Institute *for* Policy Integrity
New York University School of Law

The Other Side of the Coin:

The Economic Benefits of Climate Legislation

J. Scott Holladay
Jason A Schwartz

Policy Brief No. 4
September 2009

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Executive Summary

This policy brief conducts an informal analysis of the costs and benefits of H.R. 2454: the American Clean Energy and Security Act of 2009. EPA has prepared a formal estimate of this bill's costs, but has not considered the benefits.

Using data provided by EPA, as well as new calculations of the damages from greenhouse gas emissions recently developed by a federal interagency task force, this brief estimates the benefits of H.R. 2454's cap on greenhouse gas emissions. The results indicate that H.R. 2454 is cost-benefit justified under most reasonable assumptions about the likely "social cost of carbon." The breakeven social cost of carbon, above which the legislation is cost-benefit justified, ranges from $7.70 to $8.97. These figures are in the very low end of the range of SCC values considered by the interagency review process. Using conservative assumptions, the benefits of H.R. 2454 could likely exceed the costs by as much as nine-to-one, or more.

The estimated benefits do not include a significant number of ancillary and un-quantified benefits, such as the reduction of co-pollutants (particularly sulfur dioxide and nitrogen dioxide), the prevention of species extinction, and lower maintenance costs for energy infrastructure. Due to those limitations, the benefits estimates should be considered to be very conservative. IPI calls on EPA to conduct a full, formal analysis of the benefits of climate legislation, including whether alternate and more stringent climate policies might be even more cost-benefit justified.

Introduction

Over the past several years, as Congress has debated various climate change bills, both the House of Representatives and the Senate have wisely sought assistance from the Environmental Protection Agency (EPA) in advance of their deliberations, to investigate the likely economic consequences of the proposed legislation.[1] Most recently, before the House passed the American Clean Energy and Security Act (H.R. 2454) by a slim margin in June of 2009, Representatives Waxman and Markey sent letters asking EPA for "technical assistance" to "estimate the economic impacts" of the legislation.[2] Waxman and Markey also requested additional economic analyses from the Energy Information Administration (EIA) and the Congressional Budget Office (CBO).[3]

Unfortunately, EPA, EIA, and CBO interpreted those requests for economic analysis to apply only to the costs of such legislation and not the benefits. In fact, while EPA developed sophisticated analytical models and projected the likely costs under a variety of scenarios, the agency's report clearly states that "[n]one of the models used in this analysis currently represent the benefits of [climate change] abatement."[4] Similarly, in a table presenting the economic impacts of legislation, under the entry "Benefits from Reduced Climate Change," EPA simply wrote "Not Estimated."[5] The analyses conducted by EIA and CBO do not calculate the benefits either.[6] Meanwhile, Congress has not explicitly asked EPA or any other government agency to complete a systematic review of the potential scope and magnitude of the benefits that climate change legislation will generate.

A balanced and rigorous analysis of costs and benefits is an invaluable decisionmaking tool for legislators. In order to craft specific legislative language, to compare a bill with competing legislative alternatives, and ultimately to cast a rational and educated vote, legislators need to understand the full range of consequences—both positive and negative—that their decisions will have on the economy, the environment, and public health. But so far, in its study of climate change legislation, Congress has focused its information-gathering efforts much more on costs than benefits. Climate change is arguably one of the most complex issues to face Congress in recent memory, and yet Congress is essentially conducting its deliberations after having reviewed barely half the data.

The direct benefits of climate change legislation like H.R. 2454 will result from reducing the emissions of greenhouse gas pollutants (GHGs, which principally include carbon dioxide, methane, nitrous oxide, sulfur hexafluoride, perfluorocarbons, and hydrofluorocarbons). Cutting national GHG emissions will mitigate the speed and severity of climate change effects, including the myriad impacts on the environment, the economy, public health, and national security.

A rough estimate of such benefits can actually be generated through a straightforward calculation: projected tons of greenhouse gas emissions avoided, multiplied by the monetary valuation of incremental damage from each ton of greenhouse gas emissions. The first figure has already been calculated by EPA and other agencies, published in the various economic analyses of H.R. 2454. The second figure—also known as the "social cost of carbon" (SCC)—has until recently only ever been estimated by federal agencies on a rather ad hoc basis.[7]

But in a newly finalized regulation on energy efficiency standards, the Department of Energy "rel[ies] on a new set of values recently developed by an interagency process that conducted a more thorough review of existing estimates of the social cost of carbon."[8] Now that a consistent range of SCC estimates exists and has the support of multiple federal agencies, computing the benefits of climate legislation becomes possible. Simply by using figures already calculated, peer-reviewed, and published by various federal agencies, this policy brief conducts a preliminary but balanced cost-benefit analysis of the main climate change proposal now under consideration by Congress: H.R. 2454, the American Clean Energy and Security Act of 2009.

Analytical Scenarios and Models

This policy briefs relies principally on data generated and analyzed by EPA in its study of the economic consequences of H.R. 2454, the American Clean Energy and Security Act of 2009. Reports published on H.R. 2454 by the Energy Information Administration (EIA) and the Congressional Budget Office (CBO) also offer cost estimates and provide useful comparisons. Unfortunately, the raw data released by EIA does not extend beyond the year 2030.[9] Given that H.R. 2454 proposes significant GHG reductions in the years 2031 through 2050,[10] the lack of data for this period would seriously compromise the integrity of any estimation of the benefits from GHG reductions. Similarly, CBO's report does not contain sufficient raw data to support a thoroughly balanced cost-benefit analysis.[11] Because EPA's analysis covers the full time period through the year 2050, and because in many cases EPA offers year-by-year raw data in an online annex,[12] relying on EPA's work will allow for a more complete cost-benefit comparison.

Any cost-benefit analysis of a policy proposal needs a baseline scenario or reference case against which to compare the effects of the policy. In EPA's latest analysis of H.R. 2454, the agency updates its reference case to account both for separate federal energy legislation recently enacted into law and for the recent economic downturn.[13] Both factors result in lower projections for total greenhouse gas emissions in the "no policy" scenario. The bill proposes reductions relative to 2005 U.S. emissions, so the new baseline implies that fewer emissions will need to be cut to achieve the reduction targets, thereby lowering the overall costs of compliance.[14]

Notably, the baseline scenario does not assume the future existence of any additional domestic or international climate policies not already in effect.[15] For example, the scenario does not include the recently announced—but not yet finalized or enforced—fuel economy standards for passenger cars and light-duty trucks,[16] nor does the scenario assume any new international climate treaty will emerge from the upcoming negotiations in Copenhagen this winter.[17]

EPA has estimated the reduction in GHG emissions for a variety of possible policy alternatives. This brief will focus on calculating the costs and benefits of moving from the baseline emissions level (termed "Scenario 1") to the basic emissions profile under H.R. 2454 (called "Scenario 2"). Other scenarios project emissions levels if certain legislative provisions are altered or if domestic political and economic conditions change.[18] Changes to the existing bill or the current political climate are hard to predict, so this analysis does not address such alternatives. Ideally, Congress should ask EPA to conduct a complete cost-benefit analysis of a range of policy scenarios. This brief simply demonstrates that such analysis is feasible and takes a preliminary look at the most straightforward case. This focus is not intended to suggest that H.R. 2454 contains the optimal suite of climate policies; indeed, this analysis will conclude that a more stringent GHG cap could maximize net benefits.

Scenario 2 models the various provisions of H.R. 2454.[19] The scenario includes bonus allowances for carbon capture and sequestration, energy efficiency standards, output-based rebates, international offsets, and allocations to local energy providers used to lower consumers' utility rates. These are all stipulations of the current bill. The scenario does not explicitly model the strategic allowance reserve, assuming that emitters will purchase allowances and the pool will be used up. The scenario does predict significant actions by other countries. Countries that have already made international commitments to cut their emissions under the Kyoto Protocol (with the exception of Russia) are expected to continue to cut emissions even beyond Kyoto's current implementation period, and ultimately to reduce their emissions by the year 2050 to fifty percent below their 1990-level emissions. The rest of the world is assumed to reduce their emissions as well, but more gradually and less stringently.

EPA has used two economic models to estimate the emissions reductions and costs associated with H.R. 2454.[20] The Applied Dynamic Analysis of the Global Economy (ADAGE) model is a dynamic Computable General Equilibrium model of the U.S. economy, including international trade. The Intertemporal General Equilibrium Model (IGEM) models only the U.S. economy, but has a more detailed representation of energy and environmental issues; perhaps importantly, because it does not model international emissions, IGEM does not capture possible emissions leakage.[21] ADAGE offers a more complete representation of the full global economy,[22] but is less useful for conducting counterfactual policy experiments. EPA's online data annex provides year-by-year results for IGEM but only five-year snapshots for ADAGE,[23] making analysis based on IGEM data more transparent. Ultimately, each model has its own strengths and weaknesses,[24] and so this policy brief will use EPA's data generated under both ADAGE and IGEM.

Most of H.R. 2454's provisions begin to take effect in 2012 and last until 2050.[25] For both the ADAGE and IGEM models, EPA has published data through the year 2050, so this policy brief will calculate costs and benefits of H.R. 2454 from 2012 through 2050.[26] The costs of climate change policy may be concentrated more intensely in earlier years, especially beginning in the year 2025, when emissions reduction targets under H.R. 2454 become much more stringent.[27] Moreover, compliance costs for environmental standards historically have tended to decrease over time, with the deployment and innovation of new advanced technologies and compliance strategies.[28] In contrast, the benefits of climate change policy may increase over time, because "future emissions are expected to produce larger incremental damage as physical and economic systems become more stressed as the magnitude of climate change increases."[29] Therefore, focusing on the period from

2012 through 2050 may tend to overestimate the total costs and underestimate the total benefits of climate change mitigation.

EPA, the Department of Energy, and various other federal agencies often use different base years to calculate the impacts of inflation and different discount rates to reflect the fact that benefits in the future are worth less than benefits today. To make the data comparable, this policy brief presents all monetary values in terms of 2007 U.S. dollars and uses a discount rate of 5%.[30] The discount rate is calculated from the year 2009.

The choice of discount rate is particularly important in analyzing the benefits of climate change legislation because the costs and benefits are realized at different times. While the discounting of costs and benefits is necessary and appropriate in many contexts, certain applications of a discount rate—especially a rate as high as 5%—to calculating the social cost of carbon are highly controversial. This policy brief will apply a discount rate to all stages of analysis, to be consistent with the current practices of federal agencies; however, this brief will also make note of when the application of a particular discount rate is likely too high. See other publications from the Institute for Policy Integrity for more detail on why discounting should be inapplicable in certain contexts.[31]

All calculations, estimates, and charts presented in this policy brief were generated using a Microsoft Excel spreadsheet, which is available online at the Institute for Policy Integrity's website.[32]

Costs

In its economic analysis, EPA presents its cost calculations as an average annual loss of consumption per U.S. household. Specifically, EPA estimates that under H.R. 2454, average annual household consumption will decline by $80 to $111 (in 2005$) per year relative to the baseline scenario.[33] Using the raw data made available on EPA's website, it is possible to calculate the total, cumulative costs on a nationwide basis from 2012 through 2050. Since costs and benefits fluctuate year-by-year with the stringency of H.R. 2454's provisions, it is more transparent to use annual and cumulative figures (rather than a single average) when comparing the costs and benefits of climate legislation.

The following table shows total costs for select years, as well as cumulatively over the 2012-2050 period, under both the ADAGE and IGEM models. According to EPA, these cost calculations "include the effects of higher energy prices, price changes for other goods and services, impacts on wages, and returns to capital."[34] Importantly, the cost figures have been adjusted to reflect the value of emissions allowances that will be auctioned off under H.R. 2454's cap-and-trade scheme, with some revenues being returned to consumers and to lower- and middle-income families. On the other hand, notably, "[t]he cost estimates do not account for the benefits of avoiding the effects of climate change."[35] Also, EPA's cost estimates do not include the government's costs of administering, monitoring, and enforcing H.R. 2454.[36]

Table 1: Cost Estimates by Model (in Millions of 2007$)

Year	ADAGE Model	IGEM Model
2015	$6,998	$2,181
2020	$8,602	$7,188
2025	$10,417	$11,836
2030	$20,219	$16,280
2035	$23,918	$21,236
2040	$27,844	$23,026
2045	$29,989	$23,925
2050	$30,077	$24,091
Total from 2012-2050	**$732,979***	**$589,403**

*Note: ADAGE data is only available in five-year increments. Annual values were interpolated to make the ADAGE results directly comparable to IGEM.

Some of ADAGE and IGEM's cost predictions for early years (2010-2013) are negative due to investment spurred by the passage of the Act and the relatively high initial caps.[37] Because the cumulative figures calculated in Table 1 exclude negative costs in years 2010 and 2011 (since the cap does not take effect until 2012), these cost estimates are higher than some of EPA's predictions that average costs from 2010-2050.[38]

Several assumptions made by EPA for the sake of "simplicity" are likely to results in "an overestimation of abatement costs."[39] For example, EPA predicts that most emissions reduction measures will be implemented at costs below the marginal price of emissions allowances. More specifically, EPA believes the relationship between abatement costs and allowance prices will follow a convex curve, suggesting a factor greater than two. However, for the sake of simplicity, EPA chose to approximate abatement costs by dividing allowance prices by two—an assumption that will inevitably lead to an overestimation of abatement costs.

Finally, EPA's cost analysis does not model the effects of the bill's new source performance standards for methane emissions from landfills and coal mines, or of H.R. 2454's separate cap on hydrofluorocarbon emissions.[40] Therefore, these emissions will not be considered in the benefits analysis of this policy brief, despite the significant GHG reductions such provisions would achieve.

Benefits

Climate legislation like H.R. 2454 would achieve both direct and indirect benefits. The potential direct benefits result from capping GHG emissions, thereby mitigating the speed and severity of the myriad impacts of climate change on the environment, the economy, public health, and national security. Such benefits are approximated by the "social cost of carbon" (SCC), which assigns a specific monetary value to the marginal impact over time of one additional ton of carbon dioxide-equivalent emissions.[41]

Cutting GHG emissions is also likely to generate several significant indirect benefits. For example, in addition to trapping heat in the atmosphere, carbon dioxide is also absorbed by bodies of water and leads to ocean acidification, which threatens the balance of many marine ecosystems; yet ocean acidification and its effects are not typically reflected in SCC approximations. Another significant category of ancillary benefits derives from the reduction of non-target, non-GHG co-pollutants as businesses make changes to decrease their GHG emissions. Reducing such co-pollutants, like nitrogen dioxide, will achieve significant economic and health benefits, which are not otherwise included in the SCC estimates.

Calculating the Total GHG Emissions Avoided

The first step in the benefits equation is to calculate the projected tons of greenhouse gas emissions that H.R. 2454's policies would prevent from entering the atmosphere. The following figures were generated from the raw data available on EPA's website, and they represent net emissions reductions under H.R. 2454 on a global basis, taking into account any domestic or international offsets.[42]

Table 2: GHG Reduction Estimates by Model
(in Millions of Metric Tons of Carbon Dioxide-Equivalents)

Year	ADAGE Model	IGEM Model
2015	1,277	1,948
2020	1,776	2,225
2025	2,559	2,506
2030	3,180	2,778
2035	3,655	3,039
2040	4,214	3,384
2045	5,207	3,896
2050	6,149	4,410
Total from 2012-2050	**121,490***	**113,768**

*Note: ADAGE data is only available in five-year increments. Annual values were interpolated to make the ADAGE results directly comparable to IGEM.

These numbers do not include an addition 39-40 billion metric tons of carbon dioxide-equivalents avoided due to discounted offsets, international forestry set-asides, new source performance standards for landfills and coal mines, and a separate cap for hydrofluorocarbon emissions.[43] Not all of those additional provisions were modeled in EPA's cost estimates, and so they have been excluded from this benefits calculation. However, these figures should be kept in mind when reviewing the total economic justification for the bill, since all these additional provisions might very well generate benefits in excess of their costs.

Determining the Social Cost of Carbon

The "social cost of carbon" (SCC) is a monetary measure of the incremental damage resulting from GHG emissions. The SCC assigns a net present value to the marginal impact of one additional ton of carbon dioxide-equivalent emissions released at a specific point in time. SCC estimates take into consideration such factors as net agricultural productivity loss, human health effects, property damages from sea level rise, and changes in ecosystem services.[44]

However, all current SCC calculations involve a great deal of uncertainty that likely results in underestimation. Scientific knowledge about climate risks continues to grow more precise, but currently remains incomplete. For example, as EPA recently affirmed, "the current trajectory for [global] GHG emissions is higher than typically modeled" and the "current regional population and income trajectories…are more asymmetric than typically modeled."[45] As a result, actual climate change and vulnerability to climate change is likely much greater than captured by current SCC estimates.

Additionally, the economic models used to value costs and benefits cannot yet quantify all the likely and potential damages from climate change. Table 3 lists the impacts of climate change—some positive, but mostly negative—that have historically been omitted from the economic models used to calculate the SCC. The result of such significant omissions, according to EPA, is that current SCC estimates are "very likely" to be underestimations.[46]

In a forthcoming article, Jody Freeman and Andrew Guzman detail the five "methodological limitations of these models [that] almost certainly cause them to understate the impact and cost of climate change": "optimism about project temperature rise; failure to account for the possibility of catastrophic loss; omission of cross-sectoral [and cumulative] impacts; exclusion of non-market costs; and optimism about projected economic growth (which assumes productivity will be unaffected by climate change)."[47]

Table 3: List of Impacts <u>Omitted</u> from the FUND Model[48]

Agriculture	Reduction in growing season (e.g., in Sahel/southern Africa)
	Increase in growing season in moderate climates
	Impact of precipitation changes on agriculture
	Impact of weather variability on crop production
Biomes/ Ecosystems	Reverse of carbon uptake, amplification of climate change
	Thresholds or "tipping points" associated with species loss, ecosystem collapse, and long-term catastrophic risk (e.g., Antarctic ice sheet collapse)
	Species existence value and the value of having the option for future use
	Earlier timing of spring events; longer growing season
	Poleward and upward shift in habitats; species migration
	Shifts in ranges of ocean life
	Increases in algae and zooplankton
	Range changes/earlier migration of fish in rivers
	Impacts on coral reefs
	Ecosystem service disruption (e.g. loss of cold water fish habitat in the U.S.)
	Coral bleaching due to ocean warming
Energy	Energy production/infrastructure
	Water temperature/supply impacts on energy production
Foreign Affairs	Social and political unrest abroad that affects U.S. national security (e.g., violent conflict or humanitarian crisis)
	Damage to foreign economies that affects the U.S. economy
	Domestic valuation of international impacts
Forest	Longer fire seasons, longer burning fires, and increased burn area
	Disappearance of alpine habitat in the United States
	Tropical forest dieback in the Amazon
GDP/ Economy	Insurance costs with changes in extreme weather, flooding, sea level rise
	Global transportation and trade impacts from Arctic sea ice melt
	Distributional effects within regions
	Vulnerability of societies highly dependent on climate-sensitive resources
	Infrastructure costs (roads, bridges)
	Extreme weather events (droughts, floods, fires, and heavy winds)
Health	Increased deaths, injuries, infectious diseases, stress-related disorders with more frequent extreme weather (droughts, floods, fires, and heavy winds)
	Increases in malnutrition
	Air quality interactions (e.g., ozone effects, including premature mortality)
Snow/ Glacier	Changes in Arctic/Antarctic ecosystems
	Enlargement and increased numbers of glacial lakes; increased flooding
	Snow pack in southeastern United States
Tourism	Changes in tourism revenues due to ecosystems and weather events
	Arctic hunting/travel/mountain sports
Water	River flooding
	Infrastructure, water supply
	Precipitation changes on water supply; increased runoff in snow-fed rivers
	Increasing ground instability and avalanches

In recent years, various federal agencies have selected a wide range of SCC estimates on a rather ad hoc and inconsistent basis. For example, in 2008, the Department of Transportation assumed a value of $7 per ton of carbon dioxide for emissions reductions achieved by a proposed vehicle efficiency standard.[49] But by the following year, the agency was instead using a mean value of $33 for essentially the same regulation (and was also analyzing possible values at $2 and $80).[50] The Department of Energy has at times used a range of $0-$20,[51] while in other rulemakings has copied the Department of Transportation's figures.[52] Finally, in 2008, EPA developed a technical support document on the SCC. Using both a meta-analysis of existing literature and a specific economic model, EPA calculated a wide range of possible SCC estimates from -$6 to $695.[53] Though EPA has declared that many of these estimates are "highly preliminary, under evaluation, and likely to be revised,"[54] the agency has used them in recent rulemakings.[55]

Over the past several months, a collection of federal agencies has been working to develop a more consistent methodology for selecting SCC estimates to use in economic analysis.[56] Though the results of this interagency effort are still preliminary, the Department of Energy now feels confident enough in the interagency review process to begin using this new set of numbers in its rulemakings.[57]

The interagency review process made a number of crucial judgments in developing its SCC estimates. First, the interagency review concluded that a global SCC value should be "primary," even though a domestic SCC should also be considered.[58] In the past, some federal agencies (such as the Department of Transportation) have at times decided to count only climate change costs imposed directly on the United States, excluding broader global effects.[59] Some analysts believe the United States's share of climate effects will be comparatively small, because of the country's "relatively temperate climate, [the] small dependence of its economy on climate, the positive amenity value of a warmer climate in many parts of the United States, its advanced health system, and [its] low vulnerability to catastrophic climate change."[60]

However, as EPA has observed, such a decision would falsely assume that Americans are unwilling to pay to avoid international damages caused by U.S. emissions and that international impacts will not produce security risks or economic disruptions felt within U.S. borders.[61] In short, the global value is the "preferred" measurement since climate change "involves a global public good in which the emissions of one nation may inflict significant damages on other nations and [where] the United States is actively engaged in promoting an international agreement to reduce worldwide emissions."[62] This brief will discuss the global versus domestic issue in greater detail in the section on "Comparing Costs and Benefits," with particular attention to how current SCC estimates do not consider domestic valuations of international impacts and how U.S. action on climate change is likely a prerequisite to future international efforts, which will in turn benefit U.S. interests.

The interagency review process chose to focus on existing SCC estimates that (1) are derived from peer-reviewed studies, (2) do not weight the monetized damages to one country more than those in other countries, (3) use a "business as usual" climate scenario, and (4) are based on the most recent version of each of three major integrated economic assessment model (FUND, DICE, and PAGE). The review process then came to its own SCC estimates using averages weighted for each separate economic model, because "there appears to be no scientifically valid reason to prefer any of the three major [models]."[63]

Finally, the interagency review process selected a 3% growth rate to apply to the SCC values. Any SCC estimate is specific to pollution emitted at a particular point in time: for example, the costs imposed by GHGs released in the year 2010 will be lower than the costs imposed by GHGs released in the year 2011. The SCC is assumed to increase steadily over time, because "future emissions are expected to produce larger incremental damages as physical and economic systems become more stressed as the magnitude of climate change increases."[64] The review process selected a 3% growth rate, consistent with international recommendations and with the most recently peer-reviewed literature.[65]

Imbedded within the various SCC values calculated by the interagency review process are discount rates. Averting climate change will mostly produce benefits in the future, and discount rates are traditionally applied to account for a general preference for immediate benefits, so that a benefit accruing years from now is not worth as much as a benefit accruing today. Because in the context of climate change benefits accrue not just in the future but to future generations of people, the practice of discounting is quite controversial. See other publications by the Institute for Policy Integrity for more detail on the economic and ethical problems with discounting the costs and benefits of climate legislation.[66]

The interagency review process acknowledged that "[t]he choice of a discount rate, especially over long periods of time, raises highly contested and exceedingly difficult questions of science, economics, philosophy, and law."[67] Nevertheless, the process drew on literature that uses 3% and 5% discount rates, applied either constantly each year or via a "random walk" method that better accounts for uncertainty.[68] The Department of Energy also averaged the estimates associated with a constant 3% and a constant 5% rate, to generate a central figure that it prefers to use.

The following table shows the range of SCC estimates developed by the interagency review process at these various discount rates. Because discounting is such a controversial practice in the realm of climate change, this policy brief will also look at EPA's 2008 estimates of the SCC that used the slightly lower 2% discount rate.[69]

Table 4: Net Present Global SCC Estimates at 3% Growth Rate (in 2007$, per Metric Ton of CO_2-Equivalent Emissions)

Year of Emission	Discount Rate					
	Constant 5%*	**Random-Walk 5%***	**Average of 3% & 5% (Constant)†**	**Constant 3%***	**Random-Walk 3%***	**Constant 2%‡**
2007	$5	$10	$19	$33	$55	$68
2010	$5.46	$10.93	$20.76	$36.06	$60.10	$74.31
2015	$6.33	$12.67	$24.07	$41.80	$69.67	$86.14
2020	$7.34	$14.69	$27.90	$48.46	$80.77	$99.86
2025	$8.51	$17.02	$32.35	$56.18	$93.63	$115.77
2030	$9.87	$19.74	$37.50	$65.13	$108.55	$134.20
2035	$11.44	$22.88	$43.47	$75.50	$125.84	$155.58
2040	$13.26	$26.52	$50.39	$87.53	$145.88	$180.36
2045	$15.37	$30.75	$58.42	$101.47	$169.11	$209.09
2050	$17.82	$35.65	$67.73	$117.63	$196.05	$242.39

* Model-Weighted Mean Calculated by Interagency Process in 2009
† Department of Energy's Average of the SCC Estimates at the Constant 3% and Constant 5% Discount Rates
‡ Central Estimate of Meta-Analysis Conducted by EPA in 2008

Bear in mind that, for the reasons discussed above, all these estimates are still likely to be *under*estimates.

Quantification of Direct Benefits

Calculating the direct benefits of H.R. 2454's cap on GHG emissions is simply a matter of multiplying the projected GHG emissions avoided by the social cost of carbon. The following tables show the projected GHG emissions under either ADAGE or IGEM, multiplied by all six

SCC estimates in the range developed by federal agencies. In both tables, the benefits have been discounted at a 5% rate (consistent with EPA's discounting of costs), above and beyond any discounting already factored into the SCC values, to account for the fact that the benefits of reducing future emissions do not begin accruing until a later date.

Table 5: Direct Benefits under ADAGE Model (in Millions of 2007$, at a 5% Discount Rate)

	SCC Estimate					
Year	**Constant 5%** ($5 in 2007)	**Random-Walk 5%** ($10 in 2007)	**Average of 3% & 5%** ($19 in 2007)	**Constant 3%** ($33 in 2007)	**Random-Walk 3%** ($55 in 2007)	**Constant 2%** ($68 in 2007)
2015	$6,035	$12,070	$22,933	$39,832	$66,386	$82,077
2020	$7,623	$15,246	$28,966	$50,310	$83,850	$103,670
2025	$9,980	$19,960	$37,924	$65,868	$109,780	$135,728
2030	$11,264	$22,529	$42,804	$74,345	$123,908	$153,195
2035	$11,760	$23,521	$44,689	$77,618	$129,364	$159,941
2040	$12,314	$24,628	$46,792	$81,271	$135,452	$167,468
2045	$13,821	$27,643	$52,522	$91,222	$152,036	$187,972
2050	$14,826	$29,652	$56,339	$97,851	$163,086	$201,633
Total from 2012-2050	**$408,714**	**$817,428**	**$1,553,113**	**$2,697,512**	**$4,495,853**	**$5,558,509**

The wide range of possible SCC values generates a wide range of benefit estimates: the variability in estimated benefits is purely a function of the SCC range.[70] A starting social cost of carbon of $5 in 2007 generates benefits of approximately $409 billion over the life of the bill, while a social cost of carbon of $68 in 2007 generates benefits of about $5.5 trillion dollars. Using the SCC figures preferred by the Department of Energy in its recent rulemaking, benefits total about $1.5 trillion. The benefit estimates are relatively small during the early years of the cap, but rise as the cap's stringency increases and the SCC values grow. Despite being discounted, the benefits in 2050 are forecasted to be more than twice as large as those in 2012.

Table 6: Direct Benefits under IGEM Model (in Millions of 2007$, at a 5% Discount Rate)

Year	SCC Estimate					
	Constant 5% ($5 in 2007)	**Random-Walk 5%** ($10 in 2007)	**Average of 3% & 5%** ($19 in 2007)	**Constant 3%** ($33 in 2007)	**Random-Walk 3%** ($55 in 2007)	**Constant 2%** ($68 in 2007)
2015	$9,205	$18,410	$34,979	$60,753	$101,256	$125,189
2020	$9,551	$19,102	$36,293	$63,035	$105,058	$129,890
2025	$9,773	$19,547	$37,138	$64,504	$107,506	$132,916
2030	$9,838	$19,676	$37,385	$64,932	$108,220	$133,800
2035	$9,777	$19,554	$37,153	$64,529	$107,548	$132,969
2040	$9,889	$19,778	$37,579	$65,268	$108,780	$134,492
2045	$10,342	$20,683	$39,298	$68,255	$113,759	$140,647
2050	$10,632	$21,264	$40,401	$70,171	$116,952	$144,595
Total from 2012-2050	**$382,982**	**$765,964**	**$1,455,332**	**$2,527,681**	**$4,212,802**	**$5,208,555**

The IGEM model generates a similarly wide range of possible benefit values, reflecting the wide range of SCC estimates. The possible benefits run from $383 billion to $5.2 trillion, and total nearly $1.5 trillion using the SCC values preferred by the Department of Energy's recent rulemaking. Those cumulative benefits are consistently smaller than those from the ADAGE model due to lower estimates of overall GHG reductions (see Table 2). The IGEM model projects larger benefits in the early years of the regulation, but significantly smaller benefits during the final years covered under this cap. Even after discounting, those smaller benefits in future years lead IGEM to forecast smaller cumulative benefits over the life of H.R. 2454.

Again, bear in mind that these figures represent discounted benefits. The choice of a discount rate as high as 5% is controversial, and it can be useful in cost-benefit analysis to present the results using a discount rate of 0% as well.[71] The following chart compares the stream of benefits over time under both models at either a 0% or 5% discount rate, assuming an SCC value starting at $19 for year 2007 emissions (the value preferred by the Department of Energy).

Chart 1: Benefit Streams at 0% and 5% Discount Rates

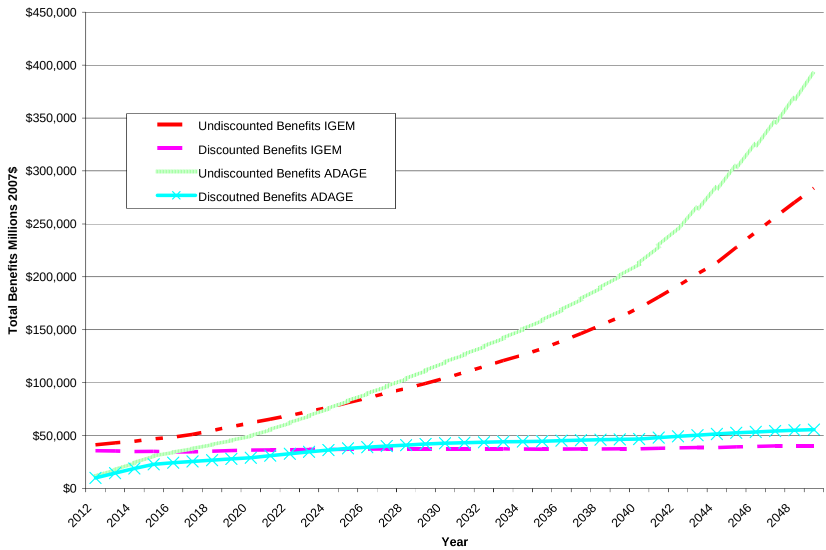


Chart 1 illustrates the importance of selecting a discount rate when estimating the benefits (or costs) of a long-term policy such as H.R. 2454. The benefits at a 0% discount rate rise very quickly as the level of emissions drops and the social cost of carbon increases, but discounting those large benefits at a 5% rate reduces their size tremendously. Assuming a starting SCC of $19 and using the IGEM model, a discount rate of 0% leads to cumulative benefit estimates of around $5.0 trillion, while discounting at 5% leads to a total benefits estimate of around $1.5 trillion.

Notably, there is only a 6%-18% difference between the ADAGE and IGEM models in either the 0% or 5% discount rate cases, whereas there is a 246%-286% difference between discounting and not discounting benefits. In other words, the choice of discount rate and the choice of SCC values are far more important than the choice of economic model when forecasting the long-run costs and benefits.

Quantification and Qualitative Discussion of Ancillary Benefits

The SCC estimates undeniably do not yet reflect all impacts of climate change (see Table 3); those omissions must be rectified in order to accurately calculate direct benefits. However, the policies implemented by climate legislation like H.R. 2454 will also generate several ancillary benefits, wholly apart from any effect tied to climate change, and definitely not captured in the social cost of carbon. These benefits include reduced ocean acidification, increased forest preservation, and reductions in local air pollutants such as sulfur dioxide, nitrogen dioxide, and particulate matter.

Such outcomes are not the primary goal of H.R. 2454, but they still provide benefits that must be considered when conducting a full economic analysis. Indeed, some past attempts to quantify ancillary benefits of various climate policies have estimated the indirect benefits at anywhere from 30% to over 100% of total compliance costs.[72] That said, ancillary benefits can often be difficult to value accurately, and so in some cases they must remain un-quantified. Nevertheless, all ancillary benefits, whether monetized or not, deserve attention when determining if the benefits of proposed legislation outweigh the costs.

Health and Economic Benefits from Co-Pollutants

As power plants begin to comply with climate legislation by becoming more efficient, switching to cleaner fuel sources (like natural gas instead of coal), or deploying controls to capture and sequester emissions, they will be reducing more than just their greenhouse gas pollution. Power plants also emit significant quantities of nitrogen dioxide, sulfur dioxide, particulate matter, and heavy metals: the pollutants responsible for producing smog and acid rain, and also for contributing to water quality deterioration, soil quality deterioration, and severe respiratory disorders. Though these co-pollutants are not the target of climate policies like H.R. 2454, such legislation will have the ancillary benefit of reducing their emission as well.[73]

EPA's models "do not incorporate the effects of changes in conventional pollutants ([sulfur dioxide, nitrogen dioxide, and mercury]) on labor productivity and public health." EPA considered this to be "an important limitation," but ultimately not a significant one, because the agency expected the actual health and economic benefits to be "small."[74] By contrast, past attempts to calculate ancillary benefits of various climate policies have predicted health effects will account for around 70-90% of the total value of ancillary benefits.[75]

Some of these ancillary benefits can be quantified using a model developed by Dallas Burtraw and other economists from Resources for the Future and the Argonne National Laboratory. In 2001, Burtraw and his colleagues released a paper on "Ancillary Benefits of Reduced Air Pollution in the United States from Moderate Greenhouse Gas Mitigation Policies in the Electricity Sector."[76] That paper makes a series of "cautious assumption[s]" to generate a "lower bound" estimate for ancillary benefits under a range of climate policies.[77] By focusing on one particular conservative scenario explored in that paper, this analysis can adapt Burtraw's model to predict some of the ancillary health benefits from H.R. 2454.

Burtraw's model estimates the ancillary benefits of applying climate policies specifically to the electricity sector. Where the climate policy is likely to lead to actual net reductions in other non-target pollutants, Burtraw's model calculates public health benefits.[78] Where the climate policy is not likely to lead to actual net reductions in other non-target pollutants, because such conventional pollutants are already subject to a strict regulatory cap, Burtraw's model predicts economic savings as the allowance price for those conventional pollutants drops.[79]

Because several significant regulatory and economic changes have occurred since 2001, ideally Burtraw's model should be updated to provide a more accurate calculation of ancillary benefits. However, the fundamental structure of Burtraw's model remains sound, and it should provide a rough estimation. Burtraw's baseline scenario assumed that, over time, some stricter regulatory controls would be developed for nitrogen dioxide and sulfur dioxide. In particular, Burtraw modeled an expanded nitrogen dioxide cap-and-trade program encompassing nineteen states and the District of Columbia.[80] In reality, the Clean Air Interstate Rule of 2005 (CAIR) now covers twenty-eight states plus D.C.[81] However, because CAIR was technically overturned by the courts and only remains in effect until EPA can replace it, and because CAIR (or its replacement) will only be phased in over time, has some seasonal components, and does not cover at least twenty-two states,[82] climate change legislation will still likely impact nationwide emissions of nitrogen dioxide, and Burtraw's model remains a good approximation.

Moreover, Burtraw's model is extremely conservative. For example, because of the difficulty in quantifying the health impacts of sulfur dioxide, ozone, and other pollutants, Burtraw only addressed the health effects of nitrogen dioxide, meaning his model's "estimates may be a lower bound of the estimates that would be achieved if a complete analysis was possible."[83] Similarly, because of the study's methodologies, the "estimate of the compliance cost savings resulting from [climate policies] would be likely to underestimate savings."[84] Finally, Burtraw's model uses a value of statistical life ($3.8 million in 1997$) much lower than EPA's current recommendation ($7.0 million in 2006$).[85]

Burtraw's model estimates a range of ancillary benefits per ton of carbon emissions avoided. This policy brief will use the lowest total estimate generated for the most analogous scenario modeled.[86] To be conservative, this analysis will assume that figure is constant and will not grow over time. EPA's ADAGE model of emissions under H.R. 2454 breaks down carbon dioxide reductions specific to electricity production.[87] By multiplying those figures and applying a 5% discount rate, ancillary benefits can be estimated.

Table 7: Ancillary Benefits in Electricity Sector

Year	CO_2 Reductions from Electricity Sector (Million Metric Tons)	Ancillary Benefits Per Ton of CO_2 (2007$)	Benefits at 0% Discount Rate (Millions of 2007$)	Benefits at 5% Discount Rate (Millions of 2007$)
2015	287.6	$4.3689	$1,256.60	$937.70
2020	673.4	$4.3689	$2,942.22	$1,720.26
2025	1,058.5	$4.3689	$4,624.50	$2,118.54
2030	1,393.9	$4.3689	$6,089.81	$2,185.89
2035	1,635.3	$4.3689	$7,144.63	$2,009.36
2040	1,922.7	$4.3689	$8,399.91	$1,851.00
2045	2,255.2	$4.3689	$9,852.60	$1,701.12
2050	2,551.6	$4.3689	$11,147.80	$1,508.09
Total from 2012-2050	**57,419.1***		**$250,858.16**	**$68,405.80**

*Note: ADAGE data is only available in five-year increments. Annual values were interpolated to derive a cumulative total.

Burtraw's model predicts that ancillary health and economic benefits from reducing co-pollutants in the electricity sector could total nearly $70 billion. This figure should be kept in mind when assessing the cost-benefit justification of H.R. 2454, but because the model is imperfect and results are available only for ADAGE data, to be conservative this total will not be added to the final direct benefits calculation.

Other sectors besides the electricity sector will also use fuel switching to comply with H.R. 2454: in particular, the transportation sector. Fuel switching in these other areas will also carry ancillary health benefits. In its recent proposed rulemaking on renewable fuels, EPA noted that switching to cleaner vehicle fuels in an attempt to reduce greenhouse gas emissions would also cut the emission of co-pollutants. Unfortunately, EPA did not attempt to monetize these benefits.[88] Without such a model to build from, it is difficult for this policy brief to attempt to quantify these ancillary benefits. Ideally, EPA should develop such a model, both for use in its renewable fuel rulemaking and to enable a complete cost-benefit analysis of climate legislation.

Ocean Acidification

In addition to acting as a greenhouse gas in the atmosphere, carbon dioxide alters ocean chemistry as it is absorbed by surface waters. The resulting acidification of water may potentially harm a wide range of marine organisms (particularly coral), as well as the food webs and valuable marine fisheries that depend on them.[89] In a recent study anticipating the economic consequences for commercial fisheries of ocean acidification, Sarah Cooley and Scott Doney note that, in the United States alone, commercial fishing contributes $34.2 billion in value to the gross national product and likely supports several hundreds of thousands of jobs; recreational fishing adds another $43 billion in total economic activity and supports around 350,000 jobs. Considering just potential losses to U.S. mollusk commercial fisheries, the economic costs of ocean acidification easily fall in the range of $0.6-$2.6 billion through the year 2060.[90] Though it is difficult to quantify what portion of such costs could be averted through policies like H.R. 2454, qualitatively the benefits of preventing ocean acidification are highly significant on a global scale.

Other Ancillary Benefits

Some of the other ancillary benefits for GHG reductions that are frequently discussed in literature—though difficult to quantify—include:[91]

- Energy security: geopolitical benefits from reduced reliance on foreign fossil fuel sources.

- Increased forest preservation: increased ecosystem service benefits from forests; increased access to recreational sites; reduced soil loss and erosion through tree farming.

- Decreased private transportation (either with shift to public options or overall decrease in miles traveled): reductions in road-related mortality; reductions in congestion and noise; cost-savings for road maintenance.

- Non-health effects of non-target pollutants: reduced nitrate loadings to marine and freshwater ecosystems; agricultural benefits from reduced ozone formation and particulate-haze effects; agricultural benefits from reduced nitrogen deposition; increased visibility.

- Possible employment gains from green collar jobs: this benefit is perhaps somewhat speculative, since possible decline in economic activity might cancel out any employment gains; EPA's current economic models do not represent effects on unemployment.[92]

A fuller analysis of and attempt to quantify all possible ancillary benefits and ancillary costs is beyond the scope of this policy brief. Ideally, Congress should request that EPA undertake such a study.

Additionally, H.R. 2454 contains particular provisions and structures unrelated to GHG reductions that may carry benefits. For example, through its distribution of revenue from the auction of emissions allowances, H.R. 2454 may provide relief to local government budgets, support for transportation and research initiatives, and improved distributional equity via tax relief to low- and middle-income families.[93] A more thorough analysis of the specific provisions of H.R. 2454 is beyond the scope of this policy brief. Such a review should be part of a comprehensive EPA cost-benefit analysis of H.R. 2454.

Comparing Costs and Benefits

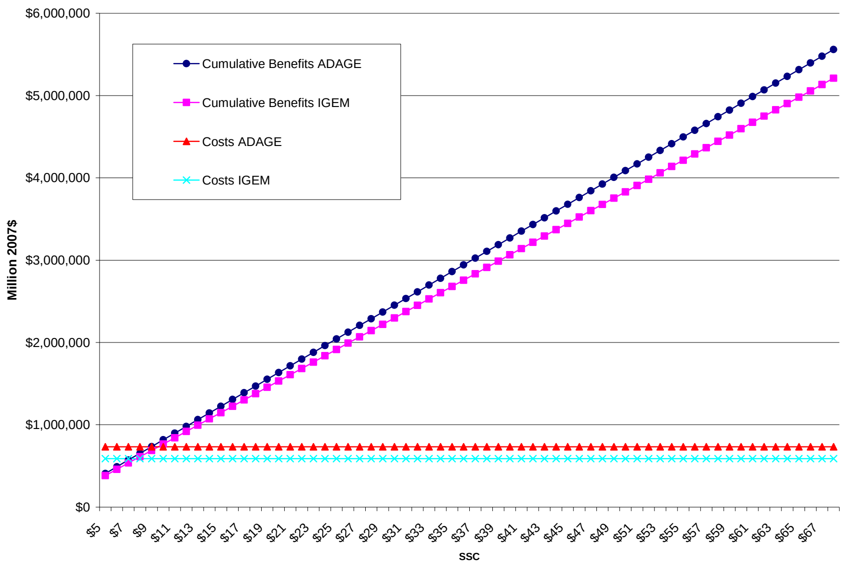
This section compares the estimated costs of complying with H.R. 2454 with estimates of the benefits as measured by the social cost of carbon and ancillary benefits. This comparison will be used to predict whether the proposed bill and possible legislative alternatives are likely to pass a more thorough cost-benefit analysis.

The Breakeven SCC

The following chart plots the estimated cumulative costs of H.R. 2454 (around $660 billion) against the projected direct benefits of the bill for a range of SCC values (from $5 per ton of carbon dioxide in 2007, up to $68 per ton). The chart continues to employ the restrictive assumptions used in the brief, and therefore does not include any ancillary benefits, and discounts costs and benefits at a 5% rate. Additionally, recall that 39-40 billion metric tons of GHG abatement are not included in the benefits analysis, because EPA excluded certain provisions from its cost estimates.

The benefits as calculated by ADAGE and IGEM increase with the SCC, but costs remain constant. Measuring benefits is more difficult than measuring costs, as SCC estimates vary widely. For that reason, it is useful to calculate the SCC that will exactly equate the benefits (excluding ancillary benefits) of the bill with the estimated cost—in other words, the "breakeven social cost of carbon." If the actual SCC is above that value, benefits of H.R. 2454 will outweigh costs, and the legislation is cost-benefit justified. For ADAGE the breakeven point is $8.97, and for IGEM it equals $7.70. The breakeven points are close, but that hides some differences in the results: ADAGE forecasts higher costs and larger emissions reductions, which cancel each other out in a cost-benefit framework. Because these values do not include (potentially large) ancillary benefits, they should be considered an upper bound on the true breakeven SCC. Notably, these figures are on the very low end of the range generated by the interagency review process, and are less than half the $19 figure preferred by the Department of Energy in its recent rulemaking.

Chart 2: Total Costs and Benefits at Different SCC Values



Maximizing Net Benefits

At the SCC values preferred by the Department of Energy, the direct benefits of H.R. 2454 are more than double the costs. Using SCC values that have a more appropriately low discount rate built in (EPA's 2% figures), direct benefits are nearly eight to nine times greater than costs. Importantly, all these benefits calculations are likely to be underestimates, due to uncertainty in forecasting the SCC values and because ancillary benefits have not been quantified and added to these numbers.

Considering how strongly benefits outweigh costs at the level of GHG emissions cap contemplated by H.R. 2454, and given the difference between the breakeven SCC calculated for the bill and projections for allowances prices under the bill,[94] it seems probable that alternate policy arranges would also be cost-benefit justified. Indeed, it is very possible that a more stringent GHG cap could even better maximize net benefits.

Limitations of This Analysis

This brief only analyzes the period for which H.R. 2454 specifies emissions targets (2012-2050). Climate change is a long-run phenomenon, with emissions today generating damages in the fairly distant future. The majority of benefits from reduced emissions are likely to accrue to future generations, while costs fall on current consumers. On the other hand, many of the ancillary benefits described in the previous section will be realized immediately. These include the health benefits from a reduction in co-pollutants and possible geopolitical benefits from reductions in energy usage.

This policy brief has not attempted to analyze whether the distribution of costs and benefits under H.R. 2454 is equitable or optimal. Many other analysts have reviewed this issue in depth and have suggested simple changes to H.R. 2454 that could improve the distributional equity of the bill. Dallas Burtraw's work on how alternate arrangements for allocating and auctioning off emissions allowances could correct some distributional imbalances is particularly instructive.[95]

Global versus Domestic Valuations

It is worth noting that the estimated costs of H.R. 2454 will be borne entirely by the United States,[96] whereas the benefits are based on a global SCC figure. The domestic SCC is typically estimated at anywhere from 2-11% of the global SCC, with the Department of

Energy preferring to approximate it at 6%.[97] While many of the ancillary benefits of H.R. 2454 not quantified in this analysis will be enjoyed by current generations of U.S. citizens, a large portion of benefits might not be felt directly or immediately within U.S. borders.

Nevertheless, as the interagency review process concluded, the global SCC is the preferred figure for comparing the costs and benefits of climate legislation.[98] To begin, many experts believe that U.S. domestic action on climate change is a prerequisite to future global climate efforts,[99] at which point Americans will see additional (and essentially free) benefits derived from international action. Greenhouse gases are global pollutants, meaning that emissions anywhere in the world generate damages everywhere. In other words, each ton of reduced emissions in the United States will generate benefits to every other nation, and visa-versa. There is currently no mechanism for the United States to capture benefits exclusively for ourselves.[100] But once other countries take reciprocal action on climate change, they will likewise generate global benefits that will in part be reaped by the United States.

Second, current models for estimating the SCC typically do not consider domestic valuations of international impacts. For example, foreign physical damages from climate change could have domestic economic costs: the worldwide disruption of agricultural production and water resources, and the potential for social unrest—including violent conflicts—as countries react to such disasters, could pose threats to the U.S. national security and economy.[101] Freeman and Guzman detail the five "spillover" effects through which international climate impacts could indirectly—but significantly—affect U.S. interests: national security threats; economic spillovers, such as higher prices on oil and other commodities, supply and demand shocks, and market disruptions; the spread of infectious diseases; climate-induced human migration; and the risks of food and water shortages, and biodiversity loss.[102] Similarly, a recent UN report suggests that a failure to act on climate change could result in a permanent loss of as much as 20% of world gross product:[103] a potentially catastrophic impact that would undeniably be felt deeply within the United States. If all cross-sectoral, indirect, cumulative, and spillover effects were captured by the economic models, the global SCC would be higher, the domestic share of the global SCC would be higher, and the clear case for aggressive U.S. action would be easier to demonstrate qualitatively.[104]

Finally, the portion of benefits falling outside the United States could be viewed as a highly effective, highly leveraged form of foreign aid. If the global SCC is assumed to be $19, then for every dollar the United States spends complying with H.R. 2454, about $2.29 in direct benefits is produced.[105] According to the conservative domestic SCC approximation of 6%, at least fourteen cents immediately comes back to the United States in direct benefits, along with currently un-quantified but potentially large ancillary benefits. The rest is distributed to foreign countries, especially to those developing nations most vulnerable to climate change, such as Bangladesh.[106] Poorer nations are likely to be hit the hardest by climate change, because they do not have the same adaptive capacity as wealthier nations; they depend more heavily on agriculture, a climate-vulnerable sector; and they tend to be located in warmer, lower latitudes.[107]

Unlike monetary foreign aid, which is susceptible to corruption and mismanagement, these climate benefits go directly to the citizens of foreign countries, who would otherwise face floods, extreme weather, increased disease, and interrupted food and water supplies. Moreover, at some point in the near future, the United States will largely be paid back. Not only is domestic action on climate change a necessary prerequisite for future international efforts that will benefit the United States, but the international offsets and other provisions contained in H.R. 2454 will help spur the kind of technological innovation and global deployment necessary for such future international efforts to succeed.[108]

In short, from almost any perspective and under almost any assumption, H.R. 2454 is a good investment for the United States to make in our own economic future and in the future of the planet.

Conclusion and Policy Recommendations

This policy brief has considered the costs and benefits of provisions of H.R. 2454, the American Clean Energy and Security Act of 2009. EPA has conducted a careful analysis of the costs of the proposed legislation, but has not considered the benefits. Using information from that cost analysis, and estimates of the social cost of carbon generated by an interagency review process, this brief was able to conduct an exploratory benefits analysis and compare those benefits to the costs previously estimated by EPA. Analysis supports the passage of climate change legislation as cost-benefit justified under most reasonable assumptions about the likely "social cost of carbon." Indeed, using conservative assumptions and excluding ancillary benefits, the benefits of H.R. 2454 could likely exceed the costs by as much as nine-to-one or more.

The Institute for Policy Integrity (IPI) supports the continuation of the federal interagency review process to refine the likely range of SCC estimates. IPI also recommends that such interagency process rethink its approach to discounting.

This brief represents a preliminary and informal analysis, but EPA has the capacity to conduct a more thorough analysis. EPA can help ensure that Congress pursues a rational approach to climate change legislation by analyzing the likely benefits of such legislation and releasing a thorough report both to Congress and to the public. The report should first explore the potential direct benefits of mitigating the speed and severity of climate change effects, including the myriad impacts on the environment, the economy, public health, and national security. Additionally, the report should reflect the many potential indirect benefits of cutting greenhouse gas emissions, such as the environmental benefits of slowing ocean acidification, and the ancillary economic and health benefits of reducing the emission of co-pollutants. EPA should follow best practices for economic analysis when reporting the estimated valuation of these benefits.[109] EPA should begin with an analysis of the current legislative proposal (namely, H.R. 2454), but ideally a full cost-benefit analysis should look at alternative policy options as well, especially more stringent options. Finally, EPA should conduct a distributional analysis of the costs and benefits for a range of policy options.

More than ever, Congress will need a clear and comprehensive summary of all the consequences of climate change legislation, to guide its decisions over the next few months. IPI asks that EPA use its extensive expertise on climate change to act as such a guide for Congress.

Notes

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[1] *See*, *e.g.*, Letter from Senator Joseph Lieberman & Senator John Warner, to Hon. Stephen Johnson, EPA Administrator (Nov. 9, 2007) (requesting analysis of S. 2191, America's Climate Security Act of 2007) (*available at* http://www.epa.gov/climatechange/downloads/L-W_Request_to_EPA.pdf); *see generally* EPA, Climate Change—Climate Economics, http://www.epa.gov/climatechange/economics/economicanalyses.html (last visited August 31, 2009).

[2] Letter from Rep. Henry Waxman & Rep. Edward Markey, to Hon. Lisa Jackson, EPA Administrator (Feb. 27, 2009) (requesting analysis of draft legislation) (*available at* http://www.epa.gov/climatechange/economics/pdfs/WM-Analysis.pdf); *accord.* Letter from Rep. Henry Waxman & Rep. Edward Markey, to Hon. Lisa Jackson, EPA Administrator (May 14, 2009) (requesting update of analysis) (*available at* http://www.epa.gov/climatechange/economics/pdfs/HR2454_Analysis.pdf).

[3] Letter from Rep. Henry Waxman & Rep. Edward Markey, to Howard K. Gruenspecht, acting EIA Administrator (Mar. 17, 2009) (*available at* http://www.eia.doe.gov/oiaf/servicerpt/hr2454/pdf/appa.pdf); CONG. BUDGET OFFICE, COST ESTIMATE—H.R. 2454: AMERICAN CLEAN ENERGY AND SECURITY ACT OF 2009 (2009), *available at* http://www.cbo.gov/ftpdocs/102xx/doc10262/hr2454.pdf (summarizing the cost estimate, in response to a request from Rep. Henry Waxman and Rep. Edward Markey of the House Committee on Energy and Commerce).

[4] EPA, ANALYSIS OF THE AMERICAN CLEAN ENERGY AND SECURITY ACT OF 2009: APPENDIX 12 (2009), *available at* http://www.epa.gov/climatechange/economics/pdfs/HR2454_Analysis_Appendix.pdf (hereinafter Appendix).

[5] *Id.* at 63.

[6] *See* ENERGY INFO. ADMIN., DEP'T OF ENERGY, ENERGY MARKET AND ECONOMIC IMPACTS OF H.R. 2454 (2009), *available at* http://www.eia.doe.gov/oiaf/servicerpt/hr2454/pdf/sroiaf(2009)05.pdf;CONG. BUDGET OFFICE, *supra* note 3.

[7] *See*, *e.g.*, EPA, TECHNICAL SUPPORT DOCUMENT ON BENEFITS OF REDUCING GHG EMISSIONS (2008) (developing a range of SCC estimates, for the agency's own use and as possible guidance for other federal agencies); Average Fuel Economy Standards, Passenger Cars and Light Trucks; Model Years 2011-2015, 73 Fed. Reg. 24351, 24413 (proposed May 2, 2008) (presenting independent SCC calculations by the

National Highway Traffic Safety Administration, Department of Transportation); Average Fuel Economy Standards, Passenger Cards and Light Trucks Model Year 2011, 74 Fed. Reg. 14195, 14337 (Mar. 30, 2009) (to be codified at 49 C.F.R. pts. 523, 531, 533, 534, 536, 537) (presenting new SCC calculations by the National Highway Traffic Safety Administration, Department of Transportation); Energy Conservation Program for Commercial and Industrial Equipment, 74 Fed. Reg. 1091, 1133 (Jan. 9, 2009) (to be codified at 10 C.F.R. pt. 431) (presenting independent SCC calculations by the Department of Energy); Energy Conservation Program for Certain Industrial Equipment: Energy Conservation Standards and Test Procedures for Commercial Heating, Air-Conditioning, and Water-Heating Equipment 74 Fed. Reg. 36312, 36342 (July 22, 2009) (to be codified at 10 C.F.R. pt. 431) (relying on the Department of Transportation's calculations of the SCC, in a Department of Energy rulemaking).

[8] Energy Conservation Program: Energy Conservation Standards for Refrigerated Bottled or Canned Beverage Vending Machines, 74 Fed. Reg. 44913, 44947 (Aug. 31, 2009) (to be codified at 10 C.F.R. pt. 431) (hereinafter BVM Rule).

[9] *See* ENERGY INFO. ADMIN., DEP'T OF ENERGY, ENERGY MARKET AND ECONOMIC IMPACTS OF H.R. 2454 (2009), *available at* http://www.eia.doe.gov/oiaf/servicerpt/hr2454/pdf/sroiaf(2009)05.pdf (raw data available at http://www.eia.doe.gov/oiaf/servicerpt/hr2454/index.html).

[10] *See* STAFF OF H. COMM. ON ENERGY & COMMERCE, 111TH CONG., SUMMARY OF THE AMERICAN CLEAN ENERGY AND SECURITY ACT (2009), *available at* http://energycommerce.house.gov/Press_111/20090724/hr2454_housesummary.pdf ("[C]arbon pollution from large sources must be reduced by 17% below 2005 levels by 2020 and 83% below 2005 levels by 2050.").

[11] *See* CONG. BUDGET OFFICE, *supra* note 3.

[12] EPA, Data Annex for June 2009 Economic Analysis of H.R. 2454, http://www.epa.gov/climatechange/economics/downloads/HR2454Analysis-DataAnnex.zip (last visited Aug. 31, 2009).

[13] *See* Appendix, *supra* note 4, at 8 (noting the inclusion of the Energy Independence and Security Act and the use of the 2009 Annual Energy Outlook). EPA's reference case does not include the impacts of the American Recovery and Reinvestment Act of 2009, also known as the federal stimulus package. *Id.*

[14] See *id.* at 59 for a demonstration of the importance of updating the baseline scenario. Under the provisions of H.R. 2454, cumulative GHG emissions over the 2012-2050 period (before domestic or international offsets) must be cut to 235-244 billion metric tons (depending on the economic model). In the old baseline, "business as usual" would have generated 354-371 billion metric tons during that 39-year period; in EPA's updated reference case, baseline emissions fall to 303-304 billion metric tons. In other words, because of the economic downturn and independent federal energy efficiency standards, the level of emissions reduction

necessary to comply with H.R. 2454 has dropped from 119-127 billion metric tons down to 60-68 billion metric tons.

[15] *Id.* at 8.

[16] *Id.* (referencing the Notice of Upcoming Joint Rulemaking to Establish Vehicle GHG Emissions and CAFE Standards, 74 Fed. Reg. 24007 (May 22, 2009)). Under the order of a recent Supreme Court case, EPA is obligation to regulate the greenhouse gas emissions from motor vehicles, but the form of such regulation is not yet certain. *See* IPI, THE ROAD AHEAD: EPA'S OPTIONS AND OBLIGATIONS FOR REGULATING GREENHOUSE GASES (2009).

[17] Current international obligations to control GHG emissions under the Kyoto Protocol do not extend beyond the year 2012. Negotiations scheduled for December 2009 in Copenhagen are intended to develop a successor treaty, but neither the form of such an agreement nor the likelihood of its passage is certain. *See* Jean-Marie Macabrey, *Concern Grows that Kyoto Successor May Not Be Finished in Copenhagen*, CLIMATEWIRE, June 12, 2009.

[18] *See* Appendix, *supra* note 4, at 9. For example, Scenario 3 analyzes H.R. 2454 without its energy efficiency provision, and Scenario 5 alters the assumptions about nuclear electricity generation capacity.

[19] *See id.* at 8.

[20] *Id.* at 10-17.

[21] *Id.* at 14 ("Emissions leakage occurs when a domestic GHG policy causes a relative price differential between domestically produced and imported goods. This causes domestic production, which embodies the GHG allowance price[,] to shift abroad, and thus [results in] an increase in GHG emissions in other countries. Additionally, emissions leakage not associated with trade effects may occur when a GHG policy reduces domestic consumption of oil[;] lower demand for oil lowers the world oil price, which increases oil consumption in countries without a GHG policy[,] thus increasing emissions.").

[22] For example, ADAGE includes capital adjustment costs, whereas IGEM does not. *Id.* at 13.

[23] *See* Data Annex, *supra* note 12.

[24] See EPA, Climate Economic Modeling, http://www.epa.gov/climatechange/economics/modeling.html (last visited Aug. 31, 2009) for a more information on the models and their relative strengths and weakness.

[25] *See* STAFF OF H. COMM. ON ENERGY & COMMERCE, *supra* note 10.

[26] Some of EPA's figures, notably the average cost estimates, analyze data starting in 2010, before most of H.R. 2454's provisions take effect. *See* Appendix, *supra* note 4, at 56 ("The average annual cost per household is the 2010 through 2050 average of the net present value of the per household consumption loss.").

[27] *See* EIA, *supra* note 9, *available at* http://www.eia.doe.gov/oiaf/servicerpt/hr2454/background.html ("H.R. 2454 is projected to lead to higher electricity prices and lower electricity demand, though most of the price impacts are expected after 2025, as the allowances allocated to retail electricity providers are phased out.").

[28] *See* RICHARD L. REVESZ & MICHAEL A. LIVERMORE, RETAKING RATIONALITY: HOW COST-BENEFIT ANALYSIS CAN BETTER PROTECT THE ENVIRONMENT AND OUR HEALTH 131-43 (2008). For example, the actual cost of phasing out leaded gasoline in the United States proved to be 95% lower than industry had expected. ROBERT V. PERCIVAL ET AL., ENVIRONMENTAL REGULATION 561 fig.4.8 (2d ed. 1996).

[29] BVM Rule, *supra* note 8, at 44949.

[30] In its recent rulemaking that reports on the results of the interagency SCC review process, the Department of Energy uses a variety of discount rates (3%, 5%, and 7%) and mostly uses 2007$ (though a few tables claim to be presented in 2006$). *See generally id*. EPA's economic analysis of H.R. 2454 uses a 5% discount rate fairly consistently, *see* Appendix, *supra* note 4, at 61 ("The economic discount rate (5%) is applied to find the net present value (NPV) of the cost in each year in the future"), though its raw data sometimes presents figures in 2000$ and other times in 2005$, *see* Data Annex, *supra* note 12.

[31] *See* Letter from IPI, to EPA's Environmental Economics Advisory Committee (Nov. 25, 2008) (critiquing EPA's 2008 draft *Guidelines for Preparing Economic Analyses*, including its recommendations on inter-generational discounting) (*available at* http://policyintegrity.org/projects/documents/CommentsonDraftEPAGuidelines11-25.pdf).

[32] IPI, Other Side of the Coin Data, http://www.policyintegrity.org/documents/OtherSideoftheCoinDataAppendix.xls

[33] *See* Appendix, *supra* note 4, at 61. Because these figures are in 2005$ and take into account the costs in years 2010 and 2011 (which will actually be negative, because H.R. 2454's cap is not yet in effect), EPA's cost estimates are slightly deflated compared to those calculated in this analysis.

[34] *Id.*

[35] EPA, ANALYSIS OF THE AMERICAN CLEAN ENERGY AND SECURITY ACT OF 2009, 4 (2009), *available at* http://www.epa.gov/climatechange/economics/pdfs/HR2454_Analysis.pdf.

[36] Appendix, *supra* note 4, at 13.

[37] *See*, *e.g.*, *id.* at 84 (discussing the pre-2012 deployment of financial incentives like renewable energy production and investment tax credits).

[38] *See id.* at 56 ("The average annual cost per household is the 2010 through 2050 average of the net present value of the per household consumption loss.").

[39] EPA, ANALYSIS OF THE AMERICAN CLEAN ENERGY AND SECURITY ACT OF 2009, *supra* note 35, at 14.

[40] *See* Appendix, *supra* note 4, at 59 (calculating approximately 24 billion metric tons of carbon dioxide-equivalent units in avoided emissions from these two provisions).

[41] Carbon dioxide equivalence make it possible to compare emissions of GHG compounds that have different impacts on climate change, by translating emissions of other gases into the amount of carbon dioxide necessary to generate the same impact on the global climate. For example 1 ton of methane emissions has a carbon dioxide equivalence of about 25 tons.

[42] International offset by year were approximated for the ADAGE model figures using the reported level of domestic offsets and the overall ratio of domestic to international offsets. See Appendix, *supra* note 4, at 59 for more details, and see IPI, Other Side of the Coin Data, http://www.policyintegrity.org/ OtherSideOfTheCoinData.xls for calculations. This relies on the assumption that the ratio of domestic to international offsets should remain constant over time, which is consistent with the IGEM model but not reported for ADAGE.

[43] *See* Appendix, *supra* note 4, at 59. It is also not clear whether EPA's figures include possible energy efficiency gains (and related GHG reductions) made in otherwise uncovered sectors, either as a direct or indirect result of the policies of H.R. 2454.

[44] At least some climate effects in the following areas are modeled by a key economic model (FUND) often used to calculate the SCC: agricultural production; forestry production; water resources; energy consumption for space cooling and heating; sea level rise, dry land loss, wetland loss, and coastal protection costs; forced migration due to dry land loss; changes in human health (mortality, morbidity) associated with diarrhea incidence, vector-borne diseases, cardiovascular disorders, and respiratory disorders; hurricane damage; and loss of ecosystems/biodiversity. *See* EPA, 420-D-09-001, DRAFT REGULATORY IMPACT ANALYSIS: CHANGES TO RENEWABLE FUEL STANDARD PROGRAM 690 tbl. 5.3-3 (2009).

[45] *Id.* at 689.

[46] EPA, TECHNICAL SUPPORT DOCUMENT, *supra* note 7, at 15.

[47] Jody Freeman & Andrew Guzman, *Seawalls Are Not Enough: Climate Change and U.S. Interests* 18 (U.C. Berkeley Pub. L. Res. Paper No. 1357690, 2009).

[48] Information and format for table based on EPA, TECHNICAL SUPPORT DOCUMENT, *supra* note 7, at 16-17, and EPA, DRAFT REGULATORY IMPACT ANALYSIS, *supra* note 44, at 691 tbl. 5.3-4.

[49] Average Fuel Economy Standards, Passenger Cars and Light Trucks; Model Years 2011-2015, 73 Fed. Reg. 24351, 24414 (proposed May 2, 2008) (selecting $7 as the midpoint of a possible $0-$14 range).

[50] Average Fuel Economy Standards, Passenger Cards and Light Trucks Model Year 2011, 74 Fed. Reg. 14195, 14350 (Mar. 30, 2009) (to be codified at 49 C.F.R. pts. 523,

531, 533, 534, 536, 537) (revising its SCC calculations, in light of substantial public comments).

51 E.g., Energy Conservation Program for Commercial and Industrial Equipment, 74 Fed. Reg. 1091, 1133 (Jan. 9, 2009) (to be codified at 10 C.F.R. pt. 431) (presenting independent SCC calculations by the Department of Energy);

52 E.g., Energy Conservation Program for Certain Industrial Equipment: Energy Conservation Standards and Test Procedures for Commercial Heating, Air-Conditioning, and Water-Heating Equipment 74 Fed. Reg. 36312, 36342 (July 22, 2009) (to be codified at 10 C.F.R. pt. 431) (relying on the Department of Transportation's calculations of the SCC, in a Department of Energy rulemaking).

53 EPA, TECHNICAL SUPPORT DOCUMENT, *supra* note 6, at 12.

54 EPA, DRAFT REGULATORY IMPACT ANALYSIS, *supra* note 44, at 682.

55 E.g., *id.* at 695-96.

56 *See* BVM Rule, *supra note* 8, at 44947. Presumably, the interagency task force includes at least EPA, the Department of Energy, and the Department of Transportation.

57 *See generally id.*

58 *Id.* at 44948.

59 *See* Average Fuel Economy Standards, Passenger Cars and Light Trucks; Model Years 2011-2015, 73 Fed. Reg. at 24414. The Department of Transportation contended this restriction was dictated by consistency, since no other non-domestic costs or benefits were measured. *Id.* However, even the Office of Management and Budget (OMB)—the federal agency charged with overseeing cost-benefit analyses—specifically permits consideration of significant international costs and benefits. U.S. OFFICE OF MGMT. & BUDGET, CIRCULAR A-4, 15 (2003) ("When you choose to evaluate a regulation that is likely to have effects beyond the borders of the United States, these effects *should be reported* separately.") (emphasis added).

60 WILLIAM NORDHAUS & JOSEPH BOYER, WARMING THE WORLD 96-97 (2000).

61 *See* EPA, TECHNICAL SUPPORT DOCUMENT, *supra* note 7, at 11; *see also* Freeman & Guzman, *supra* note 47 (discussing spillover effects from the international arena into the United States).

62 BVM Rule, *supra* note 8, at 44948.

63 *Id.* at 44948-49.

64 *Id.* at 44949.

65 EPA, TECHNICAL SUPPORT DOCUMENT, *supra* note 7, at 12 n.25 (noting the international recommendation is a 2-4% growth rate).

66 *See* Letter from IPI, to EPA's Environmental Economics Advisory Committee (Nov. 25, 2008) (critiquing EPA's 2008 draft *Guidelines for Preparing Economic Analyses*, including its recommendations on inter-generational discounting) (*available at*

http://policyintegrity.org/projects/documents/CommentsonDraftEPAGuidelines11-25.pdf).

67 BVM Rule, *supra* note 8, at 44949.

68 *Id.* at 44949-44951.

69 EPA, TECHNICAL SUPPORT DOCUMENT, *supra* note 7, at 12; *id.* at 9 ("A review of the literature indicates that rates of three percent *or lower* are more consistent with conditions associated with long-run uncertainty in economic growth and interest rates, inter-generational considerations, and the risk of high impact climate damages (which could reduce or reverse economic growth).") (emphasis added).

70 These benefit numbers do not take into account the uncertainty regarding the timing or effects of climate change. Computable General Equilibrium models like ADAGE and IGEM are not capable of producing confidence intervals. Reported ranges are generated by varying the inputs to the model and do not represent uncertainty in the model.

71 *See* EPA, No. 240-R-00-003, GUIDELINES FOR PREPARING ECONOMIC ANALYSIS 48 (2000) ("In addition, all analyses should present the undiscounted streams of benefits and costs. This is not equivalent to calculating a present value using a discount rate of zero. In other words, the flow of benefits and costs should be displayed rather than a summation of values.").

72 *See* ENV'T POL'Y COMM., ORG. FOR ECON. COOPERATION & DEV. (OECD), ENV/EPOC/GSP(2001)13/FINAL, ANCILLARY BENEFITS AND COSTS OF GHG MITIGATION: POLICY CONCLUSIONS 6 (2001), *available at* http://www.olis.oecd.org/olis/2001doc.nsf/LinkTo/NT00000ABA/$FILE/JT00124610.PDF.

73 Power plants can achieve direct greenhouse gas reductions to comply with climate legislation in one of three ways. (Power plants can also reduce emissions indirectly by investing in "offset" projects, such as the capture of methane from agricultural facilities.) First, they can improve efficiency in the generation and distribution of electricity: according to the Department of Energy, if the nation's electricity production and distribution grid "were just 5% more efficient, the energy savings would equate to permanently eliminating the fuel and greenhouse gas emissions from 53 million cars." DEP'T OF ENERGY, THE SMART GRID: AN INTRODUCTION 6 (2008). Second, they can switch to cleaner fuels. Natural gas, for instance, generates about half as much carbon dioxide as coal. *See* U.S. Gov't Accountability Office, GAO-08-601R, ECONOMIC AND OTHER IMPLICATIONS OF SWITCHING FROM COAL TO NATURAL GAS AT THE CAPITOL POWER PLANT AND AT ELECTRICITY-GENERATING UNITS NATIONWIDE 2 (2008). Third, they can deploy pre- or post-combustion controls to capture and sequester emissions before they leave the smokestacks. *See* OFFICE OF FOSSIL ENERGY, DEP'T OF ENERGY, CARBON SEQUESTRATION TECHNOLOGY ROADMAP AND PROGRAM PLAN 17-18 (2007).

But those techniques work not only to reduce greenhouse gas emissions. Improving energy efficiency means decreasing the total amount of fuel needed, which in turn decreases total emissions of all air pollutants from fossil fuels, not just the greenhouses gases. Switching to cleaner fossil fuels will reduce the emissions of many other air pollutants as well: EPA calculates that "[c]ompared to the average air emissions from coal-fired generation, natural gas produces…less than a third as much nitrogen oxides, and *one percent as much* sulfur oxides at the power plant." EPA, Clean Energy: Air Emissions, http://www.epa.gov/RDEE/energy-and-you/affect/air-emissions.html. Even certain pre- or post-combustion carbon controls will reduce air pollutants as well as greenhouse gases: one innovative carbon capture technology being funded by the U.S. Department of Energy claims to "have the potential to capture all carbon dioxide emissions, while also exceeding all current environmental regulations (e.g. nitrogen oxides, sulfur oxides, etc.)." NAT'L ENERGY TECH. LAB., U.S. DEP'T OF ENERGY, PROJECT FACTS: HYBRID COMBUSTION-GASIFICATION CHEMICAL LOOPING COAL POWER TECHNOLOGY DEVELOPMENT (2006), *available at* http://www.netl.doe.gov/publications/factsheets/project/Proj329.pdf.

[74] Appendix, *supra* note 4, at 3.

[75] *See* ENV'T POL'Y COMM., OECD, *supra* note 72, at 6.

[76] *See*, *e.g.*, Dallas Burtraw et al., *Ancillary Benefits of Reduced Air Pollution in the United States from Moderate Greenhouse Gas Mitigation Policies in the Electricity Sector* (Resources for the Future Discussion Paper No. 01-61, 2001).

[77] *Id.* at 4-5.

[78] *Id.* at 4, 12-14 (listing the health benefits of ancillary nitrogen oxide reductions as reduced respiratory symptom days, eye irritation days, asthma attacks, adult and child chronic bronchitis cases, chronic cough cases, emergency room visits, restricted activity days, and hospital admissions).

[79] *Id.* at 8-9, 20-21. For example, sulfur dioxide emissions are already limited by a nationwide cap: companies need to purchase "allowances" in order to emit sulfur dioxide, and only so many allowances are sold. If a power plant achieves ancillary sulfur dioxide reductions while responding to climate legislation, it will need fewer allowances. The leftover allowances will become available for another company to purchase, allowing it to emit extra sulfur dioxide. Therefore, total emissions of sulfur dioxide are not necessarily reduced. However, that second company now can comply with the sulfur dioxide cap by purchasing extra allowances rather than investing in expensive emissions control technologies. *Id.* at 9 ("Under the [sulfur dioxide] cap, a facility that reduces its sulfur dioxide emissions makes emissions allowances available for another facility, displacing the need for abatement investment at that facility."). Investment in nitrogen oxide controls may similarly decrease. Moreover, at some point, "[t]here will be a threshold…where greenhouse gas control has made the sulfur dioxide cap no longer binding [i.e., when nobody needs to buy the extra allowances, since they are not emitting that much]. Beyond this point, health benefits from additional net reductions in sulfur dioxide will accrue….The Clinton Administration's unpublished analysis of the impacts of

stabilizing greenhouse gas emissions at 1990 levels in 2010 calculates even larger sulfur dioxide emissions reductions (on the order of four million tons)." *Id.* at 34.

[80] *Id.* at 8.

[81] *See* EPA, Clean Air Interstate Rule, http://www.epa.gov/cair/ (last visited Aug. 31, 2009).

[82] *See id.*

[83] Burtraw et al., *supra* note 73, at 3-4.

[84] *Id.* at 10.

[85] *See* EPA, GUIDELINES FOR PREPARING ECONOMIC ANALYSES 7-6 (2008 draft).

[86] Specifically, this analysis looks at Burtraw's model using "the SIP Call Baseline," which does include an expanded nitrogen oxide cap-and-trade system (and unlike an alternate baseline scenario, does not assume electricity restructuring at the national level). Burtraw's hypothetical climate policy was a carbon tax, modeled at two different stringencies. Since Burtraw found roughly equivalent ancillary benefits per ton of carbon regardless of the tax's stringency, this analysis will assume that stringency—and indeed the form of regulation—is mostly irrelevant to the per carbon generation of ancillary benefits, and therefore Burtraw's estimates are applied to H.R. 2454 (even though that legislation creates a cap-and-trade system rather than a carbon tax). To be conservative, the lower of Burtraw's estimates for this scenario was selected ($12.4 per ton of carbon in 1997$, *id.* at 22). Burtraw's estimates are converted into 2007$ and calculated per ton of carbon dioxide, rather than per ton of carbon.

[87] *See* Data Annex, *supra* note 12.

[88] EPA, DRAFT REGULATORY IMPACT ANALYSIS, *supra* note 44, at 696.

[89] *See* Sarah R. Cooley & Scott C. Doney, *Anticipating Ocean Acidification's Economic Consequences for Commercial Fishers*, 4 ENVTL. RES. LETTERS 1, 4 (2009).

[90] *Id.* at 5.

[91] *See* ENV'T POL'Y COMM., OECD, *supra* note 72, at 10-15.

[92] Appendix, *supra* note 4, at 13.

[93] *See* STAFF OF H. COMM. ON ENERGY & COMMERCE, *supra* note 9.

[94] *See* EPA, ANALYSIS OF THE AMERICAN CLEAN ENERGY AND SECURITY ACT OF 2009, *supra* note 35, at 3 (estimating allowance prices at $13 per ton of carbon dioxide in 2015).

[95] *See Climate Change Legislation: Allowance and Revenue Distribution: Hearing Before the S. Comm. on Finance*, 111th Cong. (2009) (written statement of Dallas Burtraw), *available at* http://finance.senate.gov/hearings/testimony/2009test/080409dbtest.pdf.

[96] There may be some international trade effects, especially if H.R. 2454 includes a provision attaching tariffs to imports from countries that have not enacted

reciprocal climate policies, but EPA has calculated costs in terms of per U.S. household loss of consumption.

[97] BVM Rule, *supra* note 8, at 44948.

[98] *Id.*

[99] *See* Interview by Monica Trauzzi, Managing Editor, E&E TV, with Yvo de Boer, executive secretary of the United Nations Framework Convention on Climate Change (Mar. 30, 2009) ("[W]e're really happy to see the United States back into the international climate change process….[W]e need that U.S. engagement…to come to really a global deal at the end of this year to move action on climate change forward.").

[100] *See* Brian Copeland and M. Scott Taylor, *Trade and Transboundary Pollution*, 95 AM. ECON. REV. 716-737 (1995); Hilary Sigman, *International Spillovers and Water Quality in Rivers: Do Countries Free Ride?*, 92 AM. ECON. REV. (1992).

[101] *See* EPA, TECHNICAL SUPPORT DOCUMENT, *supra* note 7, at 11 (also noting that Americans have a willingness to pay to avoid international damages caused by U.S. emissions).

[102] Freeman & Guzman, *supra* note 47, at 7 ("We do not claim that all of these things will happen at catastrophic levels, or that the United States will necessarily be dragged into every climate-related conflict around the world, but simply that the United States cannot sequester itself from all such spillovers.").

[103] DEP'T OF ECON. & SOCIAL AFFAIRS, UNITED NATIONS, E/2009/50/REV.1 ST/ESA 319, WORLD ECONOMIC AND SOCIAL SURVEY 2009: PROMOTING DEVELOPMENT, SAVING THE PLANET 154 (2009), *available at* http://www.un.org/esa/policy/wess/wess2009files/wess09/wess2009.pdf.

[104] Freeman & Guzman, *supra* note 47, at 10 ("[L]arge players may internalize enough of the benefits from the production of collective goods (here, mitigated climate change) to make it worthwhile to invest in those goods"); *id.* at 62 ("Based on a fuller accounting of what the United States stands to lose in a warmer world, investing in mitigation, even at the risk of other nations' free-riding, is the most rational course.").

[105] Average of direct benefits divided by costs for the IGEM and ADAGE models.

[106] *See* Joseph E. Stiglitz, *A New Agenda for Global Warming*, ECONOMISTS' VOICES (2004) (noting, among the principal climate change consequences, "The Maldives will within 50 years be our own 21st century Atlantis, disappearing beneath the ocean; a third of Bangladesh will be submerged, and with that country's poor people crowded closer together, incomes already close to subsistence level will be further submerged").

[107] *See* Freeman & Guzman, *supra* note 47, at 4.

108 *See* STAFF OF H. COMM. ON ENERGY & COMMERCE, *supra* note 10 (noting H.R. 2454's provisions for international technology transfer and international capacity-building). *See* DEP'T OF ECON. & SOCIAL AFFAIRS, UNITED NATIONS, *supra* note 103.

109 Generally, EPA should follow its own Guidelines on Economic Analysis. *See* EPA, NO. 240-R-00-003, GUIDELINES FOR PREPARING ECONOMIC ANALYSES (2000). But IPI believes the guidelines would benefit from some modification. *See* Letter from IPI, to EPA's Environmental Economics Advisory Committee (Nov. 25, 2008) (commenting on the 2008 draft of *Guidelines for Preparing Economic Analysis*). In particular, EPA should avoid inter-generational discounting of future costs and benefits relating to climate change, and EPA should avoid using the life-years or quality-adjusted life-years models for measuring health benefits.

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