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ANALYSIS OF THE CLIMATE PROTECTION ACT OF 2013

STANFORD FEDERAL ENERGY POLICY LABORATORY[1]

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1. Summary

Earlier this year, Senators Barbara Boxer (D-CA) and Bernie Sanders (I-VT) introduced S. 332, the Climate Protection Act of 2013. Based on a "fee-and-dividend" concept, the bill would levy a carbon pollution fee on carbon dioxide (CO_2) emissions starting in 2014 at \$20 per metric ton of CO_2, rising at 5.6% per year through 2023. Most fossil fuel producers, manufacturers or importers would be required to pay the fee. Fuels intended for export would be exempted, however, and a carbon-equivalency fee would apply to emissions-intensive imports, ensuring that domestic manufacturers face a level playing field at home and abroad.

The carbon pollution fees under the Climate Protection Act would be utilized to accomplish three goals (see Table 1):

- 3/5 of carbon pollution fees would be directly rebated to U.S. residents;
- \$20.5 billion per year would be used to assist trade-exposed industries, low-income households, displaced workers, and to increase energy R&D; and
- The remainder, about 1/4, would be used to reduce the U.S. federal budget deficit.

Using an independent version of the U.S. Department of Energy's 2013 National Energy Modeling System (NEMS-Stanford), we analyzed the macroeconomic, environmental, and distributional impacts of the Climate Protection Act. We find that the Climate Protection Act would:

- Reduce energy-related CO_2 emissions by 4,200 million metric tonnes (MMt) CO_2 in the first ten years of the program;
- Reduce CO_2 emissions from energy by 8.5% below a business-as-usual baseline level by 2020 and by 10.5% in 2023;
- Reduce CO_2 emissions from energy by 16.8% below 2005 levels in 2020, permitting the U.S. to meet its commitment under the Copenhagen Accord;
- Ensure that U.S. CO_2 emissions peaked in 2007 and decline thereafter;
- Result in modest impacts to GDP of less than one half of one percent in 2020;
- Rebate \$744 billion to households over ten years, with an average yearly household rebate of between \$181 and \$223;

[1] For more information about this analysis, please contact Michael Wara via phone (650.725.5310) or email (mwara@stanford.edu). The Stanford Energy Policy Laboratory is a collaboration between faculty and students from Stanford Law School and Stanford's Management Science & Engineering Department. We gratefully acknowledge financial support from the Precourt Institute for Energy and the Steyer-Taylor Center for Energy Policy and Finance.

- Reduce net energy-related expenditures for substantially all of the 80% of U.S. households with incomes less than $100,000 per year;
- Reduce net energy-related expenditures for the average U.S. household in all regions of the country;
- Invest $205 billion over ten years in energy efficiency in homes and industry, job training, renewable energy, and energy research; and
- Reduce the U.S. federal budget deficit by $311 billion over ten years.

2. Environmental Impacts of the Climate Protection Act

Our analysis indicates that the carbon pollution fee implemented under the Climate Protection Act (§101) would significantly reduce energy-related CO_2 emissions across the U.S. economy over the next decade. In the first ten years of the program (2014-2023), the Climate Protection Act would reduce emissions by 4,200 MMt CO_2 (see Figures 1 and 2).

Emission reductions occur more rapidly during the first two years of implementation, slowing to a more gradual decline in subsequent years. These reductions are in stark contrast to the baseline scenario, in which energy-related CO_2 emissions are expected to increase during the next decade, after sharp declines in the period from 2008 to 2011.

Due to the Climate Protection Act, annual U.S. CO_2 emissions from energy in 2023 would be 575 MMT CO_2 (10.5%) less than the business-as-usual case. More than half of these reductions come from fuel switching, primarily switching away from coal and towards renewable energy and natural gas in the electricity sector; about one quarter of the emission reductions come from increased demand-side energy efficiency (see Figure 2). By pricing CO_2 emissions, the Climate Protection Act would extend the reduction in emissions observed since 2007, marking that year as the peak for national emissions of CO_2 from energy use.

3. Macroeconomic Impacts of the Climate Protection Act

NEMS-Stanford projects that the Climate Protection Act carbon pollution fee (§101) would have modest impacts on U.S. GDP (see Figure 3). During the first decade of program implementation, differences between U.S. GDP projections for the baseline and the Climate Protection Act policy scenarios vary between 0.22% of GDP and 0.78% of GDP. At the end of the ten-year period, GDP in 2023 is $20.5 trillion in the baseline scenario, compared with $20.4 trillion in the Climate Protection Act scenario. Thus, although the emission reductions produced by a carbon price are significant, adjustments in the energy sector and the economy as a whole appear to be relatively inexpensive.

Furthermore, our projected impacts to GDP are very likely overstated. First, we do not include the impacts of policies aimed at reducing energy related carbon emissions that are funded by the Climate Protection Act (§§103, 201). By reinvesting money raised by the carbon pollution fee into activities that reduce emissions and compensate trade-exposed industries, these programs would reduce overall costs of compliance. Second, we make no attempt to simulate improvements in U.S. public health and related reductions in healthcare expenditures associated with reduced air pollution brought about by the program.[2] Third, the structure of the macroeconomic model in NEMS-Stanford does not account for any impacts of deficit reduction under the Climate Protection Act on future U.S. debt servicing costs. Finally, our projected impacts to GDP are limited by the core assumptions in NEMS. Notably, the model does not fully account for the possibility of induced innovation, which many analysts believe would be spurred by a price on carbon.[3]

4. Fiscal Impacts of the Climate Protection Act

Under the Climate Protection Act, 60% of the carbon pollution fee (§101) funds are rebated to U.S. residents (§102). Thus over the 2014-2023 period, approximately $774 billion would be recycled back to U.S. households (see Table 1).

Table 1. Fiscal analysis of the Climate Protection Act over the 2014-2023 period.
All values expressed as billion nominal USD.

Year	Fee Rate ($/t$CO_2$)	Total Fee	Rebate Value	Supporting Policies	Deficit Reduction
2014	$20.00	$102.5	$61.5	$20.5	$20.5
2015	$21.12	$106.4	$63.9	$20.5	$22.1
2016	$22.30	$110.9	$66.5	$20.5	$23.8
2017	$23.55	$117.3	$70.4	$20.5	$26.4
2018	$24.87	$124.5	$74.7	$20.5	$29.3
2019	$29.26	$131.6	$80.0	$20.5	$32.2
2020	$27.73	$138.3	$83.0	$20.5	$34.8
2021	$29.29	$144.8	$86.9	$20.5	$37.4
2022	$30.93	$152.7	$90.6	$20.5	$40.6
2023	$32.66	$160.7	$96.4	$20.5	$43.8
Total		**$1289.7**	**$773.8**	**$205.0**	**$310.9**

[2] These benefits are significant. Prominent economists recently concluded that air pollution damages from some industries, such as coal-fired power plants, are greater than the amount those industries contribute to GDP. *See* Nicholas Z. Muller, Robert Mendelsohn, and William D. Nordhaus (2011), Environmental Accounting for Pollution in the United States Economy. *American Economic Review* 101: 1649-1675. This finding is particularly important here: our modeling work indicates that the Climate Protection Act will induce coal plants to shut down early, for which the costs to GDP are included in the NEMS-Stanford results, but for which the corresponding benefits to human health are not.

[3] Environmental economists have shown that induced innovation in the context of climate policy has the potential to significantly lower compliance costs and increase social welfare. *See* Lawrence H. Goulder & Koshy Mathai (2000), Optimal CO_2 Abatement in the Presence of Induced Technological Change. *Journal of Environmental Economics and Management* 39(1): 1-38.

While NEMS includes some simple, price-induced technological change parameters, it does not allow users to assess the impacts of a broader suite of technology policies, such as the research, development, and deployment policies suggested in the Climate Protection Act. *See* Kenneth Gillingham et al. (2008), Modeling endogenous technological change for climate policy analysis. *Energy Economics* 30(6): 2734-2753; *see also* John P. Weyant (2011), Accelerating the development and diffusion of new energy technologies: Beyond the "valley of death." *Energy Economics* 33(4): 674-682.

Of the remaining pollution fees, $205 billion is allocated to policies that invest in energy efficiency in homes and industry, job training, renewable energy, and energy research (see Table 2). The remaining $311 billion is allocated to deficit reduction (§103).

Table 2. Supporting Policies under the Climate Protection Act.[4]
Units: billions of nominal dollars over a ten-year budget horizon.

Provision	Purpose	Amount
§103(c)(1)	Cost mitigation for energy-intensive and trade-exposed industries.	$ 75
§103(c)(2)	Weatherization of low-income homes.	$ 50
§103(c)(3)	Job training, education, and transition assistance for individuals employed by fossil fuel industries.	$ 10
§103(c)(4)	Energy research and development (ARPA-E).	$ 20
§201(e)(1)	Grants, loans, and loan guarantees for energy projects.	$ 50

One limitation of our analysis of the Climate Protection Act is that we do not include in our simulation the carbon equivalency fee provisions (§101) aimed at imposing the carbon pollution fee on embodied carbon in imported goods. Nor do we model rebates of the fee on exported fossil fuels (§101). Thus, our analysis is limited to a purely domestic perspective on fiscal impacts of the proposed legislation.[5]

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[4] In addition to these specific policies, the Climate Protection Act imposes a fee on carbon-intensive imported goods. The funds collected from this fee would be shared by the Environmental Protection Agency and the Department of Transportation, each of which would be permitted to fund projects that address specific environmental and economic criteria (§101). Our analysis is limited to the carbon fee and the policies in Table 2, for which the Climate Protection Act appropriates funds collected from the carbon pollution fee.

[5] Our understanding is that the exclusion of exports from the carbon pollution fee in the Climate Protection Act is due to the concern that the fee might be judged an unconstitutional export tax. *See* U.S. Const., Art. 1, § 9, clause 5. Based on our review of recent Supreme Court jurisprudence evaluating fees and taxes under the Export Clause, however, we believe that the carbon pollution fee would be permissible if applied to fossil fuel exports. *See U.S. v. IBM*, 517 U.S. 843, 847-848 (1996); *see also U.S. v. U.S. Shoe Corp.*, 523 U.S. 360 (1998).

In *IBM*, a unanimous Court reaffirmed that "nondiscriminatory pre-exportation assessments do not violate the Export Clause, even if the goods are eventually exported." 517 U.S. at 848 (citing *Cornell v. Coyne*, 192 U.S. 418, 427 (1904) (finding that a pre-exportation excise tax levied on cheese manufactured under contract for export was permissible because the tax was levied prior to goods entering the course of exportation)). We believe that a similar analysis would support the constitutionality of a nondiscriminatory upstream carbon pollution fee levied on fossil fuels, such as in the Climate Protection Act. The Supreme Court's interpretation of the Export Clause indicates that the closer to exportation that application of the levy occurs (*i.e.* the farther downstream), the more likely a fee or tax is unconstitutional. Given that the Climate Protection Act carbon pollution fee is levied very far upstream—for example, at the mine mouth for coal—we believe that, if applied to fossil fuel exports, the fee would withstand judicial review.

Finally, we note that for more than two decades, the U.S. has taxed production and import of ozone-depleting substances, including production intended for export. *See* 26 U.S.C. § 4681.

5. Environmental and Economic Impacts of the Climate Protection Act in 2020

Under the Copenhagen Accord, the U.S. has committed to reduce its economy-wide greenhouse gas emissions to "in the range of 17% below" 2005 levels by 2020.[6] To analyze this commitment, we provide a summary of the Climate Protection Act impacts in 2020 (see Table 3).

Table 3. Environmental & Economic Impacts of the Climate Protection Act in 2020.

Cumulative GDP Growth *Constant 2011 USD, 2013-2020*	\$3,470 billion (22%)
GDP reduction due to the Climate Protection Act *Constant 2011 USD, Relative to BAU 2020 Baseline*	\$85 billion (–0.44%)
CO_2 Reductions due to the Climate Protection Act *Relative to BAU 2020 Baseline*	464 MMt CO_2 (–8.5%)
CO_2 Reductions due to the Climate Protection Act *Relative to 2005 emissions*	1,009 MMt CO_2 (–16.8%)
CO_2 Reductions relative to the Copenhagen commitment *Relative to 2005 emissions*	+ 11 MMt CO_2 (+0.2%)

Although the Climate Protection Act does not mandate any specific reductions levels, NEMS-Stanford projects that the carbon pollution fee (§101) would reduce energy-related CO_2 emissions in 2020 by 464 MMt CO_2, or 8.5% below baseline emissions.[7] Compared to 2005 emissions, this is a reduction of 1,009 MMt CO_2, or 16.8%, in compliance with the commitment the U.S. agreed to in the Copenhagen Accord (see Figure 2 and Table 2). In achieving this reduction, we find that U.S. GDP is reduced by \$85 billion (constant 2011 dollars), or 0.44%. This decrease in economic output is, again, quite modest given the \$19 trillion size of the U.S. economy expected in 2020.

We note that the U.S. commitment under the Copenhagen Accord covers all emissions of six greenhouse gases,[8] whereas NEMS projects only energy-related CO_2 emissions. To account for this difference, we assume that the U.S. Copenhagen commitment is distrib-

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6 In the Copenhagen Accord, The U.S. agreed to a reduction of economy-wide greenhouse gas emissions "in the range of 17%, in conformity with anticipated climate and energy legislation" relative to 2005 levels. Copenhagen Accord, Appendix I, Quantified economy-wide emissions targets for 2020, FCCC/CP/2009/Add.1/Appendix I.

7 In addition to setting a price on carbon that would help the U.S. achieve this near-term climate commitment, the Climate Protection Act (§303) also expresses a general Congressional intention to take future actions to reduce greenhouse gas emissions 80% below 2005 levels by 2050.

8 The covered gases are CO_2, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride.

uted equally across all emissions sources, such that energy-related CO_2 emissions must decline by the same share as the overall commitment (i.e., in the range of 17% below 2005 levels). In order to fully comply with its international commitments, the U.S. will need to reduce emissions in sectors not covered by the Climate Protection Act, or achieve further cuts in the energy sector beyond those modeled in this analysis.

6. Impacts of the Climate Protection Act to Households Across Incomes

Note: In this section, all dollar values are expressed in constant 2011 dollars.

U.S. household energy expenditures vary strongly by income and to a smaller degree by region (see Figures 4, 5, and 6). We calculate the net benefit to households of the Climate Protection Act as the difference between the per capita rebate and increases in the cost of energy used by U.S. households due to the carbon fee. Although the costs of the Climate Protection Act vary by household income level and region, the rebates are the same for all Americans. The rebate to all U.S. residents would start at $181 in 2014 and increase to $223 by 2023.

We find that the Climate Protection Act's rebate to U.S. residents of 60% of the total carbon pollution fee is sufficient to offset increased energy prices for the lower 80% of U.S. households by income (see Figure 7). The highest quintile of income earners faces net energy expenditure increases under the policy. Substantially all of U.S. households with less than $100,000 in total annual income receive net benefits under the Climate Protection Act of between $70 and $250 per year over the first ten years of the program, depending on income level. Households with total annual incomes less than $50,000 can expect an average annual net benefit from the program of approximately $200 during the first ten years (see Figure 8).

Households making between $100,000 and $120,000 should expect minimal net impacts from the Climate Protection Act. In general, only households with total annual incomes above $120,000 should expect net increases in energy related expenditures due to the carbon pollution fee; costs will fall most heavily on households with total annual incomes above $150,000. Because the wealthiest Americans consume the most energy, due primarily to larger homes and frequent air travel, the carbon pollution fee rebate does not fully offset the increased costs these households will face under the Climate Protection Act. Nevertheless, the fee and rebate structure rewards any household that becomes more energy efficient, no matter the household income level.

7. Impacts of the Climate Protection Act to Households Across Regions

Note: In this section, all dollar values are expressed in constant 2011 dollars.

Our analysis also indicates that average households in all areas of the country would experience reductions in net energy expenditures due to the Climate Protection Act, despite the different quantity and mix of energy resources that these regions use today.

Different regions of the country consume different quantities and mixtures of energy resources, and thus would experience different impacts from the Climate Protection Act.

We examine the extent to which costs and benefits of the program vary by region using consumer expenditure data from the Northeast, Midwest, South, and West Census Regions. Our analysis shows that the per capita rebate in the Climate Protection Act is sufficient to more than protect the average household in all regions (see Figure 9). Our results indicate that the average household in each region will see average annual net benefits ranging from \$100 to \$210 over the first ten years of the program, depending on location.

Differences in our regional results arise primarily because of current and projected regional patterns of energy consumption—in other words, the Climate Protection Act applies equally to all residents and business, regardless of location. Regional differences primarily reflect two factors: (1) different fuel mixes in the electricity sectors in each region, and (2) different demand levels for heating and cooling services across each region. To a lesser degree, regional differences in net energy expenditures also reflect regional differences in average household size.

8. Impacts of Alternative Allocations of Carbon Pollution Fee

In this section we evaluate the distributional impacts of two alternative rebate structures. First, we assess how increasing the fraction of the carbon pollution fee rebated to consumers – from 60% to 75% – changes distributional impacts of the policy. In order to raise the rebate levels, we reallocate carbon pollution fees directed to supporting policies, with the bulk of the money going to the rebate program, and with a small increase in total deficit reduction. We call this the "75% Rebate" case. Then we assess how reducing the fraction of carbon pollution fees rebated to consumers to 50%, with additional funds devoted exclusively to deficit reduction, changes the distribution of costs and benefits from the program. We call this the "50% Rebate" case. Analysis of both cases is comparable to that presented in Sections 6 and 7 of this report.

8.1 Analysis of the 75% Rebate Case

8.1.1 Fiscal Impacts of the 75% Rebate Case

Note: In this section, all dollar values are expressed in nominal dollars.

In the 75% Rebate Case, we modified the Climate Protection Act allocation of carbon pollution fees to test the impact of increasing the per capita rebate's share from 60% to 75%. Remaining fees are allocated to deficit reduction, consistent with Senate PayGo Rules. We note that although it would be interesting to model a 100% rebate case, the 75% Rebate Case bounds the maximum possible rebate level under the Congressional Budget Office's current scoring practices.[9] As a result, the 75% Rebate Case approximates the closest practical alternative to rebating the entire carbon pollution fee.

9 *See* G. Thomas Woodward (2009), The Role of the 25 Percent Revenue Offset in Estimating the Budgetary Effects of Legislation. Congressional Budget Office, Economic and Budget Issue Brief. CBO rules require legislation that proposes a new tax or fee (such as a carbon pollution fee) to set aside 25% of total fees to offset the government's expected loss of income and payroll taxes, which make up approximately 90% of federal revenues.

The effect of increasing the rebate level to 75% is to allocate $968 billion towards the residential rebate and $322 billion towards deficit reduction in the 2014-2023 period, with $0 allocated to various programs aimed at increasing energy efficiency, renewable energy deployment, and energy research (see Table 4). With the increased rebate level, the per capita rebate would start at $239 in 2014 and rise to $344 by 2023. Under the 75% Rebate Case, the average U.S. resident would receive an annual average of $287 via the rebate during the 10-year period.

Table 4. Fiscal analysis of the 75% Rebate Case over the 2014-2023 period.
All values expressed as billion nominal USD unless otherwise specified.

Year	Fee Rate *($/tCO$_2$)*	Total Fee	Rebate Value	Supporting Policies	Deficit Reduction
2014	$20.00	$102.5	$76.9	$0.0	$25.6
2015	$21.12	$106.4	$79.8	$0.0	$26.6
2016	$22.30	$110.9	$83.2	$0.0	$27.7
2017	$23.55	$117.3	$88.0	$0.0	$29.3
2018	$24.87	$124.5	$93.4	$0.0	$31.1
2019	$29.26	$131.6	$98.7	$0.0	$32.9
2020	$27.73	$138.3	$103.8	$0.0	$34.6
2021	$29.29	$144.8	$108.6	$0.0	$36.2
2022	$30.93	$152.7	$114.5	$0.0	$38.2
2023	$32.66	$160.7	$120.5	$0.0	$40.2
Total		**$1289.7**	**$967.3**	**$0.0**	**$322.4**

8.1.2 Distributional Impacts of the 75% Rebate Cast by Income and Region

Note: In this section, all dollar values are expressed in constant 2011 dollars.

Comparing these benefits against the expected increase in household energy costs, we find that a per capita rebate of 75% of the total carbon pollution fee is sufficient to offset increased energy prices for substantially all of the lower 80%, by income, of U.S. households (see Figure 10). The highest quintile of income earners faces a small average net increase in energy costs of $20 per year. Net energy expenditures of U.S. households with less than $120,000 per year in income fall under the Climate Protection Act by between $160 and $360 per year over the first ten years of the program, depending on income level. Households with incomes less than $80,000 can expect an average annual net benefit from the program in excess of $260 (see Figures 10 and 11).

As we found in our analysis of the rebate level codified in the Climate Protection Act, net benefits to households in the 75% Rebate Case vary by region. In general, the higher per capita rebate leads to greater net benefits in all regions of the U.S. (see Figure 12). Our results indicate that the average household in each region will see average annual benefits ranging from $220 to $350 over the first ten years, depending on location. As before, the differences primarily reflect (1) the regional composition of the electric power sector, and (2) regional climate conditions, which drive energy demand profiles for heating and cooling services, and (3) to a lesser extent reflect regional variation in household size.

8.2 Analysis of the 50% Rebate Case

8.2.1 Fiscal Impacts of the 50% Rebate Case

Note: In this section, all dollar values are expressed in nominal dollars.

In the 50% Rebate Case, we modified the Climate Protection Act allocation of carbon pollution fees to test the impact of reducing the per capita rebate's share from 60% to 50%. Fees directed to programs aimed at increasing energy efficiency, renewable energy deployment, and energy research are maintained at levels specified in the Climate Protection Act; all additional fees are allocated to deficit reduction. The effect of this change is to allocate $645 billion towards the per capita rebate, $205 billion towards energy policy programs, and $440 billion towards deficit reduction in the 2014-2023 period (see Table 5). With 50% rebate levels, the per capita rebate would start at $159 in 2014 and rise to $229 by 2023. Under the 50% Rebate Case, average U.S. residents would receive an average of $191 per year via the per capita rebate during this period.

Table 5. Fiscal analysis of the 50% Rebate Case over the 2014-2023 period.
All values expressed as billion nominal USD unless otherwise specified.

Year	Fee Rate (\$/tCO$_2$)	Total Fee	Rebate Value	Supporting Policies	Deficit Reduction
2014	$20.00	$102.5	$51.3	$20.5	$30.8
2015	$21.12	$106.4	$53.2	$20.5	$32.7
2016	$22.30	$110.9	$55.4	$20.5	$34.9
2017	$23.55	$117.3	$58.7	$20.5	$38.2
2018	$24.87	$124.5	$62.3	$20.5	$41.8
2019	$29.26	$131.6	$65.8	$20.5	$45.3
2020	$27.73	$138.3	$69.2	$20.5	$48.7
2021	$29.29	$144.8	$72.4	$20.5	$51.9
2022	$30.93	$152.7	$76.3	$20.5	$55.8
2023	$32.66	$160.7	$80.3	$20.5	$59.8
Total		**$1289.7**	**$644.9**	**$205.0**	**$439.9**

8.2.2 Distributional Impacts of the 50% Rebate Case by Income and Region

Note: In this section, all dollar values are expressed in constant 2011 dollars.

Comparing the 50% rebate of carbon pollution fees against the expected increase in household energy costs, we find that the program is still sufficient to offset increased energy costs for the lower 80% by income of U.S. households (see Figure 13). The average U.S. household achieves a net benefit of $80 on average over the first ten years of the program. The highest quintile of income earners faces average annual net energy expenditure increases of $290 over the first ten years. U.S. households with less than $80,000 in annual income can expect an average annual net benefit under the Climate Protection Act of between $20 and $190 over the first ten years of the program, depending on income level. Households with incomes less than $40,000 can expect an average annual net benefit from the program in excess of $150 over the first ten years (see Figures 13 and 14).

Even with the reduced rebate level, average households in all regions still benefit from net reductions in energy expenditures under the 50% rebate case. As is the case with our analysis of the Climate Policy Act's 60% rebate level, the household net benefit of the 50% Rebate Case varies by region. In general, the lower per capita rebate leads to lower net benefits in all regions of the U.S. (see Figure 15). Our results indicate that the average household in each region will see average annual net benefits ranging from \$20 to \$130 over the first ten years of the program, depending on location. As before, the differences primarily reflect (1) the regional composition of the electric power sector, and (2) regional climate conditions, which drive energy demand profiles for heating and cooling services, and (3) to a lesser extent reflect regional variation in household size.

9. Limitations of our Distributional Analyses

Our analysis of household impacts under the Climate Protection Act is based on the energy-related household expenditures tracked in the Bureau of Labor Statistics' 2011 Consumer Expenditure Survey. Thus our household-level impact estimates do not capture GDP losses, changes to employment, or other macroeconomic factors. Because the total impact to GDP is small, however, our model results imply that the economic consequences to the non-household sectors of the economy should also be small.

Finally, we do not model the impact of non-rebate policy expenditures. This is a conservative assumption, especially because policy expenditures are designed to increase energy efficiency investments, deploy new infrastructure, assist workers with job training, and expand research funding for clean technologies. Although we do not model these benefits, NEMS-Stanford does account for the corresponding macro- and microeconomic costs associated with the entire carbon fee.

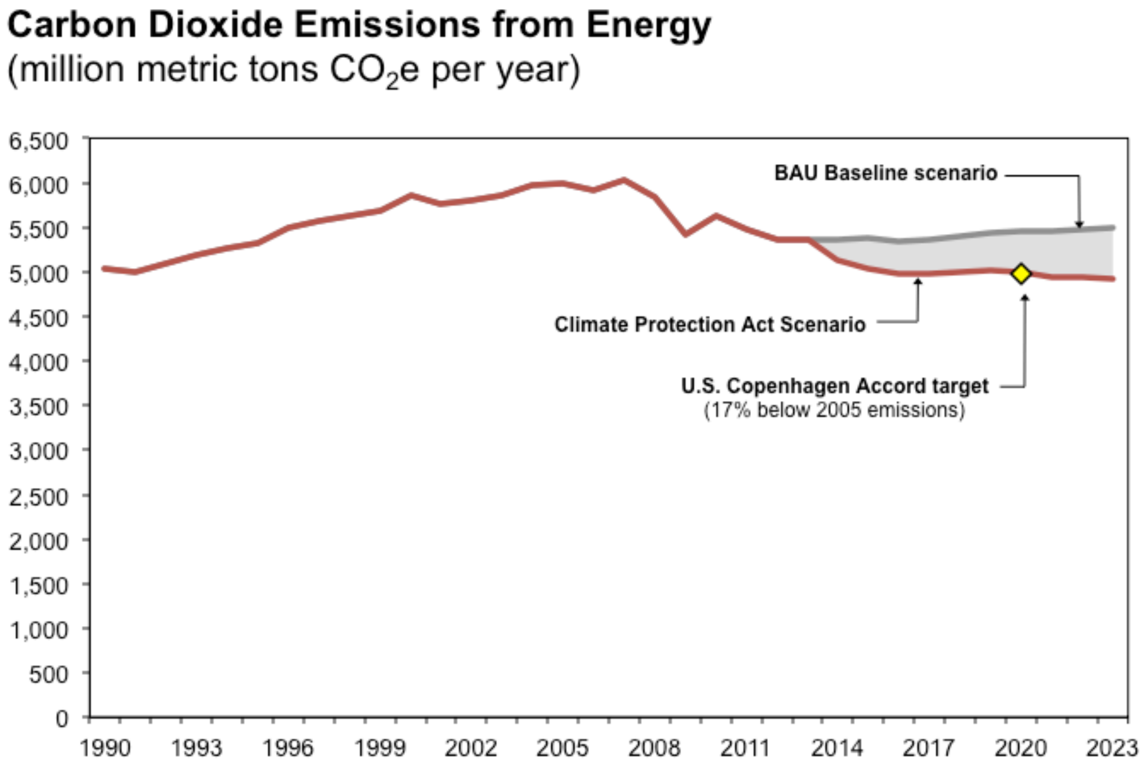

Figure 1. Estimated reductions in energy-related carbon emissions due to the Climate Protection Act. NEMS-Stanford projects that the Climate Protection Act will lower U.S. energy-related CO_2 emissions by 4,200 MMt CO_2 in the 2014-2023 period, relative to the Business As Usual (BAU) baseline scenario. In 2020, the Climate Protection Act will reduce emissions 16.8% below the 2005 level, in compliance with the commitment the U.S. agreed to in Copenhagen Accord. By pricing CO_2 emissions, the Climate Protection Act would extend the reduction in emissions observed since 2007, marking that year as the peak for national emissions of CO_2 from energy use.

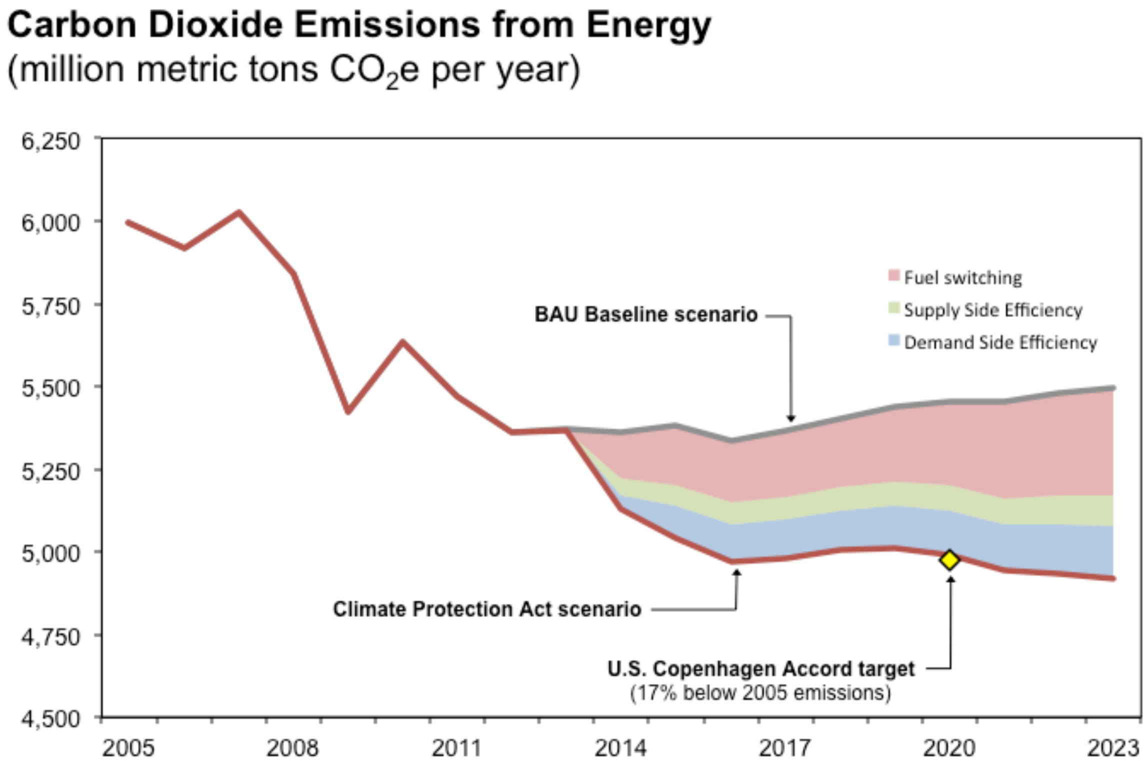

Figure 2. Estimated reductions in energy-related carbon emissions due to the Climate Protection Act. NEMS-Stanford projects that the Climate Protection Act will lower U.S. energy-related CO_2 emissions by 4,200 MMt CO_2 in the 2014-2023 period, relative to the Business As Usual (BAU) baseline scenario. In 2020, the Climate Protection Act will reduce emissions 16.8% below the 2005 BAU level, complying with the commitment the U.S. agreed to in the Copenhagen Accord. Shaded areas indicate the contribution of three categories of emissions reductions. The largest savings come from fuel switching, which accounts for 56% of the reductions in 2023. NEMS-Stanford projects the greatest fuel switching in the electricity sector, which moves away from coal and towards a combination of renewable and natural gas power plants. Of the remaining reductions, 16% will come from energy efficiency improvements on the supply side (including electricity generation efficiency gains from fuel switching), and 28% will come from energy efficiency improvements on the demand side.

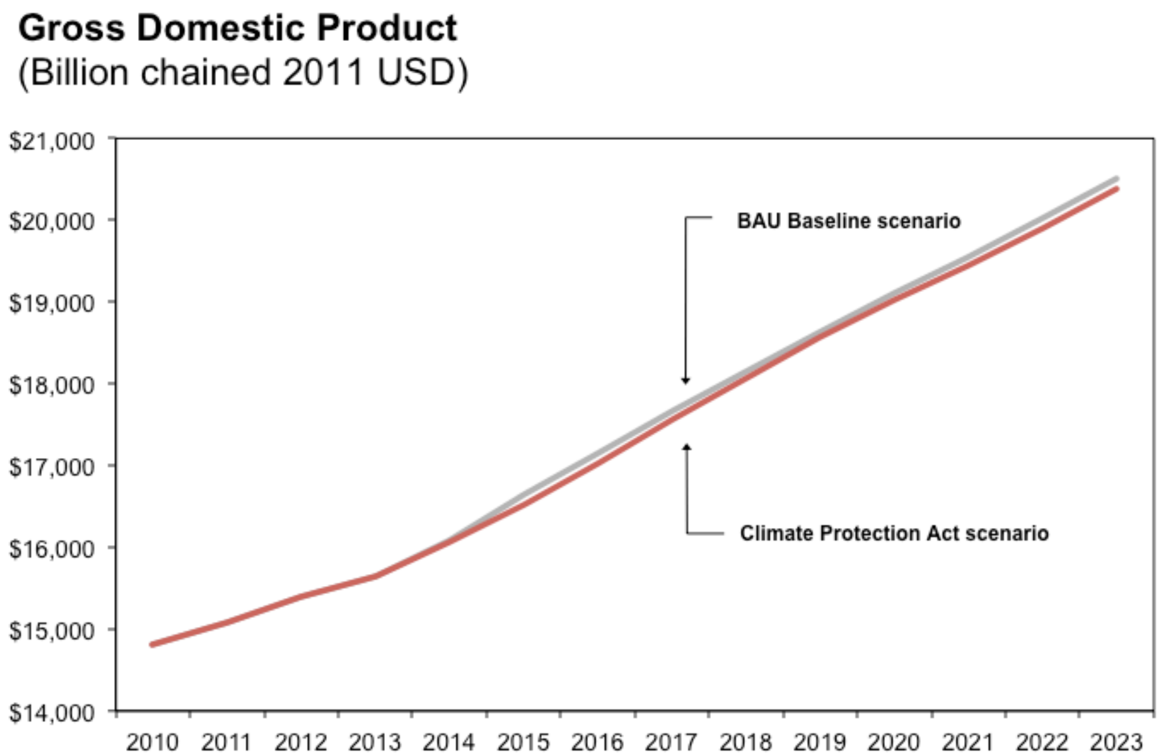

Figure 3. Impacts to U.S. GDP due to implementation of the Climate Protection Act. Our analysis indicates that the Climate Protection Act would have extremely modest impacts on U.S. GDP over the 2014-2023 period. For example, in 2020, estimated baseline GDP of $19,100 billion is reduced by $85 billion (0.44%) under the Climate Protection Act. Note that these impacts do not take account of the GDP impacts of the policy's contribution to deficit reduction or its investments in energy efficiency for trade-exposed industries, low-income household weatherization, job training, and energy research. Similarly, the GDP impacts do not include important co-benefits that would arise under the Climate Protection Act, such as reduced health care expenditures that arise from lower levels of local and regional air pollution.

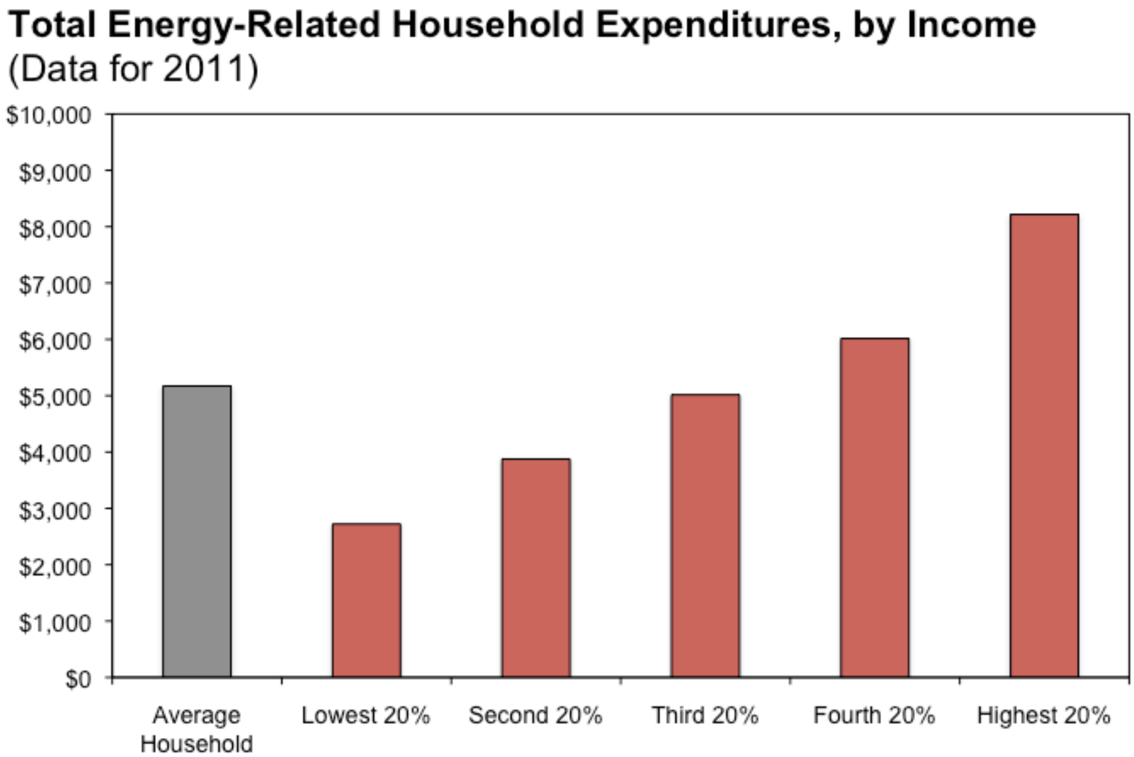

Figure 4. Household expenditures on energy in 2011 by Income Quintile. Here we show the energy-related expenditures tracked in the Bureau of Labor Statistics' 2011 Consumer Expenditure Survey. The amount of money households spend on energy is directly related to household income. This figure shows the breakdown of energy expenditures by income quintiles.

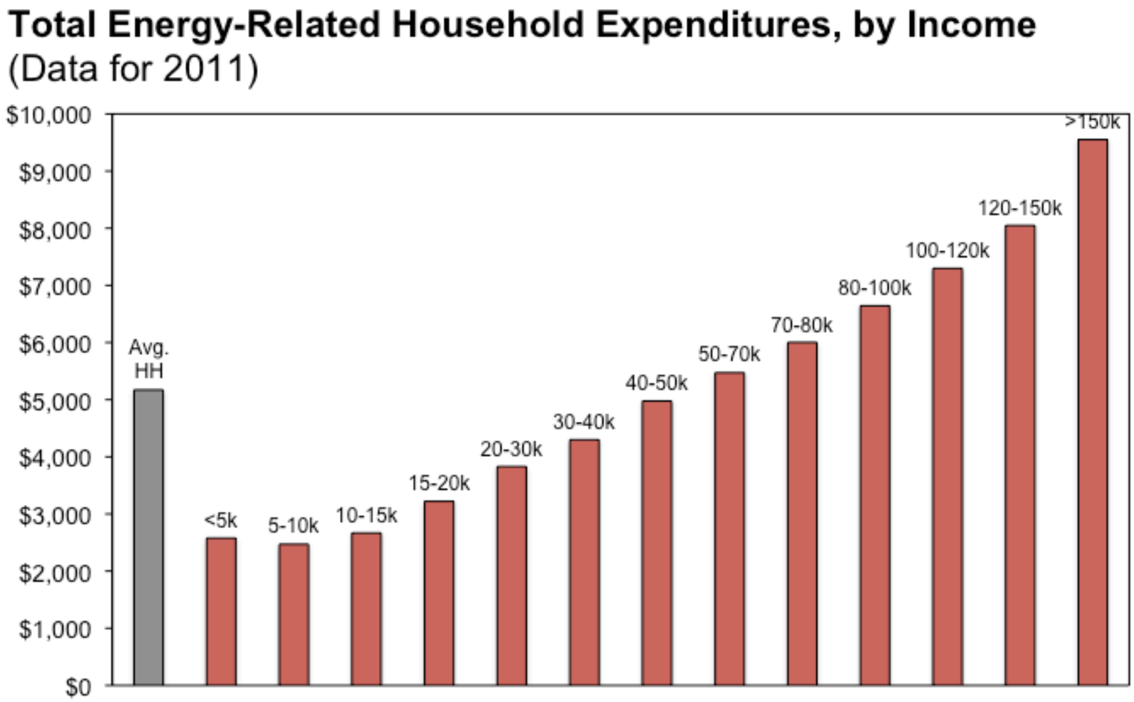

Figure 5. Household expenditures on energy in 2011 by Income Bracket. Here we show the energy-related expenditures tracked in the Bureau of Labor Statistics' 2011 Consumer Expenditure Survey. The amount of money households spend on energy is directly related to household income.

Distribution of households by income group in 2011:

Income	<5k	5-10k	10-15k	15-20k	20-30k	30-40k	40-50k	50-70k	70-80k	80-100k	100-120k	120-150k	>150k
Population	4%	4%	7%	6%	12%	11%	9%	14%	6%	9%	6%	5%	7%

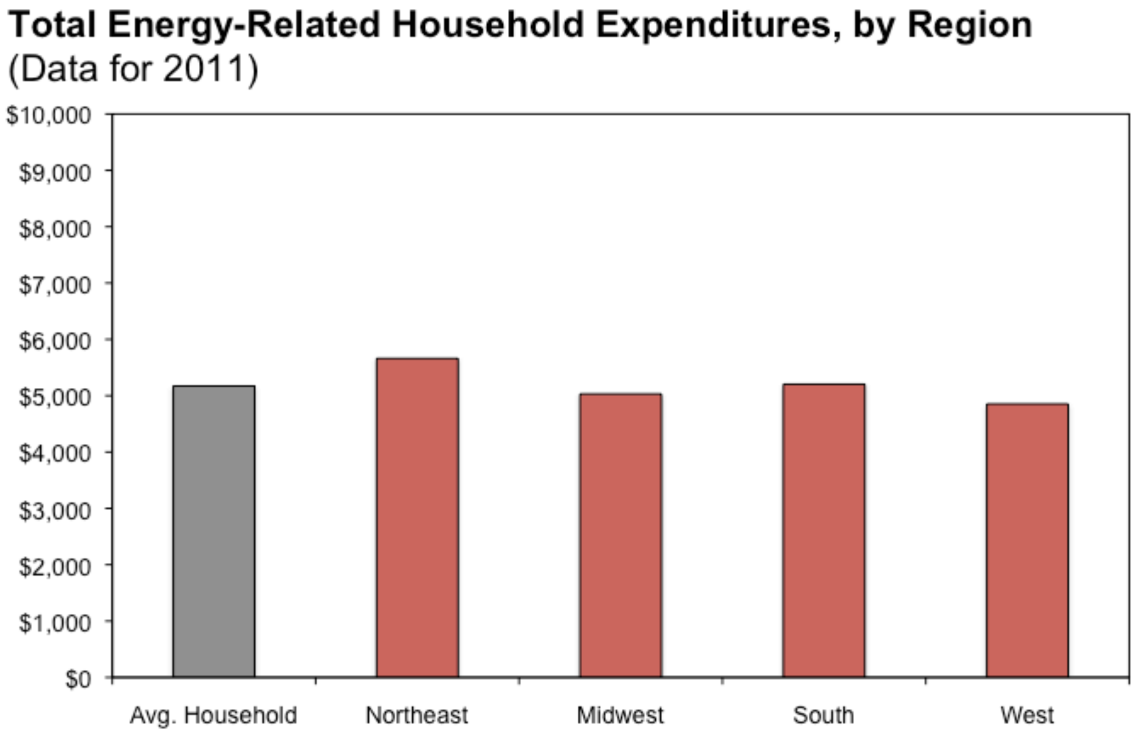

Figure 6. Household expenditures on energy in 2011 by Census Region. Here we show the energy-related expenditures tracked in the Bureau of Labor Statistics' 2011 Consumer Expenditure Survey. The amount of money the average household spends on energy varies by Census Region. The differences shown here are significantly smaller than the variation between expenditures across income levels at the national scale. The variation primarily reflects different fuel mixtures consumed across different regions, the different regional climates, which drive demand for heating and cooling services.

Distribution of households by region in 2011:

Region	Northeast	Midwest	South	West
Population	18%	22%	37%	23%

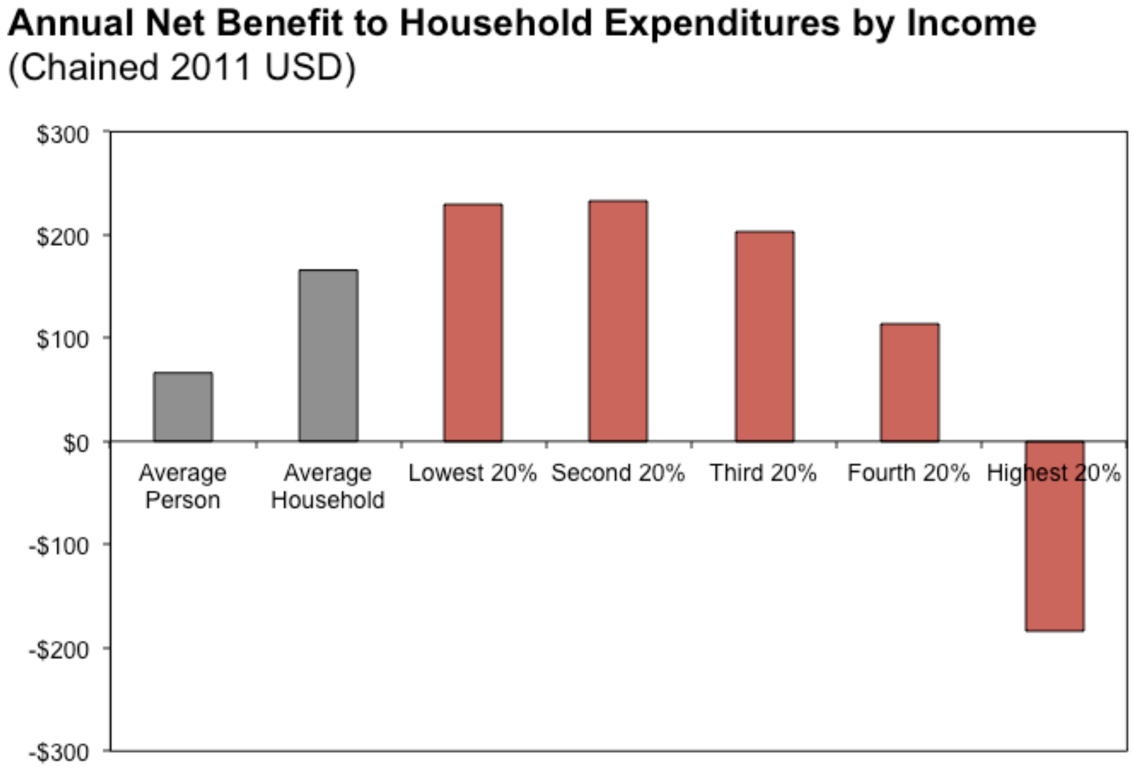

Figure 7. Estimated annual net benefit to U.S. households by income quintile, 2014-2023. Our analysis indicates that higher household energy costs are more than offset by the per capita rebate in the Climate Protection Act for the average U.S. citizen, average U.S. household, and all U.S. households in the lower four income quintiles. Under the Climate Protection Act, the highest 20% of U.S. households by income pay more in increased energy costs than they receive via the per capita rebate. These higher expenditures are mostly due to higher home energy and air travel expenditures. For U.S. households in the lower three income quintiles, the average annual net benefit to energy expenditures from the Climate Protection Act is approximately $200 over the first 10 years of the program.

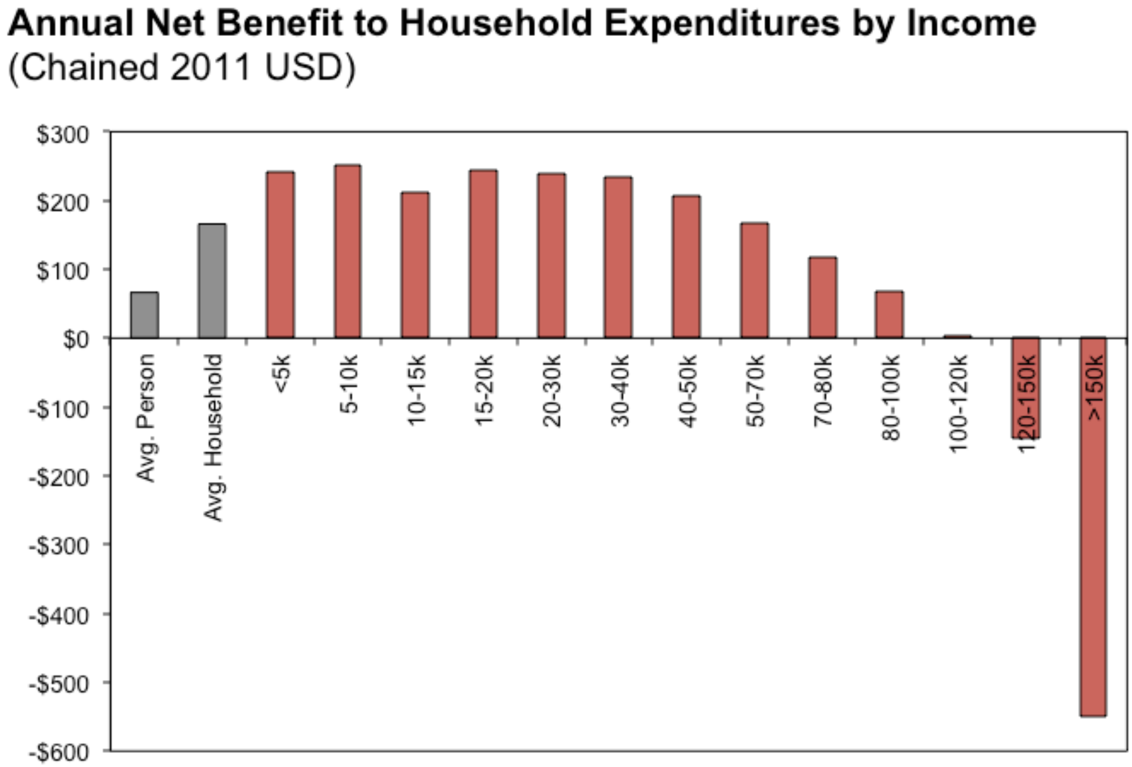

Figure 8. Estimated annual net benefit of the Climate Protection Act to U.S. households by household income, 2014-2023. Our analysis indicates that higher energy costs are more than offset by the per capita rebate in the Climate Protection Act for the average individual, average household, and substantially all households earning less than $100,000/y. For households earning less than $50,000/y, the average annual net benefit to energy-related expenditures over the first 10 years of the program is approximately $200.

Distribution of households by income group in 2011:

Income	<5k	5-10k	10-15k	15-20k	20-30k	30-40k	40-50k	50-70k	70-80k	80-100k	100-120k	120-150k	>150k
Population	4%	4%	7%	6%	12%	11%	9%	14%	6%	9%	6%	5%	7%

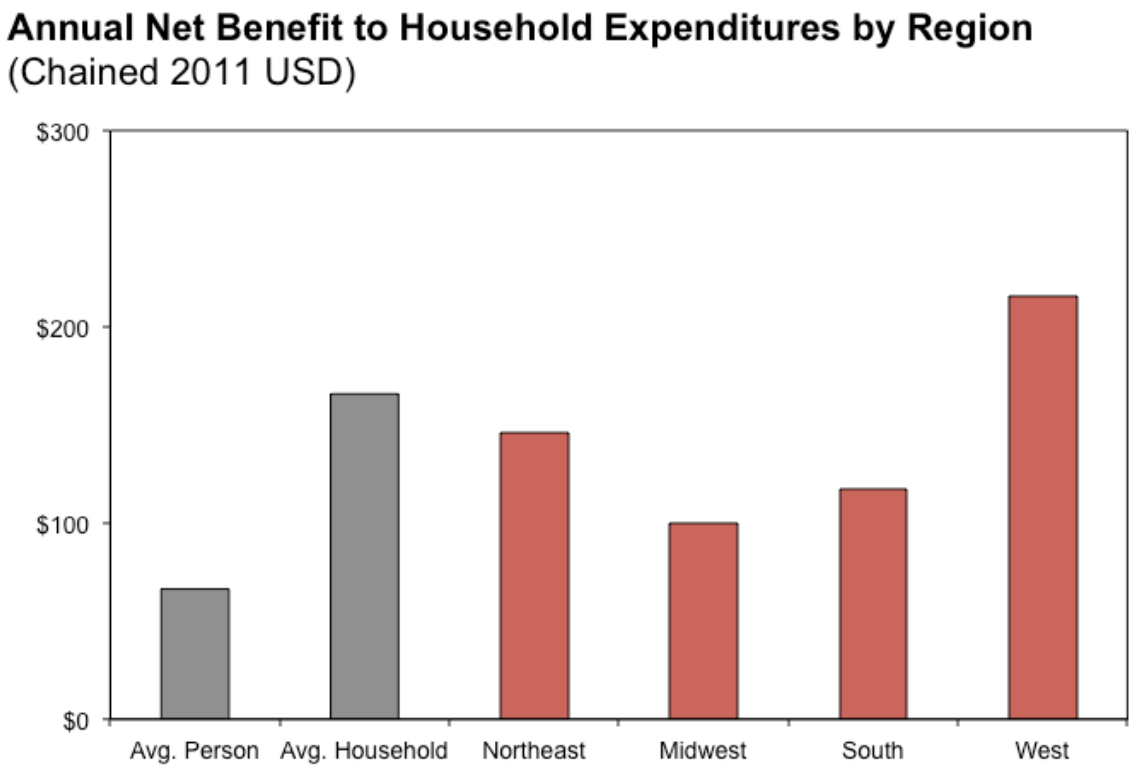

Figure 9. Estimated annual net benefit of the Climate Protection Act to U.S. households by region, 2014-2023. Our analysis indicates that higher energy costs are more than offset by the carbon pollution fee rebate for average households in all U.S. regions. The average annual net benefit to household energy expenditures over the first 10 years of the program ranges between $100 and $220. Regional variation in average household costs arises primarily because of regional differences in the composition of the electric power plant fleet, and in local climate conditions, which drive demand for heating and cooling services in buildings.

Distribution of households by region in 2011:

Region	Northeast	Midwest	South	West
Population	18%	22%	37%	23%

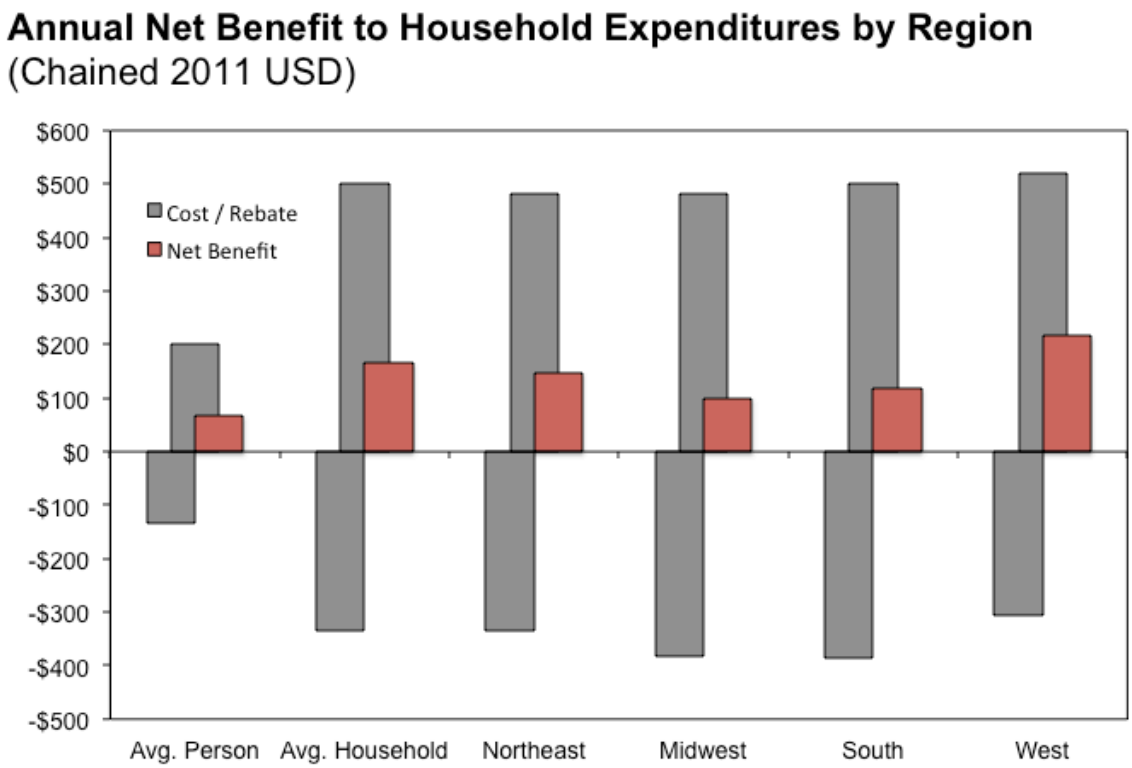

Figure 9. Estimated annual net benefit of the Climate Protection Act to U.S. households by region, 2014-2023. Our analysis indicates that higher energy costs are more than offset by the carbon pollution fee rebate for average households in all U.S. regions. Shown are estimated increases in energy cost (grey; negative), rebate (grey; positive), and net benefit (red). The average annual net benefit to household energy expenditures over the first 10 years of the program varies by region from $100 to $220. Regional variation in average household costs arises primarily because of regional differences in the composition of the electric power plant fleet, and in local climate conditions, which drive demand for heating and cooling services in buildings.

Distribution of households by region in 2011:

Region	Northeast	Midwest	South	West
Population	18%	22%	37%	23%

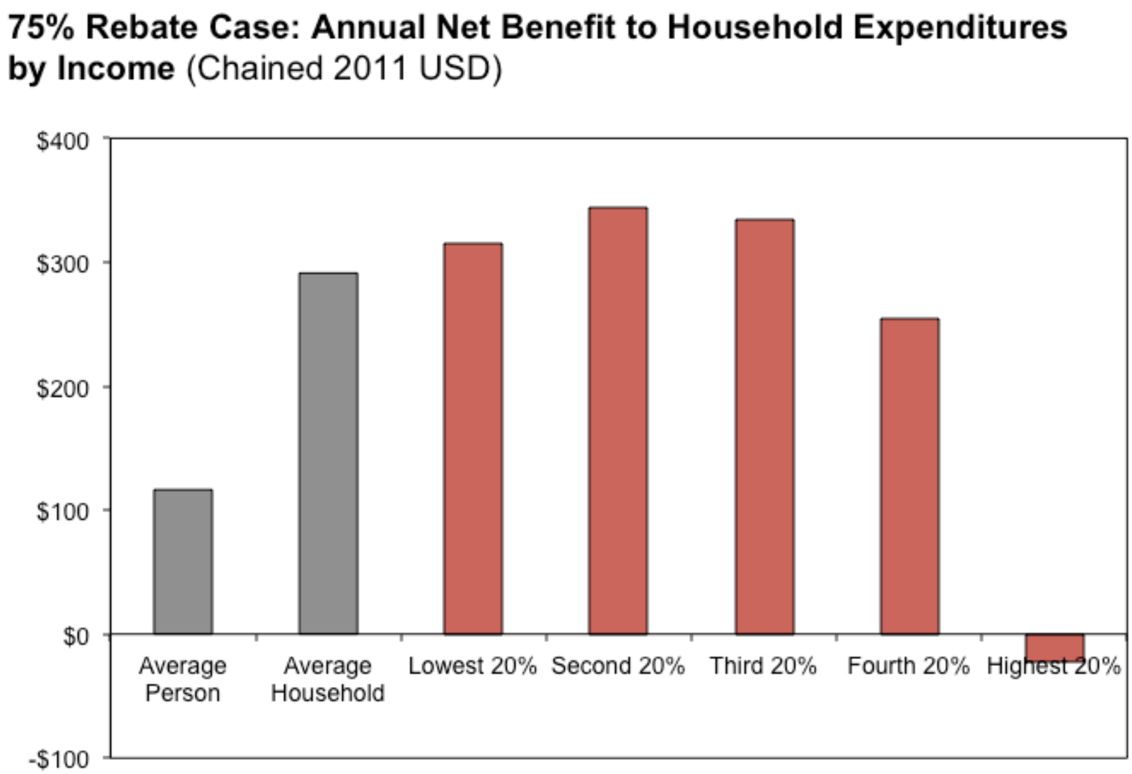

Figure 10. 75% Rebate Case, estimated annual net benefit to U.S. households by income quintile, 2014-2023. Our analysis shows that per capita rebate of the maximum fraction (75%) of the carbon pollution fee allowed by Senate PAYGO rules increases net benefit to energy-related expenditures for the average U.S. citizen, average U.S. household, and substantially all U.S. households in the lower four income quintiles. Under the 75% Rebate Case, the highest 20% by income of U.S. households pay a small amount more in increased energy costs than they receive via the per capita rebate. These higher expenditures are mostly due to higher home energy and air travel expenditures. For 60% of U.S. households, the average annual net benefit is approximately of $330 over the first 10 years of the program. To achieve the higher rebate levels in this scenario, it is necessary to eliminate all of the Climate Protection Act's non-rebate and non-deficit reduction investments in cost mitigation, energy efficiency, job training, energy research, and energy infrastructure.

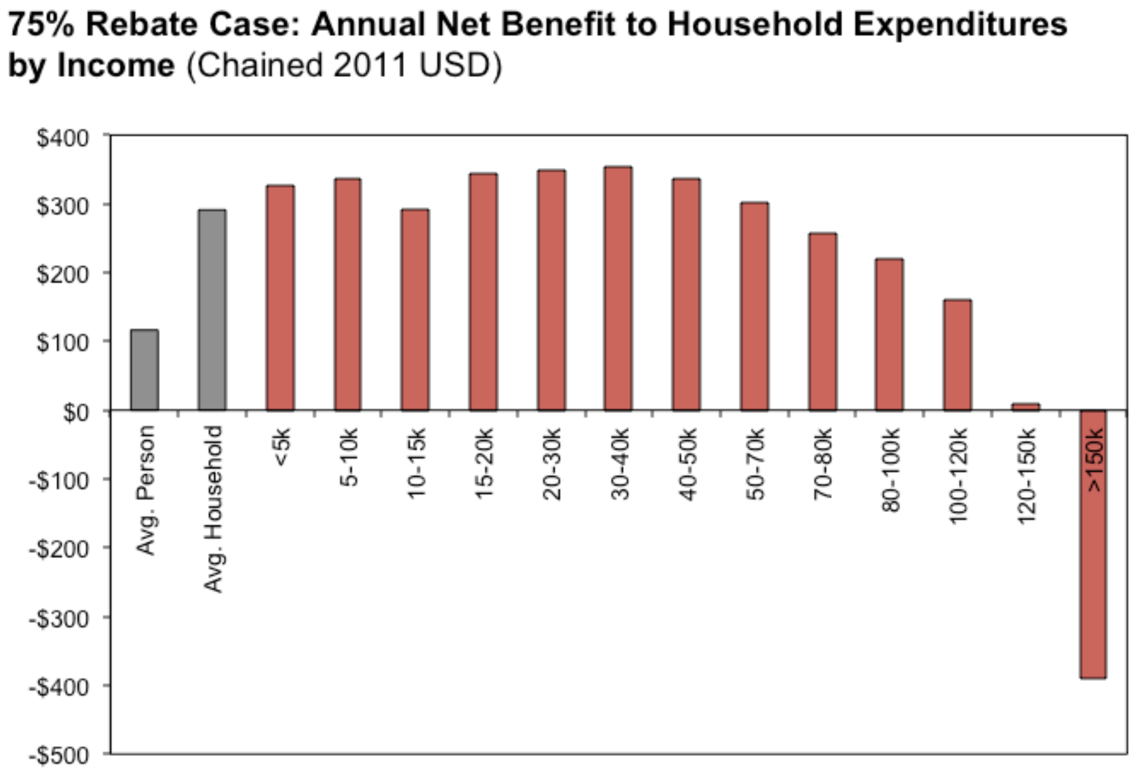

Figure 11. 75% Rebate Case, estimated annual net benefit to U.S. households by household income, 2014-2023. Maximizing the per capita rebate of the carbon pollution fee increases net benefits across all incomes, relative to the provisions in the Climate Protection Act legislation and consistent with Senate PAYGO rules. Under this new policy scenario, net benefits to energy expenditures are positive for the average individual, average household, and all households earning less than $120,000/y. For households earning less than $80,000/y, the average annual benefit over the first 10 years of the program is in excess of $250. Households with incomes in excess of $150,000/y continue to bear significant costs. To achieve the higher rebate levels in this scenario, it is necessary to eliminate all of the Climate Protection Act's non-rebate and non-deficit reduction investments in cost mitigation, energy efficiency, job training, energy research, and energy infrastructure.

Distribution of households by income group in 2011:

Income	<5k	5-10k	10-15k	15-20k	20-30k	30-40k	40-50k	50-70k	70-80k	80-100k	100-120k	120-150k	>150k
Population	4%	4%	7%	6%	12%	11%	9%	14%	6%	9%	6%	5%	7%

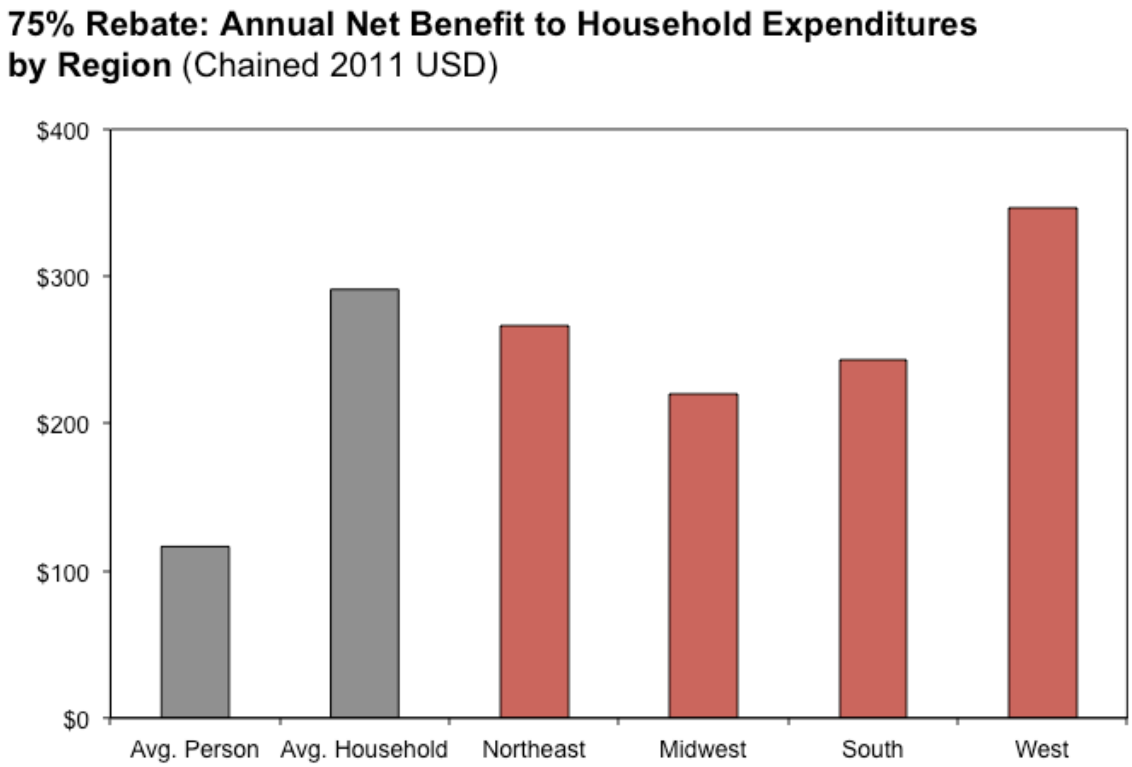

Figure 12. 75% Rebate Case, estimated annual net benefit to U.S. households by region, 2014-2023. Maximizing the per capita rebate of the carbon pollution fee increases net benefits across all regions of the U.S., relative to the provisions of the Climate Protection Act legislation and consistent with Senate PAYGO rules. In the 75% Rebate Case, the average annual net benefit to household energy expenditures varies by region from $220 to $350. Regional variation in net benefit arises primarily because of regional differences in the composition of the electric power plant fleet, and in local climate conditions, which drive demand for heating and cooling services in buildings. To achieve the higher rebate levels in this scenario, it is necessary to eliminate all of the Climate Protection Act's non-rebate and non-deficit reduction investments in cost mitigation, energy efficiency, job training, energy research, and energy infrastructure.

Distribution of households by region in 2011:

Region	Northeast	Midwest	South	West
Population	18%	22%	37%	23%

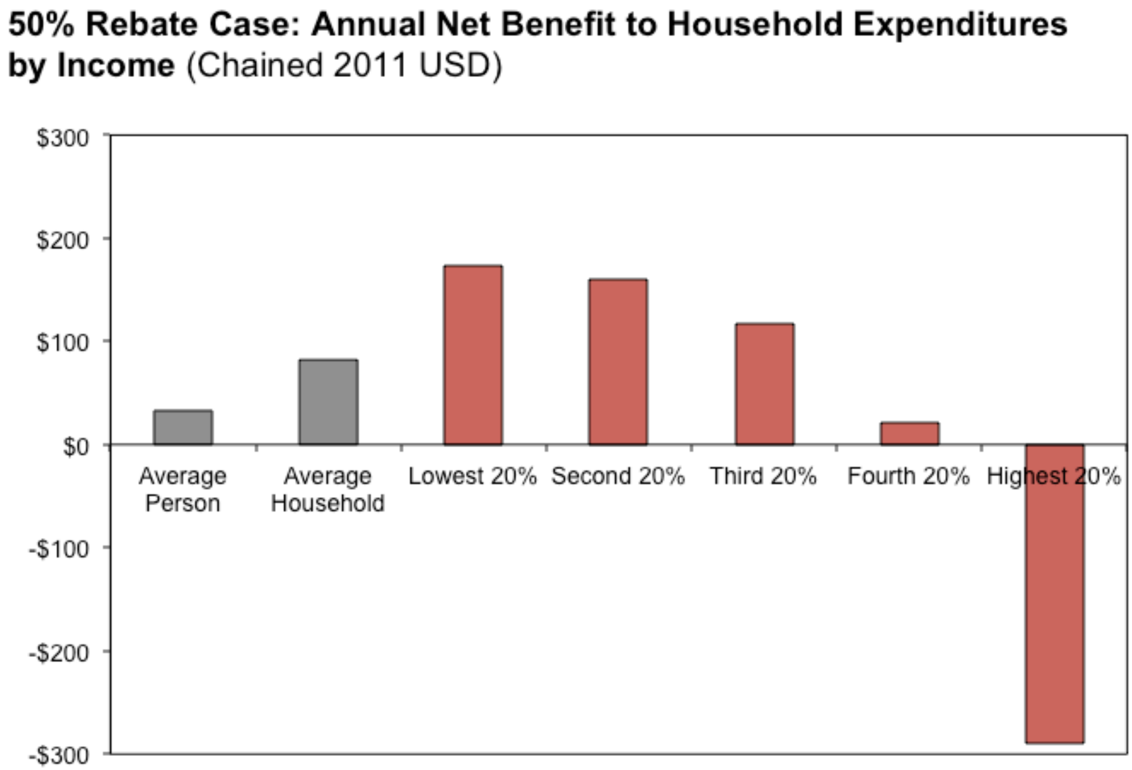

Figure 13. 50% Rebate Case, estimated annual net benefit to U.S. households by income quintile, 2014-2023. A reduction in the per capita rebate from 60 to 50 percent of the carbon pollution fee still produces net benefits to energy expenditures for the average U.S. citizen, average U.S. household, and substantially all U.S. households in the lower four income quintiles. Under the 50% Rebate Case, the highest 20% by income of U.S. households pay more in increased energy costs than they receive via the per capita rebate. These higher expenditures are mostly due to higher home energy and air travel expenditures. For average U.S. households in the lower three income quintiles, the annual net benefit of the 50% Rebate Case exceeds $110 over the first 10 years of the program.

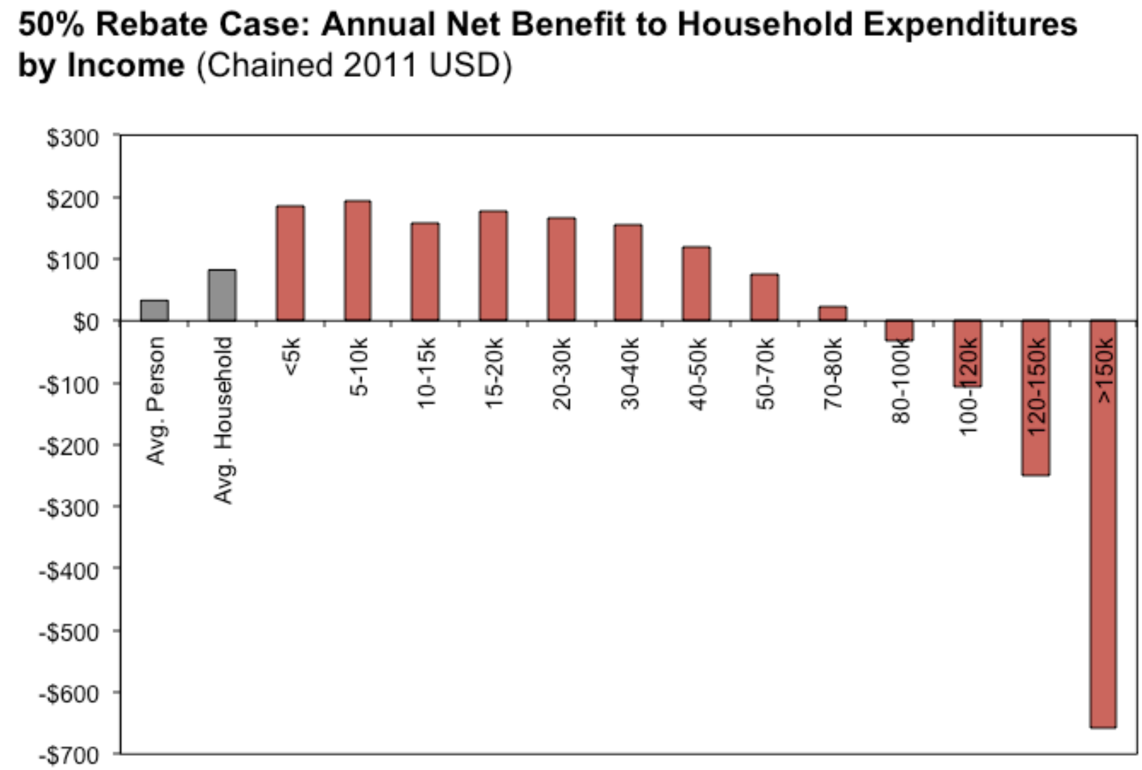

Figure 14. 50% Rebate Case, estimated annual net benefit to U.S. households by household income, 2014-2023. Reducing the per capita rebate from 60% to 50% of carbon pollution fee revenue lowers net benefits across all incomes, relative to the provisions in the Climate Protection Act legislation. Under the 50% Rebate Case, net benefits to household energy expenditures are positive for the average individual, average household, and substantially all households earning less than $80,000/y. For households earning less than $40,000/y, the average annual benefit over the first 10 years of the program is in excess of $150. Households with incomes in excess of $150,000/y continue to bear the highest costs under the 50% Rebate Case.

Distribution of households by income group in 2011:

Income	<5k	5-10k	10-15k	15-20k	20-30k	30-40k	40-50k	50-70k	70-80k	80-100k	100-120k	120-150k	>150k
Population	4%	4%	7%	6%	12%	11%	9%	14%	6%	9%	6%	5%	7%

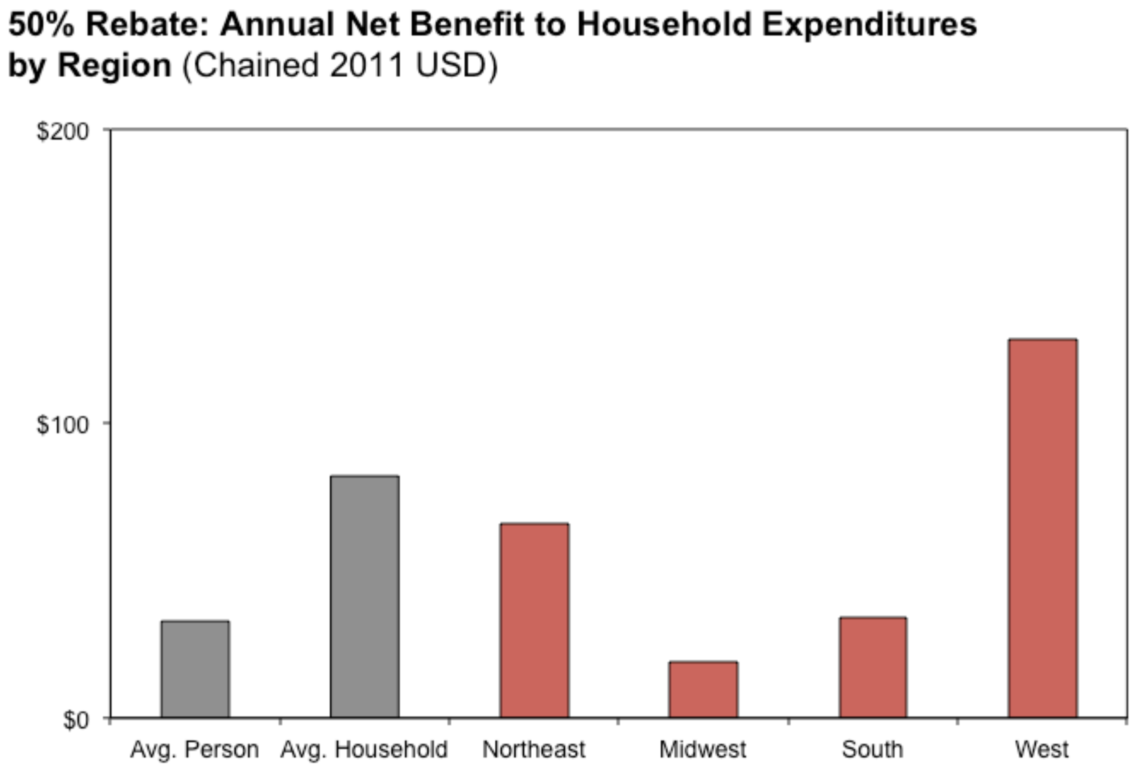

Figure 15. 50% Rebate Case, estimated net annual benefit to U.S. households by region, 2014-2023. Reducing the per capita rebate from 60% to 50% of carbon pollution fee revenue lowers net benefits across all regions, relative to the provisions in the Climate Protection Act legislation. Annual net benefits to household energy expenditures vary from $20 to $130 during the first ten years of the program. Regional variation in average household costs arises primarily because of regional differences in the composition of the electric power plant fleet, and in local climate conditions, which drive demand for heating and cooling services in buildings.

Distribution of households by region in 2011:

Region	Northeast	Midwest	South	West
Population	18%	22%	37%	23%

Appendix: Methodology and Data

Our analysis is based on an independent version of the U.S. Energy Information Administration's National Energy Modeling System, 2013 Early Release Version, which we designate NEMS-Stanford.

Although our analysis does not necessarily correspond to what the official EIA model would produce for the same scenario data, we confirmed that our version of the model accurately reproduces the EIA's published baseline scenario projections. Thus, we believe NEMS-Stanford is a reliable means of assessing what EIA's official copy of NEMS would project for the same scenarios modeled here. Nevertheless, our analysis is independent and should not be confused with official government policy analysis.

We use NEMS-Stanford to directly assess the Climate Protection Act's impacts to greenhouse gas emissions and GDP. However, NEMS tracks only CO_2 emissions from energy use, a subset of the national emissions profile that accounts for approximately 79% of gross and 91% of net greenhouse gas emissions in the United Sates.[10] When we compare the projected greenhouse gas emissions to the U.S. commitment under the Copenhagen Accord, we assume that the percentage reduction required by the overall commitment applies directly to CO_2 emissions from energy use (i.e., that a 17% reduction of total greenhouse gas emissions implies a 17% reduction in CO_2 emissions from energy). We use NEMS-Stanford for CO_2 emissions data and projections from 2010 forward; for 2009 and earlier, we use published EIA data.[11]

For the Climate Protection Act policy scenario, we modeled a starting carbon fee of $20 per metric ton CO_2 in 2014, expressed in nominal terms and increasing at 5.6% per year through 2023. NEMS has several default options for how its macroeconomic calculations treat the use of carbon fee revenue. Unfortunately, none of the default options allow a mixture of deficit reduction, residential rebates, and policy expenditures. We confirmed that the default revenue use options do not materially affect GDP, net greenhouse gas emissions, or residential energy prices; we then selected the default option that recycles all revenue back to households for the purposes of the model's internal macroeconomic analysis.

Using a separate spreadsheet-based model, we analyzed the structure of the proposed policy, with a focus on revenue use. For our main policy scenario, we assumed that 60% of the revenue would be returned to households in the form of a per capita rebate, $205 billion (nominal) would be allocated to policy expenditures, and the remaining $311 billion (nominal) would be used for deficit reduction. We also assumed, conservatively, that these last two revenue uses have zero effect on the economy. If policy programs mitigate the impacts of a carbon fee (especially in non-household sectors), or if these programs decrease energy consumption in any sector, then the actual national GDP impact should be smaller than we project. Similarly, if deficit reduction has beneficial impacts on the cost of debt service or on the interest rate on government debt, then the actual GDP impacts should be smaller than we project.

10 EPA (2012), U.S. Greenhouse Gas Emissions and Sinks: 1990-2010, Table ES-2.

11 EIA (2012), Annual Energy Review 2012, Table 11.1 (CO_2 emissions from energy consumption).

Methods: Distributional Impact Analysis

To assess the impact to households across income groups and location, we coupled the NEMS-Stanford output to the Bureau of Labor Statistics' 2011 Consumer Expenditure Survey, which provides cross-sectional data on household expenditures.[12] We begin with the cross-sectional consumption data for 2011 and apply the expected price increases, demand responses, and rebate levels, all using a consistent methodological approach.[13]

First, we identify all energy-related expenditures in the survey data and match these items to their corresponding variables in NEMS-Stanford. Next, we project the changes to expenditures using model outputs, ensuring that the projected household impacts are driven by the same price and quantity projections assumed in the NEMS framework. To estimate effects across income distributions, we project the changes to prices and demand at the residential sector level, indexing this rate of growth and coupling it to the cross-sectional household data from 2011. We ignore the effect of population growth (which biases estimated household energy consumption upwards) in order to compensate for our inability to estimate the change in income distributions in our projections (an omission that biases estimated household energy consumption downwards).

The correspondence between CES expenditures NEMS-Stanford variables is as follows:

- "Natural gas": Matched to residential natural gas prices and quantities.
- "Electricity": Matched to residential electricity prices and quantities.
- "Fuel oil and other fuels": Matched to the consumption-weighted average of propane, kerosene, and distillate fuel oil prices and quantities in the residential sector.
- "Gasoline and motor oil": Matched to retail gasoline prices and population-weighted shares of national consumption of gasoline for light duty vehicles.
- "Public and other transportation": Matched to retail gasoline prices and population-weighted shares of national consumption for light duty vehicles. This expenditure includes taxis, buses, trains, and air travel; because there is no equivalent category in NEMS, we assumed that gasoline price and quantity changes would reasonably approximate the expected consumer response to the carbon fee policy.

To assess the costs of the policy at the household level, we compare the changes in energy-related expenditures across the policy and baseline scenarios. To assess the benefits, we distribute the appropriate fraction of total carbon fee revenues projected under the policy scenario on a per capita basis. The net benefit to households is the difference between these two calculations. Note that the net benefit does not include impacts to GDP, employment, or any other macroeconomic changes.

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12 We first encountered the idea to use CES data to assess the distributional impacts of climate policy in Gilbert E. Metcalf (2008), Designing a Carbon Tax to Reduce U.S. Greenhouse Gas Emissions. *Review of Environmental Economics and Policy* 3(1): 63-83. More recently, this approach has been used to compare earlier cap-and-trade or cap-and-dividend legislation. *See* Joshua Blonz, Dallas Burtraw, and Margaret A. Walls, How Do the Costs of Climate Policy Affect Households: The Distribution of Impacts by Age, Income, and Region, *Resources for the Future Discussion Paper* 10-55 (2011).

13 The impacts studied here correspond to what economists have called the "direct component" of total impacts. *See* Kevin A. Hassett, Aparna Mathur, and Gilbert E. Metcalf (2009), The Incidence of a U.S. Carbon Tax: A Lifetime and Regional Analysis. *The Energy Journal* 30(2): 155-177.