Wind turbines in a rapeseed field in Sandesneben, Germany. Photo © Jürgen

Foreign Action, Domestic Windfall

The U.S. Economy Stands to Gain Trillions from Foreign Climate Action

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Foreword

My introduction to the effect of energy consumption on the climate came during my training as a weather officer in the Air Corps during World War II. To explain the broad range of observed temperatures, it turned out that the bulk of the atmosphere—the oxygen and nitrogen—was irrelevant; only a set of about twenty gases, present in trace quantities, were relevant. Of these, carbon dioxide was one of the most important. The instructor rather casually remarked that the production of carbon dioxide, as a by-product of industrial activity, had increased enormously over the last two centuries and would undoubtedly lead to a significant warming of the Earth.

In the language used by economists, it was immediately clear that carbon dioxide (and similar) emissions into the atmosphere constitute an externality on an unprecedentedly global scale. Everyone's emissions affect everyone else on the globe and almost immediately; in addition, the effects persist over extraordinarily long periods of time. The gains from cooperation are correspondingly great, even though any one country might gain by failing to restrict its own emissions while others do.

Peter Howard and Jason Schwartz have done a great and useful service in demonstrating the great extent to which the United States has already benefited, and how much more it will gain, from the carbon emission restrictions of other countries. These are benefits which dwarf the higher energy costs of United States emission control. They are, in fact, almost surely conservative estimates of the benefits, so the case is even stronger than these numbers show.

I urge the reading of this report, to make clear the vital stake of the United States in participating in and helping to lead in the achievement of international cooperation to avoid the enormous costs of unrestrained climate deterioration.

Kenneth J. Arrow
Joan Kenney Professor of Economics and Professor of Operations Research, Emeritus
Stanford University
Nobel Laureate, 1972

Executive Summary

The United States has already likely avoided billions of dollars of direct damage to its economy, public health, environment, and national security, thanks to actions undertaken by foreign jurisdictions, like the European Union, in the fight against climate change. Trillions of dollars more for the United States are at stake in securing commitments for future emissions reductions from foreign countries, like China and India.

The Earth's climate is a shared global resource, and greenhouse gases emitted by any individual country can affect the climate in ways that will damage all countries. Every ton of carbon pollution mitigated by a foreign country therefore benefits the United States both by helping to preserve domestic climate conditions and by protecting the United States from "spillover" effects from other geographic regions interconnected with the United States through markets, ecosystems, security threats, and migration. Additionally, the United States receives ancillary benefits as other harmful co-pollutants are incidentally controlled along with the intended carbon reductions.

The benefits to the world and to the United States of each ton of avoided carbon emissions can be monetized using a metric called "the social cost of carbon." Though the social cost of carbon framework reflects much of the latest peer-reviewed literature on the science and economics of climate change, and the framework has the backing of the U.S. government, it is widely acknowledged that this metric likely underestimates the full benefits to the United States and to the world of carbon mitigation. Nevertheless, it can be used to calculate preliminary, conservative estimates of how the United States directly benefits from foreign actions on climate change.

Many countries have already taken action to abate their greenhouse gas emissions; even more have pledged certain reductions for the coming decades if an international climate agreement can be reached during the U.N. negotiations in December 2015. As this report calculates, global actions on climate change—particularly by Europe, but also including efforts implemented by the United States and many other countries—have already benefited the United States, to date, by upwards of $200 billion. Based on existing policies to reduce carbon pollution and compared to a business-as-usual baseline, global actions will deliver upwards of another $2 trillion in direct benefits to the United States by the year 2030. If additional pledges on the table at the ongoing U.N. negotiations are secured and achieved, the commitments of non-U.S. nations alone will generate upwards of an additional $500 billion in direct benefits for the United States. And if sufficient emissions reductions are achieved worldwide to stabilize the earth's climate at a 2˚C average increase, the non-U.S. contribution to such reductions would deliver upwards of $10 trillion in direct benefits to the United States through the year 2050.

Opponents of U.S. regulation of greenhouse gas emissions have long cited fears that the rest of the world—and especially China and India—will free-ride on our climate policies if we act first. In fact, the United States already stands to gain more from global efforts on climate change than proposed U.S. regulations would cost. Should the United States fail to mitigate its emissions, it is our country that risks looking like a free-rider and undermining an international climate agreement. With countries like China and India now making ambitious pledges leading up to the December 2015 negotiations, the United States has more than ever before to gain from a global agreement to act. With trillions of dollars at stake, the United States simply cannot afford not to lead on climate change.

Part I. Foreign Countries' Carbon Reductions Will Benefit the United States (and Vice Versa)

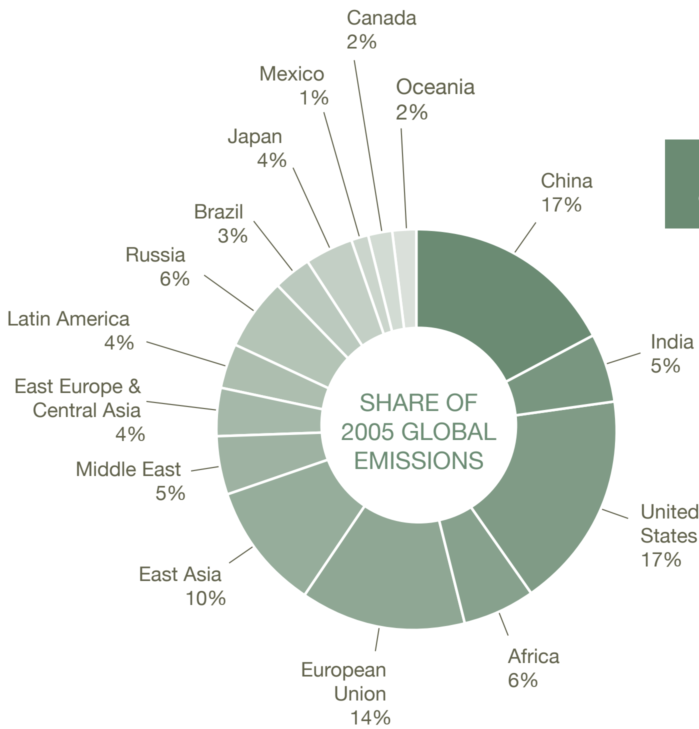
The Earth's climate is a shared global resource.[1] All countries may enjoy the benefits of stable atmospheric concentrations, temperatures, and weather patterns; yet any one country's use or depletion of Earth's climate stability—specifically, by emitting greenhouse gas pollution—can impose great harms on the polluting country as well as on the rest of the world.[2] Greenhouse gases like carbon dioxide do not stay within geographic borders or dissipate quickly. Over life spans stretching tens, hundreds, or even thousands of years, greenhouse gases become well mixed through the planet's atmosphere and so affect climate worldwide. As a result, each ton of carbon pollution emitted by the United States, for example, not only creates domestic harms, but also imposes additional and large damages on the rest of the world. Conversely, each ton of greenhouse gases abated in any other country will benefit the United States along with the rest of the world.

Though the U.S. historical contribution to atmospheric carbon concentrations remains the largest of any country to date,[3] ***several other countries have already caught up to or will exceed the U.S. share of current and future annual emissions.*** (See Charts 1-3.) In 2015, the United States is projected to be responsible for only 14% of worldwide greenhouse gas emissions.[4] China overtook the United States by 2006 as the world's largest source of carbon pollution,[5] and by 2013, China was essentially doubling the U.S. annual output of greenhouse gases.[6] If no further climate change policies are implemented and worldwide emissions trajectories continue as projected, by 2060, India's emissions will also surpass the United States, African nations will collectively emit as many tons of greenhouse gases as the United States does today, and total global annual emissions will have nearly doubled from today.[7]

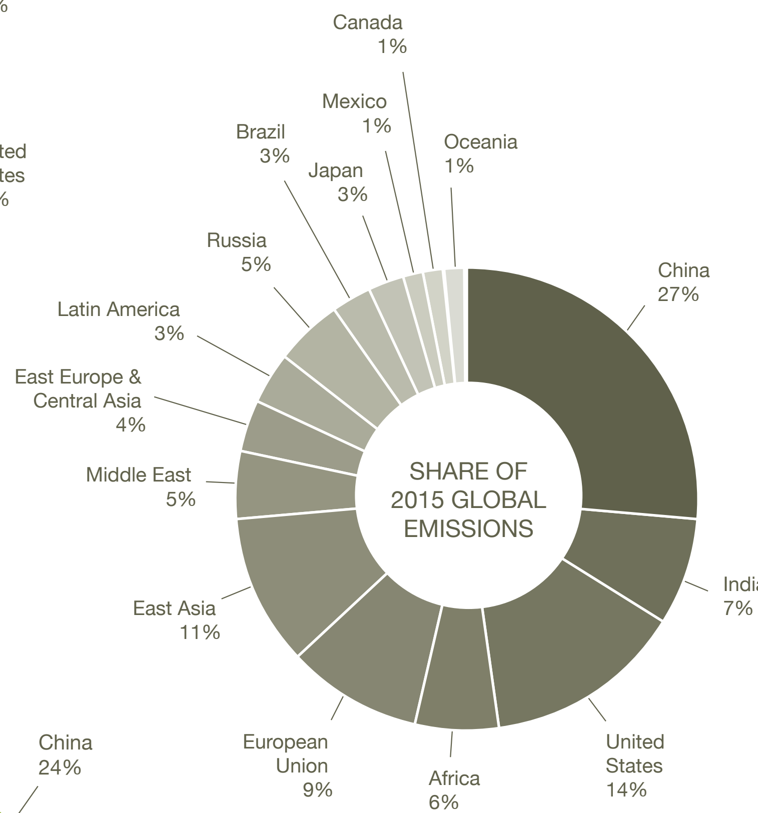
Fortunately, that dire "business as usual" scenario need not come to pass. Whether by unilateral emissions reductions already underway (e.g., by the European Union and the United States[8]), through bilateral efforts and commitments (e.g., U.S. coordination with China, Brazil, Canada, and Mexico[9]), or with the promise of reaching a multilateral climate agree during the December 2015 U.N. negotiations in Paris (e.g., India has vowed to pursue an "equitable and balanced" global climate deal[10]), many of the countries most responsible for climate change have pledged future emissions reductions, and the United States stands to benefit greatly from all such foreign emissions reductions.

Pollution in China. Photo © Clay Gilliland

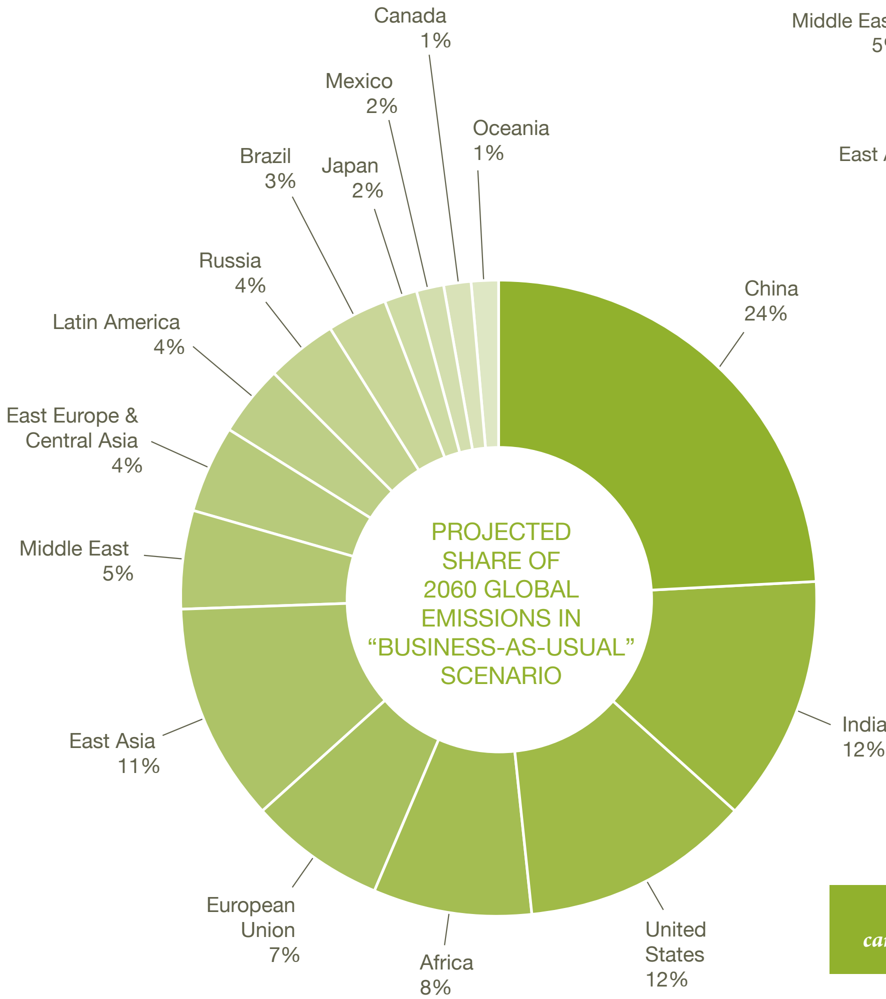
Charts 1-3: Country and Regional Shares of Global Annual Emissions over Time[11]



(total=42,609 million carbon dioxide-equivalent tons)



(total=55,565 million carbon dioxide-equivalent tons)



(Total=96,660 million carbon dioxide-equivalent tons)

Part II. The Benefits of Carbon Reductions Can Be Monetized

The "social cost of carbon" (SCC) is a framework for estimating the monetized, global damages caused by releasing an additional ton of carbon dioxide into the atmosphere. A complete list of such damages would include all economic impacts from climate change: lost agricultural and labor productivity, trade and energy supply disruptions, negative public health consequences, ocean acidification, extreme weather events, flooding, wildfires, increased pests and pathogens, water shortages, migration, regional conflicts, and loss of biodiversity and ecosystem services, among others.

Carbon dioxide is the most common (though not the most potent) greenhouse gas emitted by human activity. Adjusting for the comparative potency of various pollutants, the SCC can be roughly applied to calculate damages from "carbon dioxide-equivalent" amounts of other greenhouse gases besides carbon dioxide, such as methane (which is about 28-87 times more potent than carbon dioxide per ton[12]). Economic experts, however, argue that the full social costs of specific, non-carbon dioxide gases should be assessed through separate models, which would more accurately account for varying atmospheric life spans, among other differences.[13]

In 2009, the Obama White House's Council of Economic Advisers and Office of Management and Budget convened an interagency working group to calculate a consistent and transparent range of SCC values to use in setting and evaluating all U.S. climate regulations. With input from the Environmental Protection Agency; the Departments of Agriculture, Commerce, Energy, Transportation, and Treasury; and the White House's Council on Environmental Quality, National Economic Council, Office of Energy and Climate Change, and Office of Science and Technology Policy, the interagency group finalized its first SCC estimates in 2010, followed by slight updates in 2013 and again in 2015.[14]

Looking down from the Hollywood Hills, air pollution is visible in downtown Los Angeles on a late afternoon. Photo © Diliff

These SCC estimates aim to reflect the full global costs of any additional ton of greenhouse gases released from any source anywhere in the world—or, conversely, the full global benefits of any avoided emissions.[15] Importantly, while developed for use in U.S. regulatory policy, these SCC estimates can also be used to value the full global benefits of carbon reductions achieved by any other country. Indeed, several foreign countries have copied the U.S. interagency group's methodology or SCC estimates to evaluate their own climate policies.[16] Again, because greenhouse gases become well mixed through the atmosphere regardless of their origin, the benefits of emissions reductions do not vary depending on where the carbon abatement is achieved.

The benefits of emissions reductions do vary, however, depending on when the carbon abatement is achieved. Due to scientific projections for the future course of climate change, a ton of greenhouse gases emitted next year is marginally more damaging than one emitted today, and so the SCC estimates rise over time. The interagency group calculates a range of four estimates, largely based on different discount rate assumptions.[17] Focusing on the central of the four estimates (corresponding to a 3% discount rate) and adjusting the calculations for inflation, the interagency values for the marginal global benefits of mitigating an additional ton of carbon dioxide from anywhere in the world are:[18]

Chart 4: Global Social Cost of Carbon by Year of Emission

Year of Emission:	2010	2015	2020	2025	2030	2035	2040	2045	2050
Global SCC (2015$)	$36	$41	$48	$53	$58	$63	$69	$74	$79

Though these estimates reflect much of the latest, peer-reviewed scientific and economic literature, ***experts widely acknowledge that these SCC numbers are almost certainly underestimates*** of true global damages—perhaps severe underestimates. Using different discount rates; selecting different models; applying different treatments to uncertainty, climate sensitivity, and the potential for catastrophic damages; and making other reasonable assumptions could yield very different, and much larger, SCC estimates.[19] For example, a recent report found current SCC estimates omit or poorly quantify damages to the following sectors:

> agriculture, forestry, and fisheries (including pests, pathogens, and weeds, erosion, fires, and ocean acidification); ecosystem services (including biodiversity and habitat loss); health impacts (including Lyme disease and respiratory illness from increased ozone pollution, pollen, and wildfire smoke); inter-regional damages (including migration of human and economic capital); inter-sector damages (including the combined surge effects of stronger storms and rising sea levels); exacerbation of existing non-climate stresses (including the combined effect of the over pumping of groundwater and climate-driven reductions in regional water supplies); socially contingent damages (including increases in violence and other social conflict); decreasing growth rates (including decreases in labor productivity and increases in capital depreciation); weather variability (including increased drought and inland flooding); and catastrophic impacts (including unknown unknowns on the scale of the rapid melting of Arctic permafrost or ice sheets).[20]

Nevertheless, the interagency numbers provide a useful starting point to calculate the benefits of worldwide greenhouse gas reductions, including the benefits experienced by the United States.

Part III. Direct and “Spillover” Benefits to the United States from Foreign Action Will Be Substantial

If left unchecked, climate change will threaten the United States with serious and diverse risks to its economy, public health, security, and environment. A recent, peer-reviewed report from the Environmental Protection Agency on *Climate Change in the United States: Benefits of Global Action* includes these top-line findings:[21]

- By the end of the century, unchecked climate change could cause 57,000 deaths each year across the country due to worse air quality, plus at least 12,000 deaths annually due to extreme temperature and weather events (based on data and populations in just 49 major U.S. cities).
- By the middle of the century, electricity demand could increase up to 4%, with $34 billion more in annual supply costs.
- By the end of the century, the U.S. economy could face damages of $110 billion annually in lost labor productivity due to extreme temperatures; up to $11 billion annually in agricultural damages and $1.5 billion annually in forestry damages; and up to $180 billion in losses to key economic sectors due to water shortages.
- Over the next eighty-five years, without mitigation or adaptation to climate change, sea level rise and storm surges could damage $5.0 trillion worth of U.S. coastal property.

Similarly, the White House Council of Economic Advisers estimates that a delay in reaching a global solution to address climate change could cause an annual loss of $150 billion to U.S. GDP,[22] and the most recent U.S. National Climate Assessment details the effects to multiple and far-reaching U.S. sectors: water, energy, transportation, agriculture, forests, ecosystems, human health, urban areas, indigenous peoples, land use, and rural communities.[23]

Nevertheless, it is quite difficult to attribute monetized portions of the global SCC estimates to any particular country or region. In 2010, the interagency working group used the results of one economic model as well as the U.S. share of global GDP to generate an “approximate, provisional, and highly speculative” range of 7-23% of the global SCC as an estimate of the purely direct climate effects to the United States.[24] Yet, as the interagency group acknowledged, ***this range is almost certainly an underestimate, because it ignores significant, indirect costs to trade, human health, and security likely to “spillover” to the United States as other regions experience climate change damages.***[25]

The United States is not an island, contrary to the assumptions underlying the economic models used to calculate the SCC, which treat regions as isolated. Due to its unique place among countries—both as the largest economy with trade- and investment-dependent links throughout the world, and as a military superpower—the United States is particularly vulnerable to effects that will spillover from other regions of the world. Spillover scenarios could entail a variety of serious costs to the United States as unchecked climate change devastates other countries. Correspondingly, mitigation or adaptation efforts that avoid climate damages to foreign countries will radiate benefits back to the United States as well.[26]

Flooded areas in and around Bangkok, Thailand. © DVIDSHUB

As climate change disrupts the economies of other countries, decreased availability of imported inputs, intermediary goods, and consumption goods may cause supply shocks to the U.S. economy. Shocks to the supply of energy, technological, and agricultural goods could be especially damaging. For example, when Thailand—the world's second-largest producer of hard-drives—experienced flooding in 2011, U.S. consumers faced higher prices for many electronic goods, from computers to cameras.[27] Similarly, the U.S. economy could experience demand shocks as climate-affected countries decrease their demand for U.S. goods. Financial markets may also suffer, as foreign countries become less able to loan money to the United States and as the value of U.S. firms declines with shrinking foreign profits. As seen historically, economic disruptions in one country can cause financial crises that reverberate globally at a breakneck pace.[28]

The human dimension of climate spillovers includes migration and health effects. Water and food scarcity, flooding or extreme weather events, violent conflicts, economic collapses, and a number of other climate damages could precipitate mass migration to the United States from regions worldwide, perhaps especially from Latin America. For example, a 10% decline in crop yields could trigger the emigration of 2% of the entire Mexican population to other regions, mostly to the United States.[29] Such an influx could strain the U.S. economy and will likely lead to increased U.S. expenditures on migration prevention. Infectious disease could also spill across the U.S. borders, exacerbated by ecological collapses, the breakdown of public infrastructure in poorer nations, declining resources available for prevention, shifting habitats for disease vectors, and mass migration.

Finally, climate change is predicted to exacerbate security threats—and possibly catalyze new security threats—to the United States.[30] Besides threats to U.S. military installations and operations abroad from flooding, storms, extreme heat, and wildfires,[31] President Obama has explained how climate change is "a creeping national security crisis, . . . as [the U.S. military will be] called on to respond to refugee flows and natural disasters, and conflicts over water and food."[32] The Department of Defense's 2014 Defense Review declared that climate effects "are threat multipliers that

The landscape around Maaloula in Syria.

will aggravate stressors abroad such as poverty, environmental degradation, political instability, and social tensions—conditions that can enable terrorist activity and other forms of violence," and as a result "climate change may increase the frequency, scale, and complexity of future missions, including defense support to civil authorities, while at the same time undermining the capacity of our domestic installations to support training activities."[33] As an example of the climate-security-migration nexus, prolonged drought in Syria likely exacerbated the social and political tensions that erupted into an ongoing civil war,[34] which has triggered an international migration and humanitarian crisis.[35]

In short, the direct and spillover effects of climate change to the United States are considerable, and carving out any precise, quantified portion of the global SCC that does not apply to the United States is very difficult and controversial.[36] Nevertheless, using the interagency group's conservative and speculative range of 7-23% for the direct U.S. share can help provide perspective on the minimum degree to which foreign action on climate change already has or could benefit the United States.

Part IV. Foreign Countries' Existing Policies and Pledges Promise Carbon Reductions Worth Trillions to the United States

Many countries have implemented climate policies that have already meaningfully reduced greenhouse gas emissions and so benefitted the United States, but the most significant and quantifiable individual effort to date may be the European Union's Emissions Trading Scheme. The world's first and largest market-based program to reduce greenhouse gas emissions has been rolled out in three phases: the first two covered the years 2005-2012, and the third phase runs from 2013 through 2020. "Independent studies at the regional, national, and firm levels have confirmed that the [trading scheme] has been a significant contributor to reductions in European emissions," even after factoring in the recent global economic slowdown.[37] Economists have calculated that during the first two phases, Europe's program already reduced on average 40-80 million metric tons of carbon dioxide-equivalents per year, or about 320-640 million metric tons total over the first eight years, as compared to a "business-as-usual" scenario.[38] The European Commission has indicated its willingness to continue to reduce its trading program's emissions cap in the future if other major emitters make proportional commitments.[39]

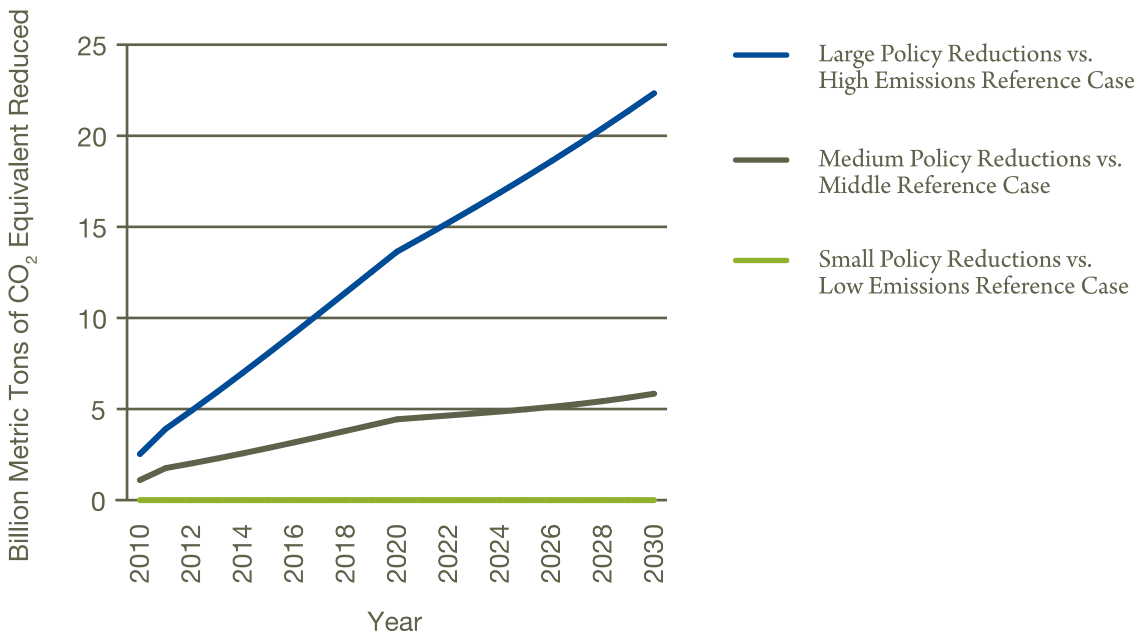
Using the average annual reductions already achieved by the European trading scheme, multiplied by the interagency group's central estimate for the global SCC (likely an underestimate due to, among other factors, omitted damages) and the interagency group's conservative range for the direct U.S. share (also likely an underestimate, due to spillover effects), ***we can calculate a range of direct benefits that the United States has already gained from Europe's actions as, at minimum, between $101 million and $662 million just from emissions reductions in the year 2010 alone.***[40]

Other countries have significant and binding emissions limits scheduled to take effect in the coming years. For example, Canada has finalized regulations for its coal-fired power plants that will reduce greenhouse gas emissions by 219 million metric tons of carbon dioxide equivalents over the period from 2015-2035.[41] Using estimates for the global SCC based on the U.S. interagency group's work, Canada calculated the worldwide benefits of its planned greenhouse gas reductions as $5.6 billion (Canadian dollars).[42] Converting to U.S. dollars and again applying the interagency group's conservative range for domestic benefits, the direct U.S. share of the benefits from that Canadian regulation will total at least between $350 million and $1.15 billion.[43]

Several organizations and academics have aggregated the emissions reductions from such existing policies implemented by countries across the world, and have forecasted business-as-usual baseline scenarios for comparison. This report utilizes one such dataset, developed by Climate Action Tracker,[44] to calculate the U.S. benefits of global action. Climate Action Tracker's data is based on country submissions to the U.N. Framework Convention on Climate Change, academic literature, and other tools and scenarios like the International Energy Agency's *World Energy Outlook*. Though their data is subject to uncertainty and some other limitations,[45] it allows for a preliminary estimate of how much the United States may gain as foreign countries reduce their carbon pollution. (See Appendix for more on data and methodology.)

The data from Climate Action Tracker allows us to build several different emissions scenarios. Specifically, we can alternatively assume a high, middle, or low level of emissions for the global baseline case, and we can assume that existing climate policies will achieve either large, medium, or small levels of emissions reductions. Comparing various policy and reference cases, we can estimate the direct U.S. benefits of existing worldwide carbon mitigation efforts (including those undertaken by the United States). ***During the last five years alone, existing global policies have likely reduced up to 24 billion metric tons of carbon dioxide-equivalent emissions, thereby directly benefiting the United States by at least $60 to $231 billion.*[46] *Over the next fifteen years, direct U.S. benefits from global climate policies already in effect could reach over $2 trillion.***

Charts 5 & 6: Global Carbon Reductions and Their Monetized Benefits[47] —
Current Global Policies vs. Reference Case (2010-2030)



Years	Small Reductions * Global SCC	Medium Reductions * Global SCC	Large Reductions * Global SCC	Direct U.S. Share of Medium & Large Cases
2010-2014	$0	$403 Billion	$1,006 Billion	$60–$231 Billion
2015-2030	$0	$2,904 Billion	$9,817 Billion	$436–$2,258 Billion
Total (2010-2030)	$0	$3,307 Billion	$10,823 Billion	$496–$2,489 Billion

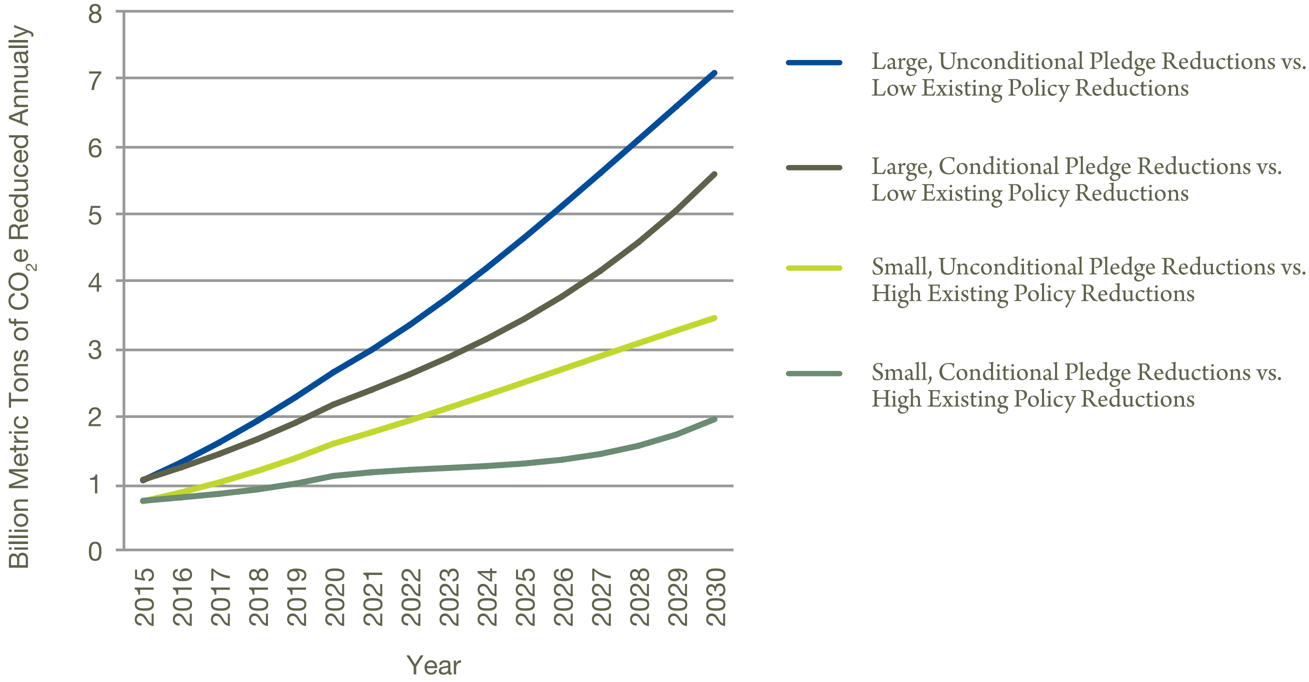
Note: Global emissions reductions include U.S. reductions.

Solar Power Plant in Andalusia, Spain. Photo © Koza1983

Similarly, we can forecast the future emissions reductions from pledges and commitments made by non-U.S. countries, and estimate the direct U.S. share of those benefits. Following the December 2014 meeting of the United Nations Framework Convention on Climate Change, which was held in Lima, Peru, member nations, including many countries most responsible for greenhouse gas emissions, announced numerical pledges to meet their share of necessary emissions reductions. Over 100 countries have submitted plans, including China, India, Brazil, Australia, Japan, Europe, and the United States;[48] submissions to date cover countries responsible for over 85% of global emissions.[49] These pledges are intended to set the stage for a new international agreement to be negotiated at the next U.N. meeting, in December 2015 in Paris, France.[50] Though these pledged reductions are not yet fully realized or binding (nor may they be sufficient on their own to completely solve the threats to global climate), they help put in perspective what is at stake in an international agreement to address climate change.

The Climate Action Tracker data aggregates various pledges and other commitments from countries to act on climate change,[51] and the promised emissions reductions can be compared against a "business as usual" pathway to calculate the tons of carbon pollution that a new international climate agreement would mitigate, as compared to the status quo. In addition to allowing different assumptions about whether the baseline and pledge cases reflect high or low emissions reductions, the Climate Action Tracker data also allows pledged reductions of individual countries to either be unconditional or else conditioned upon other actions. Assuming large, unconditional pledges, foreign nations have committed to reduce their emissions by up to 60 million additional metric tons of carbon pollution through the year 2030, cumulatively, over and above already existing efforts. ***If these foreign reduction pledges are achieved, over the years 2015-2030 the United States could gain direct benefits of at least $54-$544 billion.***[52]

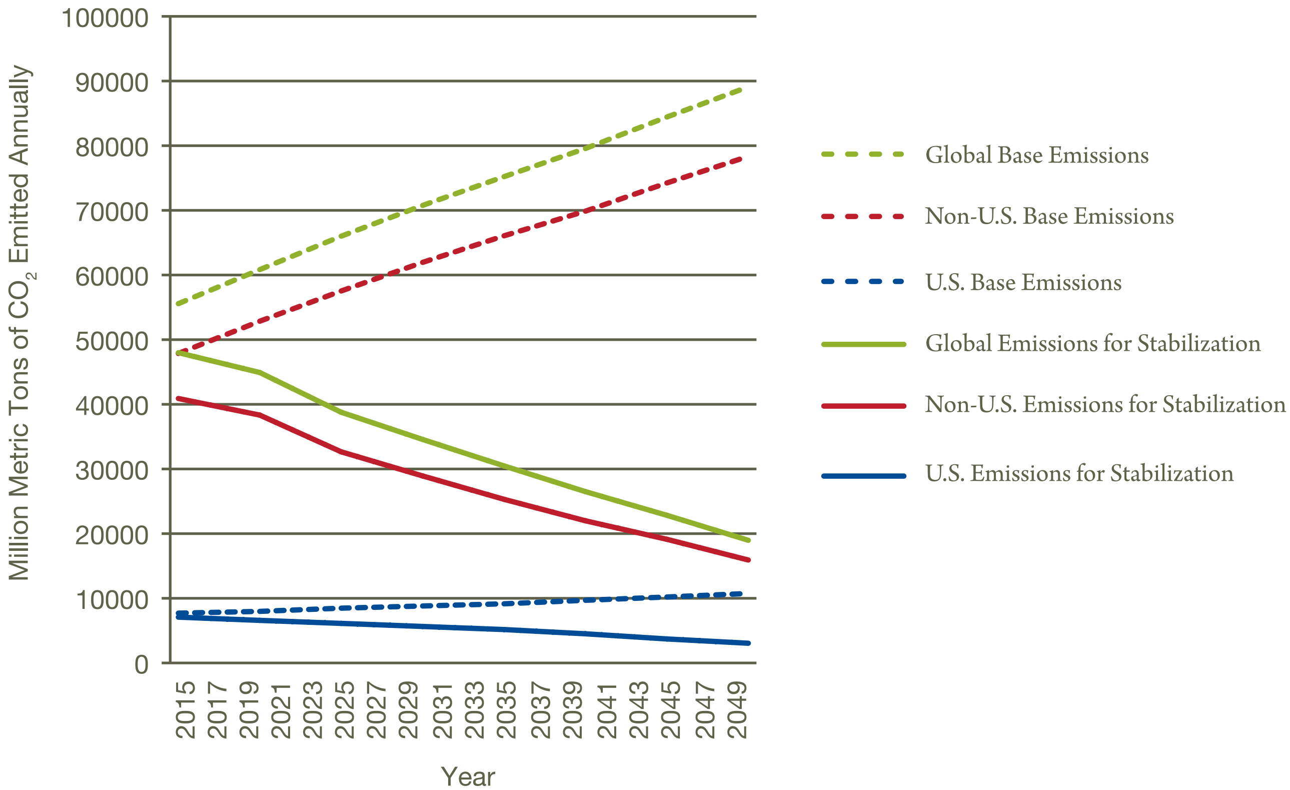
Charts 7 & 8: Non-U.S. Carbon Reductions and Their Monetized Benefits[53]—Future Pledges vs. Existing Policies (2015-2030)



Scenario	Existing Policy Base Assumptions	Pledge Conditions	Global Value 2015-2030 (Reductions * Global SCC)	Direct U.S. Share 2015-2030
Small & Conditional	High reductions under existing policies	Small, conditional pledges	$770 billion	7% multiplier → $54 billion
Small & Unconditional	High reductions under existing policies	Small, unconditional pledges	$1,286 billion	15% multiplier → $193 billion
Large & Conditional	Low reductions under existing policies	Large, conditional pledges	$1,847 billion	15% multiplier → $277 billion
Large & Unconditional	Low reductions under existing policies	Large, unconditional pledges	$2,363 billion	23% multiplier → $544 billion

Multiplied over many decades of emissions reductions, direct U.S. benefits from existing and pledged foreign actions to combat climate change could easily reach into the trillions of dollars. While those direct U.S. benefits from foreign action and pledges are impressive, even the Lima reduction pledges may still not be sufficient to stabilize the Earth's climate. The Environmental Protection Agency has recently calculated the emissions pathways necessary to achieve various stabilization scenarios. To limit global average temperatures to a 2˚C increase over pre-industrial levels, EPA predicts that worldwide emissions would have to decrease by 79% from baseline, business-as-usual levels by the year 2050.[54]

Chart 9: Carbon Reductions Necessary to Stabilize Climate at 2˚C (2015-2050)



If these climate-stabilizing reduction targets are achieved, the direct value to the United States from foreign reductions alone could total at least \$874–\$2,873 billion by 2030, and at least \$3.1–\$10.0 trillion by 2050.

While there is much uncertainty in all these estimates, it is worth remembering that two key figures—the social cost of carbon and the U.S. share—are based on conservative methodologies and are very likely to underestimate actual benefits to the United States of foreign action of climate change. In particular, not only does the social cost of carbon framework currently omit many significant, un-quantified climate effects and inter-regional spillovers, but it also does not factor in a number of important ancillary benefits to U.S. health and welfare.

Part V. Ancillary Benefits to the United States from Foreign Climate Action Could Be Substantial

Most greenhouse gas emissions worldwide are generated from the combustion of fossil fuels to produce energy. The most obvious tactics, therefore, to reduce greenhouse gas emissions are to switch to different, cleaner fuels for energy production and to reduce the need to produce energy by increasing efficiency or curbing demand. Advantageously, decreasing the combustion of dirty fossil fuels will reduce emissions of not only greenhouse gases: other harmful pollutants are additional, costly byproducts of energy production. Therefore, greenhouse gas mitigation efforts will often inevitably limit other types of dangerous pollution as well. Some of these ancillary pollution reductions by foreign countries will benefit the United States, though they are not monetized in the SCC numbers.

For example, fossil fuel combustion produces black carbon, as a component of what is more commonly referred to as soot. Not only does black carbon directly absorb sunlight and heat, but it can alter cloud covering and blanket snow and ice, affecting their heat-reflecting abilities and exacerbating global warming. Pound for pound, black carbon's global warming potential may be up to 3,000 times more potent than carbon dioxide.[55] As other countries take action to address their greenhouse gas emissions, their black carbon pollution may also decrease, further benefiting the global climate and, therefore, the United States as well. For example, a 2014 World Bank report calculated that retrofits to reduce fuel consumption in just 10,000 heavy-duty trucks in Sao Paulo, Brazil would generate significant black carbon reductions over the next two decades, producing global climate benefits worth up to half a billion dollars (plus another half billion in climate benefits from other greenhouse gas reductions).[56]

Photo © Jeff Kubina

Other pollutants with global effects that could be incidentally and fortuitously reduced along with foreign countries' climate actions include toxics like mercury. Mercury is often emitted from the combustion of coal and carries a number of serious health effects, including neurological impairment. In 2013, the United States joined over 140 countries in negotiating the Minamata Convention on Mercury, which recognizes mercury as "a chemical of global concern owing to its long-range atmospheric transport, its persistence in the environment once anthropogenically introduced, its ability to bioaccumulate in ecosystems and its significant negative effects on human health and the environment."[57] As other countries burn less coal in an effort to reduce greenhouse gas emissions, the United States will experience health and welfare benefits from reduced exposure to mercury. One study found that two-thirds of the mercury deposited onto the U.S. mainland each year originates in other countries.[58] The typical human exposure pathway involves consumption of fish contaminated with mercury: between imported seafood, fish caught in the open waters of the world's interconnected oceans, and domestically produced fish exposed to mercury pollution that drifted inside our borders from other countries, foreign reductions of mercury could have major health benefits for U.S. citizens.[59]

A few ancillary pollutant reductions may have only more regional benefits. EPA has acknowledged that sulfur dioxide and particulate matter from the United States can drift across its borders into neighboring Canada and affect the health and welfare of Canadians.[60] So, too, can such emissions from Canada and Mexico affect U.S. health and welfare, and reductions in fossil fuel combustion in our neighboring countries will deliver not only climate benefits to the United States, but additional health and welfare benefits from ancillary pollutants as well.

Conclusion

Opponents of U.S. action on climate change often allege that the benefits do not justify the costs, arguing that any climate benefits will be illusory unless all other countries have already committed to reciprocal emissions reductions, and that if any benefits do materialize they will be spread diffusely across the planet. Even following recent, ambitious pledges by China and India to reduce their future emissions, critics of U.S. action continue to claim that developing countries will simply free-ride on our actions and that the rest of the world is not doing enough to justify U.S. regulation.[61]

In fact, the direct benefits to the United States from existing foreign actions on climate change likely outweigh the costs of any efficient U.S. policy. For example, the Clean Power Plan—EPA's regulation of the carbon emissions from existing power plants—is estimated to cost as much as $8 billion per year. Yet not only do the Clean Power Plan's air quality co-benefits to U.S. public health (up to $34 billion per year) alone far exceed those costs, and not only do the regulation's climate benefits (about $20 billion in 2030) also far exceed those costs,[62] but the benefits to the United States from action taken *by other countries* far exceed the costs of this U.S. climate regulation. Existing climate policies worldwide—including significant efforts by Europe, Canada, and many other countries, as well as U.S. policies already on the books—may generate upwards of $2 trillion in direct benefits to the United States by 2030. The arguments against further U.S. action ring hollow.

To the contrary, the case for U.S. leadership on climate action is persuasive. Should the United States fail to mitigate its emissions, it is our country that risks looking like a free-rider and undermining an international climate agreement. With recent, ambitious pledges from China and India, trillions of dollars in direct benefits to the United States from foreign efforts are on the line at the U.N. meeting in December 2015—U.S. leadership on climate change is well justified by the likely return on investment. With our economy, public health, environment, and national security at stake, the United States simply cannot afford not to act.

Endnotes

[1] The Earth's oceans (at risk of acidification from carbon pollution) are also global common resources. Common resources are goods that are non-excludable but rivalrous. To the extent that the social cost of carbon does not fully reflect damages from ocean acidification, this report does not capture the additional benefits to the United States as foreign actions to address climate change simultaneously mitigate the acidification of the world's shared oceans.

[2] A handful of geographic regions may experience short-term benefits from climate change, such as temporary agricultural gains in colder regions, but even in those areas, long-term, catastrophic scenarios would bring significant harms.

[3] *See* PBL Netherlands Environmental Assessment Agency, *Countries' Contributions to Climate Change*, Oct. 31, 2013, http://www.pbl.nl/en/publications/countries-contributions-to-climate-change (citing Michel G.J. den Elzen et al., *Countries' Contributions to Climate Change*, 121 Climatic Change 397 (2013)); *see also* World Resources Institute, *Navigating the Numbers: Greenhouse Gas Data and International Climate Policy* at 32 (2005) (calculating that the United States was responsible for 29.3% of cumulative emissions over the years 1850-2002, the most of any country).

[4] *See* Sergey Paltsev et al., *Integrated Economic and Climate Projections for Impact Assessment*, 131 Climatic Change 21, at Electronic Supplemental Material 2 ("ESM2") (2015) (one of the primary articles relied on by U.S. EPA, *Climate Change in the United States: Benefits of Global Action* (2015)); *see also* European Commission Joint Research Centre & PBL Netherlands Environmental Assessment Agency, *Trends in Global CO_2 Emissions: 2014 Report* at 4 (2014) (showing in 2013, the United States contributed 15% of total global carbon dioxide emissions).

[5] *China Overtakes U.S. in Greenhouse Gas Emissions*, N.Y. Times, June 20, 2007 (reporting 2006 data); *see also* Paltsev et al., *supra* note 4, at ESM2; European Comm'n Joint Research Ctr., *supra* note 4, at 23.

[6] *See* European Comm'n Joint Research Ctr., *supra* note 4, at 23; *see also* Paltsev et al., *supra* note 4, at ESM2 (predicting that in 2015 China will emit 14,808 million tons of carbon dioxide equivalents, compared to 7,702 from the United States).

[7] *See* Paltsev et al., *supra* note 4, at ESM2.

[8] *See* European Commission, *The EU Emissions Trading System*, http://ec.europa.eu/clima/policies/ets/index_en.htm; U.S. EPA, *Clean Power Plan for Existing Power Plants*, http://www2.epa.gov/cleanpowerplan/clean-power-plan-existing-power-plants; U.S. EPA, *What EPA Is Doing about Climate Change*, http://www3.epa.gov/climatechange/EPAactivities.html.

[9] *See* White House Press Secretary, *U.S.-China Joint Presidential Statement on Climate Change*, Sept. 25, 2015 (announcing China's pledge to begin a national emission trading system in 2017); White House Press Secretary, *U.S.-Brazil Joint Statement on Climate Change*, June 30, 2015; U.S.-Canada Regulatory Cooperation Council, *RCC Working Group Work Plan: Light-Duty Vehicle Emissions*, Mar. 28, 2012 & White House Press Secretary, *Joint Statement on U.S.-Mexico Climate Policy Cooperation*, Mar. 27, 2015 (discussing coordination of greenhouse gas regulation between the United States, Canada, and Mexico).

[10] *India Coordinating with Nations for Balanced Agreement in Climate Change Summit*, Economic Times, Aug. 11, 2015; *see also* Joanna Plucinska, *India Pledges to Reduce Carbon Emissions 33%-35% by 2030*, Time, Oct. 2, 2015. In addition to the December 2015 negotiations, the International Civil Aviation Organization is also working on an international carbon dioxide standard for aircraft, expected to be finalized in 2016. *See* ICAO

Press Release, *CO_2 Aircraft Standard Cited as Aviation Climate Solution*, Sept. 30, 2015.

11 Data from Paltsev et al., *supra* note 4, at ESM2. Note that these figures were calculated by converting all greenhouse gas emissions into carbon dioxide-equivalent tons, adjusted by each pollutants' global warming potential relative to carbon dioxide. Not only have relative global warming potentials been adjusted in recent years, but this methodology may not fully capture the relative damages of some shorter-lived greenhouse gases like methane. *See infra* note 13.

12 *See* Intergovernmental Panel on Climate Change, *Climate Change 2013: The Physical Science Basis*, tbl. 8.7 (2013) (part of the 5th Assessment Report). Methane's global warming potential relative to carbon dioxide depends principally on the timescale of analysis (methane has a shorter lifespan compared to carbon dioxide and so is relatively more potent over a twenty-year horizon versus a one hundred-year horizon), as well as on the source of methane (fossil methane has a higher potency than agricultural methane) and whether climate-carbon feedback is included.

13 *See* Disa Thureson & Chris Hope, *Is Weitzman Right? The Social Cost of Greenhouse Gases in an IAM World* 21 (Örebro University-Swedish Business School Working Paper 3/2012). EPA has recently proposed a "social cost of methane" framework, which the agency has published and opened for public comment. *See* Emission Guidelines and Compliance Times for Municipal Solid Waste Landfills, 80 Fed. Reg. 52,099, 52,143 (Aug. 27, 2015) (based on A.L. Marten et al., *Incremental CH_4 and N_2O Mitigation Benefits Consistent with the U.S. Government's SC-CO_2 Estimates*, 15 Climate Policy 272 (2014)). The "social cost of methane" estimates are of a roughly similar magnitude as estimates derived from adjusting the social cost of carbon numbers to methane by using carbon dioxide-equivalents (using a relative global warming potential of 25, which is likely an underestimate, *see supra* note 12), though the "social cost of methane" estimates are slightly higher and likely more accurate. Since the social cost of methane methodology has not been finalized yet, this report uses the carbon dioxide-equivalent methodology.

14 *See* Interagency Working Group on the Social Cost of Carbon, *Technical Support Document: Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12,866 (2010)* [hereinafter "2010 TSD"]; Interagency Working Group on the Social Cost of Carbon, *Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12,866* (2013) [hereinafter "2013 TSD"]; Interagency Working Group on the Social Cost of Carbon, *Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12,866* (2015) [hereinafter "2015 TSD"].

15 Citing both the global impacts of climate change and the coordinated global action needed to mitigate climate change, the interagency group concluded that calculating the full global effects of U.S. emissions (as opposed to only domestic effects) is the most justified and preferred approach for measuring the benefits of U.S. climate regulations. *See* 2010 TSD, *supra* note 14, at 10-11; 2013 TSD, *supra* note 14, at 14-15.

16 *E.g.,* Heavy-Duty Vehicle and Engine Greenhouse Gas Emission Regulations, SOR/2013-24, 147 Can. Gazette pt. II, 450, 544 (Can.), *available at* http://canadagazette.gc.ca/rp-pr/p2/2013/2013-03-13/html/sor-dors24-eng.html ("The SCC is used in the modelling of the cost-benefit analysis . . . . The values used by Environment Canada are based on the extensive work of the U.S. Interagency Working Group on the Social Cost of Carbon."); *see also* Benedict Clements et al., International Monetary Fund, *Energy Subsidy Reforms: Lessons and Implications* 9 (IMF Policy Paper, Jan. 28, 2013) (using the U.S. interagency numbers in IMF policy reviews).

17 Discount rates reflect the fact that a dollar today is worth more than a dollar tomorrow, and translate a stream of future costs and benefits into their net present value.

18 Estimates from the 2015 TSD, *supra* note 14, have been adjusted for inflation to 2015$.

19 *See* Joint Comments from Institute for Policy Integrity et al., to Office of Information and Regulatory Affairs, on the Technical Update of the Social Cost of Carbon, OMB-2013-0007-0085, Feb. 26, 2014; *see also* Richard L. Revesz, Peter H. Howard, Kenneth Arrow, Lawrence

H. Goulder, Robert E. Kopp, Michael A. Livermore, Michael Oppenheimer & Thomas Sterner, *Global Warming: Improve Economic Models of Climate Change*, 508 Nature 173 (2014).

20 Peter Howard, *Omitted Damages: What's Missing from the Social Cost of Carbon* 5 (Cost of Carbon Project Report, 2014), http://costofcarbon.org/.

21 EPA, *Climate Change in the United States: Benefits of Global Action* (2015).

22 Exec. Office of the President, *The Cost of Delaying Action to Stem Climate Change* 2 (2014). *See also* Risky Business Project, *The Economic Risks of Climate Change in the United States* 2-5 (2014) (finding, for example, a one-in-twenty chance that nearly $1.5 trillion worth of coastal U.S. property will be submerged by 2100, plus $100 billion annually in storm damages; also finding risks of a 3% loss to labor productivity and up to 70% losses in agricultural yields to some U.S. regions, absent adaptation, which would carry its own significant costs).

23 U.S. National Climate Assessment, *Climate Change Impacts in the United States* xi (2014).

24 2010 TSD, *supra* note 14, at 11.

25 *Id.* Indeed, the integrated assessment models used to develop the global SCC estimates largely ignore inter-regional costs entirely. *See* Howard, *supra* note 20. Though some positive spillover effects are also possible, such as technology spillovers that reduce the cost of mitigation or adaptation, *see* S. Rao et al., *Importance of Technological Change and Spillovers in Long-Term Climate Policy*, 27 Energy J. 123-39 (2006), overall spillovers likely mean that the U.S. share of the global SCC is underestimated, *see* Jody Freeman & Andrew Guzman, *Climate Change and U.S. Interests*, 109 Columbia L. Rev. 1531 (2009).

26 *See* Freeman & Guzman, *supra* note 25, at 1563-93.

27 *See* Charles Arthur, *Thailand's Devastating Floods Are Hitting PC Hard Drive Supplies*, The Guardian, Oct. 25, 2011.

28 *See* Steven L. Schwarz, *Systemic Risk*, 97 Geo. L.J. 193, 249 (2008) (observing that financial collapse in one country is inevitably felt beyond that country's borders).

29 Shuaizhang Feng, Alan B. Krueger & Michael Oppenheimer, *Linkages Among Climate Change, Crop Yields and Mexico-U.S. Cross-Border Migration*, 107 Proc. Nat'l Acad. Sci. 14,257 (2010).

30 *See* CNA Military Advisory Board, *National Security and the Accelerating Risks of Climate Change* (2014).

31 U.S. Gov't Accountability Office, GAO-14-446 *Climate Change Adaptation: DOD Can Improve Infrastructure Planning and Processes to Better Account for Potential Impacts* (2014).

32 Pres. Barack Obama, Commencement Address, U.S. Military Academy at West Point, New York, May 28, 2014.

33 U.S. Dep't of Defense, *Quadrennial Defense Review 2014* vi, 8 (2014).

34 *See* Center for American Progress et al., *The Arab Spring and Climate Change: A Climate and Security Correlations Series* (2013); Colin P. Kelley et al., *Climate Change in the Fertile Crescent and Implications of the Recent Syrian Drought*, 112 Proc. Nat'l Acad. Sci. 3241 (2014); Peter H. Gleick, *Water, Drought, Climate Change, and Conflict in Syria*, 6 Weather, Climate & Society, 331 (2014).

35 *See, e.g., Ending Syria War Key to Migrant Crisis, Says U.S. General*, BBC.com, Sept. 14, 2015.

36 Given that integrated assessment models currently do not capture many of these key inter-regional costs, use of the global SCC may be further justified as a proxy to capturing all spillover effects. *See* Robert E. Kopp & Bryan K. Mignone, *Circumspection, Reciprocity, and Optimal Carbon Prices*, 120 Climate Change 831, 833 (2013).

37 Environmental Defense Fund, *The EU Emissions Trading System: Results and Lessons Learned* vi (2012).

[38] *See* Timothy Laing et al., *The Effects and Side-Effects of the EU Emissions Trading Scheme*, 5 WIREs Climate Change 509 (2014) (synthesizing the literature); *see also* EDF, *supra* note 37, at vi (estimating a 480 million metric ton reduction from 2005-2009).

[39] European Comm'n, *Working with International Partners*, http://www.e.europa.eu/clima/policies/international ("The EU is offering to step up its 2020 reduction targets to 30% if other major economies commit.").

[40] $36 [central estimate for SCC in 2010] * 40 million metric tons [low estimate of 2010 reductions] * 7% [low estimate of domestic share] = $100.8 million.

$36 [central estimate for SCC in 2010] * 80 million metric tons [high estimate of 2010 reductions] * 23% [high estimate of domestic share] = $662.4 million.

[41] Reduction of Carbon Dioxide Emissions from Coal-Fired Generation of Electricity Regulations, SOR/2012-167, 146 Can. Gazette pt. II, 1951, 2041 (Can.).

[42] *Id.* at 2042, 2044. Note that Canada used the interagency group estimates available at the time. Recalculation using the interagency group's 2015 update may result in very slightly different estimates.

[43] $5.6 billion in Canadian dollars is worth $5.0 billion in U.S. dollars (using February 2014 conversion rates). Seven to twenty-three percent of $5 billion is between $350 million and $1.15 billion.

[44] http://climateactiontracker.org/

[45] For example, their data does not allow the creation of a full U.S. reference scenario, though it does allow for a global reference scenario.

[46] This range reflects the medium reductions/middle reference scenario multiplied by the midpoint of the domestic share estimates, and the large reductions/high reference scenario multiplied by the high domestic share estimate. The low domestic share estimate, when multiplied by the small reduction/low reference scenario, would have given a zero dollar value, which is theoretically possible using Climate Action Tracker's data, but is inconsistent with the observed reductions already achieved by Europe and other countries, which have positively benefited the United States, as calculated above at note 40.

[47] These calculations use data from Climate Action Tracker, together with the interagency group's most recent central SCC estimates, which are based on a 3% discount rate and have been inflated to 2015$.

[48] UNFCCC, *INDCs as Communicated by Parties*, http://www4.unfccc.int/submissions/indc/Submission%20Pages/submissions.aspx (last visited Oct. 6, 2015).

[49] Climate Action Tracker, *Tracking INDCs*, http://climateactiontracker.org/indcs.html (last visited Oct. 6, 2015).

[50] United Nations Framework Convention on Climate Change Conference of the Parties, Press Release, *Lima Call for Climate Action Puts World on Track to Paris 2015*, Dec. 14, 2014, http://newsroom.unfccc.int/lima/lima-call-for-climate-action-puts-world-on-track-to-paris-2015/

[51] The data from Climate Action Tracker used in this report is several months old and does not fully reflect all the specifics of more recent pledges. Most notably, China has recently announced a national emissions trading program, and India has pledged to reduce up to 35% of its emissions by 2030 (compared to 2005 levels). *See supra* notes 9-10. The exclusion of these recent, ambitious pledges from major emitters suggests this report may underestimate the benefits from securing such international commitments.

[52] These estimates are consistent with estimates from employing alternate methodologies and datasets. For example, according to estimates used by the OECD and compared to a business-as-usual scenario, pledges from the 2009 Copenhagen Accords could result in reductions in the year 2020 of between 2.3 billion metric tons of carbon dioxide-equivalents (for the least ambitious end of the pledges) to 9 billion metric tons (in the most optimistic scenario). Int'l Transp. Forum, OECD, *Reducing Transport Greenhouse Gas Emissions: Trends and Data* 25 (2010); *see also* Joeri Rogelj et al., *Analysis of the Copenhagen Accord Pledges and Its Global Climatic Impacts—A Snapshot of Dissonant Ambitions*, 5 Envtl.

Research Letters 1, 5-6 (2010); Joeri Rogelj et al., *Copenhagen Accord Pledges are Paltry*, 464 Nature 1126 (2010); M.G.J. den Elzen et al., *Pledges and Actions: A Scenario Analysis of Mitigation Costs and Carbon Market Impacts for Developed and Developing Countries* (Netherlands Research Programme on Scientific Assessment and Policy Analysis for Climate Change WAB-500102-032, 2009). The U.S. share of these pledges is equal to about a 1.1 billion metric ton reduction in the year 2020 on the low-ambition end, and 1.3 billion on the high-ambition end. *See id.* at 35-36, 38 tbls. 2.1 & 2.2 (citing a business-as-usual baseline for the United States in 2020—as developed for analysis of the Waxman-Markey legislative proposal—at 7.39 billion tons, and listing low- and high-ambition pledges for the United States as 0% to 3% below 1990 levels) *compare* U.S. EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2012* at ES-7 (2014) (setting the 1990 baseline at 6.23 billion tons). That means that under Copenhagen, foreign countries alone pledged between a 1.2 billion metric ton and 7.7 billion metric ton reduction in the year 2020. If all Copenhagen pledges were achieved (including U.S. pledges), total global benefits will be between $110 billion and $432 billion from worldwide carbon reductions just in the year 2020. The direct U.S. share of purely foreign emissions reductions would be at least between $4 billion and $85 billion, again just in the year 2020 alone. The magnitude of the estimates from this alternate methodology is consistent with this report's preferred methodology based on Climate Action Tracker data, and so supports this report's overall conclusions.

53 These calculations use the interagency group's most recent central SCC estimates, which are based on a 3% discount rate, and inflates those estimates to 2015$.

54 *See* EPA, *Benefits of Global Action*, *supra* note 4; Paltsev et al., *supra* note 4.

55 World Bank, *Reducing Black Carbon Emissions from Diesel Vehicles: Impacts, Control Strategies, and Cost-Benefit Analysis* 29 (2014).

56 *Id.* at 35 (estimating that, over the years 2013-2035, the program would generate $1.14 billion in total climate benefits, 51% of which derive from black carbon reductions, using 20-year time horizon global warming potentials and a 1% discount rate).

57 Minamata Convention on Mercury, Preamble.

58 Electric Power Research Institute, *Sources of Mercury Depositing in the United States* 3 (2006).

59 *See* EPA, *Regulatory Impact Analysis for the Final Mercury and Air Toxics Standards* 65-66 (2011) (discussing the complexities of the mercury exposure pathways through the global fish ecosystems and markets).

60 Federal Implementation Plans to Reduce Interstate Transport of Fine Particulate Matter and Ozone, 75 Fed. Reg. 45,209, 45,351 (Aug. 2, 2010).

61 *See* Sen. Jim Inhofe, Statement on China's Climate Announcement, Sept. 25, 2015 ("The Obama administration will use regulatory overreach to claim our nation's commitment, while China's pledge has no guarantee of enforcement. This is a great deal for the Chinese who are slated to continue increasing emissions . . . ."); Valerie Volcovici, *China Climate Announcements Turn Tables on Congress Foes*, Reuters, Sept. 25, 2015 (quoting Donald Trump, "[Climate change is] not a big problem at all. . . . If you look at China, they're doing nothing about it."); Steve Benen, *Rubio Needs a New Excuse to Ignore the Climate Crisis*, MSNBC.com, Oct. 2, 2015 (explaining that Marco Rubio remains against U.S. regulation following China and India's announcement, and that Rubio's campaign still stands by his quote from two years ago: "There are other countries that are polluting in the atmosphere much greater than we are at this point. China and India, they're not going to stop doing what they're doing.").

62 EPA, *Regulatory Impact Analysis for the Clean Power Plan Final Rule* at ES-22 (2015), http://www2.epa.gov/sites/production/files/2015-08/documents/cpp-final-rule-ria.pdf.

Appendix

Data and Assumptions

Climate Action Tracker provided us with data for global and U.S. emission reductions:

- Global reference scenarios, variously assuming high, medium, or low emission levels.
- Global policy scenarios, assuming either high or low emission levels (or, put another way, low or high emission *reductions*, respectively). We used their data to create a third global policy scenario to estimate middle emission levels, by taking the simple average of the high and low scenarios.
- U.S. policy scenarios, assuming either high or low emission levels.
- Global pledge scenarios, assuming either that individual nations' pledges are conditional or unconditional on other actions. We used their data to create a third global pledge scenario to estimate some mix of conditional and unconditional actions, by taking the simple average of those two scenarios.
- U.S. pledge scenarios, labeled "A" and "B," and based on various different assumptions. The scenarios are largely similar, and so we focus on scenario A, since the data is slightly more internally consistent.

Methodology to Calculate U.S. Benefits from Global Policies and Pledges

To calculate the U.S. benefits expected over 2015-2030 from existing global climate policies (including U.S. policies):

1. First, we generated three different estimates of global emission reductions from 2015-2030 due to current global policies by taking the difference between emissions under the reference and policy scenarios: a high emission reduction estimate (global reference high less global policy low), a medium emission reduction estimate (global reference medium less global policy medium), and a low emission reduction estimate (global reference low less global policy high). While there are more possible permutations, this gives us the highest and lowest possible emission reductions along with one possible middle path.
2. Any negative estimates of emissions reductions are adjusted to zero, on the assumption that a climate policy should not increase emissions relative to the baseline scenario (though of course, such perverse results could in reality be possible).
3. Next, we multiplied the estimated emission reductions for each year by the corresponding federal SCC estimate, as released in the Interagency Working Group's 2015 Technical Update. We used the central SCC values, which were based on a 3% discount rate, and we adjusted the values to 2015 U.S. dollars.
4. To calculate the present value of these emission reductions to global society, we discount future benefits back to present value in 2015 by using a 3% discount rate, and summed values over the 2015-2030 period.
5. Finally, to calculate the value of these emission reductions to the United States, we multiply these present value estimates by a multiplier that ranges from 7% to 23%, reflecting a preliminary and conservative estimate of the U.S. domestic share of the global SCC, as specified by the 2010 Interagency Working Group. Specifically, we multiplied the high value emission reduction path by 23% to achieve an upper boundary value; we multiplied the low value emission reduction path by 7% to achieve a lower boundary value; and we multiplied the medium value emission reduction path by 15% (the simple average of 7% and 23%) to achieve a middle value.

To calculate the additional U.S. benefits expected over 2015-2030 from global climate pledges (focusing on benefits from non-U.S. pledges):

1. First, we generated four different estimates of global emission reductions over 2015-2030 from global pledges by taking the difference between emissions under the current policy scenarios and the pledge scenarios: the maximum emission reduction estimate (global policy high less global unconditional pledge), the second highest reductions (global policy high less global conditional pledge), the second lowest emission reductions (global policy low less global unconditional pledge), and the minimum emission reduction estimate (global policy low less global conditional pledge). While there are more possible permutations, this approach generates the highest and lowest possible emission reductions along with possible middle paths. There are no negative emissions reductions estimates, so no further adjustments are necessary (compared to above methodology).

2. Next, we generated two different estimates of U.S. emission reductions over time from U.S. pledges by taking the difference between emissions under the U.S. policy and pledge scenarios: the maximum emission reduction estimate (U.S. policy high less U.S. pledge path A) and the minimum emission reduction estimate (U.S. policy low less U.S. pledge path A).

3. To calculate the non-U.S. emission reductions due to pledges, we took the difference between global and U.S. emission reductions from pledges. To reduce permutations to a manageable number, we assume either that high emission pathways must hold for both the world and the United States or else that low emission pathways must hold for both the world and the United States. In other words, we assume that the United States will not indefinitely take aggressive action if the rest of the world continues to take only minimal action, and vice versa. This leaves four possible path ways: (1) High and Unconditional [(Global Policy High – Global Unconditional Pledge)-(U.S. Policy High – Pledge A)]; (2) High and Conditional [(Global Policy High – Global Conditional Pledge)-(U.S. Policy High – Pledge A)]; (3) Low and Unconditional [(Global Policy Low – Global Unconditional Pledge)-(U.S. Policy Low – Pledge A)]; and (4) Low and Conditional [(Global Policy Low – Global Conditional Pledge)-(U.S. Policy Low – Pledge A)]

4. To estimate the value of non-U.S. emissions reduction to global society over time, we multiply the above emission reductions for each year by the corresponding federal SCC estimate, as released in the Interagency Working Group's 2015 Technical Update. We used the central SCC values, which were based on a 3% discount rate, and we adjusted the values to 2015 U.S. dollars.

5. To calculate the present value of these emission reductions to global society, we discount future benefits back to present value in 2015 by using a 3% discount rate, and summed values over the 2015-2030 period.

6. Finally, to calculate the present value of these non-U.S. emission reductions to the United States, we multiply these present value estimates by a multiplier that ranges from 7% to 23%, reflecting a preliminary and conservative estimate of the U.S. domestic share of the global SCC, as specified by the 2010 Interagency Working Group. Specifically, we multiplied the high value emission reduction path by 23% to achieve an upper boundary value; we multiplied the low value emission reduction path by 7% to achieve a lower boundary value; and we multiplied the two medium value emission reduction paths by 15% (the simple average of 7% and 23%) to achieve middle values.

For all data and calculations, see the Excel tables on policyintegrity.org.

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