Cutting Carbon Emissions at a Profit: Opportunities for the U.S.

Executive Summary

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Short Summary

This report identifies and corrects shortcomings in recent modeling studies on the economics of reducing greenhouse gas emissions in the U.S. The major assessments of the Kyoto Protocol — by the U.S. Energy Information Administration, the Clinton White House Council of Economic Advisers, the U.S. Department of Energy Interlaboratory Working Group, and the Stanford Energy Modeling Forum — are found to be seriously incomplete. Each study is shown to omit one or several of four major cost-reducing policy options, resulting in cost estimates that are far too pessimistic.

The present study is the first to integrate all cost-cutting policy options into a coherent coherent least-cost policy framework. Three domestic policies — a national carbon cap and permit trading program, productivity-enhancing market reforms and technology programs, and recycling of permit auction revenues into economically advantageous tax cuts — are combined with international emission allowance trading.

In analyzing this integrated least-cost approach, the present study introduces no new models. It relies on established, peer-reviewed methodologies used in the major U.S. assessments to date.

This reassessment leads to the following principal findings:

1) The U.S. could meet the emission reduction targets set forth in the Kyoto Protocol by 2010 and exceed them by 2020 while increasing economic output from baseline growth projections.
2) In 2010, an integrated least-cost strategy would produce an annual net output gain of about $50-60 billion/yr or roughly 0.5 percent of GDP. By 2020, this gain grows to $120 billion/yr or 1 percent of GDP. On a cumulative net present value basis, the U.S. would gain $250 billion by 2010 and $600 billion by 2020.
3) Most of these economic gains can be achieved through a purely domestic no-regrets strategy. International trading adds some further benefits, but these are not decisive for a positive economic outcome.
4) A strong synergy exists between a national energy policy aimed at safeguarding the economy and a least-cost policy aimed at slowing climate change. By reducing consumption of oil and natural gas relative to rising business-as-usual trends, a climate policy would help protect the U.S. against energy price shocks.
5) Net economic benefits can be realized in the early years of implementation and continue to grow over time. As energy-using equipment and capital stocks turn over, market, organizational, and institutional reforms have the effect of speeding up and completing the penetration of currently available, highly cost-effective energy efficiency technologies that require little or no time-consuming research, demonstration, and commercialization.
6) Potential economic savings from energy productivity gains far exceed the costs of technology R&D programs. Together with expanded markets under a climate protection policy, these have the effect of accelerating cost reductions for renewable energy sources and other low-carbon technology options.
7) Postponing least-cost emissions reduction policies or embarking on suboptimal policies would result in lost opportunities for the U.S. economy of $50-150 billion/yr in 2010.
8) In the context of an integrated least-cost strategy, credits for carbon sinks and constraints on the use of the Kyoto flexibility mechanisms are of only minor significance.
9) An integrated least-cost approach would more effectively insulate U.S. industries from competitiveness problems than a global emissions trading approach applied in isolation. Productivity gains and tax shifts would reduce production costs and export prices in most industries below baseline levels rather than merely limiting increases in costs and prices.
10) The perception that emission reduction targets such as those of the Kyoto Protocol are unavoidably costly or unfair is the result of outdated modeling assessments. Integrated economic analysis such as that contained in this report is needed as an input for future climate negotiations.

> ***"Economic studies have found that there are many potential policies to reduce greenhouse- gas emissions for which the total benefits outweigh the total costs. For the United States in particular, sound economic analysis shows that there are policy options that would slow climate change without harming American living standards, and these measures may in fact improve U.S. productivity in the longer run."***
>
> *— From the Economists' Statement on Climate Change signed by over 2,500 economists including eight Nobel laureates in 1997.*

Executive Summary

Conventional wisdom has it that implementing the Kyoto treaty would unavoidably lead to slower economic growth and higher costs for U.S. consumers and businesses. Recent energy supply problems have heightened these concerns. As a result, many policy makers in the U.S. feel that they are faced with an unhappy trade-off between the environmental advantage of early and stronger climate policy action and the perceived economic benefit of later and weaker action.

This purported conflict between economic and environmental goals has strongly shaped the U.S. stance in the UN climate negotiations. In order to reduce domestic economic impacts, the U.S. has called on developing countries to make emission reduction commitments of their own, and it has demanded the unrestricted use of the Kyoto flexibility mechanisms and large credits for carbon sinks.

These positions have centrally contributed to the recent collapse of the UN Conference of Parties (COP) negotiations: many participants and observers saw the U.S. positions on sinks and flexibility mechanisms as indirect attempts to rewrite the Kyoto targets. More recently, the U.S. administration has entirely rejected the treaty in its current form.

The present report finds that U.S. perceptions of national interests in the pre- and post-Kyoto negotiations have been greatly distorted by flawed and outdated economic modeling studies. What has been missing in the assessments so far is an integration of individual policy options into a coherent least-cost framework drawing on all major cost-reducing policies simultaneously. New information presented in this report shows that such an economically efficient, integrated energy and climate approach would allow the U.S. to fully meet emission reduction targets such as those set forth in the Kyoto Protocol and significantly exceed them by 2020, and do so while increasing economic output, not decreasing it.

By 2010, an integrated least-cost strategy would produce a gain of $50-60 billion/yr to the U.S. economy (constant 1997 dollars). These gains grow to $120 billion/yr by 2020 —before accounting for the benefits of slowing climate change. The cumulative gain over the next decade would be more than $250 billion, growing to a cumulative $600 billion over the second decade (net present value in 1997 dollars). The present report also shows that these positive economic impacts are neither dependent on — nor materially augmented by — U.S. proposals on sinks and flexibility mechanisms.

Furthermore, the present analysis shows that an integrated least-cost approach to climate mitigation solves two problems with one policy strategy. The most important element of a money-saving climate strategy — increased energy productivity investments — is also the most cost-efficient way for overcoming current energy supply problems in the U.S. Large opportunities for cost-effective investments in demand-side efficiency and cogeneration reduce not only the projected use of coal, but also of natural gas and oil. By doing so, a climate-oriented energy policy protects U.S. consumers and firms from rising costs of energy services and from risks of supply disruptions in the electricity, oil, and gas markets.

These conclusions arise from a fresh examination of the key economic analyses of the Kyoto Protocol that were published during 1997-2000, either by the U.S. government itself or as an outflow of major academic projects. In the present report, we subject these studies to an analytical review and integrate their findings into an internally consistent economic perspective. We then use this perspective to evaluate the U.S. position in the UN climate treaty negotiations and proposed responses to energy challenges at home.

A Least-Cost Strategy: Flexibility with No Regrets

To minimize abatement costs, climate change mitigation needs to combine four major policy approaches:

(1) Economy-wide policies that send uniform and consistent price signals to all economic actors through taxes or, alternatively, through domestic emission caps that are linked to a permit auction and trading scheme (cap-and-trade systems). The price and cost of permits adds a carbon charge to energy prices that works in the same manner as a carbon tax.

(2) Domestic reforms based on cost-benefit tested incentives, standards, and voluntary agreements. These reforms would reduce market, organizational, institutional, and regulatory barriers to highly profitable energy efficiency investments and other no-regrets technology options. Also included here are targeted technology R&D and commercialization programs for reducing the costs of renewable energy sources and other low carbon technologies.

(3) Linkage of emissions tax revenues or permit auction revenues with tax shifts and subsidy reforms, such as cuts in taxes on payrolls or investments, to offset revenues received from taxes on emissions or permit auctions. Such fiscal reforms can further increase energy efficiency and total factor productivity in the economy, adding a second no-regrets element that produces economic and environmental double dividends.

(4) Trading of emission allowances with other countries that have lower-cost abatement opportunities than those available in the domestic economy. This is the 'flexibility' strategy based on the Kyoto mechanisms: international emissions trading (IET), Joint Implementation (JI), and the Clean Development Mechanism (CDM).

A fifth element consists of suitable adjustment policies that shield carbon-intensive industries and their workers from having to bear a disproportionate burden, such as border tax adjustments and regional adjustment funds. These policies do not improve economic efficiency per se but help reduce political conflicts that might otherwise impede or prevent timely action.

At the center of the present review is the treatment of these strategies for minimizing mitigation costs and social impacts in the studies supporting U.S. policy development. Since most cost assessments to date incorporate the first policy option — price signals based on a carbon tax or permit trading system — our focus is on whether the other cost-reducing options were included in each assessment, or omitted from analysis.

How Adequate are U.S. Cost Assessments?

Our review shows that all the major economic assessments being cited in the U.S. debate on the Kyoto treaty are significantly incomplete (Table 1). Though each major cost-reducing policy option is examined in at least one study, no study examines the joint application of all domestic no-regrets options, or for that matter, the joint application of the domestic no-regrets options and international trading.

This observation calls into question claims that the U.S. lacks affordable domestic mitigation options, or that the U.S. is heavily dependent on international trading mechanisms and credits for carbon sinks if it is to reduce costs to acceptable levels. The validity of these claims can only be established through an analysis in which all of the major cost-reducing policy options described above are implemented jointly.

The present report is the first to offer such an integrated least-cost analysis. We reexamine the economics of the Kyoto Protocol

Table ES.1: Policy Analysis Gaps in U.S. Assessments of the Kyoto Protocol

	Scope of policy analysis		
	Market reforms, technology programs	Tax shift reforms	International allowance trading
1998 Energy Information Administration			
Domestic	No	No	
Annex I trading	No	No	**YES**
Global trading + sinks	No	No	**YES**
Domestic plus weak double dividend	No	**YES**	
Annex I trading plus weak double dividend	No	**YES**	**YES**
Global trading plus weak double dividend	No	**YES**	**YES**
1999 Energy Modeling Forum-16			
No trading	No	No	
Annex I trading	No	No	**YES**
Global Trading	No	No	**YES**
1998 White House/Council of Economic Advisors			
"Domestic Only" policy case	No	No	
Annex I trading	No	No	**YES**
Best case trading	No	No	**YES**
1997 Interlaboratory Working Group (IWG)			
Non-price policies, moderate	**YES**	No	No
Non-price policies, strong	**YES**	No	No
Same plus $50/tC tax	**YES**	No	No
2000 Clean Energy Futures study (IWG)			
Moderate scenario, no C charge	**YES**	No	No
Advanced scenario, no C charge	**YES**	No	No
Advanced scenario including $50/tC charge	**YES**	No	No

for the U.S. by calculating what its economic impacts would be if the U.S. were to implement its provisions using an integrated least-cost policy approach. In pursuing this analysis, we do not introduce any new models or modeling techniques, but rely on procedures and results that have already been developed and used in the U.S. government's own studies.

Methodology of this Report

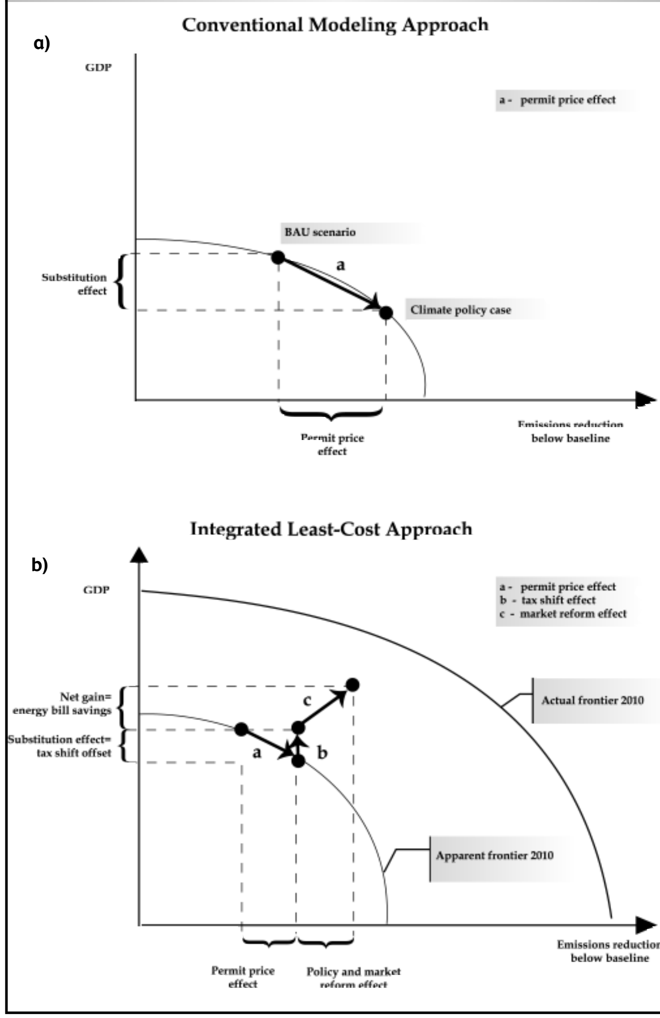
An integrated analysis of the above four policy options requires the joint evaluation of carbon charges and market and institutional reforms. A convenient and operational approach to this task has been developed by the U.S. Department of Energy's Interlaboratory Working Group (IWG). It is based on the familiar economic concept of the trade-off curve between GDP growth and carbon emission reductions. Conventional economic instruments such as carbon taxes or permit auctions move the economy along that curve while cost-effective market reforms and tax shifts move the economy towards the curve or shift the curve itself.

The standard modeling approach is depicted in Figure ES.1a: a carbon charge is implemented to reduce emissions to their target level. In conventional models the historical trade-off curve for the economy is described as the production possibilities frontier, i.e., the best the economy can do given available inputs of labor, capital, and technology. As a result, emissions can only be reduced by moving the economy *along* the trade-off curve to a point with lower emissions. This movement is brought about by energy price effects from carbon taxes or permit auctions, which lead to adjustments in the mix of energy and non-energy inputs by consumers and businesses. These economic substitution effects somewhat reduce GDP.

The concept of no-regrets policies rests on the empirical observation that the economy does not operate fully at the frontier of optimal economic and technological efficiency. The trade-off curve of conventional models is only an *apparent* frontier. Cost-benefit tested market reforms — such as the utility demand-side management programs of many states, the appliance efficiency standards of the U.S. Department of Energy, and marketing and information efforts like the U.S. Environmental Protection Agency's Energy Star and Green Lights programs — represent a move *toward* the actual frontier by eliminating market, organizational, and institutional barriers to cost-effective investments. By increasing energy efficiency and total factor productivity, more GDP can be produced with fewer emissions. Similarly, economically efficient tax shifts reduce dead-weight losses from the tax system. In both cases, the economy's trade-off curve is shifted *outward* toward higher GDP/carbon ratios.

When carbon charges and no-regrets policies are implemented jointly (Figure ES.1b), much of the targeted emissions reduction is provided by market reforms. As a result, required carbon charges are smaller, and so are GDP losses from economic substitution effects. Depending on their design, tax shift reforms can partially or more than fully offset these losses. Assuming that losses are

Figure ES.1: Conceptual framework for modeling greenhouse gas mitigation policies



just offset, the net economic impact of carbon mitigation becomes equal to the net change in the total cost of energy services (lighting, heating, cooling, driving, etc.) brought about by market reforms and technology programs.

The present study is the first integrated analysis of these policies and effects. Emissions reductions and economic gains from cost-benefit tested market reforms and technology programs (arrow **c** in Figure ES.1b) are derived from the U.S. Department of Energy's *Clean Energy Futures* study (CEF), which was published in November 2000. This major analysis was conducted by the U.S. DOE's Interlaboratory Working Group, a team of experts from five national laboratories. The CEF study represents a highly conservative assessment of these non-price policies, and it combines them with domestic permit trading. However, it does not cover tax shifts or international trading, and it analyzes levels of emission reductions that remain well below the Kyoto target for 2010. Other studies have suggested that the U.S. has further options that would permit emission reductions up to and beyond this target at favorable cost.

The impacts of carbon charges (arrow **a** in Figure ES.1b) are derived from the work of the Energy Modeling Forum (EMF-16) at Stanford University. The groups participating in this Forum analyzed the economic impacts of the Kyoto Protocol on the basis of standardized runs for a number of different economic models, including the model used by the Clinton administration's Council of Economic Advisers in its official evaluation of the Kyoto treaty. These studies provide the best available basis for calculating the substitution effects of carbon charges on the U.S. economy. They also analyze international trading and the Kyoto flexibility mechanisms. However, they do not cover market reforms or tax shifts, and they omit the important effects of these domestic no-regrets policies on the international allowance market. Our study derives central (average) estimates from this comparative work (labeled 'EMF-16 Mean' in the accompanying charts and tables).

Gains in GDP from tax shifts (arrow **b** in Figure ES.1b) are derived from a number of U.S. government and academic studies. These studies show that tax shifts can be designed with widely varying effects on GDP, ranging from a partial offset of losses (weak double dividend) to more than a complete offset leading to net gains (strong double dividend). For our central estimates, we assume that tax shifts will just offset the GDP losses from economic substitution effects caused by carbon charges.

Following the arrows in Figure ES.1b, the total economic impact of an integrated climate policy is calculated as the sum of these effects. Interactions between carbon charges and net savings in energy service bills are already accounted for in the models used in the above studies. We additionally include the environmental co-benefits associated with lower fossil fuel consumption and, in our global trading analysis, the cost of purchasing international emission allowances. The details of these calculations are documented in the main report.

Solving Two Problems with One Strategy

Conventional wisdom has it that domestic action to reduce carbon emissions in the U.S. is expensive because of a lack of cheap low-carbon technologies. The central proposition – that the U.S. lacks cost-saving opportunities for domestic emission reductions in its energy system – is at odds with the U.S. government's own authoritative studies by the national laboratories. Our review of this and other work shows that a strong overlap exists between a national energy policy aimed at safeguarding the U.S. economy and a least-cost oriented climate policy.

This synergy is clearly demonstrated in the *Clean Energy Futures* study by the national laboratories. It not only offers a comprehensive analysis of the nation's domestic technological options in fighting climate change; it also illustrates how an integrated least-cost strategy aimed at the climate problem can help the U.S. deal with vulnerability to oil price shocks, disproportionate growth in the consumption of gas, demand and supply imbalances in electricity markets, and resulting volatility in energy prices.

To correctly perceive the national economic interests of the U.S. in the international negotiating process, it is important to understand these interactions. Beginning with the energy supply picture, Figures ES.2a and 2b compare the growth in U.S. oil, gas, and electricity requirements in 2010 and 2020 for the CEF reference case (business as usual or BAU scenario), and for the climate policy case (CEF 'Advanced' scenario). The level of demand and the mix of energy supplies in the CEF reference case is based on a widely used forecast issued by the U.S. Energy Information Administration (EIA).

Relative to the baseline projections of the EIA, the CEF climate policy scenario not only reduces the consumption of carbon-intensive coal, but also of oil and gas. Specifically, oil consumption is 10 percent lower in 2010 and 21 percent lower in 2020. Electricity requirements change by the same percentages, and natural gas consumption is lower by 7 percent in 2010 and by 12 percent in 2020.

Indeed, the CEF analysis shows that with certain electricity market improvements, gas-fired cogeneration of heat and power could reduce total U.S. gas requirements even further than shown in Figure ES.2, at a net cost saving for consumers and firms, while reducing U.S. carbon emissions by 26 and 40 MtC in 2010 and 2020.

These results suggest that a least-cost oriented climate policy does not need to worsen U.S. supply problems in the natural gas or electricity markets. On the contrary, a least-cost approach would help relieve and prevent these problems. Moreover, such relief is not a transient respite but keeps on growing over the next two decades, as is evident from comparing Figures ES.2a and 2b.

Unlike with purely supply-oriented approaches, this substantial relief of U.S. energy supply problems does not arise from lowered economic activity or reduced energy services (driving, lighting, heating, cooling, etc.). As is evident from comparing Figures ES.2 and ES.3, the need for growth in conventional energy sources is alleviated by investments in energy efficiency, and to a secondary degree, in renewable energy sources. In the CEF scenario, the combined contribution of efficiency and renewables to total energy services triples from 7 percent in the reference forecast to about 20 percent by 2010, and quadruples to about 30 percent in 2020.

As the CEF study documents, not only are more efficient demand-side technologies currently available, they also are highly cost-effective. By clearing away the market, organizational, and institutional barriers that currently hamper the rapid diffusion of these technologies, the U.S. can cut its energy bills while simultaneously gaining important breathing space for readying a new generation of cheaper and cleaner energy supply technologies. At the same time, the U.S. can avoid excessive investments in long-lived energy supply facilities that would further lock in yesterday's technologies.

Figure ES.2a: Effect of a least-cost climate strategy on U.S. energy supply requirements in 2010

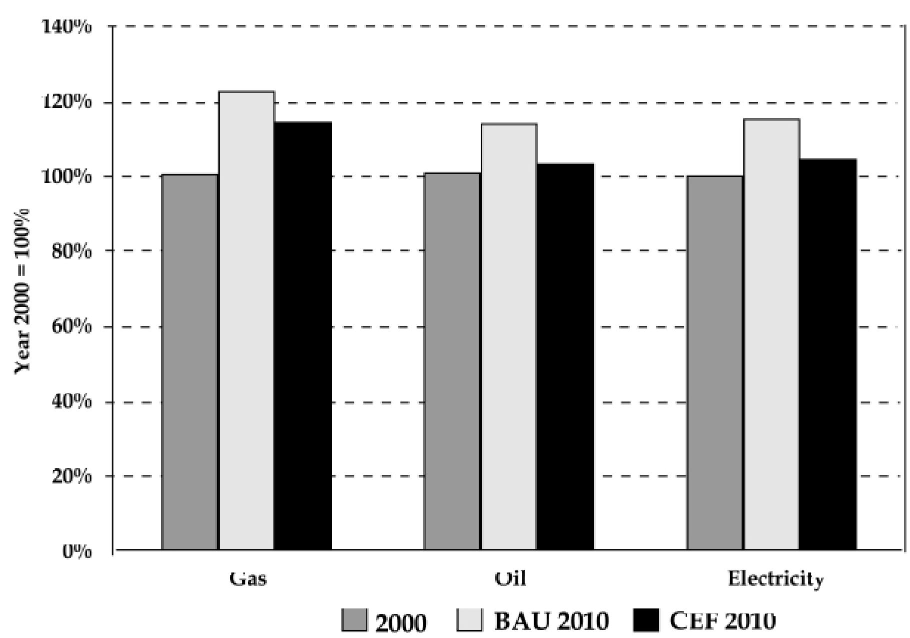


Figure ES.2b: Effect of a least-cost climate strategy on U.S. energy supply requirements in 2020

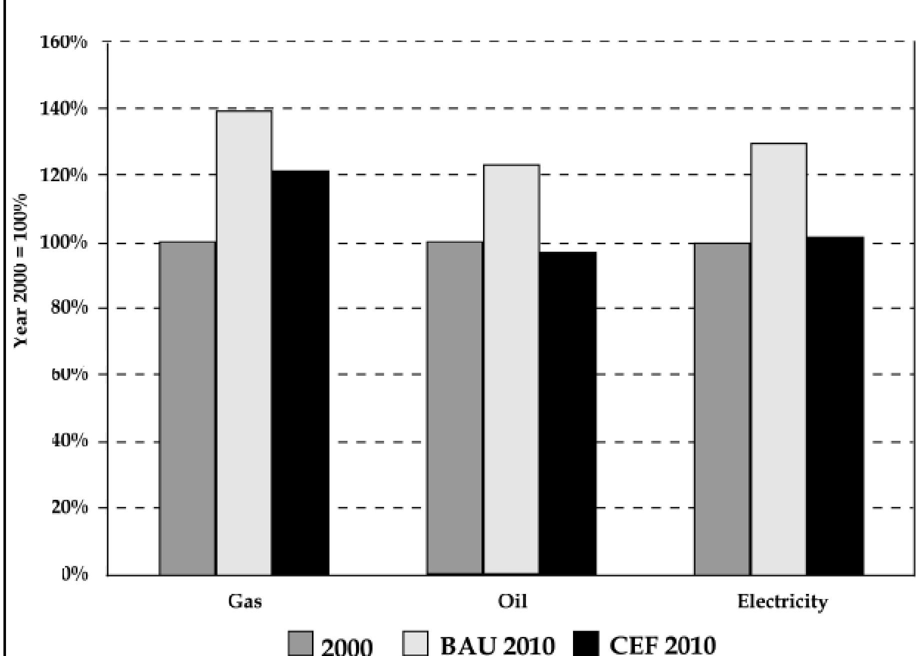


Figure ES.3: U.S. energy mix in 2010 and 2020,
Clean Energy Futures scenario versus Reference case

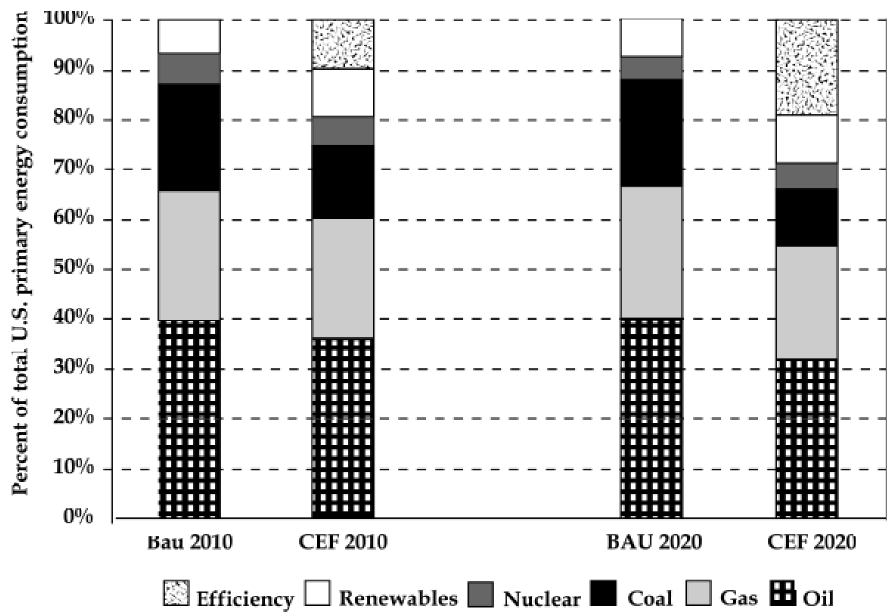
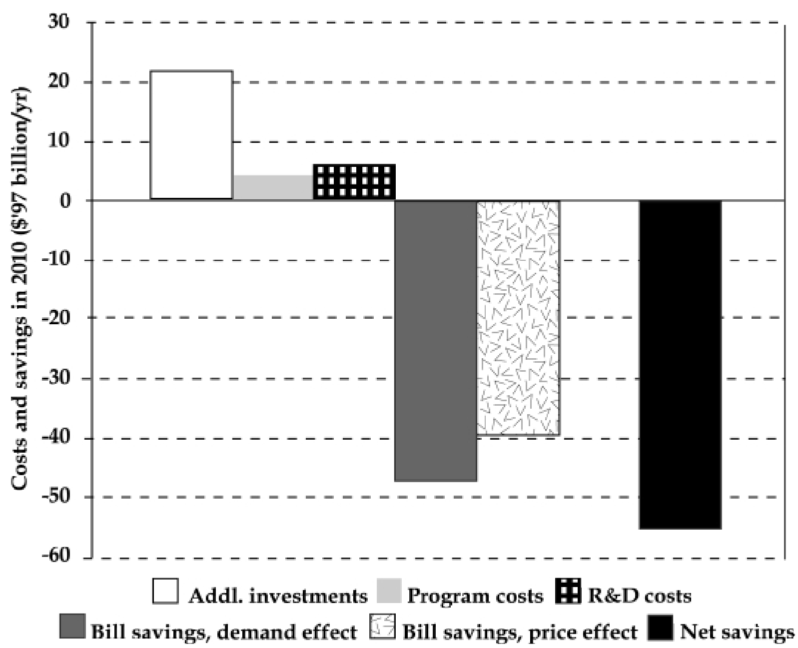


Figure ES.4: Net economic savings from market reforms, CEF scenario without carbon charge, U.S. In 2010



Money Saving from Domestic Market Reforms

The overlap between a least-cost climate policy and national energy policy extends to the economic realm. The key sources of this synergy are cost-benefit tested market reforms that facilitate cost-effective energy efficiency investments, combined with increased R&D efforts.

The EIA reference case excludes all such market reforms (beyond those already in place or under way in the base year). This assumption reflects past policy trends and considerations of political economy. Though market reforms are economically worthwhile on their own in the absence of climate change, many policy-makers hesitate to advocate such government actions unless they also represent a least-cost path for realizing other clearly identified societal objectives. The broader environmental objective of reducing greenhouse gas emissions is operative in the *Clean Energy Futures* policy scenario but is not considered in the EIA's Annual Energy Outlook forecast, which is a business as usual perspective.

The assumptions used in the CEF scenarios regarding the effectiveness of expanded market reforms are a highly conservative extrapolation of past experience with such programs. Only a portion of all new and replacement investments in energy using equipment is shifted toward higher efficiency technologies compared to the reference case. For example, in the buildings sector, this fraction is about a third in 2010 and half in 2020. Even with these conservative assumptions, market reforms are shown to have powerful economic effects. They include:

(1) Productivity gains from energy efficiency investments;

(2) Accelerated reductions in the costs of current and emerging technologies;

(3) An expanded array of no-regrets efficiency technologies;

(4) Lower (pre-tax) prices for fossil fuels and a relatively cheaper electricity supply mix at lower levels of total demand; and

(5) Avoided pollution damage and control costs.

Figure ES.4 shows economic results for the CEF scenario when market reforms are implemented *without* a climate policy component, i.e., without a carbon cap and permit auction system. The annual cost for investments, program delivery, and R&D is about $30 billion/yr. These costs are far exceeded by the roughly $45 billion/yr in reduced expenditures on energy that occur on account of higher energy productivity and reduced demand alone, assuming the same energy prices as in the EIA reference case (demand effect). However, reduced energy demand produces a sizeable additional economic benefit from its effect on energy prices, which adds another benefit of close to $40 billion/yr (price effect). Finally, the co-benefits of reduced environmental damages from air pollution and other impacts add a saving of roughly $5 billion/yr.

Net gains — calculated as (demand effect) plus (price effect) plus (avoided pollution damages) minus (investments and program costs) — are $60 billion/yr in 2010. For the sake of simplicity, we refer to these savings as net energy bill savings. More precisely, they are a reduction in the total national cost of energy services (i.e., in the total expenditures on energy carriers plus levelized investments and program and R&D costs, some of which deliver energy services through efficiency improvements rather than energy consumption). These net energy bill savings are 8 percent in 2010, equivalent to 0.5 percent of projected GDP.

By 2020, these figures double to $123 billion/yr (including $12 billion/yr in avoided pollution damages), equivalent to 16 percent of the national energy bill or 1 percent of GDP. If the EIA reference projections of future U.S. energy prices should turn out to be too low — as would be the case if recent trends persist — the economic benefits of market reforms could be significantly larger still.

As the CEF study shows, the energy productivity savings from no-regrets market reforms are far greater than the funds needed to pay for the accelerated introduction of renewable energy sources or other carbon-reducing technology options.

Cutting Carbon Emissions at a Profit

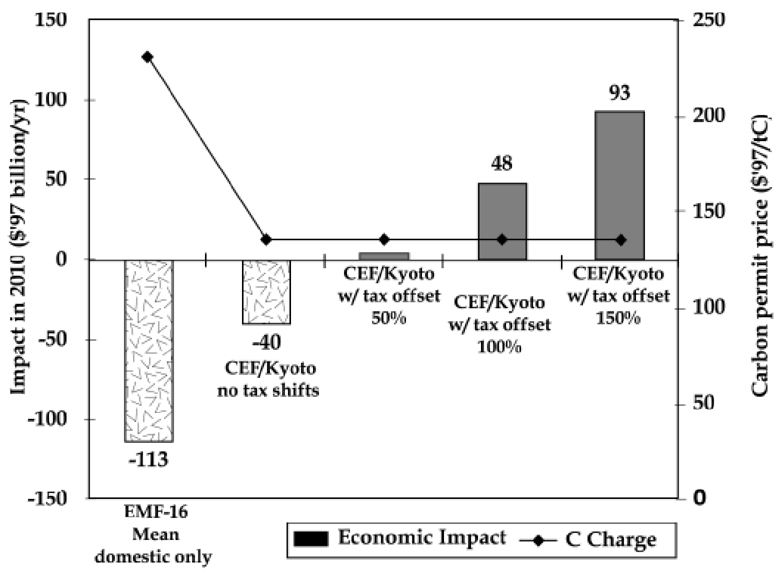
With its conservative assumptions, the CEF study's market reforms alone produce about thirty percent of the U.S. Kyoto target in 2010 and about half in 2020. When a $50/tC charge is added, the CEF scenario leads to a roughly 60 percent realization of the Kyoto target in 2010 and 85 percent in 2020.

This roughly doubling of emissions reductions brought about by the carbon charge diminishes net economic savings by only a small fraction. The national cost of energy services rises by only $6 billion/yr in 2010 and $3 billion/yr in 2020, respectively, relative to the no-carbon-charge case. (In this calculation, which adopts a national perspective, the carbon charge payments themselves cancel, since they are merely a transfer payment).

Our report finds that even though the CEF scenarios do not reach the Kyoto target, the U.S. can fully achieve that level of emission reductions at a net economic gain — even if a purely domestic strategy is used. The key to this outcome is a combination of the above-discussed no-regrets market reforms with tax shifts that offset the negative GDP effects of a cap-and-trade permit system or carbon tax, as qualitatively illustrated in Figure ES.1 above.

Again, the EIA forecast used as the reference case in the CEF study does not include any no-regrets options for implementing carbon charges, i.e., growth-enhancing tax shifts. Though they are economically worthwhile on their own, such tax shifts require new sources of government revenues to offset reductions in existing, more distortionary taxes. Climate policy scenarios do include new revenues from carbon taxes or emissions permit auc-

Figure ES.5: Economic Impact in 2010 —
U.S. Kyoto target, domestic strategy with and without market and fiscal reforms



tions, but no such new source of revenues is available in the EIA reference case.

Figure ES.5 shows how market reforms and tax shifts play out in the aggregate in 2010. The chart compares the Kyoto analysis of the Energy Modeling Forum with an integrated least-cost approach in which the CEF scenario is extended to reach the Kyoto target. Under a domestic permit trading system alone, a high permit price of $230/tC is required to reach the Kyoto target. The resulting economic losses based on the mean of estimates from the Energy Modeling Forum are of the order of $130 billion/yr. Co-benefits of reduced pollution reduce this figure to about $110 billion, or 1 percent of projected year 2010 GDP.

When domestic market reforms are added, the permit price required to reach the Kyoto target drops to less than $140/tC. This reduces GDP losses from substitution effects. At the same time, market reforms trigger cost-effective energy productivity investments, which cut the costs per unit of energy service as well as the nation's total bill for energy services. As a result of these savings, economic losses shrink by about two-thirds to $40 billion.

When tax shifts are also included, GDP losses from substitution effects are eliminated entirely. Depending on the extent and effectiveness of tax shifts (we model 50 to 150 percent offset of substitution losses), U.S. economic output in 2010 increases by an amount that ranges from less than 10 to more than 90 billion dollars per year (again including environmental co-benefits of about $20 billion).

For the midpoint level of effectiveness (100 percent offset), tax shifts just compensate for the GDP impacts of the carbon charge. What remains, then, are the reductions in the total cost of energy services from market reforms (simply referred to as net energy bill savings), plus the environmental co-benefits of reduced carbon emissions. With a carbon charge of roughly $140/tC, net savings from market reforms are lower than they would be in the absence of carbon charges, but the co-benefits of avoided pollution compensate much of this effect. The total economic gain is about $50 billion/yr, equivalent to about half a percent of projected GDP in 2010.

Extending the Time Horizon to 2020

The extension of the above analysis to 2020 is of great importance for the U.S. policy debate and the UN negotiations in that it indicates whether emission reductions can be profitably maintained or even increased over the following decade as economic growth continues to push the reference forecasts beyond current emissions levels.

Using the CEF results for 2020, we examine a domestic least-cost strategy, again consisting of permit trading, market reforms, and tax shifts. We analyze two alternative emission reduction targets. In the first case, it is assumed that the U.S. Kyoto target for 2010 (i.e.,1990 emission levels minus 7 percent) will be maintained in the subsequent decade. In the second case, the target is increased to the minus 20 percent level originally proposed at Kyoto by the Alliance of Small Island States (AOSIS), a group of countries most vulnerable to sea level rise.

As expected, the U.S. energy system in 2020 is more responsive to both market reforms and carbon charges. The Kyoto target is reached at $65/tC — roughly half the charge required in 2010. Expanding emission reductions to minus 20 percent of 1990 levels requires only a modest further increase in the carbon price, to $77/tC.

Net economic benefits are roughly $120-125 billion/yr in 2020, equivalent to 0.9 percent of projected GDP. This is more than double the economic gains achieved with the same strategy in 2010. When the year 2020 emission reduction target is extended from minus 7 to minus 20 percent of 1990 levels, net economic gains are somewhat lower but still of the same order of magnitude as for the Kyoto target. The higher carbon charge necessary in 2020 to achieve the minus 20 percent target does lead to reduced net savings in energy service bills. However, this effect is partially offset by larger environmental co-benefits.

The more than doubling of net benefits between 2010 and 2020 is explained by three factors: (a) money-saving productivity investments are far from saturation in 2010, and are continuing to penetrate the capital stock in the period between 2010 and 2020; (b) capital stock turnover in many important categories of energy-using equipment, and thus the penetration rate of demand-side efficiency programs, is inherently faster than economic growth, on account of short (10-20 year) equipment lifetimes; and (c) the costs of advanced low-carbon technologies decline at an accelerated pace, due to learning curve effects and R&D impacts.

Examining the CEF scenarios for the entire period from now until 2020, it is evident that a domestic no-regrets strategy of permit auctions, tax shifts, and market reforms already becomes significantly profitable within the first couple of years of implementation. From there, it grows more lucrative year by year as the capital stock turns over.

These findings call for a revision of conventional wisdom, which presumes an economic advantage from postponing most emission reductions to later years. Larger emissions reductions do become easier to achieve in later years, as more time is allowed for the adjustment process in the economy. However, because growing levels of emissions reductions below the baseline become profitable even in the early years, foregoing the early reductions implied in the Kyoto target would amount to a significant opportunity cost for U.S. consumers and firms.

International Implementation

The positive economic picture found so far further improves when a domestic least-cost strategy is integrated with the Kyoto flexibility mechanisms. Here, we analyze the limiting case of unrestrained global emissions trading. Other scenarios with only a supplementary role for trading are discussed in the subsequent section. Figure ES.6 compares the international trading case of the EMF-16 analysis with the results for the CEF/Kyoto strategy combining international flexibility with domestic no-regrets action.

As a point of reference, the chart begins with the domestic worst-case policy based on a carbon tax without tax shifts or market reforms. When global trading is incorporated into this policy case, the carbon price drops by more than 80 percent from $230/tC to about $40/tC. Total mitigation costs decline by two thirds or more.

While global trading can reduce U.S. mitigation costs by significant percentages, it alone cannot prevent economic losses. By contrast, domestic market and fiscal reforms can produce net benefits on their own. If these gains are enhanced by international

Figure ES.6: Economic Impact in 2010 —
U.S. Kyoto target, domestic permit trading versus global trading versus integrated least-cost strategy

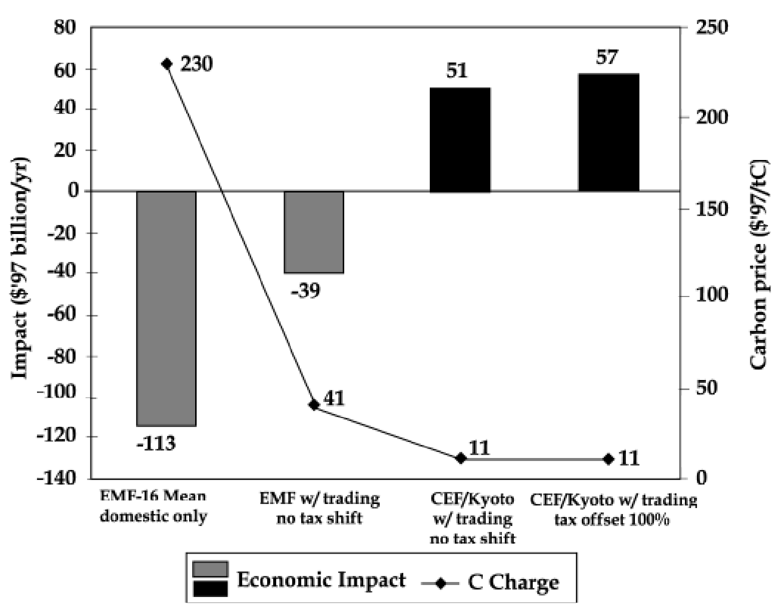
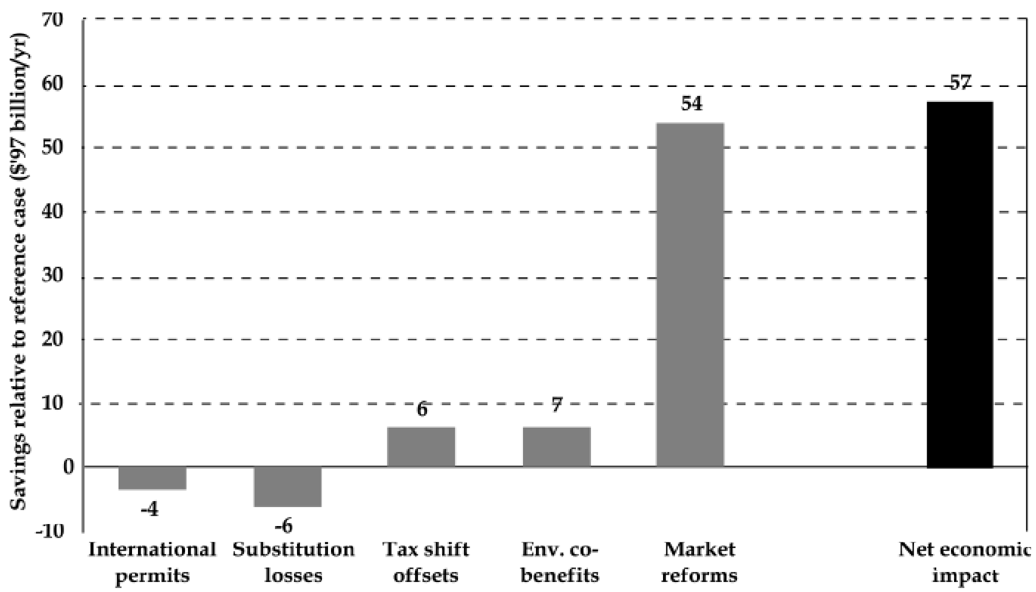


Figure ES.7: Cost and savings components of an 'international flexibility plus domestic no regrets' strategy for the U.S., year 2010



allowance trading, the carbon price drops from about $40/tC to $11/tC, due in part to feedback effects of U.S. domestic no-regrets policies on the international allowance market.

Our analysis shows that a fully integrated 'flexibility with no regrets' strategy yields economic benefits of $57 billion/yr in 2010. Figure ES.7 shows the individual components of this aggregate result. The graph also shows that tax shifts are of lesser importance in the context of an international strategy: economic substitution losses are diminished on account of the much lower carbon price.

Summary of Results for 2010 and 2020

The main results of our review are summarized in Figure ES.8. These results support several conclusions. The first conclusion is that with an integrated least-cost policy mix, the U.S. can meet targets such as those set forth in the Kyoto Protocol at a net economic gain ranging from about 0.5 percent of GDP in 2010 to about 1 percent of GDP in 2020. Insofar as some of the total benefits are from avoided environmental damages (in areas other than climate change), not all of these economic gains may show up in the country's GDP accounts, but they are economic gains nonetheless.

The second conclusion is that postponing carbon mitigation in the U.S., or reducing abatement efforts to less than the U.S. target under the Kyoto Protocol, brings with it significant lost opportunities for the U.S. economy. Such lost opportunities are of the order of $50-60 billion per year in 2010, and about $120 billion per year by 2020.

The full opportunity cost of inaction is measured by the sum of foregone annual economic gains in the period between now and 2020. By the end of the first Kyoto commitment period in 2012, U.S. consumers and businesses would forego cumulative economic gains of about $250 billion (net present value of growing annual gains, discounted to the year 2001 at a 5 percent real discount rate, constant 1997 dollars). For the entire period until 2020, this figure rises to more than $600 billion.

The third conclusion is that positive net economic impacts are centrally driven by productivity-enhancing market reforms. A focus on international rather than domestic strategies is misplaced, because GDP losses from carbon charges can be minimized through either domestic tax shifts or international trading. The implication of this finding for the UN FCCC negotiations is further discussed below.

How Important is Emissions Trading?

Our analysis shows that the economic significance of international allowance trading has been grossly exaggerated. To measure the significance of international trading, the appropriate point of reference is the 'no trading' case examined in the EMF-16 assessments, in which the only policy is a domestic permit trading system or carbon tax. The mean of the EMF-16 estimates of the impact of the U.S. Kyoto target for this policy case is a GDP

Figure ES.8: Economic impacts of an integrated least-cost strategy for reducing U.S. carbon emissions in 2010 and 2020

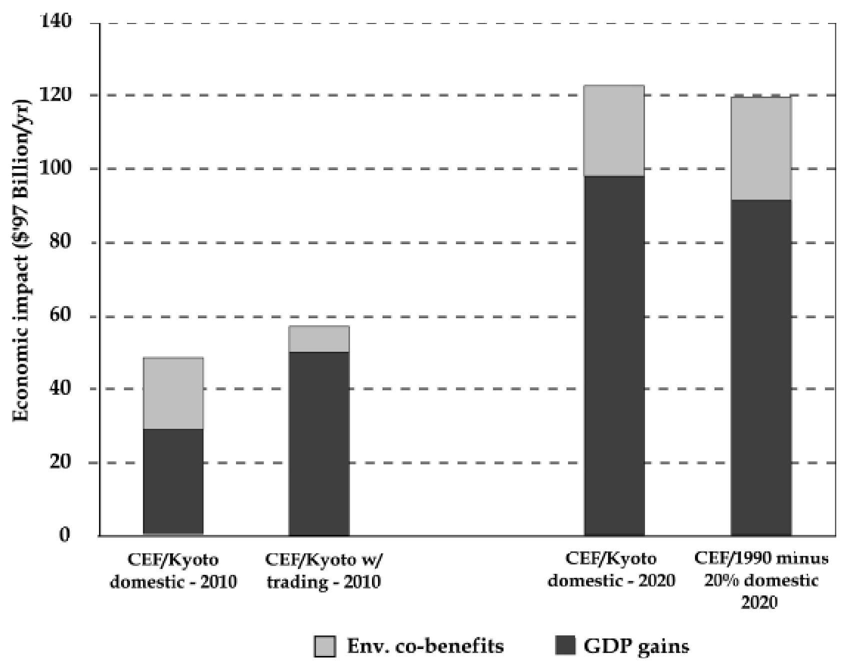
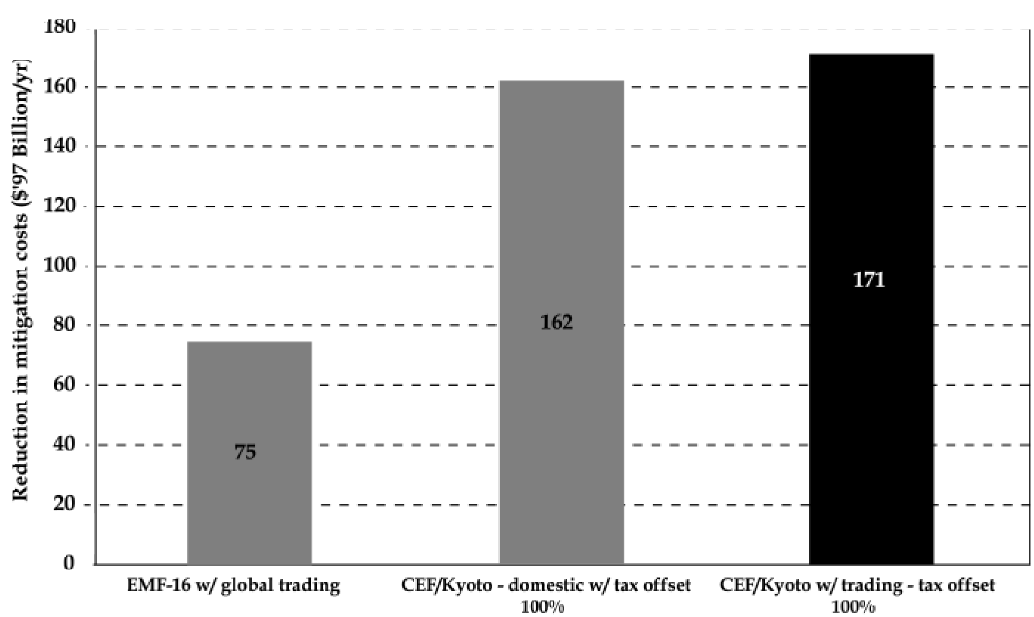


Figure ES.9: Reductions in U.S. mitigation costs from domestic market and fiscal reforms and global allowance trading relative to domestic permit trading only, year 2010



loss of about $110 billion/yr in 2010.

Relative to our average derived from the EMF-16 global trading case, the domestic least-cost approach of the CEF/Kyoto scenario improves economic results by eliminating all GDP losses and generating a net benefit instead. The economic improvement is roughly $(110+50) = $160 billion/yr in 2010. This figure is far larger than what is achieved in the EMF-16 'global trading' case, which reduces mitigation costs by only about $75 billion (Figure ES.9).

When the CEF/Kyoto scenario is expanded to incorporate international trading, results improve further to about $170 billion/yr, or by roughly $10 billion/yr. It is this marginal improvement of $10 billion/yr relative to the domestic gain of $160 billion/yr that measures the marginal significance of international trading.

These proportions indicate that trading adds no more than a roughly five percent improvement. About 95 percent of theoretically feasible abatement cost reductions can be achieved through domestic market and fiscal reforms alone. The purported major significance of international trading turns out to be an artifact of incomplete modeling analyses of domestic policy options.

Not only that, a one-sided reliance on international trading would be expensive for U.S. consumers and firms. Figure ES.9 implies that in the absence of domestic market and fiscal reforms, global allowance trading as assumed in the EMF-16 scenario would saddle the U.S. economy with opportunity costs of roughly $(160-75) = $85 billion/yr in 2010.

Rather than obtaining emission reductions at negative net cost from domestic action, U.S. energy users would end up paying for investments abroad that provide carbon reductions at a positive cost. The fact that this cost burden would be lower than in the absence of trading does not change the fact that exclusive reliance on trading (i.e., a lack of domestic action) would result in a sizeable economic penalty.

How Robust are these Finding?

A sensitivity analysis of our results shows that international trading can provide a certain amount of insurance against domestic policy failures, as well as against the large variation in GDP estimates from current economic models. This effect is illustrated in Figure ES.10, which shows high/low sensitivity ranges for the domestic and international CEF/Kyoto least-cost strategies. Our sensitivity tests include both a fourfold variation in predictions from economic models (highest versus lowest GDP loss for a given carbon price); a range of ancillary benefit estimates; and variations in tax shift offsets and no-regrets emission reductions by plus or minus a third.

As shown in the chart, the uncertainty band under international trading is only half as wide as under the domestic strategy. Equally important, trading shifts the full range of economic outcomes into positive territory.

These uncertainty-reducing benefits are maximum effects since a purely domestic strategy is the point of reference. Since the Kyoto Protocol foresees at least a partial implementation of targets through international mechanisms, the marginal benefits or backstop provided by a move to global trading is likely to be

Figure ES.10: Uncertainty range of Kyoto impacts for a least-cost strategy with and without global trading, U.S. in year 2010

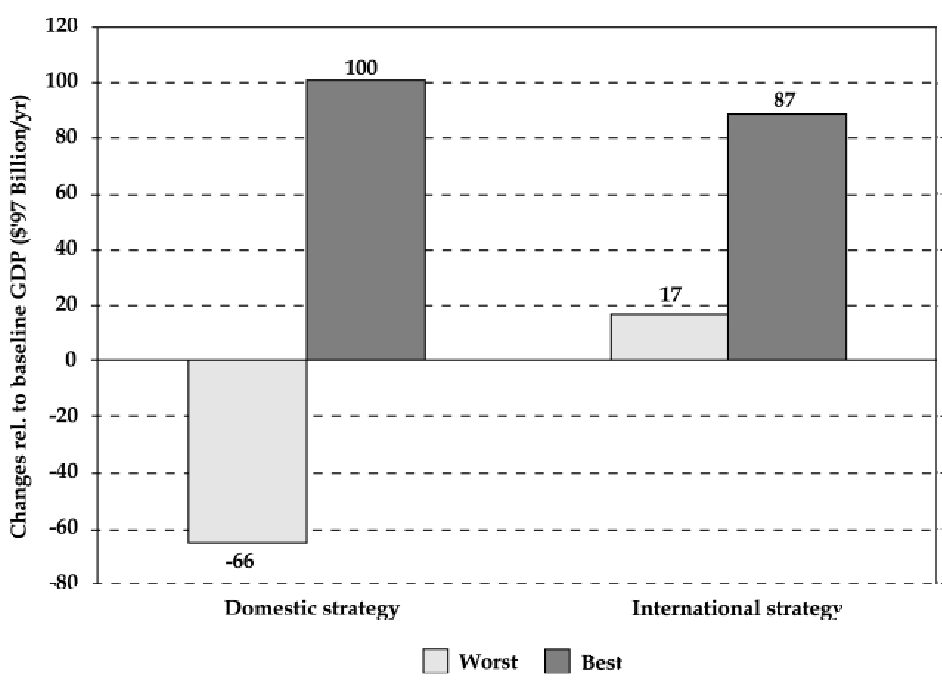


Figure ES.11: Incremental economic savings for the U.S. from obtaining credits of 100 MtC for enhancement of sinks, year 2010

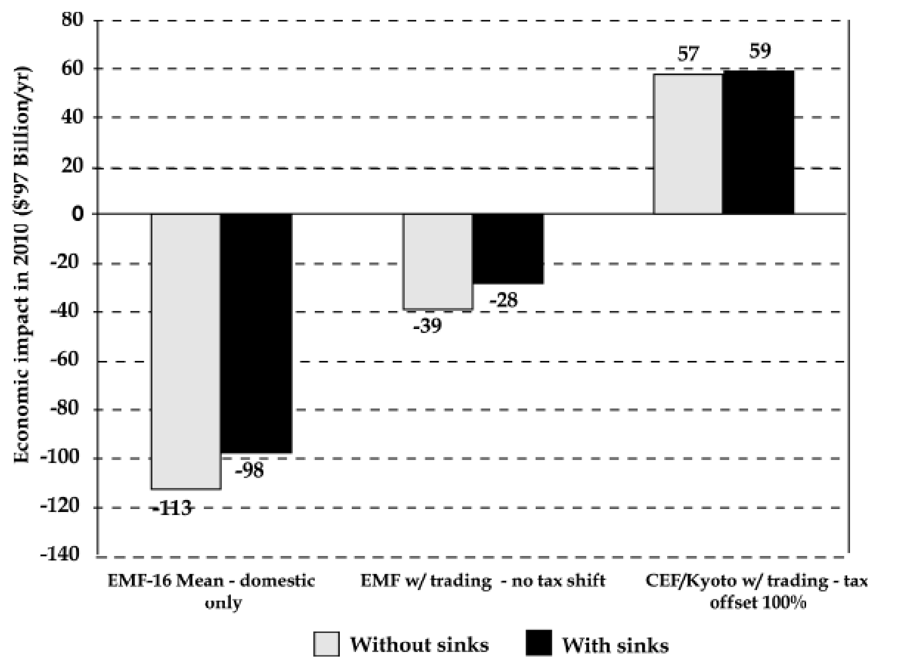
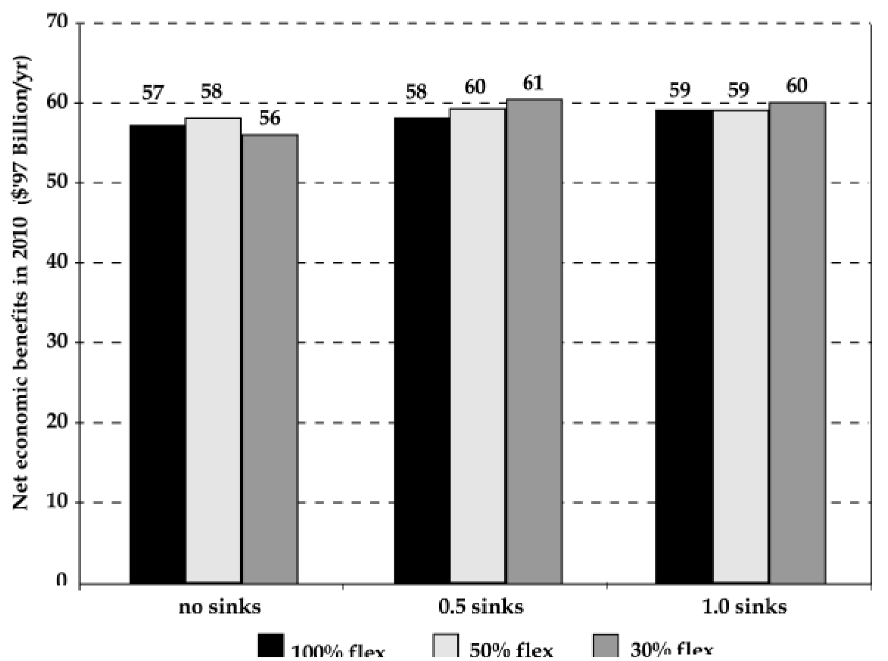


Figure ES.12: Change in U.S. Kyoto benefits in 2010, least cost with alternative rules on sinks and supplementarity



smaller than indicated in Figure ES.10. Furthermore, the workability and reliability of the proposed international flexibility mechanisms is as yet untested.

Negotiations on Sinks and Supplementarity

Just as a least-cost integration of all policy options reduces the marginal significance of international trading, so does it diminish the importance of credits for sinks. Figure ES.11 shows the savings the U.S. would obtain if it were to gain agreement for 100 MtC in such credits for 2010.

In the context of a least-cost strategy, sinks add savings of $2 billion/yr in 2010. Relative to the roughly $170 billion in savings already obtained by the CEF/Kyoto strategy (see Figure ES.9 above), sinks represent a mere one percent effect.

Similar findings apply to the impact of constraining the Kyoto flexibility mechanisms to a supplementary role. The U.S. negotiating position has strongly emphasized unlimited use of the Kyoto flexibility mechanisms in meeting national targets while the EU has proposed a roughly 50 percent limit that would require countries with targets to undertake most reductions at home. Meanwhile, various studies including analyses in EMF-16 have pointed out that the U.S. would likely be a net beneficiary of moderate flexibility constraints, but have found those constraints detrimental from a global economic efficiency perspective.

From the perspective of an integrated strategy of domestic no-regrets reforms plus international trading, U.S. insistence on unconstrained use of the Kyoto mechanisms turns out to be even more misplaced. First, in a least-cost approach to mitigation, supplementarity constraints are economically insignificant for the U.S. Second, if the U.S. proposal for 100 MtC in credits for sinks is combined with a least-cost mitigation strategy as outlined above, sinks plus domestic no-regrets options already supply about 250 MtC, or just about half of the U.S. Kyoto target.

The least-cost economics of the U.S. position on supplementarity, and of various negotiating outcomes regarding supplementarity and sinks, is shown in Figure ES.12. It combines three outcomes for sinks (no credits, half credits, full credits = 100 MtC) with three flexibility limits (100% = unconstrained, 50% limit, and 30% limit).

We show the net economic impact of each outcome relative to the EIA baseline projection used in the CEF business as usual case. A least-cost strategy including unconstrained international trading and full sinks (the U.S. negotiating position) results in an absolute economic gain of $59 billion relative to the business-as-usual reference case (see Figures ES.8 and ES.11 above).

The marginal effects of alternative outcomes, at less than $3 billion/yr in either direction, are in the five percent range — hardly the sort of impact that could justify the collapse of international negotiations.

What About Individual Industries?

Although the overall economy-wide impacts of a well-designed climate policy are positive, this does not necessarily mean that impacts on some individual sectors of the economy could not be adverse. Even if the U.S. approach to date — emphasizing global trading and credits for sinks rather than no-regrets market, institutional, and fiscal reforms — is economically inefficient for the U.S. economy, might it nevertheless represent a sensible strategy for protecting the competitiveness of important

Figure ES.13: Distribution of U.S. jobs in 1995 (total = 132 million)

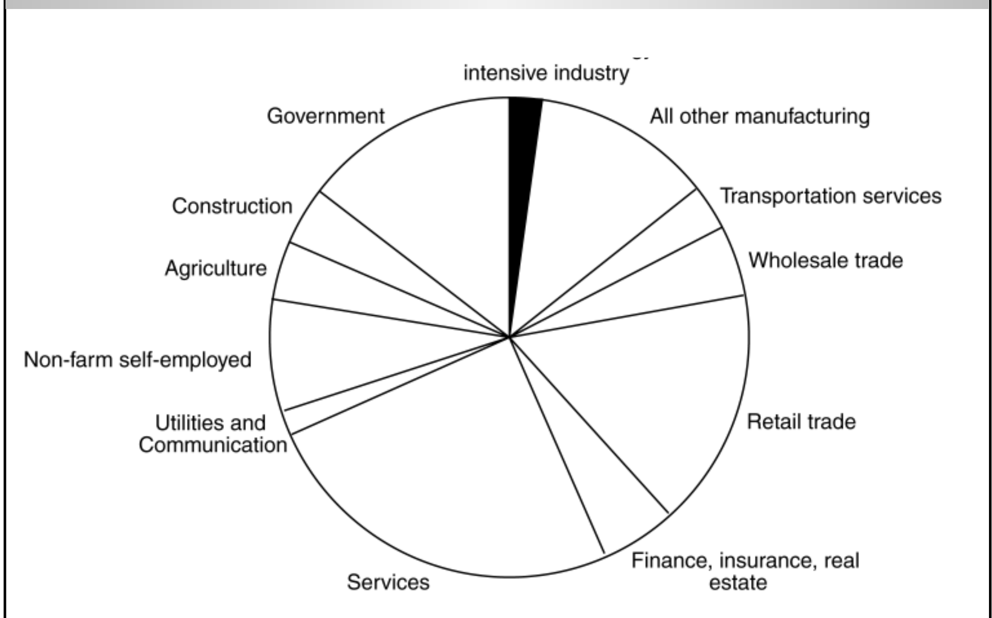
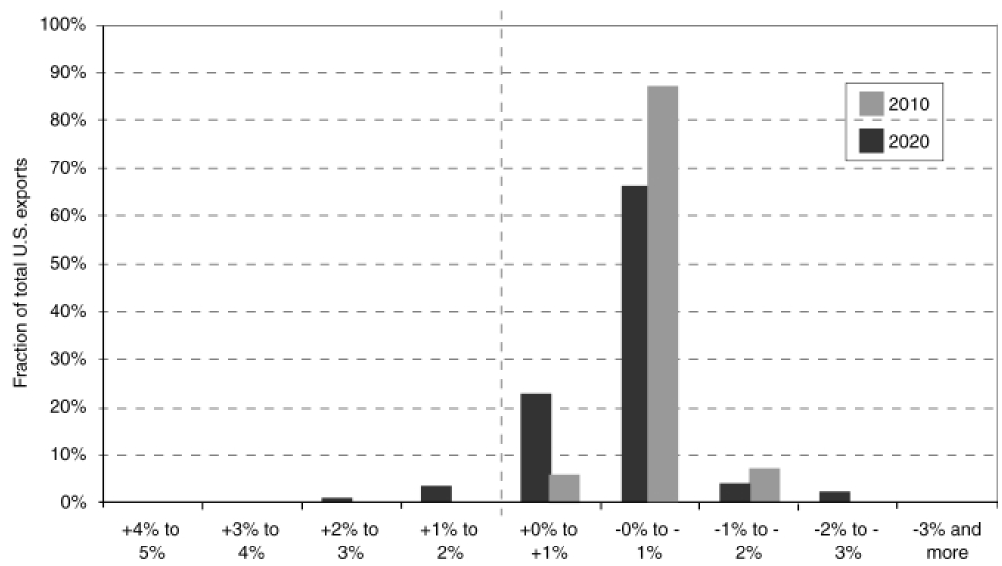


Figure ES.14: Impact of CEF scenario plus payroll tax rebate on prices of U.S. Exports ($50/tC)



trade-exposed or disproportionately carbon-intensive industries?

Our study finds that the perceived advantages of a global trading strategy for U.S. industries rest on comparisons with ill-designed domestic climate policy scenarios that mainly rely on a carbon charge. Relative to this analytical "straw man," global trading does show significant economic benefits for the U.S., both in terms of aggregate costs and sectoral competitiveness impacts.

However, an integrated analysis of cost-reducing policy options shows that a global trading strategy pursued in isolation not only incurs large opportunity costs for U.S. businesses and consumers in the aggregate, but also is inferior in maintaining the competitiveness of trade-exposed energy-intensive industries.

Here, a sense of proportions is helpful. Figure ES.13 shows that the share of U.S. employment in trade-exposed energy-intensive industries is on the order of one percent of total employment. All other industries, including more than 90 percent of U.S. manufacturing employment, is found in industries where energy costs represent less than three percent of production costs or — in the case of transportation services — where trade competition is inherently limited. The effect of carbon charges on the competitiveness of these industries necessarily must be minimal.

In addressing competition from developing countries without carbon charges, U.S. industries including the energy-intensive basic materials industries would be better served by an integrated no-regrets strategy. This is borne out by Figure ES.14, which shows how a $50/tC carbon charge would affect U.S. export prices if this charge is combined with the market reforms of the CEF scenario, and if revenues are recycled into a payroll tax cut. In 2010, no industry would see export prices rise by more than 3 percent, and only about five percent of industries would see price increases of more than 1 percent. Such changes would easily be swamped by ordinary exchange rate fluctuations unrelated to climate policy.

The overwhelming majority of U.S. industries — three quarters in 2010, and about 95 percent in 2020 — would see a decline in the prices of their exports. Energy productivity investments and tax rebates have the net effect of reducing production costs despite the application of the $50/tC charge. An integrated least-cost strategy including international allowance trading would further enhance the competitiveness of U.S. industries.

The U.S. has advocated the global trading approach as a way of generating meaningful participation by the developing countries, who would be induced to undertake domestic emission reductions to sell permits. Such global trading has also been viewed as a policy that would relieve pressure on the U.S. coal industry.

Our assessment finds that global emission allowance trading would have some such effect. However, it comes with a large price tag for U.S. consumers and businesses as a whole. Choosing the global trading approach over an integrated least-cost approach for the sake of protecting the U.S. coal industry would save an estimated 10,000 to 20,000 coal mining jobs at an opportunity cost of close to $100 billion/yr, or $5-10 million/yr per job saved. An adjustment fund providing direct assistance to affected coal workers and their communities would be 50 to 100 times cheaper and could be financed with just three percent of domestic permit auction revenues.

Meaningful Participation by Developing Countries

Some policy makers believe that the current exemption of developing countries from binding emission reduction commitments is providing these nations with an unfair competitive advantage and is undermining the effectiveness of global climate protection efforts. This perceived imbalance along with other cost concerns has led to attempts by the U.S. to rewrite the UN climate treaty through the post-Kyoto negotiating process, and more recently, to its outright rejection.

The present analysis suggests that the perception of the Kyoto Protocol as burdensome and unfair is unfounded simply because its implementation could be achieved at a net economic gain for the U.S. while at the same time improving the competitive position of U.S. industries. This finding points to a way out of the present diplomatic stalemate. It also offers a promising way of obtaining the earliest and whole-hearted participation of developing countries: self-interested U.S. leadership in implementing the Kyoto target through the full use of no-regrets policy options.

Such leadership would likely set in motion an irresistible economic process. First, energy productivity oriented market reforms would be widely imitated throughout the developing world. Second, domestic market reforms in the U.S. and other OECD countries would not only accelerate technological innovation but also speed the diffusion of more efficient vehicles, appliances, and industrial equipment to developing countries. A principal mechanism would be foreign direct investments by U.S. and other OECD multinationals whose technological priorities continue to be strongly influenced by policies adopted in the U.S.

Conclusions

Flawed and incomplete cost assessments have severely distorted the U.S. policy debate on climate policy and on the Kyoto Protocol. The integration of existing studies into a coherent least-cost policy framework turns conventional wisdom upside down. It shows that if U.S. climate policies embrace market and fiscal reforms, carbon-cutting investment shifts result in cumulative net economic gains of $250 billion by the end of the first Kyoto commitment period and $600 billion by 2020 — before counting the benefits of avoided climate risks and damages.

Our analysis also shows that an energy strategy aimed at mitigating climate change would simultaneously relieve current U.S. energy problems and help safeguard the U.S. economy. Though mitigation will involve significant administrative and political challenges, meeting these challenges offers tangible economic rewards for U.S. consumers and improved competitiveness for U.S. firms. Conversely, inaction and delay carry significant opportunity costs.

In view of these results, objections to emission reduction goals such as the Kyoto target as too costly or unfair must be considered economically uninformed. Likewise, the U.S. insistence in recent international negotiations on certain outcomes regarding sinks and flexibility constraints is would seem to be misguided. Given that the U.S. can meet and exceed targets such as those of the Kyoto Protocol at significant economic gains, and given recent evidence of increased global warming risks, it is in the national interest of the U.S. that carbon and other greenhouse gas emissions be speedily curtailed, both domestically and globally. Future U.S. climate policy should be based on improved information regarding the nation's economic and technology options.

About IPSEP

The International Project for Sustainable Energy Paths (IPSEP) is a private research organization based in California, with associates in the U.S. and Europe. IPSEP's research focuses on energy and development policies that integrate mitigation of global warming pollution with energy and economic productivity improvements and with development policies fostering greater equity between the rich and poor nations of the world.

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