CLIMATE ECONOMICS BRIEF OCTOBER 2009

What will it cost to protect ourselves against potentially catastrophic global warming?

Last year, an EDF report synthesized the findings of several state-of-the-art economic models to show how affordable it will be to protect ourselves against the potentially catastrophic consequences of global warming.[1] Since then, new studies have come out that confirm the consensus among credible economic analyses: the American economy can grow strongly even as we cap our carbon emissions.

This policy brief examines the potential impact on the American economy of a cap on the heat-trapping pollution that causes global warming. We start by focusing on analyses of the American Clean Energy and Security Act of 2009 (H.R. 2454, "ACES"), passed by the U.S. House of Representatives in June. We then take a wide-angle perspective to put these recent studies in the context of our previous survey.

The conclusion we reached in that earlier report remains just as valid now:

> **The United States can enjoy robust economic growth over the next several decades while making ambitious reductions in global warming pollution. If we put a cap on carbon now, we can tackle climate change at a minimal cost to our economy.**

Economic analysis of the House climate legislation

Macroeconomic forecast: Robust growth

The centerpiece of the House bill is a cap-and-trade program that puts a steadily declining limit on greenhouse gas emissions, reaching 17% below 2005 levels by the year 2020 and 83% below 2005 levels by 2050. In assessing the likely economic impacts of this bill, we rely on analyses from the most credible, objective, and highly respected modeling groups in government and academia: the Environmental Protection Agency (EPA); the Energy Information Administration of the Department of Energy (EIA); the Massachusetts Institute of Technology (MIT); and the Congressional Budget Office (CBO). (See footnote for details.)[2]

Our use of a range of analyses is faithful to a cardinal rule about models: Don't trust any single number. The uncertainties and limitations inherent in models are large enough that the forecast from any given model tells us more about the assumptions employed by its creators than it does about the actual impacts of a particular climate policy.

AMBITIOUS CLIMATE POLICY IS AFFORDABLE

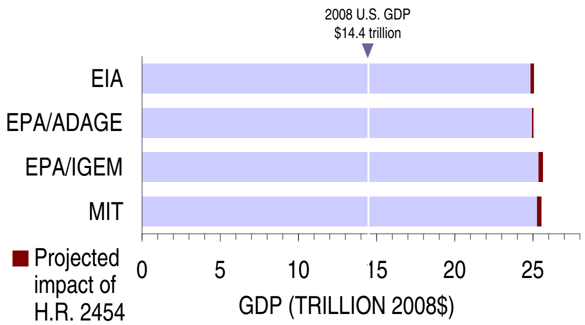
These models vary in their projections of economic output. But they do agree on one thing: The U.S. can enjoy robust economic growth while achieving deep reductions in greenhouse gas emissions. Indeed, against the backdrop of the dynamic American economy, the impact of climate policy is minuscule.

The predicted economic impacts of climate policy are sometimes characterized as "losses" to the economy. But they will occur relative to an economy that is much larger and wealthier than today's. In the year 2015, for

This Climate Economics Brief is available at http://www.edf.org/documents/10458_EDF_Cost-Brief_Oct2009.pdf. Subsequent reports in this series will provide a primer on economic modeling; show how delay will drive up the costs of curbing emissions and risk locking in irreversible climate change; survey estimates of the costs of inaction; and recount the stakes and status of the race to develop and commercialize the next generation of energy technologies.

example, U.S. gross domestic output (GDP) is projected to be 15 to 20% larger than today. The estimated impact of ACES in that year, relative to the no-policy case, ranges from a slight reduction of 0.4% to an increase of 0.1%. By the year 2030, the U.S. economy is expected to grow by about 70%. In that year, the estimated cost to the U.S. economy of capping greenhouse gas emissions among these models ranges from 0.4% to 1.1%—with an average of less than one percent of GDP.

Figure 1—GDP forecasts in the year 2030



The bars show estimated GDP under business as usual, with the tips representing the cost of climate policy.

The U.S. economy has averaged nearly 3% growth per year in the postwar period, and is projected to continue at something close to that pace once the economy rebounds from the current downturn. The estimated effect of a carbon cap on the rate of economic growth will be almost imperceptible: just two to five hundredths of a percentage point annually (0.02 - 0.05%) over the next two decades. To put these numbers in context: the models suggest that if the American economy will reach a size of $25 trillion in January 2030 under "business as usual," it will get there sometime between March and May of that year with a carbon cap.

> U.S. GDP is predicted to reach $25 trillion in January 2030. With a carbon cap, it will get there sometime between March and May.

ONLY ONE SIDE OF THE LEDGER

Like most macroeconomic models used to forecast the costs of capping emissions, these analyses look at only one side of the ledger. They evaluate the costs of reducing global warming pollution, but do not measure the resulting payoff—the benefits of averting dangerous climate change. Nor do they consider the ancillary benefits such as improved local air quality.

As a result, the models' estimates of economic impact all correspond to the cost of climate policy compared to a "business-as-usual" scenario in which we don't cap carbon emissions, yet don't bear the consequences. That's an alternative that doesn't exist in reality. Failure to curb global warming pollution will lead to a future marked by record heat waves, rising sea levels, more intense hurricanes, fiercer droughts, threats to agriculture and wildlife populations— a future that will be anything but "business-as-usual." These impacts of unchecked climate change, which are unaccounted for in the macroeconomic models, have been graphically documented for the United States in a report recently issued by the U.S. Global Change Research Program.[3]

Indeed, our use of fossil fuels is already imposing enormous costs on our economy — not only changing our climate, but polluting our air and undermining national security. Over the next few decades, during the transition to a low-carbon economy, we will continue to burn fossil fuels—but the cost of doing so will reflect the heat-trapping gases being pumped into the atmosphere. Taking those true costs into account will level the playing field and encourage the development of new, cleaner sources of energy.

Household impacts: A postage stamp a day

We just saw how minimal the projected impact of capping carbon will be on the U.S. economy as a whole. But overall economic indicators like GDP can seem pretty abstract compared with the cost to the American family. Here as well, the models agree that the costs will be small and affordable.

HOUSEHOLD CONSUMPTION

A cap on carbon is expected to raise household costs slightly, as the effects of higher energy prices ripple through the economy. This represents the investment needed to pay for the transition to a more secure clean-energy economy.

> Economic analyses by CBO, EIA, and EPA all estimate that we can cap carbon for about the cost of a postage stamp a day per household.

What is most striking is how modest this down payment is anticipated to be. CBO estimates that the cost to the average household in the year 2020 will be just $160 — about 44 cents a day, or the cost of a postage stamp. (All values are expressed in constant 2005 dollars unless otherwise noted.) The analyses by EIA and EPA put the annual household cost in 2020 even lower, at $84 to $126, or 23 to 35 cents per day. MIT's estimates are higher, in large part because they model a 20% reduction from 2020 (instead of 17%) and impose a more rapid expansion in renewable energy generation than what the actual legislation requires. Even so, MIT estimates a household impact of only $319 in 2020.

The best summary figure for household impact is the average annual household cost over the entire span of the bill, in present value terms. EPA's estimated average annual cost is just $80 to $111 per household, while EIA's estimate (through 2030, when EIA's model ends) is $83. Again, MIT's estimate comes in highest, at $404, in part because it models more stringent provisions.

Opponents of action will rely on fuzzy math to inflate the costs to households—for example, by taking the total market value of emission allowances and dividing it by the number of households. But the aggregate market value of allowances has little to do with the bottom line that matters to households: the net cost of a cap on carbon. While fossil energy costs will rise, they will be partially offset by savings from energy efficiency and by the hundreds of billions of dollars that the legislation returns to consumers.

The impact on low-income families deserves particular mention. Because these households are highly vulnerable to climate change—as was vividly demonstrated by Hurricane Katrina—they have much to gain from a cap on carbon. And yet low-income households are also the ones least able to absorb any increase in cost, however modest it may be in the aggregate.

A small fraction of allowance value can fully offset the increased costs to low-income families.

The good news is that because the projected cost to the economy is so small, the required compensation is small as well. ACES auctions 15% of allowances and directs the revenues to moderate and low-income households through tax credits, in addition to limiting increases in utility bills. As a result, CBO estimates that in 2020, the poorest one-fifth of U.S. households would see a benefit of $125 a year under the legislation.

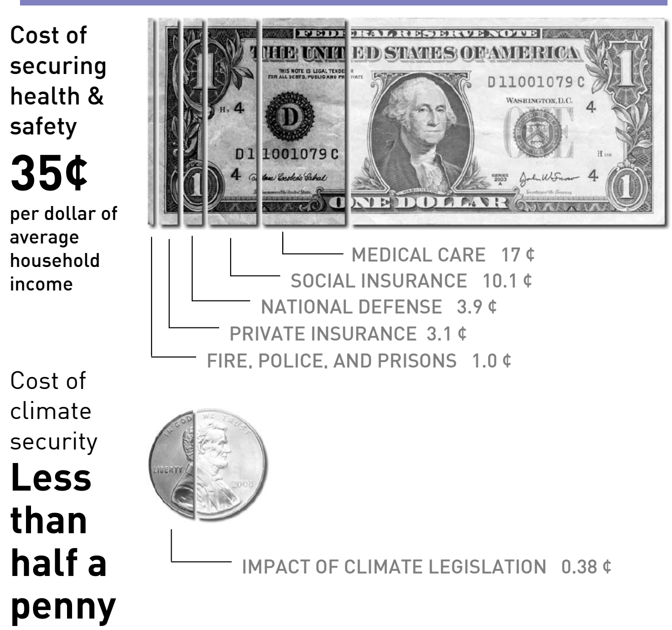
CLIMATE SECURITY

A useful way to put these household consumption impacts in context is to consider what Americans already spend to protect themselves and their families. This includes the costs of medical care, fire and property insurance premiums, and taxes that pay for Social Security or fire and police services. Spending on climate security—protecting ourselves against potentially catastrophic climate change—falls in the same category.

Figure 2 shows how much of every dollar of income an average American family currently spends on household protection and security. The chart also shows the projected reduction in consumption due to climate policy, now expressed as a fraction of income.

The cost of a carbon cap amounts to 0.38 cents per dollar of household income – less than half a penny. By way of comparison, on average Americans spend more than three cents per dollar on private insurance, almost four cents on national defense, and a penny on fire and police. And these expenditures pale compared to spending on medical care (including government spending on hospitals and household spending on medical treatment and equipment) or social insurance programs such as Social Security.[4]

Figure 2—Household security expenditures



ENERGY BUDGETS

Although energy costs are accounted for in household consumption, they will be especially visible to consumers — making them worth a separate look. As it turns out, the projected effects of climate policy on household energy budgets will be modest—thanks to cost savings from energy efficiency, investments in cleaner energy sources, and provisions in the legislation that return allowance value to households via electric utilities.

Utility bills The estimated impacts of climate legislation on energy costs are often framed in terms of prices per kilowatt hour of electricity or cubic foot of natural gas. What matters to households, however, is the bottom-line impact on utility bills. The difference is crucial, because households have a number of opportunities to reduce their energy use at little cost.

> Projected impacts on monthly electric bills through 2030 range from a decrease of $5.60 to an increase of $2.80.

To estimate the impact on monthly utility bills, we look to the EPA and EIA analyses, because these forecast residential energy consumption as well as prices. In the early years of legislation, through 2020, both models predict that the average American household will see a decrease in electricity bills as result of climate legislation (relative to a no-policy case), thanks to greater energy efficiency. In EPA's analysis, this effect translates into average monthly electricity bills for the period 2010-2030 that are projected to be $5.61 (3.5%) lower under climate policy than in the reference case. In the later years of the program, EPA predicts increases in energy costs, as the allowance allocations to electric utilities are phased out.

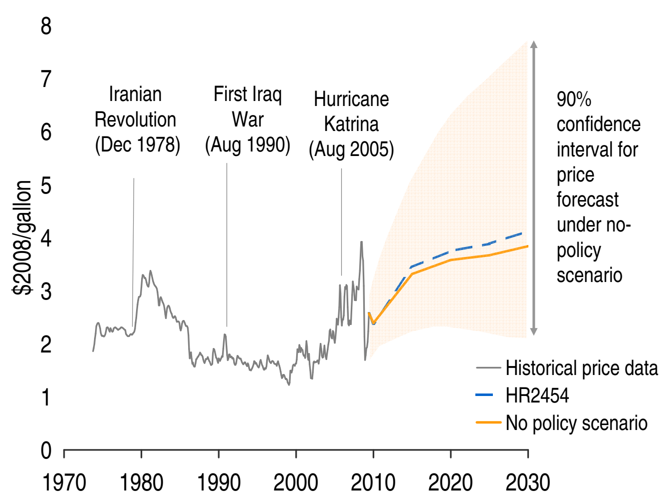
For the same 2010-2030 period, EIA projects a modest increase due to a carbon cap — a difference of $2.79 (2.5%) relative to a no-policy case.[5] When natural gas is added in, average monthly utility bills in EIA's analysis are estimated to be $3.87 higher through 2030 than in the reference case.

Gasoline prices While a cap on carbon will have a slight impact on gasoline prices, this will be virtually unnoticeable against the ups and downs we are already familiar with. In the year 2020, the EIA and EPA analyses forecast that gasoline prices will be only 14 to 20 cents per gallon higher than they would be without any policy. In the year 2030 the impact of the bill is estimated to be an increase of 22 to 35 cents (6 to 9%). These estimates translate into annual increases of just a penny or two per gallon per year, relative to the no-policy case. By way of comparison, prices have risen by more than 22 cents during the course of an single month seven times in the past two and a half years.

As Figure 3 shows, gasoline prices have been volatile over the past several decades, responding sharply to weather events and geopolitical conditions.[6] The familiar swings in gasoline prices underscore the futility of trying to predict what they will be in a decade or two. Nobody knows what gasoline prices will be next year, let alone in 2030. To illustrate this point, Figure 3 shows a shaded "confidence region" for gasoline price forecasts based on past price movements.[7] Relative to the ups and downs of past experience, and to the fundamental uncertainty of future forecasts, the projected impact of capping carbon is tiny.

In fact, the real concern with petroleum is not the almost imperceptible increase in price that might follow from climate legislation, but rather our overwhelming—and increasing—dependence on foreign oil. In 1975, the U.S. imported about one-third of the petroleum we consumed; by last year, that figure had risen to 57%. A shift to cleaner energy sources, spurred on by a carbon cap, will help us reverse that trend. Based on EPA and EIA's analyses, ACES could cut annual U.S. oil consumption by roughly 5% – amounting to savings of over $20 billion a year at current prices.

Figure 3—U.S. average retail gasoline prices 1973-2008 with projections to 2030



The lines show historical and projected prices of gasoline at the pump. The shaded area shows a 90% confidence interval for the forecast.

The emerging consensus: Strong climate policy is affordable

The economic analyses of the legislation passed by the House add to an emerging consensus among economic models of climate policy. Addressing a problem as serious as global warming will not be free—but the cost to the American economy and to household budgets will be minimal.

> The median projected cost to the economy of a carbon cap over the next two decades is less than half of one percent of GDP.

Table 1 and Figure 4 summarize the estimated impacts on the U.S. economy across the models presented here as well as the analyses in our earlier report. The median projected cost to the economy of capping greenhouse gases on the present value of U.S. GDP is less than one-half of one percent over the next two decades, and below one percent through the middle of the century.

These models are not crystal balls. But when a wide range of credible models, relying on a range of different assumptions, reach the same conclusion again and again, that should give us confidence that we can take action to cut global warming pollution without any significant adverse impact on our economy.

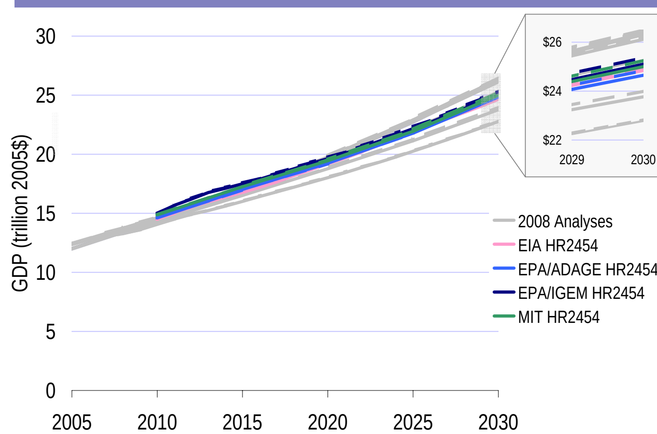
The only prospects for economic harm are the consequences of doing nothing. We have both the responsibility and the opportunity to put the American economy on a clean-energy path for the twenty-first century. If we fail to take action, we will have bought ourselves a few months of GDP growth — at an enormous price to our children and grandchildren.

Table 1—Projected impact of climate policy on U.S. GDP from a range of models

Modeling team	Policy considered	Projected reduction in GDP vs BAU 2010-2030	Projected reduction in GDP vs BAU 2010-2050
EPA/ADAGE	**ACES**	**0.03%**	**0.38%**
EIA	S.2191	0.20	n/a
EIA	**ACES**	**0.25**	**n/a**
MIT	80% below 1990	0.44	0.61
EPA/ADAGE	S.2191	0.44	0.78
MIT	S.2191	0.46	0.59
DOE-PNNL	50% below 1990	0.47	0.88
MIT	50% below 1990	0.51	0.65
MIT	**ACES**	**0.51**	**0.96**
EPA/IGEM	**ACES**	**0.60**	**1.03**
RTI/ADAGE	50% below 1990	0.81	1.39
EPA/IGEM	S.2191	2.15	3.59
	Median	0.46	0.83
	Average	0.57	1.09

Numbers represent the projected percentage reduction in the present value of GDP relative to the reference scenario over the time periods 2010-2030 or 2010-2050, using a discount rate of 3%. Analyses in **bold** are of the House bill; others are taken from last year's EDF report on earlier analyses of the costs of climate policy. RTI denotes the Research Triangle Institute. DOE-PNNL is the Department of Energy's Pacific Northwest National Laboratory. "50% [or 80%] below 1990" refers to cap-and-trade policy scenarios with emissions reduction targets declining steadily to 50 or 80% below 1990 levels by the year 2050.

Figure 4—GDP projections under business as usual and a range of climate policies.



Analyses of ACES are color-coded; gray lines represent previous analyses. For each model, dashed line represents reference scenario and solid line represents climate policy. The inset shows forecasts for 2030.

Notes

1. Nathaniel Keohane and Peter Goldmark, "What Will It Cost to Protect Ourselves from Global Warming?," available at http://www.edf.org/climatecosts.

2. These analyses differed somewhat in what aspects of cost they considered. The EPA used two models, ADAGE (run out of the Research Triangle Institute) and IGEM (a modeling effort led by professors at Harvard and Northeastern Universities). Both include projections for GDP impacts and household costs. The ADAGE model also provides detailed projections for residential energy expenditures. EIA's NEMS model includes projections for GDP, household costs, and residential energy prices and consumption (allowing us to compute household energy expenditures). MIT's EPPA model generates projections for GDP and welfare (used as a measure of household costs), but does not provide estimates of residential energy prices or consumption. Finally, CBO performs its own independent analysis of household costs, using a separate modeling approach; but its other projections (including GDP impacts) are based on a survey of other studies such as EPA, EIA, and MIT.

   Most of the analyses include multiple scenarios and in some cases multiple reference (no-policy) cases, in order to test the sensitivity of model results to various assumptions. We use the core EPA policy scenario, the "Basic" EIA scenario, and MIT's "Medium Offsets" scenario. For MIT, we computed the costs of HR2454 relative to the "Reference+EISA+ARRA" case.

   Sources: EPA: U.S. Environmental Protection Agency, Office of Atmospheric Programs, "EPA Analysis of the American Clean Energy and Security Act of 2009," June 23, 2009, available online with data tables at http://www.epa.gov/climatechange/economics/economicanalyses.html#hr2452. EIA: Energy Information Administration, Office of Integrated Analysis and Forecasting, "Energy Market and Economic Impacts of H.R. 2454, the American Clean Energy and Security Act of 2009," August 2009, available with data tables at at http://www.eia.doe.gov/oiaf/servicerpt/hr2454/index.html. MIT: Sergey Paltsev, John M. Reilly, Henry D. Jacoby, and Jennifer F. Morris, "The Cost of Climate Policy in the United States, Appendix C: Cost of Climate Policy and the Waxman-Markey American Clean Energy and Security Act of 2009 (H.R. 2454)," MIT Joint Program on the Science and Policy of Global Change Report No. 173, April 2009; available online at http://globalchange.mit.edu/files/document/MITJPSPGC_Rpt173_AppendixC.pdf. CBO: Congressional Budget Office, "The Economic Effects of Legislation to Reduce Greenhouse-Gas Emissions," September 2009, available at http://www.cbo.gov/ftpdocs/105xx/doc10573/09-17-Greenhouse-Gas.pdf.

3. The report, along with region-by-region summaries, is available at www.globalchange.gov.

4. Here is how we make these calculations. To compute the figure for climate legislation, we first calculated the percent reduction in present value of household consumption for the EPA, EIA, and MIT analyses over the period 2010-2050 (2010-2030 in the case of EIA), using a discount rate of 3%. We then multiplied the percent reduction by average household consumption in 2005 to get a dollar figure, and divided by average household income. Expressing the number per dollar of household income, which is necessary to make an "apples-to-apples" comparison with the other categories of household spending, is equivalent to multiplying the percentage reduction in consumption by 0.85, equal to the fraction of income that the average household spent on consumption.

   Numbers for other household spending represent the average amount contributed by households, either through direct consumption or through tax dollars. Since governments also collect tax revenue from other sources (e.g. corporate profits and commercial real estate), the fraction of household income spent on government services is smaller than the fraction of GDP.

   Consumer expenditure data come from the National Economic Accounts maintained by the Bureau of Economic Analysis; we used figures for 2005 from Table 501 of the System of National Accounts data for the purposes of spending categories. Data are available at http://www.bea.gov/national/xls/tab501.xls. Federal government expenditure is taken from the National Income and Product Accounts tables maintained by the Bureau of Economic Analysis. State and local government expenditure comes from U.S. Census Bureau statistics, available at http://www.census.gov/govs/www/estimate05.html. Finally, to allocate household tax payments to government services, we drew on two sources: Congressional Budget Office, "Historical Effective Tax Rates: 1979 to 2004" (December 2006), available at http://www.cbo.gov/ftpdocs/77xx/doc7718/ EffectiveTaxRates.pdf; Robert S. McIntyre, Robert Denk, Norton Francis, Matthew Gardner, Will Gomaa, Fiona Hsu, and Richard Sims, "Who Pays? A Distributional Analysis of the Tax Systems in All 50 States," 2nd ed. (Washington, D.C.: Institute on Taxation and Economic Policy, January 2003). All expenditure figures are for 2005.

5. The EIA reports residential electricity price, total residential electricity demand, and the total number of households. We first compute the number of households using electricity by multiplying EIA's forecast for total households by the share of households using electricity in 2005, according to the 2005 Residential Energy Consumption Survey. Dividing total residential electricity demand by the number of households yields household consumption; multiplying by price yields expenditures. The dollar figure given in the text represents a simple, undiscounted average.

6. All gasoline prices correspond to the sales-weighted average retail price of gasoline, for all grades across the United States, including federal and local taxes. The historical data represents monthly average retail prices from the EIA's February 2008 Monthly Energy Review.

7. The shaded area (corresponding to a 90% confidence interval) is constructed as follows. We started with the assumption (standard for energy prices) that gasoline prices follow a random walk with drift, and hence that deviations from the long-term trend are normally distributed. Using annual time-series data from the EIA for the period 1973-2005, we then estimated the drift and variance of retail gasoline prices. The shaded area in the figure represents 1.64 times the estimated standard deviation, above and below the projected price path.