



Carbon Pricing 101

Strategies to put a price on global warming pollution



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Executive summary

Global warming is the existential challenge of our time, threatening lives, livelihoods and the future of the planet. Wildfires, extreme storms and other impacts of global warming are already causing devastation around the world. Those impacts will only become more dramatic over time unless we move to cut greenhouse gas (GHG) emissions immediately and dramatically.

To prevent the worst impacts of global warming, the United States must achieve carbon neutrality by 2050. The Intergovernmental Panel on Climate Change (IPCC) warns that world carbon emissions must reach net zero around 2050 to limit global warming to 1.5°C over preindustrial levels – the level beyond which catastrophic climate changes could occur.¹

U.S. policymakers must use every practical policy tool to make this zero-carbon transformation a reality – promoting rapid deployment of renewable energy sources, investing in research and development of clean energy technologies and energy efficiency and taking regulatory actions to push polluters away from using dirty fossil fuels. Policymakers must act decisively, which will require securing bipartisan support.

A central element in this strategy should be putting a price on carbon pollution (known as carbon pricing) to push polluters to cut emissions and switch to clean energy. Pricing carbon pollution makes polluters pay for the damage they cause and incentivizes them to use energy more efficiently and shift from oil, coal and natural gas to clean, renewable energy.²

Carbon pricing spurs investment in efficient and clean technologies. It can generate revenue that can be invested in clean energy, be returned to the public as a dividend or support other public priorities. Carbon pricing protects the interests of future generations and will accelerate the transition to a cleaner, healthier planet, working as part of a broader set of regulatory actions to reduce emissions of carbon dioxide and other greenhouse gases that cause global warming.

Carbon pricing is recognized as a valuable tool around the world. As of May 2020, 46 countries and 32 subnational jurisdictions had implemented or scheduled 61 carbon pricing initiatives, covering about 22% of annual global GHG emissions.³

Which gases are greenhouse gases?

Carbon dioxide (CO₂) is the principal driver of global warming, but other greenhouse gases (GHGs) include methane, nitrous oxide and fluorinated gases.⁴ The primary focus of this paper will be on reducing CO₂ emissions, but the paper also will address application of carbon pricing to other GHGs and land use, land use change and forestry (LULUCF) activities (see pages 22-23).

Governments in the United States should establish carbon pricing programs to help move the nation toward net-zero greenhouse gas emissions by 2050.

There are many choices jurisdictions must make in designing carbon pricing programs – choices with important implications for program effectiveness.

Cap-and-trade programs and carbon taxes can both be effective tools to put a price on carbon pollution, but there are important differences between the two strategies.

There are two key mechanisms for putting a price on carbon pollution: a cap-and-trade system or a carbon tax. Cap-and-trade (sometimes called cap-and-invest or cap-and-dividend) programs set a cap on the level of carbon or other GHG emissions allowed by specified emitters.⁵ Emissions allowances (representing a specific amount of carbon pollution) are auctioned or given away to emitters, with the total number of allowances issued adding up to the cap.⁶ Polluters able to cut emissions cheaply can sell excess allowances to polluters with higher reduction costs or purchase fewer of them at auction, creating a market price for emissions.⁷ Requiring polluters to pay to emit carbon pushes companies toward cleaner fuels and catalyzes innovation.⁸ Caps drop over time to keep GHG emissions falling. As of 2020 there were 31 cap-and-trade programs implemented or planned worldwide, including in 11 U.S. states.⁹

A carbon tax, on the other hand, sets a price directly on emissions or on the carbon content of fossil fuels.¹⁰ Taxing emissions sends a price signal to polluters to shift to lower-emission alternatives, and to consumers to purchase products with lower carbon inputs.¹¹ Individual decisions by firms and households will determine how much emissions will fall, unless tax levels are set to target specific emissions reductions. There are 30 carbon tax programs operating or planned around the world today (including one city-level program in Boulder, Colorado), but no state-level programs in the United States.¹²

A price on carbon can be set at a level designed to drive desired reductions in emissions or to recoup the estimated damage to society caused by carbon pollution. Setting a price strategically to drive reduc-

tions toward an emissions target is more promising, since it helps governments achieve policy goals. Models can be used to estimate tax levels needed to reduce emissions along a reduction pathway, and mechanisms created to allow the price to be increased or decreased over time as needed to hit specific targets on the way toward net-zero emissions.¹³ In contrast, some international organizations, economists, other academics and think tank experts favor using an estimated social cost of carbon (SCC) to aggregate environmental, economic and social damages from emissions.¹⁴ An SCC, however, is derived via complex calculations, produces widely varying results and is ultimately subjective.

Carbon pricing is an essential tool to fight global warming, but is not sufficient on its own. Carbon pricing programs are by themselves a proven tool for cutting emissions and can generate large revenues that can be invested into further emissions reductions (or for other purposes). Some analyses conclude carbon pricing can be more effective as part of a comprehensive regulatory strategy to reduce emissions, rather than as a stand-alone approach.¹⁵ A World Bank-sponsored commission, for example, concluded that climate change is driven by multiple market failures, beyond the failure to price carbon, and thus requires multiple policy tools to address.¹⁶ The most promising approach supports carbon taxes within a strategy of broad regulatory actions and sets prices to target specific emission reductions, trending toward net-zero emissions over time.¹⁷

Carbon pricing has a track record of effectiveness in the United States and elsewhere, with new programs in the process of being proposed or launched. Carbon pricing programs have operated at the state level for more than a decade, with the northeastern and mid-Atlantic states' Regional Greenhouse Gas Initiative (RGGI) and California both managing effective cap-and-trade programs.¹⁸ The Transportation and Climate Initiative (TCI), a collaboration of northeastern and mid-Atlantic states, has been exploring a cap-and-trade program for transportation, and three of the states plus the District of Columbia agreed in December 2020 to launch the TCI Program in their jurisdic-

tions by 2023.¹⁹ Several states – notably Oregon and Washington – have proposed ambitious carbon pricing programs through legislation or referenda, though no other state programs have yet been adopted.²⁰

More proposals are being developed at the national level. Twelve carbon pricing plans were introduced in the 116th Congress (of which 10 proposed a national carbon tax, one a national cap-and-trade program and one a hybrid program).²¹ None of these programs passed either chamber of Congress, however.

Carbon pricing has great potential as a central part of the U.S. policy toolkit to fight global warming. U.S. policymakers should adopt carbon pricing policies with the following elements:

1. Implementing carbon tax and/or cap-and-trade programs as part of a broad set of policies to address global warming.

- Strategies to address global warming also should include use of existing regulatory powers (e.g., the Clean Air Act), reduction/elimination of fossil fuel subsidies, expansion of incentives/subsidies for renewables, research and development (R&D) investments, investments in green infrastructure and others.

2. Setting carbon tax rates and caps to target emissions reductions.

- Carbon pricing programs should use emission reductions timelines, rather than revenue targets or estimates of the social cost of carbon, to set tax levels or caps. This could include accepting caps at levels above emission reduction targets, but that generate revenue that is used to cut emissions further through investments.

3. Investing carbon pricing revenues in renewable energy, energy efficiency, green infrastructure and broad public benefits.

- Carbon pricing programs should direct revenues across sectors as part of overall efforts to decarbonize the economy and to increase public awareness of the importance of carbon pricing in addressing GHG emissions.
- All other uses of carbon pricing revenues should benefit the public.

4. Ensuring the integrity of programs and preventing loopholes.

- Carbon pricing programs should include backstops that ratchet up prices or otherwise accelerate emission reductions if emissions targets are not met.
- Programs should ideally be comprehensive, covering the entire economy.
- Programs should include measures to prevent “carbon leakage,” e.g., via a border carbon adjustment/border tax adjustment.
- In the case of cap-and-trade, policymakers should adopt tight limits on offsets and ensure that any cost-containment provisions built into the program do not interfere with progress toward needed emission reductions.

Introduction

On August 31, 2020, the International Panel on Climate Change (IPCC) commemorated the 30th anniversary of its first assessment of the science of global warming, issued in 1990.²² In a statement, IPCC Chair Hoesung Lee noted the initial assessment’s conclusion that greenhouse gas emissions would warm the planet, but that “unequivocal detection of the enhanced greenhouse effect from observations is not likely for a decade or more.”²³

Thirty years later, the effects of global warming are all around us. In its most recent assessment, issued in 2014, the IPCC concluded that “[h]uman influence on the climate system is clear, and recent anthropogenic emissions of greenhouse gases are the highest in history. Recent climate changes have had widespread impacts on human and natural systems.”²⁴

Global warming is now a part of our everyday lives, as we see rising sea levels, increased flooding, massive forest fires wreaking havoc on the western United States and Australia, heat waves, droughts and other destructive changes. These events are causing widespread impacts including damage to public health and property, population resettlement, crop failures and loss of agricultural productivity, species loss, ocean acidification and other damage to natural ecosystems.

Even as the damage has increased, many governments and stakeholders have spent years disagreeing over the most viable approaches to reducing

the emissions that fuel global warming. Environmental organizations have struggled against entrenched and well-funded industry opposition, which has worked to sow confusion and doubt over the certainty of global warming and has fought regulatory efforts at every turn.

Today, however, the threat is immediate, and the urgency to act is irrefutable. The good news is that the world has more technological and policy tools than ever before to address global warming. One such tool, which has widely demonstrated its usefulness, is carbon pricing.

In the United States, thoughtful leaders, advocates and the public are advancing federal, regional and state-level carbon pricing plans that offer the hope of moving the country toward a zero-carbon future. This white paper describes the key features of carbon pricing, reviews the experience of existing carbon pricing programs and recent proposals, and suggests a series of principles and guidelines to ensure that carbon pricing programs deliver maximum benefits for the climate.

The United States has an opportunity to act boldly to help avert tragedy and preserve a sustainable world for our descendants. Throughout our history, Americans have always risen to meet great challenges, and must do so again. A livable future for our children and grandchildren depends on it. By ensuring that polluters pay for damaging our climate and reinvesting the proceeds into the clean energy transition and programs that benefit the public, the U.S. can take a big step toward making that livable future a reality.

What is carbon pricing?

Carbon pricing is a policy approach whereby governments put a price on emissions of carbon dioxide and/or other greenhouse gases (GHGs) – forcing emitters to either pay for permission to continue polluting or switch to lower-polluting energy sources.²⁵ The price gives polluters an incentive to switch away from polluting fossil fuels and to reduce GHG emitting activities generally.

Carbon pricing is justified both in terms of mainstream economics and as a tool to drive emission reductions. Mainstream economists frame carbon pricing as a way to capture the external costs of carbon emissions.²⁶ The rationale is that these external costs – sometimes called social cost of carbon (SCC) – include all of the economic, social and environmental impacts of global warming.

Photo: Ale Alvarez via Unsplash



Factory in New York City.

If polluters are forced to bear the full costs of their behavior – rather than shift those costs onto the public or future generations – they will be more likely to make decisions that benefit society as a whole.

Carbon pricing can be more usefully described as a tool to send economic signals aiming to drive GHG emissions down to a societally determined amount.²⁷ By making carbon more expensive, governments push polluters to shift from highly polluting fossil fuels to low or zero-carbon energy sources. The result should be lower carbon emissions.

Carbon pricing is also justified because it puts the onus for the damage caused by GHG emissions back onto those emitters responsible for them, rather than having society as a whole bear this burden.²⁸ The “polluter pays” principle has long been a cornerstone of environmental policy, and carbon pricing is consistent with that principle.

There are two primary carbon pricing policy instruments in use or under discussion: cap-and-trade programs (or emissions trading systems [ETS]), including variations such as cap-and-invest and cap-and-dividend; and carbon taxes or fees.

Both instruments can be adjusted for scope and point of application. The broader the scope of the program – the more major emissions sources it covers – the more effectively it will reduce emissions. Carbon pricing can be applied at different points along the energy supply chain. The simplest approach is to target “upstream” points – suppliers of coal, oil and natural gas, including mines, wells, gas processing facilities and refineries – where the fewest entities would be subject to the cap or tax.²⁹ This involves putting a price on fuels in proportion to the amount of carbon they contain. The cap or tax alternatively could target “midstream” points (electric utilities) or “downstream” points, which include energy-using industries, homes or vehicles (amounting to millions of sources). Regardless of the point of application, carbon price costs generally would be passed down the supply chain and affect prices of goods and services for consumers.³⁰

Carbon pricing pros and cons

Carbon pricing advantages

Carbon pricing is a useful market-based approach to addressing global warming. It offers the promise of achieving multiple policy goals:

- reducing GHG emissions;
- spurring investment in energy efficiency and clean technologies; and
- generating revenue (from either carbon taxes or cap-and-trade programs in which allocations are auctioned). This revenue can be invested in clean energy, be returned to the public as a dividend or support other public priorities.

Multilateral institutions, think tanks, economists and other academics have long advocated for carbon pricing. The IPCC, the International Monetary Fund, the World Bank, and the Organization for Economic Cooperation and Development (OECD) all support carbon pricing as a cost-effective, market-based means to achieve emissions reductions.³¹ As a market-based approach, carbon pricing can require fewer prescriptive rules or penalties than other regulatory approaches to reducing emissions.

Carbon pricing also has the benefit of a broad scope, since it can be extended across major sectors of the economy. Emissions sources change over time, and a carbon price will hit whichever source is emitting the most at any time, doing so immediately. The carbon price can be adjusted up or down by policymakers to meet changing emissions reduction targets.

Carbon pricing can also begin to drive emission reductions immediately upon adoption, as opposed to approaches that hinge on the development and widespread deployment of new technologies. Implementing a carbon pricing program is a flexible, cost-effective way for economies to move toward a low-carbon future.

Carbon pricing disadvantages

Despite their benefits, carbon pricing programs present challenges. Their complexity is one issue; policymakers need to consider many factors in their design. While program scope should be as broad as possible, policymakers must realistically assess which GHG sources the program can or should cover for maximum impact. In most real-world cases, both cap-and-trade and carbon tax programs focus on covering the largest emitters across the economy, such as utilities, large industries or fuel suppliers. Targeting small emitters directly, of which there are millions, is impractical and could make program administration too costly.

Carbon pricing also faces political obstacles.³² Carbon pricing assigns costs up front via a visible tax or allowance cost, which can generate public opposition, while benefits are more diffuse (although direct household rebates are intended to address this problem – see page 20). The up-front nature of carbon pricing can make it an easy political target for polluters who can either defeat the policy or lobby to secure loopholes and exemptions.

In addition, carbon pricing raises concerns that higher energy prices will hit lower income groups particularly hard. Carbon emissions generally increase with income, meaning that wealthier households will tend to pay more than lower-income households.³³ However, carbon prices in the form of energy spending could tend to make up a larger share of a poorer household's income, leading to concerns about regressivity.

Carbon pricing programs can be designed to address this issue, either by returning dividends on a flat per-capita basis, or by targeting a share of program revenues toward assisting low-income households in improving energy efficiency and dealing with any additional costs imposed by the program.³⁴

While this may address the substantive issues, some groups contend that it does not address the political challenges of carbon pricing, suggesting the public does not see receiving dividends as a direct consequence of a carbon pricing policy.³⁵

Others have criticized carbon pricing as too incremental in producing emissions reductions (mainly the case when a cap is too weak or a tax is too low), or for failing to adequately promote innovation.³⁶

Many of these criticisms can be addressed either through the design of carbon pricing or the adoption of complementary emission reduction policies. Adjustments to program scope, levels of taxes or caps, and use of dividends can address most of the issues noted above. In any case, cap-and-trade and carbon tax programs are complex and do have limitations. This has led some studies to conclude that carbon pricing alone is an incomplete policy solution to address global warming. **Implementing carbon pricing within a larger framework of policies to promote clean energy, including regulations, clean energy targets, R&D investments, tax credits and subsidies or other taxes, is more likely to be effective in achieving significant long-term emission reductions than carbon pricing alone.**

Cap-and-trade programs

Cap-and-trade programs – also called emissions trading systems (ETS) or in some cases cap-and-invest programs – use market forces to drive reductions in pollution. The earliest national cap-and-trade program in the U.S. was established under the Clean Air Act of 1990 and secured significant reductions in sulfur dioxide and nitrogen oxide emissions, pollutants in acid rain.³⁷ Based in part on this model, cap-and-trade programs have been considered for carbon emissions for decades, and as of May 2020 were operating in 11 U.S. states, the European Union, Quebec and other Canadian provinces, as well as in other countries around the world (see pages 25-27).³⁸ Cap-and-trade is often promoted as a way to replace some regulation of technology choices and standards, though it alternatively can complement other regulations and thus enhance emissions reductions.³⁹

A cap-and-trade program sets a cap on the total level of carbon dioxide or other greenhouse gas emissions allowed by an established range of emitters.⁴⁰ Under the program, pollution allowances (each representing a specific amount of permissible emissions) are either auctioned off to emitters or allocated to them, with the total

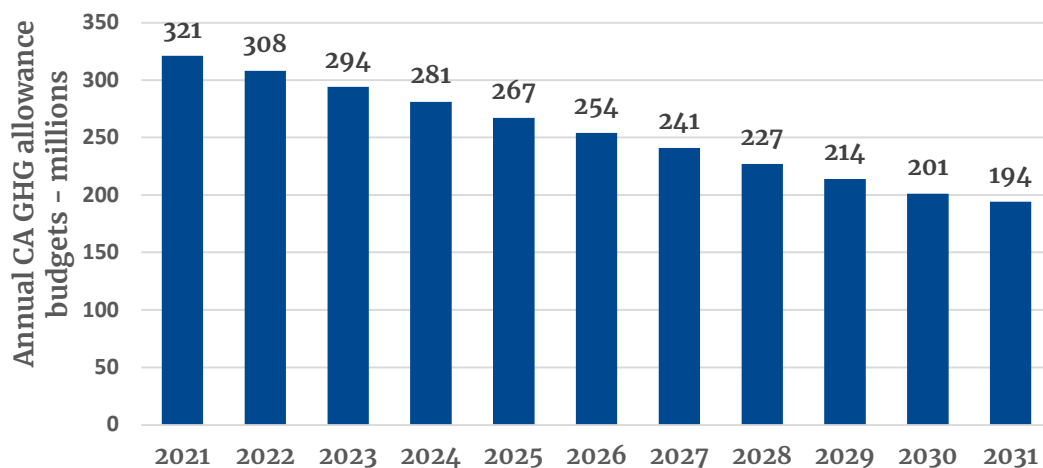
number of allowances adding up to the carbon cap.⁴¹ Those emitters able to reduce emissions at low costs can either sell excess allowances to industries that face higher costs for reductions or purchase fewer of them at auction.⁴² This generates supply and demand for emission allowances and produces a market price for emissions.⁴³ The price sways the decisions companies make about their fuel sources and catalyzes research and innovation. Policymakers reduce the emissions cap over time to keep GHG emissions trending downward and maintain pressure on polluters to make continued cuts.

Cap-and-trade pros and cons

Cap-and-trade programs have advantages and disadvantages. They provide certainty about emission levels, via the cap.⁴⁵ They have been politically palatable enough to be adopted in numerous jurisdictions. Programs that auction off emission allowances (such as the northeastern and mid-Atlantic states' Regional Greenhouse Gas Initiative – see page 26) generate revenues that can be used for various public purposes.⁴⁶ These purposes can include spending on investment in clean energy, targeted support for disadvantaged groups, the payment of dividends or energy rate relief to households or reduc-

tions in budget deficits or in other taxes.⁴⁷ So-called cap-and-invest programs specifically invest revenues from allowances toward clean energy policies and technologies that can further cut emissions.⁴⁸ Cap-and-trade programs can thereby help meet environmental, economic and social policy goals.

Cap-and-trade does not, however, let policymakers know up front how much it will cost polluters to achieve emissions reductions, and hence how much an overall cap on carbon emissions would cost economy-wide, since the price of traded allowances is set by the market.⁴⁹ (This is the reverse of how carbon taxes operate – see page 13). Policymakers can lay out a timeline to tighten the cap and keep GHG emissions on a downward trajectory, which can drive allowance costs upward.⁵⁰ To insulate industry from large fluctuations in traded allowance prices, and help them anticipate their compliance costs, policymakers can adopt price ceilings and floors, or other cost-containment mechanisms.⁵¹ These are featured in some existing programs, but if implemented in ways that increase the amount of allowable pollution – either temporarily or permanently – cost-containment mechanisms can undermine the effectiveness of the programs in reducing emissions.



Note: one allowance equals one metric ton of CO₂ equivalent (MTCO₂e).

Figure 1: GHG allowance budgets (cap) under California's cap-and-trade program⁴⁴

Especially in the absence of a price floor, cap-and-trade programs can also be unpredictable in the amount of revenue they generate – a big challenge if policymakers come to depend on cap-and-trade revenue to finance emissions reduction programs or other public benefits. In California, for example, the economic turmoil resulting from COVID-19 led to a collapse in carbon prices and dramatic reduction in the amount of revenue flowing to the state for use in programs to promote clean energy and reduce emissions.⁵²

Designing cap-and-trade programs is a complex process. Besides questions of scope, policymakers must also determine target levels and timelines for emissions reductions, assess whether and how to give away and/or auction

allowances, and decide timeframes for using allowances (i.e., whether allowances can be “banked” for the future or “borrowed” from the future, and over what period unused allowances must be surrendered).⁵³ In addition, governments need to decide whether to allow firms to use cheaper offsets (verified emissions cuts that occur outside of the segments of the economy covered by the cap) to meet their obligations and must manage complementary regulation also targeting carbon emissions.

The more complex cap-and-trade programs are, the harder it is for the public to understand and support them, and the easier it is for polluters or others to manipulate or game them. In its early stages, for example, China and other countries took advantage of the

Examples of carbon pricing programs

European Union Emission Trading System (ETS).

The EU ETS is a cap-and-trade program set up in 2005 under the Kyoto Protocol, a treaty under the 1992 UN Framework Convention on Climate Change (UNFCCC) that required industrialized and emerging economies to limit and cut GHG emissions according to agreed targets.⁵⁶ The EU ETS covers major energy-using power plants and industrial facilities producing about 40% of EU GHG emissions.⁵⁷ The U.S. National Academy of Sciences concluded that the EU ETS has cut EU CO₂ emissions by 3.8% over a no-ETS scenario and saved 1 billion tons of emissions from 2008 to 2016.⁵⁸ The program began auctioning allowances in 2013; this generated over 11.8 billion euros of revenue from 2013-15, most of which EU member states invested into climate and clean energy programs.⁵⁹

British Columbia Carbon Tax. In 2008, British Columbia implemented an initial tax of \$10 Canadian (\$9.38 U.S.)/ton of CO₂ equivalent (tCO₂e) on the purchase and use of fossil fuels.⁶⁰ Provincial authorities raised the tax over time, reaching \$40 Canadian (\$30.15 U.S.)/tCO₂e by 2019, and it now covers about 70% of the province’s CO₂ emissions.⁶¹

The tax appears to have been effective in reducing emissions, and revenues have been used for tax credits for lower-income households and for tax cuts.⁶²

The Regional Greenhouse Gas Initiative (RGGI).

RGGI is a cap-and-trade system covering power sector emissions in Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, Vermont, and Virginia (as of January 1, 2021), and Pennsylvania is considering joining.⁶³ RGGI conducted its first auction of CO₂ allowances in 2008. The program reduced the emissions cap by 2.5% annually from 2015 to 2020.⁶⁴ Cumulative auction proceeds from the program have reached nearly \$4 billion.⁶⁵ RGGI is a cap-and-invest program, so states use their auction proceeds mainly to fund investments in energy efficiency, renewable energy and GHG abatement programs. Proceeds also fund direct bill assistance, to improve program equity. RGGI includes both upper and lower limits on allowance prices.

See **Carbon Pricing in Practice**, pages 25-28, for more detail.

European ETS through excessive use of inadequately monitored offsets, which effectively gave the EU a false “benefit” of recording emissions reductions, without the expected net reductions actually happening (see page 24).⁵⁴ Governments therefore need to provide strong oversight to ensure the system works correctly.⁵⁵ Deciding all of these issues requires substantial resources, expertise and sophisticated modeling, but is well within the capacity of capable and effective governments.

Despite these complexities, California, the northeastern and mid-Atlantic states, the EU and other jurisdictions have adopted cap-and-trade programs, given their emissions reduction potential. These jurisdictions’ experiences with their programs have been generally but not universally positive (see pages 25-28).

Carbon tax programs

A carbon tax differs from cap-and-trade by setting a direct price on carbon emissions, usually by establishing a tax rate per ton of carbon emitted, or on the carbon content of fossil fuels. Carbon taxes aim to secure cost-effective emissions reductions and correct the market failure occurring when the price of damages from carbon emissions – also known as the social cost of carbon – is not included in the price of fossil fuels.⁶⁶ A carbon tax sends a price signal to polluters to shift to lower-emissions alternatives and invest in innovation, as well as to households to shift to purchasing products produced with lower carbon inputs. The tax leaves it to the market, via individual decisions by firms and households, to determine how much emissions will be reduced by the program (though carbon tax programs can be designed with automatic adjusters that increase or decrease the tax depending on the trajectory of emissions).

A key difference, therefore, between a carbon tax and a cap-and-trade program is that a carbon tax provides certainty to emitters about costs, but uncertainty for policymakers about how much emissions will be reduced, since there is no emissions cap or limit. Policymakers use modeling to anticipate how much emissions will drop at different tax levels.

What should a carbon tax cover?

A carbon tax ideally should have the broadest possible scope. A well-designed upstream/midstream tax, for example, could cover a large proportion of U.S. GHG emissions. The EPA estimated the U.S. emitted 5,903 million metric tons of CO₂ equivalent (MMTCO₂e) in net GHG emissions in 2018.⁶⁷ Applying a tax to the points where carbon fuels enter the economy would be an efficient approach, since this covers a limited number of facilities – for example, the tax could be applied to the roughly 710 coal mines, 140 oil refineries and 551 natural gas processing plants in the U.S.⁶⁸ This would cover most major emissions sources of GHGs in the country.⁶⁹

Alternatively, a program targeting the over 8,000 facilities monitored under the EPA’s Greenhouse Gas Reporting Program (GHGRP) could cover 85-90% of U.S. GHG emissions.⁷⁰ Of these facilities, about 7,600 entities emit over 25,000 metric tons of CO₂e annually, primarily in the electricity and industry sectors, and account for about 50% of U.S. GHG emissions.⁷¹ The additional 1,000+ reporting entities include suppliers of fossil fuels and industrial gases, accounting for most emissions in the transportation, commercial and residential sectors, or about 40% of total U.S. emissions.⁷² An upstream/midstream approach focusing on these entities would be far simpler to administer than a downstream tax, which would need to cover hundreds of thousands or potentially millions of sources.

Using an upstream/midstream tax does involve a trade-off, in that these taxes are less visible to the consumer (wherein big polluters would pass on fees to consumers, who then pay indirectly) than downstream taxes (under which the consumer would pay the tax directly). This helps politically in advocating for upstream/midstream taxes but has the downside of making the cost of climate pollution (and the value of clean energy) less clear to the population than would a downstream tax.

A “carbon” tax can also be designed to include all major greenhouse gases. Carbon dioxide accounted for 81% of U.S. GHG emissions in 2018, with methane, nitrous oxide and fluorinated gases making up the remainder.⁷⁴ A carbon tax could be designed

broadly, to capture more of the non-CO₂ sources of greenhouse emissions, or emissions outside of the energy supply chain – such as methane produced by livestock or landfills – but this would add to program complexity and the number of sources that would need to be monitored. A downstream tax could potentially cover these sources, though this would likely be resource-intensive to implement.

Setting carbon tax levels

A central question for carbon taxation is how tax levels should be set. Several approaches have been proposed. The most effective, simplest approach is to set the level to hit a societally adopted emissions reduction target. Using this approach, policymakers need to assess emission reductions goals and then establish an initial tax level. Many proposals assume initial tax levels will be set low, to avoid heavy cost shocks to firms, and rise over time to generate greater reductions and maintain firms’ incentives to switch to lower carbon energy sources. The amount of the tax also would likely need to increase as “low-hanging fruit” emission reductions are achieved first, leaving more challenging and expensive reductions for later years.

Multilateral organizations such as the OECD, economists and other academics, some think tank experts, and a few environmental organizations (for example, Environmental Defense Fund) propose using the social cost of carbon to set tax levels.⁷⁵ Other academics and many environmental groups have criticized this approach as impractical, however, since multiple studies conclude an SCC cannot be estimated with enough precision to be an effective policy tool.⁷⁶

Models developed to assess the range of environmental, social and economic costs of carbon emissions use widely varying assumptions and inputs, producing a dizzying array of SCC estimates – ranging from as little as \$0 to as much as \$2,000/ton of carbon emissions.⁷⁷ In 2010, the Obama EPA estimated the U.S. SCC at \$45/ton, but the Trump administration in 2017 quickly changed assumptions and slashed the estimate to \$1-6/ton.⁷⁸ Some environmental groups estimate the SCC at around \$50/ton in current dollars, but caution this doesn’t include all environmental damages from carbon emissions.⁷⁹ Given the imprecision involved, an SCC is not an effective tool for setting carbon tax levels.

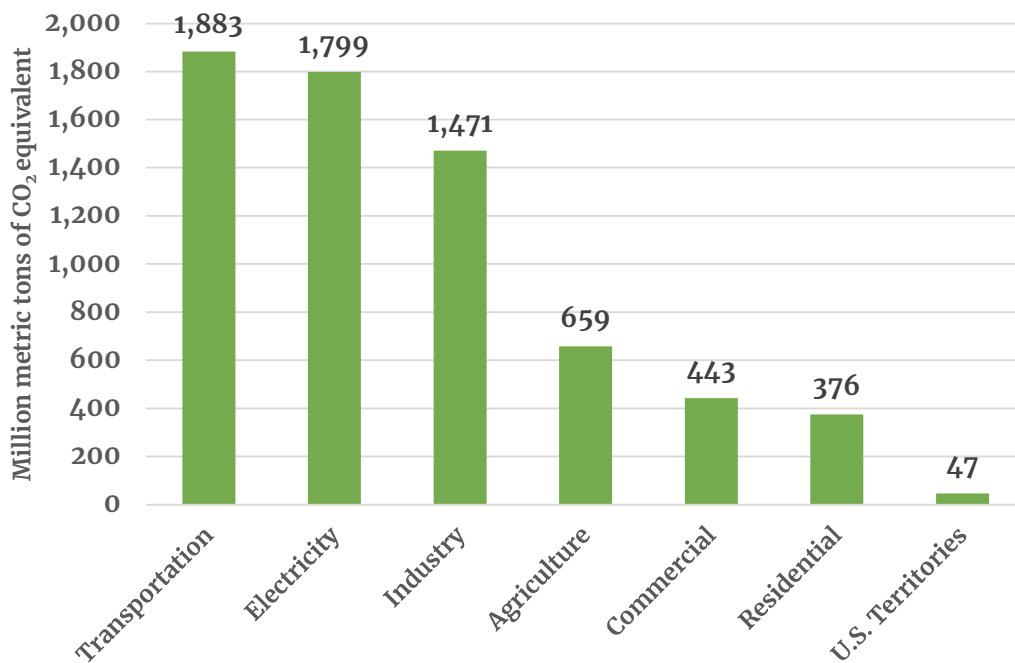


Figure 2: U.S. GHG emissions by economic sector, 2018⁷³

The best approach, used in some existing carbon tax programs and proposals, is to set tax levels to target specific emissions reductions goals.⁸⁰ Some programs, including in Canada, include so-called backstops, whereby policymakers can adjust the tax rate or impose new taxes if reduction goals are not met.⁸¹

A new study elaborates on the approach of using emissions reduction goals to set tax levels on the way toward net zero emissions. The authors conclude this “near term to net zero” (NT2NZ) emissions approach is more concrete, transparent and consistent than SCC-based pricing. They project that targeting net zero carbon levels in the U.S. by 2050 would require carbon taxes of \$34 to \$64 by 2025 and \$77 to \$124 by 2030.⁸² They advocate the NT2NZ approach within a broader set of regulatory policies as the most effective approach to cut emissions. This approach is promising in offering an effective framework for implementing carbon taxes. This process also would require sophisticated modeling but could generate a more reliable emissions reduction trajectory than is possible with an SCC.

Carbon tax pros and cons

Carbon taxes move an economy toward a net zero carbon path and stimulate investment in clean energy technologies, allowing governments to meet environmental goals. Carbon taxes boost demand for clean energy and assets and provide new economic opportunities in new markets. Carbon taxes are efficient, since they set a simple price signal. This makes them a cost-effective way to generate emissions reductions,

potentially putting less of a financial burden on firms than other, more complex regulations. Governments can advertise this cost-effectiveness to build political support for carbon tax programs.⁸⁴

Carbon tax programs are generally simpler to administer than cap-and-trade programs. Another advantage of carbon tax programs is that they can have a very broad scope, for example including all major fossil fuels producers and users, as well as potentially other industry sectors that produce greenhouse gases.

Carbon taxes also can generate enormous revenues. U.S. proposals for an economy-wide carbon tax project it would produce annual revenues of hundreds of billions of dollars.⁸⁵ These revenues could be used for a range of purposes – they could be reinvested into clean energy technology deployment and innovation, be invested for other public purposes, come back to households as a dividend or improve governments’ fiscal positions (see pages 19-21).

However, because they involve a highly visible up-front cost, while benefits are more diffuse, carbon taxes provide a focal point that opponents of the policy can target. This can make securing political support for carbon taxes more difficult and has stymied or undone carbon tax proposals within the U.S. and elsewhere. Given this, plus the challenges with program complexity, carbon taxes, like cap-and-trade programs, are **best used within a larger framework of policies to promote emission reductions, including regulation, clean energy investment, tax credits, subsidies, and other taxes.**

What is a border tax adjustment/border carbon adjustment?

A border carbon adjustment (BCA) or border carbon tax (BCT) is intended to assist firms vulnerable to international competitors who do not face a carbon tax or cap. A BCA involves applying an import tax to selected energy-intensive imports and paying domestic firms for carbon tax-related costs they incur in manufacturing goods for export from the United States.⁸³ (See page 22.) A BCA would pressure trade partners to adopt similar carbon pricing policies. It also could reduce carbon or emissions leakage, whereby a carbon tax or cap induces polluting industries to cut emissions in the U.S. but then move production and jobs to areas without carbon taxes, potentially increasing emissions abroad.

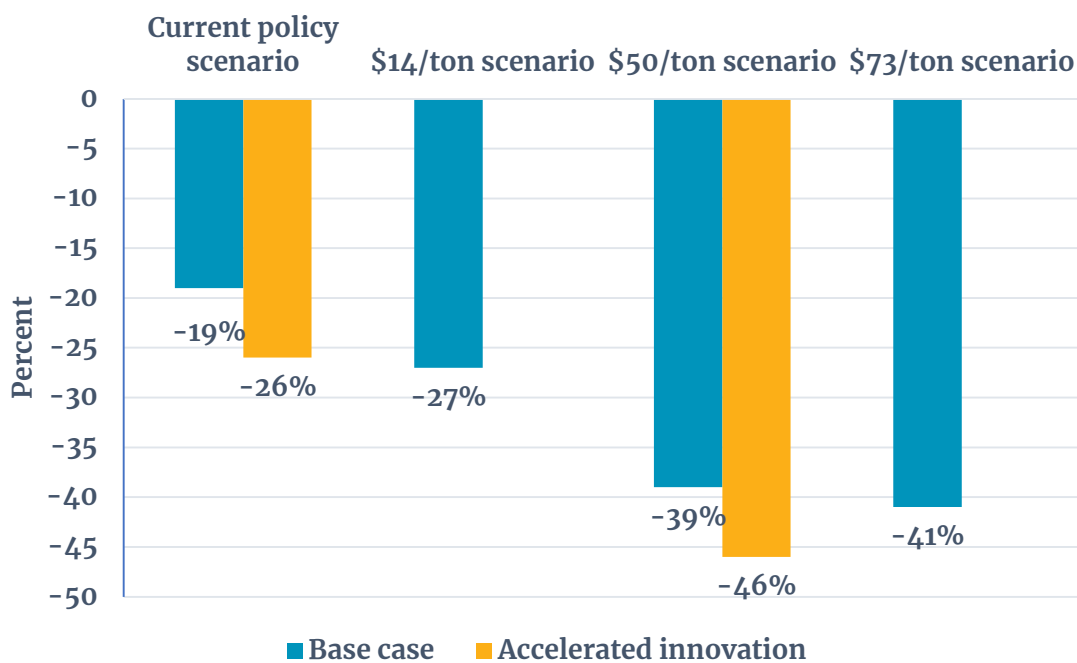
Considerations for implementing a carbon tax

Emissions impacts

Numerous studies have estimated the impacts of potential carbon pricing programs on emissions, as well as examining the economic, social and equity impacts. Many authors have focused on carbon taxes. A 2018 report by the Center on Global Energy Policy (CGEP) at Columbia University's School of International and Public Affairs examined three U.S. carbon tax pricing scenarios.⁸⁶ The group modeled the analysis after recent U.S. congressional proposals and assumed a tax beginning in 2020 that would apply to all CO₂ emissions from fossil fuel combustion or consumption, plus meth-

ane emissions from fossil fuel production, covering about 80% of U.S. GHG emissions. This tax would be applied at the point of production or importation (upstream) and would be accompanied by a border adjustment on imports and exports of energy-intensive products to protect domestic producers from competitors in other countries without such a policy. (See "What is a border tax adjustment/border carbon adjustment" on page 15.)

The three CGEP scenarios used initial taxes of: \$14/ton of CO₂ emissions, rising 3% annually; \$50/ton, rising 2% annually; and \$73/ton, rising 1.5% annu-



Note: Current and \$50/ton scenarios show a range of emissions reduction depending on the pace of clean energy innovation where reduction is deeper (orange range) if innovation is faster than expected.

Figure 3: Emissions reductions by 2030 under different CGEP carbon tax amounts (% change from 2005 levels)⁸⁸

ally. CGEP concluded that the taxes would drive reductions in U.S. GHG emissions of between 27% and 46% below 2005 levels by 2030, versus 19% to 26% under the current (no tax) policy scenario.⁸⁷

Under the mid-range, \$50/ton scenario, which the authors deemed the most practical, CGEP projected emissions would drop 3.5%/year, falling to 39% to 47% below 2005 levels by 2030.⁸⁹ This compares favorably to IPCC estimates that emissions would need to fall by 45% worldwide by 2030 (albeit from 2010 levels) on the way to net zero global emissions by 2050, to limit warming to 1.5°C.⁹⁰

Other rigorous studies show similar results. A 2018 Stanford Energy Modeling Forum (EMF) exercise used 11 models to project GHG reductions under different carbon tax scenarios, using varying assumptions. The EMF 32 study projected that a carbon tax of \$25 in 2020 rising 1% annually would reduce CO₂ emissions 17% to 38% below 2005 levels by 2030.⁹¹ A carbon tax of \$50 in 2020 rising 5% annually would cut emissions 26% to 47% below 2005 levels by 2030.⁹²

CGEP projects a \$50/ton tax would drive a massive drop in coal production, a minor reduction in oil and natural gas production, and major increases in renewable energy usage versus the current policy scenario.⁹³ About 80% of reductions would come from the power sector (mostly due to plummeting coal usage), with industrial emissions dropping 9%, building emissions 5%, and transportation emissions only 3%.⁹⁴

A large proportion of U.S. GHG emissions, however, are produced by the transportation sector – 28% in 2018.⁹⁵ Given this, the CGEP outcome showing only a small reduction of transportation emissions reaffirms the position that **a carbon tax should be accompanied by complementary regulatory policies to achieve long-term emission reduction targets.**

In the transportation sector, the slow timing for capital stock turnover of vehicles and development of low-carbon transportation infrastructure is a key reason for the need for complementary policies. Vehicle purchasers likely are not thinking about a potentially strong

price signal 10 years from now in deciding which car to buy today. Their decision will lock in their carbon emissions from the vehicle for years to come, however. Similarly, the ability of people to enjoy low-carbon transportation choices such as rail transit, walking and biking 10 or 20 years from now will depend more on infrastructure investment decisions made today than on a near-term carbon price. While imposing a rising carbon price can help change consumers' future expectations (and therefore their decisions), accompanying this with additional regulatory policies and forward-looking public investment decisions could accelerate the decarbonization process significantly.

Economic and social impacts

The CGEP study projected that overall macroeconomic impacts of implementing a carbon tax would be modest. U.S. Gross Domestic Product (GDP) would be affected by less than 0.6% annually across all scenarios from 2020-30; the impact could be positive or negative, depending on how revenues are used.⁹⁶ The study projected GDP would increase slightly for the \$50/ton scenario if revenues were returned as payroll tax cuts (which would be regressive), but decrease slightly if revenues were rebated to the public or used for deficit reduction.⁹⁷ The study asserts that consumption and employment would follow paths similar to this under the \$50/ton scenario.

The Stanford EMF study showed similar results, projecting GDP would be only about 1.0% lower each year in future years after the application of a carbon tax at different levels, versus the current policy scenario.⁹⁸ Note that negative GDP impacts would be greater if the models did not incorporate a border adjustment to protect U.S. firms from international competitors not facing a carbon tax. In this context it is important to note that the GDP impact of global warming damage if a tax is *not* imposed is likely to be greater – one study noted that if the U.S. does not implement extensive climate change mitigation measures, GDP in 2100 could be 10.5% lower than would otherwise be the case.⁹⁹

Projected social and equity impacts of carbon taxes on households depend greatly on plans for how revenues

would be used. Carbon taxes are viewed by some stakeholders as regressive, under the assumption that costs of the tax would be passed forward entirely to households. While both higher and lower income households likely would pay more for energy, energy costs are a greater percentage of income for lower income households, so price rises would have a greater proportional impact on them. Lower-income households could also be affected by indirect impacts of carbon tax programs, for example if labor patterns change and jobs are displaced.

CGEP projects direct carbon tax costs would be passed down to households under the \$50/ton scenario, but with only moderate impact on household energy costs.¹⁰⁰ Prices for gasoline, diesel and natural gas would be slightly higher in 2030 than under the current scenario, but within the ten-year range of prices experienced between 2008 and 2018.¹⁰¹ Electricity prices would be around 20% higher, with coal prices far higher, than the 2008-18 range.¹⁰²

However, redirecting or “recycling” some of the revenues back into cutting other taxes or public investments can improve public welfare. Several

studies show directing some or all of revenues into household rebates would eliminate most regressive impacts of carbon taxes (see page 20).¹⁰³

High levels of projected revenues

Multiple analyses have shown a carbon tax in the range of \$50/ton would generate large annual revenues. CGEP projected a tax at that level would generate \$180 billion/year in net new federal receipts, after accounting for the fact that non-carbon tax revenues would fall slightly.¹⁰⁴ (CGEP maintains revenue would stay roughly constant year to year, since increases from the rising tax rate would be balanced out by decreases as emissions decline). The Stanford EMF 32 study projected revenues of \$200 billion/year at the outset of the policy with a \$50/ton tax, rising slightly over time and with total revenues over the 2021-2030 period of between \$2.03 trillion and \$2.48 trillion.¹⁰⁵ In both cases, the revenue produced by a carbon tax is substantial but relatively small when compared with all federal spending, which in fiscal year 2019 totaled \$4.4 trillion.¹⁰⁶

Photo: American Public Power Association courtesy of Unsplash



Solar installation in Indiana. Existing carbon tax and cap-and-trade programs have devoted a share of revenues toward the expansion of clean energy sources such as solar power.

How should carbon pricing revenues be used?

Economists and policymakers have considered many options for using revenues from either cap-and-trade programs or carbon taxes, balancing environmental, economic, social and political concerns. Options used or discussed include investment in clean technologies and climate adaptation, a dividend to households, a “tax swap” to reduce taxes on capital and/or labor, and reversion to the government’s general fund for deficit reduction or other spending.

Investment

A U.S. federal carbon tax or state level taxes should prioritize investment of revenues in clean energy as a way to maximize progress in reaching emissions goals. Many stakeholder groups support such investment while also backing the use of some funds to ensure that lower-income households are not disproportionately hit by higher energy prices, or to support communities that have historically suffered from environmental contamination.¹⁰⁷ In addition, some groups support using revenues to facilitate an economic transition in communities facing job losses from reduced fossil fuel production.

Existing cap-and-trade and carbon tax programs have directed substantial revenues to clean energy investment, with positive outcomes. Cap-and-trade programs in the EU (EU ETS), California, the northeast and mid-Atlantic states (the Regional Greenhouse Gas Initiative - RGGI) and Quebec all funnel much or all of their auction revenues into various energy efficiency, renewable energy and GHG abatement

programs. Studies suggest these investments contribute to emissions reductions, reduced consumer electricity bills, and expanded critical public services like public transportation.¹⁰⁸ (See pages 25-27). British Columbia, for example, which imposed a carbon tax in 2008, directs revenues to several uses, including green initiatives such as programs to improve industrial energy efficiency.¹⁰⁹

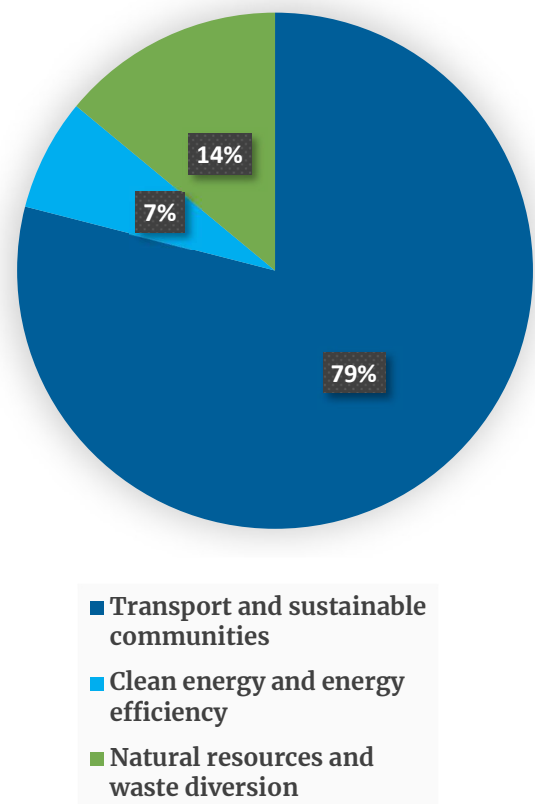


Figure 4: California’s cap-and-trade auction revenue use, 2018¹¹⁰

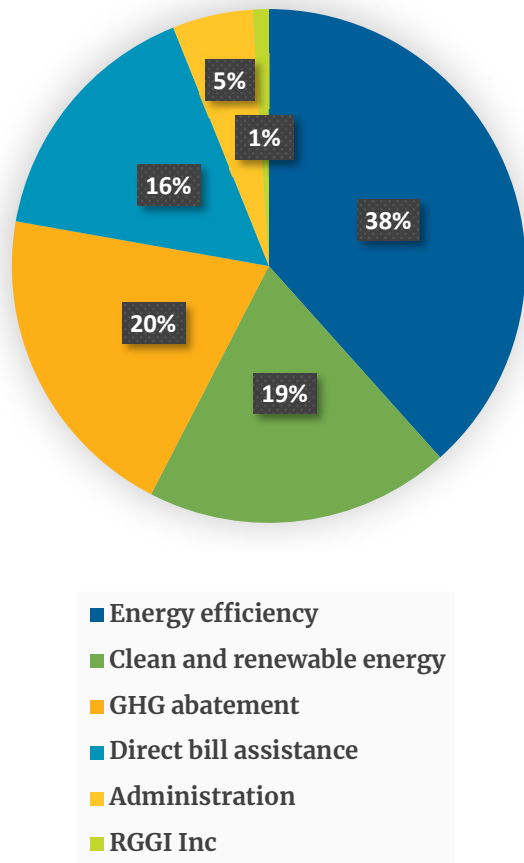


Figure 5: Regional Greenhouse Gas Initiative states' auction revenue use, 2018¹¹¹

Household dividend/rebate

Carbon dividends create an opportunity to distribute money back to households. Equal dividends could provide money to households across all income groups, in similar fashion to the Alaska Permanent Fund, which sends annual payments derived from oil to all Alaskans.¹¹² This supports the principle that the atmosphere is a common resource, and compensation for polluting it should be shared equally. Dividends could invest millions of Americans further into the zero-carbon transition, and thus make a carbon pricing policy harder to unwind.¹¹³

Much as a carbon price would have a larger relative impact on the budget of low-income households, a carbon dividend, allocated equally across all households, would be progressive in replacing a larger share of the

income of those households. Carbon pricing dividends also could be targeted to help people in vulnerable groups, such as lower income households and communities affected by the transition from high-carbon to low-carbon energy sources (e.g., coal mining towns).

The CGEP study found that under the \$50/ton carbon tax scenario, using revenues for equal household rebates produced a progressive outcome, with lower-income households (bottom two U.S. income quintiles) seeing a significant reduction in tax burden, while medium or higher income households (top three U.S. income quintiles) faced a neutral or slightly higher tax burden. Other revenue options, including use for a payroll tax cut, corporate income tax cut or deficit reduction, were regressive, costing lower income households proportionally more than higher income households.¹¹⁴ The CGEP study projects that protecting lower-income households from regressive impacts could be done with about 10% of carbon tax revenues.¹¹⁵

Tax swap

Some proposals suggest using carbon pricing revenues for a swap to reduce taxes on capital and/or labor, including payroll or corporate tax cuts. These uses of revenues by themselves do not advance the overall carbon pricing goal of reducing emissions, nor do they necessarily enhance equity. Proponents argue that tax swaps can help lower economy-wide costs of a carbon tax or cap, including compliance costs for firms or indirect costs which could affect labor supply, investment or long-run growth.¹¹⁶ They point to studies that suggest targeting these tax reductions could reduce some distortionary impacts of certain taxes on the economy, but generally acknowledge that different revenue uses can produce social outcomes that may be regressive or worsen equity in some respects, i.e., hitting some part of the population proportionally harder than others.¹¹⁷ Cutting payroll or corporate income taxes may lower costs of a carbon tax to the firms involved, for example, but worsen equity outcomes. The overall impacts of potential tax swaps on equity remain unclear and dependent on the particular circumstances.

General fund/deficit reduction

Directing revenues to the U.S. Treasury general fund, primarily for deficit reduction purposes, is an option favored by some to enhance fiscal responsibility and reduce interest costs to the government. While a tax swap would have rapid economic impacts, deficit reduction would provide longer-term benefits in the form of reduced interest payments and greater fiscal flexibility for future generations. Some existing carbon pricing programs abroad use this option, and it is featured in several proposals for a U.S. carbon tax. Carbon tax revenues, however, would make only a minor dent in the deficit. The U.S. fiscal deficit has become extremely large, particularly after COVID pandemic-related spending – the Congressional Budget Office (CBO) estimates it will reach \$3.3 trillion in 2020, or 16.0% of U.S. GDP – while initial annual revenues from an economy-wide carbon tax are projected at \$200 billion or less.¹¹⁸

Other carbon pricing design issues

There are other design factors policymakers need to address in considering carbon taxes, some of which also apply to cap-and-trade programs. These include:

Carbon leakage and competitiveness

Many stakeholders have raised concerns that applying a carbon price in the U.S. could generate carbon or emissions “leakage,” whereby the tax induces polluting industries to cut emissions in the U.S. but then move production, jobs and emissions to areas without carbon taxes. This would generate dual negative policy outcomes – harming U.S. economic activity while not reducing global emissions. A related concern is that a carbon tax would raise prices for domestic manufacturers while not impacting prices of goods produced abroad (in countries without a carbon tax), putting U.S. firms at a competitive disadvantage. If not addressed, this could harm profitability of some industries, reduce their market share, and result in loss of U.S. jobs.¹¹⁹

To address these concerns, multiple carbon pricing proposals incorporate a border carbon adjustment (BCA), also called a border carbon tax (BCT).¹²⁰ (See page 15.) A separate approach to addressing competitiveness losses from carbon taxes, so-called output-based rebating, would provide rebates to emission-intensive firms for tax payments in proportion to the firms’ output. Studies suggest, however, that output-based rebates would be less effective in reducing carbon leakage and less cost-effective than BCAs.¹²¹ Most recent proposals therefore feature BCAs as the preferred option to address competitiveness and leakage.

Another approach to preserving competitiveness in state-level proposals has been to exempt certain export-oriented industries from carbon tax programs or bring them under the program in phases. A ballot initiative proposing a carbon tax in Washington state (Initiative 1631) included exemptions for aircraft manufacturer Boeing (the state’s biggest employer), large aluminum manufacturer Alcoa, and pulp-and-paper mills.¹²² Such exemptions reduce the effectiveness and scope of a carbon tax and should be minimized. BCAs could be viable competitiveness measures at the state level, if designed so as to avoid constitutional provisions against measures restricting interstate trade.¹²³

Some stakeholders, including industries impacted by carbon taxes, say BCAs violate World Trade Organization (WTO) rules against protectionist tariffs, though this is not yet legally settled. BCAs would be among the most complex elements of carbon pricing programs to administer, with impacts across many economic sectors. The EU is nevertheless considering a BCA on imports competing with EU producers subject to ETS restraints. As of early 2021, neither the EU nor any individual countries have overcome the legal and technical challenges to imposing a BCA.¹²⁴

Non-energy carbon dioxide emissions, other greenhouse gases and sequestration

Policymakers also must assess whether to make a carbon price more comprehensive by extending it to non-energy sources of CO₂, such as agricultural and forestry land use, industrial processes and waste processing. These produce methane, nitrous oxide and

fluorinated gases, which together account for almost 20% of U.S. GHG emissions.¹²⁵ Expanding the scope of carbon pricing to these sectors and emissions would increase reductions but also add to the complexity of the program.

Experts suggest such an expanded tax program should include tax credits for measures to sequester carbon, through carbon capture and storage technology (CCS), forestry land use or other means.¹²⁶ Using forestry land for sequestration in some cases can be constructive, although measuring additionality – the net extra emissions that sequestration would remove – is difficult. This potentially would be easier to administer as a separate program from a carbon tax.

Promoting biological capture and sequestration of carbon could help to remove carbon from the atmosphere, and thereby advance overall emissions reduction goals. CCS technology for fossil fuel facilities, on the other hand, could legitimize and create momentum for continued fossil fuel use – which policymakers should avoid – while leakage of technologically sequestered carbon could pose health risks to humans and wildlife.¹²⁷ Currently, the Internal Revenue Service offers a tax credit for carbon sequestration, intended primarily to promote investment in CCS technologies by major coal and natural gas producers as well as large industrial facilities. As of March 2020, nine major U.S. facilities had injected significant amounts of CO₂ into geological formations for long-term storage.¹²⁸ No facilities are yet conducting large-scale CCS strictly for the purpose of carbon removal, however, and the technology remains embryonic.

Exemptions

Many carbon pricing programs have exempted certain industries and sectors for political and other reasons, reducing their coverage. The EU ETS, for example, covers only 40% of EU GHG emissions, while Canada's provincial programs cover between 47% and 90% of emissions per province.¹²⁹ California's cap-and-trade program covers a hefty 85% of state emissions.¹³⁰ The northeast and mid-Atlantic states' program was intended only to include power plants, and so cov-

ers about 19% of regional emissions.¹³¹ There may be substantive reasons for exemptions in some programs, or they may have been deemed necessary for political purposes. Nevertheless, the use of carbon pricing exemptions should be minimized to ensure programs can achieve emissions reduction goals.

Offsets

Carbon offsets, designed to allow polluters to meet emissions targets by purchasing emissions reductions from unregulated sectors of the economy, have proven difficult to implement in ways that deliver real emission reductions and prevent environmental harm. Offsets, included in many international cap-and-trade pricing programs, in theory allow polluters to reduce emissions elsewhere, usually in developing countries. Offsets essentially replace the “polluter pays” mechanism of carbon pricing programs with the option to pay entities “not to pollute.” While this is intended to achieve the same net reduction at lower cost for the polluter, it is hard to measure “non-pollution” as effectively as actual pollution, and offset programs face difficulties in assuring that emissions reductions are real, additional, quantifiable, permanent, verifiable and do not contribute to other environmental harm.¹³² An additional concern is that as countries build out carbon pricing programs to cover almost all of the economy, there are fewer potential offset sources outside of the system, making them less viable as an emissions reduction approach.

The UN maintains two programs to generate offsets, either through investment in wind and solar energy (Clean Development Mechanism – CDM) or via forestry land use (Reducing Emissions from Deforestation and Forest Degradation – REDD). The EU ETS has used both mechanisms but does not anticipate continuing to use such international credit programs in the future.¹³³ California uses five categories of offsets in its cap-and-trade program: U.S. forest projects, livestock projects, ozone depleting substances projects, urban forest projects and mine methane capture.¹³⁴

While those designing offset programs have sought to include stiff rules aiming to ensure effectiveness, studies have shown offsets do not produce major GHG

emission reductions and are subject to significant levels of misuse.¹³⁵ A proposed U.S. cap-and-trade system in the Waxman-Markey bill, which passed the House of Representatives in 2009, included offsets that analysis showed would not generate real emissions reductions.¹³⁶

Since offsets are often located in developing countries, accountability and control over them is often limited. In some cases, offsets have been gamed for profit in ways that could raise emissions. The U.S. General Accounting Office conducted studies in 2008 and 2011 showing the EU ETS issued too many allowances and employed offsets of unverifiable quality, contributing to low allowance prices.¹³⁷ The 2011 study also examined the high degree of difficulty in verifying that international offsets actually produced additional GHG reductions, noting the possibility of perverse outcomes of incentivizing new pollution in developing countries so polluters there could collect offset payments for subsequently reducing emissions.¹³⁸

In all, given that offsets are highly complex, subject to fraud, and even if legitimate may only be available in limited supply, they either should not be included in carbon pricing programs or be tightly limited to very few categories and very small amounts of total emissions.

Carbon pricing in practice

As global warming impacts increase, more governments around the world are embracing carbon pricing. As of May 2020, 46 countries and 32 subnational jurisdictions had implemented or scheduled for implementation 61 carbon pricing initiatives, of which 31 are cap-and-trade programs and 30 are carbon tax programs. All told, those programs cover about 22% of total annual global GHG emissions.¹³⁹ Internationally, carbon pricing programs operate in the EU, other European countries, South Korea, Mexico, Chile, Argentina, South Africa, New Zealand, in cities in China and Brazil and at multiple levels in Canada. In the United States, the Regional Greenhouse Gas Initiative (RGGI), a cap-and-trade program for 11 northeastern and mid-Atlantic states, began in 2009, while California launched its cap-and-trade program in 2013. Several of these programs are assessed below.

International carbon pricing programs

European Union Emission Trading System (ETS).

The EU ETS, a cap-and-trade program, is the world's first and largest carbon market.¹⁴⁰ The EU ETS was set up under the Kyoto Protocol, the treaty which operationalized the 1992 UN Framework Convention on Climate Change and required industrialized and emerging economies to limit and cut GHG emissions according to agreed targets.¹⁴¹ The EU ETS began operations in 2005, when the Kyoto Protocol entered into force.¹⁴² The EU ETS now operates in all EU countries plus other small European states and covers over 11,000 major energy-using power plants and industrial facilities that produce about 40% of EU GHG

emissions.¹⁴³ In its first two phases, from 2005 to 2012, the EU ETS had limited coverage and most allowances were free.¹⁴⁴ For its third phase, from 2013 to 2020, the EU ETS shifted to an EU-wide declining emissions cap versus prior national caps, moved to auctioning allowances, expanded the sectors and gases covered and incorporated internal aviation into the system.¹⁴⁵

The EU ETS has been effective in reducing EU GHG emissions, despite the fact that allowance prices have been lower than expected. Allowance prices were near 30 euros/ton (about \$35/ton) when allowance trading launched in 2008 but fell below 10 euros/ton from 2012 to 2018.¹⁴⁶ In 2019-2020, prices surpassed 20 euros/ton and hit 32.7 euros/ton (\$39.97/ton) in late December 2020.¹⁴⁷ EU officials assessed that EU member state governments issued too many allowances and included many exceptions for certain industries in early ETS stages. Member state governments have consequently tightened rules in recent years. A U.S. National Academy of Sciences analysis concluded that the EU ETS has been successful in reducing EU CO₂ by 3.8% over a no-ETS scenario, saving more than 1 billion tons of emissions from 2008 to 2016.¹⁴⁸ The program also generated large revenues – the European Commission reported that EU member states used over 80% of 2013-15 auction revenues, 9.65 billion euros, for investment into climate and clean energy programs.¹⁴⁹

Canada – British Columbia. In 2008, British Columbia implemented the first broad-based carbon tax in North America, applying an initial tax of \$10 Canadian/ton of CO₂ equivalent (tCO₂e) to the purchase

and use of fossil fuels. The tax has risen consistently, reaching \$40/tCO₂e in 2019.¹⁵⁰ The tax covers the purchase and use of fossil fuels, accounting for 70% of the province's GHG emissions.¹⁵¹ One study notes the tax appears to have been effective in reducing emissions, which averaged 6.1% lower from 2008-2013 than in 2000-2007, but it is difficult to confirm the reductions were due directly to the tax.¹⁵² The tax does not cover the electricity sector, but most electricity in British Columbia is generated via hydropower. Revenues have been used for rebates to lower-income households and for tax cuts, to maintain progressivity and industry competitiveness against firms outside of the province. Additional revenues from recent increases in the tax will also support clean energy programs in the province. British Columbia's lack of substantial heavy industry likely has contributed to the program's acceptance. The program remains relatively popular and does not appear to have harmed the economy or employment.¹⁵³

Carbon pricing in the United States

The Regional Greenhouse Gas Initiative (RGGI).

RGGI was the first mandatory cap-and-trade system in the United States, covering carbon dioxide emissions from the power sector in the states of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, Vermont and Virginia. (New Jersey joined the original program, left in 2011, and returned in 2020, while Virginia joined officially on January 1, 2021.)¹⁵⁴ Pennsylvania is also considering joining the program. RGGI was set up in 2005 and conducted its first auction of CO₂ allowances in 2008.¹⁵⁵ The program established a cap for emissions from power facilities over 25 MW in size (165 facilities in nine states, minus New Jersey and Virginia), revised the cap downward in 2014, and reduced the cap by 2.5% annually from 2015 to 2020.¹⁵⁶ On September 2, 2020, RGGI completed its 49th allowance auction, bringing total auction proceeds over the life of the program to \$3.66 billion.¹⁵⁷ RGGI is a cap-and-invest program, so states use their share of auction proceeds primarily to fund investments in energy efficiency, renewable energy and GHG abate-

ment programs. Proceeds also fund direct bill assistance for electricity costs, to improve program equity. RGGI includes both upper and lower limits on allowance prices.

RGGI has had positive results, but perhaps could have achieved more with stiffer targets. The Congressional Research Service (CRS) noted that studies from 2015 to 2018 showed the program produced significant benefits, including playing a role in achieving overall regional power sector emission declines of over 50% between 2005 and 2018, delivering net health benefits of \$5.7 billion and substantial net economic benefits.¹⁵⁸ However, emissions were well below the cap before 2014, and allowance auction prices have been low throughout the program's history (\$6.82/ton of CO₂ in the September 2020 auction).¹⁵⁹ Emitters secured more allowances than they needed and have banked allowances for future use. RGGI states cut the cap by 45% in 2014 to match actual emissions. CRS concluded that while the program's actual impact on national GHG emissions is limited, it can help guide design of other state or federal programs.¹⁶⁰

California Cap-and-Trade Program. California's cap-and-trade program, launched in 2013, is the fourth-largest emissions trading system in the world.¹⁶¹ It is the major element of the state's plan to reduce emissions 40% below 1990 levels by 2030 and 80% below 1990 levels by 2050.¹⁶² The program covers about 450 businesses, including large power plants and industrial facilities, as well as fuel distributors, accounting for around 85% of the state's emissions.¹⁶³ The emissions cap declined 3% annually from 2015-20 and will shrink 5% annually from 2021-30. Most allowances are distributed via quarterly auctions, with some allocated for free. California's program is linked to Quebec's cap-and-trade program, so businesses in one program can use allowances or offsets in the other for compliance.

The program is considered to have contributed to the 5.3% drop in California's GHG emissions from 2013 to 2017.¹⁶⁴ Allowance auctions generated \$12.5 billion in revenues by 2020.¹⁶⁵ The state has

amended revenue use rules several times, with laws in 2016 and 2017 directing that most revenues go toward reducing toxic air pollutants and promoting low- and zero-carbon transportation, sustainable agriculture, healthy forests and other environmental projects, while 35% of revenues must be directed toward assisting disadvantaged and low-income communities.¹⁶⁶

One problem with California's program, however, as is the case with other cap-and-trade programs, is that revenues have varied widely with economic cycles. During the COVID-19 recession, for example, revenues have dropped precipitously as energy use has fallen, since the marginal cost of emissions reductions needed to hit the emissions cap has plummeted. This has substantially reduced the resources available for the revenue goals outlined above.¹⁶⁷ In this sense, the program is almost a victim of its own success. On balance, though, California's cap-and-trade program has been successful and should continue to function well within the broader range of state policies intended to drive the state toward overall carbon neutrality by 2045.

Recent U.S. proposals

Carbon taxes have drawn increasing attention from a few prominent former Republican officeholders, as well as Democrats inside and outside of Congress and advocates across the political spectrum.¹⁶⁸ Several bipartisan proposals have been offered in Congress, and a bipartisan industry subcommittee of U.S. Commodity Futures Trading Commission issued a September 2020 report calling for adoption of a U.S. carbon tax and dividend program.¹⁶⁹

Federal proposals

Numerous federal carbon pricing plans have been proposed in the past several years. None have passed either chamber of Congress.

Baker-Schultz. The bipartisan Climate Leadership Council, which brought together James Baker, George Schulz, Henry Paulson, Martin Feldstein, Larry Summers, and Ernest Moniz – with support from major industry representatives and several large environmental NGOs – published a four-point carbon tax plan in

2017.¹⁷⁰ This would impose a gradually rising carbon tax that would return all revenues to Americans as a dividend, eliminate federal carbon regulations deemed to be unnecessary or duplicative, and assess a border tax adjustment to prevent loss of U.S. firm competitiveness and reduce carbon leakage. In January 2019, the Wall Street Journal published a letter signed by nearly 3,600 U.S. economists from both parties supporting the plan.¹⁷¹ Baker-Schultz has not been formally proposed as legislation.

Proposals introduced in 116th Congress (2018-20).

Twelve carbon pricing proposals were introduced in the 116th Congress (2018-20).¹⁷² None of these plans passed either chamber, but of them, 10 proposed carbon taxes, one proposed a cap-and-trade system, and one proposed a hybrid between a cap-and-trade system and an adjusting performance standard. In sum, the plans show how momentum has shifted toward carbon taxes as the preferable carbon pricing option versus cap-and-trade. The proposals differed on the proportion of U.S. emissions that would be covered, initial tax levels and rate of increase, point of coverage (upstream vs. downstream entities) and treatment of existing federal and state regulation on carbon emissions.¹⁷³ Nearly all of the proposals would have set tax levels to target emissions reductions, instead of using an SCC – which is also notable – and nearly all included a border tax adjustment. The bills proposed revenues be devoted to household dividends, investment in clean technology and infrastructure, capital or labor tax cuts, worker transition assistance, or other uses.¹⁷⁴

The plan introduced by Representative Ted Deutch (D-FL), among the most ambitious of newer proposals, would establish a national carbon tax, starting at \$15/ton of CO₂ and rising to near \$100/ton by 2030, covering nearly all energy sector CO₂ emissions.¹⁷⁵ It would rebate revenues as an equal dividend to households and suspend EPA regulatory authority in areas believed to be redundant with a carbon tax. A Columbia University study projected that if enacted, the bill would produce steep emissions reductions and produce a progressive tax outcome for households.¹⁷⁶

Most of the other proposals offered variations on these assumptions and projections. The final bill, introduced by Representative Sean Casten (D-IL), proposed an innovative hybrid between a cap-and-trade plan and adjustable performance standards that targets elimination of GHG emissions from the electric and industrial thermal energy emissions sectors by 2040.¹⁷⁷ These sectors accounted for about 40% of U.S. GHG emissions in 2018.¹⁷⁸

State proposals

Multiple U.S. states are considering or have recently considered carbon pricing proposals.

Transportation and Climate Initiative (TCI). This regional collaboration of 12 northeastern and mid-Atlantic states, plus the District of Columbia, focuses on improving transportation, reducing transportation sector emissions and promoting the clean energy economy.¹⁸⁰ Participating states include Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont and Virginia.¹⁸¹ TCI has bipartisan support across the region, including the Republican governors of Massachusetts and Maryland. Since 2010, TCI states have collaborated on projects to promote clean vehicles and fuels, sustainable communities and other topics.¹⁸²

In 2015, TCI states began to consider a regional cap-and-trade program for transportation that would target significant emissions reductions by 2030, as well as generate new economic growth and jobs.¹⁸³ In December 2020, Connecticut, Massachusetts and Rhode Island, plus the District of Columbia, signed a Memorandum of Understanding agreeing to launch the Transportation and Climate Initiative cap-and-trade program (TCI-P) in their jurisdictions by 2023.¹⁸⁴ Other states remain engaged in the process of developing the program and may choose to join at a later date.¹⁸⁵

Oregon cap-and-invest bills. The Oregon state government has been considering a carbon pricing plan through various initiatives since 2007.¹⁸⁶ By 2019, the legislature was focused on a general legislative approach

of creating an economy-wide cap-and-invest program that would set a decreasing cap in line with meeting Oregon's goals of cutting emissions 45% below 1990 levels by 2035 and 80% below 1990 levels by 2050.¹⁸⁷ As proposed in corresponding bills in the Oregon State House and Senate in 2018, the policy would have applied to about 100 large facilities and companies in the transportation, electric and gas utility and industry sectors, responsible for about 80% of Oregon's GHG emissions.¹⁸⁸ Allowances would have been auctioned, with revenues going to clean transportation projects, energy efficiency projects, adjustment assistance for affected workers, rate credits for low income households and climate projects in impacted communities.

In June 2019, House Bill 2020, which would have established the cap-and-invest program, was approved by the state House of Representatives. The state Senate prepared to vote on the bill, but the Senate's Republican minority fled the state, denying the quorum needed to vote on the legislation. In February 2020, the plan was reintroduced as Senate Bill 1530, revised to gain more support from rural communities. Nevertheless, after legislative wrangling, Senate Republicans again disappeared on February 24, 2020, denying a quorum for a vote on the revised proposal. Governor Kate Brown then signed an Executive Order March 10, 2020, aiming to use state regulatory powers to cap and reduce GHG emissions along the trajectory the legislative proposals would have covered. The state Department of Environmental Quality prepared a plan to develop specific elements of the program, which it released for public comment in July 2020.¹⁸⁹

Washington referenda. Voters in Washington state rejected consecutive carbon tax referenda, the first (Initiative 732) in 2016 and the second (Initiative 1631) in 2018, for a variety of reasons.¹⁹⁰ Both would have established ambitious programs and reduction timelines. Governor Jay Inslee proposed new legislation in 2020 to reduce emissions in other ways, but these bills did not pass in the 2020 legislative session.¹⁹¹

Table 1. Carbon pricing bills introduced in the 116th Congress¹⁷⁹

Proposal	Date introduced
CARBON TAX PLANS	
Energy Innovation and Carbon Dividend Act of 2019 (H.R. 763) introduced by a bipartisan House coalition led by Rep. Ted Deutch, D-FL	January 24, 2019
The American Opportunity Carbon Fee Act of 2019 (S. 1128) reintroduced by Sens. Sheldon Whitehouse, D-R.I., Brian Schatz, D-HI, Martin Heinrich, D-N.M., and Kirsten Gillibrand, D-N.Y.	April 10, 2019
The Climate Action Rebate Act of 2019 (S. 2284 and H.R. 4051) introduced by Sens. Chris Coons, D-Del., and Dianne Feinstein, D-CA., and Rep. Jimmy Panetta, D-CA.	July 25, 2019
The Stemming Warming and Augmenting Pay (SWAP) Act of 2019 (H.R. 4058) introduced by Reps. Francis Rooney, R-FL, and Dan Lipinski, D-IL.	July 25, 2019
The Raise Wages, Cut Carbon Act of 2019 (H.R. 3966) introduced by Reps. Dan Lipinski, D-IL, and Francis Rooney, R-FL.	July 25, 2019
The America Wins Act of 2019 (H.R. 4142) introduced by Rep. John Larson, D-CT.	August 2, 2019
The Modernizing America with Rebuilding to Kickstart the Economy of the Twenty-first Century with a Historic Infrastructure-Centered Expansion Act of 2019 (H.R. 4520) introduced by Reps. Ryan Fitzpatrick, R-PA., and Salud Carbajal, D-CA.	September 26, 2019
The Carbon Reduction and Tax Credit Act (H.R. 5457) introduced by Rep. Sean Patrick Maloney, D-N.Y.	December 17, 2019
The America's Clean Future Act (S. 4484) introduced by Sen. Dick Durbin, D-IL.	August 6, 2020
Consumers Rebate to ban Emissions and Boost Alternative Energy Act (H.R. 8175) introduced by Rep. Jerry McNerney, D-CA.	September 4, 2020
CAP-AND-TRADE PLAN	
The Healthy Climate and Family Security Act of 2019 (S. 940 and H.R. 1960) introduced by Sen. Chris Van Hollen, D-MD, and Rep. Don Beyer, D-VA.	March 28, 2019
HYBRID PLAN	
The Tradeable Performance Standard Act, introduced by Rep. Sean Casten, D-IL.	October 14, 2020

Table credit: Frontier Group

Recommendations

An extensive review of carbon pricing principles and programs worldwide shows that carbon pricing is an essential and effective tool to cut emissions. Both cap-and-trade and carbon tax programs have generated significant emissions reductions and substantial revenues for investment. Carbon taxes and cap-and-trade programs, at both the federal and state levels, hold promise as central elements of a broader regulatory framework to drive the U.S. toward net-zero greenhouse gas emissions by 2050.

Carbon pricing has great potential as a vital part of the U.S. policy toolkit to fight global warming. U.S. policymakers should adopt carbon pricing policies with the following elements:

1. Implementing carbon tax and cap-and-trade programs as part of a broad set of policies to address global warming.

- Strategies to address global warming should include use of existing regulatory powers (i.e., the Clean Air Act), reduction/elimination of fossil fuel subsidies, expansion of incentives/subsidies for renewables, research and development (R&D) investments, investments in green infrastructure and others.

2. Setting carbon tax rates and caps to target emissions reductions.

- Carbon pricing programs should use emission reductions timelines, rather than revenue targets or estimates of the social cost of carbon, to set tax levels or caps. This could include accepting

caps at levels above emission reduction targets, but that which generate revenue used to cut emissions further through investments.

3. Investing carbon pricing revenues into renewable energy, energy efficiency, green infrastructure and broad public benefits.

- Carbon pricing programs should direct revenues across sectors as part of overall efforts to decarbonize the economy, and to increase public awareness of the importance of carbon pricing in addressing GHG emissions.
- All other uses of carbon pricing revenues should benefit the public.

4. Ensuring the integrity of programs and preventing loopholes.

- Carbon pricing programs should include backstops that ratchet up prices or otherwise accelerate emission reductions if emissions targets are not met.
- Programs should ideally be comprehensive, covering the entire economy.
- Programs should include measures to prevent “carbon leakage,” e.g., via a border carbon adjustment/border tax adjustment.
- In the case of cap-and-trade, policymakers should adopt tight limits on offsets and ensure that any cost-containment provisions built into the program do not interfere with progress toward needed emission reductions.

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