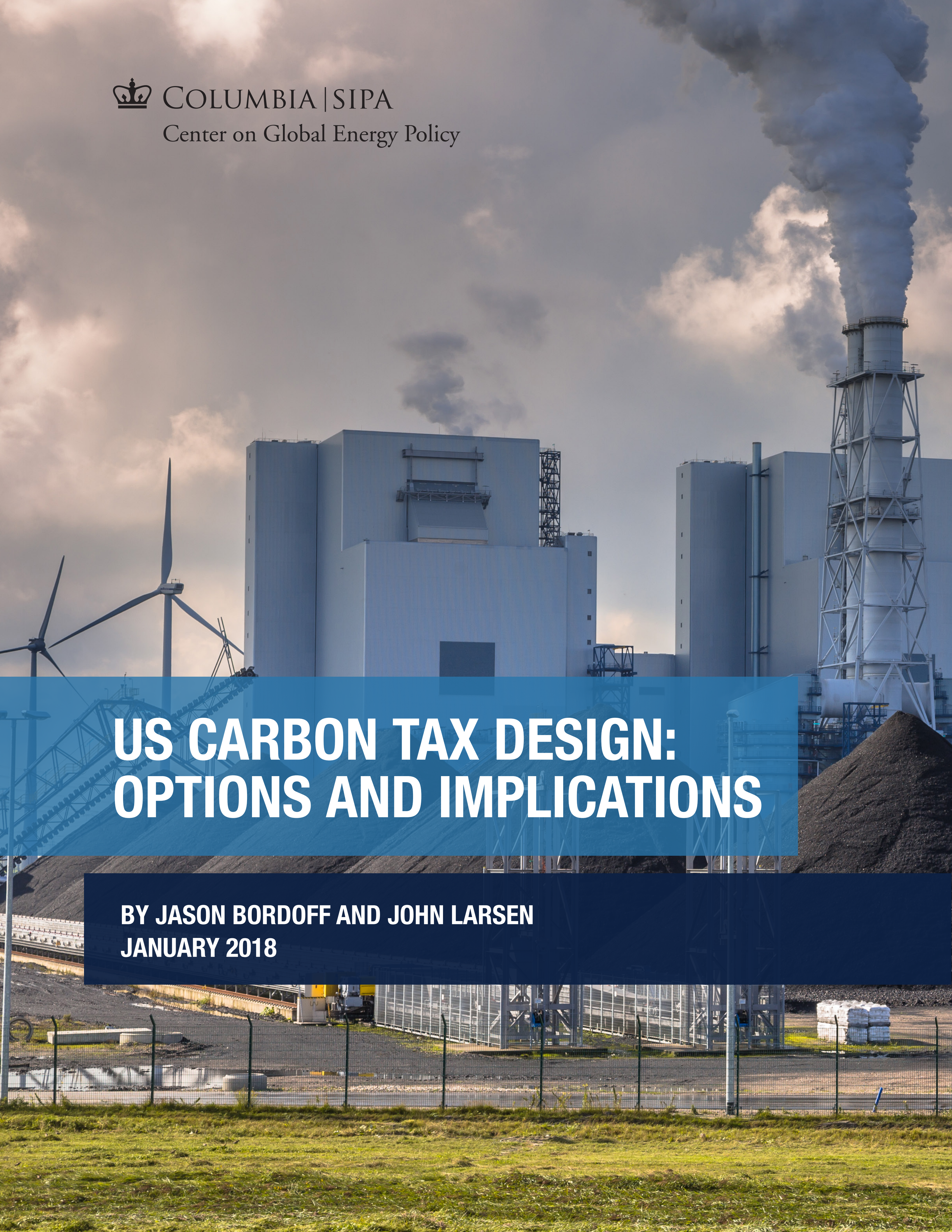

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US CARBON TAX DESIGN: OPTIONS AND IMPLICATIONS

BY JASON BORDOFF AND JOHN LARSEN
JANUARY 2018

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TABLE OF CONTENTS

PREFACE

While there seem to be no immediate prospects for a national carbon tax in the United States, there is growing interest among some policymakers, thought leaders, and "elder statesmen" across the political spectrum. If and when a legislative opening emerges in the coming years, policymakers will need to grapple with a range of important design issues that will determine the effectiveness of a carbon tax in reducing carbon emissions.

The Center on Global Energy Policy (CGEP) at the School of International and Public Affairs (SIPA) of Columbia University has initiated a major research initiative to answer key questions related to the development of a carbon tax. In considering development of a tax, policymakers and stakeholders will need to understand, among other issues:

- The design options available (e.g., a carbon tax coupled with tax reductions elsewhere; with revenue spent on R&D or other clean energy programs; with revenue rebated to households; a sector specific tax [such as electricity or transportation] versus an economy-wide tax; or some other mechanism) and
- Their respective environmental, energy market, and economic impacts, including how a carbon tax would interact with existing energy, environmental, and tax policies at the state and national levels.

CGEP plans to address these key questions through a series of reports, public events, and meetings and briefings. CGEP's initiative will bring a unique, academic, and nonpartisan voice to the issue. Research will be presented using language that is clear for all stakeholders.

This scoping paper, the first in the initiative, outlines the key design options that policymakers will need to address in the design of a carbon tax. Additional papers in this series will include:

- Interaction between a carbon tax and existing policies
- Energy market and environmental impacts of a carbon tax
- Macroeconomic effects of a carbon tax
- Distributional effects of a carbon tax
- How a carbon tax might affect international competitiveness
- Transition assistance for communities affected by a carbon tax
- Synthesis report

Papers addressing the effects of a tax on the energy sector and the environment, and a tax's macroeconomic and distributional effects, will report the results of modeling undertaken by external quantitative research teams who are examining the effects of different tax scenarios.

Other papers will be authored by members of the Columbia University community in collaboration with outside experts.

CGEP is not making specific recommendations about the enactment of a tax or its design and is not advocating for any particular policy. CGEP strongly believes in the importance of bringing together unique perspectives to address the most pressing energy issues. The purpose of academic research is to promote the competition and comparison of ideas, as well as foster debate and disagreement. We hope this initiative, including this series of papers, helps inform public discussion about implementation of a carbon tax and the trade-offs that exist in its pursuit.

EXECUTIVE SUMMARY

How does a society pay for the environmental and social costs of industrial and commercial activity? This question is front and center as nations work to address climate change across the globe. Economists broadly agree about the cost effectiveness of a market-based approach to reducing the emissions associated with climate change, with a carbon tax being one of the most popular of systems under consideration.

In the United States, opposition to any system that would address the costs of climate change—even one based on market principles—remains significant. Yet there has been a recent uptick in interest in a carbon tax, including from prominent members of both parties. The possibility of greater future legislative interest in a carbon tax means that a number of important policy design questions may need to be considered, and there has been considerable exploration of these questions to date by various research institutes and universities.

Building on this work, the Center on Global Energy Policy at Columbia University's School of International and Public Affairs is undertaking a research effort in collaboration with external partners to explore the range of issues that policymakers will need to understand, model the effects of different scenarios that policymakers may choose to consider, and produce insights that will inform the policymaking process. This Carbon Tax Design research initiative will serve as a resource for both stakeholders and policymakers through a series of papers, public events, workshops, and policymaker briefings about the key design choices and the implications of those choices in the implementation of a carbon tax.

This initial scoping paper lays out the set of issues to be addressed by identifying the key design choices to be made in implementing a carbon tax:

- **Scope and Emissions Coverage:** Determining which sectors and which gases are taxed and what amount of total US greenhouse gas (GHG) emissions would be covered by a tax is critical. The broader the scope, the more efficient and environmentally effective the tax, as it increases the number of GHG abatement opportunities.
- **Point of Taxation:** Carbon emissions can be taxed upstream, at the point of fuel production, downstream at the point of fuel consumption, or at points in between. An upstream approach taxes emissions from end-use sectors without having to track emissions and tax payments from millions of downstream emitters such as vehicles, factories, and buildings. A downstream approach taxes tons of CO_2 that enter the atmosphere at the point where they are emitted. Policymakers must weigh the desired scope of the tax, existing emissions and/or fuel reporting infrastructure, administrative efficiency, and politics in determining where to tax.
- **Tax Rate:** The combination of the tax rate and the total coverage of the program (as determined by the scope and point of taxation) is what ultimately determines revenue collection, environmental effectiveness, and energy market outcomes. However, there is no

guarantee that a carbon tax set at a particular price will guarantee the achievement of a particular emission reduction goal.

- **Revenue Allocation Options:** Large new sources of federal government revenue are not found frequently, and if a carbon tax is seriously considered, there will be an endless number of stakeholders arguing in favor of their preferred approach. This paper discusses six options for what to do with revenues achieved through a carbon tax, although more than one approach could be chosen. The limiting factor is ultimately the net revenue derived from the tax.
- **Interaction between Carbon Taxes and Other Energy/Environmental Policies:** Any carbon tax, especially one with an economy-wide scope, will interact with a range of existing energy and environmental policies. Federal regulations, federal research and development on energy technologies, federal subsidies for clean energy, federal royalty, bonus, lease, and tax revenue from fossil fuel production, state regulations and carbon pricing systems, and state revenue from carbon pricing systems should be taken into account in the design of any tax.
- **International Trade Effects and Distributional Considerations:** A carbon tax would affect US trade as well as the companies that engage in trade. Policymakers need to discuss how to reduce the risks to US exports that would be subject to a tax when competing against foreign firms not subject to a tax. Work is also needed to understand how a carbon tax would affect households at different income levels, affect different sectors of the economy, and different parts of the country.

INTRODUCTION

In 1920 British economist Arthur Cecil Pigou published *The Economics of Welfare,* in which he argued that tax policy should be used to address those environmental or social costs of industrial or commercial activity that are not borne by the individuals or companies responsible, but instead by society as a whole.[1] Pigouvian taxes have since been used to address a range of "externalities," from the public health costs of tobacco and alcohol consumption to the impact of chlorofluorocarbons on the ozone layer. In 1973 economists and others in the academic community began advocating for a Pigouvian tax to internalize the costs that carbon dioxide and other greenhouse gas (GHG) emissions impose on human health and the economy by changing the earth's climate.[2] Over the next four decades, the idea has gained traction among economists but received relatively little attention from policymakers.

The Clinton Administration proposed a Pigouvian tax on energy consumption, but not GHG emissions, in 1993—though by excluding wind, solar, and geothermal, its proposal resembled a carbon tax.[3] Clinton's "BTU Tax" legislation passed the House but failed in the Senate.[4] Some moderate House Democrats blamed their subsequent loss in the 1994 midterm elections on their BTU tax vote,[5] and the experience left many politicians allergic to energy or environmental taxes of any kind.[6] As concern about climate change grew in the late 1990s and 2000s, elected officials increasingly looked to cap-and-trade systems, which had been pioneered by the President George H. W. Bush Administration and used successfully by the EPA to reduce other pollutants, as the preferred strategy for reducing GHG emissions.[7]

There is broad agreement among economists about the benefits of market based instruments as a cost effective strategy for reducing GHG emissions.[8] There is much disagreement, however, about the choice of instrument, with some economists preferring cap-and-trade[9] and others a carbon tax.[10] In theory, cap-and-trade offers certainty about the level of emissions abatement but uncertainty about cost, while a carbon tax offers certainty about cost but uncertainty about how much emission reductions a given carbon price will achieve.[11] In practice, there are many hybrid approaches and other differences.[12]

During the last two decades, a number of cap-and-trade bills have been introduced in the United States Congress, culminating in the American Clean Energy and Security Act, which passed the House in 2009.[13] Yet that legislation failed in the Senate, and once again a number of moderate House Democrats lost their seats in the subsequent midterm election, as Democrats lost their House majority.[14]

Following the defeat of legislative action, and in some cases as legally required by current statutes following the Environmental Protection Agency's finding that GHG emissions threaten public health,[15] President Obama sought to reduce GHG emissions using existing executive authorities under the Clean Air Act, the Energy Independence and Security Act, and other statutes.[16] Some of the more significant regulations promulgated by President Obama included carbon dioxide emission standards for new and existing power plants,[17] methane emission (a highly potent GHG) standards for oil and gas production,[18] and fuel economy standards for both cars and trucks.[19]

At the state level, policymakers have also shied away from a carbon tax, opting for other policies to accelerate clean energy and reduce GHG emissions. Some have opted for a cap-and-trade mechanism to price GHG emissions, while others have adopted alternative polices using regulatory approaches and/or mandates. California, for example, adopted an economy-wide cap-and-trade program with the passage of Assembly Bill 32, the California Global Warming Solutions Act of 2006,[20] and also passed various additional regulatory mandates, such as a renewable portfolio standard (RPS) and a low-carbon fuel standard.[21] Nine states in New England and the mid-Atlantic participate in the Regional Greenhouse Gas Initiative (RGGI), a cap-and-trade program covering the power sector.[22] Twenty-nine states have RPS mandates,[23] and 26 states have energy efficiency resource standards (EERS).[24]

Outside the United States, a carbon tax has gained some momentum as a cost-effective tool to address climate change. British Columbia, for example, adopted a carbon tax nearly a decade ago and is planning to expand its scope of coverage and raise the level.[25] Chile's carbon tax comes into effect this year.[26] Still other countries have put a price on carbon through a cap-and-trade system. Most notably, China's cap-and-trade system, which has been tested in various provinces for several years, will expand to nationwide coverage in 2018.[27]

Over the past few years, the idea of a carbon tax in the United States has begun to attract attention outside the academic community and from across the political spectrum. In 2012 former South Carolina representative Bob Inglis launched the Energy and Enterprise Initiative, which presented a carbon tax as a conservative strategy for addressing climate change.[28]

In 2014 former Republican Treasury secretary Hank Paulson argued for a carbon tax in *The New York Times.*[29] In 2015 the Niskanen Center, a libertarian think tank, released a study making the "conservative case for a carbon tax."[30] Republican elder statesmen George Shultz and James Baker III did the same in a *Wall Street Journal* op-ed in February 2017.[31] A few months later in May, a group of conservative business leaders and former government officials launched the Alliance for Market Solutions, which also advocates a carbon tax.[32] And in June 2017 the Climate Leadership Council announced a group of founding members, including prominent businesses and senior Republicans, to support a carbon tax.[33]

On the other side of the aisle, Senator Bernie Sanders made a carbon tax a centerpiece of his 2016 presidential campaign.[34] Secretary Hillary Clinton explored a carbon tax before opting for a plan that did not require congressional legislation.[35] Reflecting these two views, the 2016 Democratic Party platform stated that "carbon dioxide, methane, and other greenhouse gases should be priced to reflect their negative externalities," but that "climate change is too important to wait for climate deniers and defeatists in Congress to start listening to science."[36] Several Democratic senators—including Sheldon Whitehouse, Brian Schatz, Bernie Sanders, and Barbara Boxer—have promoted a carbon tax in prior sessions of Congress, and in July 2017 Senators Whitehouse and Schatz reintroduced a bill establishing a carbon tax.[37]

As momentum builds for comprehensive tax reform, interest in a carbon tax has also grown from some who are motivated less by solving the problem of climate change than they are by finding sources of government revenue that impose less economic distortion than current taxes on capital and labor.[38] Both parties agree, for example, that corporate tax reform is needed, but there is no agreement on how, or even whether, to pay for a lower corporate tax rate. The tax cut just passed by Congress lowers the corporate tax rate, among other provisions, but without offsetting revenue the Joint Committee on Taxation estimated that the law will cost more than $1 trillion over the next decade.[39]

While political opposition to a carbon tax remains significant, the recent uptick in interest and greater possibility of future legislative consideration have raised a number of important policy design questions. What level of a carbon tax would be required to achieve environmental and/or revenue goals? What would be the impacts on energy prices and energy production? How would these impacts vary by household income and geography? What are the economic and distributional implications of different revenue uses? How would a carbon tax interact with existing energy, environmental, and tax policies at the federal, state, and local levels?

There has been considerable exploration of these questions to date by various research institutes and universities.[40] Building on this work, the Center on Global Energy Policy at Columbia University's School of International and Public Affairs has partnered with the Rhodium Group, with contributions from scholars at various think tanks and universities, to explore the range of issues that policymakers will need to understand, model the effects of different scenarios that policymakers may choose to consider, produce insights that will inform the policymaking process, and serve as a resource for both stakeholders and policymakers. The outcome of this Carbon Tax Design research initiative will be a series of papers, public events, workshops, and policymaker briefings about the key design choices and the implications of those choices in the implementation of a carbon tax.

BACKGROUND AND CONTEXT

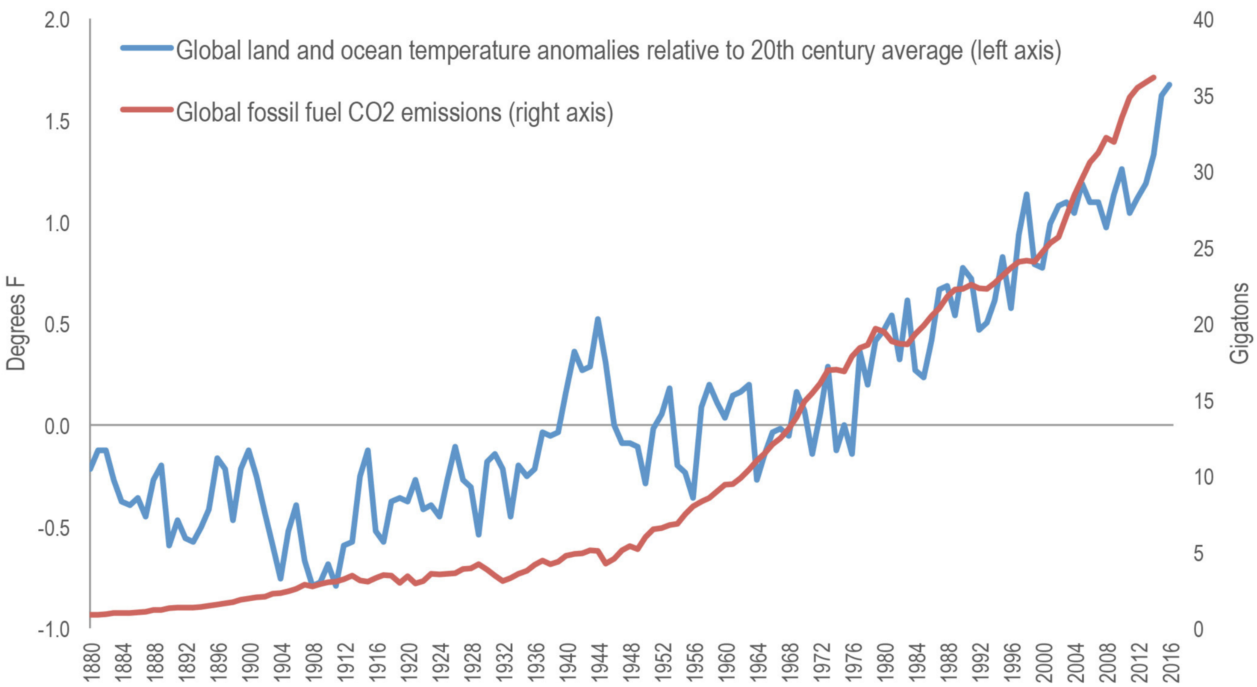
Since the late nineteenth century, the earth's average surface air temperature has increased by about two degrees Fahrenheit (figure 1).[41] While the climate is naturally variable, these increases transcend traditional annual, decadal, or even multidecadal variability.[42] Since Guy Stewart Callendar's pioneering work in the 1930s,[43] scientists have become increasingly convinced that human activity is affecting the earth's climate and that GHG emissions are the principal cause of the observed warming over the past hundred years.

Globally, carbon dioxide (CO_2) emissions from fossil fuel combustion and industrial processes are the largest source of GHG emissions, accounting for 65 percent of GHG emissions in 2010.[44] CO_2 is also emitted when plants decompose, and absorbed from the atmosphere when they grow. Accordingly, changes in land use and forestry are a major net contributor to global GHG emissions, accounting for 11 percent of the total in 2010.[45] Methane (CH4) emissions from oil and gas production, coal mines, agriculture, waste, and other sources accounted for 16 percent of global GHG emissions.[46] Nitrous oxide (N20) emissions, primarily from agricultural activity, accounted for another 6 percent,[47] with the remaining GHG emissions comprising of hydrofluorocarbons (HFCs) and other "f-gases."[48] Between 1970 and 2012, annual global GHG emissions nearly doubled[49] (figure 1). Global concentrations of CO_2 now seasonally exceed 400 parts per million (ppm),[50] far above anything experienced in the last 800,000 years[51] and likely higher than any time over the past 3 million years.[52]

The Economic Costs of Climate Change

Changes in global temperatures due to human activity impose costs on human and economic systems, costs that are not borne directly by the companies and individuals that undertake the activity. Moreover, given that CO_2 stays in the atmosphere for decades, the cost of today's emissions are not borne exclusively by the current generation.[53] In their 2015 book *The American Climate Prospectus,* Houser et al. estimated that continuation of past emissions trends will likely cost the United States between 1.2 percent and 5.4 percent of GDP by late in this century based on just six impact categories (energy, mortality, labor productivity, coastal property, agricultural production, and crime), relative to a world without a changing climate.[54] Those impacts, however, are unevenly distributed geographically, with some states suffering more than others. In Florida, for example, a continuation of current emissions trends will likely cost the state between 10.1 percent and 24 percent of its economic output.[55] Other methodologies find even larger economic damages.[56]

Figure 1. *Global temperature change and fossil fuel CO_2 emissions*



Source: NOAA and CDIAC.

The economic costs of climate change are even larger outside the United States, regardless of the methodology used. For example, at the upper end of the range, Burke, Hsiang, and Miguel find that a continuation of current emissions trends could reduce average global incomes by 23 percent by the end of the century, relative to a world without a changing climate.[57] Moreover, the poorest countries are most at risk. In their central scenario, Burke, Hsiang, and Miguel find that average income in the poorest 40 percent of countries declines by 75 percent by 2100 under a continuation of past emissions trends, relative to a world without climate change.[58] The disproportionate distribution of the economic effects of climate change has global implications, through trade, migration, conflict, and agricultural disruption, and creates additional risks for the United States.

Global and US Policy Progress to Date

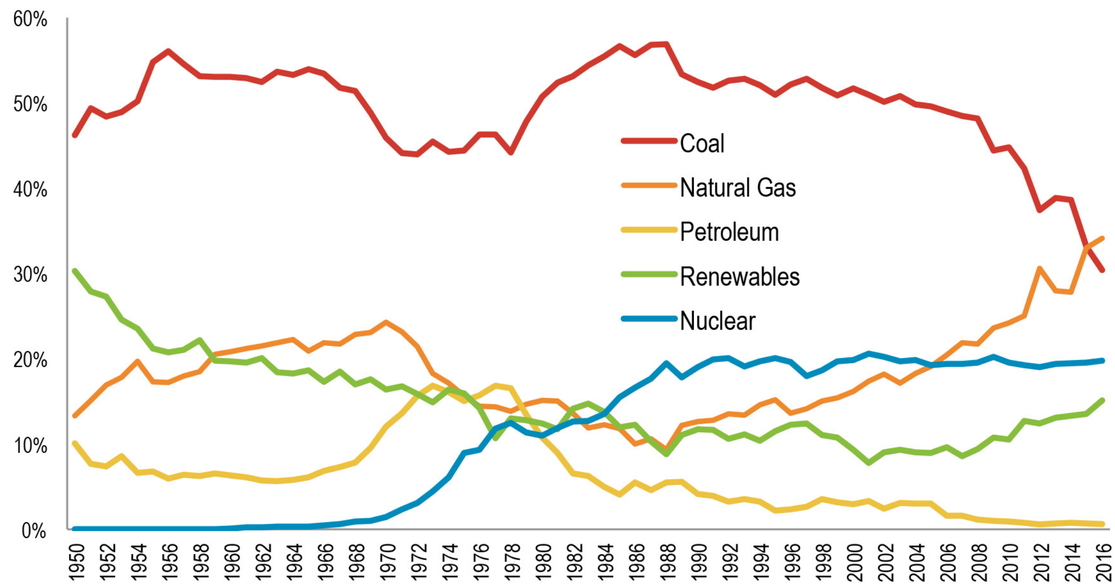
The global effort to address climate change began in earnest with the negotiation of the United Nations Framework Convention on Climate Change (UNFCCC) at the Rio Earth Summit in 1992. Ratified by 196 countries plus the European Union, the UNFCCC has provided the foundation for all subsequent international climate change negotiations.[59] This includes the Kyoto Protocol, signed in 1997, which included the first national commitments to reduce GHG.[60] However, only developed countries made commitments in the Kyoto Protocol to reduce emissions. The Protocol was never ratified by the United States. Earlier that year, the Senate voted 95–0 for the "Byrd-Hagel Resolution," insisting that the United States only participate in international climate agreements that included emission reduction commitments from developed and developing countries alike.[61]

After President Obama was elected in 2008, the United States led an international effort to develop a new architecture that included emission reduction pledges from both developed and developing countries. In the first iteration of this—the Copenhagen Accord negotiated in 2009—the United States pledged to reduce GHG emissions "in the range of" 17 percent below 2005 levels by 2020.[62] The Accord was not accepted by all parties to the UNFCCC, but 114 countries agreed to it, and more than 80 countries pledged some form of emission reduction.[63] In December 2015 all parties to the UNFCCC joined the United States in negotiating the landmark Paris Agreement, which includes emissions reduction commitments from 191 countries, accounting for 98.9 percent of global GHG emissions.[64] As part of the agreement, the United States committed to reducing emissions 26–28 percent below 2005 levels by 2025.[65] While national emission reduction commitments extended only to 2025 or 2030, the Paris Agreement included a goal of limiting global temperature increases to "well below" two degrees Celsius above preindustrial levels.[66]

Over the past eight years, the United States has made important progress toward meeting these commitments. Energy related CO_2 emissions in 2016 were 14 percent below 2005 levels, the lowest point in nearly 25 years.[67] Economy-wide GHG emissions were 11.5 percent below 2005 levels in 2015, and likely declined further in 2016.[68] A range of market and policy factors are responsible for this decline. After years of consistent growth, US electricity demand has been flat since 2007.[69] While the Great Recession played a significant role in flattening demand for electricity, new building codes, appliance standards, and federal, state, and local energy efficiency incentive programs have helped keep electricity demand flat while the economy has recovered.[70] Cars and trucks have become more efficient as well, driven by a combination of relatively high gasoline and diesel prices between 2011 and 2014 and new federal fuel economy and GHG emission standards.[71] The most dramatic changes have been in the electric power sector, where coal's market share has fallen from an average of 51 percent between 1949 and 2008 to just 30 percent in 2016 (figure 2).[72] A recent report from the Center on Global Energy Policy found that half of this decline was due to the shale boom and resulting decrease in the price of natural gas, which eroded coal's competitiveness in US electricity markets.[73] The remainder is primarily due to growth in renewable energy generation, particularly wind and solar.[74] Driven in large part by federal tax incentives and state renewable portfolio standards, US wind power generation increased more than threefold between 2008 and 2016.[75] Solar generation expanded more than fortyfold over the same period.[76]

Figure 2. *US power generation by fuel*

Percent of generation



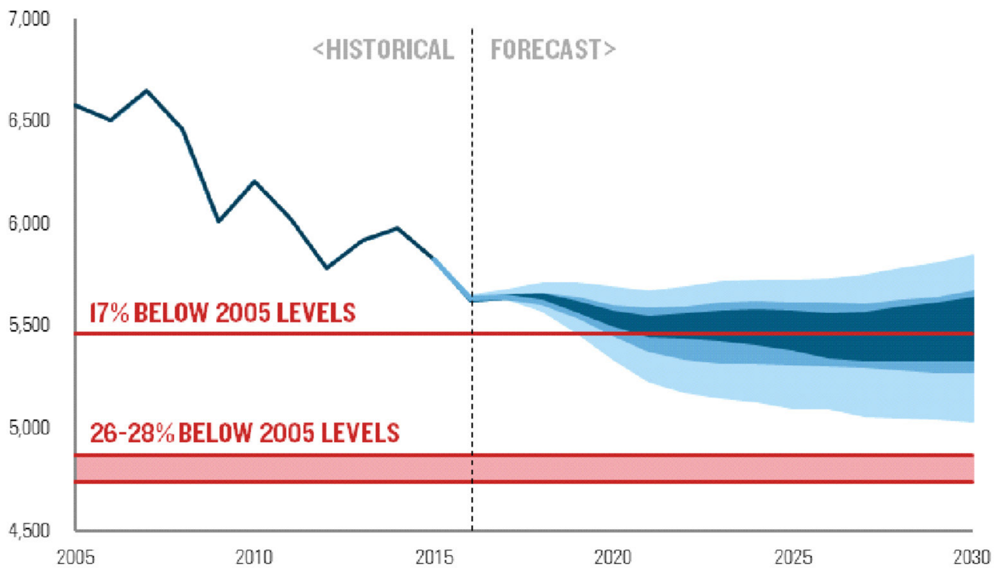
Source: Energy Information Administration (EIA).

During his last few years in office, President Obama adopted or proposed a range of regulations aimed at further reducing GHG emissions in the view that a Republican-controlled Congress was unlikely to cooperate in doing so through legislation. These regulations included limits on methane emissions from new and existing oil and gas production, new model building-energy codes and federal appliance standards, and CO_2 emissions limits on new and existing power plants.[77] In its last year in office, the Obama Administration negotiated a global agreement to accelerate the phaseout of hydrofluorocarbons,[78] and in its last few weeks in office, the Obama Administration finalized a "mid-term review" of the model year 2017–2025 GHG emission standards for cars and light trucks.[79] Even with all the policies put in place by the Obama Administration, however, the United States was still unlikely to meet its Paris Agreement climate targets without additional policy measures.[80]

Since taking office, the Trump Administration has either sought to roll back or called for a new review of many of President Obama's climate regulations.[81] One recent report estimated that under current federal and state policy (as of late May 2017), US GHG emissions will be between 13 and 23 percent below 2005 levels in 2025 depending on the rate of economic growth, developments in natural gas prices and renewable energy costs, and evolution in land use and forestry in the United States.[82] If operators of economically challenged nuclear

Figure 3. *US net GHG emissions under current policy with energy and economic uncertainty*

MMt CO2e



Source: Rhodium Group.

plants choose to shut them down, that will make it even more difficult to achieve US climate goals. That leaves the United States 3 to 13 percentage points short of its Paris Agreement target, let alone long term emission reduction levels consistent with the Paris Agreement's two degree goal.

CARBON TAX DESIGN ELEMENTS

If the concept of a carbon tax attracts more serious attention in the future from politicians (as opposed to just former officials and academic economists), the specifics of the policy will matter. A carbon tax has the potential to have significant impacts on GHG emissions, the US economy and labor market, energy prices and investments, the US trade balance and budget deficit, corporate profitability, and income inequality. But the shape and magnitude of these impacts depend entirely on how the tax is designed.

This section considers three of the main questions that arise in carbon tax design. First, the scope and emissions coverage of the program: In other words, which sectors and gases are taxed and what amount of total US GHG emissions are covered by the program? Second, the point of taxation: Who is paying the tax to the government? Finally, what level should that tax rate be set at initially and over time? These three design elements are interrelated, and each presents a series of important trade-offs. In subsequent sections we discuss options for how the revenue generated by a carbon tax is used, how it interacts with other domestic energy and climate policies, and international trade effects that policymakers must consider.

Scope and Coverage

A carbon tax can cover a particular economic sector or apply to nearly the entire US energy system and even nonenergy consuming activities as well. In this context, the term "scope" means the range of emissions that are subject to the tax. Essentially, the carbon tax base is defined by total amount of GHG emissions subject to the tax at the point of taxation minus any exemptions/credits elsewhere in the economy. The broader the scope, the more efficient and environmentally effective the tax because it increases the number of GHG abatement opportunities.[83] This drives the pursuit of least cost emission reduction opportunities as firms and consumers adjust their energy preferences in response to changes in prices. Because sectors of the economy excluded from the scope of the tax will not make cost-effective emission reductions that the tax would have induced, narrowing the scope of the tax will reduce the number of abatement opportunities. Separate policy efforts could be pursued to drive emission reductions in nontaxed sectors, but by excluding them from an economy-wide carbon tax, it would be difficult to calibrate those policies so that they achieve the same level of efficiency as a carbon tax.

A broader scope also allows for more revenue generation at a given tax rate, or a lower tax rate to achieve the same revenue target. However, broadening the scope also expands the number of groups facing a new tax liability and thus could potentially increase political opposition to a tax.[84] In addition, the administrative burden associated with monitoring and verifying emissions reductions from certain sources may be sufficiently high that it does not make sense to make them subject to a carbon tax.

There are four important interrelated design questions that must be answered when establishing the scope of a carbon tax. (1) Which fuels are subject to the tax? (2) Which sectors are subject to the tax? (3) Which gases are subject to the tax? (4) Are there exemptions to the tax or credits to offset the tax? The answers to these questions will be informed by politics as well as the technical and administrative limitations of measuring and reporting emissions and payment of the tax.

Which Fuels Are Subject to the Tax?

A threshold question is whether the tax applies to all coal, petroleum, natural gas, and derivative products consumed in the United States or to some subset of fuels? The question is important because if some fuels are not covered, the tax would almost certainly create an incentive to increase the use of the nontaxed fuels, allowing the consumer to avoid the tax. That would lower tax revenue and increase emissions. In most economy-wide carbon pricing programs in place today, as well as current legislative proposals for a carbon tax, nearly all fossil fuels and derivative products are covered.[85]

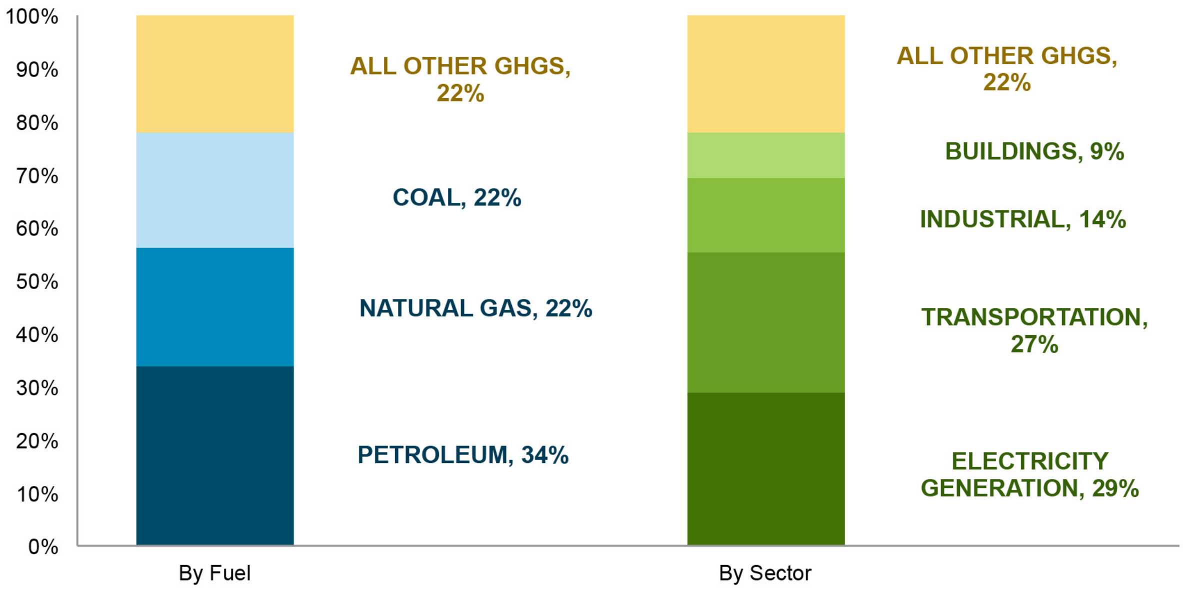
An important issue related to the question of which fuels to tax is how and whether to tax nonfossil fuels that also emit CO_2, such as biomass-derived fuels, including ethanol and wood pellets. Taxing such fuels expands the opportunity to reduce emissions at a given carbon price but can also create administrative complexity because there is significant debate over the extent to which, if at all, these fuels lead to net decreases in atmospheric CO_2 on a life cycle basis.[86] In 2015 gross emissions from biomass were 291 million metric tons before considering any carbon sequestration from the cultivation of fuel feedstocks, representing 5 percent of all GHG emissions.[87] Excluding biofuels from the tax base narrows the scope of the tax and may simplify the politics of crafting the policy. However, it also runs the risk of substantially shifting energy consumption toward biofuels that may or may not provide a net climate change benefit. If biofuels are subject to the tax, policymakers would need to decide whether the tax should be applied at the same rate per ton as fossil fuels or at a lower rate to reflect the life cycle GHG emissions of the fuel relative to fossil fuels.[88] Biofuels derived from different feedstocks could be taxed at different rates if the latter approach is used. This could add complexity to the tax framework, and perhaps make it more difficult to administer, but would establish incentives to shift energy consumption to biofuels with lower life cycle GHG emissions.

Which Sectors are Subject to the Tax?

Once the fuels subject to the tax have been selected, policymakers would then need to identify which fuel-consuming sectors will be covered by the tax. The tax could be applied broadly to all economic sectors, such as industry, buildings, transportation, and electric power, or it could target a subset of them.

Sectoral scope varies across existing carbon pricing programs. Both California and British Columbia cover all major energy consuming sectors.[89] The Regional Greenhouse Gas Initiative (RGGI) program in the Northeast is an example of a carbon pricing program that applies to the power sector only.[90] Meanwhile, the European Union’s cap-and-trade program covers electric power, most large industrial sectors, and domestic aviation but excludes emissions from buildings and all other modes of transportation.[91]

Figure 4. *Fossil fuel CO_2 shares of total US GHG emissions by fuel and sector, 2015*



Source: EPA, Rhodium Group analysis.

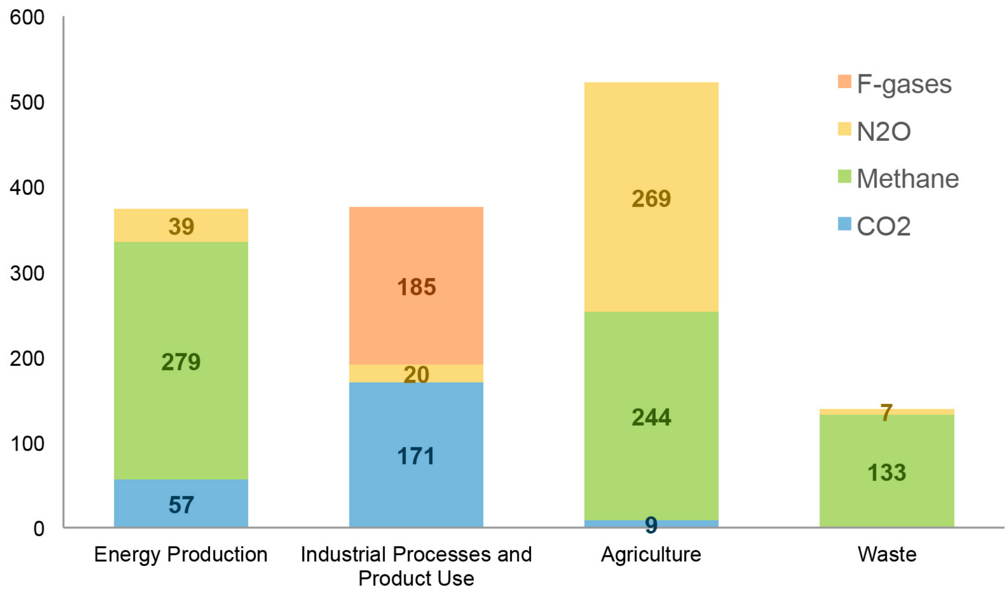
As discussed above, broadening the tax to cover all major energy consuming sectors increases the tax base, allowing for more revenue generation at a given tax rate. It also increases the environmental effectiveness of the program by minimizing leakage and providing consistent market signals to drive lower-carbon energy consumption. The more sectors included in the program, the greater the level of emission reductions that can be achieved at a given price, and the less it will cost to achieve any given level of emission reductions.

Which Gases Are Subject to the Tax?

Another key question is whether to apply the tax to fossil fuels only or more broadly. As figure 4 shows, 22 percent of US GHG emissions come from activities other than the combustion of fossil fuels.[92] These activities include CO_2 emissions from industrial processes (other than combustion), methane emissions from energy production, agriculture and landfills, nitrous oxide emissions from agriculture and f-gases, man-made industrial gases primarily used as refrigerants (figure 5). Most existing carbon pricing programs cover CO_2 from the combustion

Figure 5. *Nonfossil fuel US GHG emissions by sector and gas, 2015*

Million metric tons CO2e



Source: EPA, Rhodium Group analysis.

of fossil fuel in covered sectors. British Columbia's carbon tax stops there,[93] while California and the EU cover process emissions from industry (non-combustion CO_2, methane, N_2O, HFCs, and PFCs).[94]

Just as expanding application of the tax to all energy consuming sectors increases the economic efficiency, revenue generation, and environmental effectiveness of the tax, expanding the tax to cover some or most of these other gases outside of fossil fuel emissions will do the same. It will also increase the administrative complexity of the program.[95] In particular, methane from fossil fuel production along with the agriculture and waste sectors are largely untouched by a carbon tax applied only to fossil fuels. But the majority of emissions from these sectors could be taxed if the scope were expanded to cover all or most GHGs.

Emissions of some gases from certain activities can be challenging to measure and assign to a specific taxpayer. For example, nitrous oxide emissions from agricultural soils are a function of several factors, including soil type, crop choice, fertilizer application, and farming practices.[96]

While these emissions make up half of all emissions from agriculture,[97] measurement and attribution challenges may make it difficult to apply the tax from these activities. If policymakers also want to achieve emission reductions from nontaxed sectors and activities, they can consider developing alternative policies, such as incentives or regulations that may not have the same technical issues. Other activities are more amenable to taxation, such as process emissions from industrial activity where emissions can be measured using sensors at the smokestack.[98] The ability to expand the scope of the tax to cover multiple GHGs may reach technical limits but could still provide a greater number of abatement opportunities.

Expanding the scope of a carbon tax program to cover emissions other than fossil combustion CO_2 can increase tax revenue and environmental benefits, especially when considering that many of these GHGs, such as methane and HFCs, have an outsized radiative forcing impact in the near term.[99] In most instances, such emissions need to be taxed downstream since they generally aren't associated with an upstream feedstock like fossil fuels. For example, methane emissions from landfills would be measured at the landfill site and then taxed. An important exception to this general rule is HFC-23, an industrial gas used in refrigeration and other industrial and consumer products. Because it is a man-made GHG, it could be amenable to taxation at the point of production, much like fossil fuels. In addition, different GHGs have different potency relative to CO_2 measured as their global warming potential (GWP).[100] As such, the tax rate must be multiplied by the appropriate GWP for each ton of taxed gas to send the equivalent price signal seen elsewhere across the economy. When this is done, the potential for sticker shock by non-CO_2 GHG emitters is real given that the effective tax rate on methane or N_2O would be 25 and 298 times larger respectively than that of CO_2 (depending on the time frame chosen to compare the different gases). What's more, the GWP values change over time to reflect the most recent science, and GWP values change if different time scales (20 years vs. 100 years) of radiative forcing are considered.[101] If non-CO_2 GHGs are to be taxed, program designers will need to decide which GWPs are most appropriate.

Table 1. *GHGs and global warming potentials relative to CO_2*

GHG	GWP
CO_2	1
Methane	25
Nitrous Oxide	298
HFC-23	14,800

Source: EPA. Note: 100-year GWPs from the IPCC's AR4 consistent with current international GHG accounting standards are presented here.

As with fossil CO_2, infrastructure needs to be in place to measure and report emissions. This is the case for most industrial process emissions as well as key sources of methane emissions such as coal, oil and gas production, and landfills. As discussed earlier, some sources are not readily amenable to taxation because of a lack of reporting infrastructure or challenges in accurately measuring emissions. Emissions from agriculture are the most structurally difficult to measure of any major sector, representing about 8 percent of US emissions in 2015, and they include N_2O emissions from fertilizer use and methane from livestock, among other sources.[102]

Potential Exemptions to the Tax

There may be GHG-emitting activities that are so small or technically challenging to tax that it may not be administratively practical to tax them. This issue becomes more relevant when considering taxation of non-fossil-fuel-combustion GHG emissions because most sources are diverse and decentralized and aren't easily taxed at specific points in their supply chains, as will be discussed further in the next section. As discussed above, emissions from agricultural soil may be too difficult to measure and tax, justifying their exemption from an emissions tax. But opening the door to exemptions creates challenges as well. Taxed entities will seek exemptions for their activities, even if there are no technical or administrative grounds for such exemptions. To the extent that exemptions are established, the tax base will shrink and revenue generation and environmental effectiveness will decrease. Political support for the tax could also decline, as was the case with President Clinton's BTU tax in the early 1990s[103]—even as its prospects may be boosted by the curbed opposition from exempted industries and sectors.

Potential for Refundable Tax Credits in Certain Circumstances

Beyond exemptions, there may be reasons to consider refundable tax credits to entities that use taxed fossil fuels in a way that does not result in GHG emissions and contribute to climate change or, depending on the design of the tax, results in the export of taxed fuels. Thus the type and number of entities where credits may be applicable will depend on where the point of taxation is placed. The next section further discusses the point of taxation. For example, the use of fossil fuels as feedstocks in the production of plastics and chemicals and the use of carbon capture and storage (CCS) technology at power plants to remove CO_2 from emission streams and permanently inject it underground are examples of fossil fuel–consuming activities that technically can lead to zero GHG emissions. While deployment of CCS remains small today, 12 percent of US oil demand is currently not combusted, used largely in the petrochemical sector to make plastics and other products.[104] Without a refundable tax credit for each ton of CO_2 not emitted for such reasons, future CCS-equipped plants, for example, would have no incentive to pursue this emission reduction strategy. Feedstock producers would be forced to internalize the cost of the tax even though their actions create no GHG emissions. To provide a financial incentive for CO_2 storage facilities to prevent leaks, they too could be subject to paying the tax for any emissions that escape—although that, too, may be difficult to measure and administer.

Activities subject to carbon pricing through future international frameworks may also be deserving of tax credits. For example, international shipping and aviation could be candidates for such a provision if an upstream approach is used since emissions from both sectors are due to be controlled under international frameworks in the near future.[105]

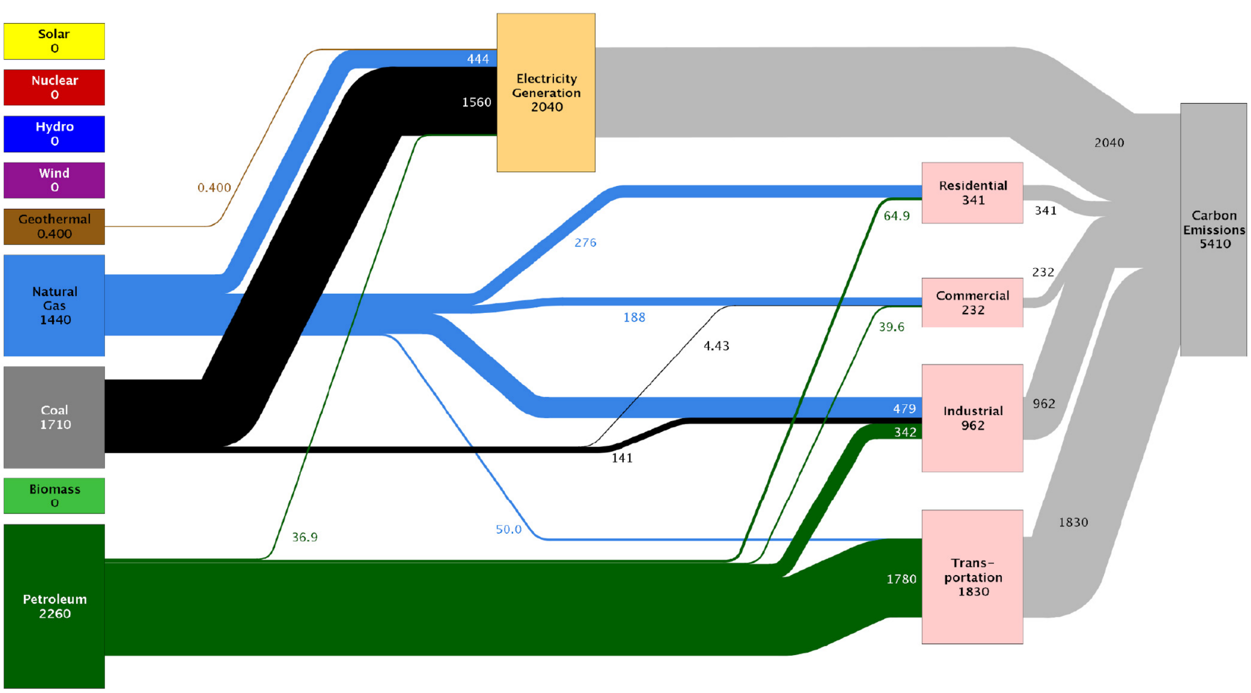
Credit recipients need not be the same entities that pay the tax; they simply need to use, consume, or export a covered fuel that has already been taxed.

Potential to Exempt Exports

To prevent shifts in production and create a level playing field, a carbon tax imposed in the United States may also need to exempt exports, as well as apply to imports. That concern is mitigated, however, to the extent other countries have policies that price carbon similarly, creating complex questions about harmonization across borders as more and more countries adopt carbon prices.

Exempting exports is relatively straightforward for fossil fuel exports themselves. The United States has recently exported up to two million barrels per day of oil[106] and is set to become one of the largest exporters of natural gas within a few years.[107] It remains an exporter of coal, although the EIA projects that going forward exports will be relatively small.[108] Exemptions for the carbon content of exported carbon-intensive manufactured products raises complex administrability issues, as it can be challenging to calculate the embedded carbon in imports or exports. The decision about whether to exempt product exports represents a trade-off between the competitiveness of US industry and the environmental impact of the proposed tax. The issue of how to address industrial competitiveness concerns is addressed more fully later in this paper.

Figure 6. *US energy carbon dioxide emissions, 2014*



Source: Lawrence Livermore National Laboratory, 2015.

Point of Taxation

Identifying the point of taxation—that is, the specific point in the supply chain where the tax is levied—is a critical element in the design of a carbon tax. Selecting the point of taxation requires considering the desired scope of the tax, existing emissions and/or fuel reporting infrastructure, administrative efficiency, and politics.

Key to this discussion is the issue of administrative efficiency. Ideally, the point of taxation should be placed at the point(s) in the supply chain where the greatest share of emissions is covered, the fewest number of entities are subject to the tax, and no fuel is inadvertently taxed twice.[109] This minimizes the administrative resources required to levy and collect the tax. Given the complexity of the US economy and energy system, as depicted in figure 6 below, identifying the point of taxation is not a straightforward task. A well-designed tax would also avoid leaving significant sources of emissions untaxed, which could potentially undermine the environmental integrity of the program through domestic emissions leakage.

Carbon emissions can be taxed upstream at the point of fuel production, downstream at the point of fuel consumption, or at points in between. An upstream approach taxes fossil fuels at or near the point of production based on their carbon content. It is attractive because it covers emissions from end-use sectors without having to track emissions and tax payments from millions of downstream emitters such as vehicles, factories, and buildings. A downstream approach taxes tons of CO_2 that enter the atmosphere at the point where they are emitted. Proponents of a downstream approach argue that the tax should be placed closest to the point of consumption because consumers (and their vehicles, buildings, power plants, and

Table 2. *Number of entities at select potential points of taxation*

Upstream		**Midstream**		**Downstream (Multiple Fuels)**	
Facility Type	**Number of facilities**	**Facility Type**	**Number of facilities**	**Facility Type**	**Number of facilities**
Coal Mines	**710**	**Oil Refineries**	**140**	**Electric Generating Units**	**10,280**
Oil Wells*	**545,520**	**Natural Gas Processing Plants**	**551**	**Aircraft/Highway Vehicles/Trains and Ships**	**269,636,682**
Natural Gas Wells	**555,364**			**Gas Stations**	**168,000**
				Residential Buildings	**69,700,000**
				Commercial Buildings	**2,933,000**
				Manufacturing Facilities	**116,661**

Source: EIA, DOT, Rhodium Group analysis. Note: Oil well count includes ~216,000 wells that also produce natural gas.

factories) are the actual emitters of GHGs, and a tax that is more salient to the consumer will elicit a greater response.[110] Moreover, given the current regulatory structure already in place to assess and collect excise taxes, including fuel taxes,[111] it may be easier to administer a carbon tax that is applied close to the actual point of consumption than to create upstream systems to administer the tax even if the tax is collected from more entities than an upstream tax. Upon review of leading current national carbon tax legislative proposals, it appears that most would place the point of taxation upstream.[112] However, the largest carbon pricing programs in place around the world use either a downstream or hybrid approach.[113]

Applying the tax upstream at the point of production or import could be attractive for its relative simplicity. There are, for example, only about 710 coal mines in the United States.[114] In contrast, applying the tax to over 1,100,000 oil and gas wells across the United States presents some challenges.[115] However, even though the number of wells is large, nearly all oil and gas producers have experience with paying taxes based on wellhead production given that nearly all of them are subject to state severance taxes.[116] An alternative could be to place the tax at the mine mouth for coal but place oil and gas taxation slightly downstream at the point where oil enters refineries and natural gas enters processing plants. There are only about 140 refineries and 551 gas processing plants in the United States.[117] While this framework would cover all petroleum emissions (so long as imported refined products are taxed at the border), 25 percent of US natural gas production is "pipeline ready," meaning that the gas produced from the wellhead is of sufficient quality to be injected directly into the pipeline system without processing, which would bypass the point of taxation. This could be addressed by taxing natural gas at the wellhead or as it passes through the roughly 1,300 local distribution companies (LDCs) that sell gas to consumers[118] (not shown in the table) and as it enters the thousands of factories and power plants that bypass LDCs and use natural gas delivered through interstate and intrastate pipelines. While this hybrid approach dramatically increases the number of taxed entities relative to taxing at the processing plant, the infrastructure for tracking LDC natural gas sales and from large facilities is already in place and may lead to lower administrative costs than placing the tax at the processor level.[119] Indeed, this is the approach to covering natural gas that is currently used in California's carbon pricing program.[120]

Alternatively, applying the tax completely downstream at all points of emissions may be possible but administratively difficult and costly. Requiring every person and business to pay for the CO_2 emitted by the tens of millions of buildings and hundreds of millions of vehicles in the United States is impractical and technically difficult.[121] Still it is possible to apply a carbon tax at or close to the final point of sale based on the carbon content of fuel. This approach would look similar to the current federal excise tax on motor fuels but applied more broadly to cover all fossil fuel products.[122] A hybrid approach could be used where large stationary emitters (such as factories, refineries, and power plants) are taxed directly at the smokestack, while fuels used in vehicles and buildings are taxed close to the final point of sale. Additional administrative infrastructure may be required to implement this approach. When taking a downstream approach, it is possible that some emissions that occur along fossil fuel supply chains may not be covered by the tax unless they are explicitly identified as taxpayers. This could apply to emissions from sources such as pipelines, natural gas processing plants, refineries, and fuel used to power oil and gas wells.

Passing Costs through to Consumers

No matter where in the US energy system the tax is applied, firms will attempt to pass these costs through to consumers in the form of higher energy prices. We see this today across energy markets. For example, when global oil prices go up, refiners and retailers pass those costs on to consumers in the form of higher gasoline and diesel prices.[123] Demand for fuel then adjusts in the medium term in response to price changes.[124] Reduced demand can lower the profits of companies and increases incentives to produce and sell lower-carbon forms of energy. Even where energy firms are unable to pass through all of the carbon tax, there will still be a reduction in profits and an incentive to sell lower-carbon energy to make up the difference. An efficient carbon tax should enable pass-through of the cost of the carbon tax, as that price signal would not only give producers an incentive to reduce the carbon intensity of their goods to increase competitiveness, but would also provide consumers with an incentive to curb consumption and the carbon intensity of their consumption. In short, the environmental benefits of a carbon tax will be maximized if the price signal can be passed through to consumers.

Imported Energy and "Leakage"

Separately, 26 percent of the primary energy consumed in the United States is imported.[125] To avoid leakage and an associated competitive advantage to overseas energy producers, it is important to tax imported fossil fuels if they are not otherwise covered in the tax framework. Doing so levels the playing field and avoids any potential increase in import dependence solely due to a carbon tax. If an upstream point of taxation is used, then the most likely place to tax imported fuels is at their point of entry into the United States because the number of points is relatively small, and US Customs and Border Protection tracks imports in order to collect duties. If a carbon tax is assessed downstream, it is unnecessary to tax imports.

The Relationship between Point of Taxation and Coverage

The approach to exemptions from the tax and refundable tax credits will vary depending on the point of taxation. If an upstream approach is used, then tax credits will be required to compensate fossil fuel exporters and nonemissive uses of fossil fuels, because the tax is applied before it reaches these consumers. If a downstream approach is used, then exporters won't require credits, and nonemissive uses of fuels won't result in taxable emissions.

With this in mind, expansion of the tax to cover non-fossil-fuel-combustion emissions would be relatively straightforward for large stationary source emitters and producers of industrial gases. These sources include industrial facilities, fossil fuel production, landfills, cement producers, and HFC-23 producers. If a downstream approach is already being used for fossil fuel combustion CO_2 emissions, many sources may already be subject to the tax and the tax could be applied to all GHGs emitted from the facility.

Table 3. *Comparison of possible frameworks for point of taxation*

Point of Taxation	Share of 2015 US emissions covered	Pros	Cons
Power plants at point of emissions	~30%	• Existing reporting infrastructure • Tax entities familiar with emissions pricing	• Low coverage • Potential leakage to end-use sectors
All fossil fuels at point of production/refining (for oil) and import	~79%	• Broader coverage • Prevents leakage between sectors	• More complex reporting infrastructure
All fossil fuels at point of production/refining and import plus large stationary noncombustion CO_2 and other GHGs	~86%	• Broadest coverage • Prevents leakage between sectors • Covers some high GWP emissions	• Most complex reporting infrastructure

Source: RHG analysis of EPA data.[126] Note: All coverage estimates do not include any potentially applicable tax credits for nonemissive uses, though fossil fuel exports are accounted for.

Estimates of total emissions coverage that would be achieved under three points of taxation approaches are presented in table 3. Under a power sector CO_2-only approach, 29 percent of 2015 US emissions would be covered. If all fossil fuels are covered at the point of production, refining (for oil), and importation, then coverage increases to 79 percent of 2015 emissions. Emissions from agriculture, waste, energy production, and industrial processes would not be taxed. Finally, if the approach to cover all fossil fuels is expanded to include large stationary source emissions of other GHGs, coverage expands to 86 percent of 2015 emissions. In this example, agriculture and small stationary source emitters would not be subject to the tax. Each expansion of coverage increases the complexity of the taxation regime due to the issues discussed earlier. However, greater coverage provides a much larger tax base from which to generate revenue and creates more opportunities to reduce GHG emissions for less than the price of the carbon tax.

Tax Administration and Associated Infrastructure

Given the focus on a federal carbon tax, we assume that the Internal Revenue Service (IRS) would be charged with administration of the program. While this is a logical choice, arguments could be made for other agencies to administer the program, such as the EPA or Department of Energy given their expertise in energy and GHG emissions. Assuming the IRS is administrating the tax, the agency will certainly need to incorporate data or infrastructure from other federal, and possibly state, sources into its tax guidance in order to implement the program.

The importance of robust and reliable reporting and tax payment infrastructure cannot be overstated in the context of a carbon tax. First and foremost, accurate reporting is required to prevent fraud, which undermines faith in the program and its effectiveness, and also reduces revenue. Almost as important is the need to make calculation and payment of the tax as streamlined and as simple as possible to reduce political opposition to what is effectively a new regulatory requirement on businesses, and to minimize the cost of administering the program. There are a number of existing frameworks that could be used on their own or in combination to support the administration of a carbon tax.

Federal and State Excise and Severance Taxes

Federal excise taxes on motor fuels, oil, and coal, along with the infrastructure for accounting and payment of these taxes, have been in place for decades.[127] This infrastructure that is used to collect federal excise taxes, which are reported to the IRS on IRS Form 720, could be leveraged to assess all emissions from fossil fuel combustion, with modest modifications.[128] In addition, nearly every energy-producing state applies severance taxes on fossil fuels at the point of production (e.g., the mine mouth or the wellhead).[129] A federal carbon tax could leverage this existing infrastructure if the point of taxation is placed at the point of production.

EPA's GHG Reporting Program

Another promising "one-stop shop" for emissions data by entity is EPA's Greenhouse Gas Reporting Program (GHGRP). This mandatory program tracks annual GHG emissions from 8,000 reporting entities in 41 industry categories.[130] All data are reported electronically using standardized methodologies and are then verified by EPA. Between GHGRP reporting by emitters and by fuel suppliers, up to 90 percent of US GHG emissions are accounted for by the program.[131] The IRS could leverage this platform for quantifying tax liabilities of each entity covered under the point of taxation, especially if a downstream approach is used for large emitters.

US Customs

US Customs tracks imports and exports of all products in the United States, including fossil fuels, at points of entry and exit.[132] These data and reporting infrastructure would be helpful in applying a carbon tax on imports and tax credits on exports if not already accounted for elsewhere—although a lot more data would be needed to estimate the carbon intensity of imports, especially for goods other than fossil fuels.

Energy Information Administration Surveys

The Energy Information Administration (EIA) conducts dozens of statistical data surveys on energy production, transportation, and consumption at weekly, monthly, and annual intervals.[133] Typically, the identities of reporting energy producers are kept confidential to protect sensitive information. If identification information could be shared with the IRS, then EIA's data infrastructure could present another option for tracking carbon tax liabilities, depending on the point of taxation.

Monitoring and Verification Requirements

Just as with income and other forms of taxation, mechanisms must be in place to make sure that taxpayers are following the rules. Some carbon pricing and emissions reporting programs require third-party verification of data and some level of government oversight.[134] This is similar to the use of tax accountant services in current taxation frameworks where the third-party entities sign off on the integrity of reporting and tax payment. In addition, the IRS could audit taxpayers to provide an additional check on the integrity of the program.

Tax Rate

Determining the level of the carbon tax, or tax rate, is one of the most important questions in any carbon tax program design. It's also one of the more controversial components given that it becomes the "top line" number stakeholders use to assess environmental effectiveness and economic and market impact. In reality, the combination of the tax rate and the other key design decisions described in this paper is what ultimately determines revenue collection, environmental effectiveness, and energy market outcomes.

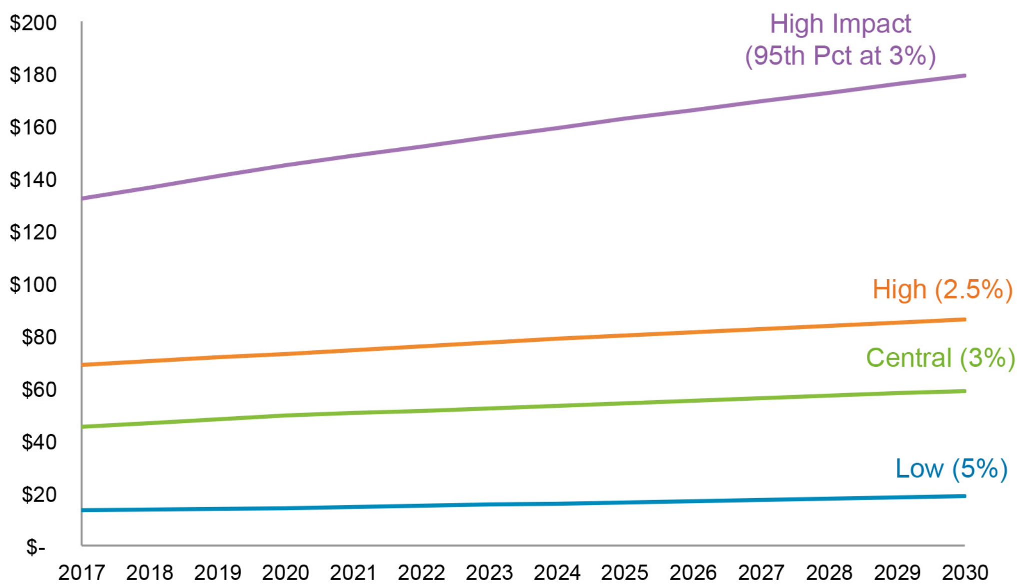
As noted at the outset, this is very different than a cap-and-trade program, in which an allowable emission quantity is defined (the cap) and the emissions price required to meet that cap is uncertain (although it can be estimated with energy system models). With a carbon tax, the price is defined explicitly, but the resulting effect on overall emissions is unknown (though it too can be estimated with energy system models). In selecting a carbon tax over a cap-and-trade program, policymakers are trading emissions certainty for price certainty.[135] This trade-off can be mitigated with hybrid approaches, such as a cap-and-trade system that has a minimum and maximum allowance price, or a carbon tax that automatically adjusts over time depending on what actual emission reductions are achieved after the program is in place.[136]

The Pigouvian Approach

In theory, the appropriate tax rate depends on the objective policymakers implementing the tax are seeking to achieve. For example, if policymakers are imposing a tax in a purely Pigouvian manner—to internalize the economic costs of GHG emissions in individual and firm decision-making—they may use the social cost of carbon (SCC) as a point of reference. The SCC is the estimate of the societal cost (measured as a reduction in welfare) of an additional ton of GHGs emitted into the atmosphere in a given year. Under the Pigouvian approach, the

Figure 7. *Social cost of carbon range 2017–2030*

2017 USD/Metric Ton CO_2



Source: IWG 2016, Rhodium Group analysis.

SCC is internalized to all consumers and firms throughout the economy. If it is cheaper than the social cost to abate a ton of CO_2, then it makes sense to do so. If the cost of abatement exceeds the social cost of carbon, then under this view, it is preferable to emit. The Obama Administration formed an Interagency Working Group (IWG) to draw on available climate science and economic research to estimate the SCC for use in agency regulations effecting GHG emissions. In their most recent report, the IWG's central estimate of the SCC was $45 per metric ton of CO_2 in 2017, rising at 2 percent per year, adjusted for inflation.[137] In this report, we consider the range of SCC estimates published by the IWG to establish a spectrum of possible carbon tax rates (figure 7).

There remains considerable uncertainty around the right value for the SCC.[138] This includes uncertainty regarding how much a given level of CO_2 in the atmosphere will increase global temperatures, how much harm that amount of warming will cause, the existence of tipping points in the earth's system where warming accelerated dramatically beyond a certain threshold even when GHG emissions were reduced, and how to discount the value of future harm in today's dollars.[139]

Table 4. *Recent fuel prices, SCC derived tax rates, and resulting fuel-specific tax rates in 2020 and 2017 USD*

		Units	Illustrative Tax rates ($/metric ton CO_2)						
			5 year low	**5 year high**	**Difference**	**$14**	**$50**	**$73**	**$145**
Coal	**Bituminous**	$/short ton	$54.80	$74.15	$19.35	$32.97	$115.40	$170.35	$337.95
	Subbituminous		$33.24	$38.55	$5.31	$23.70	$82.94	$122.44	$242.91
	Lignite		$21.15	$27.53	$6.38	$19.39	$67.86	$100.18	$198.74
	Crude Oil	$/bbl	$31.24	$111.92	$80.68	$6.11	$21.40	$31.59	$62.66
	Gasoline	$/gallon	$1.93	$4.15	$2.22	$0.12	$0.44	$0.64	$1.27
	Diesel/ heating oil		$2.06	$4.37	$2.31	$0.14	$0.51	$0.75	$1.48
	Jet fuel		$0.96	$3.38	$2.43	$0.14	$0.48	$0.71	$1.42
	Propane		$1.98	$3.84	$1.86	$0.08	$0.28	$0.41	$0.81
Natural Gas		$/MMBtu	$2.29	$7.65	$5.37	$0.75	$2.63	$3.88	$7.70

Source: The Climate Registry, Interagency Working Group, Energy Information Administration, Rhodium Group analysis. Note: Coal prices are national average price of fuel delivered to the power sector. Petroleum and natural gas prices are economy-wide national average delivered prices.

In early 2017, the National Academies of Sciences issued a report calling on the federal government to update the SCC to reflect the best available science.[140] However, in a March 28, 2017, Executive Order, President Trump instructed agencies to revert to older White House guidance to calculate the SCC.[141] In its revised estimates, the Trump Administration estimated the SCC to be between one and six dollars per ton.[142]

Translating the Tax Rate into Changes in Fuel Prices

A carbon tax is applied to fossil fuels based on the carbon content of each fuel. Table 4 shows the fuel-specific tax rates for select commonly used fuels in 2020. With the exception of coal, the most carbon-intensive fossil fuel, fuel-specific tax rates under the SCC estimate of $73/ton or lower are within the range of interannual market price fluctuations—as measured looking at five-year changes in fuel prices.[143]

The actual impact on fossil fuel prices due to a carbon tax is determined not just by the tax rate but the shifts in supply and demand for all fossil fuels in response to the tax. Future papers in this series will examine this question.

Adjusting Rates to Meet Emissions Targets

There is no guarantee that a carbon tax set at the SCC will achieve a given level of emission reductions. As discussed above, the purely Pigouvian answer to this question would be that it does not matter. If you set the marginal price equal to the marginal cost of a ton of GHG, then the market will decide the optimal level of emission reductions. This view, however, presupposes that the tax is applied globally and assumes a high degree of accuracy in the estimate of the SCC.

Alternatively, the level of a carbon tax can be adjusted more frequently to achieve a given level of emission reduction. In this way, the carbon tax acts more similarly to how a cap-and-trade system might operate, providing quantity rather than price certainty. Such an approach may have benefits in international climate negotiations where nations have agreed to meet certain abatement targets, individually and collectively.[144]

With this in mind, carbon taxes with starting rates and annual increases that are different from the SCC could be seen as reasonable options for a US program. Available energy system modeling provides a range of estimates of the carbon tax rate necessary to achieve the Paris Agreement target of a 26 to 28 percent reduction from 2005 levels in 2025. For example, one analysis found that when applied to all US fossil fuels, three different carbon tax rates could achieve the targets: $21/ton in 2017 with no real (inflation adjusted) increase; $17 increasing at a real rate of 3 percent; and $13.5 rising at a real rate of 6 percent.[145] In its 2016 Annual Energy Outlook, the EIA analyzed a scenario where a carbon tax on all fossil fuels started at $0/ton in 2017 and increased linearly to $35/ton in 2023 and then at a real rate of 5 percent to reach $80/ton in 2040. In this scenario, energy CO_2 emissions in 2025 were 30 percent below 2005 levels, a sufficient reduction to put the United States in the range of the Paris target.[146]

There is relatively little understanding, however, of what level of carbon tax would be required to reduce emissions by more than 80 percent below 2005 levels by 2050 or to achieve interim targets in 2030 and 2040. This is one of the core questions that this research effort will explore.[147] Yet even with the best available modeling in hand, policymakers concerned with meeting specific emission reduction targets will likely need to include some kind of periodic adjustment mechanism so the tax can be increased or decreased in light of actual emissions trends.

Adjusting Rates to Meet Revenue Goals

A carbon tax program driven primarily by a desire to create revenue to meet a new spending or tax cut goal could result in a very different tax rate (and scope) than a tax designed primarily to either internalize the cost of GHG emissions or achieve a specific emission reduction target. Introducing a carbon tax as a means of raising revenue to reduce the deficit or offset the cost of reducing other, more economically distorting taxes, such as taxes on labor and income, may be quite desirable politically. Yet a tax rate driven by revenue rather than environmental considerations has potential downsides too. First, the revenue gains are uncertain, as it is not possible to know in advance how consumers will respond to the carbon price. Second, the calculation of what tax is needed for a given amount of revenue must consider that the revenue from an indirect tax, like a carbon tax, is likely to be offset in part (the US government assumes by 25 percent) by a reduction in other government revenue.[148] Third, the optimal tax rate and pace of escalation from an environmental standpoint may be quite different than the optimal tax rate from a revenue standpoint.

Recent analyses by the Congressional Budget Office (CBO) and the Department of the Treasury suggest that 10-year cumulative net revenue from a carbon tax on all fossil fuels plus some large stationary sources of nonfossil CO_2 GHGs could be in the range of $977 billion to $2.2 trillion inclusive of the revenue offset.[149] These are substantial sums in the context of a $3.65 trillion annual FY2017 federal budget. The difference between the two ranges is largely due to different assumed tax rates. CBO assumed a tax rate of $25/ton rising at a real rate of 2 percent per year,[150] while the Treasury assumed a much higher tax rate that closely follows the central estimate for the SCC of $49/ton rising at a real rate of 2 percent per year (table 5).[151] Illustrating the uncertainty in emission reductions and tax revenue associated with a carbon tax, the Treasury analysis considered an additional scenario where the scope and rate of the tax is held constant but emissions decline further in response to the tax due to rapid technological progress. The result is lower emissions and a cumulative net revenue estimate of $1.6 trillion.[152]

Table 5. *Recent federal government carbon tax revenue estimates*

Analysis	Tax rate	5 years	10 years
		Cumulative net revenue ($ billions)	
CBO	$25/ton rising at 2 percent real starting in 2017	$437	$977
Treasury (main scenario)	$49/ton rising at 2 percent real starting in 2019	$1,050	$2,219
Treasury (rapid tech. progress scenario)	$49/ton rising at 2 percent real starting in 2019	$875	$1,636

Source: CBO, the Treasury.

REVENUE ALLOCATION OPTIONS

Arguably, the most contentious issue in designing a carbon tax—other than whether to pursue the policy in the first place—is what to do with the revenue it generates. Large, new sources of federal government revenue are not found frequently, and if a carbon tax is seriously considered, there will be an endless number of stakeholders arguing in favor of their preferred approaches.

This section organizes potential revenue allocation options into six main categories and raises important considerations for each:

- *Refunds and rebates:* carbon tax revenue can be rebated directly to taxpayers, either on a lump-sum basis or tailored to their individual tax burdens.
- *Tax cuts:* revenue can be used to reduce other federal taxes, such as payroll or corporate income taxes.
- *Mitigation and adaptation investments:* revenue can be spent on programs aimed at climate change mitigation or adaptation.
- *Adjustment assistance:* revenue can be targeted at firms and industries adversely affected by addressing climate change, like coal communities.
- *Spending on other policy goals:* revenue can be considered for general use, as is most revenue and used for spending on other federal programs through the normal budgeting process.
- *Deficit reduction:* revenue can be used to reduce the federal deficit and thus the amount of money the US government has to borrow annually to fund existing spending priorities and appropriations.

More than one approach to revenue allocation can be chosen in the design of a carbon tax program. Ultimately, the limiting factor is the net revenue derived from the tax. While combinations of these options are certainly likely in an actual policy debate, we discuss them individually here.

Refunds and Rebates

Secretaries Shultz and Baker recently coauthored a report from the Climate Leadership Council that argued for refunding all carbon tax revenue directly to taxpayers.[153] This revenue use has attracted other Republican thought leaders in the past who are concerned about a new source of revenue being used to expand federal government spending.[154] This approach also represents one way to reduce the burden a carbon tax places on consumers, and particularly on low-income households that cannot afford an increase in energy expenditures.[155] Rebates can be made on a lump-sum basis, where everyone receives the same amount, or can be returned proportionate to the estimated impact of the tax. What is important is that the dividend is calculated independently of the taxpayer's consumption of fossil fuels and other goods and services. Otherwise, the price signal generated by the carbon tax may not get fully passed through to consumers.

A key consideration with a rebate/refund approach is the means of distribution. If offered as a typical tax credit, only Americans that exceed the standard deduction and have a tax liability to offset will receive a refund. If offered as a refundable tax credit, anyone who files a tax return would qualify, though that still does not include all Americans, such as some retirees, children, and others who don't file tax returns. A third option is for the federal government to issue a check similar to Social Security payments to each citizen, resident, or household. Another important consideration is whether carbon tax revenue is considered general revenue or is treated as an entitlement, like Social Security or Medicare. The latter may provide a higher degree of confidence among voters that carbon tax revenue collected will ultimately be returned, while the former allows policymakers more discretion in how to use the revenue.[156]

Tax Cuts

Economists have long argued that an efficient tax system can optimize investment and consumption and lead to better overall welfare and greater economic growth.[157] A key consideration in an efficient tax system is removing taxes on the activities that benefit society, such as capital and labor, and applying taxes to the things that do not benefit society. Internalizing the external costs of GHG emissions through a carbon tax presents an opportunity for a tax swap where the government taxes something that does not benefit society and generates revenue that could be used to reduce taxes on activities that do.

There are three types of distortionary taxes that are often highlighted as candidates for a carbon tax swap: capital taxes, including corporate income taxes and taxes on investments; labor taxes, such as payroll taxes and income taxes on wages; and consumption taxes, including fuel excise taxes and state sales taxes.[158] Reducing capital taxes incentivizes additional investment. Reducing labor taxes either reduces labor costs for employers (incentivizing them to hire more); increases after-tax compensation to employees (incentivizing them to work more); or a mix of both.[159] Reducing consumption taxes incentivizes higher consumption of taxed goods and services.[160] Tax swaps present another opportunity for reducing the burden of a carbon tax on consumers as well as producers.

A forthcoming paper in this series will assess and compare the macroeconomic impact of various carbon tax revenue allocation choices, including the tax swaps described earlier.

Climate Change Mitigation and Adaptation Investments

Many advocates of a carbon tax argue that the revenue should be used to deliver additional GHG emissions reductions and associated environmental benefits beyond those achieved by the tax.[161] Under a cap-and-trade system, direct investments in clean energy or energy efficiency would have no emissions impact—they would instead reduce the price of emissions allowances. Under a carbon tax, these investments can deliver additional abatement; the question is how efficient they are relative to creating a higher tax. Investments likely to be efficient are those that address market failures other than the social cost of GHG emissions, that nevertheless impact energy production and consumption. For example, a long body of economics literature makes the case for government investment in R&D, as private firms underinvest in R&D because they cannot capture the full social benefits of innovation.[162] Carbon tax revenue can be used to address this market failure by supporting clean energy R&D. Spending to address principal-agent and other barriers to energy efficiency investment is another potential use. Carbon tax revenue could also be used to reduce emissions in sectors not covered by the tax but where cost effective abatement opportunities exist, such as land use and agriculture.

On the adaptation side, carbon tax revenue could also be used to fund additional research and assistance in preparing for the impacts of climate change. This could include, for example, increases to spending on NASA and NOAA programs that monitor extreme weather or on early warning systems for at-risk communities. In addition, some portion of revenues could be directed to investments in improving the climate resilience of the nation's critical transportation and energy infrastructure. Such investments have the potential to avoid substantial costs from more intense and frequent natural disasters in the future.[163]

Transition Assistance

Other advocates argue that revenue should be used to mitigate the negative impacts of the transition to a lower-carbon economy on specific industries or communities or to help pay for the public health impacts of fossil fuel combustion. Reducing fossil fuel consumption and production in response to a carbon tax will impact some communities more than others. Coal-mining communities, and those with coal-fired power plants, would likely be the most immediately impacted, followed by oil and gas producing communities and those with large refineries. These communities may seek to use funds for economic diversification, including infrastructure, education, workforce training, small business incubation, and tax credits to help attract new investment.

A carbon tax would also affect the international competitiveness of energy-intensive companies in the United States, like steel, aluminum, chemicals, and cement. Under the American Clean Energy and Security Act, a share of allowance revenue was used to mitigate these impacts through an output-based rebating system.[164] Industry would likely ask for a similar provision as part of carbon tax legislation or the imposition of a border tax imposed on imported energy-intensive goods. This is discussed more fully later on in this paper.

Spending might also aim to address the effects of past air pollution and climate impacts. Fossil fuel combustion not only releases GHG emissions but also other pollutants that impact human health. In California, a share of cap-and-trade revenue is earmarked for investment in communities that have been disproportionately impacted by these pollutants in the past.[165] In the state of Washington, many environmental justice (EJ) groups were opposed to the carbon tax ballot measure in 2016 because it did not include such a provision.[166] EJ groups will likely advocate for revenue being used to address the legacy effects of air pollution from fossil fuel combustion in any national carbon tax debate as well.

Spending on Other Policy Goals

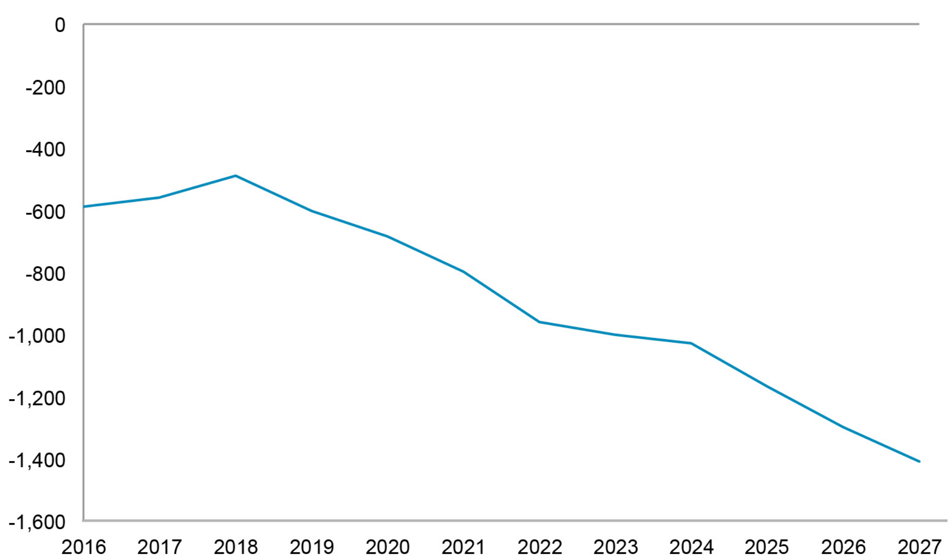
Revenue could also be used to fund government spending priorities entirely unrelated to climate change. Considering carbon tax revenue as general use revenue would allow policymakers to assess the relative merits of spending a dollar on climate change versus the broadest array of other possible government priorities and allocate resources accordingly. The budget process is designed to consider these explicit trade-offs across priorities, while earmarking funds for particular uses from particular revenue sources narrows the scope of consideration and may result in spending on less efficient government programs.

Deficit Reduction

For those concerned with the size and sustainability of US government debt, carbon tax revenue may be an attractive option for deficit reduction. In 2015, the federal government's budget deficit was over $400 billion[167] and is projected to be closer to $700 billion on average through 2022.[168] The recent tax bill passed by Congress increases this yet further. The estimates of possible carbon tax revenue presented in table 5 above range from $97 to $220 billion per year on average over 10 years. Revenues at the high end of that range would be sufficient to cut the deficit in half and make a meaningful contribution to reducing the country's nearly $15 trillion public federal debt.[169]

Figure 8. *CBO Projection of Revenue Minus Outlays 2016-2027*

Billion Current USD



Source: CBO.

Even if most carbon tax revenue is rebated, used to reduce other taxes, or used to fund new spending, some amount of deficit reduction may be required to keep the legislation revenue neutral through congressional budget scoring. The exact amount is contingent on the details of the carbon tax design. As discussed above, the CBO assumes a carbon tax will reduce other sources of federal tax revenue by 25 percent of the revenue generated by the carbon tax.[170] Under this scoring approach, up to 25 percent of the revenue generated by a carbon tax could be required to offset other revenue losses for the legislation to be considered revenue neutral.[171]

INTERACTION BETWEEN CARBON TAXES AND OTHER ENERGY AND ENVIRONMENTAL POLICIES

A carbon tax, especially one with an economy-wide scope, will interact with a range of existing energy and environmental policies. The portfolio of federal polices to promote energy development (renewable, nuclear, and fossil), energy efficiency, and GHG emission reductions is broad. It is implemented by a wide range of federal agencies.[172] An even larger amount of energy and environmental policy making is done at the state and local level.[173]

How a carbon tax will interact with existing policies is a key design question. As discussed, if the aim of a carbon tax is to achieve GHG reductions at lowest cost, it may make sense to remove other policies that reduce emissions at a higher cost or by predetermining where in the economy emissions reductions should come from. On the other hand, there may be various market failures and regulatory barriers that prevent the price signal from a carbon tax from working as efficiently in practice as it might in theory. For example, a wide behavioral economics literature reveals that consumers suffer from various biases in making decisions—like whether to pay more today for a more fuel-efficient device that will save them money over time—and thus may not react in the optimal way to a carbon tax.[174]

Interaction with existing policies is also important because there are some policies that are aimed at addressing environmental issues other than climate change (like local air pollution) or other priorities (like energy security), and these policies can significantly impact the way in which energy systems respond to a carbon tax. For example, the original goal of fuel economy standards—administered by the Department of Transportation under authority from Congress—was to reduce oil consumption for energy security reasons. Only later did a ruling by the Supreme Court and a subsequent "endangerment finding" by the US Environmental Protection Agency (EPA) lead to fuel economy standards being developed as well aimed at regulating GHG emissions from the tailpipe.[175]

Understanding interaction with existing policies is key because the reality is that any political deal to enact a carbon tax is highly likely to include elimination of various regulations and regulatory authorities that federal agencies currently have to address climate change. Many companies on record as supporting a carbon tax already may only do so if a carbon tax is adopted in lieu of other climate regulations.[176]

This section identifies the most significant existing energy and environmental policies with which a carbon tax would interact. Subsequent analysis in this series will model these interactions in detail and highlight areas where existing policy complements a carbon tax and where it conflicts.

Federal Regulations

Federal agencies have promulgated a wide range of energy and environmental regulations under authority granted to them by Congress. Some are designed specifically to reduce GHG emissions—such as the EPA's New Source Performance Standards (NSPS) for CO_2 emissions from power plants;[177] CO_2 emission standards for existing power plants (the Clean Power Plan);[178] and GHG emission standards for vehicles.[179] These rules were adopted by the Obama Administration following the failure of cap-and-trade legislation to impose an economy-wide price on carbon.[180] Following the EPA's endangerment finding, which concluded that GHG emissions pose a threat to public health, the EPA was legally obligated to regulate GHG emissions under the Clean Air Act.[181]

Given that an economy-wide carbon tax would attempt to price the social cost of carbon emissions from these sources, the questions arise whether these regulations are duplicative and unnecessary if Congress were to adopt a carbon tax.[182] A challenge in assessing this claim is that many policies may have other purposes or may address other market failures aside from the cost of carbon. As noted above, not only are GHG emission standards for vehicles promulgated by the EPA under authority to regulate GHG emissions,[183] but fuel economy is regulated by the National Highway and Transportation Safety Administration under authority from Congress to reduce dependence on foreign oil.[184] Moreover, there may be other market failures—such as behavioral biases that undermine the ability of consumers to respond most economically to a carbon price signal—that would serve as evidence in favor of other government policies, such as mandating higher levels of fuel economy.

There is another collection of regulations that reduce GHG emissions but are intended primarily to address issues other than climate change. This includes building-energy codes and appliance standards aimed at reducing energy waste and energy costs for households and businesses.[185] The climate benefits of these regulations are factored into rulemakings but as just one component alongside other quantifiable benefits, like consumer savings, reduced local air pollution, and enhancement of the nation's energy security.[186] If a carbon tax is implemented, regulators would have to adjust the manner in which they calculate the benefits of these programs. For example, if the federal government were using a SCC of $45/ton of CO_2 for rulemakings, and there was a federal carbon tax of $25, then climate benefit of any emission reductions resulting from the regulations could be calculated using the remaining $20/ton difference between the carbon tax and the SCC. The quantification of the nonclimate benefits in the rule would stay the same. Indeed, to the extent these regulations address market failures that a carbon tax does not address (like building codes that overcome principal-agent barriers preventing building tenants from improving the energy efficiency of their homes or businesses), they can make the tax more effective in reducing GHG emissions.

Finally, there are federal energy market regulations and permitting procedures that may need to evolve to accommodate the level of market transformation a carbon tax is intended to produce. This includes electricity and natural gas market regulations from the Federal Energy Regulatory Commission[187] and the interagency process for permitting new transmission infrastructure, not to mention state and local permitting issues.[188]

Federal research and development on clean energy technologies

The federal government spends $6 billion each year on research and development of clean energy technologies.[189] Even with an appropriate price on carbon, there are other market failures that would continue to justify government R&D spending. There is a substantial body of research suggesting there are positive externalities to research and development in many areas, including clean energy.[190] Given that private firms are unable to capture the full social value of their innovation, they do not make socially optimal investments in emission reducing technology, even in the presence of a relatively high carbon tax.[191] Federal clean energy R&D may, however, need to be refocused if a carbon tax were to be adopted.

Federal Subsidies for Clean Energy

The federal government provides subsidies for clean energy in a variety of ways, especially through the tax code. The Production Tax Credit (PTC), for instance, provides a per kWh subsidy for 10 years of operation of new wind facilities[192] and has played a major role in the threefold expansion of wind generation that's occurred in the United States over the past eight years.[193] The PTC has traditionally been extended year-by-year, though there were a few years in which it expired.[194] As part of a bipartisan tax deal in December 2015, Congress adopted a multiyear phaseout of the PTC.[195] All facilities that commence construction in 2017 receive a $0.0184/kWh credit, a 20 percent reduction from 2016 levels. That amount will be reduced by 40 percent from 2016 levels in 2018 and 60 percent in 2019 before being eliminated entirely in 2020.[196]

The Investment Tax Credit (ITC) allows companies and households to receive a federal tax credit equivalent to 30 percent of the purchase cost of new solar or wind systems and 10 percent of new geothermal electric systems (fuel cells, microturbines, geothermal heat pumps, and other technologies used to be covered as well).[197] Like the PTC, Congress adopted a multiyear phasedown for the ITC in December 2015. For solar systems, which account for the vast majority of ITC credits, systems that commence construction in 2021 receive a 26 percent credit—those that begin construction in 2021 receive a 22 percent credit, after which the credit is set to 10 percent for all future years.[198] The phasedown schedule for wind and geothermal systems is more aggressive.[199] Many clean energy technologies also qualify for accelerated depreciation under the Modified Accelerated Cost Recovery System (MACRS), which provides a considerable tax benefit.[200] There used to be a wide range of tax credits available for residential and commercial buyers of select energy efficiency technology, but nearly all expired at the end of 2016.[201]

When first adopted, clean energy tax credits like the PTC and ITC were intended to help spur the development of new, emerging clean energy technologies.[202] For more mature technologies, like wind and solar photovoltaic (PV), they now effectively serve as a large-scale deployment policy—helping to close the cost gap with natural gas and coal in power generation.[203] One policy rationale for these subsidies is that they offset the lack of an internalized social cost in hydrocarbon use. Imposing a carbon tax would thus undermine one of the key rationales for solar and wind tax credits, as the cost of hydrocarbon-based energy would now reflect the social cost of carbon. In that way, a carbon tax might eliminate the need for the PTC and ITC for wind and solar PV if they were not both already on a path to being phased out (or down, in the case of solar). In the face of a carbon tax, federal subsidies might need to be refocused to encourage the development of early-stage technologies.

Federal Royalty, Bonus, Lease, and Tax Revenue from Fossil Fuel Production

A carbon tax will affect demand for coal, oil, and natural gas produced everywhere, including on federal lands and waters. Because resources on federal lands are owned by the public, the federal government currently collects revenue from this production through leasing, bonus awards, and royalty payments to ensure that the public captures the value of the resources extracted.[204] The government also collects other revenue that may be affected by a carbon tax, such as other excise taxes on gasoline that are used to fund transportation needs. To the extent a carbon tax reduces demand for gasoline and diesel, those sources of revenue will decrease—even as drivers of alternative-fuel vehicles continue to use the roads. Policymakers will increasingly need to consider how to meet these other federal funding needs, including whether any revenue from the carbon tax should be directed at these purposes. As discussed above, a carbon tax could reduce revenue from income and payroll taxes as well. Understanding the impact of a carbon tax on these revenue streams is important to assessing its net impact on the federal budget as a whole.

It is also important to determine whether other excise taxes may already internalize part of the social cost of carbon. For example, as discussed previously, a $50/ton carbon tax would raise the cost of gasoline 44 cents. But 32 states already have taxes on gasoline that exceed 44 cents/gallon when both state and federal taxes are summed.[205] Drivers may thus be seen as already paying for the social costs of the carbon in their gasoline use. However, to the extent the purpose of the tax is to correct other negative externalities, such as congestion or road use, the carbon tax may need to be additional. The interaction of existing taxes with a future carbon tax requires careful consideration by policymakers.

State Regulations and Carbon Pricing Systems

As noted, policies that directly regulate the same GHGs that are subject to the carbon tax present possible conflicts. This is not only the case with respect to federal policies but also with conflicting state policies, such as the 10 state cap-and-trade programs discussed above. Regulated entities in these states will face a situation where they are paying for carbon emissions twice and are subject to additional administrative burdens with no additional environmental benefit (unless caps are ratcheted down to be bindings on emissions). This raises a key question in carbon tax design: Should a federal carbon tax *preempt* state carbon pricing programs and possibly other policies as well?

In modern history, there are few instances where states have been completely preempted and removed from the field of regulation unless there are conflicts with the commerce clause of the constitution.[206] Yet if the federal government adopts a nationwide approach to internalize the social costs of carbon emissions, there will be little policy rationale for a state to do so as well. To impose a federal tax on top of a state tax or regulation would effectively constitute double taxation or regulation because the taxpayer is already paying for the social damages they are causing. Yet given the uncertainty about the optimal level of a carbon tax, some states may wish to go beyond the federal approach and impose additional carbon taxes for emissions. A given state may want to reduce emissions more quickly than the federal government; may hold a different view than the federal government about the right way to discount future climate damages in today's dollars (adopting a lower discount rate); or may wish to pursue more of a precautionary principle to set a higher carbon tax in light of the large uncertainties about what the costs of climate change will end up being. If such a state believes the right level of a carbon tax is $100/ton rather than $40/ton, it may argue it should be allowed to impose a $60/ton tax on emissions in addition to the federal carbon tax.

Moreover, as discussed, state carbon pricing programs have been around long enough that they are now a relied upon source of revenue for key programs.[207] If these programs were preempted as part of a federal carbon tax, states may well argue for compensation.

If states were allowed to impose a higher carbon price, they could either maintain a cap-and-trade program with a minimum allowance price above the federal tax rate or apply their own carbon taxes in addition to the federal program. While no state has a carbon tax in place currently, six states on the West Coast and Northeast are currently contemplating them.[208] There are countless examples of instances where states tax the same things that the federal government taxes, including income, motor fuels, investments, and other activities.[209] Carbon might be similar. This approach might also simplify the additional administrative burden imposed on regulated entities since they would just need to pay the tax rather than engage in allowance auctions and emissions trading.

Beyond carbon pricing, there is also the question of whether states should be permitted to implement other climate regulations and mandates. If there were full certainty that the federal government had accurately internalized the social cost of carbon, for example, some may argue there is little need for states to also impose regulations that indirectly price emissions in order to achieve greater reductions in tax GHG emissions, such as through renewable portfolio standards. To the extent that state renewable mandates led to a higher supply of renewable energy than a carbon tax alone would have, they are effectively imposing a higher price on carbon and directing that those emission reductions come from more renewable energy.

State Revenue from Carbon Pricing Systems

Like the federal government, states use excise taxes on motor fuels to fund infrastructure investment.[210] A federal carbon tax will affect these revenue streams. States also could see royalties from energy production shift away from carbon-intensive fuels as well as a decline in severance tax receipts from fossil fuel production. In addition, as discussed earlier, 10 states currently have GHG cap-and-trade programs in place, covering at a minimum electric power.[211] These states rely on the revenue from the auction of compliance allowances to fund a variety of programs.[212] For example, in California, it is estimated that the state generated over $2 billion a year in 2015 and 2016 from allowance auctions with the money targeted toward clean energy and transportation projects.[213] A federal carbon tax will drive capped emissions down in these states, possibly to the point where allowance auction prices hit their minimum levels, and may reduce the volume of allowances sold. Both of these impacts will reduce revenue from these programs. In response, states may appeal to the federal government to seek compensation for lost revenues as a result of a national carbon tax program. Alternatively, instead of relying on a federal solution to this problem, states could make up the revenue through other channels, such as raising excise and severance tax rates.

INTERNATIONAL TRADE EFFECTS

A carbon tax will raise the cost of production for certain industries, through higher energy prices, a new tax obligation for GHG emissions released during fuel combustion and industrial processes, or some combination of both depending on the scope of the tax and the point of taxation. For particularly energy-intensive or GHG-intensive industries, this could create a competitive disadvantage vis-à-vis peers in countries without a carbon tax or with one set at a lower level. If this resulted in production shifting abroad, it would both increase the economic cost of the program and undermine its environmental effectiveness as industrial emissions leak to other countries—although research finds the scale of this potential problem to be smaller than often perceived.[214]

The Cap-and-Trade Experience

Preventing a loss in international competitiveness and emissions leakage was a major legislative design issue in the American Clean Energy and Security Act (ACES).[215] That bill opted for a combination of output-based rebating and a border carbon tax adjustment.[216]

Output-Based Rebating

ACES dedicated approximately 14 percent of all allowances under the cap-and-trade program it created for provision to energy-intensive trade-exposed industries (EITEIs) to offset the impact of the program on their production costs.[217] These allowances were rebated to companies commensurate with their outputs and at a sector-wide average emissions intensity.[218] This maintained an incentive for firms to reduce emissions, as reducing their emissions increased their rebate amounts. California has adopted a similar program under Assembly Bill 32.[219]

Border Carbon Adjustment

Under ACES, the output-based rebating program would have phased out over time and been replaced with a border carbon adjustment (BCA) that required importers of EITEI goods to purchase allowances to cover the embedded emissions in those products.[220] This was waived for countries deemed to have a comparable climate policy in place.[221]

Carbon Tax Design Decisions

A similarly broad set of choices faces carbon tax design. Namely, is it better to address competitiveness and leakage concerns through tax rebates for EITEIs or by imposing a domestic carbon tax on imported EITEI goods? Should the tax then also be rebated for domestically produced products that are exported? Legislators will also need to answer the following policy design questions:

Eligibility

What products qualify as energy intensive and trade exposed and thus eligible for either a tax rebate or a border adjustment? ACES defined EITEI as any industry that met the following criteria:[222]

a. *Energy intensity:* where the cost of purchased electricity and fuel is greater than 5 percent of total shipment value.

b. *GHG intensity:* where the number 20 multiplied by the number of tons of GHG emitted in the production of the good (including the generation of purchased electricity) divided by total shipment value is greater than 5 percent.

c. *Trade intensity:* where the value of total imports and exports are greater than 15 percent of total shipment value.

This determination was to be made based on publicly available historical data from the US Census, EIA, and other federal agencies.

Embedded GHG Calculations

If a carbon tax is going to be rebated to EITEIs, legislators will need to decide whether to do so based on a sectoral average GHG intensity or firm-specific reporting. If the US carbon tax is instead adjusted at the border, legislators will need to decide how to assess the GHG emissions emitted during the production of the imported good to determine the amount of tax to be assigned. This could be done at the US national average level (likely the most administratively simple) or based on federal agency assessment of the average emissions intensity of production in the exporting country, which can be complex. Different processes for producing steel, for example, can consume different amounts of energy. Failure to give appropriate credit to firms that use cleaner processes might not only lead to international trade challenges[223] but might also undermine the incentive firms have to reduce emissions in the face of a US carbon tax. Legislators will also need to decide whether to give importers the ability to appeal this determination through provision of firm-specific information.

Comparability/Reciprocity

If a carbon tax is adjusted at the border, legislators will need to determine whether to do so for all imports or whether to exempt imports from certain countries because they have a comparable climate policy in place. If another country has a carbon tax set at the same level as the United States, this assessment is straightforward. However, if another country pursues other climate and energy policies—such as efficiency standards, mandates for renewable energy deployment, or subsidies for nuclear energy—it may be challenging to assess whether these actions are comparable to the ambition of US policy efforts.

ACES sought to exempt imports from countries with comparable policies, but because of the way “comparability” is generally defined in international climate negotiations (and thus by the federal agencies implementing the legislation), the border adjustment would likely have been waived for imports from countries with a significantly lower effective carbon price, thus undermining the efficacy of the provision in preventing a loss of US competitiveness.[224] An alternative under a carbon tax would be to impose the carbon tax on all imports, in the same way that countries with value-added taxes impose them on imports. Trading partners with their own domestic carbon prices could then rebate their carbon fees to their producers upon export, though this too raises administrative questions.

GATT Consistency

A key consideration for legislators in all of the choices is whether or not they are consistent with US commitments in the General Agreement on Tariffs and Trade (GATT) and other trade agreements.[225] A border adjustment would need to be designed so that it would not violate the "national treatment" obligation in article III of GATT by discriminating against imports or the "most-favored nation" obligation in article I by discriminating among importing nations.[226] The legal assessment of these questions would depend heavily on the considerations discussed earlier, such as whether higher-carbon steel is like lower-carbon steel and whether another nation has taken comparably effective climate actions that would prohibit differential treatment. If a border tax was found illegal for these reasons, the question would then arise whether it was nonetheless permissible because it satisfied one of the allowed exceptions to GATT rules, such as the exception for measures "relating to the conservation of exhaustible natural resources if such measures are made effective in conjunction with restrictions on domestic production or consumption."[227] A separate paper in this series will explore all these international trade questions in greater depth.

DISTRIBUTIONAL CONSIDERATIONS

A carbon tax will not impact all Americans equally. All the choices—regarding the scope and level of a carbon tax and how the resulting revenue should be used—that have been discussed will impact different groups of Americans in different ways. This section discusses some of the most important distributional considerations policymakers should keep in mind when drafting carbon tax legislation.[228]

Income

A carbon tax would raise the cost of energy to households and businesses, with important distributional consequences. Low-income households generally spend a larger share of their incomes on energy than high-income households.[229] Higher energy costs to businesses result in higher-cost consumer products. These indirect price increases are generally thought to be more evenly distributed across income levels.[230]

The net impact of a carbon tax on Americans of different income levels depends, in part, on how the revenue is used. A lump-sum rebate is generally thought to make the tax highly progressive—at least for the bottom half of the income distribution[231]—while using the revenue to reduce the corporate income tax would likely make it regressive. The distributional profile of a carbon tax also varies when viewed over the lifetime of an individual rather than just at a particular point in time.[232] It also depends on the distributional profile of regulations that are avoided or eliminated in implementing the carbon tax.[233] Finally, the impacts of climate change that a carbon tax is designed to avoid also differentially impact Americans of different income levels.[234] The papers in this series will take all these actors into account when analyzing the impact of different carbon tax design options.

Sectoral

A carbon tax would impact some sectors of the economy more than others. Coal mining and power generation will likely be the most significantly impacted, followed by oil production and refining. Natural gas production, distribution, and power generation are likely to benefit in the short and medium term under a carbon tax as a lower-carbon alternative to coal but may suffer in the long term unless carbon capture and sequestration technology is successfully commercialized. Renewable and nuclear energy will likely benefit as will advanced vehicle manufacturing and energy efficiency technology.

Outside the energy sector, EITEIs will likely be impacted, at least to a small degree. Without a policy to mitigate these adverse impacts, some production will likely migrate to other countries with less stringent climate policy. The sectoral impacts of a carbon tax will also depend on how revenue is allocated. For example, cuts in corporate income or payroll taxes can have meaningful sectoral implications, as will lump-sum rebates that increase consumer spending among low and middle income Americans. A paper in this series will model the sectoral impacts of a carbon tax in detail under a range of possible design scenarios.

Geographic

Finally, a carbon tax will not impact all parts of the country equally.[235] Fossil-fuel-producing states and those that rely on coal for a large share of power generation are likely to be more negatively impacted than those with relatively low-carbon electrical systems. Rural communities will likely face larger energy cost increases as a share of income than urban residents because low population density typically is associated with higher per capita oil demand. Communities with rich renewable resources are more likely to capture the clean energy investment a carbon tax would incentivize. Here, as well, revenue allocation decisions will play an important role in determining the net impact across geographies—particularly if legislators choose to address geographic heterogeneity in energy production and consumption directly, as they did in ACES through free allowance allocations to carbon-intensive utilities and local distribution companies. The impacts of climate change a carbon tax is designed to avoid will also be unevenly spread across the country. The papers in this series will take all these factors into account.

CONCLUSIONS

While the immediate prospects for a national carbon tax in the United States may appear remote, there is growing interest among some policymakers and increasingly among businesses, NGOs, thought leaders and “elder statesmen” on both sides of the political aisle. Should a legislative opening emerge in the years ahead, policymakers will need to grapple with a range of important design issues that will determine the effectiveness of the tax in reducing GHG emissions; its impact on energy markets and prices; the distributional and economic growth implications of different revenue allocation options; and interactions with existing tax, energy, and environmental policy at the federal, state, and local level. The key design choices identified in this paper will be analyzed in a series of forthcoming papers through this carbon tax design research initiative.

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