large domestic agricultural and forestry offsets program.[11] Also, ACES incorporates numerous provisions aimed at improving the quality of its offsets program compared to the CDM.[12] Nevertheless, the fundamental conceptual and administrative challenges that have confronted the CDM are unlikely to be absent from an ACES offsets program. Such a program will

[7] *Ibid.*

[8] The United States is a useful point of reference in this regard since it did not ratify the Kyoto Protocol and so is not trying to reduce emissions in order to comply. During 2008 and 2009, the EIA estimates that U.S. emissions have fallen by between eight and nine percent.

[9] *See,* Environmental Protection Agency, *EPA Analysis of the American Clean Energy and Security Act of 2009: H.R. 2454 in the 111th Congress* (Jun. 23, 2009)

[10] ACES *supra* note 1, §§ 751–756.

[11] ACES *supra* note 1, §§ 501–511.

[12] ACES *supra* note 1, §§ 731, 739, 509, 531.

struggle to create offsets of undisputed high quality because of difficult baseline determination problems, both in domestic agricultural and forestry settings and in the international regime. It will have to confront the reality that its rulemakings are potentially subject to challenge in court under the Clean Air Act and/or the Administrative Procedure Act. The CDM Executive Board faces no such scrutiny of its decisions, or potential source of delay, in its implementation.

In addition, the ACES cap-and-trade program is, far more than the EU ETS, dependent on offsets both for cost-controland for environmental effectiveness. Most analyses of the bill indicate that allowance prices will approximately double in the absence of a ready supply of offsets.[13] In its analyses of the bill, EPA estimates that less than 50% of emission reductions that occur due to its enactment will be in capped sectors prior to 2030 (See *Figure 4*). The majority of the bill's environmental impact hinges on the offsets program having superb environmental quality. If not, then emissions will occur under the cap and be covered by offset credits that due not represent real world reductions. In order to accomplish this objective, the ACES offset program, both international and domestic, will have to accomplish a far higher level of environmental oversight than has proven possible, even with the best intentions, within the CDM.

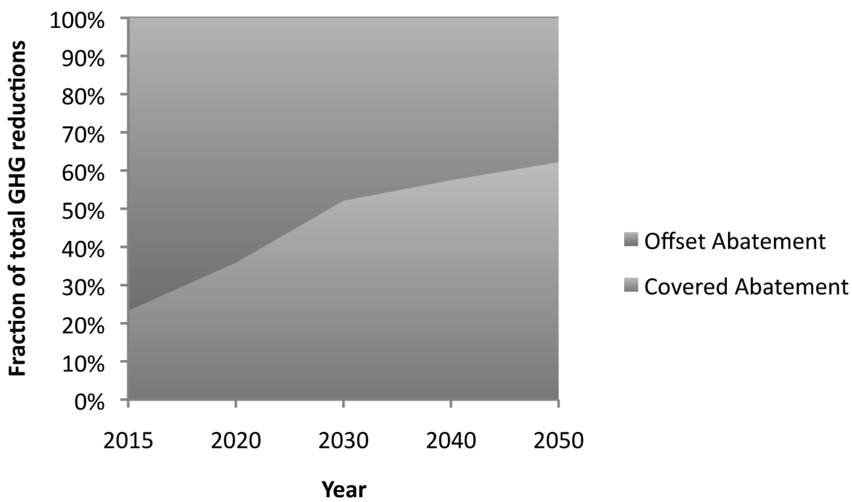


Figure 4. An EPA projection of the relative proportion of emissions reductions that occur at sources covered by the ACESA cap and at offset projects occurring at sources that are not covered by the cap.

In order to avoid chronic shortages of credits, and consequently very high allowance prices for covered entities, USDA and EPA will have to accomplish more stringent environmental review of offsets at a much faster rate than the CDM—at least 20 times the speed of the current CDM. All economic analyses of the bill suggest that its costs will nearly double if offset supply is significantly constrained or delayed.[14] Failure to produce the expected offset supply might both cause undue harm to the U.S. economy and undermine long-term support for the ACES program. In the event that offset supply proves lower than expected under ACES, the EPA and USDA will come under tremendous pressure to lower standards in order to increase the rate of supply of new offsets into the U.S. emissions trading market. The dependence of ACES on offsets thus exposes it to significant environmental and political risks. Insufficient offset supply may drive a reduction in standards thus undermining the basic rationale for a carbon market. Alternatively, if USDA and EPA are unable or unwilling to increase supply by lowering standards, political support for the program might be severely undermined.

[13] EPA *supra* note 9; Congressional Budget Office, Economic and Budget Issue Brief: *The Use of Offsets to Reduce Greenhouse Gases* (August 3, 2009); Energy Information Administration, *Energy Market and Economic Impacts of H.R. 2454, the American Clean Energy and Security Act of 2009* (Aug. 4, 2009).

[14] *Ibid.*

6. A Conservation Incentive Program Would Provide Greater Benefits to the Environment and to Farmers and Forest Land Owners

Allocation of a substantial block of the allowance pool to a Conservation Incentive Program could be used to accomplish many of the benefits promised by agricultural and forestry offsets. One of the key benefits of offsets is that they extend incentives to reduce emissions beyond the scope of sectors covered by the cap. Offsets create a potential financial benefit for reductions in uncapped sectors, such as agriculture, or uncapped jurisdictions, such as Brazil, to reduce GHG pollution even though they are not required to do so. This benefit need not be sacrificed just because offsets are not relied upon for cost-containment. The simple solution is to dedicate revenues raised by the auction of allowances towards reductions outside of the cap.

Revenue produced by the auction of a dedicated fraction of the allowance pool could be channeled towards GHG emission projects on farms and forests via a Conservation Incentives Program (CIP). Such a program could assist the agricultural and forestry sectors in reducing their emissions. This could be accomplished via payment for the cost of particular activities that are known to result in lowered emissions or via open requests for proposal for emission reduction activities.

Administration of an agricultural and forestry Conservation Incentive Program would be far simpler than an offsets program. The two great challenges of administering an agricultural offset program are measurement and permanence. A CIP, because it is not linked to an emissions trading market greatly simplifies both. Measurement of carbon emissions of similar accuracy and precision to covered sources is difficult and costly to accomplish on farms and in forests. This is the case both because baselines are difficult to determine in heavily regulated sectors and because site-specific quantification is expensive. At the same time, permanence looms large for sequestration based offsets because reversals threaten the integrity of the cap. In contrast, a CIP could handle these issues more flexibly and could more realistically shape an emissions reduction program to fit the needs and capabilities of both U.S. farms and forests. A CIP would enable society to capture greater benefits from the contributions that farms and forests have to make towards reducing emissions while also simplifying the process of farmers and foresters gaining credit for their actions.

A Conservation Incentives Program could take better account of the co-benefits provided by practices that reduce GHG emissions from U.S. farms and forests. Linkage to a carbon market narrows the factors that can be considered in paying farms and forests to a single dimension—tons of carbon dioxide reduced or sequestered. In reality, the changes that lead to reductions in GHGs will also have tremendous co-benefits in terms of water and air quality as well as biodiversity. Farms and forests deserve credit for the additional benefits that a GHG oriented program will provide but will be unlikely to receive it from a carbon market. Furthermore, despite a desire to do so, USDA and EPA will have a hard time favoring projects that produce substantial co-benefits in addition to GHG reductions over those that solely produce tons of carbon. A CIP, because it is not tied directly to the carbon market, would allow USDA and EPA to be more flexible in taking these other benefits into account when determining payments to land owners.

By paying for practices rather than allowing farms and forests to sell tons of carbon, a CIP might produce more stable streams of revenue for farmers, thus increasing participation. Pricing of carbon offsets is ultimately determined by the supply of offsets and allowances in the carbon market relative to demand from covered entities. Just as with other commodities, swings in price can be quite dramatic. Farmers and forest managers are familiar with the key commodity markets with which they interact and are used to managing the risks associated with price volatility. That being said, changing farm or forest practice in order to generate an uncertain quantity of offsets of uncertain price will in practice reduce participation. Managing these risks requires forward selling the offset stream at a substantial discount to an offset aggregator that is willing to bear both the quantity and price risks. While this will reduce the volatility of this novel income stream, it will also reduce its benefits to agriculture and forestry, since the carbon offset middlemen will demand (and deserve) to be compensated for holding this risk. Because a CIP would not create these risks for land managers, they would both capture more of the financial gains from the program and could participate without incurring increased risks to their operations.

Finally and not unimportantly, a CIP, rather than requiring the creation from whole cloth of a new set of capabilities at USDA and EPA, can take advantage of preexisting programs to get moving quickly and with little controversy. Regulation of a large offsets market requires a unique set of skills and capacities. These take time to develop. In addition, an offset system under ACES would require the promulgation of numerous regulations. Many of these rulemakings, however carefully managed, are likely to be challenged in court because of the importance of the offsets program to the environmental integrity of ACES and to the economic well being of farmers. Rather than spend 8 to 10 years developing and then litigating a complex regulatory apparatus for offsets, it makes far more sense to grow the currently existing programs via enhanced revenue streams from the cap-and-trade system, while shifting their focus towards a new emphasis on GHG emission reduction and sequestration.

7. The Advantages of a Price Collar Over Offsets for Cost-Control

A price collar or symmetric safety valve sets a reliable and simple upper and lower bound on allowance prices in a cap-and-trade system. A price collar places a hard and certain limit beyond which U.S. permit prices would not fluctuate. These trigger points would increase each year at a predetermined rate in excess of inflation over the life of the program. Operating such a system would be relatively straightforward compared to the complexity of a high quality offsets system. If allowance prices exceeded the price ceiling, the government would sell allowances into the market until the price fell below the ceiling. All allowance auctions would be held with a reserve price such that no allowances would enter the market at a price below the floor. If an exogenous shock caused prices in the secondary market for allowances to fall below the floor, the government could respond by reducing the number of allowances released for auction at regularly scheduled intervals until the price stabilized at the desired level.

The history of emissions trading schemes indicates that *ex ante* predictions of permit prices are generally inaccurate and biased toward overestimation of cost. Experience with cap-and-trade programs to date indicates that a lower bound on prices is as important as an upper bound. The U.S. Acid Rain Trading Program (ARTP), the Regional Clean Air Incentives Market (RECLAIM), and the EU ETS have, more often than not, exhibited prices far below marginal abatement costs predicted prior to their enactment. In the ARTP case, this was because abatement costs were in fact far lower than predicted. For RECLAIM, the problem was early over-allocation of allowances. In the EU ETS case, this was because of over-allocation in the first phase of trading (2005–2007) and due to recession in the second (2008–present). All three emissions trading markets have also experienced relatively brief periods of very high prices. The truth is that because we don't know with much certainty what marginal abatement costs will be under cap-and-trade, what fuel prices will be, and the future trajectory of GDP, it is impossible to predict with any accuracy or precision what allowance prices will be. Pretending otherwise is a misuse of the models used to estimate differences between policy outcomes.[15]

A symmetric safety valve provides reliable cost-containmentfor covered entities planning for compliance with a cap-and-tradesystem. In theory, offsets provide a solution for firms worried about the costs of compliance with cap-and-trade. In practice as described above, the biggest carbon offset market has been unable to provide either cost-containment or the environmental integrity required to ensure quantity certainty. Further, there is little reason to believe that the causes of this failure can be avoided under ACES. In contrast, a safety valve, because it responds directly to the price of allowances, provides far greater certainty that costs will not exceed a particular level during any given compliance period. Especially under a program like ACES that provides emissions targets until the mid-twenty-first century, such cost certainty allows for sound long-term investment planning on the part of vertically integrated utilities and merchant generators. In Europe under the EU ETS, it has proven very difficult for utilities to plan for new generation when there is tremendous uncertainty as to the carbon price. Such planning certainty is an important policy objective of any U.S. climate program and a key prerequisite to charting a secure, clean, and low-carbon U.S. energy future.

A symmetric safety valve will also provide a reliable minimum price for allowances that will enable firms to confidently make investments in new pollution reduction technologies. The history of cap-and-trade programs is as much a story of prices that fell below expectation as above. This result has led the clean-tech start-ups that create and venture capital firms that fund new energy technologies to ignore carbon prices when planning and investing. A price collar that

[15] The computed general equilibrium and energy system models used to estimate future allowance price and program costs are likely far more reliable at estimating differences between policies than absolute costs. For example, estimates of the difference between a case with offsets and without offsets is likely more informative than an estimate of the absolute cost of either.

provides long-term certainty as to the minimum price of allowances in a U.S. cap-and-trade would allow the innovative firms to count on a certain level of advantage relative to traditional fossil generation technologies. Providing this minimum certainty would allow startups to more fully capitalize on the societal benefits that their new low-carbon technologies will provide. As a consequence, a price floor would increase the provision of these technologies to the U.S. economy, increase the number of green jobs created by a U.S. climate program, and help to position the U.S. as a leader in the global energy revolution.

While a price collar does not provide absolute certainty of emissions limits, neither would a real-world carbon offset system. It's important to emphasize what is not given up in the choice of cost-containment strategy. The main criticism of symmetric safety-valve proposals is that they do not provide quantity certainty for climate policy.[16] That is, they do not pretend to provide certainty as to the level of pollution that will be allowed in any given year. As has been shown above, offset systems promise to provide this certainty, but in practice fail to do so. Thus the choice between quantity certainty under a cap, trade, and offset system like ACES and quantity uncertainty under cap-and-trade with a price collar is in reality, a false choice—neither approach can provide both cost containment and certainty as to the maximum pollution level. In fact, given the low allowance price history of emissions trading programs, it is at least likely that a price collar would provide superior environmental results due to its ability to reduce the supply of allowances when prices fall too far.

8. Conclusions

Experience with the CDM has shown that large compliance grade offset markets fail to provide either adequate environmental integrity or a sufficient supply of offsets. The former results in substantial doubt as to the reality of reductions promised by the cap on emissions; the latter in significant cost uncertainty for the program.

Revenues raised from the auction of a dedicated block of allowances could be used to create a domestic agricultural and forest GHG pollution reduction program that better matches the needs and capabilities of these sectors. By doing so, farms and forests could dramatically reduce their GHG emissions while avoiding the costs and uncertainties associated with the implementation of a large offsets program. In addition, they could do so today, rather than after the administrative rulemakings necessary to implement the program have occurred. Finally, because such a program would not be tied to carbon markets, it could take better account of the many co-benefits provided by improved GHG management on farms and in forests.

A symmetric safety valve creates certainty as to the range of possible allowance prices. This allows firms to plan for a worst-case and allows new technologies to fully capitalize on a minimum guaranteed return from the carbon market. It also insures that the political calculus of costs and benefits central to the enactment of the cap-and-trade program is in fact realized in practice.

The CHAIRMAN. Thank you, Dr. Wara.

Well, I will ask the four other panelists what they think of Dr. Wara's proposal to use additional incentives instead of going the offset route.

Dr. MURRAY. Mr. Chairman, I think it is an intriguing proposal and one that has been discussed in the policy discourse in many circles, the idea of having an agricultural program that is supplemental to the cap-and-trade program rather than an integral part of it. I think some of the challenges associated with that would be whether or not the volume of financing could come to the scale necessary to address the problem. The scale of the carbon market in the United States to address the problem could be on the order of tens of billions of dollars, and whether or not the Federal appropriations process would bring that much money to the table is, I suppose it is a question for you and your colleagues.

So I think that is important. I also think it is important to point out that regardless of whether it is the government paying for it through supplemental program or the market paying for it through

[16] A lack of quantity certainty is also the major criticism of carbon taxes.

an offset system, quality is still important. We want the government to get what they are paying for as well, and so some of the issues associated with ensuring the integrity of the program I would submit apply to a public supplemental program as well as a market program.

Dr. McCarl. We have been running a program that looks an awful lot like what he describes since the 1920s in the form of erosion programs. I do remember that in 1985 or so when I was at Oregon State, someone indicated that 90 percent of the money to control erosion was spent on land that didn't have an erosion problem. There is a huge targeting issue here and it is not unique to cap-and-trade. It is just unique to how we do this and how get this thing working.

Dr. Sohngen. I would just reiterate for the most part what the two previous folks have said and add that in my experience, part of my experience is working as an extension economist and working with some farmers on implementing some of the farm bill programs. I just want to reiterate what Brian said earlier, it is, in fact, the measuring, monitoring, verifying function of the government with respect to some of the programs that are in place for environmental pollution improvement are quite limited and they would appear to be just as difficult to achieve as what we would have in a private market. I would actually think that the private market might actually be better at doing some of those things, at getting around some of the measuring, monitoring and verifying issues. The incentives are, perhaps, better for the private market because they have an incentive to figure out contracts, to figure out measuring and monitoring schemes that work effectively, efficiently and cheaply. Actually doing it through a market has some great benefits as opposed to doing it through the government.

The Chairman. Dr. Hayes, any comment?

Dr. Hayes. I did have some concerns when I read the ACES Act about the viability of international offsets, especially for the reasons that he mentioned. I do see a lot of money leaving the United States and the potential for scandal if those programs are not run effectively. However, if you look at the ACES Act itself, it has enormous reliance on international offsets, and I am not sure that worldwide agriculture can come up with the needed carbon savings unless you use some kind of offset program.

One thought that I had is that it might be possible to pay farmers to sink char, which is really a form of coal that comes from burning wood and cellulose in the absence of oxygen and pay them to sink that rather than to participate in a domestic offset program. That may have potential. Otherwise I would see a problem with the approach because they can't come up with the kind of numbers we need in the absence of a large afforestation effort.

The Chairman. Thank you.

Dr. McCarl, it is my understanding that EPA utilized your model in doing their analysis of H.R. 2454. Is that correct?

Dr. McCarl. My model was one part of their total analysis. They used quite a few others.

The Chairman. Okay, but can you walk us through how you arrived at the conclusion that millions of acres could shift from crop production to trees?

Dr. MCCARL. Well, one way that it does happen is that a ton of wood is about 50 percent carbon, which means when you convert to carbon dioxide, it is roughly 4 tons. If you take wood now and sell it for a pulp price, you get somewhere $60 a ton or something maybe a little more than that. If you have a $50 a ton carbon dioxide price, then that is $200, meaning it is three to four times as valuable as the current use of much of our forested lands, and this would yield a much greater conversion of land into forestry. So the model looks at basic economic forces. It looks at the opportunity cost of the land and its existing use. It looks at the new return streams and it moves land to the point the economic value is equalized across all the possible uses.

The CHAIRMAN. Thank you.

Mr. Goodlatte.

Mr. GOODLATTE. Well, thank you, Mr. Chairman. This is fascinating. I have way more questions than I can ask in 5 minutes. I hope you will consider doing a second round here.

I think the Chairman asked a very important question that opens the door to an appropriate discussion about this legislation, and that is asking the rest of you your opinion of Dr. Wara's alternative solution, because I find that alternative solution intriguing as well. I think that Dr. Murray hit the nail on the head when he criticized it by saying it would cost tens of billions of dollars. In fact, it would cost tens of billions of dollars per year for the rest of this century to substitute that alternative to the cap-and-trade proposal that is in this legislation. To suspect that the Congress would vote for legislation that would provide tens of billions of dollars to accomplish that and then to either offset reductions in other government spending or raise revenues to pay for it is exactly why that approach is not likely to happen.

But that also exposes the problem with this legislation itself because the fact of the matter is, this costs our society tens of billions of dollars and the cap-and-trade legislation simply does an excellent job of masking that cost. It is in the form of increased costs ultimately to consumers, not only in food prices, as we see reflected here, but also in terms of increased costs of electricity, of other sources of energy that are directly used by consumers, increased costs of manufactured goods, even increased costs of services are all masked in this cap-and-trade proposal that will indeed cost tens of billions of dollars per year to our society. It will end up costing us millions of jobs, and a much bleaker future which leads back to a question that I am not sure any of you came here to answer because you are all economists. Is that correct? You are not an economist? Okay, well, what is your——

Dr. WARA. I am a lawyer and I used to be a geochemist.

Mr. GOODLATTE. All right. Well, the chemist might get a little closer, but the real question here is, what kind of cost-benefit analysis of this entire process is being done relative to whatever environmental benefits are derived from doing this relative to this enormous cost that we are putting through this system? So my question to each of you is, are you familiar with another alternative that has been proposed by another, I think he is also an economist but I am not sure, a fellow some of you are probably familiar with named Bjørn Lomborg, who has a written book called *Cool It.* He has written some other books in this area. Are any of you familiar with Mr. Lomborg's work? Basically he says global warming exists, global warming is at least in part and perhaps significantly caused by human activity but that cap-and-trade, the Kyoto protocols and even the kind of undertaking that Dr. Wara would propose. It is an enormous waste of resources that redirects huge sums of money, trillions of dollars over the course of this century for a very limited marginal benefit in terms of the climate change that will be affected. That it would make much more sense to devote multiple times the amount of money we put into research today into developing with government resources but still a fraction, $\frac{1}{20}$ of the cost of this legislation, developing more efficient alternative sources of energy that are carbon emission-free whether it is wind energy or solar or geothermal or hydrogen, or things we haven't even thought of. All of which are today far more expensive than our traditional sources of coal, oil, and natural gas. Even nuclear power, which somehow this legislation gives very short shrift to and it is totally carbon emission-free, and by far the most efficient way to generate energy that we have available to us right now today. This would be the better alternative to pursue and that we are also by this expensive cap-and-trade process foregoing the opportunity to spend those resources on cleaner water, fighting diseases, eliminating hunger around the world. Instead, we see from Dr. Glauber's testimony earlier, and from some of your testimony as well, confirming that this is going to add to the cost of food fairly significantly. One of you, I think it was Dr. Hayes, said that corn prices will be 28 percent greater than they otherwise would be than the baseline and soybeans 20 percent by 2023. Dr. Glauber said hog production will be 23 percent lower and beef slaughter ten percent lower, which would yield higher prices again in the 20 to 30 percent range for several of these commodities as well. Why are we doing that?

Do any of you want to take on that basic question that each one of us had to do when we voted for or against this legislation, and say is there a better alternative to this whether it is Dr. Wara's or something else that would address this problem without going to this enormous diversion of very scarce resources? Dr. Murray?

Dr. MURRAY. Thank you, Congressman. In response to the first part of the question——

Mr. GOODLATTE. You could call it a diatribe if you want. I wouldn't be offended.

Dr. MURRAY. That is fine. It was a fine one at that. You may be aware of a study that was done by Lord Nicholas Stern, former Chief Economist of the World Bank and is now in the United Kingdom.

Mr. GOODLATTE. I am familiar with it and of the criticism of it.

Dr. MURRAY. And of the criticism, and it is not without criticism. But it is in my view the most comprehensive study that has actually tried to look at the evidence from the bottom up looking at a different range of empirical evidence and projections that are out there from the damage from climate change, and so you are aware of the conclusion that the benefits of taking action exceed the costs. Another set of studies or some other work that was really more commenting no that is by an economist at Harvard, Martin Weitzman, that looked at it. He concluded somewhat glibly and rather famously that the Stern review is right but maybe for the wrong reasons, and his point of view is that this is better characterized as a risk problem and so we don't really—there is a distribution of possible climate outcomes and towards the middle of that distribution——

Mr. GOODLATTE. I am going to interrupt for a second. Mr. Lomborg says that when you take a look at a wide array of studies that have been done in this area, the outcome is that you lower the temperature if you take the mean average of those studies by less than a ½° centigrade, I think he says 2⁄10° centigrade by 2080. So I don't——

Dr. MURRAY. Well, I will have to look at Dr. Lomborg's——

Mr. GOODLATTE. I commend it to you. I think he is very pragmatic about this and does not shy away from the problem, but takes the solution in a very different direction. He is part of the so-called Danish school or Copenhagen school, which seems a little ironic that they are going to Copenhagen in a couple of weeks. He would very much disagree with the conclusions that most of the people going there are headed to draw. Thank you. If you want to finish, I will be happy to——

Dr. MURRAY. Just to say that there is the notion that there is a small probability of high what economists and other analysts call fat tail risk. At the very upper end of the distribution, there is a small probability of truly catastrophic costs that if you look at it from an insurance perspective that that provides a strong economic incentive for action. But I don't want to take more time than I have available to me.

Mr. GOODLATTE. Well, the Chairman is giving me leave to let others jump in even though I am way beyond my time.

Dr. MCCARL. I happen to be the ag economist much to the chagrin of some people I work with that said climate change is beneficial for agriculture on a national basis, and the same thing in forestry. So I do believe we need to look at cost-benefit of this stuff. Risk is a pretty big issue. Galveston got wiped out by a hurricane a couple years ago and there are 62 meters of potential sea-level rise between Greenland and Antarctica, so there are some areas that are pretty vulnerable and at pretty big risk in this particular arena. I don't think there is——

Mr. GOODLATTE. So what do we say to those people who say that there is a huge risk of various types of diseases that are on the rise around the world and we don't have the resources to address those. If you are in a developing country you won't have the resources to develop clean water and better other land management techniques because we are going to divert these costs into an artificially high price of energy. This is really what cap-and-trade is all about, creating a higher price for energy in order to encourage and allow the development of other competing sources of energy that are cleaner to be able to compete in that environment. That is really the net effect of cap-and-trade, is it not?

Dr. MCCARL. I think we have an—you have an extraordinarily difficult job to balance the competing uses for funds. I do think if we don't act on the climate change issue that we are seen as a world leader and the rest of the world won't act on the climate change——

Mr. GOODLATTE. Sure, but we are a world follower on this issue. I mean, Europe has been dealing with cap-and-trade for a long time with limited success, if at all. Quite frankly, they only addressed this with regard to fixed sources of energy production like power plants and so on. Their cap-and-trade doesn't include transportation and so on. And Lomborg doesn't say do address this. He says you are better off doing things to prepare for sea-level rises, you are better off doing pragmatic things like developing a trend where roofs are white instead of dark colors and other things that would help to deflect the impact of the rising temperatures. We should develop alternative sources, which if you put more money into doing that you could come up with non-carbon sources of energy at a faster rate than cap-and-trade will bring, without as much cost.

Dr. MCCARL. Well, let me make two real quick points. I am on the National Academy panel on limiting climate change and our report is written, and I can't really say what is in it yet but something that—I mean, a portfolio solution is obviously going to be something we have to pursue with R&D subsidies as well as other actions to limit emissions. I will just give a couple of words of caution, one of which is, in 1977 I was asked by the Office of Technology Assessment to look at making corn into ethanol including making corn stalks into ethanol which we would be able to do in 2 or 3 years. Today that is known as cellulosic ethanol, and today we still say it is about 5 years off. I mean, picking the winners——

Mr. GOODLATTE. My livestock farmers are praying for cellulosic ethanol but they have been praying for it for a very long time.

Dr. MCCARL. Since at least 1977, I would suggest, and in the energy bill we have requirements we are going to have to meet in 3 or 4 years, but I am not sure we know if we really will get there. I think the portfolio solution is it. I think that he is right in that we do need big R&D subsidies for some of these sorts of things. On the other hand, I think that is something that is going to be substantially in the future before it completely pays off and we may need some other actions like cap-and-trade to get things going. The real question is one of what is the long-term damages and are the costs worth the damages. Actually, from a very strict accounting standpoint, it is difficult to justify some of the actions that have been talked about in terms of the damages that we are seeing if you really do it on a financial cost-benefit analysis basis.

Mr. GOODLATTE. Anyone else? Dr. Sohngen.

Dr. SOHNGEN. If I could just comment here, I actually appreciate that you brought up Bjørn Lomborg's work. Our forestry study was part of his most recent set of estimates where he looked at 16 different climate options, and forestry ended up pretty well. It scored at number eight, so the forestry offsets look pretty good relative to other options that were substantially lower than that.

Mr. GOODLATTE. Great. Our problem, however, is that it takes an awful lot of land out of agricultural production to accomplish it.

Dr. SOHNGEN. Sure, sure.

Mr. GOODLATTE. And here is another question I have about that. I understand the short-term benefit of that, but ultimately you have to do something with those trees. You have huge forests of trees containing a lot of carbon in them, but as trees get older they take in less carbon and at some point they start dying and they are going to either give that carbon back off or you have to do something else with it. What is the long-term solution there? We won't be around when this happens, but I would still like to know.

Dr. SOHNGEN. I hope we are around when some of it happens, but most of our models actually assume that forests, at least productively managed forests, which is roughly 600 million hectares to 1 billion hectares, are managed. Those forests will continue to be managed so that the harvested products from those, they will be removed and replanted to forests. So for the most part——

Mr. GOODLATTE. But what are you going to do with the carbon when you remove it from those forests?

Dr. SOHNGEN. It works its way into products. About 30 percent of it works its way permanently into forest products. The other 60, 70 percent goes up in the atmosphere and then is within the next 10 to 15 reentered into the forest through the regrowth of the forest. So the cycle actually can continue on and you can allow the harvesting. It has a large, about a 30 to 40 percent reduction in timber prices by 2030 or so.

Mr. GOODLATTE. You referred in your testimony to $500 per hectare or basically $200 an acre in remuneration. What is that? Over what period of time is that?

Dr. SOHNGEN. That is an asset value so the present value today. That is for every——

Mr. GOODLATTE. So once you make the decision to do this, that is the offset value you will get forever, it is not $200 per year?

Dr. SOHNGEN. Right, and that is allocated across every hectare in the world. We don't anticipate that every hectare in the world would get that.

Mr. GOODLATTE. How is a farmer going to make a living converting his farm into trees if he is only going to get $200 per hectare plus what he can sell his wood for?

Dr. SOHNGEN. Well, that includes a lot of places like Boreal forest, which are pretty low value trees, so if you actually looked at the distribution of it around the world, a farmer in Ohio for that same allocation would get something like $70 to $80 per acre per year rising over time. So, by 2030 they conceivably are getting $120 per acre per year. So that asset value is a very rough estimate aggregated across lots of different hectares in the world, but when you look at individual places, the numbers are pretty astounding.

Mr. GOODLATTE. So if we could eat trees, we would really be in good shape.

Dr. SOHNGEN. We might make fuel out of them some day.

Mr. GOODLATTE. Well, I agree, but then you are going to put that carbon back in the atmosphere.

Dr. Hayes?

Dr. HAYES. I am not brave enough to be able to do cost-benefit analysis of this Act but I have——

Mr. GOODLATTE. I wish somebody had, though. Is anybody aware of a really——

Dr. HAYES. There is a ranking of different worldwide policies and this kind of climate change comes up poorly. I was surprised how poorly it does come up. I believe there were three Nobel Prize winners on that committee so——

Mr. GOODLATTE. Would you send to the Committee information on how we can find that?

Dr. HAYES. I will do that.

Mr. GOODLATTE. Thank you.

Back to you now.

Dr. WARA. One small point I would make is that I agree with the sense of your comment, and the broadest sense of what Lomborg said in that innovation is the solution. It is the way out of this problem. We need to create a climate of innovation in the energy sector to help us find ways to make energy that is cost-effective relative to fossil energy, but does not create the environmental harms that fossil energy appears to create in this context. Cap-and-trade is one of the ways to get there in the sense that it produces a price signal from which forms of energy that don't produce carbon dioxide can benefit. I will tell you, when I talk to clean tech companies in Silicon Valley and the venture firms that fund them, one of the most significant components to their mind of the proposal in ACES is the reserve price in the allowance auctions. That there would be a floor on prices so that firms would be guaranteed at least $10 per ton carbon and that allows these clean tech firms to plan, to say if we can compete with coal at a $10 carbon price, then we have a viable product. It is that price signal that spurs a lot of investment and, potentially, innovation and more cost-effective innovation than really large government programs can necessarily provide.

Mr. GOODLATTE. Well, thank you for that very generous allocation of time.

The CHAIRMAN. The chair thanks the gentleman.

The gentleman from Minnesota.

Mr. WALZ. Thank you, Mr. Chairman, and I very much value the Ranking Member. He is a very valuable asset to this Committee and to me personally, challenging me to look at things differently. I think that line of questioning was very intriguing, one that I am interested in because I would have to agree with the Ranking Member on this. I am more than willing to look at other alternatives. I want to thank each of you for bringing that. That is what we are supposed to be doing as we are trying to work this out and trying to get there, what is going to happen. So I thank the Ranking Member for that. He does challenge me to look at those.

And there are some things that came up. One of the things I have been looking at, I was using the *Other Side of the Coin* study, the New York University Institute, the Policy Institute there, talking about the cost-benefit analysis, and what we are doing when we look at agricultural sectors, which is the farm—the Agriculture Committee's responsibility is disaggregating that data—but losing out of everything else that was happening in the economy. Do you think that is a weakness of what we are doing here in trying to question you on this without looking at the macro level of the entire program, whether it be cap-and-trade or some other type of ability to look at carbon, if that makes any sense? What we are doing as I see us pinpointing on this and we may see a little offset, we may see a few changes, but according to them, the cost-benefit analysis is 9:1, 9 positive. One of the best investments we could make is to get this country going. I think it is where the Ranking

Member was going, and I agree wholeheartedly with him. If we don't couple this with an energy policy that starts to move us away from carbon-based fuel, it is going to be very difficult.

So the Ranking Member will be glad to know that I put together a coalition with my Republican colleague from the 3rd district, labor, chamber of commerce and groups to ask for the overturning of the nuclear moratorium in Minnesota. I don't believe I could support this legislation without simultaneously working in that regard.

So what I am asking you is that as we come here today and we are looking at the impact on agriculture, we can't do that, can we, without looking at the whole sector that this impacts?

Dr. MCCARL. Eighty-four percent of the emissions are from coal and fossil fuels. About six percent are directly from agriculture and then there is some reduction due to forests. Now, on a global basis, agriculture is a little bigger than that, but no, it doesn't make sense to look at the impacts of this on an agriculture-only basis.

Mr. WALZ. Does anybody else have anything on that one?

Dr. SOHNGEN. Just one note. We did—as part of our analysis for the Copenhagen consensus, we analyzed offsets in forestry alone as a policy to combat climate change *versus* forestry as a synergistic policy that was a complement with energy policies, and when it was a complement the benefit-cost ratio was 1.6:1. When it was alone, it was less than 1:1, so it was not—you shouldn't do offsets if you are not going to do other things.

Mr. WALZ. Right. Very good.

Just as all of you are experts in this, I have been quoting and using a little bit of the study out of the University of Tennessee. They are using POLYSYS for modeling. My concern is getting broad-based modeling. I think many of you in here, Dr. McCarl especially, have put together some really good studies, very helpful to me. My one big concern, the Chairman of the whole Committee mentioned the different baselines, an EPA baseline, ag baseline. What about the baseline of doing nothing? And I heard Dr. Murray talk about this as insurance risk. I think that is very intriguing, meaning if we just sat and don't do anything, what is that going to do? Do we have that data in your mind?

Dr. MURRAY. I will just speak maybe in an attempt to clarify or maybe to understand when you refer to the different baselines, I want to make sure——

Mr. WALZ. Yes. If EPA regulates, here is what is going to happen to agricultural costs and the input costs; and here is what USDA has according to today; here is if we use RFS standards; here is we have multifaceted offsets that are well crafted in my mind; and then one of those being, what is this going to look like if we do absolutely nothing and the climate continues to change on what is the perceived trajectory.

Dr. MURRAY. Sir, the multiple baselines that you are referring to tend to refer to different policy options so there is really one baseline, which would be what happens in the future under business as usual in terms of on the cost side, and all these analyses have, as your question suggests, really focused on just the cost side. So, the reason that EPA and USDA maybe look at different baselines is, they want to say well, here is what happened by putting in the renewable fuel standard in the energy bill, how did that actually affect the baseline. But, you have to say since that is now part of law that that is part of the baseline and so they kind of look at different variations to see how each of those things contributed to emission reductions goals, and how each of those things impacted economic goal.

Mr. WALZ. And if we look at, like you said, there is a wide spectrum here. I know that Natural Resources Defense Council says within 90 years this is going to cost us nearly $2 trillion a year to sit and do nothing—disease increases, water use, natural disasters. So does that factor in?

Dr. MURRAY. I would say in any of the studies that you have alluded to, the government studies do not generally look at the environmental damages associated with no action. So to answer your question, no, those are not factored into the baseline in these studies. Do they need to be? I think the suggestion of the last 15 minutes of conversation has been yes.

Mr. WALZ. I think I am looking at this as Pascal's wager. I don't want to find out on that end. And my question is, is that the best way to go. I think what the Ranking Member is saying is, I am searching for those things. I am very intrigued by this idea of us investing in new buildings, those types of things. We tried to do a green schools build type of thing. But I was under the impression, and the way I saw it with sulfur dioxide and everything, that cap-and-trade is the more free-market way to do that than having government dictate what your buildings are going to look like. Would you respond to that?

Dr. MCCARL. Well, I wanted to say two things. The energy modeling forum has been doing a bunch of studies under different stabilization scenarios, they call them, and one is: what happens if you don't do anything; what happens if you try to bring it so we never get above 700 parts per million; what happens if you try to get it to 500 parts per million of carbon dioxide in the air, and so they have a whole history of those and what the costs are and what the benefits are and the GDP costs and those kinds of things. The big hope with cap-and-trade is that there have been some judgments made that there is excess carbon dioxide being put into the atmosphere and we call it an economic externality. I mean, if you drive a great big car, you don't care about how much carbon dioxide is coming out. If we put a price on those emissions, that will stimulate private industry to make investments and it is better than everybody trying to pick winners. We let the private market pick the winners. And so that is what the cap-and-trade is all about, and in fact, if the best technology option is to have white roofs and develop nuclear energy, *et cetera*, it is something we think the private market will discover in reacting to these things through the cap-and-trade.

Mr. WALZ. And I think that is interesting because the biggest—

Mr. GOODLATTE. Would the gentleman yield?

Mr. WALZ. Absolutely.

Mr. GOODLATTE. Well, thank you. I think the gentleman's question is a very good one, and in fact the trade part of cap-and-trade is very much the free-market approach. When you are talking about a poison like sulfur dioxide that is directly harmful to human consumption whereas carbon dioxide, which we are putting out a lot here today as we talk about this issue, is not. I think that was a very good use of cap-and-trade because it did use the free market to eliminate something that very definitely and directly and as quickly as possible——

Mr. WALZ. So the gentleman's point is, it is the carbon itself——

Mr. GOODLATTE. Is it the cap, which is a government decision about what is appropriate here, and the cost-benefit analysis, comparing it to other alternatives.

Mr. WALZ. Which I have to be honest is one of the biggest challenges for me as I am very—if we do this, and I believe we need to get it done, if it doesn't have as big a impact as it needs to have to reverse these trends, that is the fear. I don't want to pull the car halfway out of the ditch, I want to pull it all the way out of the ditch, and that is why I am searching for these, and I am more than open to the other alternatives. I know this gets clear to the extreme of geo-engineering if that is where you want to go, and there are some intriguing things there, 2,000 ships blowing water into the air in the middle of the ocean to cool the temperature. I appreciate that, and as I said, I appreciate all of you for your research and the Ranking Member for always challenging assumptions for me. I appreciate that. I yield back.

The CHAIRMAN. I had a follow-up question but Dr. McCarl just answered it, so the gentleman from Virginia, if you have questions?

Mr. GOODLATTE. I have one additional question. Dr. Hayes' testimony discusses a presentation of his model to agriculture producers. As many of us might have expected, farmers and ranchers have grave concerns about changes in commodity prices and land conversion. In each of your opinions, can an offset program be created that does not change the structure of the agriculture sector in pretty dramatic ways, and how do we accomplish that if you think that can be done? Dr. Murray, I will start with you.

Dr. MURRAY. I guess I will go first. You know, I will give you a typical economist answer: what do you mean by dramatic? I think that in some ways it doesn't work unless change is substantial, unless the change on the landscape is done in such a way to reduce greenhouse gas impacts. So 30 million acres going from agricultural lands to forest, that is about one percent of the total landscape of the United States. It is about two or three percent of the agricultural landscape. Certainly it is a big number, but it needs to be looked at in the context of the entire landscape. I think of that as delivering benefits in terms of achieving the climate goal more cost effectively, then that is probably a transformation worth making. I don't think transformations should be done just for the purposes of transformation. It needs to be the end goal, which is to reduce greenhouse gases.

Mr. GOODLATTE. Is your answer no, an offset can't be done without changing the structure of the agricultural sector?

Dr. MURRAY. If I had to answer yes or no, I would say no.

Mr. GOODLATTE. Dr. McCarl?

Dr. MCCARL. When I look at this thing, I see that without the offset program by mid-century, corn prices will be down to $1.50. With the offset program, it will be about $3. I think there is very substantial change in the structure of the agricultural sector that is going to happen whether or not we do offsets. I think the offsets might make for a bit wealthier agricultural sector, and perhaps keep more people and resources in rural areas and agriculture than would happen otherwise. But, in terms of are we going to produce exactly the same goods in the same places, the offsets would dramatically change that around; so will climate change.

Mr. GOODLATTE. Dr. Sohngen?

Dr. SOHNGEN. Yes, sir. That was a great question. Just real quickly, I agree with the previous speakers and the answer is no, from my perspective, there will be massive structural change. But, Dr. Bruce McCarl said it right, that it will involve the net transfer of wealth into the landholding sector in this country. So that would be the effect of a cap-and-trade system. It would probably be a benefit, a large benefit, whether it comes through some renewable fuel standards that push biofuels, or whether it comes through a cap-and-trade system that pushes carbon sequestration in the landscape. Land becomes more valuable so people who own land gain quite substantially from the cap-and-trade system.

Mr. GOODLATTE. Dr. Hayes, you heard the direct brunt of the criticism from the farmers. What do you think?

Dr. HAYES. My research agreed with Dr. McCarl's and Dr. Glauber's and that is that taking those millions of acres of crop acres, that is where the big costs occur in terms of food price increases. And if you are looking for 50 million acres of crop acres to avoid deforestation, the CRP program has about 30 million that potentially could be afforested, and we have about 90 million acres of pasture that has enough rainfall to grow trees, and then surely there is another 20 million acres you can find there. So I would differentiate between crop acres, pasture, and CRP and you can get almost as much good out of CRP and pasture and let the crop acres remain in crop production.

The CHAIRMAN. Thank you.

Dr. Wara?

Dr. WARA. I think a large-scale offset program can't work unless practices are changed. The point that Dr. McCarl made is the key one. Whether it is climate change or change in demand for meat in developing countries, the agricultural economy of the United States and globally is going to change over the next several decades in dramatic ways. This could be a part of it or it might not be, but there is no—the reality is that because of the growing wealth of developing nations especially, agriculture will be changing, and the question is how.

Mr. GOODLATTE. Thank you.

Thank you, Mr. Chairman.

The CHAIRMAN. The chair thanks the gentleman and the chair thanks our witnesses for a very interesting discussion today.

Under the rules of the Committee, the record of today's hearing will remain open for 10 calendar days to receive additional material and supplementary written responses from the witnesses to any questions posed by a Member.

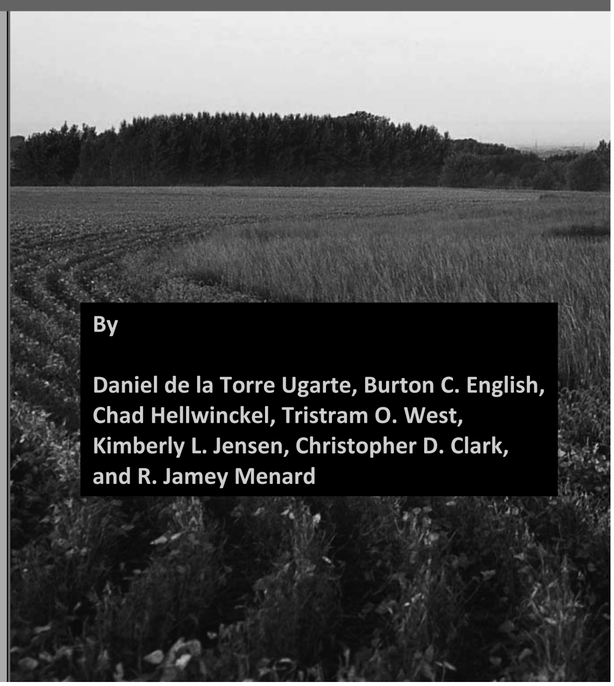
This hearing of the Subcommittee on Conservation, Credit, Energy, and Research is adjourned. Thank you very much.

[Whereupon, at 1:30 p.m., the Subcommittee was adjourned.]

[Material submitted for inclusion in the record follows:]

SUBMITTED REPORT BY HON. TIM HOLDEN, A REPRESENTATIVE IN CONGRESS FROM PENNSYLVANIA

Analysis of the Implications of Climate Change and Energy Legislation to the Agricultural Sector



25x'25
AMERICA'S ENERGY FUTURE

BEAG
BIO-BASED ENERGY ANALYSYS GROUP

APAC
AGRICULTURAL POLICY ANALYSYS CENTER

UT Department of Agricultural Economics, Institute of Agriculture, The University of Tennessee

By

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November 2009

BACKGROUND
Congress is currently considering energy and climate change legislation and numerous questions have arisen as to what impact various policy proposals may have on the agricultural and forestry sectors. To better assess these impacts, the 25x'25 Alliance asked the University of Tennessee's Bio-based Energy Analysis Group (BEAG) to analyze how several proposed energy/climate change policy scenarios might impact land use change, feedstock production, feedstock prices, and farm income, as well as carbon costs and payments for producers.

Results from the University of Tennessee study will be presented in four parts. This first report focuses on a detailed agricultural sector analysis evaluating the impacts on agriculture as a result of providing carbon offsets and supplying energy feedstocks from agricultural based products and by-products from crops and livestock while incorporating projected wind and solar impacts from renewable energy farms. Subsequent reports will address impacts on the forest sector and will incorporate economic analysis of the nation's economy conducted at the state and national levels.

ABOUT BEAG
The Bio-based Energy Analysis Group (BEAG), located at the University of Tennessee, is an inter-disciplinary research and outreach group which strives to provide decision makers in government and industry with the most up to date economic and environmental analysis of the bio-based energy industry at the state, regional, and national levels. In 2006, BEAG assessed the ability of the agriculture and forestry sectors to produce 25 percent of the energy consumed by the nation by 2025 while continuing to produce safe, abundant and affordable food, feed and fiber. Among the key findings, the study found that America's farms, forests and ranches can play a significant role in meeting the country's renewable energy needs, that the 25x'25 goal is achievable and that it can be met without compromising the ability of the agricultural sector to reliably produce food, feed and fiber at reasonable prices. The report can be viewed at
http://www.25x25.org/storage/25x25/documents/RANDandUT/ut_ea_report.pdf

ABOUT 25x'25
25x'25 is a renewable energy initiative backed by organizations and individuals united by a common interest in making America's energy future more secure, affordable and environmentally sustainable. Through its diverse alliance of agricultural, forestry, environmental, conservation and other organizations and businesses, 25x'25 partners have been working collaboratively since 2005 to advance the goal of securing 25 percent of the nation's energy needs from renewable sources by the year 2025. 25x'25 is led by a national steering committee composed of volunteer leaders from the agricultural, forestry and renewable energy communities. The initiative is supported by the Energy Future Coalition. More on 25x'25 can be found at www.25x25.org

The study has been funded by The Energy Foundation. An electronic copy of the report can be viewed and downloaded at www.25x25.org

(Cover photo courtesy of USDA NRCS.)

Executive Summary

This study projects how meeting several proposed energy/climate change policy scenarios might impact the U.S. agricultural sector. For the purposes of each scenario studied, it is assumed that the Renewable Fuels Standard (RFS) established by the Energy Independence and Security Act of 2007 is in play. Along with the RFS, policy scenarios that have been analyzed include a cap-and-trade regulatory system and varying treatments of agricultural offsets.

KEY FINDINGS

Under a properly constructed cap-and-trade program:
- Net returns to agriculture are projected to be positive – including up to $13 billion annually in additional revenues for agriculture and forestry – and exceed baseline projections for eight of nine crops analyzed;
- Income from offsets and from market revenues is higher than any potential increase in input cost including energy and fertilizer;
- At projected carbon prices of up to $27 per $MtCO_2e$, afforestation of cropland will not occur;
- Major shifts in commodity cropland use does not occur;
- Demand for bioenergy feedstocks will cause significant shifts to hay and dedicated energy crop acreage from pasture conversion;
- Crop and beef prices are not disrupted; and
- Biomass feedstock production creates significant direct and indirect reduction in greenhouse gases (GHG). This includes a direct reduction of an accumulated 460 million metric tons CO_2 equivalent.

If emissions are regulated by EPA without the benefit of multiple offsets:
- Net farm income is projected to fall below baseline projections;
- Agriculture is subjected to higher input costs with no opportunity to be compensated for the GHG reduction services the sector provides;
- Impacts to beef production are uncertain; and
- If afforestation and grassland sequestration are the only offsets allowed, and carbon prices are as high as $160 per $MtCO_2e$, sixty million acres of cropland could be converted to forests and grasslands.

The study looks at a "baseline" policy scenario, which is an extension of the USDA agricultural baseline through 2030. Four other scenarios are then compared with the *Baseline Scenario*.

Among the other four scenarios is one in which emissions, including those from the agricultural sector, are regulated by the EPA in accordance with a 2007 Supreme Court ruling holding the agency responsible for regulating greenhouse gas emissions under the Clean Air Act (*EPA Led Scenario*). No legislative guidance is presumed for this scenario.

Another scenario limits the offsets available to agriculture to methane capture, afforestation, and conservation tillage (*Limited Offsets Scenario*). Crop residue removals under this limited offset scenario must be carbon neutral.

A third scenario allows for many agricultural offsets, including those for bioenergy crop production and grassland sequestration, but there is no requirement that the removal of crop residues at harvest be carbon neutral (*Multiple Offsets Scenario*). However, crop residue removal must be held at acceptable levels for erosion.

The final scenario also allows many offsets, but the removal of crop residues at harvest must be carbon neutral (*Multiple Offsets/RCN Scenario*). For this final scenario, the effects of pasture conversion and forage replacement on the cattle industry were estimated.

The study used POLYSYS, an agricultural policy simulation model of the U.S. agricultural sector, to project the impacts to the agricultural sector from these potential policy scenarios. The results show impacts on economic returns, climate benefits, feedstock prices, and land use impacts.

The *Multiple Offsets/RCN Scenario* is projected to produce the highest net returns to agriculture and the greatest climate benefits, but ranks third in terms of biomass price. Because this scenario performs well in meeting three important objectives (net returns, environmental performance, and biomass prices), the study devotes further analysis to it, using the *Baseline* and *EPA Led Scenarios* as reference points. The *Multiple Offsets/RCN Scenario* provides nearly $209 billion more in net returns than the *Baseline Scenario* and $364 billion more than the *EPA Led Scenario*. The *Multiple Offsets/RCN Scenario* also provides an additional 463 million metric tons of reduced CO_2 equivalent, and 31 million metric tons more in reductions when measured against projections made for the *EPA Led Scenario*.

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Analysis of the Implications of Climate Change and Energy Legislation to the Agricultural Sector

Study Purpose and Background

The purpose of this study is to project how existing and proposed energy and climate change policies that increase the use of renewable energy and reduce greenhouse gas emissions might affect the U.S. agricultural sector. At the time of our analysis, these policies included the Energy Independence & Security Act of 2007 (EISA), which established a renewable fuels standard (RFS) requiring the production of 36 billion gallons of renewable fuels by 2022 (U.S. Congress, 2007), and the American Clean Energy Security Act (ACES), which includes a renewable electricity standard (RES) and a cap-and-trade program to reduce greenhouse gas (GHG) emissions. Additionally, the Supreme Court recently ruled that the Environmental Protection Agency (EPA) has the authority to regulate GHGs under the Clean Air Act (CAA). Although the Senate is now working on climate legislation, it was not available during the time of this analysis.

The June 26, 2009 passage of ACES by the U.S. House of Representatives—representing the first time that either chamber of Congress has passed legislation to regulate GHG emissions—suggests that Congressional action to address climate change is possible. ACES sets targets to reduce national GHG emissions from high-emitting industries to 3 percent below 2005 levels by 2012, 17 percent by 2020, 42 percent by 2030, and 83 percent by 2050. The reduction would occur under a cap-and-trade program to be administered by EPA and USDA. Regulated sources would be required to obtain "allowances" from EPA to emit a specified amount of emissions with EPA reducing the total amount of allowances distributed each year in order to meet the reduction targets. However, the U.S. Supreme Court's decision in Massachusetts v. Environmental Protection Agency, 549 U.S. 497 (2007) and the Environmental Protection Agency's response (EPA, 2009b), suggest that, absent Congressional action, EPA will regulate GHG emissions under the CAA.

A cap-and-trade program is a market mechanism to reduce emissions. Regulated sources with excess allowances (i.e., sources with more allowances than emissions) would be allowed to trade or sell them to other regulated or non-regulated entities. Initially, about 85 percent of the allowances would be given away with the remaining 15 percent auctioned off, although the amount auctioned would increase over time. Regulated sources would be prohibited from emitting more GHG than they had allowances for, unless they purchased offset credits from projects that would result in reductions of GHG emissions or sequestration of GHG (House of Representatives, 2009).

In its current form, ACES specifically excludes the agricultural and forestry sectors from the industries to be regulated under the GHG cap and allows for the production of offsets from agricultural and forestry sources. Although the "Peterson Amendment" to

ACES provides some guidance on what agricultural practices would qualify as an offset, uncertainty remains. Offset project eligibility is a critical issue for determining how the legislation might affect agriculture and its ability to meet the existing RFS and the proposed RES. For example, if practices related to bioenergy crop production are not included in the list of approved offset practices, then it might become prohibitively expensive for agriculture to produce enough feedstocks to meet the RFS and RES.

This study seeks to project how varying specifications for allowable offsets in a cap-and-trade program might impact the agricultural sector and generate climate benefits, as measured by changes to net carbon flux. (Net carbon flux represents the amount of carbon leaving a system). We modeled how sector changes will impact land use change, feedstock production, feedstock prices, and farm income, as well as carbon costs and payments for producers.

Study Assumptions and Methods

The Renewable Fuels Standard (RFS) set forth in EISA is assumed to continue in this study. The RFS requires 36 billion gallons of renewable fuels by 2022, with 16 billion gallons coming from cellulosic ethanol and one billion gallons from biodiesel by 2012. Along with the RFS, policy scenarios analyzed include cap-and-trade and varying treatments of agricultural offsets. The most restrictive treatment, called the *EPA Led Scenario*, enforces the Supreme Court verdict for EPA to regulate GHG emissions under the Clean Air Act, which does not allow for the creation of an offsets market.[1] To account for this lack of offsets coupled with carbon regulation, this study uses the EPA estimated equivalent carbon price (EPA, 2009).

The second most restrictive treatment of offsets, the *Limited Offsets Scenario*, only allows for methane capture, afforestation, and conservation tillage, but does not include the production of bioenergy crops or grasslands sequestration.[2] In this treatment, crop residues are harvested for bioenergy production, but removals must be carbon neutral. Although crop residues are often left on the field to prevent soil erosion, additional material must be left to replenish soil carbon.

[1] Title V of the Clean Air Act (CAA) requires that any entity with the potential to emit more than 100 tons per year of a regulated pollutant must obtain a permit in order to operate. As USDA points out in its comments to the Advance Notice of Proposed Rulemaking for Regulating Greenhouse Gas Emissions under the Clean Air Act: "If GHG emissions from agricultural sources are regulated under the CAA, numerous farming operations that currently are not subject to the costly and time-consuming Title V permitting process would, for the first time, become covered entities. Even very small agricultural operations would meet a 100-tons-per-year emissions threshold. For example, dairy facilities with over 25 cows, beef cattle operations of over 50 cattle, swine operations with over 200 hogs, and farms with over 500 acres of corn may need to get a Title V permit" (EPA, 2008). If so, this would mean that a large share of the nation's livestock operations and other large farms would need to get a Title V permit and pay the requisite permitting fee. The New York Farm Bureau has calculated that the permitting fee imposed by EPA for Title V permits could amount to as much as $175 per dairy cow, $87.50 per head of beef cattle, $20 per hog." (New York Farm Bureau, 2008).

[2] Most bioenergy crops are perennials with long-lived, deep root stocks that build carbon into soil organic matter.

The most liberal treatment analyzed, *Multiple Offsets Scenario*, allows methane capture, afforestation, conservation tillage, production of bioenergy crops, and grasslands sequestration, but does not require that crop residue removal be carbon neutral. Crop residue removal must still be held at acceptable erosion levels.

The final treatment evaluated, *Multiple Offsets/RCN Scenario*, allows many agricultural offsets, including methane capture, afforestation, conservation tillage, production of bioenergy crops, and grasslands sequestration, but still requires that removal of crop residues be carbon neutral. For the *Multiple Offsets Scenario/RCN Scenario*, the effects of pasture conversion and animal unit replacement on the beef cattle sector are evaluated.

These policy scenarios are compared with the *Baseline Scenario*, which is an extension of the USDA agricultural baseline through 2030 assuming continuance of the EISA RFS. A summary table of the scenarios evaluated is presented below in Table 1.

Agricultural Sector Modeling

Key Biomass Sources

The key biomass sources considered as part of this study are corn grain, soybeans, switchgrass, hybrid poplar, willow, crop residues (corn stover and wheat straw), wood residues (forest residues, mill wastes, fuel treatments and forestland thinnings), and animal manure (beef, dairy, hogs, and poultry). Switchgrass is a perennial native grass that can be grown from Colorado to the East Coast of the United States and from the Gulf Coast into Canada. Switchgrass yields in some areas can exceed ten dry tons per acre and, as a native grass, does not require large amounts of inputs (Bransby). Hybrid poplars are fast growing trees that can easily be propagated from stem cuttings. As with switchgrass, chemical and fertilizer applications for hybrid poplars are lower than many row crops. Except for arid regions, hybrid poplar can be grown throughout most of the United States and can produce up to ten dry tons per acre (Tuskan). Willow is often found in wetlands and near water sources but can also grow in a variety of well-drained soils in areas with regular rainfall. Willow propagates well with seedlings or with cuttings and yields can exceed eight dry tons per acre (Abrahamson, et al., 1998). Other crops such as Energy Cane, Giant Reed, Giant Miscanthus, and Napier Grass could provide higher yields at a lower cost in some areas of the country. For this study, dedicated energy crop baseline yields are assumed to be equal to levels provided by Perlack (2009).

Forest residues, wood from fuel reduction, and mill wastes are included in the analysis. However, the potential for forestry is understated in this analysis as standing timber is not incorporated into the potential supplies of cellulosic materials. Thus, the nation's over 400 million acres of privately owned forest land, over forty million of which are plantation forests (Smith, Miles, Perry, and Pugh, 2008), are not considered as a source of additional woody feedstocks. A summary of the bioenergy sources is presented in Figure 1.

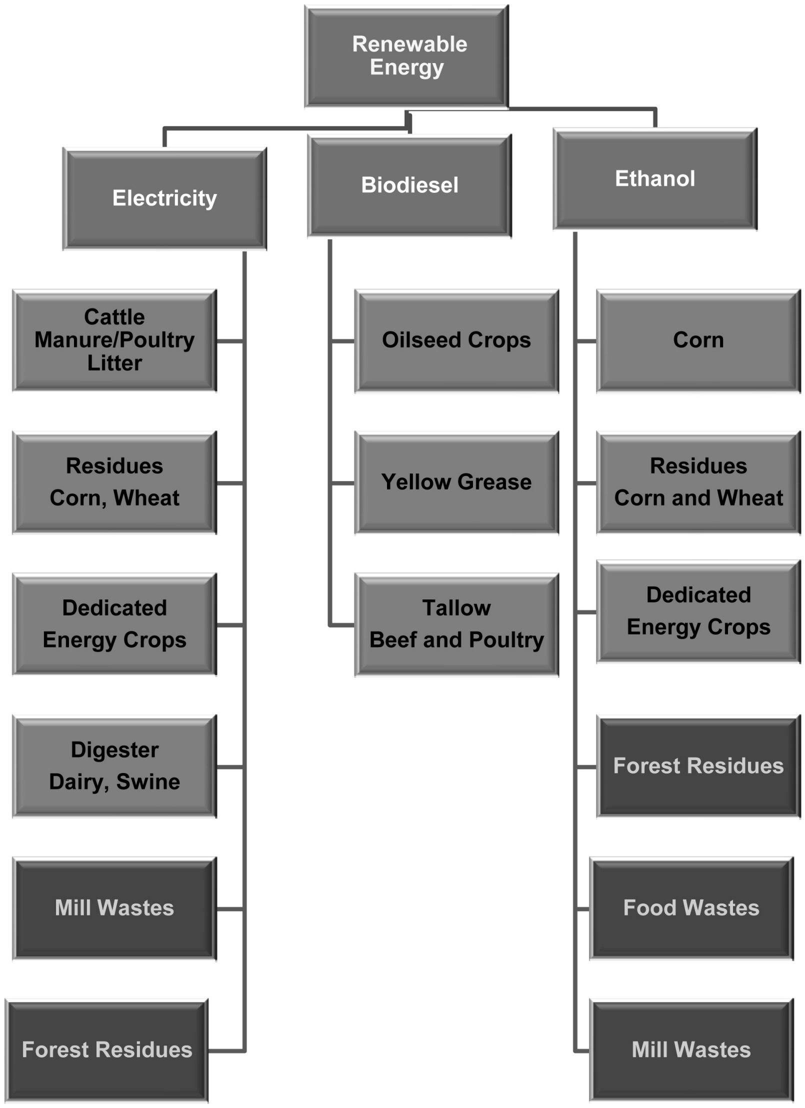


Figure 1. Bioenergy Sources

Table 1. Climate Change and Energy Legislation Scenarios Analyzed and Key Assumptions

Scenario	Attributes/Offsets	Crop Residues Constrained at Soil Carbon Neutral Levels	Pasture Conversion/ Livestock	Fertilizer Exempt from Regulation	Carbon Price per Ton CO_2 Eq.
1. *Baseline*	USDA baseline extended to 2030/Continuance of EISA RFS	No	No pasture conversion	N/A	None
2. *EPA* (Supreme Court/EPA)	No cap-and-trade Legislation EISA RFS /High energy Costs with no offsets	No	Pasture conversion allowed 1. With AUM replacement[a] 2. Without AUM replacement	No	Up to $160
3. *Limited Offsets*	Cap-and-trade Legislation with EISA RFS/ High energy Costs with offsets conservation tillage, afforestation, and methane capture	Yes	Pasture conversion allowed 1. With AUM replacement 2. Without AUM replacement	No	Up to $27
4. Multiple Offsets	Cap-and-trade Legislation with EISA RFS /High energy Costs with multiple offsets including conservation tillage, afforestation, methane capture, grassland sequestration, and bioenergy crops	No	Pasture conversion allowed 1. With AUM replacement 2. Without AUM replacement	Yes	Up to $27
5. *Multiple Offsets/ RCN*	Same as Scenario 4 but with residues at carbon neutral levels after harvest	Yes	Pasture conversion allowed 1. With AUM replacement 2. Without AUM replacement	Yes	Up to $27

[a]An animal unit month (AUM) is the amount of forage required by an animal unit (AU) for one month.

Modeling Process

The methodology for modeling the agricultural sector's response to meeting energy requirements under EISA's RFS with varying provisions for GHG regulation is schematically displayed in Figure 2. The schematic of the process starts with the definition of the energy targets for biofuels under the RFS and for renewable energy under the RES. As can be seen from the figure, additional feedstock materials beyond what are needed to meet biofuels targets under the RFS are then used toward meeting the RES. The information and data on conversion costs for agricultural and forest feedstocks are introduced into POLYSYS to estimate the quantity and type of energy to be produced from agriculture, as well as prices, farm income, and government payments.

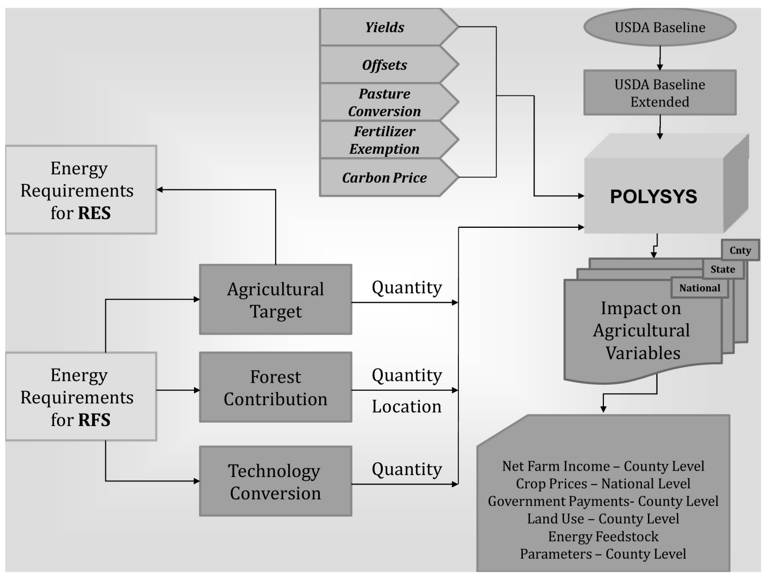


Figure 2. Process for Modeling Impacts on Agricultural Variables

POLYSYS

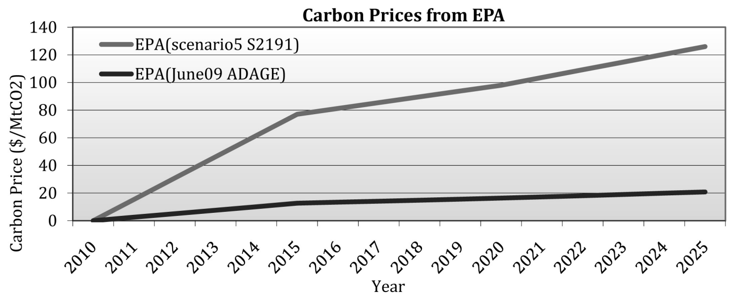
We used POLYSYS to project agriculture sector impacts from potential climate and energy policies. POLYSYS is a robust agricultural policy simulation model of the U.S. agricultural sector that includes national demand, regional supply, livestock, and aggregate income modules (De La Torre Ugarte, Ray, and Tiller, 1998). POLYSYS is anchored by published baseline projections for the agricultural sector and simulates deviations from the baseline. The projected impacts obtained from POLYSYS include impacts to net farm income, government payments, and energy feedstock parameters. These impacts can be obtained at the county, state, and national level. The projected impacts also include changes in crop prices. These impacts are available at the national level.

The POLYSYS model includes the eight major U.S. crops (corn, grain sorghum, oats, barley, wheat, soybeans, cotton, and rice), as well as switchgrass, hybrid poplar, willow, and hay (alfalfa and other hay included). Corn and wheat residue costs and returns are added to the corresponding crop returns, if profitable. POLYSYS is structured as a system of interdependent modules of crop supply, livestock supply, crop demand, livestock demand and agricultural income. The supply modules are solved first, then crop and livestock demand are solved simultaneously, followed by the agricultural income module. This project includes a bioproducts module that fills exogenous demands from the feedstock sources. The bioproducts module captures the dynamics of corn grain and cellulosic feedstocks competing to fill ethanol demand by using a search by iteration method to find the optimal allocation of feedstocks to satisfy these demands.

Additional Key Assumptions

Carbon Prices and Offsets

Carbon prices are those assumed by EPA in its analysis of ACES. The carbon price levels considered are up to $27 per Mt of CO_2 and up to $160 per Mt of CO_2 (EPA, 2009). The carbon price level of up to 160 per Mt of CO_2 was estimated by EPA to be the price equivalent for carbon when no domestic offsets are allowed. Offsets are priced at the same level as allowances, but after discounts for transaction costs and the expected program discounts for unintentional reversals, the net receipts per ton will be reduced. The net receipts as a portion of the carbon prices employed for each activity type are: 40 percent for a change in tillage practices, 30 percent for afforestation, 20 percent for methane capture, and 20 percent for production of bioenergy crops. For the change in tillage practices, a level of 40 percent reflects the high degree of uncertainty regarding what rate of sequestration will be recognized, the term of contract issue interaction with a significant amount of land that is farmed on one-year renewable leases, and a high degree of uncertainty on how the duration/permanence issue will be addressed by policymakers. For the planting of herbaceous energy crops, the level of 20 percent reflects that perennials are less likely to be planted on land operated with one-year leases, lowered likelihood of reversal, but potentially higher costs of quantification and verification. With respect to afforestation, the level of 30 percent reflects higher costs of quantification and verification, higher probability of leakage, and higher probability of reversal risk due to natural events (disease and fire). The 20 percent rate for methane capture reflects the high initial cost of verification and documentation, low opportunity for aggregation, and high documentation and monitoring requirements specific to each project. The carbon price and offset value assumptions are illustrated in Figure 3.



Offsets Transaction Cost Discounts			
Change in tillage practices	**40%**	**Afforestation**	**30%**
Planting herbaceous energy crops	**20%**	**Methane capture**	**20%**

Figure 3. Carbon Prices (from EPA) and the Value of Offsets

Pastureland Conversion

One of the key interests of this study is land use, and especially the use of cropland to produce energy feedstocks. Another use is pastureland. Cropland "in pasture" is defined as land that previously has been used for crop production but has since shifted to pasture use. An increase in the intensity of the management of this pastureland could free a significant portion of the acreage for crop or dedicated energy crop production. However, not all of these lands will be available for conversion to cropland. In regions where irrigated hay production exceeds dryland hay production, it is assumed that irrigation would be needed to convert these lands to cropland. Hence, in these areas, an increased level of inputs would be required. Since the analysis assumes energy crop production will be undertaken using few inputs, pasture/range lands are constrained from being converted to energy crop production in these areas. In addition, if pastureland is converted to energy crops rather than to hay, then additional hay production must occur to produce an equivalent of feed, reflecting an increase in intensity on hayland. This requirement results in the same amount of roughage being available for the livestock sector and assumes that current pasture/range land is utilized for roughage. Additional reductions to pastureland available for conversion were made in response to environmentally sensitive lands identified by 25x'25 state alliances.

Afforestation and Grassland Sequestration

Afforestation and grassland sequestration were considered as offsets in all scenarios except the *EPA Led Scenario*. Although the *EPA Led Scenario* does not explicitly allow offsets, we use EPA's estimated carbon price equivalent to regulation to analyze the sensitivity of afforestation and grassland sequestration to carbon prices.

Livestock Sector

The analysis includes two "extreme" treatments for the cattle industry to project the outer bounds of potential impacts to that sector. The first treatment of the livestock sector allows that there is forage replacement, where forage productivity in permanent pasture makes up for any forage losses due to shift of hay or cropland in pasture to dedicated energy crops. The second assumes that head reduction occurs. In this case, loss of forage due to shifting land use to energy crop production can only be met by reduction in the total number of animals.

Limitations in Modeling Offsets

The study uses a conservative approach in modeling potential offsets. Several types of offsets could be incorporated into policies; however, not all could be modeled due to a lack of data. Examples of unmodeled crop offsets include those increasing nitrogen efficiency, alternative nitrogen application methods, biochar utilization, and seed improvements. Those for livestock could include changes in diet, improvements in diet efficiency, alternative management systems, or intensive grazing.

Key Drivers

Our model results are driven by key factors. These drivers include:

- *the demand for bioenergy crops generated from continuance of EISA;*
- *availability of carbon credits for dedicated energy crops;*
- *transactions costs for offsets;*
- *the cost of carbon, and, more specifically whether or not fertilizer will be exempted from the cap;*
- *and constraints on harvesting of crop residues at carbon neutral levels.*

Results

Overview

The performance of the policy scenarios can be evaluated in terms of each scenario's ability to meet policy objectives. The objectives considered in this analysis are represented in Table 2 and include net returns to agriculture, net carbon flux, and biomass price. As can be seen in Table 2, the *Multiple Offsets/RCN Scenario* is projected to produce the highest net returns to agriculture and the lowest net carbon flux, but ranks third in terms of biomass price. Because this scenario performs well in terms of these three potential policy program objectives, further analysis focuses on this scenario along with the *Baseline Scenario* and the *EPA Led Scenario* as reference points. The *Multiple Offsets/RCN Scenario* provides nearly $209 billion more in accumulated net returns than the *Baseline* and over $364 billion more than the *EPA Led Scenario* over the period 2010-2025.

Table 2. Ranking of Scenarios by Potential Program Objectives

	Objective [a]					
	Economic Indicator		Climate Benefits		Low Cost Feedstock	
Scenario	Ag Net Returns		Net Carbon Flux		Max Biomass Price	
	Billion $		MMt CO_2		$/dt	
Baseline	4,067	(4)	1,820	(5)	49.00	(1)
Multiple Offsets	4,134	(3)	1,527	(4)	49.00	(1)
Multiple Offsets/RCN	4,276	(1)	1,357	(1)	59.00	(3)
Limited Offsets	4,226	(2)	1,418	(3)	61.00	(5)
EPA Led	3,912	(5)	1,388	(2)	60.00	(4)

[a]Accumulated values for 2010-2025

Crop Net Returns are Positive Under a Well-Constructed Cap-and-Trade Program

Contrary to previous studies, our results show that the agricultural economy is not negatively impacted by a well-constructed cap-and-trade policy. The net crop returns under the *Multiple Offsets/RCN Scenario* are greater than *Baseline* and *EPA Led Scenarios,* as shown in Figure 4. By 2025, not only does the *Multiple Offsets/RCN Scenario* outperform the *EPA Led Scenarios* by nearly $27 billion, but it is also exceeds the *Baseline Scenario*.

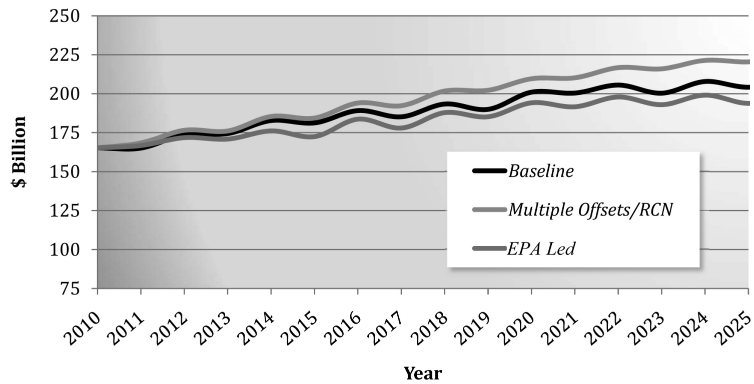


Figure 4. Net Crop Returns by Selected Scenario: 2010-2025

Similarly, average crop returns would increase for eight of nine major crops under the *Multiple Offsets/RCN Scenario* as can be seen in Table 3; however, under the *EPA Led Scenario*, all major crops, except corn and barley, are projected to experience a negative change in net returns compared to the *Baseline*. The decline in rice crop net returns under the *Multiple Offsets/RCN Scenario* of approximately $2 million per year constitutes less than .1 percent decline. In the case of bioenergy crops, the *Multiple Offsets/RCN Scenario* yields a higher average change in crop returns than did the *EPA Led Scenario.* The *Multiple Offsets/RCN Scenario* results in just over $4 billion average annual change in net returns compared with the *Baseline*.

Table 3. Average Change in Net Returns and Carbon Payments by Scenario and Crop: 2010-2025

	Baseline	*Multiple Offsets/RCN*		*EPA Led*	
Crop	+EISA Net Returns	Average Change Crop Returns	Net Carbon Receipts	Average Change Crop Returns	Net Carbon Payments
			(Million $)		
Corn	31,713	1,937	131	336	-
Grain Sorghum	438	40	4	(53)	-
Oats	73	11	5	(33)	-
Barley	511	36	7	3	-
Wheat	7,726	210	91	(494)	-
Soybeans	21,736	680	196	(411)	-
Cotton	451	20	3	(177)	-
Rice	2,811	(2)	1	(121)	-
Energy Crop	737	4,764	819	2,807	-

Carbon Payments for Dairy and Hogs Methane Capture

In addition to changes in net crop returns, net agricultural returns would be supplemented with carbon payments for methane capture.[3] The level of net returns for hog and dairy producers are shown in Figure 5. Projected net returns for methane from hogs exceed $120 million by 2025 and for dairy exceed $208 million by 2025.

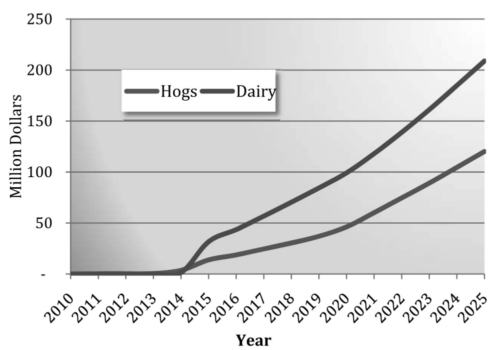


Figure 5. Net Returns of Carbon Credits To Methane Production for Hogs and Dairy Under the Multiple Offsets/RCN Scenario: 2010-2025

[3] Net returns for dairy and hog digesters incorporate both an electricity credit and a bedding credit in addition to the carbon payment.

Cropland Use Remains Stable

During consideration of climate legislation in the Congress, concerns have been raised that an agriculture offsets program could unintentionally drive afforestation on prime cropland. Our findings, which use EPA's carbon price projections for the cap-and-trade program of up to $27 per $MtCO_2$, show that both crops and herbaceous perennial grasses outcompete afforestation at these prices. Therefore, the agricultural sector is able to achieve significant food and biomass production goals, resulting in positive income. Table 4 shows only 5.3 million acres shift for corn, soybeans, and wheat combined, which is typical of shifts that occur as a result market forces. The main land use changes come from the conversion of pasture into hay and dedicated energy crop production.

Table 4. Estimated Land Use by Scenario, 2025

	Baseline	*Multiple Offsets / RCN*	*EPA Led*
		(million acres)	
Corn	90.5	89.3	90.2
Soybeans	65.9	63.0	62.9
Wheat	52.0	50.8	50.5
Hay	75.8	91.0	85.0
Ded. Energy Crops	49.5	76.4	66.9
Pasture	355.1	318.7	334.2
Total Land	**688.8**	**689.2**	**689.6**
(Pasture Converted)	50.1	84.3	68.8

Crop and Bioenergy Feedstock Prices Remain Stable

Cap-and-trade legislation would not create major disruptions in crop or bioenergy feedstock prices, and would enhance price returns to producers. Changes to crop prices are all within 10 percent of the *Baseline*, which are of a magnitude typical to those caused by normal market forces. For corn and wheat, the *Multiple Offsets/RCN Scenario* is projected to produce higher crop prices than the other two scenarios by the year 2025. Under all three scenarios, cotton prices are nearly equal. For soybeans, the *EPA Led Scenario* results in the highest price by 2025. These crop price projections are shown in Table 5.

Table 5. Crop Prices by Scenario, 2015-2025

	Corn ($/bushel)		
	2015	**2020**	**2025**
Baseline	3.60	4.16	3.91
Multiple Offsets /RCN	3.64	4.45	4.08
EPA Led	3.73	4.65	4.06
	Soybeans ($/bushel)		
	2015	**2020**	**2025**
Baseline	10.64	9.47	10.32
Multiple Offsets /RCN	10.75	9.49	11.30
EPA Led	10.71	9.36	11.42
	Wheat ($/bushel)		
	2015	**2020**	**2025**
Baseline	5.87	6.59	7.04
Multiple Offsets / RCN	5.95	7.00	7.57
EPA Led	5.90	7.07	7.52
	Cotton (cents/pound)		
	2015	**2020**	**2025**
Baseline	0.63	0.69	0.71
Multiple Offsets / RCN	0.64	0.70	0.73
EPA Led	0.65	0.71	0.73

Increasing the Allowed Agricultural Offsets Provides Largest Climate Benefits

The changes in net carbon flux under the three policy scenarios are displayed in Figure 6. As can be seen in this figure, carbon emissions decline under all three scenarios. The largest climate benefits, however, come from the scenario with the greatest number of offsets that also keeps residue harvest carbon neutral (the *Multiple Offsets/RCN Scenario)*. Because they are perennials, have deep root structures, and require fewer inputs, herbaceous dedicated energy crops contribute significantly to sequestering carbon and reducing GHG emissions from agriculture. Further reductions in GHG under the *Multiple Offsets/RCN Scenario* result from methane capture.

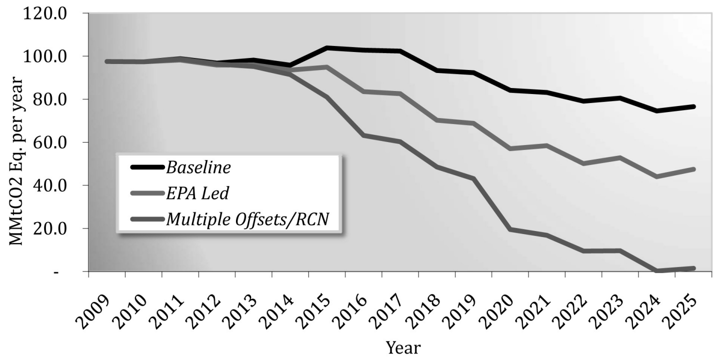


Figure 6. Net Carbon Flux by Scenario: 2009-2025

Afforestation on Cropland Only Occurs at High Carbon Prices

The only scenario with carbon prices high enough to lead to significant conversion of cropland to forest or grasslands occurs under a price line that allows carbon prices rising to $160 per $MtCO_2$. At these prices, significant land use changes are projected to occur. About forty million acres of cropland could convert to forests, 75 million acres of pasture could convert to forests, and twenty million acres of cropland could convert to grasslands. As can be seen in Figure 7, greater afforestation only occurs at higher carbon prices, and significant shifts of cropland to forest begin to occur at $80/$MtCO_2$.

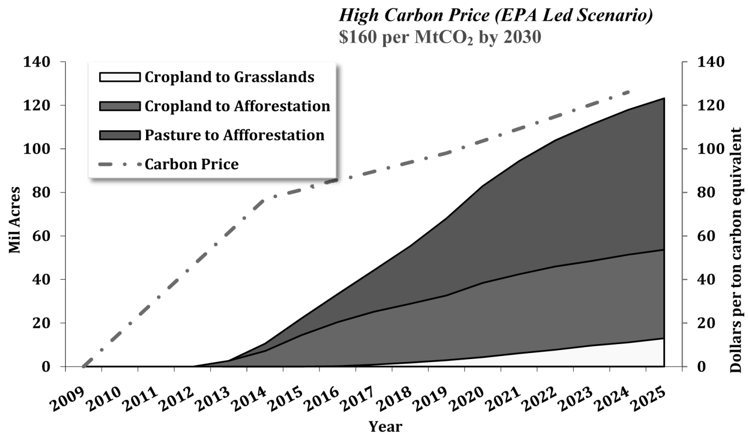


Figure 7. Afforestation Under the *EPA Led Scenario*: 2009-2025

Livestock Sector Impacts

To conduct a sensitivity analysis for the livestock sector, we considered two "extreme" treatments. As was previously noted, the main land use change will be a conversion of pasture to hay or dedicated energy crops. The first treatment assumes total forage replacement and the second assumes that the only way for the sector to adjust is to undergo herd reduction. Under forage replacement, increased forage productivity in permanent pasture makes up for any losses due to shifts of hay or cropland in pasture to dedicated energy crop production. Under a herd reduction treatment, loss of forage due to land use shifts can only be met by reduction in the total number of animals. We compare the beef sector impacts under the *Multiple Offsets/RCN Scenario* relative to the *Baseline* under these two treatments in Table 6. Notably, the beef cattle sector does not experience major net return disruptions under either treatment. Instead, the forage replacement treatment is projected to result in an overall slight increase in net returns to the sector.

Table 6. Beef Sector Impacts, 2025 and 2010-2025 Average

	Percent Changes from the *Baseline*			
	Forage Replacement		Herd Reduction	
Variable	2025	Average 2010-2025	2025	Average 2010-2025
Inventory	0.0	-0.0	-14.1	-4.0
Production	-0.1	-0.1	-8.4	-2.1
Beef Cattle Farm Price	0.9	0.5	6.0	1.6
Net Returns	1.1	0.6	-0.5	0.2

Regional Impacts of Cap-and-Trade Predominantly Positive

Figures 8 and 9 show the regional distribution of net returns changes from the *Baseline* under the *Multiple Offsets/RCN Scenario* in 2025. The net returns in these maps include crop prices and carbon payments, livestock returns, forest residue payments, and methane capture payments. Figure 8 assumes forage replacement for livestock, while Figure 9 assumes herd reduction. The green to blue shaded areas denote positive returns, while the orange to red areas indicate negative returns compared with the *Baseline*. As can be seen in the figures, the majority of the nation will experience positive returns under this scenario. In the second figure, Figure 9, there are increased losses in areas that have cow-calf operations, but greater gains in other areas.

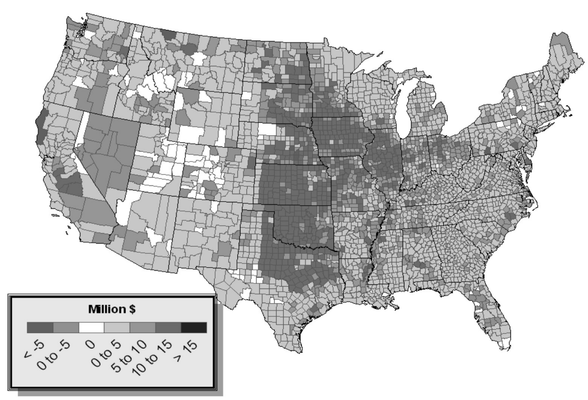


Figure 8. Regional Effects of the *Multiple Offsets/RCN Scenario* on Net Returns to Agriculture, With Forage Replacement: 2025

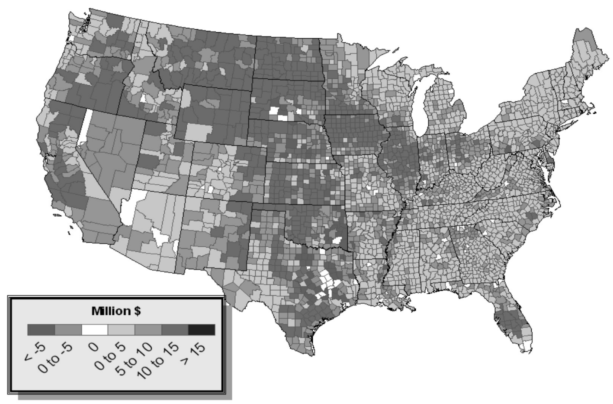


Figure 9. Regional Effects of the *Multiple Offsets/RCN Scenario* on Net Returns to Agriculture, With Herd Reduction: 2025

Conclusions and Implications

The impacts of cap-and-trade policies upon the agricultural sector could have dramatically different outcomes depending upon how the policy is constructed. However, a well-constructed cap-and-trade program that allows multiple offsets for agriculture (including bioenergy crop production) and manages residue removal to be carbon neutral, can generate positive net returns to agriculture while yielding carbon benefits. Such a policy is projected to provide nearly $209 billion more in net returns by 2025 than the baseline. Such a policy also is projected to provide over $364 billion more net returns than a policy where EPA regulates carbon without the benefit of multiple offsets.

The net returns under our optimized cap-and-trade scenario are positive for most major crops (eight out of nine analyzed). Afforestation of cropland does not occur at projected carbon prices of $27 per $MtCO_2$, a reasonable price assumption and within the "price collar" recently proposed by the Senate. Additionally cap-and-trade under such a policy scenario does not result in major shifts in commodity crop land use. The demand for bioenergy feedstocks, however, is projected to result in significant shifts in hay and dedicated energy crop acreage via pasture conversion. In addition, crop and beef prices are not majorly disrupted.

Climate benefits are also greatest under our optimized cap-and-trade scenario. Emissions are projected to be lower over time compared with the baseline or even an EPA regulated scenario. Herbaceous dedicated energy crops contribute significantly to sequestering carbon and to reducing GHG emissions from agriculture. Further reductions in GHG result from methane capture. Climate benefits from biomass feedstock production and methane capture include significant direct and indirect reductions (from substituting renewable fuels for fossil fuels) in GHG emissions. However, the benefits of indirect GHG emission reductions for biofuels are not considered in this study.

However, if carbon emissions are regulated by EPA as prescribed under the Supreme Court ruling, net farm income is projected to fall below baseline projections. Furthermore, 60 million acres of cropland could be converted to forests and grasslands. Under this type of policy scenario, agriculture is subjected to higher input costs with no opportunity to be compensated for the GHG reduction services the sector provides, and the impacts to beef production are uncertain.

The results from this study demonstrate how the effects of policies on agriculture and GHG emissions dramatically change given provisions in these policies. Policy provisions that do not take in account the role that agriculture has in providing environmental services will increase production costs and decrease net returns to the agricultural sector. However, provisions that sufficiently credit the role of environmentally sound agricultural management practices and carbon sequestration benefits of bioenergy crop production can benefit both agriculture and the environment. Legislative approaches under debate in Congress should carefully consider the potential environmental benefits that agriculture can provide.

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