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The Economic Costs of the Lieberman–Warner Climate Change Legislation

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THE ECONOMIC COSTS OF THE LIEBERMAN–WARNER CLIMATE CHANGE LEGISLATION

WILLIAM W. BEACH, DAVID W. KREUTZER, PH.D., BEN LIEBERMAN, AND NICOLAS D. LORIS

Members of Congress are considering several bills designed to combat climate change. Chief among them is Senate bill 2191—America's Climate Security Act of 2007—spearheaded by Joseph Lieberman (I–CT) and John Warner (R–VA). This bill would set a limit on the emissions of greenhouse gases, mainly carbon dioxide from the combustion of coal, oil, and natural gas.

Since energy is the lifeblood of the American economy, 85 percent of which comes from these fossil fuels, S. 2191 represents an extraordinary level of economic interference by the federal government. For this reason, it is important for policymakers to have a sense of the economic impacts of S. 2191 that would go hand in hand with any possible environmental benefits. This Center for Data Analysis (CDA) report describes and quantifies those economic impacts.

Our analysis makes clear that S. 2191 promises extraordinary perils for the American economy. Arbitrary restrictions predicated on multiple, untested, and undeveloped technologies will lead to severe restrictions on energy use and large increases in energy costs. In addition to the direct impact on consumers' budgets, these higher energy costs will spread through the economy and inject unnecessary inefficiencies at virtually every stage of production and consumption—all of which will add yet more financial burdens that must be borne by American taxpayers.

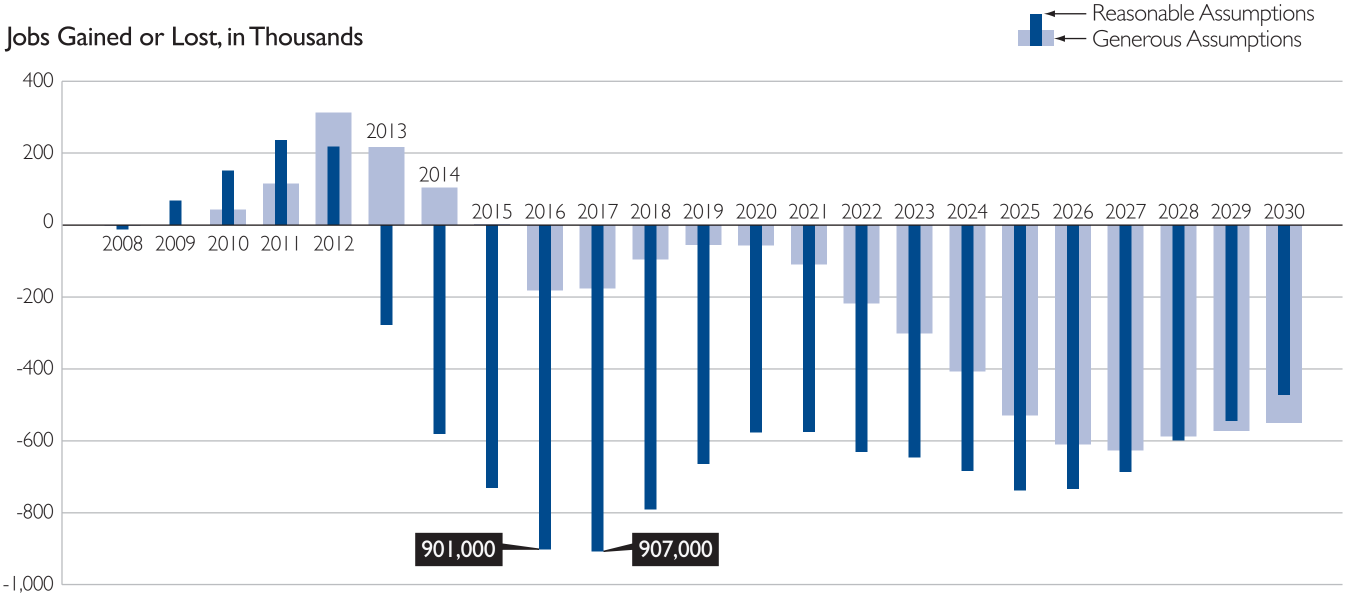
S. 2191 extracts trillions of dollars from the millions of American energy consumers and delivers this wealth to permanently identified classes of recipients, such as tribal groups and preferred technology sectors, while largely circumventing the normal congressional appropriations process. Unbound by the periodic review of the normal budgetary process, this *de facto* tax-and-spend program threatens to become permanent—independent of the goals of the legislation.

The recent experience with ethanol mandates illustrates some of the costs and risks created when a government imposes significant new regulations on the energy market. Ethanol production has been bedeviled by unintended impacts on world food prices, unexpected environmental degradation from expanding acres under cultivation, and frustratingly slow progress in commercializing cellulosic ethanol production. In spite of tremendous expense, the production goals set for ethanol are unlikely to be met, and the hoped-for environmental improvements are even less likely to occur. Yet the challenges posed by the ethanol program are a small fraction of those posed by S. 2191.

OVERVIEW

S. 2191 imposes strict upper limits on the emission of six greenhouse gases (GHGs) with the primary emphasis on carbon dioxide (CO_2). The mechanism for capping these emissions requires emitters to acquire federally created permits (allowances) for each ton emitted. The cost of the allowances will be significant and will lead to large increases in the cost of energy. Because the allowances have an economic effect much like the effect of an energy tax, the increase in energy costs creates correspondingly large transfers of income from private energy consumers to special interests.

Change in Total Private Employment Due to S. 2191



Source: Heritage Foundation calculations using Global Insight's U.S. Macro Model.

Chart 1 • CDA 08-02 heritage.org

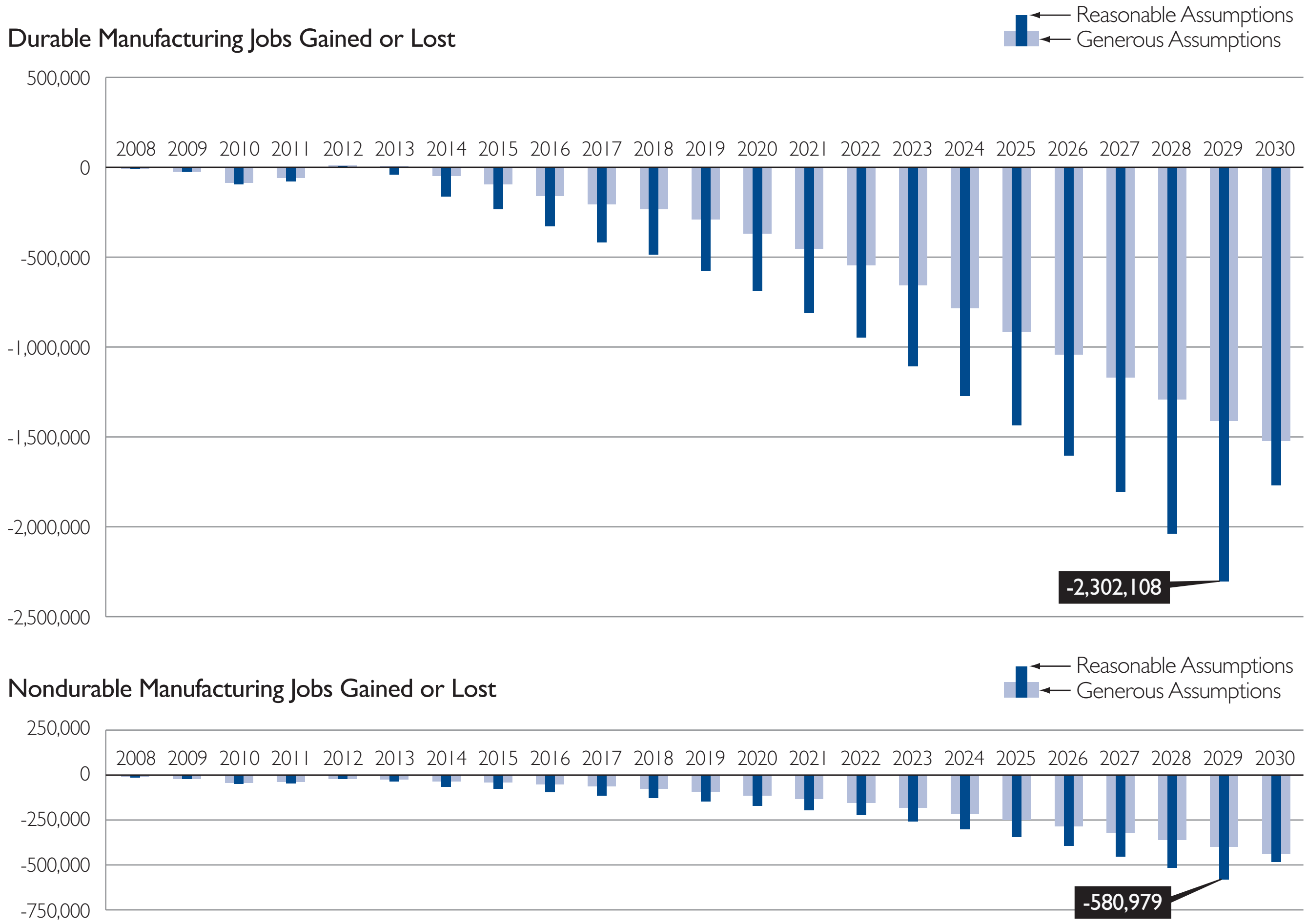
Implementing S. 2191 will be very costly, even given the most generous assumptions. To put a firm floor under the cost estimates, we assume that all of the problems of meeting currently enacted federal, state, and local legislation are overcome. A further unlikely condition is added; namely, that a critical but unproven technology—carbon capture and sequestration—will be ready for full-scale commercial use in just 10 years.[1] Making a more reasonable assumption about just this one technology leads to dramatically higher (but by no means worst-case) costs.[2] We use these two cases to bracket our cost projections of S. 2191:

- Cumulative gross domestic product (GDP) losses are at least $1.7 trillion and could reach $4.8 trillion by 2030 (in inflation-adjusted 2006 dollars).
- Single-year GDP losses hit at least $155 billion and realistically could exceed $500 billion (in inflation-adjusted 2006 dollars).
- Annual job losses exceed 500,000 before 2030 and could approach 1,000,000.
- The annual cost of emission permits to energy users will be at least $100 billion by 2020 and could exceed $300 billion by 2030 (in inflation-adjusted 2006 dollars).[3]
- The average household will pay $467 more each year for its natural gas and electricity (in inflation-adjusted 2006 dollars). That means that the average household will spend an additional $8,870 to purchase household energy over the period 2012 through 2030.

Our analysis does not extend beyond 2030, at which point S. 2191 mandates GHG reductions to 33 percent below the 2005 level. However, it should be noted that the mandated GHG reductions continue to become more severe and must be 70 percent below the 2005 level by 2050.

1. Carbon capture and sequestration (CCS), also known as carbon storage, is being explored as a way to reduce greenhouse gases. According to the World Resources Institute, "CCS requires capturing carbon dioxide from power plants and other industrial facilities, transporting it to suitable locations, injecting it into deep underground geological formations, and monitoring its behavior.… [T]here are no widely approved standards for…CCS projects." See World Resources Institute, "Carbon Capture and Sequestration (CCS)," at *http://www.wri.org/project/carbon-capture-sequestration* (April 30, 2008).
2. For the more realistic scenario, we assume that CCS is not commercially viable before 2030. In the generous-assumptions case, this technology is adopted in 2018.
3. To put these numbers in perspective, taxpayers spent $43 billion on the Department of Homeland Security in 2007, $155 billion on our nation's highways in 2005, and $549 billion on the Department of Defense in 2007.

Annual Change in Manufacturing Jobs Due to S. 2191



Source: Heritage Foundation calculations using Global Insight's U.S. Macro Model.

Chart 2 • CDA 08-02 heritage.org

In addition to taking a bite out of consumers' pocketbooks, the high energy prices throw a monkey wrench into the production side of the economy. Contrary to the claims of an economic boost from "green investment" and "green-collar" job creation, S. 2191 *reduces* economic growth, GDP, and employment opportunities.

Though there are some initial years during which S. 2191 spurs additional investment, this investment is completely undermined by the negative effects of higher energy prices. Investment contributes to the economy when it increases future productivity and income. The greater and more effective the investment, the greater the increase in future income. Since income (as measured by GDP) drops as a result of S. 2191, it is clear that more capital is destroyed than is created. The cumulative GDP losses for the period 2010 to 2030 fall between $1.7 trillion and $4.8 trillion, with single-year losses reaching into the hundreds of billions.

The hope for "green-collar" jobs meets a similar fate. Firms are saddled with significantly higher energy costs that must be reflected in their product prices. The higher prices make their products less attractive to consumers and thus less competitive. As a result, employment drops along with the drop in sales.

With S. 2191, there is an initial small employment increase as firms build and purchase the newer more CO_2-friendly plants and equipment. However, any "green-collar" jobs created are more than offset by other job losses. The initial uptick is small compared to the hundreds of thousands of lost jobs in later years. Table 1 shows the high and low projections of the employment and income effects of S. 2191.

Net Change in Employment and Income Due to S. 2191

For Selected Years, High and Low Projections

Change Category	2010 High	2010 Low	2015 High	2015 Low	2020 High	2020 Low	2025 High	2025 Low	2030 High	2030 Low
Employment	+141,000	+33,000	+15,000	-717,000	-23,000	-543,000	-479,000	-689,000	-431,000	-461,000
GDP*	+6.2	-4.7	-45.7	-168.9	-70.6	-216.4	-128.7	-329.6	-111.1	-436
Cumulative GDP Losses*			-18.5	-460.3	-377.5	-1,501.4	-898	-2,912	-1,516.4	-4,798.1

* In billions of dollars, inflation-adjusted to 2000

Source: Heritage Foundation calculations using Global Insight's U.S. Macro Model.

Table 1 • CDA 08-02 heritage.org

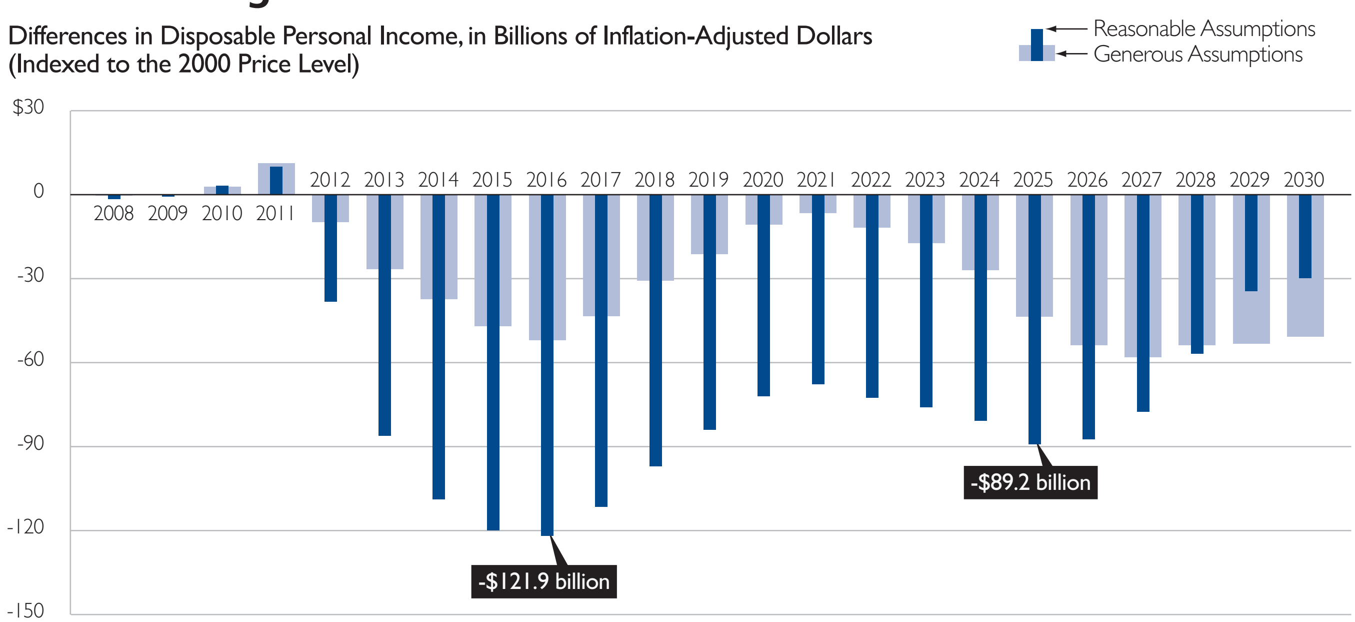
A less prominent part of S. 2191 subjects all imported goods to GHG emission rules. An understandable attempt to limit our loss of international competitiveness, this provision opens yet another area of uncertainty. For all imported goods, it will be necessary to measure the GHG footprint, compare the relative aggressiveness of national GHG limiting programs, and assign a possible emissions tariff. The inherent imprecision involved with such calculations leaves international trade vulnerable to bureaucratic caprice and increased trade tensions.

DESCRIPTION OF THE LEGISLATION

S. 2191 is a cap-and-trade bill. It caps greenhouse gas emissions from regulated entities beginning in 2012. At first, each power plant, factory, refinery, and other regulated entity will be allocated allowances (rights to emit) for six greenhouse gases. However, only 40 percent of the allowances will be allocated to these entities. The remaining 60 percent will be auctioned off or distributed to other entities. Most emitters will need to purchase at least some allowances at auction. For instance, firms that reduce their CO_2 emissions in order to meet

Annual Change in Income in the U.S. Due to S. 2191

Differences in Disposable Personal Income, in Billions of Inflation-Adjusted Dollars (Indexed to the 2000 Price Level)



Source: Heritage Foundation calculations using Global Insight's U.S. Macro Model.

Chart 3 • CDA 08-02 heritage.org

the S. 2191 targets will still have to purchase 60 percent of the needed allowances in 2012 and an even higher fraction in subsequent years.

Emitters who reduce their emissions below their annual allotment can sell their excess allowances to those who don't—the trade part of cap-and-trade. Over time, the cap is ratcheted down from a freeze at 2005 emissions levels in 2012 to a 70 percent reduction below those levels by 2050. In addition, the fraction of allowances that are given to the emitters is reduced, and a larger fraction is auctioned to the highest bidder. The primary man-made greenhouse gas is carbon dioxide and is the main focus of this study.

DISTRIBUTION OF AUCTION PROCEEDS

S. 2191 specifies how the distribution of the auction proceeds will be spent, with constant percentages from 2012 to 2036. The auction process depends on the creation of a new nonprofit corporation called the Climate Change Credit Corporation to initiate and complete the auctioning of allowances.

Eleven percent will be allocated to an advanced-technology vehicles-manufacturing incentive. While 44 percent is to be spent on low-carbon energy technology, advanced coal and sequestration programs, and cellulosic biomass ethanol technology programs, 45 percent is to be spent on assisting individuals, families, firms, and organizations in the transition to a low-carbon regime. This includes 20 percent allocated to an Energy Assistance Fund, 20 percent allocated to an Adaptation Fund, and 5 percent allocated to a Climate Change Worker Training Fund.

Specifically, the training fund would attempt to provide quality job training to workers displaced by this bill, provide temporary wages and health care benefits to those who are displaced, and provide funding for state-managed worker-training programs.

Especially given the very wide range of projected auction proceeds, earmarking them for decades into the future risks creating additional *de facto* entitlement programs.

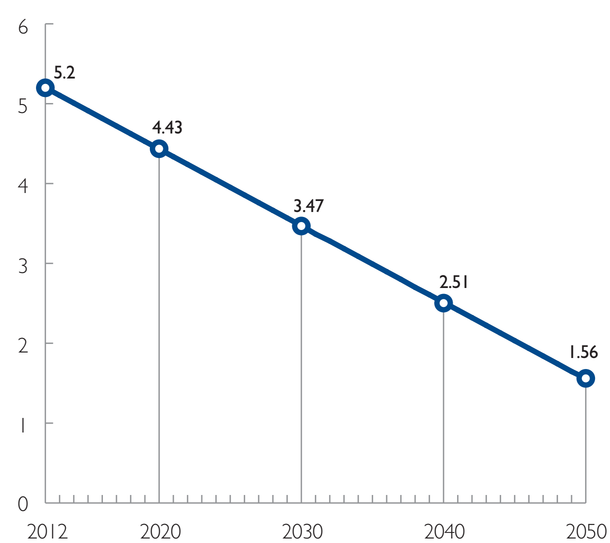
Proponents of cap and trade describe it as a flexible and market-based approach that allows the private sector to find the most cost-effective means of reducing greenhouse gas emissions. They expect the program to motivate fossil energy producers and users to reduce their carbon dioxide emissions through improvements in energy efficiency, expanded use of energy sources with fewer or no carbon emissions, or new carbon capture and sequestration (CCS) technologies that allow such emissions to be stored underground rather than released into the atmosphere.

In contrast, critics fear that many of the necessary advances are decades away from being technologically and economically viable and that, in the interim, the caps in S. 2191 can be met only with severe reductions in energy use, which would drive up energy costs significantly—and would be, in effect, a massive energy tax.

Proponents of these reductions point to the success of a similar cap-and-trade program in the 1990 Clean Air Act amendments to restrict sulfur dioxide emissions from coal-fired power plants. This program led to emissions reductions at a cost lower than anticipated. Critics question the

CO_2 Caps Set By S. 2191 Through 2050

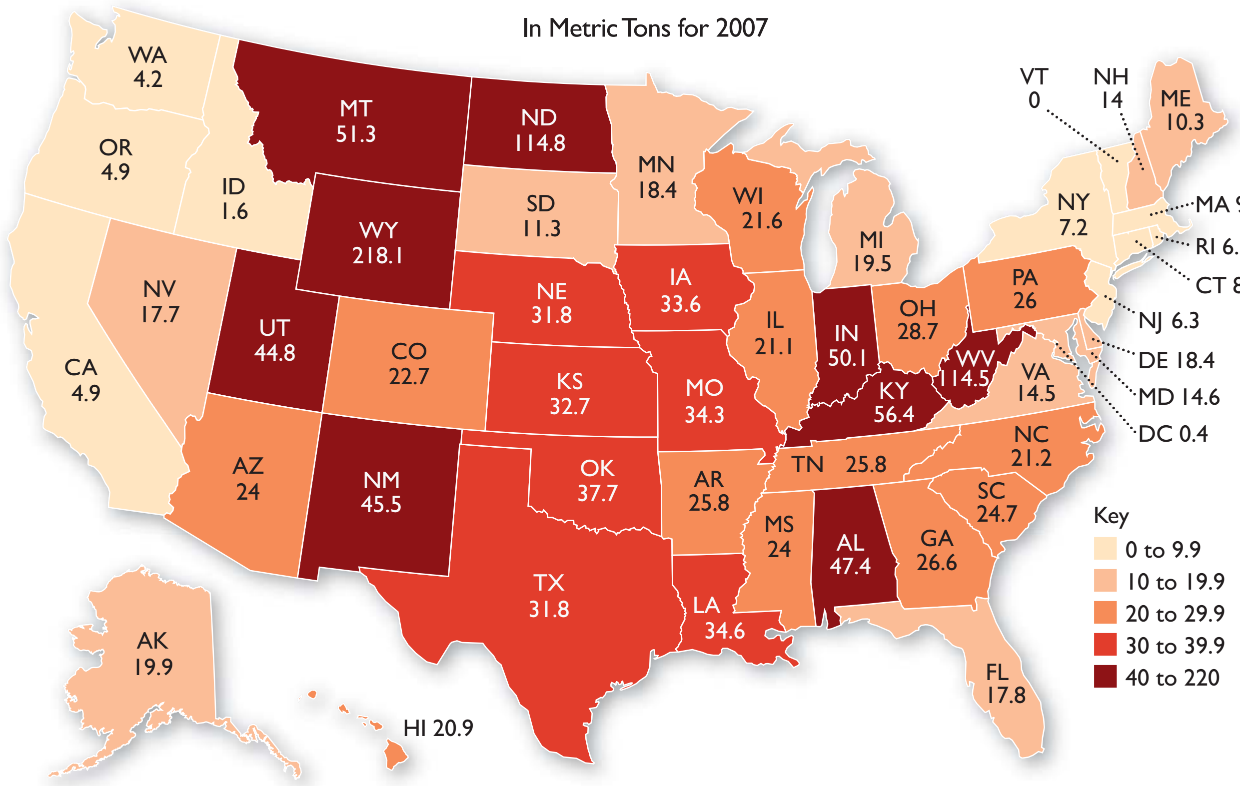
In Billions of Metric Tons



Source: America's Climate Security Act of 2007, S. 2191, 110th Congress, 1st Sess. (2007), Sec. 1201 (d).

Chart 4 • CDA 08-02 heritage.org

Per-Household Carbon Dioxide Emissions



Metric Tons in 2007—State Rankings, Highest to Lowest

1	Wyoming	218.1	14	Kansas	32.7	27	North Carolina	21.2	40	Maine	10.3
2	North Dakota	114.8	15	Nebraska	31.8	28	Illinois	21.1	41	Massachusetts	9.7
3	West Virginia	114.5	16	Texas	31.8	29	Hawaii	20.9	42	Connecticut	8.3
4	Kentucky	56.4	17	Ohio	28.7	30	Alaska	19.9	43	New York	7.2
5	Montana	51.3	18	Georgia	26.6	31	Michigan	19.5	44	New Jersey	6.3
6	Indiana	50.1	19	Pennsylvania	26.0	32	Delaware	18.4	45	Rhode Island	6.2
7	Alabama	47.4	20	Arkansas	25.8	33	Minnesota	18.4	46	California	4.9
8	New Mexico	45.5	21	Tennessee	25.8	34	Florida	17.8	47	Oregon	4.9
9	Utah	44.8	22	South Carolina	24.7	35	Nevada	17.7	48	Washington	4.2
10	Oklahoma	37.7	23	Arizona	24.0	36	Maryland	14.6	49	Idaho	1.6
11	Louisiana	34.6	24	Mississippi	24.0	37	Virginia	14.5	50	District of Columbia	0.4
12	Missouri	34.3	25	Colorado	22.7	38	New Hampshire	14.0	51	Vermont	0.0
13	Iowa	33.6	26	Wisconsin	21.6	39	South Dakota	11.3			

Source: Energy Data: *http://www.eia.doe.gov/cneaf/electricity/st_profiles/profiles_sum.html*; Household Data: *http://factfinder.census.gov*, American Community Survey 2006, Table B11001

Map 1 • CDA 08-02 heritage.org

success of this program as well as its relevance to the far more difficult task of regulating greenhouse gases.

The comparison has a more fundamental flaw, however. In contrast to the undeveloped and speculative state of current CCS technology, the technology for reducing sulfur dioxide emissions was already commercialized and widely implemented before the 1990 Clean Air Act amendments were passed.

Critics also point to the substantial difficulties that the European Union has faced since implementing its greenhouse gas cap-and-trade program in 2005 in order to comply with the Kyoto Protocol, the multilateral treaty on emissions that the United States declined to ratify.

The cap-and-trade specifics of S. 2191—the overall targets and timetables, the types of emissions and economic sectors covered, the method of allocating allowances, the measures designed to add flexibility, the provisions affecting trade, and many other factors—will determine the extent and distribution of the costs and, indeed, whether the goals are realistically achievable. These specifics are explained in more detail below.

In addition to the provisions of the bill, the many baseline assumptions about the future also affect the projected costs of S. 2191. They include assumptions about the pace of technological advances, especially those regarding the CCS breakthroughs that will be necessary for the continued use of coal, the energy source with the highest CO_2 emissions per unit of energy. Continued use of coal is critical because it provides half of the nation's electricity.

Assumptions about America's economic growth and concomitant energy needs are also of great importance, as are assumptions about the effect of previously enacted energy legislation, particularly the Energy Independence and Security Act of 2007.

THE SIMULATIONS

This CDA report discusses three different views of this country's economic future, each shaped by different policies designed to reduce atmospheric carbon dioxide and, presumably, to reduce the warming trend in global climate change. Policymakers and others who follow the climate change debate closely should find each of these three views helpful in understanding the policy alternatives currently before us. These three views are:

- **The current-law baseline.** Presented here is a highly detailed, 30-year economic forecast that incorporates the principal elements of energy and climate change policies signed into law last year.
- **Simulation of S. 2191,** America's Climate Security Act of 2007, sponsored by Senators Joseph Lieberman (I–CT) and John Warner (R–VA). The simulation builds on the detailed baseline and assumes that critical technologies are fully developed.
- **An alternative,** more realistic scenario in which critical technology does not materialize over the 20-year forecast horizon.

THE BASELINE

Key Assumptions. The baseline for the Lieberman–Warner simulations builds on the Global Insight (GI) November 2007 long-term-trend forecast. The GI model assumes that:

> [T]he economy suffers no major mishaps between now and 2037. It grows smoothly, in the sense that actual output follows potential output relatively closely. This projection is best described as depicting the mean of all possible paths that the economy could follow in the absence of major disruptions. Such disruptions include large oil price shocks, untoward swings in macroeconomic policy, or excessively rapid increases in demand.[4]

The GI long-term model forecasts the trend of the U.S. economy. "Trend" means the most likely path that the economy will follow if, for instance, it is not disturbed by a recession, extremely high oil prices, or the collapse of major trading partners. One way to think about the long-term trend is to imagine a pathway through the cyclical patterns of our economy, as well as the effects of cyclical patterns in foreign economies on the U.S. economy.

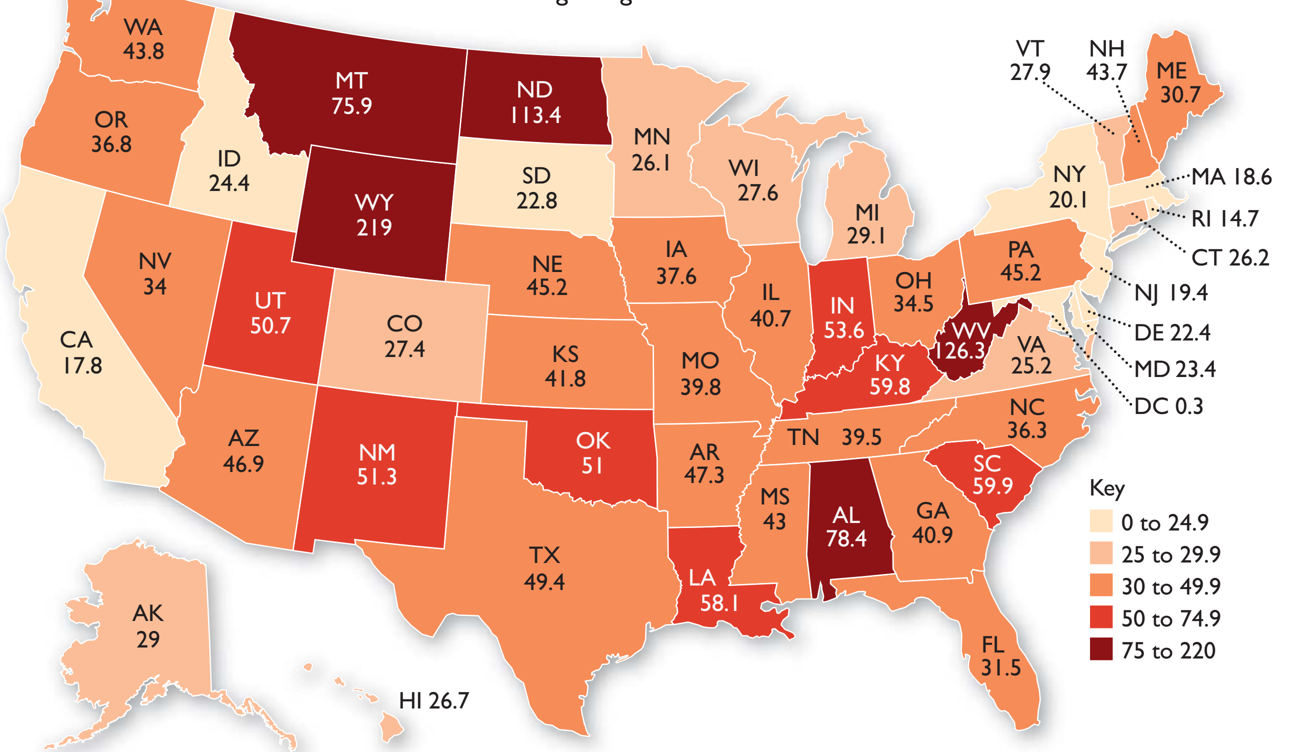
Given the fiscal and economic challenges facing the United States (particularly the mounting federal deficits stemming from the long-expected explosion in Social Security, Medicare, and Medicaid outlays), the long term already has significant risks. The baseline assumes that the economy successfully avoids any sharp drops. At the same time, there is no inclusion of similarly large, potentially positive, shocks to the economy.

Energy prices, patterns of use, and supply change continuously in response to legislation and market conditions. To evaluate the economic impact of S. 2191, we must establish what would be the expected levels of emissions and available technology over the bill's proposed lifetime in the absence of its passage. Only with the baseline situation determined can the costs of meeting the goals and constraints of S. 2191 be estimated.

4. Global Insight, "Long-Term Forecast 30-Year Overview," October 2007. Heritage analysts relied on models maintained by Global Insight, Inc., in developing the economic estimates reported in this paper. The Global Insight model is used by private-sector and government economists to estimate how changes in the economy and public policy are likely to affect major economic indicators. The methodologies, assumptions, conclusions, and opinions presented here are entirely the work of analysts at The Heritage Foundation's Center for Data Analysis. They have not been endorsed by, and do not necessarily reflect the views of, the owners of the Global Insight model.

Per-Household Net Energy Generation

In Average Megawatt Hours for 2007



Average Megawatt Hours—State Rankings, Highest to Lowest

1	Wyoming	219.0	14	Arkansas	47.3	27	Oregon	36.8	40	Minnesota	26.1
2	West Virginia	126.3	15	Arizona	46.9	28	North Carolina	36.3	41	Virginia	25.2
3	North Dakota	113.4	16	Nebraska	45.2	29	Ohio	34.5	42	Idaho	24.4
4	Alabama	78.4	17	Pennsylvania	45.2	30	Nevada	34.0	43	Maryland	23.4
5	Montana	75.9	18	Washington	43.8	31	Florida	31.5	44	South Dakota	22.8
6	South Carolina	59.9	19	New Hampshire	43.7	32	Maine	30.7	45	Delaware	22.4
7	Kentucky	59.8	20	Mississippi	43.0	33	Michigan	29.1	46	New York	20.1
8	Louisiana	58.1	21	Kansas	41.8	34	Alaska	29.0	47	New Jersey	19.4
9	Indiana	53.6	22	Georgia	40.9	35	Vermont	27.9	48	Massachusetts	18.6
10	New Mexico	51.3	23	Illinois	40.7	36	Wisconsin	27.6	49	California	17.8
11	Oklahoma	51.0	24	Missouri	39.8	37	Colorado	27.4	50	Rhode Island	14.7
12	Utah	50.7	25	Tennessee	39.5	38	Hawaii	26.7	51	District of Columbia	0.3
13	Texas	49.4	26	Iowa	37.6	39	Connecticut	26.2			

Source: Energy Data: *http://www.eia.doe.gov/cneaf/electricity/st_profiles/profiles_sum.html*; Household Data: *http://factfinder.census.gov*.

Map 2 • CDA 08-02 heritage.org

Two fundamental trends establish the baseline path of CO_2 emissions. First, aggregate income growth leads to greater demand for power across all sectors of the economy. Most of this power is generated by burning fossil fuels.

Partially offsetting the associated increase in CO_2 emissions is the second trend of increasing carbon efficiency in the energy sector. The improved efficiency comes from a variety of changes in both production and consumption, including power-generating technology that increases the yield of useable power for each ton of CO_2 emitted; continual improvements in the energy efficiency of appliances, new homes, and light vehicles; more use of renewable fuels; and greater generation and use of nuclear power.

Government mandates—federal, state, and local—continue to force additional energy efficiency and limit CO_2 emissions, which helps to achieve the goals of S. 2191. These mandates may work in parallel with S. 2191, and they create compliance costs, but since these compliance costs are already in force without the passage of S. 2191, they are not attributable to the Lieberman–Warner legislation.

Examples of the baseline costs necessary for meeting the S. 2191 goals but attributable to other legislation include:

- Manufacturing cars and trucks that satisfy the much higher fuel-economy standards mandated for the next 20 years,
- Producing 36 billion gallons of biofuels including 16 billion gallons of cellulosic ethanol,
- Complying with expensive new building codes, and
- Producing ever more energy-efficient household appliances.

Aggregate Energy Use. Continued gains in energy efficiency will restrain the growth of energy demand below the rates of economic growth and below the rates experienced in the past half-century—roughly 1.5 percent per year. These efficiencies are driven by both markets and mandates. We project baseline primary energy demand to grow at 0.5 percent each year through 2030.

Petroleum. As always, higher prices push back on quantities demanded. Though petroleum prices should come down from the current record levels as supply disruptions and bottlenecks ease, they will remain well above 1990 prices. According to baseline assumptions, petroleum prices will settle around $70 a barrel in nominal terms and decline to $46 a barrel (in 2006 dollars) by 2030. Even in the absence of Corporate Average Fuel Economy (CAFE) limit changes, higher prices induce consumers to move to more efficient vehicles.

On the mandates side, the Energy Independence and Security Act of 2007 (EISA) raises the bar for vehicle fuel efficiency. The CAFE standard rises to 35 miles per gallon by 2020 for all light vehicles. For subsequent years, the EISA mandate reads:

> For model years 2021 through 2030, the average fuel economy required to be attained by each fleet of passenger and non-passenger automobiles manufactured for sale in the United States shall be the maximum feasible average fuel economy standard for each fleet for that model year.

The expected CAFE standards are 47.5 miles per gallon for new passenger cars and 32 miles per gallon for new trucks by 2030, and the average for all light vehicles, whether new or old, will be 33 miles per gallon.

Overall, petroleum consumption will grow by 0.6 percent per year between 2005 and 2030.

Natural Gas. In the baseline scenario, gas prices settle just below $7 per million British thermal units (Btus). This is less than the current price but well above the 1990s levels. Alaskan pipeline deliveries will not start until 2025, at which point they will help to offset supply reductions in the Lower 48 as well as imports from Canada.

Nearly 100 gigawatts of old natural-gas-steam capacity is retired, and 50 gigawatts of the more efficient "natural gas combined cycle" (NGCC) plants are built. Total natural gas consumption grows by 0.4 percent per year through 2030.

Coal. In the baseline case, coal use is restrained by slower growth of energy demand and increasing generation of nuclear and renewable power. Demand will grow by an average of 0.2 percent each year through 2030.

One hundred gigawatts of old inefficient energy is retired. Sixty-five gigawatts of new and replacement coal-fired power-generation plants will be added using the "integrated gas combined cycle" (IGCC) or advanced pulverized-coal technologies. These more efficient technologies use less coal and emit less CO_2 per unit of electricity generated and are ready to be fitted for carbon capture and sequestration. Because of the additional cost, there is no use of CCS technology in the baseline case.

Better and more widely adapted scrubbing technology allows broader use of high-sulfur coal. This will open up more sourcing options and lower the average cost of coal in the energy sector.

In real dollars, coal prices will settle near the levels observed in the 1990s.

Nuclear Energy. Though there are no significant CO_2 emissions from nuclear power generation, it is not considered "renewable" for the purpose of meeting existing state-imposed targets. Nevertheless, federal incentives are already in place for an additional nuclear power capacity. There will be 12 gigawatts of new capacity built and 3 gigawatts of uprated additional capacity added at existing plants.

Resolving the problems with waste disposal is a major hurdle in expanding nuclear power generation. The baseline assumption is that nuclear power plants will continue to store the waste on site. Given the already high use of available capacity, electricity generated by nuclear power is projected to grow by only 0.5 percent per year through 2030.

Target Emission Levels for All Six Greenhouse Gases Under S. 2191

Year	2012	2020	2030	2040	2050
Reduction	2005 emission level	15% below 2005 emission level	33% below 2005 emission level	52% below 2005 emission level	70% below 2005 emission level
Million metric tons of carbon equivalent	5,200	4,432	3,472	2,512	1,560

Source: America's Climate Security Act of 2007, S. 2191, 110th Congress, 1st Sess. (2007), Sec. 1201(d).

Table 2 • CDA 08-02 heritage.org

Renewable Energy Sources. Federal and state initiatives already in place seek to increase the use of renewable energy sources. The definition of "renewable" varies from state to state but generally includes biomass, wind, and solar power.

Higher fuel prices along with state and federal mandates cause renewable fuel use to grow at 5.5 percent per year through 2030. We assume that producers will be able to meet the ethanol (corn-based and cellulose-based) targets set by the EISA, though experience thus far suggests otherwise.

SIMULATIONS OF LIEBERMAN–WARNER

Key Assumptions. Responding to concerns about adverse environmental impacts of anthropogenic greenhouse gas emissions, S. 2191 sets ever more stringent caps on emissions of these gases. Using previous emission levels as yardsticks, the 2012 cap is set at the 2005 emission level. The cap drops to 15 percent below the 2005 emission level by 2020 and 33 percent below by 2030. By 2050, the goal is to have man-made GHG emissions at 70 percent below those of 2005.

Though the main focus for the emissions targets is CO_2, Lieberman–Warner rules apply to six greenhouse gases: carbon dioxide, methane, nitrous oxide, sulfur hexafluoride, perfluorocarbon, and some byproduct hydrofluorocarbons (HFCs). All emissions are measured in terms of the warming potential of carbon dioxide.

Some of these other gases have much higher greenhouse effects per ton of emissions than does CO_2. However, these gases are emitted in much smaller volumes by human activity. CO_2 creates about 85 percent of the man-made GHG warming; therefore, this study examines only the economic impact of constraints on CO_2 emissions.

Under the Lieberman–Warner bill, producers of petroleum products, producers of natural gas, and consumers of coal must have CO_2 allowances in proportion to the output (or consumption, in the case of coal) of these fuels. The quantity of allowances available each year is equal to the cap on CO_2 emissions for that year. Some activities and technologies that reduce emissions of greenhouse gases can earn allowance credits, which can then be sold or used to offset required allowances. There are provisions that allow unused allowances to be saved for future years and, within limits, to borrow future allowances. The costs of borrowing are so high and the rewards of saving are so distant and uncertain that our analysis assumes no borrowing or saving of allowances.

S. 2191 creates the Climate Change Credit Corporation to administer the distribution of allowances and to track their ownership. In the first phase of implementation, 40 percent of the allowances are issued to current emitters. This fraction declines until 2025, at which point emitters receive zero allowances and must purchase 100 percent of the allowances they use.

BARRIERS TO TRADE: TITLE VI, GLOBAL EFFORT TO REDUCE GREENHOUSE GAS EMISSIONS

Title VI of S. 2191 is part of a global effort to reduce greenhouse gas emissions and ensures that emitting GHG in other countries does not undermine U.S. efforts to reduce GHG. The bill's supporters hope to encourage international action on GHG reduction.

To this end, the bill includes the suggestion that the President establish an interagency group to determine whether or not other countries have taken similar action to limit their release of GHG. The interagency group will be responsible for creating a reserve of international allowances, and any U.S. importer of covered goods must submit international allowances as a condition for the trade to occur.

Thus, importers of covered goods must submit emissions allowances that are equal in value to those required for those goods in our system. For instance, if the production of a product generates two tons of CO_2 , importers of this product need two tons of allowances for each product they import.

An importer must also submit a written declaration to the administrator of U.S. Customs and Border Protection for each import. Failure to make a CO_2 emissions declaration bars the importation of a good into the United States. The only exceptions will be for countries that have taken similar action to reduce GHG and countries that are identified by the United Nations as the world's least-developed.[5]

Though perhaps well-intentioned, Title VI has the potential to do serious harm to international commerce. Complex and ambiguous, it could prove to be a loose cannon—destroying trade relations instead of reducing environmental damage.

Coal Technology. Due to its abundance, coal is the cheapest source of energy and fuels about half of America's electricity supply. Carbon capture and sequestration is a promising but not yet commercialized technology for dramatically reducing CO_2 emissions from coal-powered electricity.

Of course, CCS technology has additional costs, which are higher when retrofitting existing plants than when building the technology into new plants. Even with the additional costs, CCS becomes viable in new plants when allowance costs exceed $50 per ton of CO_2 emitted.

Initial modeling showed that this $50 threshold will be reached faster than CCS technology is likely to become available. Therefore, we assume that CCS technology is adopted as soon as it is practical. That date cannot be predicted with any certainty.

The costs of meeting the CO_2 reductions mandated by S. 2191 are very sensitive to changes in the rate at which CCS technology is developed. Our generous scenario operates on the assumption that any coal-fired plant built after 2018 uses CCS. A second scenario assumes that the significant technological and political hurdles prevent CCS adoption before 2030.

Natural Gas. Because of its higher cost, natural gas is not competitive with coal in the baseline case of zero CO_2 restrictions. Though natural gas generates less CO_2 per Btu than does today's coal, it is not competitive when coal generators use CCS. In the in-between case, with some CO_2 restrictions and no CCS, high allowance prices make coal more expensive and natural gas relatively more attractive. The in-between case drives up natural gas prices and is the most costly of all for the economy.

For carbon-allowance prices in the $30 to $40 range, replacing old steam plants with combined-cycle natural gas plants makes sense. When allowance prices exceed $50, coal plants with CCS are more competitive. Regional price differences and the long lag times in replacing power plants ensure that electricity will be generated by both coal and gas for the foreseeable future.

Nuclear Energy. The projection is for no additional nuclear power beyond the base case.

5. America's Climate Security Act of 2007, S. 2191, 110th Congress, 1st Sess. (2007), Sec. 6006 (C)(4)(B).

ALLOCATION OF ALLOWANCES (REQUIRED PERMITS FOR EMITTING CO_2)

The largest initial allocations go to two covered entities: power (electricity producers) and industry (such as manufacturers). More specifically:

- Allocation to power includes new entrants, rural electric cooperatives, and incumbents.
- Allocation to industry includes new entrants, incumbents, and revocation of distribution upon facility shutdown.

If a facility is permanently shut down, it must return the difference of carbon dioxide equivalents emitted and the number of allowances received from the Environmental Protection Agency (EPA). For both of these covered entities, allocation equals 20 percent of allowances from 2012 to 2016 and then decreases by 1 percent per year until it reaches zero in 2036.

Ten percent of allocated allowances would go to load-serving entities, such as electric and gas distributors and demand-side management programs. Entities receiving allowances would be forced to pass the value of the allowance on to their customers in an attempt to mitigate the economic impact on lower-income and middle-income families. More specifically, the proceeds can mitigate the economic impact on low-income and middle-income users by reducing transmission charges and issuing rebates. On the other hand, the proceeds can be used to promote energy efficiency on the part of the consumer.[6]

Under S. 2191, the EPA would be responsible for allocating emission allowances and distributing auction proceeds. The EPA would allocate up to 9 percent of allowances to states between 2012 and 2050 for rates reflecting efficiency measures, building efficiency compliance, enactment of stringent measures, Low Income Home Energy Assistance Plan (LIHEAP), population size, and the local economy's carbon intensity. States will receive a minimum of 5 percent and an additional 1 percent to 4 percent based on the measures they take to reduce emissions.

Mitigating the economic impact on low-income families is only one of 12 ways the proceeds can be used.[7] Others include:

- Reducing use of electricity and natural gas, minimizing waste, and recycling;
- Investing in non-emitting electricity technology;
- Improving public transportation and rail services;
- Using advanced technology to reduce or sequester GHG;
- Addressing local and regional impacts—including relocation of communities affected by climate change;
- Mitigating obstacles to electricity investment by new entrants;
- Providing assistance to displaced workers;
- Mitigating impacts on energy-intensive industries in internationally competitive markets;
- Reducing hazardous fuels and preventing and suppressing wildfires; and
- Funding rural, municipal, and agricultural water projects.

Other Allowances. Eight percent of allocated allowances are designated for agriculture and forestry sequestration programs, while another 4 percent is generically allocated to support the development of CCS as well as geological sequestration. Five percent of allowances are awards for early action for covered entities, including facilities attempting to lower GHG emissions since 1994, and would decline by 1 percent each year until they reach zero in 2017.[8]

Auction of Allowances. By 2012, 18 percent of the allowances will be auctioned as part of the annual auction program. This number will increase by 3 percent per year until 2017 and then increase by 2 percent per year until 2035, when it reaches 67 percent. From 2035 to 2036, it will jump to 73 percent and remain at that level until 2050, the sunset date for S. 2191.

Additionally, the Lieberman–Warner bill requires an "early auction" within 180 days of enactment of the bill. At this time, 6 percent of the 2012 allowances, 4 percent of the 2013 allowances, and 2 percent of the 2014 allowances will be auctioned. The total cost of allowances will be passed on to energy consumers and represents an unprecedented tax hike. The annual cost of this tax (adjusted for inflation to 2006 dollars) will be at least $100 billion and could well exceed $300 billion per year by 2030.

Renewable Energy Sources. Current state and federal legislation calls for more than tripling the amount of renewable energy in power generation and increasing transport biofuels by more than 1,000 percent. This includes 16 billion gallons per year of corn-based ethanol and biodiesel and 20 billion gallons per year of cellulosic ethanol and biodiesel. Again, our assumption is that cellulosic biofuels become commercially feasible in time to meet the mandates that are already planned.

While S. 2191 has no additional mandates for biofuels, the costs of allowances for fossil fuels lead to greater use of biofuels. At this time, there is no commercially feasible cellulosic ethanol production. If this technology fails to deliver as projected, energy prices will have to rise enough to reduce the quantity of energy demanded by the amount of missing cellulosic ethanol.

ECONOMIC COSTS OF THE LIEBERMAN–WARNER BILL

The Lieberman–Warner bill affects the economy directly through higher prices for carbon-based energy, which reduces quantity demanded and, thus, the quantity supplied of energy from carbon sources. Energy prices rise because energy producers must pay a fee for each ton of carbon they emit. The fee structure is intended to create an incentive for producers to invest in technologies that reduce carbon emissions during energy production. The bill's sponsors and supporters hope that the fees are sufficiently high to create a strong incentive and demand for cleaner energy production and for the widespread adoption of carbon capture and sequestration technology.

The economic model we use to estimate the bill's broad economic effects treats the fees like a tax on energy producers. Thus, energy prices increase by the amount of the fee or tax. The demand for energy, which largely determines the consumption and, thus, the taxes collected, responds to higher energy prices both directly and indirectly. The direct effect is a reduction in the consumption of carbon-based energy and a shift, where possible, to substitutes that either do not require the fee or require a smaller one.

The indirect effects are more complex. Generally speaking, the carbon fees reduce the amount of energy used in producing goods and services, which slows the demand for labor and capital and reduces the rate of return on productive capital. This "supply-side" impact exerts the predictable secondary effects on labor and capital income, which depresses consumption.

These are not unexpected effects. Carbon-reduction schemes that depend on fees or taxes attain their goals of lower atmospheric carbon by slowing carbon-based economic activity. Of course, advocates of this approach hope that other energy sources will arise that can be used as perfect substitutes for the reduced carbon-based energy.

Our first simulation of S. 2191 attempts to make everything happen just as the authors of the legislation envision. We call this simulation the "generous assumptions" simulation, as discussed above in our assumptions section. That is, assuming the carbon-reduction targets discussed above, the implementation of CCS as well as expanded and new low-carbon fuels occurs just as planned and on time. The process is assumed to be unhampered by lawsuits or bureaucratic inefficiencies in the deployment of technology grants and consumption subsidies. Everything is "by the book."

Our second simulation relaxes the assumption that CCS technology is implemented and increases the value of carbon fees by approximately 30 percent each year after 2018. We call this simulation the "reasonable assumption" simulation. Every other assumption of our first simulation is retained.

Table 3 shows the carbon fees per ton at five-year intervals in our two simulations. Displayed alongside these values are the fees determined in other simulations of S. 2191.

If we have succeeded in these two efforts, then policymakers can expect something like the following economic effects:[9]

Economic Output Declines. The broadest measure of economic activity is the change in GDP after accounting for inflation. GDP measures the dollar value of all goods and services produced in the United States during the year for final sale to consumers. In the generous-assumptions simulation, GDP increases slightly during the first few years as,

6. *Ibid.*, Sec. 3401–3403.
7. *Ibid.*, Sec. 3403 (C).
8. *Ibid.*, Title III.
9. For a detailed description of how we estimated the economic effects of Lieberman–Warner, see Appendix 2, "Methodology."

Comparing Simulations of Carbon Dioxide Fees

Six groups conducted eight simulations of projected carbon dioxide fees that would need to be paid under S. 2191.

Carbon Fees Per Ton, Adjusted for Inflation

	The Heritage Foundation *In 2006 Dollars*		MIT (a) *In 2005 Dollars*	EPA (b) *In 2005 Dollars*	CRA (c) *In 2007 Dollars*	ACCF/ NAM (d) *In 2007 Dollars*		EIA (e) *In 2006 Dollars*
	Generous	Alternative				LW	No Offsets	
2015	$49	$49	$56	$40	$55	$55	–	–
2020	50	65	68	51	69	–	$55	$30–76
2025	58	76	83	65	88	–	–	–
2030	68	88	101	83	112	85	227	61–156
Average	56	70	77	60	81	n/a	n/a	

Sources: (a) Sergey Paltsev, et al., "Appendix D: Analysis of the Cap and Trade Features of the Lieberman-Warner Security Act (S. 2191)," 2008. MIT Joint Program on the Science and Policy of Global Change, Report 146. The LW simulation is without a CCS subsidy or other credits.

(b) Environmental Protection Agency, "EPA Analysis of the Lieberman-Warner Climate Security Act of 2008, S. 2191 in 110th Congress, March 14, 2008," at *http://www.epa.gov/climatechange/ downloads/s2191_EPA_Analysis.pdf* (5-6-2008). Intertemporal general equilibrium model results assuming no subsidies or credits (LW) and no offsets (No Offsets).

(c) Howard W. Pifer III, et al., "Managing the Risks of Greenhouse Gas Policies," CRA International (January 2008), p. 4. CRA provides a ranges of carbon prices: "…we have estimated a wide range in carbon prices from $35 to $60 in 2015, from $65 to $125 in 2030, and from $150 to $280 in 2045."

(d) American Council for Capital Formation and the National Association of Manufacturers, "Analysis of the Lieberman-Warner Climate Security Act (S. 2191) Using the National Energy Modeling System (NEMS/ACCF/NAM)," 2008, at *http://www.accf.org/pdf/NAM/ fullstudy031208.pdf* (5-6-2008), p. 9. The values in this column are from the "low-cost" case in ACCF/NAM's study.

(e) Energy Information Administration, "Energy Market and Economic Impacts of S. 2191, the Lieberman-Warner Climate Security Act of 2007," SR/OIAF/2008-01, April 2008.

Table 3 • CDA 08-02 heritage.org

for instance, energy producers decommission power plants and build new ones that are capable of accommodating CCS.

This investment-driven burst of GDP subsides after 2018. Higher energy prices decrease the use of carbon-based energy in production of goods, incomes fall, and demand for goods subsides. GDP declines in 2020 by $94 billion, in 2025 by $129 billion, and in 2030 by $111 billion (all, again, after inflation). When CCS is not implemented, the higher carbon fees produce more adverse economic effects. GDP is $330 billion below its baseline levels by 2025 and $436 billion below its baseline levels by 2030.[10]

This slowdown in GDP is seen more dramatically in the slump in manufacturing output. Again, manufacturing benefits from the initial investment in new energy production and fuel sources, but the sector's declines are sharp thereafter.

Indeed, by 2020, manufacturing output in this energy-sensitive sector is 2.4 percent to 5.8 percent below what it would be if S. 2191 never becomes law. By 2030, the manufacturing sector has lost $319 billion to $767 billion in output when compared to our baseline; that is, when compared to the economic world without Lieberman–Warner.

Number of Jobs Declines. The loss of economic output is the proverbial tip of the economic iceberg. Below the surface are economic reactions to the legislation that led up to the drop in output. Employment growth slows sharply following the boomlet of the first few years. Potential employment (or the job growth that would be implied by the demand for goods and services and the relevant cost of capital used in production) slumps sharply. In 2025, nearly a half-million jobs per year fail to materialize. The job losses expand to more than 600,000 in 2026.

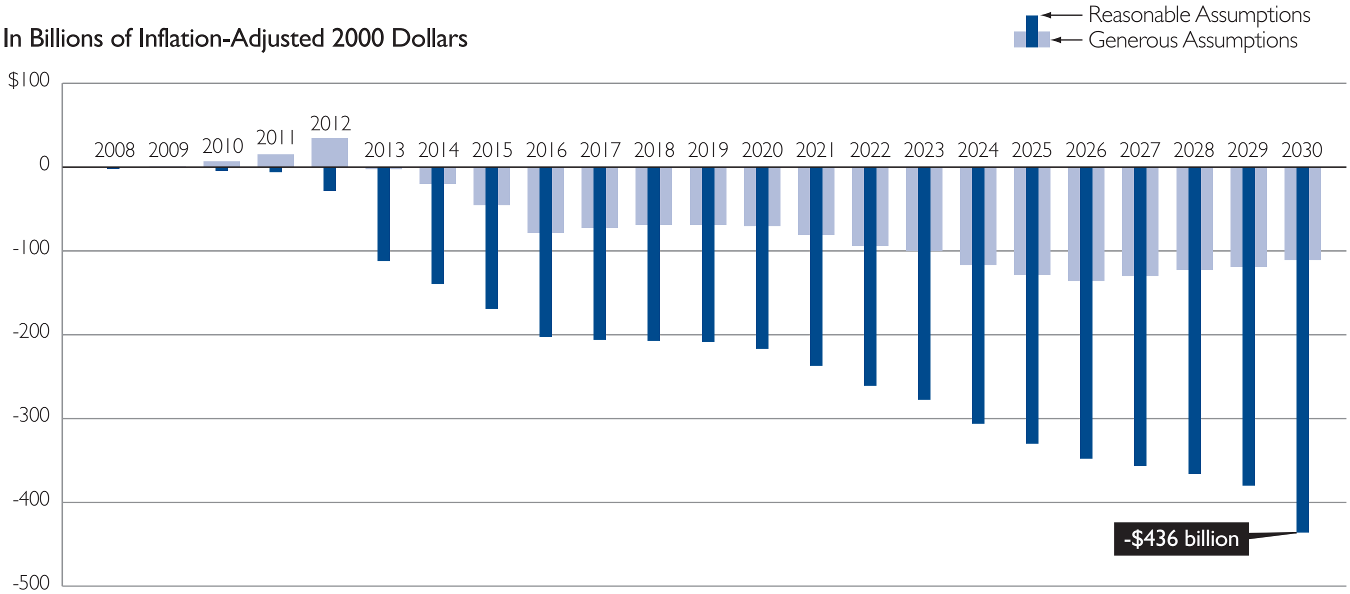
Indeed, in no year after the boomlet does the economy under Lieberman–Warner outperform the baseline economy where S. 2191 never becomes law.

For manufacturing workers, the news is grim indeed. That sector would likely continue declining in numbers thanks to increased productivity: Our baseline contains a 9 percent decline between 2008 and 2030. Lieberman–Warner accelerates this decrease substantially: Under our generous-assump-

10. For more detailed, yearly estimates of several major economic indicators, see Appendix 1.

Annual Change in Gross Domestic Product Due to S. 2191

In Billions of Inflation-Adjusted 2000 Dollars



Source: Heritage Foundation calculations using Global Insight's U.S. Macro Model.

Chart 5 • CDA 08-02 heritage.org

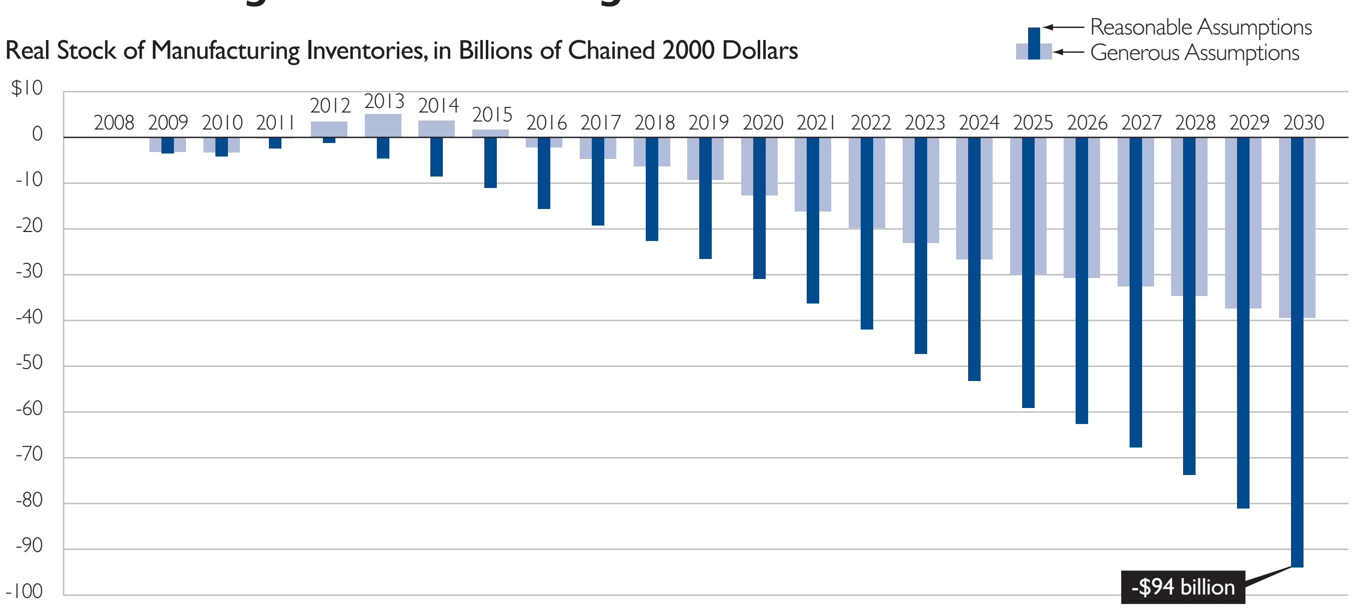
tions simulation, employment in manufacturing declines by 23 percent over that same time period, or more than twice the rate without Lieberman–Warner.

Other, less energy-intensive sectors, however, do not suffer such decreases. Employment in retail establishments ends the 22-year period 2 percent ahead of its 2008 level, despite significant cutbacks on household consumption levels. Employment in information businesses grows by 29 percent over this same time period.

Because the distribution of energy-intensive jobs across the country is unequal, some states and con-

Annual Change in Manufacturing Inventories Due to S. 2191

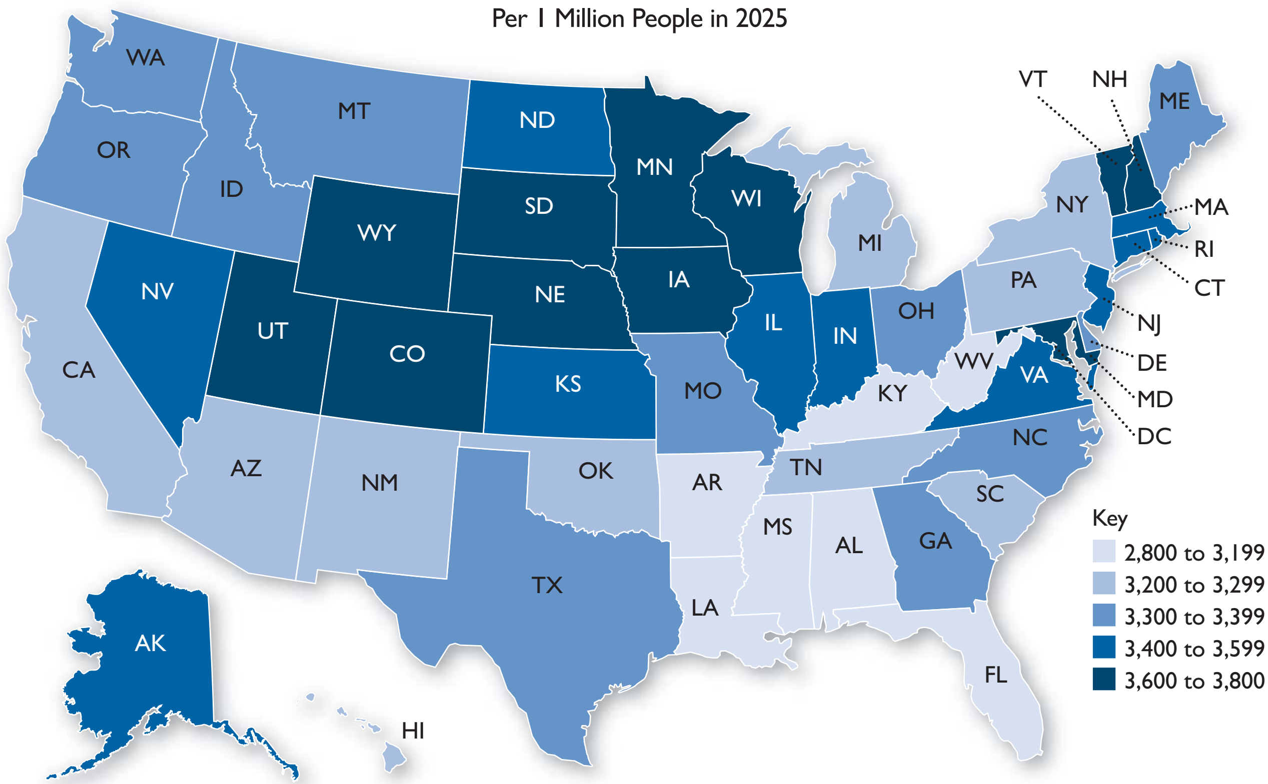
Real Stock of Manufacturing Inventories, in Billions of Chained 2000 Dollars



Source: Heritage Foundation calculations using Global Insight's U.S. Macro Model.

Chart 6 • CDA 08-02 heritage.org

Non-Farm Jobs Lost, by State (Generous Assumptions) Due to S. 2191



Jobs Lost Per 1 Million People in 2025—State Rankings, Highest to Lowest

1	Minnesota	3,738	14	Nevada	3,529	27	Maine	3,372	40	Oklahoma	3,241
2	Nebraska	3,709	15	Connecticut	3,526	28	Ohio	3,370	41	New Mexico	3,231
3	New Hampshire	3,708	16	Massachusetts	3,518	29	Idaho	3,366	42	Tennessee	3,227
4	Utah	3,708	17	Alaska	3,486	30	Delaware	3,355	43	Michigan	3,216
5	Wyoming	3,680	18	Virginia	3,477	31	Washington	3,351	44	South Carolina	3,201
6	South Dakota	3,638	19	New Jersey	3,449	32	Oregon	3,318	45	Florida	3,165
7	Colorado	3,630	20	Rhode Island	3,443	33	District of Columbia	3,314	46	Arkansas	3,131
8	Maryland	3,628	21	Illinois	3,432	34	North Carolina	3,306	47	Kentucky	3,128
9	Iowa	3,625	22	Indiana	3,428	35	California	3,299	48	Louisiana	3,098
10	Wisconsin	3,625	23	Montana	3,396	36	Arizona	3,292	49	Alabama	3,088
11	Vermont	3,614	24	Missouri	3,387	37	Hawaii	3,287	50	Mississippi	2,977
12	North Dakota	3,591	25	Georgia	3,376	38	Pennsylvania	3,267	51	West Virginia	2,861
13	Kansas	3,582	26	Texas	3,373	39	New York	3,265			

Source: Heritage Foundation calculations using Global Insight's U.S. Macro Model.

Map 3a • CDA 08-02 heritage.org

gressional districts will be hit particularly hard. Notable among the most adversely affected states are Wisconsin, New Hampshire, Illinois, and Maryland.[11]

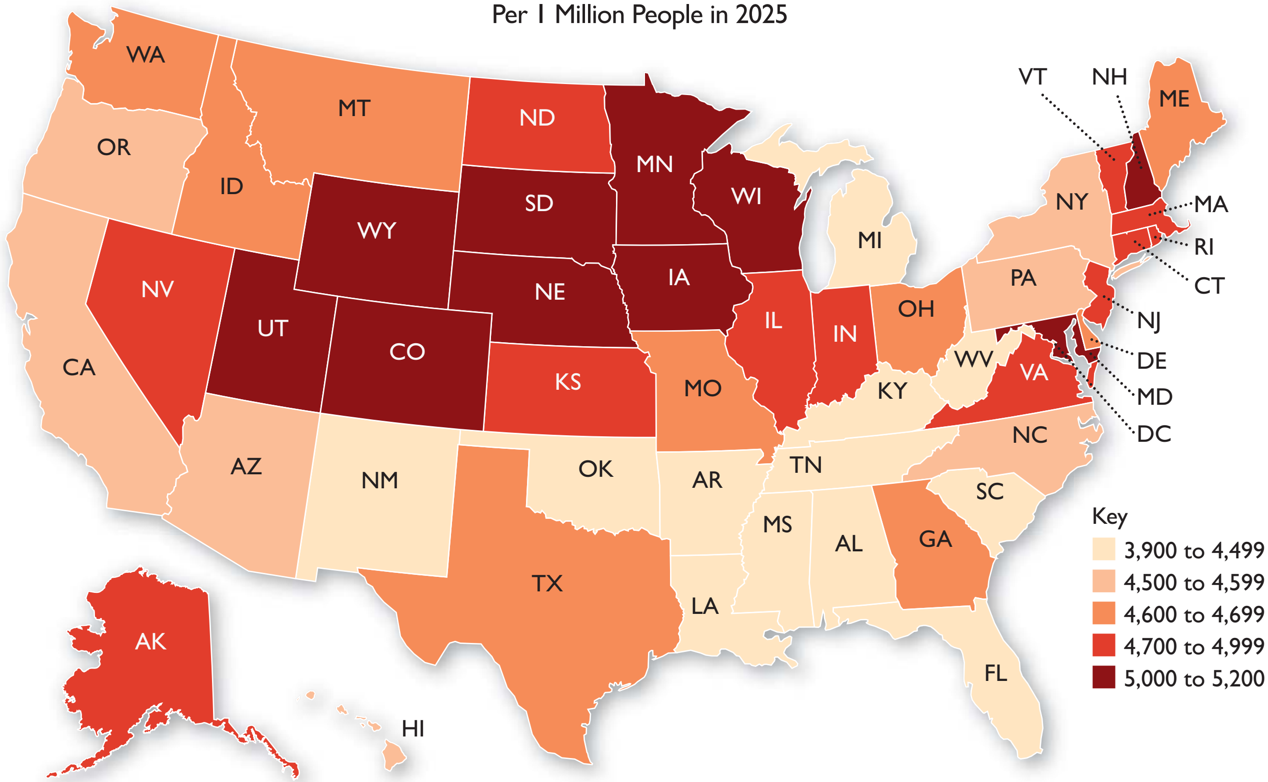
Energy Prices Rise. Higher energy prices, of course, are the root cause of the slower economy. As Chart 7 shows, consumer prices for electricity, natural gas, and home heating oil increase significantly between 2015 and 2030. Indeed, by the last year of our simulation, the total energy bill for the average American consumer has gone up $8,870 from 2012.

Incomes and Consumption Decline. Declining demand for energy-intensive products reduces employment and incomes in the businesses producing these products. Workers and investors earn less, and household incomes decline. Reductions in income in these sectors spread and cause declines in demand for other sectors of the economy.

11. For total job losses for each state under each simulation, see Appendix 3.

Non-Farm Jobs Lost, by State (Reasonable Assumptions) Due to S. 2191

Per 1 Million People in 2025



Jobs Lost Per 1 Million People in 2025—State Rankings, Highest to Lowest

1	Minnesota	5,166	14	Nevada	4,878	27	Maine	4,661	40	Oklahoma	4,480
2	Nebraska	5,127	15	Connecticut	4,874	28	Ohio	4,659	41	New Mexico	4,466
3	New Hampshire	5,126	16	Massachusetts	4,863	29	Idaho	4,653	42	Tennessee	4,460
4	Utah	5,125	17	Alaska	4,819	30	Delaware	4,637	43	Michigan	4,445
5	Wyoming	5,087	18	Virginia	4,807	31	Washington	4,632	44	South Carolina	4,425
6	South Dakota	5,029	19	New Jersey	4,767	32	Oregon	4,587	45	Florida	4,375
7	Colorado	5,018	20	Rhode Island	4,759	33	District of Columbia	4,582	46	Arkansas	4,328
8	Maryland	5,015	21	Illinois	4,744	34	North Carolina	4,570	47	Kentucky	4,325
9	Iowa	5,011	22	Indiana	4,738	35	California	4,561	48	Louisiana	4,283
10	Wisconsin	5,011	23	Montana	4,694	36	Arizona	4,550	49	Alabama	4,269
11	Vermont	4,996	24	Missouri	4,681	37	Hawaii	4,544	50	Mississippi	4,115
12	North Dakota	4,964	25	Georgia	4,667	38	Pennsylvania	4,516	51	West Virginia	3,955
13	Kansas	4,952	26	Texas	4,662	39	New York	4,514			

Source: Heritage Foundation calculations using Global Insight's U.S. Macro Model.

Map 3b • CDA 08-02 heritage.org

Our simulation captures this effect of higher energy prices. Under the generous-assumptions simulation, the income that individuals have after taxes declines by $47 billion (after inflation) in 2015 and by $50.7 billion in 2030. Our reasonable-assumptions simulation contains worse news: Disposable personal income falls $120 billion below baseline in 2015 and averages $68 billion below baseline over the entire period of 2008 to 2030.

Consumption outlays by individuals and households follow the pattern of lower income. In 2020, consumption expenditures are $52 billion lower than they would be in an economic world in which S. 2191 is not the law. Personal consumption outlays (after inflation) are $67 billion lower by 2030 and average $54 billion below baseline over the entire 22-year forecast period. Under a more reasonable assessment of the likelihood of standard use of CCS, consumption expenditures by individuals average $113 billion lower over the 22-year forecast period.

These declines in consumption are particularly dramatic in those parts of the economy that are sensitive to economic shocks: consumer durables, financial services, and discretionary medical services, among others. Chart 8 shows the effects of the decline in personal consumption outlays.

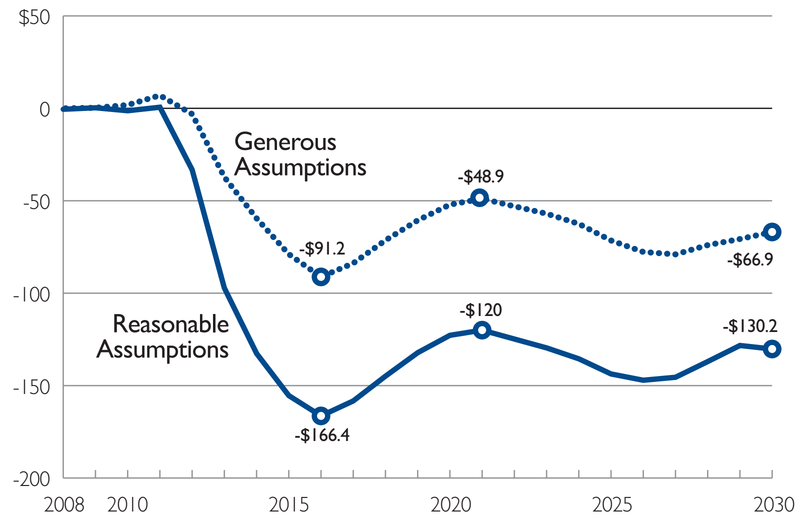
CONCLUSION

The Lieberman–Warner climate change bill is, in many respects, an unprecedented proposal. Its limits on CO_2 and other greenhouse gas emissions would impose significant costs on virtually the entire American economy. In addition, complicated tariff rules, dependent on evaluating the GHG restrictions of all trading partners, add another unknowable dimension to the costs, fueling the overall uncertainty.

The problems for our economy are increased by S. 2191's reliance on complex and costly technologies *that have yet to be developed*. The fact that this large-scale transformation of the economy must occur over relatively tight timeframes only amplifies the costs and uncertainties. The impacts would be felt by every citizen.

Personal Consumption Expenditures Due to S. 2191

In Billions of Dollars

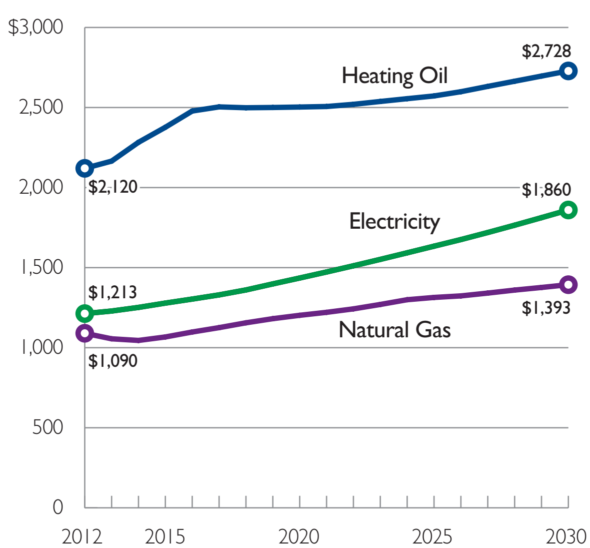


Source: Heritage Foundation calculations using Global Insight's U.S. Macro Model.

Chart 8 • CDA 08-02 heritage.org

Consumer Energy Prices Due to S. 2191 (Generous Assumptions)

Average Annual Household Prices



Source: Heritage Foundation calculations using Global Insight's U.S. Macro Model.

Chart 7 • CDA 08-02 heritage.org

Even under a fairly optimistic set of assumptions, the economic impact of S. 2191 is likely to be serious for the job market, household budgets, energy prices, and the economy overall. The burden will be shouldered by the average American. The bill would have the same effect as a major new energy tax—only worse. In the case of S. 2191, increases in the tax rate are set by forces beyond legislative control.

Under a more realistic set of assumptions, the impact would be considerably more severe. More significant than the wealth destroyed by S. 2191 is the wealth transferred from the energy-using public to a list of selected special interests.

Overall, S. 2191 would likely be—by far—the most expensive environmental undertaking in history.

—William W. Beach is Director of the Center for Data Analysis; David W. Kreutzer, Ph.D., is Senior Policy Analyst for Energy Economics and Climate Change in the Center for Data Analysis; Ben Lieberman is Senior Policy Analyst in Energy and the Environment in the Thomas A. Roe Institute for Economic Policy Studies; and Nicolas D. Loris is a Research Assistant in the Roe Institute at The Heritage Foundation.

APPENDIX 1

Key Economic Indicators (Generous Assumptions), Baseline vs. S. 2191

Fiscal Year Averages

	2010	2012	2014	2016	2018	2020	2022	2024	2026	2028	2030	2010-2030
Gross Domestic Product, *In Billions of Inflation-Adjusted Dollars (Indexed to the 2000 Price Level)*												Average
Forecast	12,338.0	13,083.8	13,663.6	14,269.7	14,980.4	15,714.2	16,448.7	17,215.3	18,079.2	18,956.5	19,894.8	15,862.6
Baseline	12,331.8	13,049.1	13,683.2	14,348.1	15,049.1	15,784.8	16,542.8	17,332.2	18,215.2	19,079.2	20,005.9	15,934.5
Difference	6.2	34.7	-19.7	-78.4	-68.7	-70.6	-94.0	-116.9	-135.9	-122.6	-111.1	-71.9
Real GDP Growth Rate, *Percent Change from Year Ago*												Average
Forecast	3.0	2.9	2.2	2.2	2.5	2.4	2.3	2.3	2.5	2.4	2.5	2.4
Baseline	2.9	2.8	2.4	2.4	2.5	2.4	2.4	2.4	2.5	2.3	2.4	2.5
Difference	0.0	0.2	-0.1	-0.2	0.0	0.0	-0.1	-0.1	0.0	0.1	0.1	0.0
Total Employment, *In Thousands of Jobs*												Average
Forecast	141,825	145,695	147,758	149,310	151,237	153,321	155,563	158,100	160,859	163,843	166,803	154,010.6
Baseline	141,791	145,378	147,643	149,476	151,306	153,344	155,744	158,458	161,412	164,347	167,264	154,179.1
Difference	33	317	115	-166	-69	-23	-181	-358	-552	-504	-461	-168.5
Private Employment, *In Thousands of Jobs*												Average
Forecast	119,081	122,700	124,473	125,764	127,448	129,279	131,488	133,877	136,472	139,262	142,003	130,153.4
Baseline	119,038	122,388	124,369	125,945	127,543	129,335	131,706	134,284	137,082	139,849	142,553	130,357.4
Difference	43	312	104	-182	-95	-56	-218	-406	-610	-587	-550	-204.0
Unemployment Rate, *Percent of Civilian Labor Force*												Average
Forecast	5.0	4.5	4.7	4.9	4.8	4.8	4.9	5.0	5.0	4.9	4.9	4.8
Baseline	5.0	4.7	4.7	4.7	4.7	4.7	4.7	4.8	4.7	4.7	4.7	4.7
Difference	0.0	-0.1	0.0	0.1	0.1	0.1	0.1	0.2	0.3	0.2	0.2	0.1
Disposable Personal Income, *In Billions of Inflation-Adjusted Dollars (Indexed to the 2000 Price Level)*												Average
Forecast	9,448.1	10,078.3	10,631.6	11,206.9	11,855.8	12,543.4	13,223.1	13,905.6	14,623.2	15,370.9	16,140.4	12,629.8
Baseline	9,445.3	10,088.1	10,668.8	11,259.0	11,886.4	12,554.0	13,234.9	13,932.5	14,676.8	15,424.8	16,191.1	12,660.2
Difference	2.8	-9.8	-37.2	-52.0	-30.6	-10.6	-11.7	-26.9	-53.7	-53.8	-50.7	-30.4
Disposable Income Per Capita, *In Inflation-Adjusted Dollars (Indexed to the 2000 Price Level)*												Average
Forecast	30,459	31,941	33,129	34,345	35,743	37,214	38,612	39,966	41,366	42,799	44,236	37,249.2
Baseline	30,450	31,972	33,245	34,504	35,835	37,245	38,646	40,043	41,518	42,949	44,375	37,338.0
Difference (Per Person)	9	-31	-116	-160	-92	-31	-34	-77	-152	-150	-139	-88.7
Difference (Family of Four)	36	-124	-463	-638	-368	-126	-137	-309	-607	-600	-555	-355.0
Personal Consumption Expenditures, *In Billions of Inflation-Adjusted Dollars (Indexed to the 2000 Price Level)*												Average
Forecast	8,816.9	9,363.4	9,787.6	10,218.8	10,729.7	11,245.7	11,755.4	12,260.0	12,777.7	13,309.8	13,857.4	11,280.6
Baseline	8,815.0	9,366.5	9,847.1	10,310.1	10,801.1	11,297.8	11,808.4	12,322.5	12,855.4	13,383.8	13,924.3	11,337.3
Difference	1.8	-3.1	-59.5	-91.2		-52.1	-53.0	-62.5	-77.7	-74.0	-66.9	-56.7
Personal Savings, *In Inflation-Adjusted Dollars (Indexed to the 2000 Price Level)*												Average
Forecast	243.8	296.4	394.7	508.7	618.0	764.2	913.2	1072.0	1253.1	1449.6	1654.9	798.5
Baseline	242.9	302.4	369.1	465.6	574.0	718.9	866.1	1027.2	1216.0	1414.5	1623.0	767.1
Difference	0.9	-6.0	25.6	43.0	44.0	45.3	47.1	44.8	37.1	35.2	31.9	31.3

Source: Heritage Foundation calculations using Global Insight's U.S. Macro Model.

Appendix Table 1a • CDA 08-02 heritage.org

Other Economic Indicators (Generous Assumptions), Baseline vs. S. 2191

Fiscal Year Averages

	2010	2012	2014	2016	2018	2020	2022	2024	2026	2028	2030	2010-2030
Personal Savings Rate, *Percent of Disposable Personal Income*												Average
Forecast	2.6	3.0	3.8	4.7	5.3	6.3	7.1	7.9	8.8	9.6	10.4	6.1
Baseline	2.6	3.1	3.5	4.2	4.9	5.8	6.7	7.5	8.4	9.3	10.1	5.8
Difference	0.0	-0.1	0.3	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.3
Gross Private Domestic Investment, *In Billions of Inflation-Adjusted Dollars (Indexed to the 2000 Price Level)*												Average
Forecast	1,894.3	2,123.7	2,198.5	2,297.3	2,445.8	2,600.0	2,749.4	2,934.6	3,196.8	3,441.6	3,726.3	2,684.9
Baseline	1,888.1	2,105.6	2,212.6	2,339.8	2,453.5	2,592.8	2,747.1	2,924.5	3,172.2	3,386.6	3,651.3	2,674.3
Difference	6.1	18.2	-14.1	-42.5	-7.8	7.3	2.3	10.1	24.6	54.9	75.0	10.6
Non-Residential Investment, *In Billions of Inflation-Adjusted Dollars (Indexed to the 2000 Price Level)*												Average
Forecast	1,470.6	1,608.1	1,700.4	1,786.4	1,932.5	2,099.7	2,269.6	2,474.4	2,729.6	3,019.2	3,337.6	2,210.4
Baseline	1,465.2	1,594.6	1,706.2	1,824.8	1,953.1	2,105.8	2,280.2	2,477.2	2,718.9	2,979.5	3,278.8	2,207.7
Difference	5.3	13.5	-5.8	-38.4		-6.1	-10.6	-2.8	10.8	39.7	58.7	2.7
Residential Investment, *In Billions of Inflation-Adjusted Dollars (Indexed to the 2000 Price Level)*												Average
Forecast	420.4	502.8	505.0	521.4	530.2	536.2	537.3	542.1	564.0	566.4	574.1	529.1
Baseline	420.3	499.4	506.9	519.6	519.8	522.9	522.6	525.8	546.0	545.0	549.2	518.2
Difference	0.1	3.4	-1.8	1.8	10.4	13.3	14.7	16.3	18.0	21.4	24.9	10.9
Change in the Stock of Business Inventories, *In Billions of Inflation-Adjusted Dollars (Indexed to the 2000 Price Level)*												Average
Forecast	35.9	40.9	29.3	30.0	36.9	36.1	36.7	39.5	53.0	52.6	62.2	40.6
Baseline	34.9	39.3	35.6	39.8	39.1	39.9	43.4	47.0	60.2	58.2	68.9	45.6
Difference	1.0	1.6	-6.3	-9.8	-2.3	-3.8	-6.7	-7.5	-7.2	-5.6	-6.7	-5.0
Full-Employment Capital Stock, *In Billions of Inflation-Adjusted Dollars (Indexed to the 2000 Price Level)*												Average
Forecast	14,594.8	15,414.9	16,203.1	16,972.9	17,817.9	18,785.4	19,856.9	21,044.8	22,370.2	23,871.0	25,538.2	19,273.7
Baseline	14,592.3	15,398.4	16,215.5	17,040.5	17,905.1	18,852.8	19,897.4	21,047.2	22,324.0	23,749.7	25,328.9	19,268.1
Difference	2.4	16.6	-12.4	-67.6	-87.2	-67.4	-40.6	-2.5	46.2	121.3	209.3	5.6
Consumer Price Index, *Percent Change from Year Ago*												Average
Forecast	1.7	2.5	2.5	2.3	2.2	2.1	2.1	2.0	2.0	2.0	2.0	2.1
Baseline	1.7	1.7	1.8	1.9	1.9	1.9	1.8	1.8	1.9	1.9	1.9	1.8
Difference	0.0	0.8	0.7	0.4	0.2	0.2	0.3	0.2	0.2	0.1	0.1	0.3
Treasury Bill–3 Month, *Annualized Percent*												Average
Forecast	4.6	5.0	5.4	5.4	5.2	5.1	4.9	4.7	4.6	4.5	4.5	4.9
Baseline	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6
Difference	0.0	0.5	0.8	0.8	0.6	0.5	0.3	0.2	0.0	0.0	-0.1	0.3
Treasury Bond–10 Year, *Annualized Percent*												Average
Forecast	5.3	5.6	5.9	5.8	5.7	5.6	5.5	5.5	5.4	5.3	5.3	5.6
Baseline	5.3	5.3	5.2	5.2	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3
Difference	0.0	0.4	0.7	0.6	0.4	0.3	0.3	0.2	0.1	0.0	0.0	0.3

Source: Heritage Foundation calculations using Global Insight's U.S. Macro Model.

Appendix Table 1b • CDA 08-02 heritage.org

Key Economic Indicators (Reasonable Assumptions), Baseline vs. S. 2191

Fiscal Year Averages

	2010	2012	2014	2016	2018	2020	2022	2024	2026	2028	2030	2010-2030
Gross Domestic Product, *In Billions of Inflation-Adjusted Dollars (Indexed to the 2000 Price Level)*												Average
Forecast	12,327.0	13,020.9	13,543.3	14,145.1	14,842.1	15,568.4	16,282.1	17,026.2	17,867.5	18,713.1	19,569.9	15,706.0
Baseline	12,331.8	13,049.1	13,683.2	14,348.1	15,049.1	15,784.8	16,542.8	17,332.2	18,215.2	19,079.2	20,005.9	15,934.5
Difference	-4.7	-28.2	-139.9	-203.0	-207.0	-216.4	-260.7	-306.0	-347.6	-366.1	-436.0	-228.5
Real GDP Growth Rate, *Percent Change from Year Ago*												Average
Forecast	2.9	2.6	2.2	2.2	2.5	2.4	2.3	2.2	2.5	2.3	2.5	2.4
Baseline	2.9	2.8	2.4	2.4	2.5	2.4	2.4	2.4	2.5	2.3	2.4	2.5
Difference	0.0	-0.2	-0.2	-0.2	0.0	0.0	-0.1	-0.1	-0.1	0.0	0.1	-0.1
Total Employment, *In Thousands of Jobs*												Average
Forecast	141,933	145,601	147,073	148,591	150,540	152,801	155,152	157,824	160,735	163,831	166,833	153,682.3
Baseline	141,791	145,378	147,643	149,476	151,306	153,344	155,744	158,458	161,412	164,347	167,264	154,179.1
Difference	141	224	-570	-885	-766	-543	-592	-635	-677	-516	-431	-496.7
Private Employment, *In Thousands of Jobs*												Average
Forecast	119,189	122,607	123,787	125,045	126,752	128,758	131,076	133,601	136,348	139,250	142,081	129,827.4
Baseline	119,038	122,388	124,369	125,945	127,543	129,335	131,706	134,284	137,082	139,849	142,553	130,357.4
Difference	151	218	-581	-901	-791	-577	-630	-683	-734	-599	-472	-530.0
Unemployment Rate, *Percent of Civilian Labor Force*												Average
Forecast	4.9	4.5	5.0	5.1	5.0	4.9	4.9	4.9	4.8	4.7	4.7	4.9
Baseline	5.0	4.7	4.7	4.7	4.7	4.7	4.7	4.8	4.7	4.7	4.7	4.7
Difference	-0.1	-0.1	0.3	0.4	0.3	0.2	0.2	0.1	0.1	0.0	0.0	0.1
Disposable Personal Income, *In Billions of Inflation-Adjusted Dollars (Indexed to the 2000 Price Level)*												Average
Forecast	9,448.5	10,050.0	10,560.1	11,137.1	11,789.4	12,482.0	13,162.4	13,851.6	14,589.4	15,367.9	16,161.4	12,588.9
Baseline	9,445.3	10,088.1	10,668.8	11,259.0	11,886.4	12,554.0	13,234.9	13,932.5	14,676.8	15,424.8	16,191.1	12,660.2
Difference	3.2	-38.1	-108.7	-121.9	-97.0	-71.9	-72.5	-80.8	-87.4	-56.8	-29.7	-71.3
Disposable Income Per Capita, *In Inflation-Adjusted Dollars (Indexed to the 2000 Price Level)*												Average
Forecast	30,461	31,851	32,906	34,130	35,543	37,032	38,435	39,810	41,271	42,791	44,323	37,127.6
Baseline	30,450	31,972	33,245	34,504	35,835	37,245	38,646	40,043	41,518	42,949	44,375	37,338.0
Difference (Per Person)	10	-121	-339	-374	-292	-213	-212	-232	-247	-158	-52	-210.3
Difference (Family of Four)	41	-483	-1,355	-1,494	-1,169	-854	-847	-929	-989	-633	-209	-841.3
Personal Consumption Expenditures, *In Billions of Inflation-Adjusted Dollars (Indexed to the 2000 Price Level)*												Average
Forecast	8,813.7	9,333.3	9,714.5	10,143.7	10,656.2	11,175.0	11,683.6	12,187.0	12,708.3	13,246.8	13,794.0	11,219.0
Baseline	8,815.0	9,366.5	9,847.1	10,310.1	10,801.1	11,297.8	11,808.4	12,322.5	12,855.4	13,383.8	13,924.3	11,337.3
Difference	-1.3	-33.2	-132.6	-166.4	-158.3	-122.8	-124.8	-135.5	-147.1	-137.0	-130.2	-118.4
Personal Savings, *In Inflation-Adjusted Dollars (Indexed to the 2000 Price Level)*												Average
Forecast	310.3	392.8	556.2	761.3	967.3	1245.7	1549.4	1903.8	2342.8	2863.0	3418.6	1,406.9
Baseline	242.9	302.4	369.1	465.6	574.0	718.9	866.1	1027.2	1216.0	1414.5	1623.0	767.1
Difference	67.3	90.4	187.1	295.7	393.3	526.8	683.3	876.7	1,126.8	1,448.6	1,795.6	639.8

Source: Heritage Foundation calculations using Global Insight's U.S. Macro Model.

Appendix Table 1c • CDA 08-02 heritage.org

Other Economic Indicators (Reasonable Assumptions), Baseline vs. S. 2191

Fiscal Year Averages

	2010	2012	2014	2016	2018	2020	2022	2024	2026	2028	2030	2010-2030
Personal Savings Rate, *Percent of Disposable Personal Income*												Average
Forecast	2.7	3.0	3.9	4.8	5.5	6.4	7.2	8.1	9.1	10.0	10.4	6.3
Baseline	2.6	3.1	3.5	4.2	4.9	5.8	6.7	7.5	8.4	9.3	10.1	5.8
Difference	0.0	0.0	0.3	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.3	0.4
Gross Private Domestic Investment, *In Billions of Inflation-Adjusted Dollars (Indexed to the 2000 Price Level)*												Average
Forecast	1,891.8	2,103.5	2,175.7	2,292.3	2,442.1	2,601.2	2,744.8	2,926.0	3,186.1	3,426.2	3,674.6	2,673.0
Baseline	1,888.1	2,105.6	2,212.6	2,339.8	2,453.5	2,592.8	2,747.1	2,924.5	3,172.2	3,386.6	3,651.3	2,674.3
Difference	3.6	-2.1	-36.9	-47.5	-11.5	8.4	-2.3	1.5	13.9	39.6	23.2	-1.3
Non-Residential Investment, *In Billions of Inflation-Adjusted Dollars (Indexed to the 2000 Price Level)*												Average
Forecast	1472.3	1605.4	1693.2	1794.9	1940.6	2109.7	2274.1	2475.5	2728.9	3017.0	3316.8	2,211.2
Baseline	1,465.2	1,594.6	1,706.2	1,824.8	1,953.1	2,105.8	2,280.2	2,477.2	2,718.9	2,979.5	3,278.8	2,207.7
Difference	7.0	10.7	-13.0	-29.9	-12.5	3.8	-6.0	-1.7	10.1	37.6	37.9	3.5
Residential Investment, *In Billions of Inflation-Adjusted Dollars (Indexed to the 2000 Price Level)*												Average
Forecast	418.7	498.0	497.5	515.2	525.3	532.9	533.8	538.1	559.0	560.1	560.6	523.8
Baseline	420.3	499.4	506.9	519.6	519.8	522.9	522.6	525.8	546.0	545.0	549.2	518.2
Difference	-1.6	-1.5	-9.3	-4.4	5.6	10.0	11.2	12.3	13.0	15.1	11.4	5.6
Change in the Stock of Business Inventories, *In Billions of Inflation-Adjusted Dollars (Indexed to the 2000 Price Level)*												Average
Forecast	33.8	29.6	22.8	25.3	31.9	32.5	32.4	34.8	48.7	47.2	51.3	35.0
Baseline	34.9	39.3	35.6	39.8	39.1	39.9	43.4	47.0	60.2	58.2	68.9	45.6
Difference	-1.1	-9.7	-12.8	-14.5	-7.2	-7.4	-11.0	-12.2	-11.5	-11.1	-17.6	-10.6
Full-Employment Capital Stock, *In Billions of Inflation-Adjusted Dollars (Indexed to the 2000 Price Level)*												Average
Forecast	14,606.2	15,427.1	16,222.0	17,026.9	17,900.6	18,881.7	19,948.7	21,120.1	22,426.1	23,914.2	25,485.9	19,323.5
Baseline	14,592.3	15,398.4	16,215.5	17,040.5	17,905.1	18,852.8	19,897.4	21,047.2	22,324.0	23,749.7	25,328.9	19,268.1
Difference	13.9	28.8	6.5	-13.6	-4.5	28.9	51.3	72.8	102.0	164.4	157.0	55.4
Consumer Price Index, *Percent Change from Year Ago*												Average
Forecast	2.2	2.3	2.4	2.5	2.7	2.8	2.9	3.0	3.1	3.3	3.5	2.8
Baseline	1.7	1.7	1.8	1.9	1.9	1.9	1.8	1.8	1.9	1.9	1.9	1.8
Difference	0.5	0.6	0.6	0.7	0.7	0.9	1.1	1.2	1.3	1.4	1.5	0.9
Treasury Bill–3 Month, *Annualized Percent*												Average
Forecast	4.8	5.3	5.3	5.3	5.1	5.1	5.0	5.0	5.0	5.1	5.3	5.1
Baseline	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6
Difference	0.2	0.7	0.7	0.7	0.5	0.5	0.4	0.4	0.4	0.5	0.7	0.5
Treasury Bond–10 Year, *Annualized Percent*												Average
Forecast	5.4	5.8	5.9	5.9	5.7	5.7	5.7	5.7	5.7	5.8	5.3	5.7
Baseline	5.3	5.3	5.2	5.2	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3
Difference	0.2	0.6	0.7	0.6	0.5	0.4	0.4	0.4	0.4	0.5	0.0	0.4

Source: Heritage Foundation calculations using Global Insight's U.S. Macro Model.

Appendix Table 1d • CDA 08-02 heritage.org

APPENDIX 2 METHODOLOGY

Analysts at The Heritage Foundation and Global Insight, Inc., employed a wide array of analytical models to produce the micro- and macroeconomic results reported in this paper. This section describes the models and the major steps taken by these analysts in shaping the modeling results.

U.S. ENERGY MODEL (LONG-TERM)

Global Insight's U.S. Energy Model has been designed to analyze the factors that determine the outlook for U.S. energy markets. A staff of more than 15 energy professionals supports the model and forecasting effort. The model is constructed as a system of several models that can be used to assess intra-market issues independently of each other. The integrated system is used to produce Global Insight's baseline Energy Outlook and allows users to simulate changes in domestic energy markets.

The U.S. Energy Model is an integrated system of fuel and electric power models and the End-User Demand Model. The solution is achieved through an iterative procedure. Also, monthly models of petroleum and natural gas prices use the framework of the long-term forecast with additional weekly and monthly information to analyze seasonal fuel prices and update the price forecasts on a monthly basis. The major models of the Energy Model and their interrelationships are described below.

End-Use Demand Model. Demand for final-use energy is modeled by sector, fuel, and census region, based on the competitive position of each fuel in its end-market. The total demand for energy is estimated as a function of the stock of energy equipment, technology change, prices of competing final energy sources, and economic performance. The initial demand profile by region of the U.S. for each fuel is then integrated with the U.S. Petroleum, Natural Gas, Coal, and Electric Power Models, each of which consists of three major sub-modules—a supply and transformation module, a transportation/transmission/distribution module, and a wholesale/retail price module.

U.S. Petroleum Model. The U.S. Petroleum Model uses the world oil price projection from Global Insight's Global Oil Outlook. The model then determines refined petroleum product prices to end-users by adding refining markups, inventory, and transportation costs. For selected products, federal, state and local taxes are also accounted for in the model.

The U.S. Petroleum Model also provides a baseline projection of U.S. crude and natural gas production that is based on an annual review of data and literature on U.S. reserves, production, and technological progress.

A simulation block for investigating the supply response under alternative assumptions is part of this model. Imported supplies of crude and petroleum products are developed by the difference between domestic production and the sum of the direct consumption of petroleum by consumers and the transformation demand for petroleum by the power sector.

Natural Gas Model. The Natural Gas Model consists of three major sub-modules: a supply module, a transmission/distribution module, and a spot-pricing module.

- The *supply module* projects production based on analysis of U.S. reserve data, exploratory and development drilling, and technological progress. A simulation block for investigating supply responses under alternative assumptions is part of this module.
- The *transmission/distribution module* projects cost by customer class.
- The *spot-pricing model* integrates the results of the End-User Demand Model, the natural gas demand by the power sector from the Electric Power Model, and the embedded supply and transmission/distribution modules to determine producer prices by basin. A conclusive solution is developed through an interactive process.

Coal Model. The Coal Model is a simulation model designed to replicate the market response of this sector under alternative scenarios. Finalized through the interactive process, the baseline market analysis is provided by JD Energy (an affiliated coal and power consulting firm) that includes analysis and forecasts of coal production, rail costs, coal flows, and coal prices.

Electric Power Model. The U.S. Electric Power Model is a detailed, regional (census region) model of the power-generation sector combined with a more aggregate module of the regional transmission and distribution sector.

The preliminary demand for regional generation is determined as a function of the demand for electricity determined in the End-User Demand Model, transmission losses, and trade. Generation requirements are met through the capacity module, which projects capacity decisions based on fuel prices, operating and maintenance costs, and technological progress. Usage is projected as a function of load and marginal production cost. Through this analysis, a preliminary demand for a certain fuel by the power sector is developed that is finalized in the iterative process.

Energy Balances Model. The Energy Balances Model completes the process. This model provides national and regional summations of energy use across all fuel types and customer classes.

Operation of the Energy Models. Lieberman–Warner sets very aggressive carbon-reduction targets between 2012 and 2050 for the covered sectors. Using the energy models described above, simulation resulted in carbon dioxide allowances rising swiftly from $20 per metric ton in 2012 to $50 in 2020 and $70 in 2030 (all in 2006 prices). These allowances significantly raise energy prices for consumers. Allowed offsets were applied to the targets, which influenced the estimation of required fees.

In addition, Lieberman–Warner lays out two other mechanisms for achieving the carbon-reduction targets: increasing energy from non-carbon sources and implementation of carbon capture and sequestration.

The absolute gains from additional non-carbon energy sources are relatively small, given the significant incentives already in place for this growth from EISA. For CCS, we assumed that its use in energy production became competitive with energy produced with natural gas only when the allowance fee rose above $50 per ton. For the generous-assumption simulation, we also assumed that the technology of carbon capture and storage was available for widespread use when the fee rose to this level. We also took into account the new-build and retirement and replacement options, which were inputs to the energy models that estimated the allowance fees.

GLOBAL INSIGHT LONG-TERM U.S. MACROECONOMIC MODEL

The Global Insight long-term U.S. macroeconomic model is a large-scale 30-year (120-quarter) macroeconometric model of the U.S. economy. It is used primarily for commercial forecasting.

Over the years, analysts at The Heritage Foundation's Center for Data Analysis have worked with economists at Global Insight to adapt the GI model to policy analysis. In simulations, CDA analysts use the GI model to evaluate the effects of policy changes not just on disposable income and consumption in the short run, but also on the economy's long-run potential. They can do so because the GI model imposes the long-run structure of a neoclassical growth model but makes short-run fluctuations in aggregate demand a focus of analysis.

The Global Insight model can be used to forecast over 1,400 macroeconomic aggregates. Those aggregates describe final demand, aggregate supply, incomes, industry production, interest rates, and financial flows in the U.S. economy. The GI model includes such a wealth of information about the effects of important changes in the economic and policy environment because it encompasses detailed modeling of consumer spending, residential and non-residential investment, government spending, personal and corporate incomes, federal (and state and local) tax revenues, trade flows, financial markets, inflation, and potential gross domestic product.

Consistent with the rational-expectations hypothesis, economic decision-making in the GI model is generally forward-looking. In some cases, Global Insight assumes that expectations are largely a function of past experience and recent changes in the economy. Such a retroactive approach is taken in the model because GI believes that expectations change little in advance of actual changes in the economic and policy variables about which economic decision-makers form expectations.

OPERATION OF THE U.S. MACROECONOMIC MODEL

The policy changes contained in Lieberman–Warner and implemented in the U.S. Energy Model (as described above) resulted in over 71 changes in the U.S. Macroeconomic Model. These changes ranged from energy-source variables (such as the price of West Texas Intermediate crude oil, an industry benchmark price series) to the carbon tax rate per ton of coal.[12] These energy model results were introduced into the macro model in the following ways:

Energy Price Effects. Heritage analysts used the market price changes in the refiner's acquisition price for oil (West Texas Intermediate) and in natural gas prices at the wellhead (Henry Hub) directly from the energy model.

The macro model contains a host of producer prices that are changed through their interaction with other variables in this model. However, the policy changes in Lieberman–Warner affect producer prices in the energy sectors directly. Thus, the energy model's settings for these producer prices were used instead of those in the macro model. Technically, energy producer prices were exogenous and driven by corresponding prices from the energy model. The following producer price categories were affected: coal, natural gas, electricity, natural gas, petroleum products, and residual fuel oil.

We employed a similar procedure in implementing changes in consumer prices. In this case, the variables affected were all consumption-price deflators. Once again, we substituted energy-model settings for these variables for their macro-model counterparts. The following consumption price deflators were affected: fuel oil and coal, gasoline, electricity, and natural gas.

Energy Consumption Effects. Both the energy model and the macro model contain equations that predict changes in demand for energy, given changes in energy prices, but the energy model contains a more detailed treatment of demand. Preferring details over generality, we lined up the demand equations in both models and substituted settings from the energy model for those in the macro model. Specifically, we lined up these demand equations:

- Total energy consumption,
- Total end-use consumption for petroleum,
- Total end-use consumption for natural gas,
- Total end-use consumption for coal, and
- Total end-use consumption for electricity.

One key transformation that took place dealt with the differing demand units used between the two models in calculating residential consumption. The energy model expresses demand in trillions of British thermal units, while the macro model projects demand in billions of constant dollars.

Another key transformation focused on consumer spending on gasoline. The energy model does not contain a separate forecast for spending on gasoline or other motor fuels. To overcome this, we projected the change in consumer spending on gasoline based on the energy model's change in total highway fuel consumption.

Revenue Estimates. The energy model produces estimates of carbon emissions and of the carbon fee in dollars per metric ton. It is a simple matter to multiply emissions by the carbon fee to obtain the "revenue" from the emissions permits.

Heritage analysts assumed that the revenue value of permits equals the entire value of these permits as government revenue, whether or not they are formally auctioned. If the government chooses to transfer ownership of the permits to other entities, then that would be reflected as a transfer payment in the national income accounts. The macro model permits allocation of permit revenues to the states, which was accomplished by multiplying total permit revenue by the statutory state percentage for each year.

These revenues then were allocated to various specified functions as follows:

- Revenues for general state needs other than low-income support,
- Revenues for low-income support administered by the states,
- Revenues allocated to electricity and gas distributors for demand-reduction programs,
- Revenues allocated to covered entities, and
- Revenues for federal government consumption.

Capital Spending. The energy model calculates capital spending by electric utilities in the base case and in the Lieberman–Warner case. Spending is higher (at least initially) and costlier in the Lieberman–Warner case because higher-cost power plants are built or because old plants are refurbished. The change in spending was applied to the macro model variable for real spending on utility investment after conversion to the appropriate base year.

12. The specific, year-by-year settings are available on request from the Center for Data Analysis at The Heritage Foundation.

The analysts then calculated what amount of spending would have been required to produce the same level of electricity capacity had the mix of spending been the same as the baseline. The purpose here is to measure the extra resources that had to go into utility construction simply because of the introduction of the resources related to the carbon fee that will produce lower emissions but which will not produce extra GDP.

OPERATION OF THE U.S. MACROECONOMIC MODEL FOR LIEBERMAN–WARNER WITH REASONABLE ASSUMPTIONS

The Lieberman–Warner simulation with reasonable assumptions builds on the generous-assumptions simulation by relaxing the CCS implementation schedule. As discussed in the assumptions section of this report, there are many reasons to doubt that CCS will be implemented over the forecast period.

Relaxing the CCS implementation schedule provides policymakers with an alternative that increases the economic costs of S. 2191 without significantly altering the legislation's other key assumptions. That is, the alternative or reasonable simulation attempts to portray the economic effects of carbon fees that are higher than in the generous-assumptions simulation while leaving nearly all of the other policy assumptions untouched.

We have calculated that carbon fees would have to increase $20 per metric ton, from $68 to $88 (adjusted for inflation), by 2030 to compensate, through decreased energy consumption, for carbon reductions that otherwise would be attained through carbon capture and sequestration. These higher carbon fees would begin in 2015, or about the time that CCS implementation is projected to result in a slowing of carbon-fee growth in the generous-assumptions simulation. For example, with CCS, carbon fees would be $50 in 2020 instead of $65.

To implement the assumption of higher carbon fees, analysts adjusted the settings of the generous-assumptions simulation described above. We left in place the energy input prices (oil, natural gas, coal, and so forth) that were used in the basic, or generous, simulation. Likewise untouched were all of the assumptions about energy production and demand contained in the baseline.

APPENDIX 3
STATE-BY-STATE EMPLOYMENT LOSSES

Non-Farm Employment Lost, By State, in 2025 Due to S. 2191

	Reasonable Assumptions	Generous Assumptions
Alabama	9,836	7,118
Alaska	1,764	1,276
Arizona	14,562	10,537
Arkansas	6,148	4,448
California	86,782	62,795
Colorado	13,984	10,119
Connecticut	9,891	7,157
Delaware	2,165	1,567
District of Columbia	1,518	1,098
Florida	41,739	30,202
Georgia	23,329	16,881
Hawaii	3,162	2,288
Idaho	3,597	2,602
Illinois	33,532	24,264
Indiana	16,469	11,917
Iowa	8,823	6,384
Kansas	7,863	5,690
Kentucky	9,289	6,722
Louisiana	9,090	6,577
Maine	3,500	2,533
Maryland	16,578	11,995
Massachusetts	18,282	13,229
Michigan	23,323	16,876
Minnesota	16,167	11,698
Mississippi	5,646	4,085
Missouri	15,010	10,861
Montana	2,481	1,795
Nebraska	5,387	3,898
Nevada	6,862	4,965
New Hampshire	4,141	2,996
New Jersey	23,364	16,906
New Mexico	4,463	3,229
New York	46,695	33,788
North Carolina	21,684	15,690
North Dakota	1,879	1,360
Ohio	29,276	21,184
Oklahoma	8,348	6,041
Oregon	9,268	6,706
Pennsylvania	30,434	22,021
Rhode Island	2,914	2,108
South Carolina	9,959	7,206
South Dakota	2,304	1,667
Tennessee	14,153	10,241
Texas	57,274	41,443
Utah	7,155	5,177
Vermont	1,895	1,371
Virginia	20,899	15,123
Washington	16,185	11,711
West Virginia	3,461	2,504
Wisconsin	16,502	11,941
Wyoming	1,580	1,144

Source: Heritage Foundation calculations using Global Insight's U.S. Macro Model.

Appendix Table 3 • CDA 08-02 heritage.org