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Long-term Carbon Policy: The Great Swap

Joseph E. Aldy
November 2016

About the Author

Joseph E. Aldy is an Associate Professor of Public Policy at the Harvard Kennedy School, a Visiting Fellow at Resources for the Future, a Faculty Research Fellow at the National Bureau of Economic Research, and a Senior Adviser at the Center for Strategic and International Studies. His research focuses on climate change policy, energy policy, and mortality risk valuation. He also serves as the Faculty Chair of the Mossavar-Rahmani Center for Business and Government Regulatory Policy Program. In 2009-2010, he served as the Special Assistant to the President for Energy and Environment at the White House. Aldy previously served as a Fellow at Resources for the Future, Co-Director of the Harvard Project on International Climate Agreements, Co-Director of the International Energy Workshop, and worked on the staff of the President's Council of Economic Advisers. He earned his doctorate in economics from Harvard University and MEM and bachelor degrees from Duke University.

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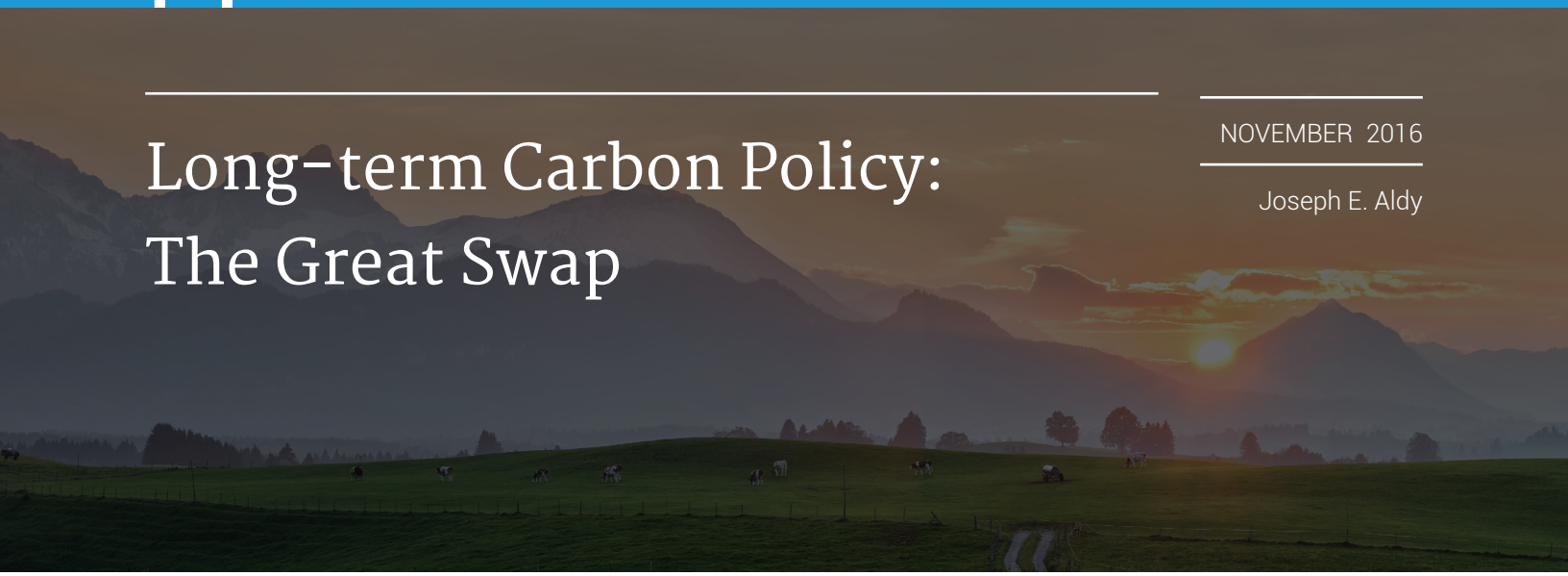

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THE POLITICAL CHALLENGE OF CLIMATE POLICY

In the past two decades, the mounting risks posed by climate change have motivated businesses, cities, states, national governments, and the international community to pledge to take action to reduce their greenhouse gas emissions. Given the scale of the problem, the breadth of action must be effective and must set the foundation for increasing mitigation efforts over time. Thus, delivering on these pledges will require effective policies to drive the deployment of low-carbon technologies today and technological innovation in the future to ramp ambition up on par with the risks of climate change.

Climate change is a problem no country can solve by itself. Since the mid-1990s, the United States has advocated for developed and developing countries to work together in combating climate change and, with the United States' leadership, the 2015 Paris Agreement delivered unprecedented commitments by virtually every country on the planet to reduce their greenhouse gas emissions. Now, the election of Donald J. Trump, an avowed global warming skeptic, has thrown America's commitment to global leadership in doubt. If the United States quits the fight against climate change, this risks unraveling the global coalition and could result in other countries following suit. This would be a tragic mistake with incalculable consequences for the entire planet. Moreover, some nations may retaliate against the United States by imposing tariffs on American-manufactured goods based on the greenhouse gas emissions associated with their production.

If, on the other hand, President Trump is willing to use his vaunted powers as a dealmaker, there are real possibilities for breaking the present impasse in Washington over energy and climate policy. Not so long ago, there was bipartisan support for the proposition that the United States must do its part to slow down the heating of the Earth's atmosphere. At the Rio de Janeiro Earth Summit in 1992, President George H. W.

Bush signed the global climate treaty, which the Senate ratified unanimously later that year. In the 2008 presidential campaign, Senators McCain and Obama supported virtually identical economy-wide greenhouse gas cap-and-trade programs with ambitious targets through 2050. Since then, Republicans have actively opposed climate policy, with only six Republican members voting for the 2009 Waxman-Markey energy and climate bill. In the wake of failed cap-and-trade legislation, the Obama Administration advanced regulations – the Clean Power Plan, fuel economy standards, appliance efficiency standards – as well as administrative initiatives to address climate change. In addition, a number of states have promoted more aggressive climate change and renewable power policies over the past decade.

The President-elect has stated his intention to reverse a number of these regulations, including the Clean Power Plan. Just as opponents of the Clean Power Plan have used the courts to slow and potentially halt its implementation, the proponents of the Clean Power Plan will use the courts to slow efforts to reverse it. Given the statutory requirements on regulatory decision-making, an agency cannot simply change its mind on a regulation without making its case and subjecting this to public comment. This legal uncertainty coupled with the continuing patchwork of state policies – including cap-and–trade programs covering power-sector carbon dioxide emissions in states representing 25 percent of the U.S. population – makes for an unpredictable investment climate for the utility sector.

Reversing existing climate change policies also raises questions about the U.S. commitment to the Paris Agreement. The key elements of the Paris Agreement represent long-standing U.S. interests – a respect for sovereignty in how each country pledges voluntary contributions to the global effort to combat climate change and a focus on transparency in implementation to assess whether all major partners undertake comparable efforts. Even if the Paris Agreement is not a first-tier priority of the incoming administration, the fact that it is a top priority for many countries around the world provides a potential leverage point for the United States in other bilateral or multilateral negotiating contexts. Since the climate agreement is part of a much more complex web of international relations, the U.S. engagement in it can facilitate

> *Some states and industries have taken the lead on climate policy, implementing carbon pricing policies and deploying wind, solar, and energy efficiency technologies.*

efforts to secure deals on the incoming administration's foreign policy priorities. Walking away from the Paris Agreement would make it much more difficult for the incoming administration to work with other countries on issues ranging from terrorism, to trade, to cybersecurity, to public health and pandemics, as well as an array of bilateral issues.

A smart deal to tackle climate change could abet tax and regulatory reform – which most Republicans support – by swapping a market-based carbon tax for sectoral regulatory policies – which most Republicans oppose. Such an approach could make even greater reductions in tax rates politically feasible and demonstrate that Republicans are in favor of smarter

environmental policy, not simply opposed to all climate change policies. This report describes how that deal would work.

THE GREAT SWAP

A "Great Swap" – a carbon tax and regulatory streamlining as a part of tax reform – can navigate these political challenges and serve as a credible way forward for the United States on climate policy.

The Benefits of a Carbon Tax

A carbon tax can drive the deployment of technologies and innovation necessary to cut greenhouse gas emissions and combat climate change risks. And, by getting the biggest climate bang for the buck, a carbon tax makes the politics and economics of driving down emissions easier. Imposing the same carbon price on all sources of emissions is not only cost-effective, but fair in the sense that everyone who pollutes must bear the same cost for their pollution. By creating a strong profit incentive for businesses to seek out and exploit low-cost ways of cutting emissions, a carbon tax can be quite effective environmentally. A transparent, administratively simple policy approach, a carbon tax represents good public policy in a democracy. Finally, an economy-wide carbon tax would enable U.S. negotiators to demonstrate continued U.S. leadership on climate policy and signal a seriousness that would elicit reciprocal policies and actions among our partners participating in multilateral climate policy. An illustration of a carbon tax is presented in the box on page 12 and elaborated further in the carbon tax design section below.

Enabling Tax Reform

An economy-wide carbon tax would produce substantial revenues – as much as several hundred billion dollars annually – that could finance significant reductions in existing tax rates on personal and corporate income. Indeed, a meaningful tax reform package will need to tap new revenue sources to deliver lower tax rates

without increasing federal deficits. The rationale for coupling a carbon tax and tax reform are twofold. First, the climate policy and tax reform benefit from each other in terms of economics. Tax reform lowers the costs to the economy -- and potentially eliminates the net costs -- of a carbon tax, while the carbon tax provides the revenues to finance the tax reform. Second, such an approach can neutralize the difficult politics that characterize each issue by broadening the political coalition that would derive a "win" from at least some element of the policy package. Such a broad coalition would ensure the durability of the carbon tax and tax reform, and is consistent with major policy efforts in the past that have coupled policy initiatives to draw broader support, such as under the regular farm bill and transportation bill processes.

The Benefits of Regulatory Streamlining

A carbon tax could substitute for the rigid and complicated framework of command and control regulations that define the status quo. The absence of a comprehensive, national climate policy has produced a vacuum. It has required a vast array of legislative changes at the state level to ramp up renewables. It has required new tax bills every year or two to continue support for renewables. The regulatory approach under the Clean Air Act will take years to surmount the political and legal hurdles, only to cover one (albeit important) industry. Then the process starts over with another industry. Likewise, appliance efficiency standards are one-by-one. And none of these policies – the Clean Air Act, tax credits, fuel economy standards, appliance standards, or state Renewable Portfolio Standards – envision more ambitious reductions after 2030 (or post-2025 in some cases). This complicated suite of policies is not the path to a low-carbon economy; it is a collection of stopgap measures waiting for more comprehensive, durable policy instruments to drive a low-carbon economy.

POLITICAL SUPPORT FOR THE GREAT SWAP

What Republicans Could Gain from the Great Swap

A carbon tax in the context of a revenue-neutral tax reform could elicit Republican support. The Republicans will have a primary objective of lowering tax rates in a tax reform, subject to the constraint that the tax reform would not increase the federal deficit. As a result, substantial tax reform that lowers tax rates can only satisfy this political constraint if it also secures meaningful revenue raisers. A carbon tax generating $100 billion to $200 billion annually in revenues could enable larger rate cuts, which would likely serve as the most important marker of policy success to key stakeholders in the Republican Party.

A number of conservative and Republican thought leaders have advocated for a revenue-neutral carbon tax. Arthur Laffer, whose work has informed much of Republican tax policy since the 1980s, and former Representative Bob Inglis (R-SC) wrote in the *New York Times* that "fiscal conservatives would gladly trade a carbon tax for a reduction in payroll or income taxes, but we can't go along with an overall tax increase." George Shultz, who served as Secretary of the Treasury and State in Republican administrations, and Nobel laureate Gary Becker advocated for a carbon tax in the *Wall Street Journal* on the condition of revenue neutrality, since this would "mean that it will not have a fiscal drag on economic growth."

The prospect of replacing a complicated mix of regulations with a carbon tax also appeals to conservative thought leaders. In the *Weekly Standard*, Irwin Stelzer of the Hudson Institute

(and formerly the American Enterprise Institute) called for a carbon tax to finance a reduction in the payroll tax, noting that "it gives conservatives a market-based tool to replace regulations and relieves them of a need to sign on to the climate change thesis by providing a true, conservative rationale – consumption taxes that ease the burden of taxation on work are pro-growth." Greg Mankiw, former Chair of the Council of Economic Advisers in the George W. Bush Administration, called for a carbon tax as a lower cost way to reduce emissions than a collection of regulations and stated in the *New York Times* that "using the new revenue to reduce personal and corporate income tax rates, a bipartisan compromise is possible to imagine."

The prospect of a bipartisan agreement still must overcome significant political hurdles. The House of Representatives voted for a resolution in June 2016 – almost completely along party lines – that expresses the sense that a carbon tax would be "detrimental to the U.S. economy." Given the text of the resolution and its political context, it would seem politically infeasible to advance a standalone carbon tax bill in a Republican-controlled House of Representatives. The silence of the resolution, however, on using a carbon tax to cut tax rates and to replace a complicated regulatory regime suggests that a Great Swap could receive serious consideration.

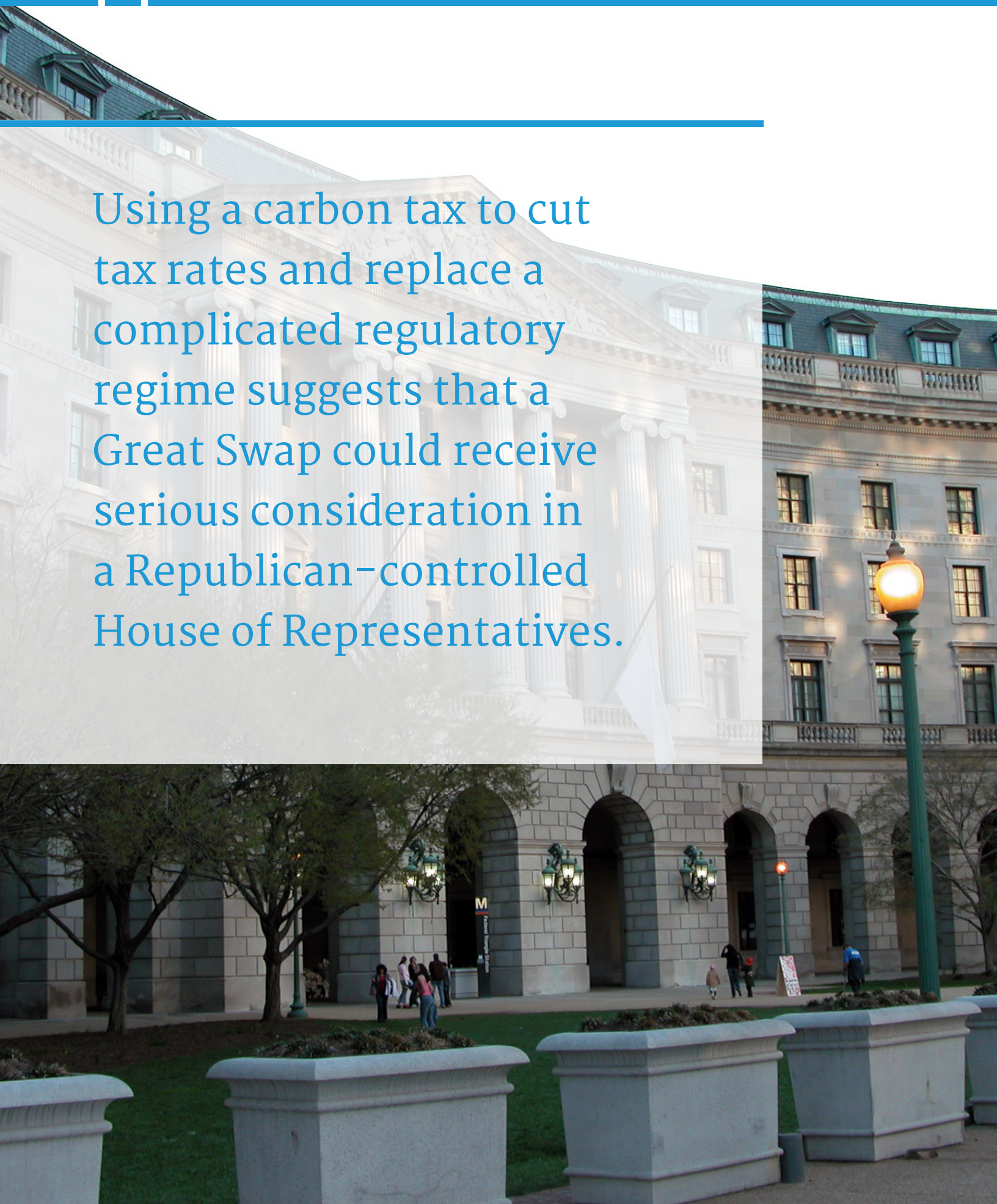
Why Progressives Would Support the Great Swap

The United States is not starting from scratch with climate policy. While carbon pricing legislation has been under consideration in the Congress since at least 2003, the absence of legislative progress has resulted in the use of existing statutory authorities to address climate change. The status quo is complicated, redundant and costly and doesn't deliver the emissions reductions we need. In just the power sector alone, utilities and electricity consumers face a large set of overlapping policies, such as state renewable mandates, energy efficiency mandates on utilities, appliance efficiency mandates, tax credits for renewable power, accelerated depreciation for renewable power, the Clean Power Plan, net metering, energy-efficient appliance rebates, state and regional carbon dioxide cap-and-trade programs, etc. Consider that, in the transportation sector in California, the gasoline a consumer purchases is subject to a state low-carbon fuel standard,

> *Many in the environmental community have worked hard to advance the Clean Power Plan and, despite its legal uncertainty, they may be reluctant to support a policy that would remove the Clean Air Act as a policy tool.*

a state carbon dioxide cap-and-trade program, a national renewable fuel standard (with carbon performance benchmarks) and, when put into a car manufactured under fuel economy standards, a tailpipe carbon dioxide standard, and a zero emissions vehicle mandate.

It is well known within the environmental community that the set of regulatory tools available under current law are not sufficiently powerful to deliver on long-term emission goals, and may not be enough to reach the Paris Agreement goal of 26 to 28 percent below 2005 levels by 2025. Several environmental groups have issued analyses that, while optimistic about the prospects of new policies to deliver on the 2025 goal, clearly recognize that the current set of policies, subsidies, and regulations in place – including the Clean Power Plan, which could be weakened through judicial review – will



Using a carbon tax to cut tax rates and replace a complicated regulatory regime suggests that a Great Swap could receive serious consideration in a Republican-controlled House of Representatives.

not deliver a 26 percent reduction in emissions by 2025.

This is the very reason leaders in the environmental community worked intensively for long-term, economy-wide cap-and-trade legislation in 2009 and 2010.

There are political risks with swapping a carbon tax for these regulatory policies and subsidies, since there are vested interests associated with the status quo. Many in the environmental community have worked hard to advance the Clean Power Plan and, despite its legal uncertainty, they may be reluctant to support a policy that would remove the Clean Air Act as a policy tool. Having said that, there may be those in the business community who would not support a carbon tax without regulatory streamlining.

Moreover, the prospect of lowering tax burdens on the middle-income and lower-income households could be quite appealing to many progressives. Delivering a tax reform that improves the progressivity of the tax code – as well as its efficiency – could serve as a way to promote economic growth and address income inequality. The opportunity to improve the progressivity of the tax code and establish a meaningful, long-term, economy-wide driver of emission reductions would likely outweigh reservations about pre-empting statutory authorities under the Clean Air Act that are still pending judicial review.

Why Business Would Support the Great Swap

The vast majority of the business community would find the Great Swap a strongly compelling alternative to the status quo. First, an economy-wide carbon tax would provide substantially more certainty than the current regulatory approach. In contrast to a carbon price, the complicated mix of regulatory instruments requires a product-by-product and/or industry-by-industry series of regulations, each of which would then involve periodic updating through new rule-makings. The vagaries of the rule-making process, as well as potential legal and legislative challenges, prevent firms from forming sensible expectations about the form and stringency of future climate regulations. The certainty of long-term U.S. climate policy through a carbon tax could also remove a barrier to business investment generally, as some firms have hedged capital outlays and R&D investments pending resolution of climate policy. As Bob Dudley, the CEO of BP, noted last year, "a global carbon price would help to unleash market forces and provide the right incentives for everyone to play their part."

> *The uncertainty about potentially irreversible changes to the global climate provides a strong case for taking action to reduce the prospect and magnitude of adverse climate change.*

Second, many businesses that would have to either comply with greenhouse gas regulations or a carbon tax would prefer the carbon tax as a less costly and more effective policy approach. For example, the vice president of public and government affairs for Exxon Mobil recently wrote in the *Dallas Morning News* that "of the policy options being considered by governments, we believe a revenue-neutral carbon tax is the best."

Third, a carbon tax would significantly ease the administrative burden for many businesses,

relative to compliance efforts under existing regulations. Many businesses already track their carbon dioxide emissions, either under EPA reporting requirements or voluntarily through such efforts as the Carbon Disclosure Project. Thus, businesses can readily assess how a carbon tax would affect the costs of their operations, in contrast to the uncertainty and complexity of regulations. Those businesses with the statutory obligation of paying the carbon tax could use their existing emissions accounting as the basis for estimating their tax payments.

> *Large American corporations, including manufacturers such as Colgate-Palmolive, General Motors, and Owens Corning; electric utilities such as AEP, Duke Energy, Exelon, and NRG Energy; oil companies, such as ConocoPhillips and Exxon Mobil; and, information technology companies, such as Google and Microsoft all employ carbon prices in internal planning ranging from $5/tCO2 to $85/tCO2.*

Fourth, a carbon tax that finances a lower corporate income tax rate would also appeal to many businesses. Depending on the level of the carbon tax and the magnitude of the corporate tax rate cut, a majority of businesses could pay less in taxes to the federal government under the Great Swap than they do under the current tax code.

Finally, an economy-wide carbon tax could also create more demand for long-lived energy technologies, such as wind, solar, and nuclear power plants. Firms and investors active in the clean energy space would benefit from a long-term policy signal, in contrast to the uncertainty associated with periodic tax extenders bills – which subsidize these technologies over short periods of time – and future regulations.

Why Labor Would Support the Great Swap

The labor community has, with some notable exceptions, supported policies that promote clean energy investment and combat climate change. For example, the demand for manufactured inputs in wind and solar power facilities translated into demand for unionized workers, such as the United Steelworkers, who supported the 2009 Waxman-Markey cap-and-trade bill. A carbon tax would provide long-term demand for such inputs, and could finance a lower payroll tax-both of which would receive the support from labor.

The challenge with the labor community lies with workers in two sectors, whose concerns cannot be addressed under the current regulatory approach to climate change. First, coal workers have a legitimate concern that climate policy will reduce demand for coal and hence lead to mine closings and layoffs. There are virtually no tools to address these concerns under current law. A carbon tax could finance a coal community fund that could enable coal workers to transition to new employment.

Greenhouse gas regulations under the Clean Air Act cannot raise federal revenues, nor does the law permit the use of revenues for aiding coal communities. Thus, a policy package of a carbon tax with a coal community program could be a more appealing alternative to the current (and future) regulations under existing statutory authority.

Steps Toward an Economy-Wide Carbon Tax

- Enact a tax on the carbon content of all fossil fuels in the U.S. economy.
- Apply the tax to the owners of coal mines at the mine gate, owners of petroleum refineries at the refinery gate, purchasers receiving imported refined petroleum product at ports of entry, and natural gas pipeline owners.
- Set the tax rate at $25 per ton carbon dioxide for all fossil fuels effective one year after the legislation is signed into law. The rate will increase at the rate of inflation, as measured by the consumer price index for urban consumers, plus 5% per year.
- Enable businesses that capture carbon and store it underground or use fossil fuels as material inputs in manufacturing to earn tradable tax credits equal to the quantity of tons valued at the going carbon tax rate.
- Evaluate the tax rate every five years. EPA will review the science, Treasury will review the economic costs of the carbon tax, and State Department will review the actions of other countries and progress in international negotiations. Based on these reviews, the President can recommend a change in the tax rate or its rate of growth to Congress. The recommendation will take the form of a joint resolution that can be voted up or down – or not voted on at all – but would not be subject to amendment.
- Use revenues from the carbon tax to finance comprehensive tax reform, including potential reductions in the corporate and personal income tax rates. Some revenues could finance a cash assistance program that targets low-income households whose taxes may be primarily in the form of payroll and/or sales taxes. In addition, some revenues could be set aside for assistance to coal communities and other communities and industries adversely affected by climate policy. One month before the start of the carbon tax, the Treasury will mail every household a $100 check and an explanation of how the carbon tax reduces the typical household's tax burden.
- Streamline and eliminate unnecessary regulations and subsidies. Once an economy-wide carbon tax is in place, businesses and consumers will have strong incentives to reduce the carbon intensity of their everyday activities. Eliminating Clean Air Act regulation of carbon dioxide emissions and related regulations can reduce the administrative burden and economic costs of the nation's climate policy program without undermining climate goals. As a part of the tax reform, subsidies for energy through tax credits, accelerated depreciation, percentage depletion, expensing of intangible drilling costs, and other provisions would be phased out.

Second, labor in energy-intensive industries such as steel, aluminum, chemicals, cement, paper, and glass may be concerned about the competitiveness impacts of domestic regulations. If energy prices increase under Clean Air Act regulations (which the Environmental Protection Agency estimates will occur under the Clean Power Plan), but foreign competitors do not face comparable climate regulatory costs, then domestic firms may be at a competitive disadvantage in the U.S. market and abroad. For example, after the Paris Climate Conference, the legislative director for the United Steelworkers noted that "those [Chinese] imports carry with them a huge cost in the amount of carbon that was emitted on its way here."

The current regulatory approach cannot provide

an explicit remedy to an increase in net imports of carbon-intensive goods manufactured in unregulated or lightly regulated foreign markets. In contrast, a carbon tax could be designed to include a border tax – effectively imposing the carbon tax on imports from countries without a comparable domestic climate policy program. This would ensure a level playing field among U.S. energy-intensive manufacturers and their foreign competitors.

The balance of this report describes in greater detail the case for an economy-wide carbon tax, the design of a carbon tax, and the potential use of carbon tax revenues.

THE CASE FOR AN ECONOMY-WIDE CARBON TAX

The Certainty and Risks of a Changing Climate

Families, businesses, and governments must confront two types of risks associated with climate change. First are the risks climate change poses for our health, safety, built infrastructure, agriculture, natural environments, economic activity, and more, around the world and for generations to come. The scientific literature on the potential climate change impacts – their magnitudes, their probabilities, and their timing – is characterized by uncertainty. While report after report from the National Academies of Sciences and the Intergovernmental Panel on Climate Change reviews and synthesizes the breadth of scholarly literature and acknowledges these uncertainties, they also make clear that human activities are changing and will continue to change the global climate and the net effect on human society is likely to be negative.[1,2,3,4,5,6,7]

However one interprets these risks, it is important to recognize that uncertainty does not justify inaction. Instead, the uncertainty about potentially irreversible changes to the global climate provides a strong case for taking action to reduce the prospect and magnitude of adverse climate change. Our country will come to regret foregoing this option if it does not undertake efforts today to avoid adverse, abrupt, and/or catastrophic climate change.

This line of thinking is quite familiar to families and business leaders when they address other kinds of uncertain risks. Homeowners have insurance that compensates them in the event that a fire burns down their house. They pay a regular premium – giving up some income they could otherwise spend on consumption – in order to ensure that the value of their largest asset (for the vast majority of home-owners) is not at risk to a catastrophic event. A business may contract with other businesses in order to lock in prices for their output. The business may give up some expected profit, but in doing so it can avoid facing potential volatility about the prices for and hence returns to production. Families and businesses spend considerable resources to reduce the potential downside risks they face in a variety of contexts. Given the scale and nature of risks associated with climate change, a prudent course of action would be to undertake investments to reduce the likelihood of the worst outcomes.

Given uncertainty about the returns to mitigating the risks of climate change, it makes sense to pursue the lowest-cost ways of reducing greenhouse gas emissions. Ensuring that Americans realize the greatest gains on their investment will make more ambitious mitigation strategies more feasible, economically and politically. Conversely, a mix of low- and high-cost policies – with dramatic differences across families, businesses, and regions of the country – may squander resources that could have

supported greater mitigation if targeted more effectively and result in investment that costs much more than the benefit it delivers.

CARBON PRICE CERTAINTY

Firms that aim to maximize profits respond to prices. A business that faces higher prices for material inputs explores ways to economize on its use of materials. Higher wages may drive some businesses to invest in labor-saving equipment in order to reduce payroll's contribution to costs. And higher costs of capital may induce some businesses to repair existing machinery instead of making new investments. In contrast, the vast majority of businesses in America do not face a price for carbon pollution. Businesses pay for labor, materials, and capital, and most businesses bear some cost for their water pollution, solid waste disposal, and most types of air pollution. These explicit and implicit prices create an incentive for firms to economize on their use of inputs and reduce their output of pollution by-products.

Carbon pricing creates a cost for emitting carbon dioxide emissions just as there is a cost to businesses of hiring workers, buying materials, or complying with air quality standards. Setting a price on carbon motivates the business to seek out ways to reduce its carbon pollution so it can realize greater profits. Likewise, a carbon price creates incentives to individuals to change their behavior – i.e., reduce their carbon footprint – in order to pay less for carbon pollution.

In practice, a carbon tax and a carbon dioxide cap-and-trade program can directly establish a price on carbon dioxide emissions. In a carbon tax, the government sets a tax per ton of emissions that must be paid on a regular (e.g., annual) basis by covered taxpayers (e.g., businesses). In a cap-and-trade program, the government sets an aggregate level of permissible emissions, creates emission allowances equal in sum to the aggregate cap that grants a regulated entity the right to emit a ton of emissions, and then allocates the allowances to the economy (e.g., through an auction, more often for free based on historic emissions). Under this program, firms can buy and sell allowances from each other and the secondary market for allowances that emerges reveals the carbon price. While there is certainty in the carbon price under a carbon tax, the cap-and-trade program yields an uncertain carbon price. In a number of prominent cases – such as the EU Emission Trading Scheme for carbon dioxide, the U.S. sulfur dioxide acid rain program, and the U.S. nitrogen oxides program – the volatility of emission allowances has been so great that it has exceeded the volatility of crude oil prices.[8]

While a carbon tax and cap-and-trade make the carbon price transparent, the vast array of regulatory and subsidy policies that reduce greenhouse gas emissions are characterized by implicit carbon prices. Even if policymakers say they oppose a carbon tax or cap-and-trade, their support for fuel economy standards, renewable subsidies, energy efficiency mandates and subsidies, fuel content regulations, and other policies increases the prices of either energy or the equipment and capital that use energy. The implicit carbon prices tend to be much higher for these policies than the prices set in past Congressional carbon tax proposals or estimated to arise under past Congressional cap-and-trade programs. These higher and quite variable implicit carbon prices mean the U.S. economy is paying much more to reduce a given amount of carbon pollution than it would under a carbon tax.

FIGURE 1: Implicit Carbon Prices Under Various Energy and Climate Change Policies

POLICY	IMPLICIT CARBON PRICE	NOTES
Regional Greenhouse Gas Initiative	$4.53/tCO2	June 2016 Auction
CA Cap-and-Trade Program	$12.80/tCO2	August 2016 Futures Price
Wind RPS	$45/tCO2	Academic article estimate
CA Low Carbon Fuel Standard	$119/tCO2	May 2016 Avg. Credit Price
Corporate Average Fuel Economy Standards	$222/tCO2	Academic article estimate
Cash for Clunkers	$237/tCO2	Academic article estimate

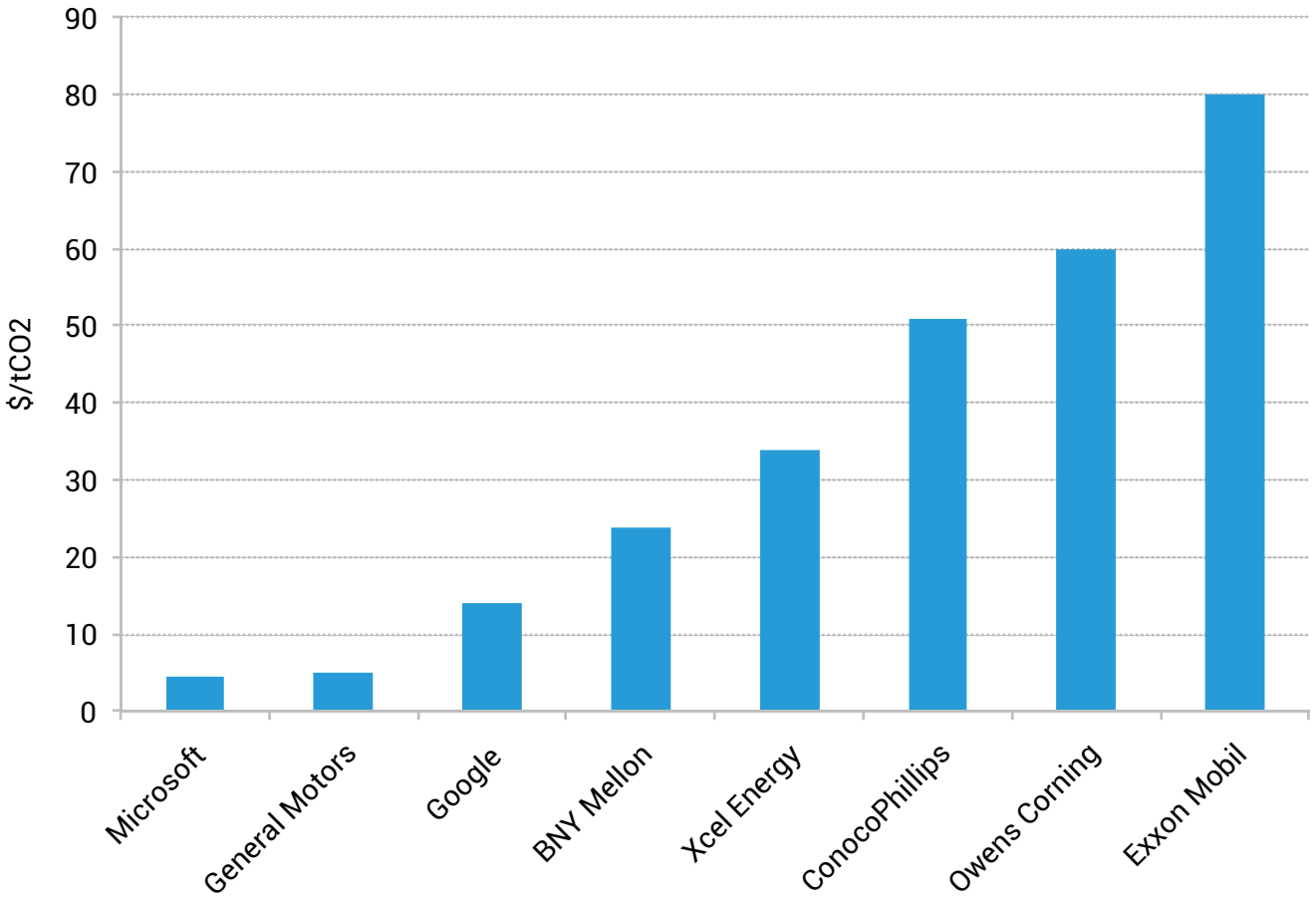
Carbon Price Certainty and Business Planning

Economists have long called for pricing carbon. In recent years, a much broader coalition of businesses has advanced the case for carbon pricing. In 2014, 74 countries and more than 1,000 businesses called on governments to price carbon through a carbon tax or emission trading systems.[9] Likewise, more than 350 institutional investors – including BlackRock, CalPERS, and Standard Bank – representing more than $24 trillion in assets called for "stable, reliable, and economically meaningful carbon pricing."[10] In 2015, six international oil companies – BG Group, BP, Eni, Royal Dutch Shell, Statoil, and Total – called on governments to price carbon as part of "clear, stable, long-term, ambitious policy frameworks" to limit greenhouse gas emissions.[11]

This is more than simply the issuing of public statements. The Carbon Disclosure Project reported that more than 400 companies use a carbon price for internal project evaluation and investment analysis.[12] For example, large American corporations, including manufacturers such as Colgate-Palmolive, General Motors, and Owens Corning; electric utilities such as AEP, Duke Energy, Exelon, and NRG Energy; oil companies such as ConocoPhillips and Exxon Mobil; and, information technology companies such as Google and Microsoft all employ carbon prices in internal planning ranging from $5/tCO2 to $85/tCO2. Formally integrating a carbon price in the assessment of business options reflects a sincere expectation that policies of one form or another will impose an explicit carbon price (e.g., a carbon tax) or an implicit carbon price (e.g., command-and-control regulations) on these companies' business operations.

The dramatic heterogeneity in expected carbon prices among these companies, however, also reflects the continued uncertainty about

FIGURE 2: Carbon Pricing in Internal Corporate Planning



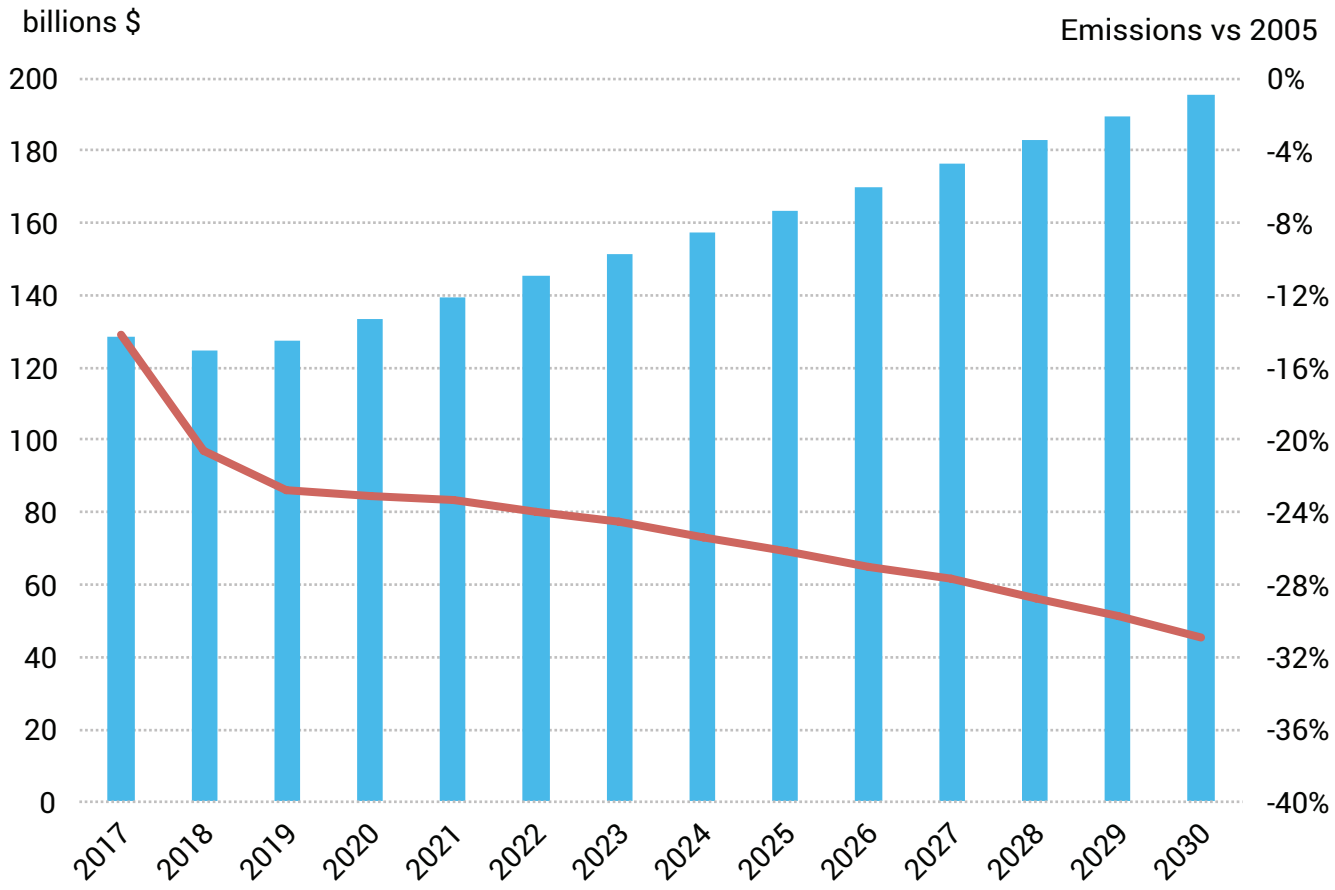
Source: Carbon Disclosure Project

the form, timing, and ambition of climate change policy. As a result, some investments will likely move forward that would not have if the company knew with greater certainty or predictability what the effective carbon price would be in the future. Likewise, some investments may not move forward that would have had the company held a more accurate understanding of future carbon prices. This less-than-optimal investment risks lowering the returns to capital and inhibiting economic growth.

Driving Emissions Reductions and Generating New Revenues

Energy suppliers will increase the price of the fuels they sell in response to the carbon tax. This will effectively pass the tax down through the energy system, creating incentives for fuel-switching and investments in more energy-efficient technologies that reduce CO2 emissions.The real-world experience of firms and individuals responding to changing energy prices demonstrates the potential power of a carbon tax to drive changes in the investment and use of emission-intensive technologies. Higher gasoline prices in 2008 helped more

FIGURE 3: Estimated Carbon Tax Revenues and Carbon Emissions vs 2005



Notes: The red line represents carbon emissions (the right vertical axis) and the blue bars show carbon tax revenues (the left vertical axis.) Constructed by author based on Annual Energy Outlook 2014 side case analyses.

fuel-efficient vehicles increase their market share, while reducing vehicle miles traveled by drivers of existing cars and trucks.[13] In recent years, electric utilities responded to the dramatic decline in natural gas prices (and the associated increase in the relative coal-gas price ratio) by switching dispatch from coal-fired power plants to gas-fired power plants, resulting in lower carbon dioxide emissions and the lowest share of U.S. power generation by coal in some four decades. Historically, higher energy prices have induced more innovation – measured by frequency and importance of patents – and increased the commercial availability of more energy-efficient products, especially among energy-intensive goods such as air conditioners and water heaters. Imposing a carbon tax would provide certainty about the marginal cost of compliance, which reduces uncertainty about returns to investment decisions and eliminates the regulatory uncertainty that inhibits energy sector investment.

Some carbon tax opponents claim that businesses will simply pay the tax and keep on polluting. This presumes that businesses would prefer to pay more tax than is necessary. This does not square with the long history of how businesses operate under the tax code or how

they respond to changes in energy prices. If a utility produces more power from its natural gas power plants than its coal plants when natural gas prices fall, then a utility is likely to do the same in response to relatively higher coal prices due to a carbon tax.

> *U.S. refineries and importers of petroleum products already pay a federal per barrel tax and coal mine operators already pay a federal per ton tax, so a national carbon tax could easily piggyback on these existing tax reporting systems.*

To illustrate the potential impacts of a carbon tax on emissions, consider a $25 per ton carbon tax that increases 5 percent annually (this is based on the Energy Information Administration's 2014 Annual Energy Outlook). This carbon tax would lower U.S. carbon dioxide emissions 26 percent by 2025 – consistent with our nation's pledge at the Paris climate summit last year – and more than 30 percent by 2030. In doing so, it would raise gross tax revenues by $130 billion to nearly $200 billion per year through 2030.

Incentives for Investment

Governments face a fundamental and insurmountable problem when considering policy options for reducing any type of pollution, and especially carbon pollution: businesses know and understand their opportunities for mitigating pollution better than the government. Any given regulator operates with incomplete information about these mitigation options in the business community. Complicating this information problem for the regulator is the fact that the opportunities for and costs of reducing pollution vary across businesses. Some have low-cost ways of reducing pollution while others have only high-cost pollution abatement approaches, but the regulator likely cannot identify and distinguish these types. As a result, a regulator who applies a common standard to all sources of pollution likely imposes greater costs than would be realized if the regulator could overcome the information problem and set standards that equate the marginal costs of regulatory compliance across all sources.

While a regulator cannot know perfectly the pollution mitigation opportunities at all firms, it can create strong incentives to realize the cost-effective outcome of equating marginal costs across all sources. A carbon tax delivers these strong incentives by leveraging businesses' profit motive. A business facing a carbon tax of, say, $25 per ton carbon dioxide will find it in its interest to seek out and exploit all emission abatement options that cost no more than $25/tCO2. The business is better off paying a tax instead of investing in abatement that costs more than $25/tCO2. Firms will converge on the cost-effective outcome of equating their marginal costs of regulatory compliance with $25/tCO2, and thus among each other. As the carbon price increases over time, all businesses will have the incentive to invest in additional pollution abatement that costs less than the rising carbon tax.

Relying on the market-based approach of pricing carbon taps into the ingenuity of businesses and entrepreneurs. The technology-neutral approach allows any clever, emission-reducing idea to have consideration in the market. Instead of relying on a relatively small number of government staff to be creative in exploring

abatement options, letting the market investigate pollution control opportunities and, through the profit motive, attract many, many more individuals to tackle the problem can result in more emissions abatement at lower cost than any analyst would predict ex ante.

This is not only a problem for the regulator. Subsidizing climate-friendly technologies through the tax code, program rebates, and implicitly through technology-specific mandates (e.g., renewable portfolio standards) also encounters this information problem. These subsidies typically focus on a type of technology as opposed to its carbon emission characteristics. For example, a megawatt-hour of solar power receives credits that have been worth ten times as much as megawatt-hour of wind power in the Commonwealth of Massachusetts' renewable portfolio standard. From the standpoint of the global climate and greenhouse gas emissions, it is not obvious why society benefits from paying ten times more for one kind of zero-carbon electricity than another kind of zero-carbon electricity.

Replacing Less Efficient Regulations and Subsidies

What passes for climate change policy today is a patchwork of instruments – subsidies, regulatory mandates, and information programs – that were not initially designed with climate change in mind. These policies represent short-term, stopgap measures to make some progress on climate, but cannot be relied upon to deliver on the ambitious long-term goals agreed to by world leaders at the 2015 Paris climate conference, the long-term goals agreed to by G7 heads of state, or the goals advanced by various environmental stakeholders. This complicated mix of policies is simultaneously overlapping and redundant in some industries and on some sources of emissions, while failing to affect the emissions of other categories of emissions altogether. Multiple regulations on some sources and no regulation on others has significant, adverse environmental impacts (the unregulated emissions will become larger shares of U.S. emissions) and economic costs (the difference between the effective carbon price on regulated emissions and the implicit zero price on unregulated emissions will continue to grow, reflecting declining bang for the buck).

What's more, the status quo provides much weaker incentives for innovation than an explicit carbon price. Given the need for innovation to deliver the next generation of low-carbon technologies in order to achieve long-term climate goals, governments should pursue policies that drive both deployment in existing climate-friendly technologies and research and development in new technologies.

The failure of current policies to generate revenues – although they do create and transfer substantial economic value – further undermines innovation. Some of the revenue generated through a carbon tax could support investment in research and development. A much larger fraction of the revenues could be directed to businesses and individuals to address concerns about the distributional impacts of raising energy prices under climate policy. Under the status quo framework, energy and climate policies increase the price of energy and the price of energy-consuming durables (cars, appliances, etc.) without transferring resources to low-income households to adjust to these costs or they subsidize renewable and efficiency technologies that disproportionately benefit the well-off.

For those concerned about competitiveness

pressures from foreign firms, the status quo does not provide any mechanism for mitigating these pressures. In fact, it increases the price of energy and the costs of energy-consuming equipment for U.S. manufacturers. The academic literature suggests that these competitiveness pressures are modest economic phenomena – other factors, such as trade policy, exchange rates, and automation have a more substantial impact than energy prices on competitiveness. Nonetheless, the political interest in policies to address adverse competitiveness impacts can only be met through new legislation.

Finally, conservatives also are critical of the energy policy status quo, if for different reasons than progressives and environmentalists. Without an alternative, however, they can't do much to change it. Blocking new climate change measures, like a carbon tax, simply means that today's inefficient jumble of sectoral policies– under the Clean Air Act, the Energy Policy Act, and other statutes – will continue. Because these policies aren't as cost-effective as an economy-wide carbon tax, doing nothing essentially means higher energy costs with fewer environmental benefits. What's more, today's regulations are far more prescriptive and intrusive than a tax would be. A serious consideration of what the policy landscape will look like in the absence of new climate legislation suggests that all sides of this issue could secure a compromise that creates a win for all involved.

Streamlining Multiple, Overlapping Policy Instruments

Replacing today's complicated jumble of overlapping policies with an economy-wide carbon tax would have many benefits. First, businesses would find it much simpler to comply with a single, transparent, and predictable tax policy. The regulatory status quo imposes heavy administrative burdens and costs on businesses, deterring innovation and market entry. The opaque nature of incentives and mandates – as well as the appearance of political connections associated with technology-specific policies – have a chilling effect on entrepreneurs who could develop novel technologies, processes, practices, and other ideas that could mitigate climate change risks.

> *The tradability of tax credits could be limited such that the tax credits could be traded only to firms with explicit carbon tax liabilities.*

Second, a carbon tax – with distributionally-fair tax reform – would be more progressive than the current approach to energy and climate policy. Subsidies to families for installing solar panels, purchasing hybrid and electric vehicles, and making home-related energy efficiency investments disproportionately benefit the wealthy. For example, recent research by University of California at Berkeley economists find that households in the top income quintile have received about 60 percent of clean energy federal income tax credits since 2006, while the bottom three quintiles have received only about 10 percent of these credits.[14] A University of California at San Diego economist has shown that fuel economy standards – because of the long-term impacts on used car markets – are also regressive, imposing greater losses in personal welfare for low-income households than for high-income households.[15] Of course, any policy that raises energy prices – cap-and-trade, renewable portfolio standards, biofuel

and low-carbon fuel mandates, etc. – are also likely to be regressive, unless they can generate revenues that are returned to the economy in a way to address the impacts on low-income households.

Third, some of today's energy and climate policies yield unintended, adverse impacts. For example, generous subsidies for electric vehicles in Georgia have encouraged people to buy more electric vehicles. That sounds like a good thing from a climate protection point of view. But those vehicles need power, and most of it in the Southeast United States is supplied by coal-burning plants. So the net effect of Georgia's subsidies is to make its air cleaner in exchange for more regionally-dispersed air pollution and coal-based electricity-sector carbon dioxide emissions.[16] In short, pushing aggressively for electric vehicles in regions with coal-intensive power systems – and no carbon or renewable policies – can make the environment worse. In addition, some subsidies simply transfer resources to households and businesses that were going to undertake the desired activity already. Under the Recovery Act, states implemented a "cash for appliances" program, quite similar to utility-sponsored rebate programs for EnergyStar-rated appliances. As many as 90 percent of all rebates claimed under these programs were by households that would have purchased an EnergyStar-rated appliance even in the absence of the rebate program.[17] Indeed, economic modeling analyses show that a less-than-optimal mix of climate policies can perversely result in greater emissions and greater costs.[18]

Finally, a carbon tax is much more transparent to citizens than the existing welter of regulations and subsidies. A carbon tax creates a clear, level playing field. Every source of carbon pollution pays the same amount per ton of emissions. Every zero-carbon technology would enjoy the same economic incentive in a market with a carbon tax. The carbon tax lets market competition pick the winners: businesses, ideas, thought-leaders, and technologies that can contribute to lower emissions. Such transparency builds confidence among citizens that their government is not playing favorites under pressure from special interests.

Regulatory Preemption

Designing a carbon tax to substitute for existing regulations and subsidies is politically fraught. It is unlikely that the businesses in the regulated community or many Republicans would support a carbon tax within a broader tax reform package without some form of regulatory relief. The environmental community may have reservations, however, about giving up regulatory authority over greenhouse gas emissions for the carbon tax.

Consider three options for how to promote regulatory streamlining. First, there could be a straight trade of the carbon tax for Clean Air Act regulatory authority, other related regulatory authorities, related subsidies in the tax code, and possibly preemption of state policies. The simpler the climate policy landscape becomes, the more cost-effective and stronger the signals for innovation will be. The extent to which the reform can advance this regulatory and policy streamlining may depend on the pushback from vested interests.

Second, the existing regulations could remain but the relevant statutory authorities would be revised such that these regulations could not be revised and made more stringent in the future. Thus, as the carbon price increases over time, the existing regulations would likely no longer serve as the binding constraint on covered

businesses. Maintaining the existing suite of policies would address the environmental community concern that there could be backsliding of environmental performance under such a swap.

Third, there could be a formalized process of retrospective review of existing regulations accounting for the carbon tax. If an existing regulation passes a benefit-cost test under retrospective review, then it could remain. If not, then it would be eliminated. This could build on a bipartisan approach to retrospective review dating back to the Carter Administration and recent efforts by the Obama Administration to institutionalize retrospective review.[19]

Generating New Revenues for Tax Reform

The U.S. government taxes both business profits and the labor income of workers. But it doesn't tax the carbon pollution that is a byproduct of business operations. In short, society taxes the fruits of labor and the returns to capital— and hence discourages labor supply and investment — but not pollution. Labor and capital are overtaxed while carbon pollution is undertaxed. Smart tax reform would lower the taxes on the socially beneficial factors of production and raise taxes on the adverse byproducts of production.

A tax swap – for example, through a revenue-neutral carbon tax and suite of income tax cuts – can address economic efficiency and distributional objectives. Some recent research shows that a carbon tax coupled with a well-targeted reform of the tax code could result in net economic growth relative to no tax swap – and this is even before the pro-growth benefits of streamlining the regulatory framework are taken into account.[20] Other research shows how a carbon tax with well-designed refunds for families could be a progressive tax reform – leaving households at the bottom of the income distribution whole and only imposing costs on the top of the income distribution.[21] It is likely that any politically successful tax reform will strike a balance between efficiency gains and a "fair" distribution, and a carbon tax can serve as a substantial revenue source to enable this balance. The reform should strive to make the tax code more competitive while also ensuring that the needs of those potentially most vulnerable under a carbon tax policy – low-income households as well as those living in communities reliant on coal production – are addressed through targeted tax relief and/or assistance.

> *The American Recovery and Reinvestment Act of 2009 offers a cautionary lesson in failing to make tax relief palpable to citizens.*

The $100 billion to $200 billion in annual revenues from an economy-wide carbon tax could play an important role in making fiscal and tax reform add up. Carbon tax revenues would likely exceed, on an annual basis, the budget sequestration that called for blunt, politically unpopular cuts to U.S. domestic and defense spending. It is on par with the revenues that would be generated by eliminating the politically popular if economically inefficient home mortgage interest deduction in the U.S. tax code. It could finance a 2 percent payroll tax reduction (and then some), such as workers enjoyed in 2011 and 2012. These revenues could also help reduce significantly the deficit, which effectively translates into lower future taxes.

The experience with a carbon tax in other

jurisdictions holds positive lessons about the prospects of a tax swap rather than cap-and-trade programs. The province of British Columbia implemented a carbon tax in 2008 that is now C$30/tCO2 on all fossil fuels. The government coupled reductions in individual and corporate tax rates and provided a low-income household benefit that reflected a full recycling of carbon tax revenues to the economy.[22] Likewise, Sweden implemented a carbon tax in 1991 as a part of a tax reform package that lowered high income tax rates.[23] In contrast, cap-and-trade programs that give away allowances for free do not generate revenues to finance income tax cuts. Moreover, the experience with state-level cap-and-trade programs in California and the northeast states suggests that most revenues finance energy efficiency and clean energy investments, not lower state income tax rates.

Leveraging Greater International Cooperation

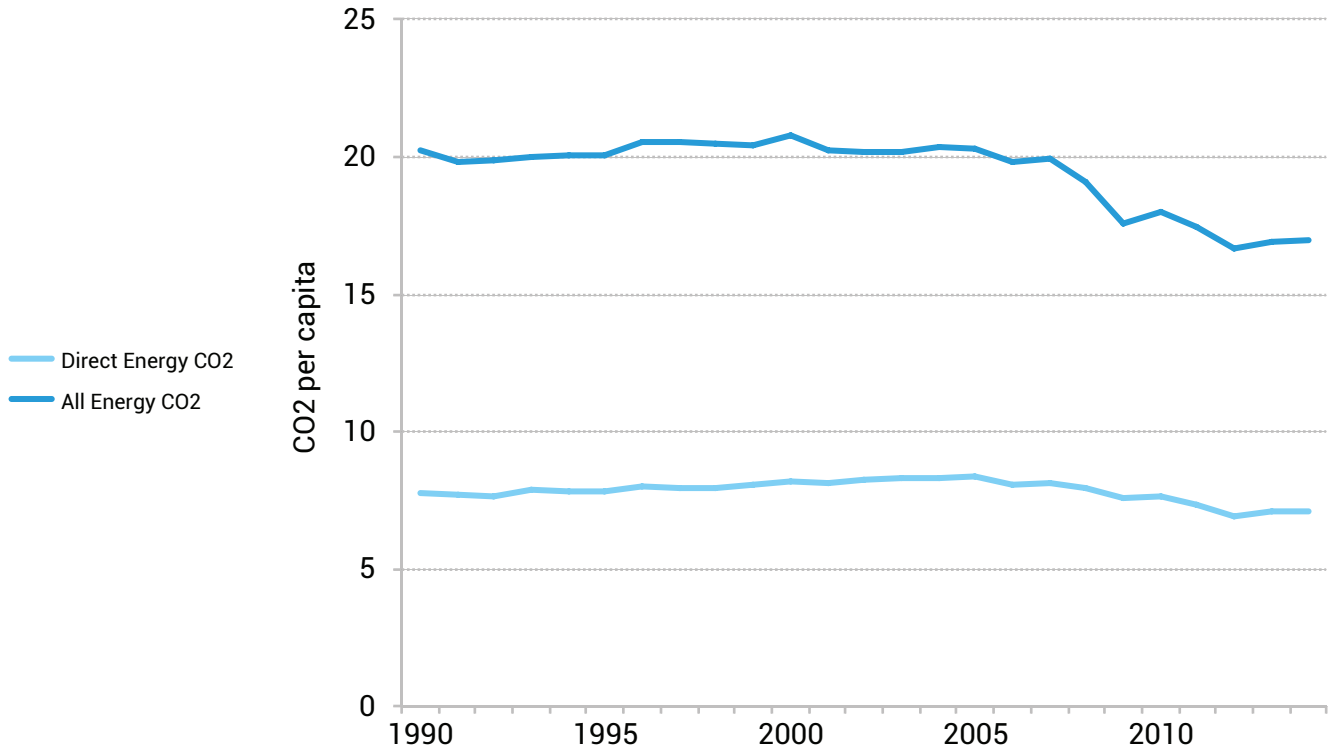
U.S. efforts to reduce carbon pollution are a critical part of the global effort to combat climate change. In December 2015, the international community agreed to a new multilateral climate policy framework in Paris. The Paris agreement was unprecedented: nearly every country in the world pledged to reduce its greenhouse gas emissions and subject these pledges to policy surveillance under a transparency regime. In addition, the international community agreed to a "global stock-taking" every five years and a regular, periodic review and updating of national pledges.

In recent years, U.S. action on climate change has had a positive impact on the negotiations and leveraged additional actions by others. (And periods of U.S. inaction have had a chilling effect on the climate talks.) For example, the U.S. government received a strong positive response to the proposal and finalization of the Clean Power Plan. This strong reception, however, highlights the potential risks internationally if the courts throw out some or all of the Clean Power Plan. The cooperation on pledged goals has also translated into bilateral cooperation with China. In 2014, the U.S. and China announced jointly their pledges for the Paris Conference, which they followed up in 2015 with joint announcements on the Clean Power Plan and China's plan to go nationwide with carbon dioxide cap-and-trade.

An economy-wide carbon tax would clearly signal the seriousness with which the United States takes climate change. Moreover, it would establish a clear metric by which it could compare effort with other countries. Some scholars have emphasized that an explicit carbon price could serve as an important focal point for international coordination, and its transparency contrasts with the challenges of observing, measuring, and/or estimating emission mitigation efforts under quantity-based targets.

The updating of the domestic carbon tax described above could be scheduled to coincide with the results of the global stock-taking and timed to adjust in line with the updating of or submission of new pledges under the Paris framework. As the United States learns how other countries are faring in implementing their pledged goals, and as the international community assesses the need for more ambitious actions, the U.S. can adjust its carbon tax accordingly. Given the significant challenge of using the current patchwork approach to ramp up U.S. mitigation ambition much beyond the current U.S. pledge to lower emissions 26 to 28 percent below 2005 levels by 2025, a carbon

FIGURE 4: Carbon emissions per capita from direct energy and total energy consumption



Source: Energy Information Administration State Energy Data System

tax would seriously enhance the credibility of the U.S. in future negotiations over its post-2025 pledges. For that matter, given some disagreement among scholars whether the current suite of policies is sufficient for the U.S. to achieve its 2025 pledge, a carbon tax may be pivotal in ensuring attainment of this initial U.S. milepost under the Paris agreement.

Changing Energy System Sets Foundation for Carbon Pricing

In the 25 years of debate over climate change policy – and implementation of policies with indirect impacts on greenhouse gas emissions – the U.S. energy system has evolved considerably. Around 1990, coal's share of power generation exceeded 52 percent, while natural gas represented about 12 percent of the power market. Wind and solar power were about 1/10 of 1 percent of power generation. In 2015, coal's share had declined 19 percentage points to 33 percent, with natural gas having a nearly identical market share (32.6 percent), and wind and solar power now providing more than 5 percent of U.S. electricity. Given that a coal-fired power plant emits about twice as much carbon dioxide as a natural gas plant to produce a kilowatt-hour of electricity, the shift from coal to natural gas and renewable sources of power has significantly reduced the U.S. electricity sector's carbon intensity.

Beyond the composition of power, the demand for power has also changed. In the 1990s, power consumption grew more than 2 percent per year. Through the first half of the 2010s, however, electricity consumption has not increased and 2015 power consumption was about 1 percent lower than 2010, despite real economic growth

of 11 percent over this time.

In the transportation sector, biofuel's share of personal transportation fuels has increased from about one-half of 1 percent in 1990 to about 10 percent today. The vast majority of the biofuels blended with motor gasoline are corn-based ethanol, and the climatic impacts of future biofuels penetration will depend on the fossil fuel intensity of their production. Demand for motor gasoline has fallen considerably from what had been expected a decade ago, reflecting higher fuel prices (even in light of the recent oil price decline), more stringent fuel economy standards, and changes in driving behavior.

The fall in energy consumption and the changing carbon intensity of energy consumption have resulted in a substantial decline in the carbon emission intensity of consumption. As Figure 4 shows, carbon dioxide emissions per capita,for all fossil fuel energy consumption have declined 17 percent over 2005-2014 to 17 tons per capita; also, emissions per capita for energy directly purchased by families and individuals – electricity, gasoline, and heating fuels (natural gas, heating oil, and LPG) – have declined 15 percent to about 7 tons per capita. As a result, a given carbon tax would have a smaller impact on household expenditures – at least 15 percent less impact – than it would have had ten years ago.

Moreover, energy prices are lower now than they have been for most of the past decade. Gasoline prices as well as residential natural gas and heating oil prices with a $25/tCO2 tax in 2017 would fall below the average prices over 2006-2015 for these fuels (see figure 5). Residential electricity prices would be slightly higher under a carbon tax than the 2006-2015 average.

HOW TO DESIGN A CARBON TAX

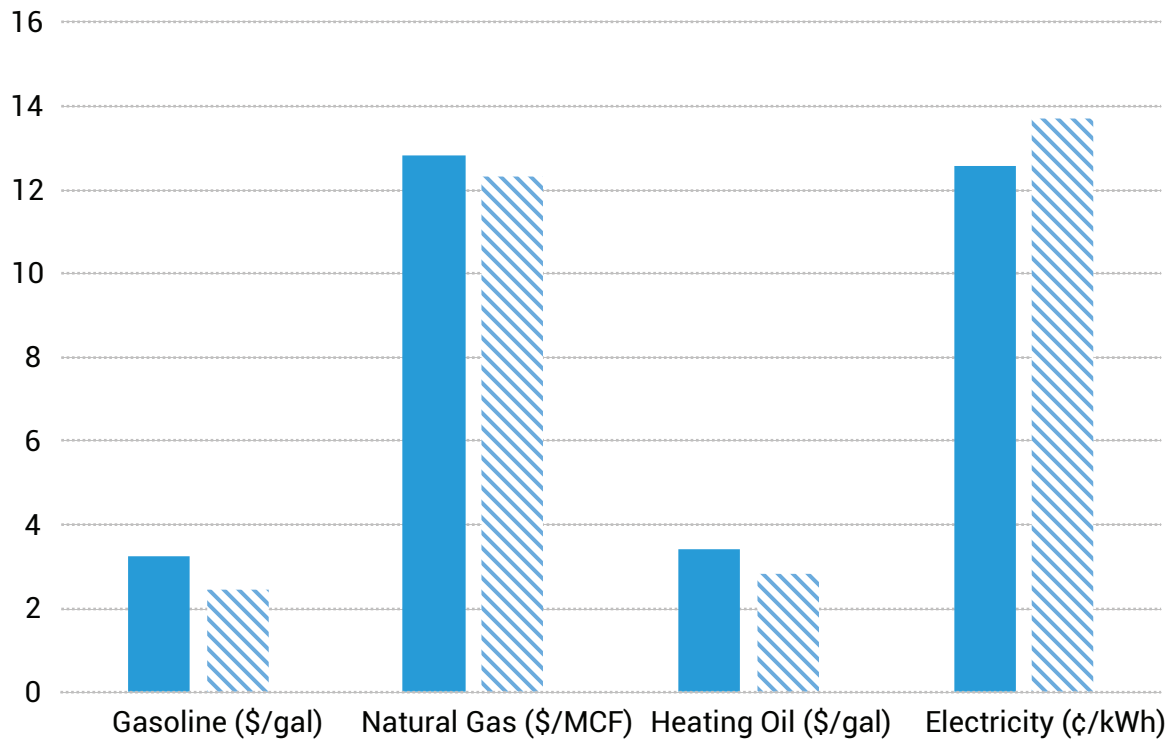
Design Principles

A well-designed carbon tax would deliver on the environmental objectives of U.S. climate policy, promote cost-effective emissions abatement, and address distributional concerns through a transparent and administratively simple approach.

Environmental Integrity: The primary intent of a carbon tax is to mitigate the risks posed by climate change. Since carbon dioxide is the primary driver of climate change, a carbon tax is a very well-targeted policy instrument. By directly focusing the policy instrument on the problem, a carbon tax influences all margins of emissions-related activity – the use of fossil fuels, investment in equipment and capital that rely on energy, and innovation. The level of the carbon tax is critical in the extent to which the policy changes behavior on these margins and thus reduces emissions.

Cost-effectiveness: A cost-effective carbon tax imposes the same price for emitting a unit of carbon dioxide emissions across all sources of emissions. Such an approach ensures the broadest possible base for the tax, which in turn allows for the largest possible revenue generation at least cost. This approach is equitable as well, because it treats all sources of pollution the same. It does not reward old, dirty facilities simply because they were built before 1970 (as is the case with a number of provisions of the Clean Air Act that have effectively exempted power plants from stringent regulations). And it does not create a complicated regulatory scheme that establishes one set of rules for "new sources" of carbon emissions and a different set of rules for "existing sources." A cost-effective tax makes it

FIGURE 5: Residential Energy Prices, 2006-2015 Average and 2017 with a $25 per ton Carbon Tax



Notes: Constructed by author using data from the Energy Information Administration's Annual Energy Outlook 2014 side case analyses and the June 2016 Short-Term Energy Outlook.

more likely that the climate policy maximizes net social benefits.

Equity: Public and political support for a carbon tax will depend heavily on both its distributional impact and how its revenues are used. A "fair" carbon tax – recognizing that different constituencies and stakeholders may hold different opinions over what is "fair" – must address the distributional consequences across income groups, across geographic regions, and upon those most vulnerable to bearing adverse impacts of the tax and associated revenue use.

Transparency: Some have argued that a carbon tax is politically vulnerable because it makes the costs of climate change policy transparent. Yet, in a democratic society, transparency is surely preferable to regulatory policies so complicated and obtuse that citizens cannot grasp their impact. A transparent price signal facilitates planning and investment by families and businesses relative to cap-and-trade, performance standards, and other policies with uncertain price impacts. A transparent cost also provides innovators and entrepreneurs with a clear target for the returns they need to make on their inventions. A carbon tax also communicates to our international partners that the United States is serious about cutting greenhouse gas emissions.

Administrative Simplicity: A tax that is simple to understand, simple to monitor and administer, and simple to enforce is one that is more likely to be complied with and drive intended behavioral responses, which, in the case of a carbon tax, is

lower carbon dioxide emissions.

Setting the Carbon Tax

A carbon tax would set the price per ton of carbon dioxide embodied in fossil fuels. A number of factors influence the setting of the tax level and how it changes over time. A carbon tax of $25 per ton is politically salient in light of current and recent state and national proposals. The State of Washington held a referendum on a $25 per ton tax that would finance a reduction in the state sales tax and rebates for lower-income households.[24]In 2010, the bipartisan Domenici-Rivlin Debt Reduction Task Force seriously considered a $23 per ton carbon tax, and it received the greatest (but not unanimous) support among revenue alternatives the task force did not select.[25] A number of carbon tax bills would set the tax rate in the vicinity of $25 per ton, including Sen. Sanders 2015 bill at $15 per ton in the first year (and surpassing $25 per ton within five years), Rep. Delaney's 2015 bill starting at $30 per ton, and Rep. Inglis's 2009 bill starting at $15 per ton in the first year (and surpassing $25 per ton within eight years).[26, 27, 28]

The tax rate that would maximize net social benefits is one in which the tax per ton of carbon dioxide is equal to the benefits of abating that ton of emissions. To illustrate this point, consider a business facing higher fuel prices as a result of a carbon tax. The appeal of the carbon tax is that it does not dictate how a business reduces emissions; it simply creates an incentive for the firm to reduce emissions. This incentive is very strong for any business that aims to maximize its profits. The business will look for ways to reduce its emissions that cost less than paying the tax (or to pay for higher-priced fuel from the supplier that has the legal responsibility of paying the tax). For example, the business may purchase a more efficient boiler, install more efficient lighting, or switch to a lower-emitting fuel if it costs less than paying the tax (directly or indirectly through fuel and power purchases). If the tax rate is set equal to the benefit of reducing emissions, then these investments cost no more than the benefit they deliver to society. The last investment a business would profitably undertake to avoid paying a carbon tax is one in which the cost of the investment is effectively the same as the social benefit. This would signal that all the investments with positive social returns had been pursued.

Published estimates of the benefits of reducing carbon dioxide emissions abound in the academic literature, and the U.S. government has issued its own estimates since 2010 to inform regulatory impact analyses for major rule-makings impacting carbon dioxide emissions.[29,30,31] The so-called "social cost of carbon" approach used by the U.S. government is currently undergoing review by a National Research Council committee. The current, primary estimate is about $45 per ton and increases about 2% annually. While the current period of relatively low fuel prices would suggest this would be an opportune time to implement a carbon tax, there would still be concerns about the short-run impacts of imposing a carbon tax at this level. Thus, it would be important to consider a transition period over which a carbon tax would phase in. For example, the carbon tax could start at a much lower level, such as $25 per ton, and grow over time at a faster rate than the growth in the social cost of carbon. After converging with the social cost of carbon, the carbon tax could then track the rate of increase in the social cost of carbon.

An alternative approach would be to identify a long-term emission target (e.g., 2050) for the country and then estimate a cost-effective price

trajectory necessary to achieve that emission target. Such an approach has informed climate policy in the United Kingdom and France. This cost-effective carbon tax trajectory could be set at a relatively low level for its first year in order to address concerns about the transition. In either case, providing information about the long-term carbon tax – such as a tax schedule over time or a transparent escalator (e.g., X% + CPI-urban measure of inflation per year) – can inform and facilitate business and household planning and investment.

Tax Base and Emissions Coverage

U.S. air quality policy has typically covered emissions at the end of the pipe: regulations of sulfur dioxide emitted from coal-fired power plant smokestacks or standards for the emissions of nitrogen oxides from the tailpipes of cars. Implementing a carbon tax at the end of pipes – hundreds of millions of cars and trucks, tens of millions of homes that heat with natural gas or heating oil, and millions of commercial businesses, factories, and power plants – would be administratively daunting. The administrative costs of this so-called "downstream" approach – for families, for businesses, and for the government – could be so great as to undermine much of the economic benefits of implementing a cost-effective policy.

The nature of fossil fuel combustion, however, permits an alternative, "upstream" approach. Instead of taxing carbon dioxide emissions, the carbon tax could be applied to the carbon content of fossil fuels. Due to the molecular properties of hydrocarbons, the complete combustion of a ton of coal, a cubic foot of natural gas, or a barrel of oil results in well-understood and precisely estimated quantities of carbon dioxide emissions.

Applying the carbon tax to the carbon content of fossil fuels can then target the bottleneck in the product cycle of fossil fuels. Under such an upstream approach, refineries and importers of petroleum products would pay a tax based on the carbon content of their gasoline, diesel fuel, or heating oil. Coal-mine operators would pay a tax reflecting the carbon content of the tons extracted at the mine mouth. Natural-gas companies would pay a tax reflecting the carbon content of the gas they transport or import via pipelines or liquefied natural gas (LNG) terminals. This carbon content of fuels scheme would enable the policy to capture about 98 percent of U.S. CO2 emissions by covering only a few thousand sources as opposed to the hundreds of millions of smokestacks, tailpipes, etc. that emit CO2 under a system targeting actual emissions.

A U.S. carbon tax would be administratively simple and straightforward to implement, since it could incorporate existing methods for fuel-supply monitoring and reporting to the government. The U.S. Energy Information Administration already tracks on a weekly, monthly, and annual basis the production, import, export, storage, and consumption of fossil fuel products. U.S. refineries and importers of petroleum products already pay a federal per barrel tax (to finance the Oil Spill Liability Trust Fund) and coal mine operators already pay a federal per-ton tax (to finance the Black Lung Disability Trust Fund), so a national carbon tax could easily piggyback on these existing tax reporting systems.

The tax base would effectively be all fossil fuels. It could be extended to some non-fossil fuel sources of emissions. For example, carbon dioxide emissions associated with cement manufacturing could be covered with a

smokestack monitoring approach (and expand the number of facilities responsible under law for reporting emissions and paying taxes by several hundred). There may be other, non-carbon greenhouse gas emissions the government could consider covering by the tax, but it is likely to become more administratively challenging going beyond fossil fuels. The question is whether the economic and environmental gains of a broader tax base justify the potentially greater administrative burden and complexity. Some non-carbon greenhouse gases may be more amenable to other types of emission mitigation policies.

Updating the Carbon Tax

Ensuring a predictable carbon tax policy plays an important role in driving technological development and deployment. Firms will make better investment decisions, families and individuals will make plans that best suit their preferences, and innovators will focus efforts on carbon-oriented inventions when they can form expectations about how a climate policy will impact the quality, variation, and prices in goods and services. A predictable climate policy can increase the likelihood that their expectations are in line with what is realized in markets. Moreover, a predictable policy is more likely to endure politically, since it is typically the surprises that motivate calls for policy reform.

This suggests two elements of carbon tax design to endure predictability. First, a carbon tax should be designed so the tax is known for many years into the future. As in past Congressional bills, this could take the form of setting the tax in the first year and then establishing an annual percentage change to the tax that applies in perpetuity, or until changed by a future Congress. This differs from cap-and-trade and command-and-control regulations in which prices are not known with certainty, and historical experience shows dramatic cap-and-trade allowance price

volatility.[32]

Second, a durable carbon tax should nonetheless be adjusted in light of new information. As the science of climate change risks improves, as we learn more about the costs of reducing greenhouse gas emissions, and as the U.S. continues to cooperate with other countries in international climate policy, there may be reasons to adjust the carbon tax. For example, if scientific research suggests that adverse climate change impacts are likely to be more severe than previously believed, then a higher carbon tax could be justified. If the costs to the economy of reducing emissions are greater than initially anticipated, then a lower carbon tax could be justified. If the rest of the global community implements ambitious emission mitigation programs, then the U.S. could reciprocate by ramping up its carbon tax.

Here's how such a gradual adjustment might work. Every five years, the EPA would publish a report on climate science and its implications for the carbon tax, the Treasury would publish a report on the economic and fiscal impacts of the carbon tax, and the State Department would publish a report on emission reduction efforts in other countries. Based on these reports, the President would submit a recommendation to Congress on how to adjust the carbon tax. This recommendation would be constrained by: (1) applying no earlier to the carbon tax schedule than five years in the future; (2) applying to only the level of the tax rate or the annual percentage change. The recommendation would take the form of a joint resolution of Congress that would not be subject to amendment (along the lines of Congressional Review Act resolutions on major rule-makings). Congress can vote the resolution up or down, or decide not to vote. In the case of a defeat of the resolution or a no vote, the status quo carbon tax rate scheme remains in place. The Presidential proposal could be synced with the timing of new rounds of mitigation pledging in the international negotiations, and thus the prospect of a Congressional vote could be used as leverage for more ambitious mitigation actions by other countries.

To facilitate the predictability of these Presidential recommendations, the law authorizing the carbon tax will also require EPA, Treasury, and State to issue principles for carbon tax adjustments and "forward guidance." These agencies would identify the data and analyses they consult in formulating their recommendation to the President, and, in periodic communications, note how they are interpreting the evolving evidence. Just as the Federal Reserve Federal Open Market Committee attempts to communicate its policy and the evidentiary basis for it so as to minimize surprises to the business and financial communities, this mechanism could allow for as-appropriate adjustments to occur that the private sector could expect as it tracks the same data as government officials.

Capturing Carbon

Some fossil fuels moving through the U.S. economy may not result in carbon dioxide emissions. For example, some hydrocarbons are used in the manufacturing of petrochemicals and the carbon is effectively embedded in the product. A downstream source of emissions could invest in technology to capture and store carbon dioxide underground. For example, the Southern Company's Kemper coal-fired power plant in Mississippi is expected to capture about two-thirds of its carbon dioxide emissions that it will then pump underground. In the former case, it would appear unfair to tax the embodied carbon in a barrel of oil that

goes into a manufactured product instead of the atmosphere. In the latter case, it would appear that an upstream carbon tax would not reward innovation in an emission-mitigation technology.

> *A downstream source of emissions could invest in technology to capture and store carbon dioxide underground.*

To address these concerns, the carbon tax could be coupled with a crediting system. For example, a firm that captures and stores CO2 through geological sequestration, thereby preventing the gas from entering the atmosphere, could claim a tax credit equal in value on a per ton basis as the carbon tax. Likewise, manufacturers who could document the quantity of carbon embodied in their products (e.g., petrochemicals) would also be able to claim a tax credit equal in value to the carbon tax. This would result in the carbon capture and storage technology enjoying the same, transparent incentives as other emission-reduction technologies. The tax credit for manufacturers of embodied carbon products would effectively offset the higher input costs of fossil fuels such that the net tax on hydrocarbons used as a material input (as opposed to energy input) in manufacturing would be zero.

The potential downside of a tax credit for these activities is that a firm would need to have sufficient tax liabilities in order to realize the economic benefit of the tax credit. Consider two options to address this risk. First, the tax credits could be tradable. Some tax law experts express concern about tradable tax credits because it adds complexity and the potential for fraud. The tradability of tax credits could be limited such that the tax credits could only be traded to firms with explicit carbon tax liabilities. While this may appear restrictive, it would likely be incorporated in contracts between manufacturers and their fuel suppliers who have the carbon tax obligation. Suppose, for example, that a fuel supplier sells natural gas for use as a feedstock to a chemical manufacturer. This company would pay the supplier a price equal to the competitive fuel price minus the carbon tax impact on that product and tradable tax credits for the product that would become embodied in the manufactured chemicals.

Alternatively, the government could provide grants equal in value to carbon tax credits to firms that don't pay enough in taxes to take advantage of the credits. This approach was employed in the context of tax credits and grants to support renewable power investment in the 2009 American Recovery and Reinvestment Act.[33] In contrast to the experience under the Recovery Act, in which the grants were a percentage of investment costs, the grants for carbon capture and storage and use as a material input in manufacturing would be equal in value to the carbon tax on a per ton basis.

Border Tax Adjustment

While stimulating the investment in low-carbon, zero-carbon, and energy-efficient technologies, the implementation of a carbon tax could adversely affect the competitiveness of energy-intensive industries. This competitiveness effect resulting from higher energy prices can result in firms relocating facilities to countries without meaningful climate change policies, thereby increasing emissions in these new locations and offsetting some of the environmental

benefits of the policy. Such "emission leakage" may actually be relatively modest, because a majority of U.S. emissions occurs in non-traded sectors, such as electricity, transportation, and residential buildings. Energy-intensive manufacturing industries that produce goods competing in international markets may face incentives to relocate and will advocate for a variety of policies to mitigate these impacts.

Additional emission leakage may occur through international energy markets – as countries with climate policies reduce their consumption of fossil fuels and drive down fuel prices, those countries without emission mitigation policies increase their fuel consumption in response to the lower prices. Since leakage undermines the environmental effectiveness of any unilateral effort to mitigate emissions, international cooperation and coordination becomes all the more important. Political concerns about competitiveness may call for a carbon border tax that effectively imposes a tax on the carbon content on goods imported into the United States. If the U.S. implemented a carbon tax and threatened to impose a border tax on imports, then it could provide some negotiating leverage in multilateral fora to secure more stringent emission reduction policies among major trading partners, and thus minimize the competitiveness impacts. Also, it is important to keep in mind that these emission leakage effects exist with any meaningful climate policy, whether through carbon tax, cap-and-trade, or status quo command-and-control authorities.

Regardless of the economic magnitudes of these impacts from existing modeling and statistical analyses, it may be important politically to design the carbon tax to counter any potential competitiveness impacts, such as through a border tax adjustment. Indeed, it may make a carbon tax more politically palatable than the status quo mix of policies, since the existing policy framework cannot authorize a border tax.

The political calculus for a border tax adjustment is likely to be influenced by the characteristics of the tax reform. A sufficiently generous reduction in, say, the corporate income tax rate financed by a carbon tax could make most manufacturers – even those with energy-intensive production processes – better off than under the status quo.

HOW TO USE THE CARBON TAX REVENUES

Returning Revenues to Families and Businesses

Criticism of a carbon tax typically focuses on the tax component – the raising of revenue and its impacts on energy prices – without a careful consideration of how the use of the revenues could lower taxes on labor and capital income. No assessment of a carbon tax is complete – on distributional, economic efficiency, or political grounds – without analysis of the return of the revenues to the economy.

The effects of a carbon tax on emission mitigation and the economy will depend in part on the amount and use of the revenues it generates. Using carbon tax revenues to finance tax reforms that improve the efficiency of the tax code could stimulate economic activity and offset some or all of the costs of cutting emissions. In addition, a relatively small percentage of the annual carbon tax revenues could also support the research and development of climate-friendly technologies, which suffer underinvestment by the private sector.

Raising energy prices could disproportionately impact low-income households, since a larger fraction of their budgets is dedicated to energy expenditures. The regressive nature of a carbon tax can be mitigated through the recycling of

revenues back to the economy. For example, British Columbia's economy-wide carbon tax program returns all revenues to the economy by cutting corporate and individual income tax rates and through a means-tested Low Income Climate Action Tax Credit. If a carbon tax is part of a broader fiscal and tax reform, the overall progressivity of the package will depend in part on the use of carbon tax revenues, but more substantially on any potential decisions regarding entitlement spending (especially means-tested Medicaid) and changes to the tax code for businesses and individuals.

> *Using carbon tax revenues to finance tax reforms that improve the efficiency of the tax code could stimulate economic activity and offset some or all of the costs of cutting emissions.*

While it is important to take into account the distributional impacts of a carbon tax – and not only by income group, but also geographically and potentially for energy-intensive industries (see more on this below on competitiveness) – the exact mix of tax cuts financed by a carbon tax will depend in large part on the nature of broader tax reform that would serve as the legislative vehicle for a carbon tax. The level and breadth of coverage of the carbon tax could be a function of revenue needs to ensure a revenue-neutral tax reform package as much as on climate change concerns. It is important to recognize that a more ambitious effort to cut personal and corporate income tax rates would likely require a more ambitious carbon tax in order to ensure revenue neutrality.

Given this premise, let me recommend one way carbon revenues could be recycled. First, the carbon tax revenues could enable a reduction in the payroll tax rate all workers pay. A 20 percent reduction in the employee's contribution payroll taxes would use approximately $100 billion of the carbon tax revenues annually, based on current payroll tax levels. Given the expected growth in carbon tax revenues over time, this 20 percent reduction in the payroll tax could be financed without any net reduction in receipts to Social Security over time. Second, a small fraction of the carbon tax could finance a coal communities transition program. For example, simply allocating 2 percent of the carbon tax revenues to this program would deliver about $30 billion in support over a ten-year window. Third, another small fraction of the revenues could be dedicated for research and development in innovative energy technologies. This would ensure that there are more low-cost ways of reducing emissions available over time, which would create greater environmental benefits and reduce the economic cost of the carbon tax. Finally, the balance of the revenues could be used to lower corporate tax rates. This could be quite substantial, especially if the carbon tax is accompanied by an elimination of energy tax expenditures.

Making the Tax Benefits Visible

Some of the public may be skeptical that a carbon tax could effectively finance lower taxes. This is not an unfounded belief, since state-level cap-and-trade programs in California and the northeast have used revenues from auction emission allowances to finance energy spending programs, not

cuts in tax rates. Indeed, some environmental groups in Washington opposed the state carbon tax referendum because the revenues would be used to cut the sales tax rate and provide low-income rebates, instead of financing clean energy programs.[34]

To make the recycling of revenues back to the economy through lower tax rates salient and credible, the government should launch the carbon tax program by mailing every household a check for $100 a month before the carbon tax starts. British Columbia's successful carbon tax began this way, and it is similar to how the 2001 Bush tax cuts were implemented with checks mailed to households. The checks would be accompanied with information explaining how a family may face lower taxes (depending on the nature of the tax reform) as the carbon tax is implemented.

> *British Columbia's successful carbon tax began this way, and it is similar to how the 2001 Bush tax cuts were implemented with checks mailed to households.*

Suppose, for example, that policymakers use a carbon tax to offset a cut in the payroll tax rate. This could be noted both in workers' paystubs and in a carbon tax dividend check they receive. The American Recovery and Reinvestment Act of 2009 offers a cautionary lesson in failing to make tax relief palpable to citizens. Thanks to this major stimulus bill, 95 percent of working Americans received a tax cut – in the form of changes in withholding rates on regular paychecks – but less than 10 percent indicated that they knew of the tax reductions when surveyed in a 2010 *New York Times/CBS News* poll.[35]

Moreover, to the extent that a carbon tax increases the price level, it would result in an adjustment in social security benefits through cost-of-living adjustments. In announcing annual inflation adjustments, the government could explain how carbon tax revenues enable an increase. In this way, the government would offset the higher energy costs that would otherwise fall on elderly Americans living on fixed incomes.

CONCLUSION

The failure to mobilize sufficient effort to combat climate change reflects the difficult political economy that characterizes the problem.[36] The task of reducing emissions yields a global public good that no individual, firm, or country has a strong incentive to produce unilaterally; imposes near-term costs on businesses and families with benefits spread out over decades and centuries; risks raising costs for domestic businesses that compete with untaxed foreign competitors; delivers uncertain returns, given uncertainties in climate science, multilateral coordination, market behavior, and technological innovation; and requires a fundamental transformation of the energy foundation of modern industrial economies. Moreover, the distribution of a climate change policy's benefits and costs varies across space and time, as well as among various political constituencies and special interests. To grossly simplify the problem, the challenge is that future, unborn generations will enjoy the benefits of climate policy while the current generation, and in particular those reaping substantial returns from a status quo that fails to address climate change, will bear the costs.

Given this description of the problem, it's not too surprising that the United States does not have a coherent, comprehensive climate change policy. How does a carbon tax address these challenges? It doesn't, but it's important to recognize that there are policy scenarios in which it doesn't have to. While this paper has focused on the motivation, design, and benefits of a carbon tax, the likely path forward for a carbon tax in the United States is likely as a part of a larger tax and fiscal reform package. Crafting a carbon tax that (a) delivers revenues to enable cutting of tax rates on families and businesses; and (b) substitutes a transparent, administratively simple, durable, and cost-effective climate policy for the complicated status quo framework can shift the economics and politics of this issue in a way that could break the decade-plus gridlock on national climate policy.

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Progressive Policy Institute
1200 New Hampshire Ave NW,
Suite 575
Washington, DC 20036

Tel 202.525.3926
Fax 202.525.3941

info@ppionline.org
progressivepolicy.org