ASSESSING U.S. CLIMATE POLICY OPTIONS

A report summarizing work at RFF as part of the inter-industry U.S. Climate Policy Forum

Executive Summary and Overview

RAYMOND J. KOPP
Resources for the Future

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Resources for the Future

Resources for the Future (RFF) is an independent, nonpartisan think tank that, through its social science research, enables policymakers and stakeholders to make better, more informed decisions about energy, environmental, and natural resource issues. RFF researchers have been engaged in climate change research and analysis for over 20 years. They are recognized, called-upon experts in the analysis and design of climate change policies and have played an influential role in advancing intellectually credible and politically sensible approaches to this challenging problem.

The Climate Policy Forum (Forum) is an initiative of the Climate and Technology Policy Program at RFF, which is funded by contributions from individuals, corporations, governments, and foundations. The Forum was supported by grants from the Doris Duke Charitable Foundation and the William and Flora Hewlett Foundation. The Climate and Technology Policy Program also received a special gift from the Center for Environmental Markets at Goldman, Sachs & Co. to support this work. The views expressed here are solely the responsibility of the authors and are not attributable to RFF, its Board of Directors, any financial contributor, or participants in the Forum. A complete list of donors to the Program and to RFF, as well as RFF's donor policies, can be found in the RFF annual report as well as on the RFF website, www.rff.org.

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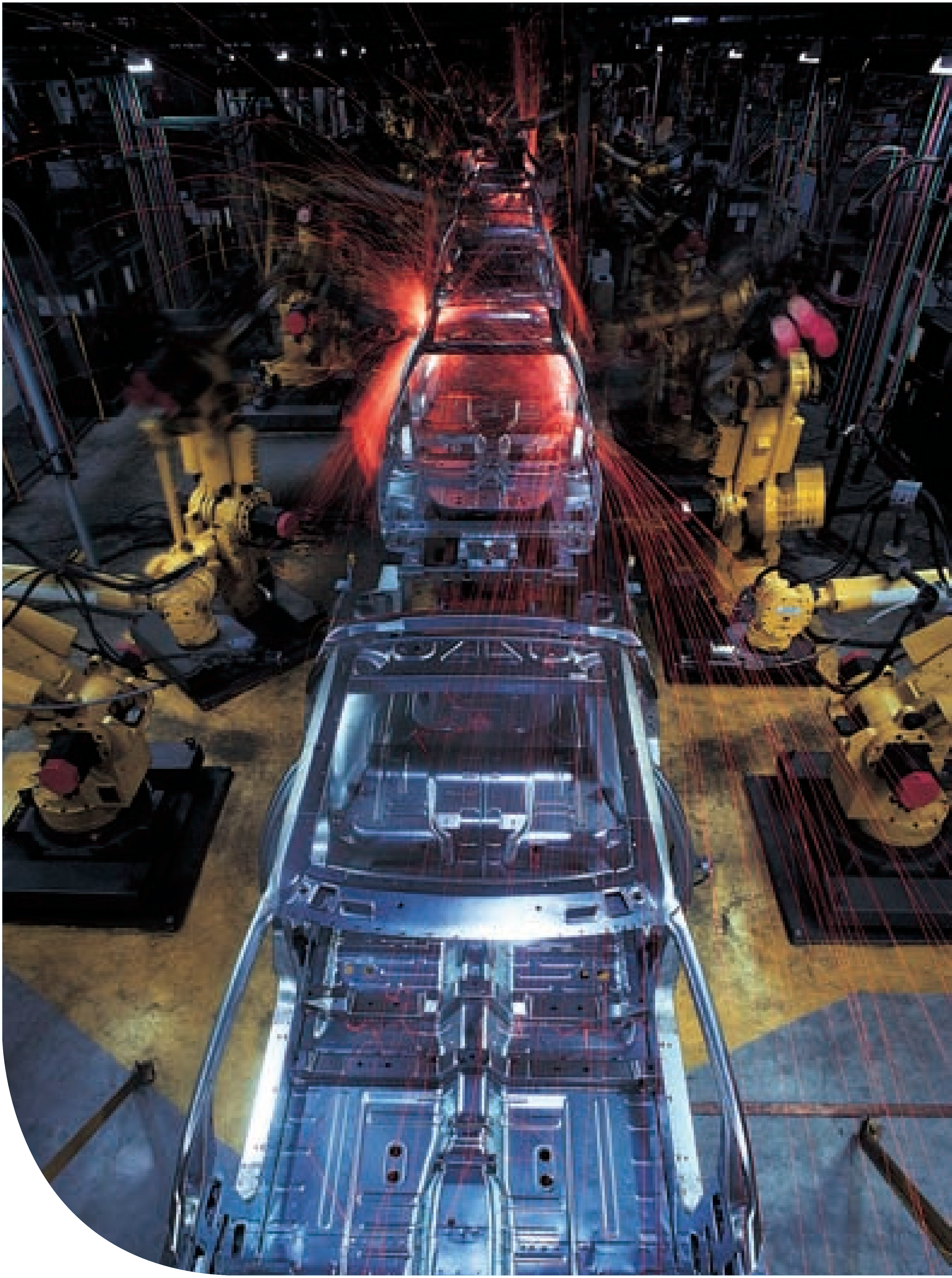
www.rff.org/cpfreport



FOREWORD

From the Participants

We are a few of the many companies that could be significantly affected by future efforts to manage the challenging risks of global climate change. We have a deep interest in finding effective approaches and in playing a constructive role. We therefore welcomed the opportunity to join with colleagues from across a wide spectrum of U.S. industry and with the world-class economists at Resources for the Future (RFF) in a frank and detailed exploration of the many issues that arise in designing effective climate policies for our nation to address this global issue. This report by RFF scholars summarizes the fruits of that exploration and the insights that emerged from months of lengthy discussion and detailed analyses. We hope this report informs policymakers and others engaged in policy discussions regarding these extremely complex issues. This hope motivated the entire project.

We entered into this process with a diverse set of views—and our views have remained diverse. Some of us, for example, support or do not oppose policy measures to limit greenhouse gas (GHG) emissions in the United States; others instead emphasize policy measures to stimulate investment in new technology; some support both of these; and still others have not taken a policy position. Our purpose was neither to reach consensus on nor to advocate for any particular policy direction. Instead, it was to learn from each other and to enhance the policy-relevance of the information provided in this report by contributing our diverse perspectives and real-world expertise. Although our input helped identify which topics became the subjects of these issue briefs, and our comments on the substance of the briefs contributed to their revision, readers should not attribute to any of us support or opposition toward particular policy options or statements based on this report.

We thank our colleagues at RFF for providing a forum to articulate concerns and questions about climate policy, for the independence and depth of their analyses, and for their enthusiasm for engaging a diverse set of views. This has been a useful and informative process for us. We believe it exemplifies constructive, thoughtful, and participatory engagement. This collaborative spirit is essential if our country is to reach consensus on a common strategy for addressing GHG concerns and the serious energy, environmental, and economic challenges that lie ahead.

Alcoa
American Honda Motor Company, Inc.
Caterpillar Inc.
Cargill, Incorporated
Chevron
Chrysler LLC
CONSOL Energy Inc.
Cummins Inc.
The Dow Chemical Company
Duke Energy
DuPont
Edison International
El Paso Corporation
Exelon Corporation
ExxonMobil
Ford Motor Company
General Electric Company
Goldman, Sachs & Co.
Lennox
Nucor Steel
Southern Company
Toyota Motor North America, Inc.
YRC Worldwide Inc.

PREFACE

The threat of climate change is motivating efforts around the world to curb greenhouse gas (GHG) emissions. Within the United States, emission-reduction policies are being debated at the local, state, regional, and federal levels, but the scale of the undertaking—in terms of the number of sources, magnitude of emissions, and time span involved—is unprecedented in the history of U.S. environmental regulation. Most would agree that an effective domestic climate policy must be one that elicits the investments needed to profoundly transform the country's energy producing and using infrastructure, while at the same time doing no serious harm to the economy or unfairly burdening particular regions, industries, or households. In attempting to craft such a policy in a context where domestic efforts must ultimately be accompanied by global action, decision-makers and stakeholders are navigating largely uncharted waters.

As a participant in the domestic policy debate, Resources for the Future (RFF) has provided ideas and analysis concerning effective, least-cost strategies to limit GHG emissions for more than a decade. As Congressional momentum for action on climate policy began to build in 2004, the demand for thoughtful, objective input on critical design issues increased significantly. Moreover, as legislators became aware of the complexity of the policy challenge they asked for ever more complete and sophisticated analyses—analyses that required a thorough understanding of the impact GHG-reduction efforts would have on producers and consumers in every sector of the U.S. economy.

To meet this need, RFF organized the U.S. Climate Policy Forum in May of 2006. The Forum brings RFF researchers together with business leaders from 23 companies that represent a broad spectrum of the U.S. economy, including automobiles and heavy equipment; electricity generation; oil, gas, and coal; transport; agriculture; and chemicals, as well as large energy consumers and financial services. The Forum's objective is to provide legislators with well-vetted, detailed policy options; important criteria for policy assessment; and well-articulated concerns (specifying the strengths and weaknesses of different approaches), from which effective federal policy might be crafted.

It was not the goal of the U.S. Climate Policy Forum to reach consensus and advocate on behalf of a specific course of action; many other organizations are filling that role. Rather, the Forum was designed to provide a process for informed dialogue on policy options and to foster a common understanding of the implications of different choices. The various issue briefs collected in this document present empirical facts, rest on a foundation of economic analysis, and attempt to be comprehensive and objective with respect to the policy issues they address. Rather than provide a single policy prescription, they aim to explain and assess a wide range of available options and to inform future policy-design decisions.

This report represents the culmination of the U.S. Climate Policy Forum process. It was written by independent RFF scholars (who retained all editorial control) and informed by a year-long dialogue with Forum participants who provided feedback and recommended areas of focus. Based on needs and priorities identified in consultations with Senate and House members and staff, former staff from relevant executive-branch agencies, corporations, and NGOs, the report is designed—first and foremost—to present information objectively and to focus on those aspects of federal policy design that are most important. In addition, the document aims to convey information in an accessible and modular fashion: accordingly, each issue brief can be read without further introduction as a stand-alone piece concerning a specific topic. The overview that precedes the issue briefs is intended to serve as both introduction and road map to the larger document: it provides essential context and summarizes key points from each of the issue briefs.

We believe that vigorous debate informed by independent analysis is critical to moving significant public policy efforts forward, and hope that this report serves to facilitate progress as federal climate policy discussions continue in the months and years ahead.

Raymond J. Kopp
William A. Pizer

Co-Directors, U.S. Climate Policy Forum
Senior Fellows, Resources for the Future

EXECUTIVE SUMMARY

Climate change is a century-scale, global challenge that will require a global response. A global response, however, emerges from national policies in leading countries. In the United States, there is a growing debate about federal legislation that would begin to tackle the problem without doing serious harm to the economy or unfairly burdening particular regions, industries, and consumers. Crafting such legislation requires thoughtful, objective input on critical design issues. To meet this need, RFF organized the U.S. Climate Policy Forum in May 2006. The Forum's objective is to provide legislators with well-vetted, detailed policy options; important criteria for policy assessment; and well-articulated concerns (specifying the strengths and weaknesses of different approaches). The 15 issue briefs collected in this report were written by RFF researchers and informed by frank discussions with 23 companies drawn from across the broad spectrum of the U.S. economy. Collectively, they attempt to provide a foundation of common understanding from which effective federal policy might be crafted. The Forum has not sought to reach consensus or advocate a particular course of action.

Throughout the analyses and discussions that follow, a key theme has been the need for policies that combine a long-term strategy for managing environmental risk with the ability to adjust, over time, to new information and developments. Addressing climate change will also require significant resources, with perhaps 1 percent or more of annual global output devoted to stabilizing atmospheric concentrations of greenhouse gases (GHGs).

These two observations motivate current interest in policies that—by placing a rising price on GHG emissions—attach a tangible market value to avoiding or reducing those emissions. Reliance on a pricing mechanism as the core element of domestic climate policy promises lower overall costs to the economy because it creates incentives to exploit the cheapest emissions-reduction options wherever they exist. Given that considerable resources will be required to address climate risks even with efficient policies, the arguments for avoiding strategies that add to cost by unnecessarily restricting flexibility are compelling. Reliance on a pricing mechanism also provides flexibility over time because the aggressiveness of the policy can be adjusted relatively easily in the future by changing a primary parameter: the emissions price.

In some areas—particularly in the electricity and transportation sectors—additional policies are likely to be implemented to promote lower-carbon technologies. Broader energy policy decisions—particularly those that affect natural gas supply, nuclear waste, the siting of renewable energy projects, electricity grid infrastructure, and energy efficiency—will also have important consequences for efforts to reduce GHG emissions. These policies can act as complements to a pricing policy, possibly reducing the cost of achieving a particular emissions goal. However, they can also work against an otherwise efficient pricing policy—raising costs at best and creating conflicting incentives at worst.

The 15 issue briefs that comprise this report aim to elucidate the important questions that confront legislators and regulators as they seek to develop effective policy responses to address climate change. Their key themes can be framed as a series of questions, which are summarized below. Of these questions, the first five concern the core design of an emissions pricing mechanism, while the last three explore the rationale for additional policies to address specific technology opportunities (and often unique features) in key sectors:

- What is an appropriate, overall GHG emissions objective for the United States at this time? While a logical starting point for answering this question involves weighing the

global cost and benefit of stabilizing atmospheric GHG concentrations at different levels, efforts to define a goal for domestic policy must also confront capital, technological, and institutional constraints, along with the United States' ability to engage, coordinate with, and motivate other major economies and emitting nations.

- What sectors of the economy should be covered by a single emissions pricing policy and where in the supply chain should energy-related carbon emissions be regulated?

- How much emphasis should be placed on providing certainty about future GHG emissions versus providing certainty about the trajectory of future GHG prices?

- Given that the impacts of a federal GHG pricing policy are likely to vary considerably across regions, industries, and consumers, how should the distributional consequences of such a policy be addressed? Specifically, how should revenues (in a tax system) or the asset value represented by emissions allowances (in a cap-and-trade program) be distributed back to society?

- How will the policy address international competitiveness concerns?

- To what extent should a domestic climate policy create additional requirements and/or incentives (beyond the GHG price signal) for accelerated technology development and deployment?

- What role do additional policies in the electricity sector—including performance standards, renewable energy portfolio standards, energy efficiency programs, and incentives for carbon dioxide (CO_2) capture and storage—play alongside a CO_2 pricing policy? How can emissions allowances or tax revenues be allocated in an equitable fashion given the varied forms of regulation and patterns of fuel use that characterize the electricity sector in different regions of the country?

- Given that significantly reducing the GHG contribution from the transportation sector will require much higher emissions prices and longer lead times than achieving similar reductions from other sectors, what is the role for vehicle fuel-economy standards, renewable or low-carbon fuel requirements, and other technology-forcing policies—either alongside or in place of a single GHG-price policy? How might these policies be designed in more or less cost-effective ways?

These questions can provide a framework for devising a climate policy from scratch, or they can help to unpack and illuminate the core elements of existing proposals. Specifically, they can help policymakers and stakeholders understand how and whether a given proposal covers key bases, how it might be improved, and whether its various elements fit together in a sensible way. As efforts to reach consensus on a federal climate policy intensify, this kind of critical thinking by all parties to the debate, including the broader public, is increasingly important.

OVERVIEW

The Basic Structure of Federal Climate Change Policy

The policy debate concerning U.S. action to address climate change is increasingly active and complicated, with a suite of proposals being considered at the federal level even as new initiatives emerge at the state, regional, and international levels. The issue briefs compiled in this report are intended to provide a guide through that debate and, in particular, to help policymakers at the federal level identify the various advantages and disadvantages of different legislative proposals. We take the position that while state-level and international activities are important—especially in terms of their eventual intersection with federal policy—it is necessary to start with an understanding of the basic questions that are central to designing an effective national policy.[1]

▸ **In thinking about the architecture of a domestic policy, two important and potentially competing design criteria must be balanced. The first is the desire to establish a clear vision of the future and provide enough policy certainty going forward that key actors in the economy—especially those faced with making long-term investment decisions—can plan effectively and adjust smoothly to greenhouse gas (GHG) constraints. Second, the policy architecture must be sufficiently flexible to evolve over time.** No domestic program adopted in the next five or even ten years is going to solve the climate change problem once and for all. Rather, it will be necessary to revisit U.S. policy at intervals and to respond to new information and developments in climate science, mitigation technologies, and international commitments. This places a premium on policies that are both capable of being modified over time without significant economic disruption and robust enough to drive the emissions reductions and technology innovation needed to produce environmentally significant results in a relevant timeframe. Policies that lock in particular actions, technologies, or political interests—for example, narrow subsidies that do not gradually phase out—may be difficult to adjust and ultimately more costly; therefore, the arguments for such policies, along with the potential for unintended consequences over the long-term, must be evaluated carefully.

Over time, a key factor in the evolution of U.S. climate policy will be the choices made and actions taken by other nations, particularly nations with large economies and significant emissions of greenhouse gases. Without concerted global action, U.S. policies alone cannot substantially alter climate outcomes. Further, to be cost-effective—and achieve global benefits at the lowest cost—national policies will need to be coordinated, if not connected. In this context, adopting a domestic policy architecture that offers the specific ability to coordinate and adjust both carbon dioxide (CO_2) prices and technology incentives is particularly valuable.[2]

▸ **Underlying this report is an assumption that establishing a price path for CO_2 and other GHG emissions—either through a tax or tradable permit program—will be a core element of future U.S. climate policy.** A pricing strategy is appealing because it responds to the need for both policy clarity and flexibility—making it possible, on the one hand, to predict prices and emissions over reasonable timeframes with a reasonable degree of certainty while also facilitating smooth adjustments over time. There are other compelling economic arguments for taking this assumption as a starting point. As a means of addressing climate-change risks, GHG reductions are equally valuable wherever they occur—but they are not equally costly. From an economic perspective, this means that costs to society can be reduced by implementing a policy that achieves cheaper emissions reductions without any trade-off in environmental benefit. Setting a price on GHG emissions sends a transparent signal to everyone engaged in emissions-producing activities—including direct emitters as well as downstream consumers of emissions-producing products—about the value of reducing emissions. Those who can reduce emissions cheaply will do so, while those who cannot will face a common CO_2 price.

1 There is obviously an important role for state action in policy areas that present potentially inexpensive emission-reduction opportunities and that have typically been addressed at the state level—examples would include building codes and utility demand-side management programs. A distinct and important question is now emerging about whether and how federal legislation might "pre-empt" state efforts to regulate—on the basis of climate concerns—in areas beyond their tradional role. On the one hand, a patch-work of state regulation creates additional costs. Further, state actions will not affect national emissions if there is a national cap: in that case, additional emissions reductions in one state as a result of state- or region-specific policies will lead to lower allowance prices and higher emissions in other states (assuming, as current federal proposals do, that there are no constraints on emissions trading between states). On the other hand, states may wish to pursue more aggressive targets in a way that prevents other states from benefiting and/or states may wish to exercise greater control over how and where mitigation occurs. Economic principles suggest it would not be efficient for states to pursue separate policies, but offer little guidance in terms of how policymakers might weigh efficiency considerations against other, competing interests and states' rights.

2 This report focuses on policies that aim to mitigate GHG emissions. Additional domestic policy concerns and international considerations apply in the case of policies aimed at spurring investment in adaptation and possible geo-engineering options for reducing climate-change risk.

The alternative to a single price policy is a more traditional approach to government regulation in which emissions abatement requirements or technology standards and incentives are applied to various GHG sources, such as power plants, factories, cars, and households. While this type of strategy is feasible, evidence suggests it could be much more expensive. Studies that compare the costs of traditional regulation to the costs of market-based approaches have typically found substantial differences: for example, a recent study by economists at RFF suggests that the costs of limiting U.S. GHG emissions through traditional regulatory approaches could be ten times higher than achieving the same result through a pricing policy.[3] Given that the costs of addressing climate change are likely to be far from trivial under any circumstances—the cost of an efficient policy has been estimated at 1 percent or more of GDP over many years—maximizing economic efficiency should be a primary consideration for policymakers. (By comparison, the total cost of existing environmental regulation in the United States has been estimated at 2 percent of GDP.)

In fact, recent interest in market-based policies has probably had less to do with academic arguments about economic efficiency and more to do with the experience accumulated through real-world emissions trading programs, starting with the U.S. Acid Rain program in the 1990s and continuing with subsequent broad-based trading programs for both sulfur dioxide and nitrogen oxides in the United States and, as of 2005, for large industrial sources of CO_2 in Europe. Of the climate-policy proposals debated in Congress, the great majority feature a cap-and-trade style approach to limiting GHG emissions. The alternative of a carbon tax has not featured as prominently in the current debate, but the larger trend toward establishing a single CO_2 price appears well established.

▸ **Strong arguments are often made for additional public support and incentives to accelerate the transition to climate-friendly technologies, particularly in the electric power and transportation sectors where a large volume of emissions are concentrated and where market problems may exist. These arguments are well supported by economic theory in the case of research and development. In the case of technology deployment, however, policies that are not carefully designed to address a specific market problem tend to raise costs relative to a simple CO_2 pricing policy.** Public spending on research and development, for example, is typically viewed as necessary to capture the broad public benefits that arise from new knowledge: because these benefits cannot be fully appropriated by individual firms, private-sector incentives for basic R&D typically fail to reflect the full societal benefits generated by those investments. Uncertainty about future policy commitments may further dilute incentives for private-sector investments in developing new technology.

Broadly speaking, technology deployment policies find support in economic arguments where there are information problems that impede the market response to price incentives, spillovers from learning associated with new technology investments, network effects for large integrated energy systems, and incomplete insurance markets for managing liabilities associated with new-technology investments. In these cases, technology deployment policies can lower the cost associated with achieving a given emissions-reduction target. Often, however, such policies are driven by other interests, including enthusiasm for particular technologies (renewables, biofuels, carbon capture and storage, hybrid vehicles, hydrogen, etc.), a desire to avoid imposing explicit costs in the form of higher energy prices, and a desire to shift costs to the general taxpayer via subsidies. Policies created largely for these reasons, rather than to address market problems, typically raise the overall cost to the economy of reaching the environmental goal compared to a simple pricing policy centered on an emissions tax or permit trading program.

▸ **For a given economic cost in aggregate, the distribution of costs across businesses and consumers—and over time—can vary considerably.** Most discussions of cost focus on aggregate economic impacts, such as changes in the cost of energy and loss of GDP. However, the distribution of impacts across different industries, regions of the country, and demographic groups can vary considerably. Competitive industries with high energy costs, regions of the country that depend on more carbon-intensive fuels, and households that have higher energy expenditures and lower incomes, are all at greater risk.

There is also a temporal dimension to costs. Many policies currently under discussion propose to achieve relatively modest near-term reductions that lead gradually to significantly deeper reductions in the future, coupled with the flexibility to move emissions-reduction obligations over time. With the predictability and flexibility afforded by this type of approach, businesses can adjust their investments and households can save now to offset higher burdens in the future. In this way, costs should be smoothed out over time. Without predictability and flexibility—or if the

3 Pizer, W. et al, 2006. Modeling Economywide versus Sectoral Climate Policies Using Combined Aggregate-Sectoral Models, *Energy Journal* 27(3), 135-168. For further discussion of these issues, see Issue Brief #5: Emissions Trading versus CO_2 Taxes versus Standards.

policy generates inaccurate expectations that lead to poor investment decisions—costs are likely be higher in the future. Alternatively, unexpected, positive developments could lead to lower costs in the future.

- **Additional technology policies—including policies designed to overcome barriers to zero- and low-carbon energy sources—can be economically efficient (that is, they may lower the overall costs to society of achieving long-term environmental goals) only as complements to, rather than substitutes for, a pricing policy.** Implementing public R&D investments, traditional performance standards for stationary sources or equipment, tradable portfolio standards for electricity generation or fuels, or subsidies alongside a broader pricing policy may be justified if the aim is to address other market problems while the CO_2 price encourages emissions reductions. The same is true for policies that address natural gas supply, nuclear waste, the siting of renewable energy projects, electricity grid infrastructure, and efficiency, where the status quo may or may not achieve an adequate balancing of costs and benefits. Used in place of a CO_2 price to achieve a given emissions-reduction target, such policies will almost certainly result in higher overall costs compared to a broad-based emissions tax or cap-and-trade program.

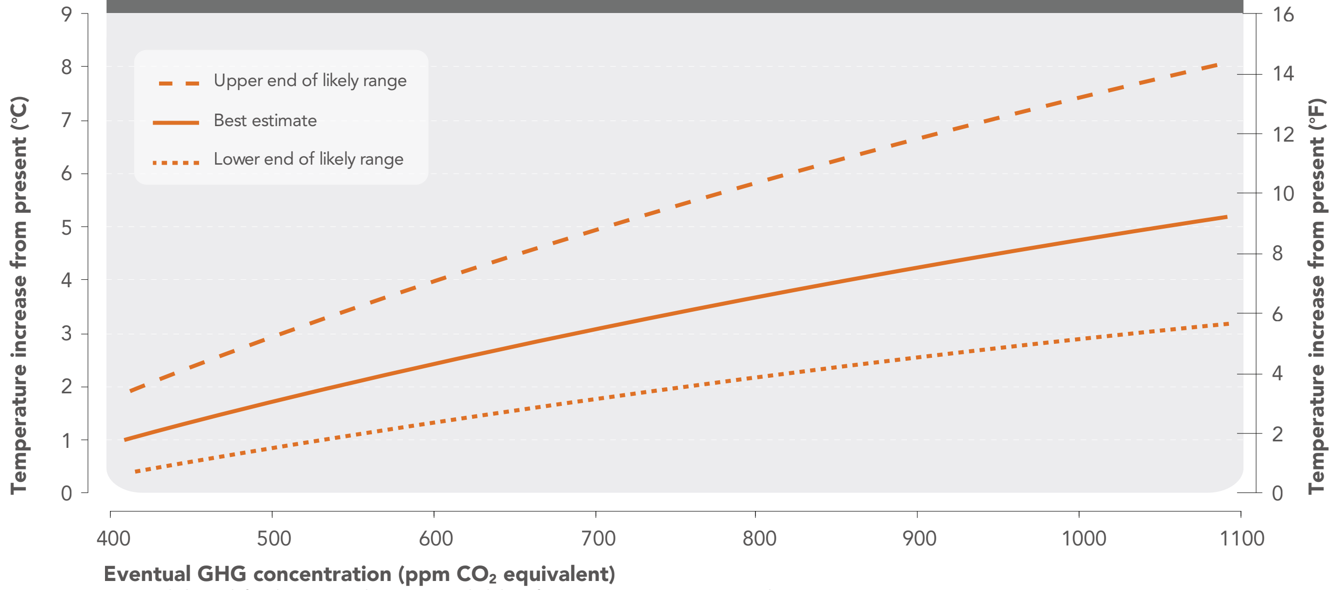
As a substitute for policies that effectively price CO_2 emissions, for example, performance standards for energy-using equipment reduce the energy-related costs of using that equipment. The effect of lower energy costs may or may not be to cause consumers to increase their use of more efficient equipment, but certainly such standards don't serve to encourage less use. (To give a concrete example: fuel-economy standards reduce the per-mile cost of driving, thus they don't encourage consumers to use their vehicles less.) In effect, low-cost opportunities to reduce emissions by simply reducing equipment use are foregone, implying higher-cost mitigation somewhere else. Also, regulations specific to a single sector will not balance the cost of whatever actions they require against potentially less costly abatement opportunities elsewhere in the economy; as a result, someone will almost certainly spend more than necessary to meet theoverall target. Third, traditional regulation does not offer the same incentives for continual innovation over time as do policies that put a price on GHG emissions—once firms meet a standard, there is no incentive to exceed it. Over time, this again leads to higher costs.

> Setting a price on GHG emissions sends a transparent signal to everyone engaged in emissions-producing activities about the value of reducing emissions.

As a complement to CO_2 pricing, on the other hand, technology policies may or may not lower costs or emissions, depending on the extent to which they address an existing market problem. In either case, it is important that policymakers understand the interaction between a broad-based pricing policy and narrower technology policies. If an emissions cap is in place, technology policies can, at best, only serve to reduce costs and will not produce additional emissions reductions. Similarly, under a tax or other price-setting mechanism, such policies can only serve to reduce emissions and will not lower the price.

- **Domestic climate policy should be viewed in the context of energy policy more broadly.** More than 80 percent of U.S. GHG emissions come from the combustion of fossil fuels. Reducing these emissions implies changing the energy sources used to power the U.S. economy toward increased reliance on zero- or low-carbon fuels. Policies that affect the availability, cost, and usability of natural gas, renewable resources, nuclear power, carbon capture and storage, and end-use efficiency improvements will have important consequences for the cost and success of climate policy. While this report focuses exclusively on the design of climate policy, policies implemented to address broader energy objectives can act to significantly support or undermine climate policy goals and to mitigate or exacerbate the economic impacts associated with achieving GHG reductions. Conversely, policies intended to address climate risks may simultaneously support or undermine broader energy policy goals. For example, climate policies that reduce oil consumption could yield energy-security benefits. On the other hand, climate

Figure 1 Likely global warming from stabilization at different GHG concentrations



Note: "Likely" is defined as greater than a 66% probability of occurrence. Source: IPCC Fourth Assessment Report.

policies that create additional demand for natural gas in the power sector—absent new supply opportunities—could drive up natural gas prices for industrial users and give rise to additional competitiveness concerns.

Key Questions for the Design of U.S. Climate Policy

As an introduction to the more detailed issue briefs that follow, it is useful to consider a series of key questions that arise in putting together a comprehensive climate-policy package. These questions can be used to build up a proposal from scratch, or to "unpack" and understand the core elements of an existing proposal. Taken together they touch on, and provide a framework for organizing, important themes from all 15 issue briefs. The first five of these questions concern the core design of a mechanism to price emissions; the remaining three explore additional policies to address specific technology opportunities (and often unique features) in key sectors.

1. What is an appropriate, overall domestic emissions objective for the United States at this time and how does that objective balance competing considerations and risks with regard to environmental protection, economic costs, technological development, institutional constraints, and global participation? A fundamental challenge in designing a domestic climate change policy is defining an initial target emissions trajectory that will, over time and in conjunction with actions by other major emitters, achieve environmental objectives at an acceptable cost to the economy. Most global analyses designed to help answer this question start with the relationship between atmospheric GHG concentrations and temperature change, work backwards from different atmospheric stabilization targets to investigate their implications for emissions, CO_2 prices, and economic output, and then contemplate a reasonable balance of costs and objectives.[4] To select an appropriate national-level, emissions-reduction goal, policymakers will need to consider the relationship between domestic action and future technology development, broader action by other major emitting nations, and longer-term emissions trends at the global level. As a starting point, it is useful to examine—as we do in Issue Brief #2—what trajectory for U.S. emissions and carbon prices would be consistent with the results obtained from global analyses of cost-effective paths to different stabilization scenarios.[5]

4 An entirely different approach is to assign economic value to climate change impacts and then compute the value of mitigation. Such an approach can generate a wide range of results depending not only on the valuation, but also rather critically on how effects over time are discounted. For example, William Nordhaus estimates mitigation benefits of \$6.40 per ton CO_2 while Nicholas Stern estimates benefits at \$85 per ton. Some of the findings from this literature are summarized in Issue Brief #3 on costs.

5 Issue Brief #2 on U.S. Climate Mitigation in the Context of Global Stabilization examines the first part of

Figure 1 is based on the synthesis report of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). It summarizes current understanding of the relationship between atmospheric concentrations of GHGs and likely changes in global average surface temperature (where "likely" is defined as corresponding to a probability range of 67 percent or higher). In the context of current emissions trends, which—if continued—would result in atmospheric GHG concentrations (in CO_2-equivalent terms) of 1,000 parts per million (ppm) by volume or more by the end of this century, stabilizing GHG concentrations in the 450–650 ppm CO_2-equivalent range would significantly reduce the magnitude of expected warming and associated risks to human welfare and ecological integrity.[6] Stabilization at 1,000 ppm implies long-term warming of as much as 3–8°C relative to present conditions, whereas stabilization at 450–650 ppm reduces the range of predicted temperature change to 0.5–4.5°C.

Translating stabilization targets of 450–650 ppm into emissions scenarios, CO_2 prices, and economic costs requires models of economic activity and emissions. Considerable analysis has been done on 650 ppm scenarios, with results that suggest achieving stabilization at this level will require global emissions to flatten out over the next several decades and CO_2 prices to reach $5–$30 per metric ton by 2030 and $20–$90 per ton by 2050—assuming global participation and efficient policies.[7] The model scenarios point to significant technology shifts, including increased reliance on systems that capture and store CO_2 emissions from coal-fired power plants, nuclear power, renewable energy, and energy efficiency. The costs incurred to achieve stabilization (again assuming efficient policies and global participation) in these 650 ppm scenarios generally amount to a reduction of less than 1 percent of GDP compared to the business-as-usual forecast over the next decade. Less is known about the economic impact of achieving more aggressive stabilization targets, but these scenarios generally involve significantly higher costs and require global emissions to begin declining in the next decade or sooner. The IPCC estimates that global stabilization in the 450–550 ppm range could be achieved at a cost of less than 3 percent of world economic output and with CO_2 prices below $100 per ton in 2030 (again, assuming global participation and efficient policies).

Detailed analyses of various scenarios for limiting U.S. GHG emissions over the next two decades produce cost and carbon-price estimates that are roughly consistent with the results obtained in global analyses.[8] The more aggressive domestic policy scenarios assume that emissions through 2030 are limited to roughly 1990 levels; the less aggressive scenarios assume emissions roughly stabilize at current levels or even increase slightly over the same timeframe. Modeled costs in all scenarios are less than 1 percent of forecast GDP for 2015. Costs reach almost 2 percent of GDP in the more aggressive scenarios by 2030, but remain below one-half of

this question; Issue Brief #3 on Assessing the Costs of Domestic Regulatory Proposals examines the second part, as well as the benefit estimates in the preceding note.

6 Here and throughout, we discuss GHGs and GHG concentrations in carbon-dioxide *equivalent* (CO_2e) terms. This means that when discussing various stabilization targets we include the atmospheric concentration of carbon dioxide plus the effect of other greenhouse gases that enter the atmosphere as a result of human activities, where those other gases are converted to a global warming-equivalent volume of carbon dioxide. Expressed in terms of carbon dioxide concentrations only, the same stabilization targets are typically 50 to 100 ppm less.

7 Here and elsewhere, prices are in current (2005–2006) dollars unless specifically indicated otherwise.

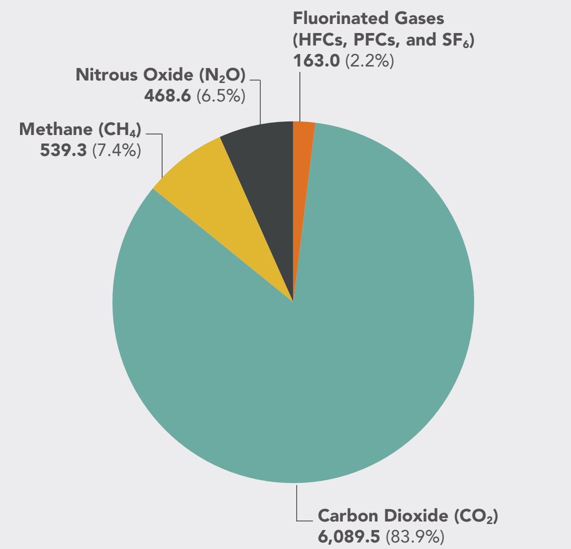
8 It is important to recognize that available models provide only a stylized representation of the likely economic impacts of different policies. As policies diverge from a simple economy-wide CO_2 pricing regime (implemented through either a cap-and-trade system or an emissions tax), overall costs could rise significantly.

1 percent of GDP under the less stringent scenarios.[9] Carbon prices range from $15 to $100 per ton CO_2 and are therefore comparable to the carbon-price estimates obtained when modeling cost-effective global stabilization scenarios in the 450–650 ppm range. Importantly, all of these estimates are for the near- to medium-term timeframe. Considerable uncertainty exists about the longer-term costs of achieving these targets. On the one hand, deeper reductions will be required as we approach the mid-century mark; on the other, capital stocks will have had more time to adjust and promising technologies may have emerged in that timeframe.

The question frequently arises, of course, how any domestic emissions target can be environmentally meaningful—or indeed worth incurring costs to achieve—absent full international participation in emissions-reduction efforts. More to the point, how can U.S. policymakers choose a domestic target while consensus on an appropriate global objective is still lacking and while other major emitting countries have yet to adopt their own emissions-reduction commitments? While acknowledging that broader international participation and a clear roadmap to achieving global reductions will eventually be necessary to address climate risks, at least four different kinds of considerations can provide justification for near-term U.S. action and can help inform the selection of appropriate domestic targets.

First, a serious policy commitment by the United States is likely to have a significant effect on the actions of other major emitting nations (and may even represent a necessary pre-condition for establishing broader participation, especially on the part of some developing countries). The European Union, for example, has announced a 2020 target of reducing emissions 20 percent below 1990 levels—and has indicated it will increase the reduction target to 30 percent below 1990 levels if other countries take comparable action. One way to approach the design of domestic policy is by asking what scale of reduction commitments we seek in other countries to achieve a globally meaningful result. Second, domestic policy can stimulate international actions more directly by recognizing offset credits associated with verifiable emissions-reduction projects undertaken in developing countries.[10] In fact, it is likely that international offsets will play a role in meeting domestic targets, especially if those targets are relatively aggressive. Thus, one could imagine defining

Figure 2 **2005 U.S. GHG Emissions: 7,260.4 MMTCO$_2$e**



Source: U.S. Environmental Protection Agency

the objectives for a U.S. program in terms of the emissions reductions we seek to achieve domestically plus some volume we expect to pursue in poorer countries.

A third option is to consider what emissions price we want to encourage in other countries, rather than what level of emissions reductions. That is, we can design a domestic policy to produce an emissions price consistent with a particular stabilization target and encourage other countries to seek a similar price. It will arguably be easier to converge toward a globally harmonized carbon price, and to develop some confidence in the feasibility of attaining a given stabilization target, once the United States has achieved political consensus on a pricing policy. Finally, a fourth argument can be made on the basis of technology considerations. Significant emissions reductions in the future—in the United States and in other countries—will depend on significant technology developments. Absent effective market incentives in the world's most advanced economies, the technology developments needed to achieve substantial global reductions and lower abatement costs to globally affordable levels will be unlikely to materialize. Accordingly, an important consideration for domestic policy is how effectively it will encourage necessary long-term technology advances.

9 The total cost of all existing U.S. environmental regulation is around 2 percent of GDP, according to estimates by the Bureau of Economic Analysis and the U.S. Environmental Protection Agency (EPA). The sulfur dioxide (acid rain) trading program is estimated to cost around 0.01 percent of GDP. Over the time period that most of these regulations have been introduced and implemented (that is, over the past 40 years), average household income has grown at an average annual rate of 1.3 percent while median household income has grown at an annual average rate of 0.7 percent.

10 Issue Brief #15 discusses international offsets in some detail.

In the end, the choice of an appropriate, initial goal for U.S. climate policy must balance multiple considerations and objectives, including the need to achieve meaningful environmental benefits, motivate broader international participation, minimize costs to the domestic economy, address competitiveness concerns, and promote low-carbon technology development and deployment (including technology transfer to developing countries).

2. What sectors of the economy should be covered by a single carbon price and where in the energy supply chain should energy-related CO_2 emissions be regulated? From the standpoint of maximizing economic efficiency, policymakers should try to cover as many emissions sources as possible with a single policy and a single emissions price. This approach expands the pool of low-cost emission reduction opportunities that can be exploited to achieve a given policy target, thereby minimizing overall costs to the economy. Equally important, this approach addresses the risk that a market-based policy will create incentives to shift emissions to sources that are not covered under the policy. For example, if households and small businesses are excluded from an emissions cap imposed on the electric power sector, these end-users may shift some of their energy consumption away from electricity and toward increased use of primary fuels (such as oil and natural gas) for space conditioning and water heating. While such shifts may, in some cases, produce gains in energy efficiency they represent a form of emissions "leakage" and will undermine the achievement of environmental objectives since emissions, rather than being reduced, merely shift from regulated to unregulated sources. Nonetheless, arguments are often made for treating some sectors differently—either by regulating them via a separate policy mechanism or by excluding them completely. In some sectors, the economic impacts of GHG regulation may be more severe or there may be a desire to create regulations tailored to specific sector needs. The latter reflects the view that different sectors and sources face different hurdles that may be best addressed through different policies, with the government choosing technologies or performance improvements rather than firms doing so in response to market signals. All of these arguments tend to run counter to conventional economic thinking and to more than a decade of research that suggests broad, market-based policies can substantially reduce costs relative to targeted regulatory approaches.

Tied up with the question of program coverage is the question of where to regulate energy-related CO_2 emissions. In contrast to most conventional air-pollutant emissions, energy-related CO_2 emissions can be effectively regulated anywhere in the fossil-fuel supply chain based on a simple calculation involving fuel carbon content and through-put. It should be noted that the same is not true for non-energy-related CO_2 emissions and for other (non-CO_2) GHGs; however, these collectively constitute a much smaller share of overall emissions. Figure 2, which shows the breakdown of U.S. GHG emissions in 2005 by gas, shows that CO_2 emissions dominate the overall emissions inventory. Because fossil-fuel combustion accounts for 95 percent of economy-wide CO_2 emissions, the climate-policy debate typically focuses on how to address this portion of the emissions pie.[11] A policy that focused on large downstream emitters would cover just over half of all of CO_2 emissions from fossil-fuel combustion.[12] Small emitters—mobile sources, households, and small businesses—would necessarily be excluded from such an approach. In contrast, an upstream program could cover virtually all energy-related CO_2 emissions by focusing on fossil-fuel producers, processors, or distributors and by calculating the compliance obligation based on the volume of fuel processed or delivered and its carbon content.[13] Hybrid program designs, in which some fuels or sources are regulated upstream while others are regulated downstream, are also possible.

Two additional observations concerning the choice of where to regulate are important. First, while past tradable permit programs have typically allocated free permits or allowances to regulated sources, there is no reason why CO_2 permits or allowances cannot be allocated to other entities in the fossil-fuel supply chain that are directly or indirectly affected by regulation. In other words, decisions about how to allocate permits or allowances need not be tied to decisions about which entities will be required to submit permits or allowances under a trading program. This distinction is important because stakeholders, if they fail to understand it, will tend to assume that decisions about where to regulate also constitute de facto decisions about how to distribute permits with a likely asset value, in aggregate, on the order of tens of billions of dollars per year (we return to this point below).

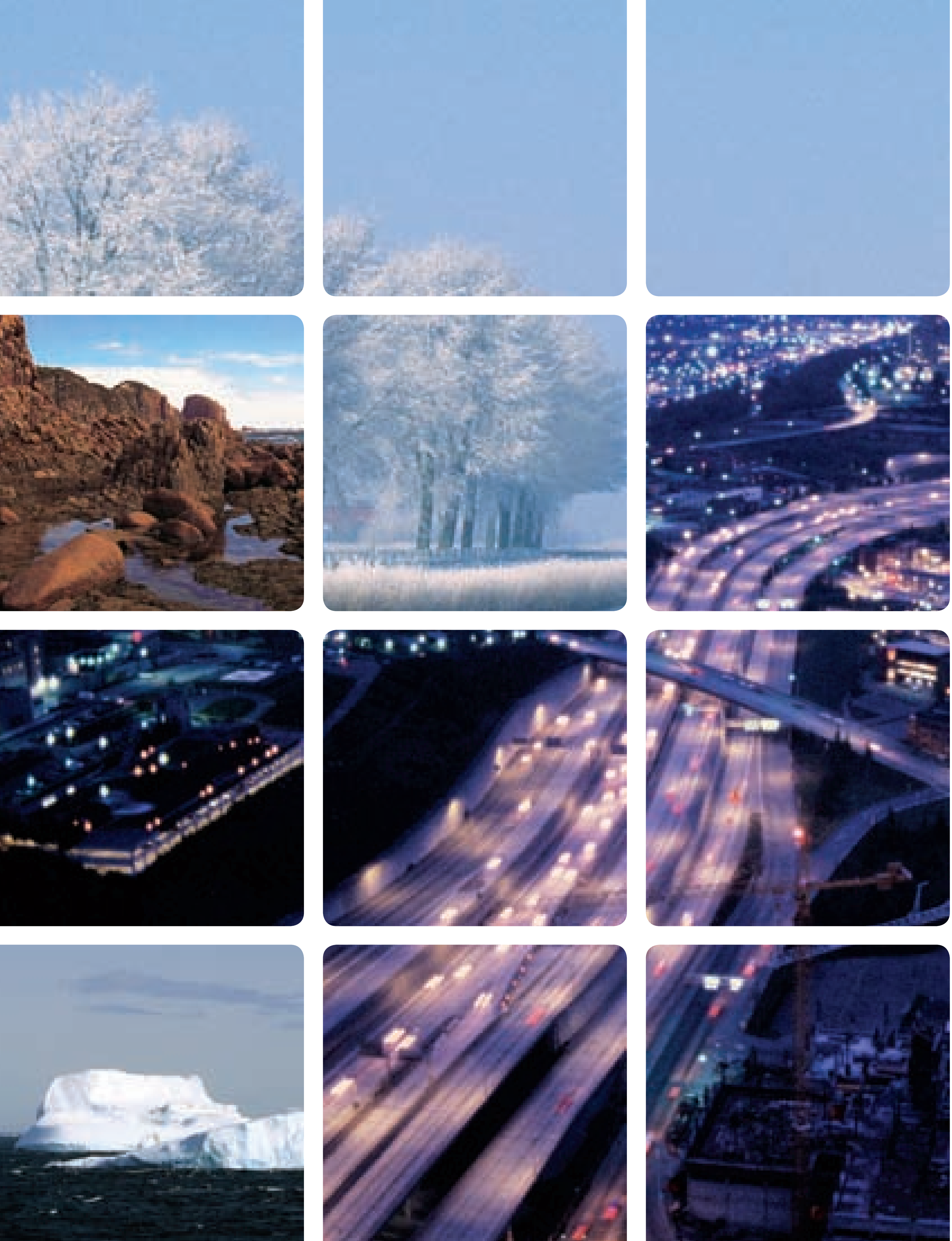
A second important point is that the decision about where to regulate—whether upstream or downstream—generally does not change the economic burden imposed on different entities in the fossil-fuel supply chain.[14] The price signal

11 We devote an entire issue brief (Issue Brief #14) to the topic of regulating "nontraditional" emissions—both process CO_2 emissions and other gases. Much of this category of emissions consists of fugitive emissions from land-use changes that would be difficult to capture outside of an offset program (see also Issue Brief #13 on agriculture).

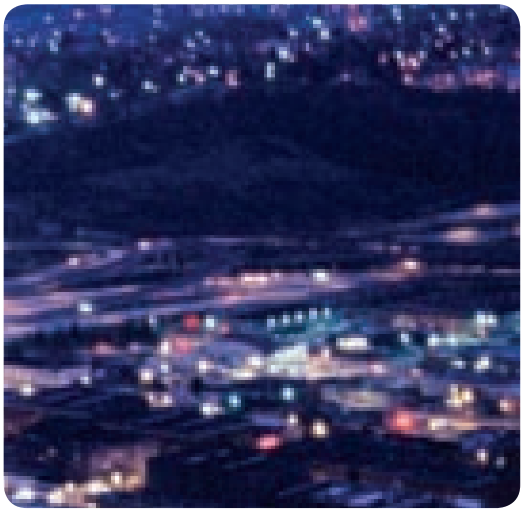
12 The distribution of source size and potential for regulation is discussed in Issue Brief #1.

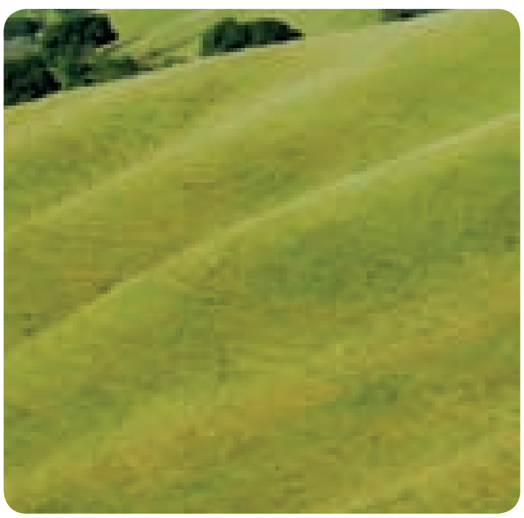
13 Under an upstream program, adjustments would have to be made for imported and exported fuels, sequestered emissions such as carbon capture and storage, and uses of fossil fuels that do not result in emissions. Note that the European Union Emissions Trading Scheme currently accounts for emissions on the basis of fuel volume and carbon content and not through direct emissions monitoring, even though emissions are regulated at the combustion source rather than upstream.

14 This is analogous to the observation that it does not generally matter whether employer or employees pay income and payroll taxes—the effect on the eventual wage paid by the employer and received by the

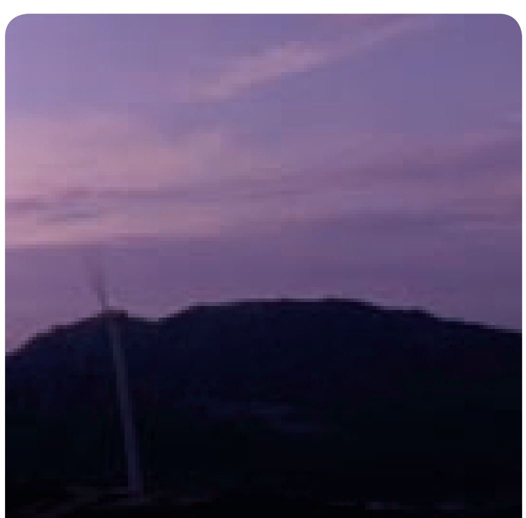
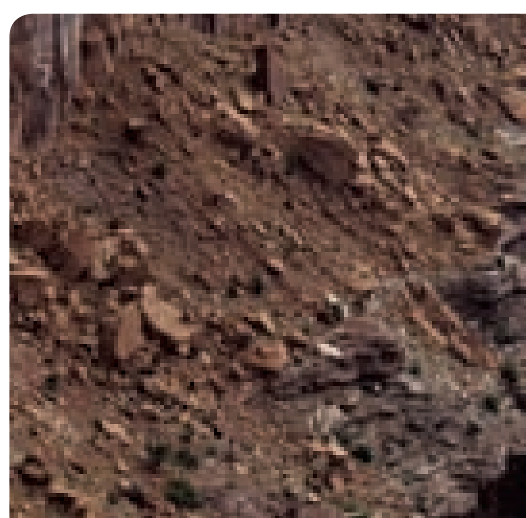






generated by an emissions tax or trading program is passed forward and backward between upstream and downstream entities and achieves the same ends regardless of where it is actually imposed. Important caveats may apply in situations where products are not competitively priced (as, for example, in regulated utility markets). Finally, the point of regulation does affect which entities bear the administrative burden of demonstrating compliance under a tradable permits program.[15]

3. How much emphasis should be placed on providing certainty about future GHG emissions versus certainty regarding the future cost of the policy? A particularly contentious issue in the debate over the design of a federal cap-and-trade program for U.S. GHG emissions is whether total emissions should be strictly capped (that is, limited), as has traditionally been the case in existing programs of this type. The alternative is to make additional allowances available when the market price of allowances reaches a pre-determined maximum. This mechanism, which is frequently termed a "safety valve," trades emissions certainty in favor of cost certainty—effectively, it means that the level of the emissions cap is not fixed but rather becomes contingent on a maximum price. Coupled with a mechanism to create a price floor—which could involve the government either (a) re-purchasing allowances if the price reaches a specified minimum, (b) specifying a minimum price in allowance auctions, or (c) tightening future emissions caps in response to persistently low prices—trading programs can, to a large extent, mimic the price certainty of a tax.[16] Disagreements about whether a cap-and-trade policy should include a safety valve are often intense because they pit two fundamental concerns—protecting the environment and protecting the economy—against each other.

Because climate impacts ultimately hinge on the long-term accumulation of global emissions, the case for choosing price certainty over emissions certainty is strongest in the early years of a U.S.-only policy. Over longer horizons and with broader global efforts, fixed emissions targets can be increasingly advantageous as they are more closely tied to actual environmental outcomes (for example, stabilizing atmospheric GHG concentrations at a particular level). This suggests that if a safety valve is used, it may be more valuable in the short run.

A number of other cost-containment mechanisms have been proposed as alternatives to a safety valve; in most cases these aim to provide similar benefits (in terms of limiting economic impacts and allowance-price volatility), even as they shift the balance back toward greater environmental certainty. Many of these proposals involve allowance banking and borrowing: for example, businesses could borrow allowances from the government in one year and pay them back in a future year, with interest. This would tend to stabilize allowance prices in response to short-term fluctuations in demand and supply, but would not affect long-term drivers of CO_2 price such as expectations about future targets, technologies, and energy demand. Of course, such expectations might still be subject to substantial uncertainty given the potential for politically motivated adjustments to longer-term term targets and other program parameters. (For example, if borrowing resulted in an acute shortfall of allowances in some future year, the political pressure to increase allowance budgets—at least temporarily—could be intense.)

A more recent proposal for reducing economic risk in connection with a domestic GHG cap-and-trade program involves a distinct government agency charged with balancing environmental and economic objectives and given the authority to intervene in markets by buying and selling allowances (and possibly in other ways). In principle, this concept could represent an attractive compromise, one that reassures private industry while promising greater environmental integrity. In practice, however, neither objective would be well served if such an agency is poorly designed, if its interventions are badly executed, or if statutory constraints tie its hands. It is worth noting that the Federal Reserve Board, which provides something of a model for this idea, was established only in response to a financial crisis nearly 100 years ago. Moreover, its performance was widely criticized during many decades of its existence. Notwithstanding these pitfalls, the concept of a "carbon Fed" is sufficiently promising that it merits further exploration.

In the often heated debate about cost-containment mechanisms, it is also important that policymakers not lose sight of the larger objective: to implement a well-designed program with broad coverage of emissions sources and clear rules concerning targets, trading, compliance, and flexibility. Such a program will deliver the most environmental benefit

employee end up being the same.

15 In a well-designed program administrative costs are likely to be small in a relative sense, compared to allowance prices and the cost of reducing emissions. However, these administrative costs—which include the transaction costs associated with buying and selling allowances, establishing internal management structures, hedging to manage price volatility in allowance markets, investing in the equipment needed to monitor emissions or fuel use, and possibly providing external verification—can still amount to a nontrivial sum in absolute terms. According to one firm with dozens of regulated facilities, administrative costs under the EU ETS can run hundreds of thousands of dollars per facility, a number that is likely to be even higher for firms with fewer facilities.

16 An emissions tax tends to come with the presumption that the revenues it generates can be used for broad social purposes, such as cutting other taxes or engaging in valuable social spending. By contrast, the assumption that has, at least until recently, accompanied most tradable permit programs is that most emissions permits will be given away for free. These issues are discussed more extensively in Issue Brief #5.

at the lowest cost and should serve as the starting point for any discussion of additional mechanisms for enhancing cost certainty.

4. How should the distributional consequences of an emissions pricing policy be addressed? Specifically, how should revenues (in a tax system) or the asset value represented by emissions allowances (in a cap-and-trade program) be distributed back to society? Under the original U.S. Acid Rain trading program, as under most of the trading programs that have followed since, the great majority of allowances has been distributed gratis (at no cost) to directly regulated entities. This need not be the case, however: permits can be given to entities other than those that are directly regulated under the program (including, for example, households or state governments). Regulated firms then buy allowances from allowance recipients. Moreover, allowances need not be given away at all: they can be sold or auctioned by the government, which can then retain and re-distribute resulting revenues for other purposes.[17]

The likely market value of emissions allowances in many proposals is not trivial, amounting to tens if not hundreds of billions of dollars annually (with similar revenue arising from a comparable carbon tax). This overall allowance value is not an indication of the overall cost of the program to the economy; rather, it represents a transfer from those who directly or indirectly pay for allowances in the form of higher fossil energy prices to those who hold allowances (whether those holders are taxpayers, in the case where government auctions allowances, or private-sector entities, in the case where government distributes allowances for free to selected firms).

Economic efficiency argues for the government selling allowances and using the revenue to cut other taxes. By some estimates, this approach could produce net economic gains as lower labor and capital taxes will encourage more employment and investment; in any case, it reduces the net burden imposed on the economy. Indeed, even if allowance revenues are not used to cut other taxes, they can fund valuable government expenditures that otherwise require an increase in taxes.[18] At the same time, this economically efficient solution could have undesirable distributional properties, imposing very different cost burdens on different sectors of the economy and different regions of the country depending on the fuels they use and their ability to pass through costs. By contrast, arguments for a free allocation are typically premised on the need to address distributional concerns by targeting free allowances to those sectors, firms, and regions that would otherwise be most adversely affected by the policy.

Any free allocation that changes in response to future business developments—such as one that continually updates firm-level shares of the total allowance pool based on production output—must be carefully scrutinized in terms of its incentive properties. Updating allocation methodologies can produce inefficient outcomes by creating incentives that promote excess production, discourage the retirement of inefficient facilities, or—depending on the specifics of the methodology—encourage continued investment in high-emitting technologies. While these incentive properties might be desirable in some cases—for example, to promote continued domestic production in industries that might otherwise be motivated to move their operations overseas—they might produce perverse outcomes in other instances (for example, a new entrant allocation that would unnecessarily encourage coal-fired power plants over lower-emitting alternatives).

In the end, decisions about how to allocate allowances or tax revenues, both within and between sectors, are deeply political in nature as they involve the re-distribution of significant wealth and require a careful balancing of competing claims. Policymakers will need to weigh a wide range of concerns and objectives: the desire to reward leaders versus help laggards, for example, or to accommodate new entrants without over-accommodating them in ways that creates perverse incentives to continue investing in higher-emitting sources. At a macro-economic level, additional trade-offs exist between equity and efficiency.[19] That is, policymakers must weigh the merits of using free allowances to compensate entities that will otherwise bear a disproportionate share of the economic burden of the policy against the overall efficiency benefits that could be realized by using allowance revenues to reduce other taxes. At the same time, policymakers will have to address the concern that an overly generous free allocation could result in unjustified windfall gains for some firms and industries.

5. How should the policy address international competitiveness concerns? A chief concern surrounding most proposals for a mandatory GHG reduction policy is that pricing emissions will adversely affect the competitiveness of U.S. businesses and may encourage businesses to move their operations overseas. This would obviously undermine

17 See Issue Brief #6 on Allocation.
18 An obvious risk is that the government would use allowance revenues in wasteful ways. If this is likely, it would argue against auctioning allowances.
19 The trade-off exists if one assumes that government will use revenues from allowance sales or emissions taxes wisely. If used to support wasteful public spending, there would be no efficiency gain from recycling allowance revenues and likely a loss.

the ability to achieve stated environmental goals, along with public support for the policy. A variety of strategies have been proposed to address these concerns.

The simplest involves starting with a modest "first step" domestically while linking more aggressive future targets to international progress. This approach recognizes that the potential for competitive distortions depends on the degree of disparity that exists between the scope and stringency of climate policies in the United States and the policies that exist in other nations. The idea would be to limit economic costs until similar efforts are underway among key trading partners. The argument against this approach is an obvious environmental one: it delivers less environmental benefit, weaker incentives for technology development, and less pressure for international participation.

Other strategies involve singling out especially vulnerable industries for special treatment. Identifying these sectors can be challenging, however: evidence suggests a need to focus on both the energy intensity of domestic producers and the level of international competition they face. Typically, industries that make primary, bulk-produced products (iron and steel, aluminum, cement, and glass) are the most vulnerable to competition from overseas suppliers. Once vulnerable industries have been identified, at least four options exist for addressing competitiveness concerns related to a GHG policy. The simplest is to exclude those operations from the policy altogether; however, this is also the most inefficient response since completely excluding an activity means forgoing possibly inexpensive mitigation opportunities that would not drive production overseas. A second option is to limit emissions from these sources using traditional, tailored forms of regulation that might be less likely to create similar competitiveness concerns. Again, however, this solution is likely to be inefficient and potentially costly. A third approach would be to use free allowances to compensate industries for higher energy-related costs (in this case, the free allocation would need to be tied to continued domestic production). The challenge would be to specify an allocation formula that adequately offsets regulatory costs without over-subsidizing production and without unfairly advantaging some firms relative to others, or U.S. firms in general relative to their foreign competitors.

The last option would be to implement additional policies that directly target imports (and/or exports) of goods to the United States, rather than attempting to adjust the impacts of the GHG policy on domestic producers. The idea would be to regulate energy-intensive, bulk commodity goods imported from countries that lack comparable CO_2 policies on the basis of embedded CO_2 content and in a manner that parallels the price impacts of domestic regulations. This approach would have the dual advantage of directly addressing competitiveness concerns while also creating incentives for other countries to adopt comparable policies. Its key downside is the potential to provide cover for unwarranted and inefficient forms of protectionism that, in addition to their immediate costs, would hinder the long-term economic development and technology transfer needed to achieve global progress in addressing climate change. In the end, a combination of strategies may be necessary to address the competitiveness concerns of different stakeholders. Among these, excluding a sector completely or using alternate, traditional regulation tend to have the most costly consequences for the rest of the economy (assuming the overall emissions goal is held constant).

6. To what extent should a domestic climate policy create additional requirements and/or incentives (beyond the GHG price signal) for accelerated technology development and deployment? Alongside the debate about how to price emissions, policymakers must confront an additional set of questions concerning the appropriate government role in technology development. At one end of the spectrum are those who believe the private sector—once motivated by a price on GHG emissions—is best positioned to make R&D and technology investments. At the other end of the spectrum are those who see a much greater role for government.[20] As noted at the outset, a relatively clear economic case can be made for government involvement in research and development, both basic and applied. That said, the best approach to managing such investments is far from clear, especially in the case of applied research. U.S. Department of Energy program offices, a new public agency, a new quasi-public corporation, and/or private research consortia could all be used to manage an increased public budget for applied energy research—each has advantages and disadvantages in terms of fostering effective management and performance, providing stable funding, degree of insulation from politics, and public accountability.

The case for public investment becomes less clear moving from research to technology deployment, a frequent target of additional policies and regulation—particularly in the electricity and transportation sectors, as discussed below. On one hand, legitimate market imperfections can justify public support for technology deployment. On the other hand,

20 These broad questions are discussed in more detail in Issue Briefs #9 and #10, which cover research, development, and demonstration and technology deployment, respectively.

technology deployment policies often go well beyond this initial motivation in practice (if such a motivation existed in the first place)—in ways that imply substantial costs and efficiency losses beyond those incurred by the CO_2 pricing policy alone. Nevertheless, such policies continue to have strong political appeal, perhaps in large part because their costs tend to be less explicit and/or fall more heavily on the general taxpayer, and because they provide a more visible means to promote popular technologies.[21]

Different technology deployment policies make different trade-offs with respect to risk, cost burden, and relative efficiency. They can be used to guarantee quantitative outcomes (via standards) or fix the price of new technologies (via subsidies). Subsidies can be structured as fee-bates to shift the financing burden from the taxpayer to lower-performing technologies. Policies that allow greater flexibility, typically in the form of crediting, banking, and trading, will tend to lower costs.

One way to evaluate technology policies as potential complements to a common CO_2 price is to consider the following questions: Does the policy address a market problem distinct from reducing CO_2 emissions and thereby provide additional, otherwise un-priced benefits? Or, are there other aspects of the policy that make it more appealing and therefore worth incurring higher costs? Are the higher costs reasonable for the volume of emissions reductions and other public benefits achieved? Is the policy as flexible and cost-effective as possible, given other key features and constraints? If the answer to these questions is yes, the benefits of the additional policy under consideration are more likely to outweigh its costs.

7. How can climate policies be designed to address equity concerns and confront multiple technology challenges in the electricity sector, given the considerable variation in resource portfolios and regulatory structures that characterizes this industry? The electric power industry represents one of the largest and most concentrated sectors for GHG emissions, and one where international competitiveness concerns generally do not apply.[22] With only 3,000 facilities that together account for 33 percent of U.S. GHG emissions, any long-term climate solution must deal with the challenge of transforming the nation's power sector. Complicating this challenge is the fact that the electricity industry is enormously diverse, with different regions of the country relying on a different combination of fuels and generation technologies—and hence characterized by different CO_2-emissions profiles—and being governed by different regulatory structures. This variation has important implications for the use of complementary policies and for the design of a CO_2 pricing policy itself.[23]

Alongside the debate about how to price emissions, policymakers must confront an additional set of questions concerning the appropriate government role in technology development.

Given the importance of the electric power industry, it is perhaps not surprising that numerous complementary policies—in addition to a CO_2 pricing policy—have been proposed for this sector. These range from increased public support for basic research and development to additional technology policies, including direct subsidies, performance standards for new facilities, portfolio standards for existing facilities, and energy efficiency programs. These policies need to be evaluated carefully because while some may resolve various market problems others can lead to more costly solutions than are otherwise necessary. For example, carbon capture and storage may be a critical technology that does not benefit from adequate incentives under a broad-based CO_2 price because of long-term policy uncertainty and the additional liabilities associated with underground storage and other unfamiliar aspects of the technology. While additional incentives may be justified by these and other considerations, it remains the case that additional incentives for carbon capture and storage and other climate-friendly technologies in the electric sector must be carefully monitored to avoid creating imbalances with other abatement opportunities.

In the context of an emissions trading program, special complexities arise with respect to allocating allowances within

21 For more information on biofuel policies, see Issue Brief #13 on climate change and agriculture.

22 Of course, electricity *users* often face international competition. Hence the competitiveness issues discussed previously in this overview may be very relevant for electricity-*consuming* sectors.

23 For a longer discussion of topics specific to the electricity sector, see Issue Brief #11.

the power generation sector. In general, the electricity industry as a whole should be able to pass through a large fraction of the cost associated with GHG regulation (including the cost of both mitigating emissions and purchasing necessary allowances) as electricity prices rise to reflect emissions costs. This means that if a free allocation is meant to offset regulatory cost burdens, the bulk of any free allocation should go to electricity users and only a relatively small share of the allowances associated with electricity-related CO_2 emissions needs to be given to electric power generators. In different regions of the country, however, the way in which emissions costs are passed through and the consequences of free allocation to generators will be very different depending on whether electricity markets are competitive or regulated. In regulated regions, generators are traditionally protected by rules that guarantee a rate of return on investments and could expect to be allowed to pass through all costs. At the same time, regulators are likely to ensure that the value of any free allowances allocated to generators in regulated regions will be passed on to consumers by way of reducing the price impact of the CO_2 policy. In competitive regions, the price of electricity is set by the marginal generator—which will rise to reflect the opportunity cost of CO_2 allowances regardless of any free allocation generators receive. Here, the degree to which individual generators can pass through emissions costs depends on their emissions profile compared to the marginal generator. Thus, in competitive regions, free allocation can be used to offset those emissions costs that are not passed through and are borne by generators. The possibility also exists, however, that free allocation to some generators in competitive regions will more than offset costs and result in increased profits.

These and other considerations have led to a variety of proposals for handling allocation in the electric sector, including proposals that establish a greater role for auctions.[24] At a minimum, many current proposals now envision any free allocation that exists in the early years of program implementation will be phased out over time. Such a phase-out aligns with the underlying notion that free allocation is supposed to compensate for unequal regulatory burdens—burdens that eventually become more evenly distributed as existing capital depreciates and new investments are made. Some have proposed that free allowances be allocated to load-serving entities instead of generators, with the idea that this could lead to more consistent outcomes—in terms of the impact on retail electricity prices—across regulated and competitive regions alike. Allocation to load-serving entities could be based on a variety of measures including electricity consumption, population, or emissions by generators in a state or region. Still other proposals include allocations to end-users, including both large industrial users as well as state governments ho could then use allowance assets to address local issues.

8. What are possible approaches to address emissions in the transportation sector, where achieving reductions comparable to those in other sectors might otherwise require significantly higher carbon prices and longer lead times? How do available policy options compare in terms of the emissions reductions they achieve, the costs they impose, the distribution of those costs, and their short- and long-term effects on different drivers of transport-sector emissions, including vehicle fuel economy, fuel carbon content, and vehicle miles traveled? As in the electric power sector, numerous additional policies have been proposed to reduce GHG emissions and advance other policy objectives in the transportation sector. It is unclear whether this interest in additional sector-specific policies stems from transportation's large share of overall emissions (28 percent of the U.S. total, including 16 percent of the U.S. total from light-duty vehicles alone), from the historic regulation of light-duty vehicle fuel economy, or from the observation that under a typical carbon pricing policy, transport-sector emissions are unlikely to decline very much. Regardless, various policies have been proposed to directly address two of the three factors that drive overall GHG emissions from this sector: the fuel-economy of new vehicles and net GHG emissions from the production and use of different transportation fuels. The remaining factor is vehicle miles traveled, which has increased by 25 percent over the last decade for light-duty as well as larger vehicles. There are few policy alternatives to a carbon price for delivering incentives to reduce travel demand.[25]

As in the electric power sector, the use of additional policies (beyond a GHG price) will tend to raise the overall cost of reducing emissions unless those policies are addressing additional market problems. In the case of fuel economy standards, the concern is frequently voiced that consumers do not adequately value fuel economy, thereby justifying the existing CAFE (Corporate Average Fuel Economy) program and creating momentum to strengthen current standards.[26] Recent changes in the CAFE standard for light trucks offer some guidance for making the overall program more cost-effective and could be applied to cars. Meanwhile, additional program reforms (such as trading across fleets and

24 In the Northeast states' Regional Greenhouse Gas Initiative, states are required to auction at least 25 percent of available allowances and use the revenue to support energy efficiency programs. Several RGGI states have decided to auction 100 percent of available allowances.

25 For a more complete discussion see Issues Brief #12 on the transportation sector.

26 This same concern does not typically extend to commercial modes of transport—primarily trucking, shipping, and aviation—where energy users more clearly value fuel economy. This is presumably why the overwhelming focus of transportation policy debates is on strategies for improving light-duty vehicle fuel economy, rather than addressing energy use by other modes of transportation.

manufacturers, a safety valve mechanism, and/or shifting to a feebate program) could improve efficiency even further.

Fuel requirements, such as a renewable fuels standard or low-carbon fuel standard, by contrast, represent a relatively new policy approach for addressing transport-sector GHG emissions.[27] In their most flexible form, fuel standards specify an average life-cycle emissions rate per gallon that must be met in aggregate, and are designed to achieve that rate as cost-effectively as possible. Nonetheless, both fuel standards and vehicle efficiency standards should be evaluated carefully to ensure that they do not go too far in creating higher mitigation costs in a narrow area of activity when cheaper emission-abatement opportunities exist elsewhere.[28]

In contrast to the electric power sector, where additional policies (such as a renewable portfolio standard) are typically viewed as complementary to a carbon pricing policy, fuel and vehicle performance standards in the transport sector are sometimes viewed as potential substitutes for including the sector in a unified GHG pricing policy, particularly since any policy that can be portrayed as raising the price of gasoline tends to be politically unpopular. The argument is also often made that demand for transportation fuel is relatively inelastic at the level of price signal contemplated in most current GHG cap-and-trade proposals; therefore, excluding the transportation sector from an economy-wide CO_2 price would not be expected to have the effect of foregoing a significant quantity of emissions abatement. Nevertheless, over time excluding transport sector emissions from a broader pricing policy and relying instead on fuel and vehicle standards is likely to be increasingly inefficient, as CO_2 prices rise and the potential impact of higher fuel prices on vehicle miles traveled could become more important. Equally important, distinct transportation policies such as low-carbon fuel requirements and vehicle fuel economy standards do not trade-off CO_2 mitigation opportunities across sectors.

Understanding Current Policy Proposals

More than a dozen legislative proposals to address climate change had been introduced in the first session of the 110th Congress as of September 2007. A few of these draft bills propose to tax GHG emissions, a greater number would establish an economy-wide GHG cap-and-trade program, and two propose cap-and-trade programs that cover only the electric power sector. In addition, the House and Senate have each passed energy bills that provide a variety of technology incentives in the electricity and transportation sectors, and elsewhere. To highlight the range of policy options already on the table, and to demonstrate how the design questions discussed in this report can be used to understand the differences between competing proposals, we summarize key aspects of the various bills now under discussion at the federal level.[29]

Emissions Targets

All the economy-wide cap-and-trade proposals put forward in the 110th Congress specify emissions targets out to 2030, and most extend out to 2050. Over this time period, all envision reducing U.S. GHG emissions below current levels. Proposed targets for 2030 range from reducing emissions to roughly 1990 levels (Bingaman-Specter, S. 1766; Udall-Petri draft) to achieving 25–40 percent reductions below 1990 levels (Sanders-Boxer, S. 309; Kerry-Snowe, S. 485; Waxman, H.R. 1590). The bills that cover only emissions from electric power generation aim to return that sector's emissions to 1990 levels by sometime in the 2020–2030 timeframe. Under current proposals, likely emissions prices in 2030 generally range from \$30 to \$100 per ton CO_2. The two tax proposals that have been introduced in the House of Representatives—Stark (H.R. 2069) and Larson (H.R. 3416)—set price rather than quantity targets for U.S. emissions. Based on the modeling results discussed in Issue Brief #3, H.R. 3416 should achieve 1990 emission levels by 2030 (if not sooner) since it proposes to tax GHG emissions at more than \$130 per metric ton CO_2 in that timeframe. H.R. 2069, meanwhile, might or might not ever reduce U.S. emissions to 1990 levels: it does not account for inflation, and so—in real terms—the carbon price under this legislation is unlikely to ever exceed \$60 per metric ton CO_2.[30]

Reducing U.S. emissions to 1990 levels or below by 2030 could be consistent with achieving a global stabilization goal of 550 ppm CO_2-equivalent (CO_2e) if other nations follow suit by adopting similar targets—it may even be consistent with achieving a more protective stabilization target if other countries take comparable action relatively quickly. A domestic target of 1990 emission levels or below in 2030 may also be justified, however, even in the context of a less protective global stabilization goal (say 650 ppm CO_2e), if it is paired with substantial reliance on offset projects in developing countries to demonstrate compliance.[31] Action

27 A national renewable fuel standard was part of the Energy Policy Act of 2005; more recently, a low-carbon fuel standard has also been proposed in California.

28 In the case of policies designed to promote biofuels, it will also be important to consider impacts on land use, water, and other commodity markets. These isses are discussed in Issue Brief #13, which examines a host of issues relevant to climate change and agriculture.

29 As various proposals for federal legislation continue to be debated, updated information on the key features of current bills will be available at http://www.rff.org/climatechangelegislation.

30 Indeed, at an annual nominal inflation rate of 2 percent per year—historically a low rate—the carbon tax would max out at \$50–60 per metric ton CO_2 in real terms after about 50 years and decline after that.

31 For example, a 2030 emissions cap set at 25 percent below 1990 levels could be viewed as a commitment to cap U.S. emissions at 1990 levels *plus* finance additional reductions (equal to 25 percent of domestic

by other countries would still be required over the next several decades, but a tough domestic target paired with international offsets and a less demanding global stabilization target would allow for greater delay in implementing reductions on the part of developing countries. Without substantial use of international offsets, a program designed to reduce domestic emissions substantially below 1990 levels by 2030 would be expected to produce emissions prices at the higher end of the range noted above (i.e., on the order of $100 per ton CO_2e), the same target with substantial use of offsets would likely result in prices at the lower end of the range (i.e., approximately $30 per ton CO_2e).

Program Coverage and Point-of-Regulation

Current legislative proposals adopt three main approaches to the issue of program coverage and point-of-regulation. The electric-sector cap-and-trade bills regulate CO_2 emissions only and impose the compliance obligation at the point of emissions—in other words, on electricity generators. Because they are limited to one sector, these bills would cover roughly one third (33 percent) of total U.S. GHG emissions.[32] The two tax proposals that have been introduced also regulate only CO_2 emissions, but provide economy-wide coverage by taxing fossil-fuel producers (coal mines, petroleum refiners, and natural gas processors or pipeline operators) and importers on the basis of fuel carbon content. These bills would effectively cover roughly 80 percent of total U.S. GHG emissions. The remaining economy-wide cap-and-trade bills would all regulate the six major GHGs listed in the Kyoto Protocol—carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6)—but for practical reasons would probably exclude fugitive emissions of methane and nitrous oxide. As a result, these bills could cover up to 85 percent of total U.S. GHG emissions.

Among the economy-wide cap-and-trade bills, only the Udall-Petri draft takes an entirely upstream approach to regulating emissions from fossil-fuel use. The Bingaman-Specter proposal (S. 1766) adopts a hybrid approach, regulating natural gas and oil upstream (specifically, the compliance obligation would fall on natural gas processors, petroleum refiners, and importers of both fuels), while regulating coal emissions downstream at large industrial facilities that burn coal—mainly electric generating units. Because virtually all downstream coal users are large emitters, this approach essentially covers all CO_2 emissions from fossil-fuel combustion. Therefore, both of these bills would likely capture 85 percent of total U.S. GHG emissions under a single pricing policy.

A different type of hybrid approach is proposed in Lieberman-McCain (S. 280), which regulates transportation fuels upstream at the petroleum refiner and natural gas and coal emissions downstream at large emitters (above 10,000 metric tons of emissions per year). Because this bill does not cover emissions from primary energy use in the residential or agricultural sectors, it would miss 6 percent of total U.S. GHG emissions, as well as any emissions from small sources in the manufacturing and commercial building sectors.[33] The Lieberman-Warner draft uses a similar approach. Other bills do not specify whether regulation would be upstream or downstream. A fully downstream program focused on large CO_2 emitters and includable sources of other GHGs would cover slightly less than half of total U.S. GHG emissions.

Cost vs. Emissions Certainty

By their nature, tax bills provide the most certainty about emissions prices—generally they do not even set specific quantity targets. The Stark proposal (H.R. 2069) attempts to combine near-term price certainty with a long-term emissions target: it calls for a tax that rises continually until U.S. CO_2 emissions fall to 80 percent below 1990 levels. As noted previously, however, this target is unlikely to be achieved because the proposed rate of increase in the emissions tax does not account for inflation. Nevertheless, H.R. 2069 illustrates how a tax proposal might attempt to combine near-term price certainty with a long-term emissions target. Current cap-and-trade proposals, meanwhile, fall along a spectrum in terms of the relative emphasis they place on cost vs. emissions certainty. The Bingaman-Specter bill (S. 1766) and Udall-Petri draft include a safety-valve mechanism to provide cost certainty; in both proposals, the safety-valve price starts at $12 per metric ton of CO_2 and escalates 5 percent (above inflation) thereafter.[34] By adjusting the rate of escalation such that the safety-valve price eventually exceeds the possible cost of reductions needed to achieve a given emissions target, this type of proposal could be designed to favor price certainty in the near term and emissions certainty in the long term. Other bills use allowance borrowing to address cost and price-volatility concerns. Under this approach, the aggregate amount of emissions allowed over time should remain (essentially) unchanged,[35] but firms can borrow against future emission-reduction requirements to meet short-term compliance needs and make up the difference later. Both Lieberman-McCain (S. 280) and the Lieberman-Warner draft allow regulated entities to borrow up to 15 percent of their

1990 emissions) in developing countries.
32 CO_2 accounts for nearly all electricity sector GHG emissions.

33 Issue Brief #1 provides additional detail about the size distribution of various emission sources and likely coverage of downstream programs.
34 This $12 figure is expressed in 2012 dollars; it translates to about $11 in current (2006) dollars.
35 Actually, aggregate emissions over a given time period will tend to fall because borrowing provisions generally charge a rate of interest on borrowed allowances to prevent strategic manipulation.

total compliance obligation, limiting the borrowing period to five years. Compared to a safety valve, borrowing provisions obviously place a stronger emphasis on maintaining emissions certainty: firms can re-shuffle their emissions profile over time to smooth out short-term supply-demand imbalances and associated price volatility, but eventually aggregate emissions from all firms still have to meet the cap.[36]

Another approach to balancing cost vs. emissions certainty is proposed in the Lieberman-Warner draft legislation, which would create a regulatory body with discretionary power to adjust the number of allowances in circulation and/or the rate at which firms can borrow. Even as it sought to manage price volatility and other market concerns, this new government entity would presumably also operate under some obligation to ensure that long-term environmental goals are met. The concept of a Federal Reserve-like entity to oversee allowance markets is a relative new one and deserves further consideration.[37] Ordinary cap-and-trade proposals that do not include provisions for borrowing or a safety valve provide the greatest emission certainty—examples include the Kerry-Snowe (S. 485) and Waxman (H.R. 1590) bills—but leave much greater uncertainty about compliance costs.

Cap-and-trade proposals that do not include provisions for borrowing or a safety valve provide the greatest emission certainty but leave much greater uncertainty about compliance costs.

Allowance Allocation and Revenue Distribution

Cap-and-trade programs and carbon tax legislation tend to take widely different approaches to allowance allocation and revenue distribution. The two tax proposals introduced in the 110th Congress direct receipts from emissions taxes into the general fund of the U.S. Treasury. The Stark bill (H.R. 2069) does not attempt to dictate the subsequent use of these funds whereas the Larson bill (H.R. 3416) specifies that new revenues are mostly to be used to provide payroll tax rebates, with a declining portion reserved for R&D support and transition assistance to vulnerable industries.

Current cap-and-trade proposals typically specify a blend of free and auctioned allocation, though they rarely allow revenue from any auction to go to the general fund of the U.S. Treasury. The share of allowances to be auctioned ranges from 24 percent of the cap (Bingaman-Specter, S. 1766) up to 80 percent (Udall-Petri draft), with remaining allowances to be allocated for free to various stakeholders.[38] Among recently introduced proposals with detailed provisions concerning this issue, several leave decisions concerning the distribution of allowances available for free allocation to regulatory administrators. Some bills, including S. 1766 and the Feinstein-Carper electric-power sector bill (S. 317), start with a smaller auction but gradually move towards auctioning most allowances. Proceeds from auctioning allowances are used to fund technology R&D (several bills), guaranteed loan provisions (Lieberman-McCain, S. 280), transition assistance (S. 280, S. 1766), engagement with developing countries (Udall-Petri draft), adaptation measures (several bills), debt reduction (Udall-Petri draft), and other measures.

Free allowance allocation to industry ranges from 53 percent in S. 1766 to 20 percent in the Udall-Petri draft. S. 280 specifies that allowances given away for free—the amount is unspecified—must go to regulated entities who surrender allowances; other bills—S. 1766 is an example—distribute free allowances to industries that are not directly regulated to reduce cost impacts on these industries. Most of these bills do not specify in advance how free allowances are to be distributed to individual firms within a sector; however, the two bills that are limited to the electric sector provide specific direction on these issues. Specifically, Alexander-Lieberman (S. 1168) distributes free allowances on the basis of historic heat input, while Feinstein-Carper (S. 317) provides for an updating allocation based on electricity output (existing nuclear generators are excluded).

36 Arguably, the dististinction between a safety valve and borrowing begins to blur if safety-valve allowances are drawn from future auctions as they are sold and if, as borrowing occurs, there is some natural feedback to future adjustments in the cap.
37 This idea is discussed in greater length in Issue Brief #5, which compares different approaches to regulation, including taxes and tradable permits.
38 S. 1766 also sets aside 14 percent of available allowances for direct technology incentives and 9 percent for state governments. This might be viewed as equivalent to auctioning a 23 percent share of allowances with the revenues being directed to particular purposes.

Provisions to Address International Competitiveness Concerns

Several current legislative proposals—including Bingaman-Specter (S. 1766), the Udall-Petri draft, as well as the Stark tax proposal (H.R. 2069)—can be said to address competitiveness concerns by adopting less aggressive emission-reduction targets (Udall-Petri) or emissions prices (H.R. 2069) than competing proposals, or by including a safety valve that limits costs (S.1766).

Some current proposals also include more targeted provisions to address competitiveness concerns in specific industries. Most cap-and-trade bills, for example, direct free allowances to industries that face competitive pressure. Bingaman-Specter also includes provisions that allow the President, starting in 2020, to require that importers of carbon-intensive goods—iron, steel, aluminum, or cement, for example—submit allowances for a product's embedded carbon content if the country of origin does not have a climate policy comparable to that of the United States. This mechanism not only creates incentives for major trading partners to implement GHG-reduction policies, it also seeks to address the problem of emissions leakage. The Lieberman-Warner draft legislation contains similar provisions.

Technology Provisions

All of the current climate-policy proposals before Congress make some provision for technology research, development, demonstration, and deployment. In addition to specific technology mandates for the electricity and transportation sectors, which are discussed in the next two sections, a variety of technology provisions are included in the proposed climate legislation and the energy and tax bills now being debated by Congress. Among the climate change policy proposals, the Larson emissions tax bill directs one-sixth of revenues—up to $10 billion annually—to a newly created Energy Security Trust Fund that would support research and development for clean energy technologies. The Lieberman-McCain cap-and-trade proposal would create a new Climate Change Credit Corporation, funded by allowance auctions, which would promote low-carbon technology deployment.

The separate energy bills passed by the House and Senate include a variety of technology provisions and thus highlight a broad spectrum of options for addressing technology development and deployment. The energy bill passed by the House would create an Advanced Research Projects Agency-Energy (ARPA-E) within the Department of Energy. This agency would be modeled after DARPA at the Department of Defense with the similar aim of supporting cutting-edge research in high-risk, high-return technologies.[39]

Both the House and Senate energy bills also aim to increase energy efficiency by promoting the deployment of more efficient lighting technologies through measures such as advanced procurement, efficiency standards for light bulbs, and technology prizes. In addition, these bills would amend the Energy Policy and Conservation Act to expedite rulemakings on efficiency standards and to update standards for a variety of devices, including consumer appliances and space heating and air conditioning products.

The House energy bill includes provisions designed to promote international technology transfer. Specifically, it authorizes $200 million for the U.S. Agency for International Development to promote clean and energy-efficient technologies; in addition, it provides funding to support a Clean Energy Technology Exports Initiative. The House bill also establishes a government corporation called the International Clean Energy Foundation that would make grants to promote and advance GHG-reducing technologies and projects outside the United States.

Additional Policies for the Electric Power Sector

Many of the climate-related policy proposals currently before Congress include a Renewable Portfolio Standard (RPS)—that is, a requirement that electric generators produce a minimum percentage of electricity using renewable energy technologies. The Kerry-Snowe bill would establish a 20 percent RPS for 2021, phased in 5 percent at a time in four-year increments. This proposal also creates an energy efficiency performance standard for retail electricity suppliers that requires suppliers to reduce electricity use by 9 percent by 2021. The Sanders-Boxer and Waxman bills contain similar renewable portfolio and energy efficiency requirements. The House energy bill includes a 15 percent RPS for 2020 that must be met by new renewable generation (i.e., facilities placed in service since 2001), with energy efficiency projects eligible to fulfill about one-quarter of the total RPS requirement. The House energy tax bill extends through 2012 the production tax credit for renewable energy technologies (including wind, biomass, geothermal, marine, hydrokinetic, and qualified hydropower), although it places a limit on the production credit for new facilities that start operations after 2008. The energy bill passed by the House includes support for research and development in renewable energy technologies for generating electricity, authorizing an average of more than $200 million annually between 2008 and 2012 for marine,

39 An ARPA-E agency was included in the America COMPETES Act (H.R. 2272) which was signed into law by the President on August 9, 2007.

geothermal, and solar renewable energy technologies. The Senate energy bill also includes research and development support for marine, hydrokinetic, and offshore wind energy technologies. Both bills include funding for "smart grid" technology, with the House bill authorizing over $2 billion in matching funds for related deployment efforts.

Finally, many bills currently before Congress support research, development, and demonstration efforts to advance geologic carbon capture and storage (CCS). Among the climate proposals, the Bingaman-Specter bill creates incentives for this technology by providing bonus allowances for CCS projects. The Lieberman-Warner proposal calls for the newly-created Climate Change Credit Corporation to use 20 percent of proceeds from auctioning allowances to support public-private partnerships aimed at commercializing CCS technology. The House and Senate energy bills both include extensive support for CCS, providing for federal research, development, and deployment support on the order of $1.5 billion over a five-to-six year period starting in 2008.

Among the bills that propose to establish a GHG cap-and-trade program for the electric sector only, the Alexander-Lieberman legislation would create a New Source Performance Standard for CO_2 emissions from new electric generating units.

Additional Policies for the Transport Sector

Several of the climate bills (e.g., Kerry-Snowe, Sanders-Boxer, etc.) have extensive provisions concerning vehicle and transportation standards, including requirements aimed at supporting a nationwide supply and distribution infrastructure for biofuels; a 35 percent credit for manufacturers who invest in energy-saving vehicle components; a $3,000–$3,150 tax credit for the purchase of new hybrid, flex-fuel, or plug-in hybrid vehicles; and a GHG emissions standard for new passenger vehicles (the proposed standard, which is specified in grams of CO_2 emissions per mile, is identical to the standard that has been adopted by California).

The energy bills that were passed in the summer of 2007 by both chambers of Congress include provisions designed to reduce GHG emissions from the transport sector. In particular, the Senate bill included provisions to raise Corporate Average Fuel Economy (CAFE) standards for light-duty vehicles (passenger cars and light-duty trucks) to 35 miles per gallon (mpg) by 2020 (current standards equate to around 24 mpg) and to make the CAFE program more flexible by allowing credit trading among manufacturers. Both the Senate and House bills include measures to support new vehicle technologies: for example, the House bill includes loan guarantees for advanced vehicle battery manufacturing and grants for plug-in hybrid demonstration programs. The House also passed an energy tax bill that would establish a new tax credit—with a base amount of $4,000—for consumers who purchase plug-in hybrid vehicles.

The Senate energy bill also includes a renewable fuel standard (RFS) that would mandate 36 billion gallons of renewable fuels by 2022, with 21 billion gallons of that total coming from advanced biofuels such as cellulosic ethanol, biodiesel, or biobutanol. Biofuels would be assessed and labeled based on lifecycle GHG emissions. Additional provisions would support the deployment of biofuel infrastructure; these include grants for installing fuel distribution facilities and support for research on the environmental and economic impacts of biofuels. The total funding authorization for renewable, low-carbon, and biofuels is more than $1 billion. Although the House bill does not contain an RFS, it does include support for biofuels-related research and development, including studies on economic and technical feasibility, alternative infrastructure needs, and environmental impacts. Finally, the tax bill passed by the House extends the current production tax credit for biodiesel and creates a new production tax credit for cellulosic ethanol of 50 cents per gallon.

An Introduction to the Full Report

Assessing U.S. Climate Policy Options consists of 15 issue briefs that explore in greater detail key issues related to the design of a mandatory federal climate policy for the United States. They provide information on emissions sources, targets, and costs; program coverage and scope; price versus emissions certainty; allowance allocation; competitiveness impacts and responses; technology research and deployment; sector-specific issues surrounding electricity, transportation, and agriculture; the regulation of non-traditional GHGs; and offsets. While this overview has sought to draw out major themes and organize key points from the issue briefs around a series of questions, the briefs themselves provide a foundation for addressing the major questions policymakers will confront in designing federal climate legislation.

You can find a list of the issue briefs on page 26.

ASSESSING U.S. CLIMATE POLICY OPTIONS

Here is a list of the issue briefs contained in the full report, which is available at www.rff.org/cpfreport.

ISSUE BRIEFS

1 Greenhouse Gas Emissions and the Fossil Fuel Supply Chain in the United States by Daniel S. Hall. Describes GHG emissions in the United States by gas, fuel, and sector. Additional detail is provided concerning the number of facilities involved at different points in the fossil-fuel supply chain.

2 U.S. Climate Mitigation in the Context of Global Stabilization by Richard G. Newell and Daniel S. Hall. Examines global emission trajectories consistent with stabilizing atmospheric GHG concentrations at different levels. Also explores the implications of different trajectories and stabilization targets for U.S. emissions and carbon prices.

3 Assessing the Costs of Regulatory Proposals for Reducing U.S. Greenhouse Gas Emissions by Joseph E. Aldy. Compares modeled economic impacts associated with achieving different domestic emission targets over the next two decades.

4 Scope and Point of Regulation for Pricing Policies to Reduce Fossil Fuel CO_2 Emissions by William A. Pizer. Discusses various options for including different CO_2 sources in a GHG pricing policy.

5 Emissions Trading versus CO_2 Taxes versus Standards by Ian W.H. Parry and William A. Pizer. Compares two market-based regulatory strategies—taxes and emissions trading—as well as more traditional forms of regulation, including options for balancing cost certainty against emissions certainty.

6 Allowance Allocation by Raymond J. Kopp. Examines options for allocating allowances in the context of a tradable allowance program.

7 Competitiveness Impacts of Carbon Dioxide Pricing Policies on Manufacturing by Richard D. Morgenstern, Joseph E. Aldy, Evan M. Herrnstadt, Mun Ho, and William A. Pizer. Presents current research findings on the likely impacts of CO_2 pricing on vulnerable industries.

8 Addressing Competitiveness Concerns in the Context of a Mandatory Policy for Reducing U.S. Greenhouse Gas Emissions by Richard D. Morgenstern. Explores various options for mitigating competitiveness concerns associated with the impact of a GHG policy on vulnerable industries.

9 Climate Technology Research, Development, and Demonstration: Funding Sources, Institutions, and Instruments by Richard G. Newell. Examines issues surrounding expanded public support for climate change technology research.

10 Climate Technology Deployment Policy by Richard G. Newell. Discusses policy options for encouraging the deployment of new, low-carbon technologies that have passed the research, development, and demonstration phase.

11 The Electricity Sector and Climate Policy by Karen L. Palmer and Dallas Burtraw. Covers special issues surrounding GHG regulation in the electricity sector, including policy options as well as allocation issues.

12 Transport Policies to Reduce CO_2 Emissions from the Light-Duty Vehicle Fleet by Raymond J. Kopp. Surveys policy options for reducing CO_2 emissions from light-duty vehicles, including policies that address vehicle miles traveled, vehicle fuel economy, and the carbon intensity of transportation fuels.

13 Climate Change and U.S. Agriculture by Juha Siikamäki and Joseph Maher. Examines the impacts of climate change on U.S. agriculture, the potential for agriculture-based emissions offsets, and questions surrounding biofuels policy.

14 Mandatory Regulation of Nontraditional Greenhouse Gases: Policy Options for Industrial Process Emissions and Non-CO_2 Gases by Daniel S. Hall. Addresses options for regulating emissions of GHGs other than CO_2 from fossil-fuel combustion.

15 Offsets: Incentivizing Reductions While Managing Uncertainty and Ensuring Integrity by Daniel S. Hall. Discusses trade-offs that must be considered in designing an offset program as part of a CO_2 pricing policy.

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