U.S. Energy Subsidies: Effects on Energy Markets and Carbon Dioxide Emissions

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by

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For additional information on Subsidyscope, please visit www.subsidyscope.org or email us at subsidyscope@pewtrusts.org.

1. Overview

Over the period from 2005 through 2009, the U.S. government spent $96.3 billion on about 60 different subsidies that were directed at increasing energy production, subsidizing energy consumption, or increasing energy efficiency.[1] Although few of these programs were directed at carbon dioxide (CO_2) emissions, they affected U.S. CO_2 emissions through their effects on U.S. energy markets, resulting in some subsidies that increased CO_2 emissions, and others that reduced them.

This paper uses a model of U.S. energy markets to examine the effects of U.S. government subsidies—both spending programs and tax provisions—on energy markets and CO_2 emissions from 2005 through 2009. Over that period, U.S. expenditures shifted from energy subsidies that increased CO_2 emissions toward those reducing CO_2 emissions (Figure 1). In 2005, U.S. government expenditures on subsidies that increased CO_2 emissions were $9.1 billion and expenditures on subsidies that reduced CO_2 emissions were $3.4 billion. By 2009, the respective figures shifted to $15.4 billion for subsidies that increased CO_2 emissions and $18.5 billion for subsidies that reduced CO_2 emissions. Subsidies that increased CO_2 emissions include tax provisions for fossil fuel companies, assistance for low-income housing cooling and heating, and the alcohol fuels excise tax. Subsidies that reduced CO_2 emissions include programs such as the home weatherization program, tax credits for energy efficient home improvements and renewable energy production, and loan guarantees for energy efficient improvements.

[1] All expenditures represent estimated outlays rather than budget authority. All spending data is in 2009 U.S. dollars unless otherwise noted.

As the expenditures shifted, so did the net effect on CO_2 emissions (Figure 2). In 2005, the net effect of U.S. government energy subsidies was to increase U.S. CO_2 emissions by 53.1 million metric tons—about 0.9 percent of the country's energy-related CO_2 emissions that the U.S. Energy Information Administration (EIA) (2010) estimated for that year. In 2009, the net effect of U.S. government subsidies was to reduce U.S. CO_2 emissions by 38.0 million metric tons—about 0.7 percent of the 5.4 billion metric tons of U.S. energy-related CO_2 emissions that the EIA (2010) estimated for that year.[2]

Much of the shift owes to the 2009 stimulus package, which substantially increased the U.S. energy-related subsidies that reduced CO_2 emissions. Our estimates show that had the United States eliminated CO_2 reducing subsidies over the 2005 to 2008 period, U.S. energy-related CO_2 emissions would have been 0.2-0.3 percent higher.[3] In 2009, however, the impact of eliminating these subsidies would have been to increase U.S. energy-related CO_2 emissions by 1.4 percent.

In contrast, U.S. energy-related subsidies that increased CO_2 emissions generally had a diminishing effect from 2005 through 2009. The long-run effect of eliminating these subsidies in 2005 would have been to reduce U.S. energy-related CO_2 emissions by 1.0 percent in 2005. Similar calculations for the subsidies in place in later years yield long-run reductions of 1.3 percent in 2006, 1.2 percent in 2007, 0.5 percent in 2008, and 0.7 percent in 2009.

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[2] Because the reported totals are obtained by combining separate estimates for each subsidy, any reported total should be considered an upper-bound estimate for the combined effects of multiple subsidies. Because the subsidy programs do not overlap by very much, however, the extent of overestimation that results from combining separate estimates should be relatively small.
[3] This estimate is based on a comparison of actual U.S. emissions against a counterfactual that assumes that the market has made a long-run adjustment to the elimination of each subsidy.

If the energy-related subsidies that increased CO_2 emissions had been eliminated, U.S. government expenditures would have been an average of $12 billion less per year and U.S. energy-related CO_2 emissions would have been an average of about 1.0 percent lower over the 2005 through 2009 period. The remainder of the report is organized as follows: Section 2 explains the approach we used to estimate the impact of each subsidy on U.S. energy markets and CO_2 emissions from 2005 through 2009; Section 3 presents our estimates of how each energy subsidy affected CO_2 emissions; Section 4 examines some issues to consider; and Section 5 offers concluding observations.

2. Estimation Approach

This paper develops and uses a model of U.S. energy markets to examine the effects of U.S. government subsidies on energy markets and CO_2 emissions from 2005 through 2009. We identify the U.S. government expenditures on each subsidy for each year. For each subsidy, we start from a baseline that includes the subsidy in place and evaluate what the energy market prices and quantities would have been in the absence of the particular subsidy, using a partial equilibrium approach.[4] From the estimated differences in energy market conditions with and without the subsidy in place, we calculate how each subsidy affects CO_2 emissions through the use of emissions coefficients associated with each fuel or energy source.

To put each subsidy on equal footing, we develop a comprehensive simulation model of U.S. energy markets to evaluate each of the various energy subsidies.[5] The model uses supply and demand relationships to represent end-use consumption of oil, natural gas,

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[4] Partial equilibrium models look at a single market in isolation or at several markets together without the full specification of a closed economic system.
[5] Appendix A describes in more detail the structure of the model we used to evaluate the subsidies.

coal and electricity in four sectors (residential, commercial, industrial and transportation); the primary energy production of a number of different sources of energy; and the transformation of primary energy into electricity. The model primarily represents U.S. energy markets, but it also captures interaction with world energy markets as appropriate.

The model's coverage generally follows the approach taken by the U.S. Energy Information Administration (EIA) in constructing the National Energy Modeling System (NEMS). The model represents the integrated world oil market with limited detail outside the United States. Because natural gas markets are less integrated than other markets on a global basis the model represents interaction with the rest of the world through imports and exports. The limited interaction of the U.S. coal market with the rest of the world also is represented through imports and exports. For electric power, interaction with Canada and Mexico is represented by net imports.

We calibrated the model so that the prevailing U.S. energy market conditions for each year from 2005 through 2009, with all the subsidies in place, are considered business as usual. The effects of each subsidy are quantified through a counterfactual exercise that evaluates how the market would have looked in the absence of the particular subsidy being examined. To evaluate energy markets in two comparative steady states—one with the subsidy always in place and the other as though the subsidy never existed, we took the approach that both the business as usual cases and the counterfactuals represent complete long-run adjustment to two different sets of market conditions. As such, we built the model with long-run elasticities of supply and demand.[6]

[6] To develop these elasticities, we consulted a number of sources including Dahl's (2009, 2010a, 2010b, 2010c, 2010d, 2010e) extensive surveys of international energy demand elasticities. We also developed

2.1 Subsidy Data

For data on government expenditures on the subsidies for 2005 through 2009, we relied primarily on the estimates of tax expenditures included in the Office of Management and Budget (OMB) annual report *Analytical Perspectives, Budget of the United States Government* for the years 2007-2011. Following the approach taken by EIA for its 2008 report, *Federal Financial Interventions and Subsidies in Energy Markets 2007*, we obtained government expenditure data for each year from the *Analytical Perspectives* dated two years later. For example, we obtained government expenditure data for fiscal year 2009 from *Analytical Perspectives* for fiscal year 2011. By following this procedure, we obtained estimated expenditures rather than projections of expenditures. For those few tax expenditures where greater detail was needed than provided in OMB's *Analytical Perspectives*, we relied on estimates made by the Joint Committee on Taxation (JCT). Estimates for direct government spending programs were obtained from the U.S. Department of Energy and the U.S. Department of Agriculture. Estimates of the interest payments made by the Bonneville Power Administration, Southeastern Power Administration, Southwestern Power Administration, Tennessee Valley Authority, and Western Area Power Administration were obtained from various reports produced by these organizations.

2.2 Modeling the Energy Subsidies

For each subsidy, we use the government expenditure data and the market prices and quantities to make appropriate changes to the demand or supply curve(s) affected by

elasticities through the comparison of various scenarios run with NEMS and NEMS-RFF, and used modelers' judgment when necessary.

the subsidy. We then use the simulation model to determine what the energy-market prices and quantities would have been in the absence of the subsidy. Those changes in market quantities are the basis for calculating the changes in CO_2 emissions.

The energy subsidies we evaluate fall into three broad categories: those increasing energy supply, those increasing energy demand, and those promoting energy efficiency. Each of these subsidies can increase or decrease CO_2 emissions. Subsidies for the consumption or production of energy sources with low or no CO_2 emissions can result in an overall reduction in CO_2 emissions, while subsidies for the consumption or production of energy sources with high CO_2 emissions can result in an overall increase in CO_2 emissions.

Subsidies for investment in improved energy efficiency generally are thought to reduce CO_2 emissions. In some cases, however, the improved efficiency creates a sufficient incentive for expansion of the application such that the energy savings is not as big as might be initially expected. For instance, an increase in home energy efficiency may lead people to build bigger homes that partially offset or more than offset the gains in energy efficiency. This phenomenon sometimes is called a "rebound effect."[7] Because we do not use a behavioral model, we cannot take into account the rebound effect; but Haas and Schipper (1998) found that the rebound effect is relatively small.

2.3 Estimating the Impact on CO_2 Emissions

For each subsidy, the estimated change in CO_2 emissions is the result of the total effects of changes throughout the U.S. energy market. We sum the change in emissions across all primary fuels represented in the model. For each primary fuel source, we use CO_2 emissions coefficients to quantify the change in emissions. The coefficients for oil,

[7] See Greening et al. (2000).

natural gas, and coal are from by the U.S. Energy Information Administration. The coefficients for biodiesel and ethanol are calculated as adjustments to the coefficients for diesel and gasoline, respectively—reflecting differences in life-cycle emissions between biodiesel and diesel and between ethanol and gasoline as described in Appendix A.

3. Energy Subsidies and Carbon Dioxide Emissions

We use the model of U.S. energy markets described above to evaluate 48 of 59 energy subsidy programs operated by the federal government from 2005 through 2009. To divide the analysis into digestible pieces, we first consider the 13 most prominent subsidies that reduced CO_2 emissions; then 15 subsidies that had lesser effects in reducing CO_2 emissions; the 11 most prominent subsidies that increased CO_2 emissions; then 9 subsidies that had lesser effects in increasing CO_2 emissions. We also list another 11 subsidies for which government expenditures produced negligible or no effects.[8]

3.1 Energy Subsidies that Most Reduced CO_2 Emissions

The 13 energy subsidies that we estimate reduced CO_2 emissions the most from 2005 through 2009 are:

- low-cost residential weatherization;
- energy efficiency and conservation block grant program;
- U.S. Department of Agriculture (USDA) rural energy for America program;
- Department of Energy (DOE) state energy program;
- special tax rate for nuclear decommissioning reserve funds;
- credit for energy efficiency improvements of existing homes;
- production tax credit, investment tax credit and grants for renewable power generation;
- credit for energy efficient appliances;
- exclusion for utility-sponsored conservation measures;
- biodiesel excise tax and small agri-biodiesel producer tax credits;
- deduction for certain energy-efficient commercial building property;

[8] Appendix B contains a more detailed description of each subsidy and how it was represented in the model.

- energy efficient appliance rebate programs; and
- USDA electric programs.[9]

Except for the biodiesel tax credits, all of these programs promote energy efficiency. Over the five years examined, these 13 programs combined to reduce U.S. CO_2 emissions by about 123.3 million metric tons (Table 2A). The capital investments made through these programs also will pay dividends of additional reductions in CO_2 emissions in the future.

Together, the programs generally led to sharper reductions in CO_2 emissions from 2005 through 2008, but the sharpest reduction came in 2009, when existing programs were expanded and new programs were created to bring the total to 13. In 2005, these subsidies resulted in an estimated 9.4 million metric ton reduction in U.S. CO_2 emissions. By 2008, these subsidies resulted in an estimated 13.9 million metric ton reduction in U.S. CO_2 emissions. In 2009, the subsidies resulted in an estimated 72.7 million metric ton reduction in U.S. CO_2 emissions.

As might be expected, spending on the top 13 subsidies reducing CO_2 emissions increased from 2005 to 2009 (Table 2B). In 2005, overall expenditure on these subsidies was $1.27 billion (in constant 2009 dollars).[10] By 2008, the expenditure increased to $3.79 billion. In 2009, the figure was $16.18 billion dollars.

The extent to which tax expenditures affected CO_2 emissions varied considerably across the 13 subsidy programs (Table 2C).[11] In 2009, for instance, tax expenditures ranged from a low of $18 per metric ton of CO_2 reduced (for the USDA rural energy

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[9] Each of these 13 programs is described in Appendix B, section B.1.
[10] All government expenditure estimates are in constant 2009 dollars.
[11] Tax expenditures are government revenue losses resulting from provisions in the tax code that allow a taxpayer or business to reduce his or her tax burden by taking certain deductions, exemptions, or credits. Tax expenditures have the same effect on the federal budget as government spending and they can have effects on recipients similar to grants or other types of subsidies.

program) to a high of $746 (for the production tax credit, investment tax credit, and grants for renewable energy).[12]

As these programs were added or expanded from 2005 to 2008, the government expenditures generally increased per metric ton of CO_2 emissions reduced, rising from an average of $136 in 2005 to $273 in 2008. For these 13 programs combined, the government expenditure dipped to $222 per metric ton in 2009. The 2009 decrease resulted from the introduction of programs with lower government expenditures per metric ton of CO_2 emissions reduced, the expansion of lower cost programs, and to the growth of existing programs in a way that reduced government expenditure per metric ton of CO_2 emissions reduced.

3.2 Other Energy Subsidies that Reduced CO_2 Emissions

We estimate that another 15 energy subsidies also reduced CO_2 emissions from 2005 through 2009, but were less effective in doing so than the 13 examined in Section 3.1 above. These included:

- credit for investment in clean coal facilities;[13]
- five-year modified accelerated cost recovery system for solar, wind, biomass, and ocean thermal electric power generation;
- credit for the construction of new energy-efficient homes;
- USDA high energy cost grants;
- credit for holding clean renewable energy bonds;
- credit for residential purchases and installation of solar and fuel cells;
- USDA biorefinery assistance loan guarantees;
- DOE residential buildings program;
- DOE loan guarantees for energy efficiency improvements;

[12] To some extent the latter figure is misleading. The estimates of CO_2 emissions reduced through investment programs—such as the production tax credit, investment tax credit, and grants for renewable energy—are only for the year in which the program expenditures were made. These investment programs have a legacy of reducing CO_2 emissions in future years that we did not quantify.

[13] As described in 4.4 below, clean coal facilities produce more electric power for a given amount of coal than the conventional coal facilities. As a result, the subsidy reduces coal consumption and CO_2 emissions.

- DOE subsidies in support of the commercial buildings initiative;
- federal interest rate support for public utilities for electric power generation transmission and distribution;
- USDA renewable energy program;
- USDA repowering assistance payments;
- deferral of gain from dispositions of transmission property to implement Federal Energy Regulatory Commission (FERC) restructuring policy; and
- renewable energy production incentive.[14]

These programs promote energy efficiency or the development of energy sources with lower CO_2 emissions than the energy sources they displace. Over the five years examined these 15 programs reduced U.S. CO_2 emissions by about 4.1 million metric tons (Table 3A).

Combined, the 15 programs showed increasing reductions in CO_2 emissions from 2005 through 2008, but the sharpest reductions came in 2009, as existing programs were expanded and new programs were created. In 2005, these subsidies resulted in an estimated 159,000 metric ton reduction in U.S. CO_2 emissions. By 2008, these subsidies resulted in an estimated 765,000 metric ton reduction in U.S. CO_2 emissions. In 2009, these 15 subsidies resulted in an estimated 2.4 million metric ton reduction in U.S. CO_2 emissions.

Overall spending on these 15 subsidies remained fairly stable from 2005 through 2009 (Table 3B). In 2005, overall expenditure on these subsidies was $2.1 billion. By 2008, the expenditure fell to $1.7 billion. In 2009, however, the figure rebounded to $2.3 billion dollars.

Although the total spending on these 15 programs was less than the cost of the 13 programs that led to a greater reduction in CO_2 emissions, they generally have higher government expenditures per metric ton of CO_2 emissions reduced than the first 13 we examined (Table 3C). The estimated effect also varies considerably across the programs.

[14] Each of these 15 programs is described in Appendix B, Section B.2.

In 2009, the low was $137 per metric ton of CO_2 reduced (for the credit for construction of new energy-efficient homes and Department of Energy residential building subsidies) and the high was $71,035 (for the federal electricity interest rate support for public utilities).

In 2005, the combined government expenditure on the five active programs was $13,300 per metric ton of CO_2 emissions reduced. The figure fell to $2,200 per metric ton in 2008, and declined further to less than $1,000 per metric ton in 2009. The 2008 and 2009 reductions were owed mostly to the introduction of programs with lower government expenditures per metric ton of CO_2 emissions reduced.

3.3 Energy Subsidies that Most Increased CO_2 Emissions

The 11 energy subsidies that we estimated most increased CO_2 emissions from 2005 through 2009 are:

- alternative fuel production credit;
- alcohol fuels excise tax and credit;
- USDA corn payments attributable to ethanol;
- expensing of exploration and development costs;
- low-income home energy assistance program;
- excess percentage over cost depletion;
- capital gains treatment of royalties in coal;
- exclusion of special benefits for disabled coal miners;
- special rules for refund of the coal excise tax;
- 84-month amortization of pollution control equipment; and
- temporary 50 percent expensing for equipment used in the refining of liquid fuels.[15]

Over the five years examined these 11 programs increased U.S. CO_2 emissions by about 276.3 million metric tons (Table 4A).

Together these programs had their biggest impact from 2005 to 2007—generating estimated CO_2 emissions of 61.8 million metric tons in 2005, 79.0 million metric tons in

[15] Each of these 11 programs is described in Appendix B, section B.3.

2006, and 71.9 million metric tons in 2007. In 2008, however, spending on the alternative fuel production credit (which is primarily used for refined coal) was sharply reduced and the CO_2 emissions generated by the top 11 programs fell to an estimated 26.8 million metric tons. In 2009, most of the other programs saw increased expenditures, and the estimated CO_2 emissions generated by these programs rebounded to 36.8 million metric tons.

Overall spending on these 11 subsidies remained fairly stable over the five-year period from 2005 to 2009 (Table 4B). In 2005, these subsidies accounted for $8.63 billion in government expenditures. The spending increased to $12.28 billion in 2006 and to $12.77 billion in 2009.

Government expenditure per metric ton gain in CO_2 emissions varied considerably across the programs (Table 4C). In 2009, for instance, it ranged from a low of $73 per metric ton of CO_2 increased (for the alternative fuel production credit) to a much higher $580 (for temporary expensing of equipment used in the refining of liquid fuels).

From 2005 to 2008, the government expenditure per metric ton of CO_2 emissions increased from an average of $140 in 2005 to $407 in 2008. One of the big contributors to this change was the shrinkage of the alternative fuel production credit. In 2009, however, government expenditures per metric ton gain in CO_2 emissions fell to $347, mostly as the result of an expansion of programs with lower government expenditures per metric ton of CO_2 emissions increased.

3.4 Other Energy Subsidies that Increased CO_2 Emissions

We estimate that another 9 energy subsidies also increased CO_2 emissions from 2005 to 2009, but had less effect than the 11 examined in Section 3.3 above. These include:

- enhanced oil recovery credit;
- partial expensing for advanced mine safety equipment;
- black liquor;
- the treatment of natural gas distribution pipelines as a property with a 15-year lifespan;
- exception from passive loss limitation for working interests in oil and gas properties;
- amortization of all geological and geophysical expenditures over two years;
- alternative fuel excise tax credit;
- pass through of credits for low sulfur diesel to cooperative owners; and
- expensing of capital costs for compliance with Environmental Protection Agency (EPA) sulfur regulations.[16]

Over the five years examined these nine programs increased U.S. CO_2 emissions by about 2.3 million metric tons (Table 5A).

Only one of these programs existed for all five years examined. Hence, the estimated effect on CO_2 emissions does not show much consistency over time. Combined, the programs generated estimated increases in CO_2 emissions of 848,000 metric tons in 2005, only 81,000 metric tons in 2006, 423,000 metric tons in 2007, 451,000 metric tons in 2008, and 464,000 metric tons in 2009.

The combined expenditure on these programs also varied over time (Table 5B). Combined expenditures were $428 million in 2005, $74 million in 2006, $333 million in 2007, and $334 million in 2008. Combined expenditures were $2.6 billion in 2009 as producers of black liquor (a by-product of the paper-making process) took advantage of the subsidy for cellulosic alcohol fuels.

Under the alternative fuel excise tax credit, the government obtained a small amount of revenue in 2009. For that year, we estimate the program reduced CO_2 emissions.

[16] Each of these nine programs is described in Appendix B, section B.4.

Because the total spending on these nine programs was greater than the 11 programs that had a greater impact on CO_2 emissions, these nine programs generally have higher government expenditures per metric ton of CO_2 emissions increased than the 11 most prominent programs (Table 5C). In 2009, the estimated effect also varied considerably from $508 per metric ton of CO_2 increased (for the expensing of capital costs with respect to complying with EPA sulfur regulations) to a much higher $8,857 per metric ton (for black liquor).

The government expenditure per metric ton of CO_2 emissions increased shifted with the programs. For these nine programs, government expenditure per metric ton of CO_2 emissions increased was $505 in 2005, $915 in 2006, $787 in 2007, and $740 in 2008. The subsidy for black liquor had a large effect in 2009, boosting the government expenditure per metric ton of CO_2 emissions increased to $5,610.

3.5 Energy Subsidies Not Evaluated

The U.S. government provides another 10 energy subsidies that we did not formally evaluate (Table 6). These subsidies include:

- the exclusion from income taxation of interest from bonds for various energy facilities;
- the accelerated depreciation of electricity transmission facilities for income tax purposes;
- a five-year carryover for net operating losses for electric transmission equipment;
- smart grid implementation program;
- preferential tax treatment of the income of certain electric cooperatives;
- DOE state energy activities;
- tax credit for production from advanced nuclear power facilities;
- expensing of tertiary injectants used in mining;
- preferential tax treatment of natural gas gathering lines; and

- qualified energy conservation bonds.[17]

Expenditures on all these programs combined amounted to less than 1 percent of the expenditure on total energy subsidies. In some cases, a preliminary analysis revealed that the programs would not affect energy use or CO_2 emissions. In other cases, the small scale of the expenditures produced effects that were smaller than the model could reliably estimate.

4. Additional Issues to Consider

When considering our estimates, several issues should be taken into account. One is the use of long-run analysis for newly introduced subsidies for which long-run elasticities may not be known. Another is the potential bias in summing up individual estimates, as well as the overall sensitivity of the estimates to the assumed elasticities. Additionally, there may be sensitivity of the energy efficiency results to the modeling assumptions. Further issues include the estimated effects of subsidies for clean coal and biofuels on CO_2 emissions.

4.1 Use of Long-Run Analysis

For long-existing subsidies, the approach of using long-run analysis has the advantage of helping to correct for the mismatch between the timing of the subsidies and their effects on U.S. energy markets. For instance, oil and gas subsidies can affect production and CO_2 emissions many years later. Taking a steady-state approach, we

[17] Also excluded from the analysis are subsidies that do not primarily affect energy, such as the credit for clean fuel vehicles and properties, are not specific to energy, such as the foreign tax credit, or yielded no government expenditures from 2005 to 2009, such as provision of the low oil spill liability fund (Table 7). In our analysis we do not consider these subsidies, although they may affect energy markets.

examine the general effect of energy subsidy programs on CO_2 emissions over time—although the effects may be realized over a number of years.[18]

Our approach of using long-run elasticities in estimating the market responses raises a potential issue for relatively new subsidies—particularly the energy efficiency subsidies that were included in the 2009 economic stimulus package. Can the estimated responses made with long-run elasticities represent relatively new programs? Recognizing that the initial shift in demand or supply does not depend on the elasticities and that we are interested in CO_2 emissions, which are related to the quantities of energy consumption, the answer is a qualified 'yes.' For each energy source, the quantity estimates made with long-run elasticities will be substantially similar to those made with short-run elasticites if the ratio of the short-run supply elasticity to the long-run supply elasticity is substantially similar to the ratio of the short-run demand elasticity to the long-run demand elasticity. Such conditions generally hold for energy markets.

4.2 Summing Individual Estimates

The effects of each subsidy are evaluated by using the model to find the energy market conditions that would have prevailed had that subsidy not existed. The counterfactual for each subsidy is evaluated independently. As such, the reported totals for combinations of subsidies should be regarded as upper-bound estimates. Because the subsidy programs do not overlap by very much, however, the reported totals are likely to be fairly close to estimates obtained by combining individual subsidies.

4.3 Sensitivity of the Results to Model Elasticities

[18] A steady-state approach refers to an economy that can be evaluated with static analysis.

The estimated results are dependent on the elasticities assumed for the analysis.[19] Had we modeled the supply of those energy sources that reduce CO_2 emissions as more elastic, the estimated impact of the subsidies in reducing CO_2 emissions would show a greater impact, and the dollar expenditure per ton of CO_2 emissions reduced would be lower. Had we modeled the supply for those energy sources that increase CO_2 emissions as more elastic, the estimated impact of the subsidies in increasing CO_2 emissions would show a greater impact, and the dollar expenditure per ton of CO_2 emissions increased would be lower.

Moreover, had we modeled energy demand as more elastic, the impact of both the subsidies that reduce and increase CO_2 emissions would show greater impact. For subsidies reducing CO_2 emissions, the estimated reduction would be greater, and the dollar expenditure per ton of CO_2 emissions reduced would have been estimated at a lower value. For subsidies increasing CO_2 emissions, the estimated increases would be greater, and the dollar expenditure per ton of CO_2 emissions increased would have been estimated at a lower value.

4.4 Sensitivity of the Energy-Efficiency Assumptions

Estimates of the potential gains in energy efficiency found in studies such as McKinsey (2009) and the actual response of market participants seem to be quite divergent. If investments in energy efficiency are seen as an annuity, consumers seem to demand extremely short payback periods. The difference between the potential and the practice has been variously attributed to market barriers, uncertainty, consumer behavior, and hidden lifestyle changes. In addition, a substantial portion of government expenditure

[19] The scope of the project prevented us from undertaking a formal sensitivity analysis of the elasticities.

on subsidies for energy efficiency goes to individuals who would have made the investments anyway.

Because we are interested in capturing the actual response of consumers to subsidies for energy efficiency rather than capturing the engineering potential, we consulted a number of modelers participating in a recent Energy Modeling Forum study on energy efficiency. After doing so, we made several adjustments in treating energy efficiency subsidies as annuities.[20] First, we assume that half the government spending has no effect in reducing energy consumption because that number of the end users would have undertaken the activity anyway. Second, we reflect the idea that consumers who actually make the investments demand short payback periods by calculating the annuity with a discount rate of 18 percent and a projected lifetime of 20 years for buildings and 15 years for appliances.

The estimated effects of the energy-efficiency subsidies, including the DOE Weatherization Assistance Program, are sensitive to the assumptions we made about how market participants likely responded to them. In particular, assuming that only 45 percent of the government spending has no effect on consumer behavior, rather than 50 percent, would increase the effectiveness of the energy-efficiency programs in reducing CO_2 emissions by almost 10 percent. In contrast, using a higher discount rate, such as 36 percent, rather than 18 percent, would increase the required energy savings needed to justify the investment, which would imply a greater energy savings and a greater reduction in CO_2 emissions than we estimate.

[20] See Energy Modeling Forum (2011) and McKibbin et al. (2010).

We also assume no rebound effect results from government subsidies for energy efficiency. Were the actual rebound effect about 15 to 25 percent, the energy savings from energy efficiency subsidies would be reduced by a little less than 15 to 25 percent. The reductions in CO_2 emissions would be correspondingly smaller.

4.4 Emissions Effects of Subsidies for Clean Coal

We find that the subsidies for clean-coal facilities for generating electric power reduce CO_2 emissions. These findings derive largely from the fact that clean coal facilities produce more electricity from a given amount of coal. With the subsidy in place, our model shows the more efficient clean coal facilities displacing conventional coal facilities. Although the subsidy lowers the cost of coal-fired electric power generation, which encourages an increase in overall end-use energy consumption, the substitution of higher efficiency facilities actually reduces the amount of coal used to produce electric power and the consequent CO_2 emissions.

4.5 Biofuel Subsidies: Increased or Reduced Emissions?

The Alcohol Excise Tax Credit and USDA corn payments attributed to ethanol provide the largest portion of total biofuel expenditures. At $3.5 billion (2009 dollars), U.S. government expenditures on biofuels represented about 92 percent of all federal subsidies for renewable energy sources in 2005. By 2009, federal expenditures on biofuels increased to $7.7 billion but only accounted for about 76 percent of the federal subsidies for renewable energy, as legislation created new subsidies for other renewable sources of energy.

Perhaps surprisingly, we find that the alcohol subsidies increase CO_2 emissions—even though we assume corn-based ethanol yields somewhat lower life-cycle CO_2

emissions than conventional diesel and gasoline. The increased supply of ethanol brought about by the subsidies has two effects. One is to substitute the ethanol for petroleum products. The other is to lower the overall market price of liquid fuels, which increases consumption. We find that the second effect is sufficiently strong to increase CO_2 emissions—even though ethanol is thought to have slightly lower life-cycle CO_2 emissions rate than gasoline.[21]

On the other hand, the subsidies for biodiesel reduce CO_2 emissions. The increase in biodiesel supply does yield increased U.S. consumption of diesel fuels. Nonetheless, the lifecycle emissions of biodiesel are sufficiently low relative to that for conventional diesel such that the substitution effect dominates, and overall CO_2 emissions are reduced.

5. Conclusion

Over the five-year period from 2005 through 2009, the U.S. government spent $96.3 billion on about 60 different energy subsidy programs. Although few of these programs were directed specifically at increasing or decreasing CO_2 emissions, the programs affected emissions through their effects on energy markets. We examined 48 of these subsidy programs—accounting for more than 99 percent of the total expenditure on energy-subsidy programs and all of the programs that had a significant effect on CO_2 emissions.

We find that from 2005 through 2008, U.S. energy-related subsidies had the net effect of increasing CO_2 emissions by an average of 47.3 million metric tons per year. By 2009, however, U.S. government spending shifted toward subsidies that reduced CO_2 emissions. In 2009, the Obama administration's stimulus package created a shift toward

[21] Modeling gasoline demand as somewhat more inelastic did not alter this finding. Given the only slightly lower lifecycle CO_2 emissions associated with ethanol as opposed to gasoline, demand would have to be extremely inelastic for the substitution effect to dominate.

subsidies that decreased CO_2 emissions, with a net effect of reducing CO_2 emissions by about 37.9 million metric tons in that year.

Of the programs that reduce CO_2 emissions, the Rural Energy for America Program had a particularly strong effect per dollar of U.S. government expenditure. A number of energy-efficiency programs also had strong effects per dollar of U.S. government expenditure. In contrast, subsidies for nuclear electric power generation, renewable electric power generation, general electric power generation, and biodiesel had less effect per dollar of U.S. government expenditure.

Generally, the subsidies that most increased CO_2 emissions per U.S. government dollar spent include those for coal, oil, and natural gas. In particular, the subsidies for coal—such as the alternative fuel production credit, preferential capital gains treatment of coal royalties, exclusion of special benefits for disabled coal miners, 84-month amortization of pollution-control equipment, special rules for refund of the coal excise tax, and partial expensing for advanced mine safety equipment yielded big increases in CO_2 emissions per dollar of government expenditure.

If the goal is to reduce CO_2 emissions we find that the least costly approach for the government is eliminating or substantially reducing subsidies that increase CO_2 emissions vs. subsidies to reduce CO_2 emissions. Subsidies cost taxpayers money, distort energy markets, and give some companies and some forms of energy an artificial advantage at the expense of others.[22] If the subsidies that increased CO_2 emissions were to be eliminated, U.S. government expenditures would have been, on average, $12 billion less per year and

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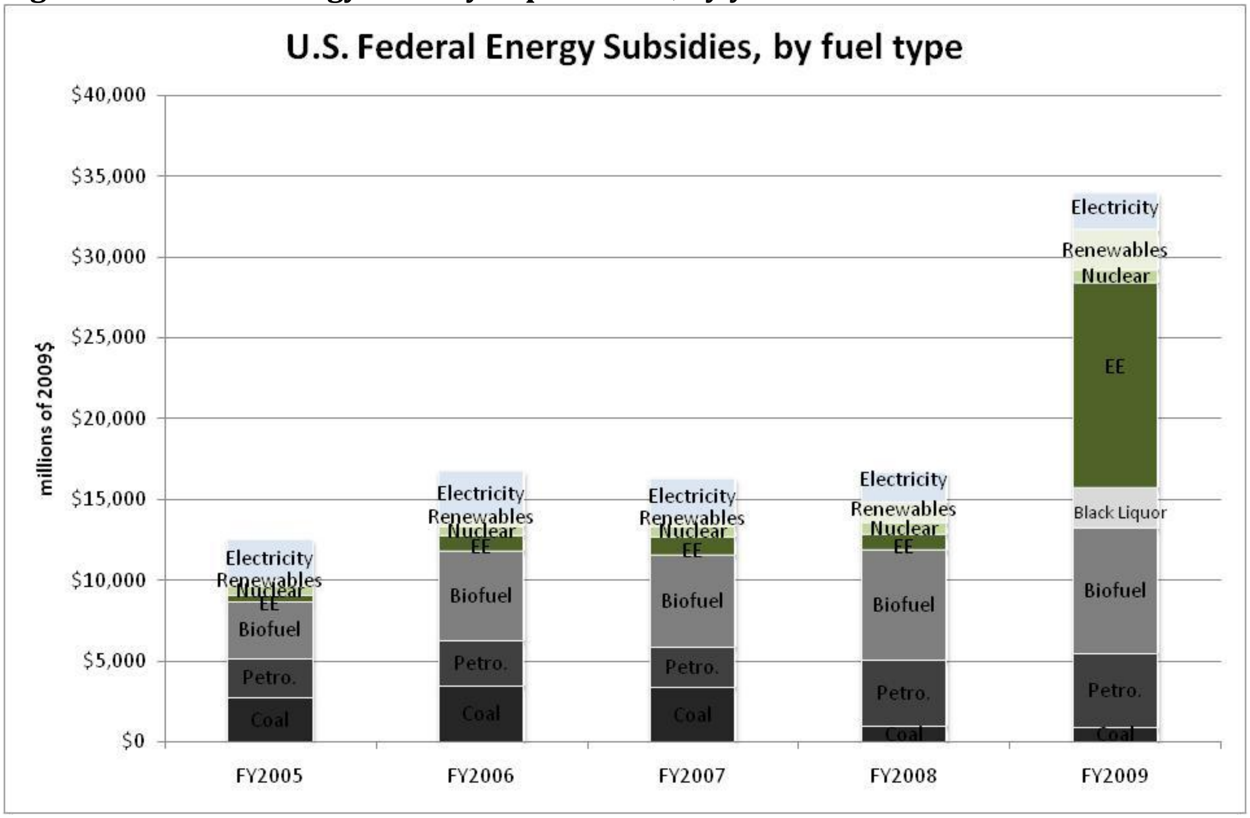
[22] See Allaire and Brown (2009).

U.S. energy-related CO_2 emissions would have been, on average, about 1.0 percent lower over the 2005 through 2009 period.[23]

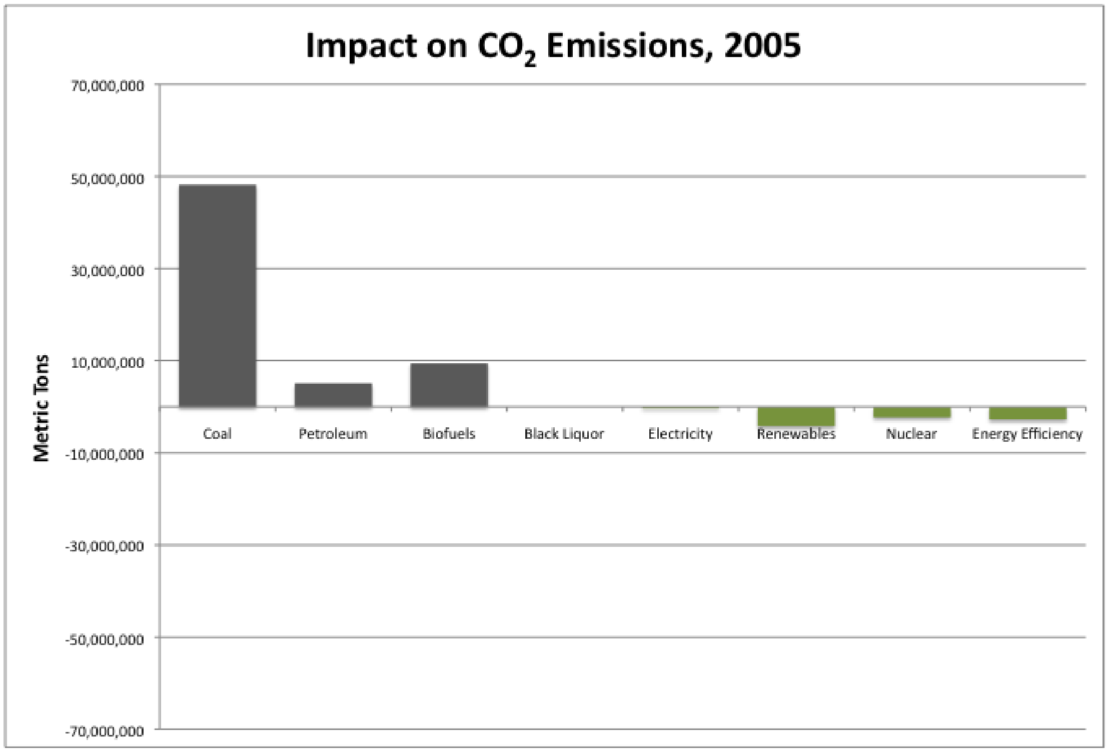
Figure 1. Federal Energy Subsidy Expenditure, by year and fuel



Note: Subsidies that increase CO_2 emissions are shown in shades of gray. Subsidies that decrease CO_2 emissions are shown in green. Subsidies with mixed effects are shown in blue.

[23] See EIA (2010) for an estimate of U.S. energy-related CO_2 emissions from 2005-2009.

Figure 2. Effects of Subsidies on CO_2 Emissions



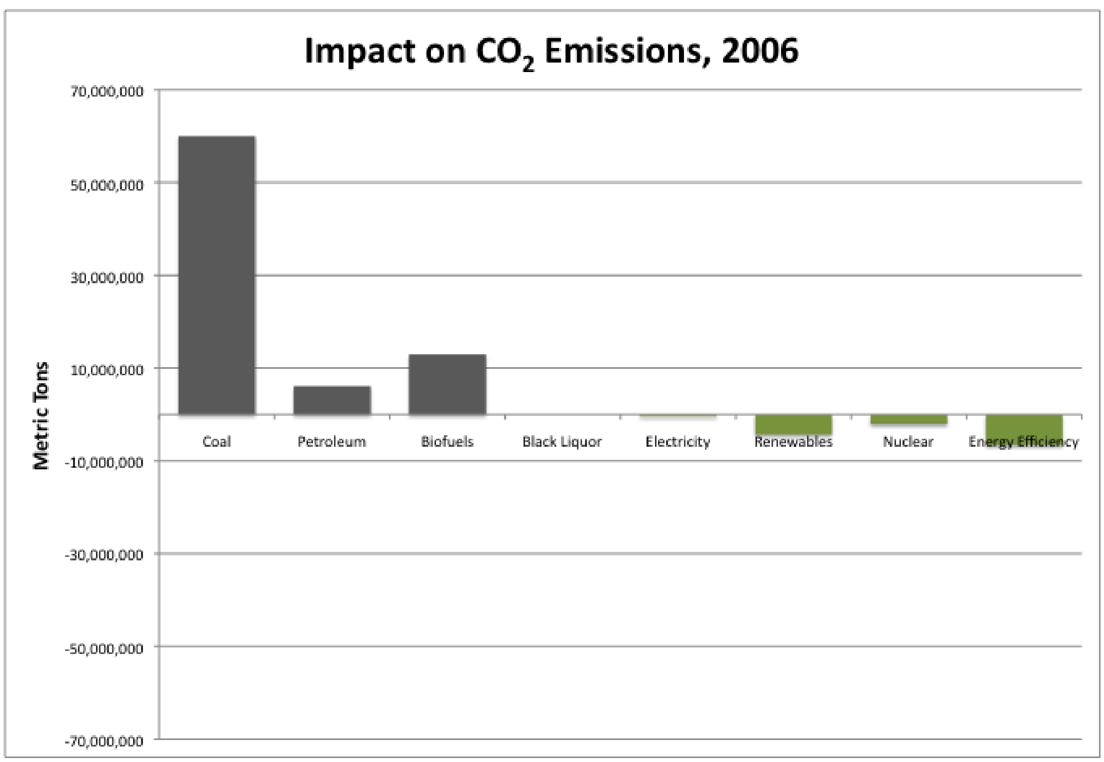
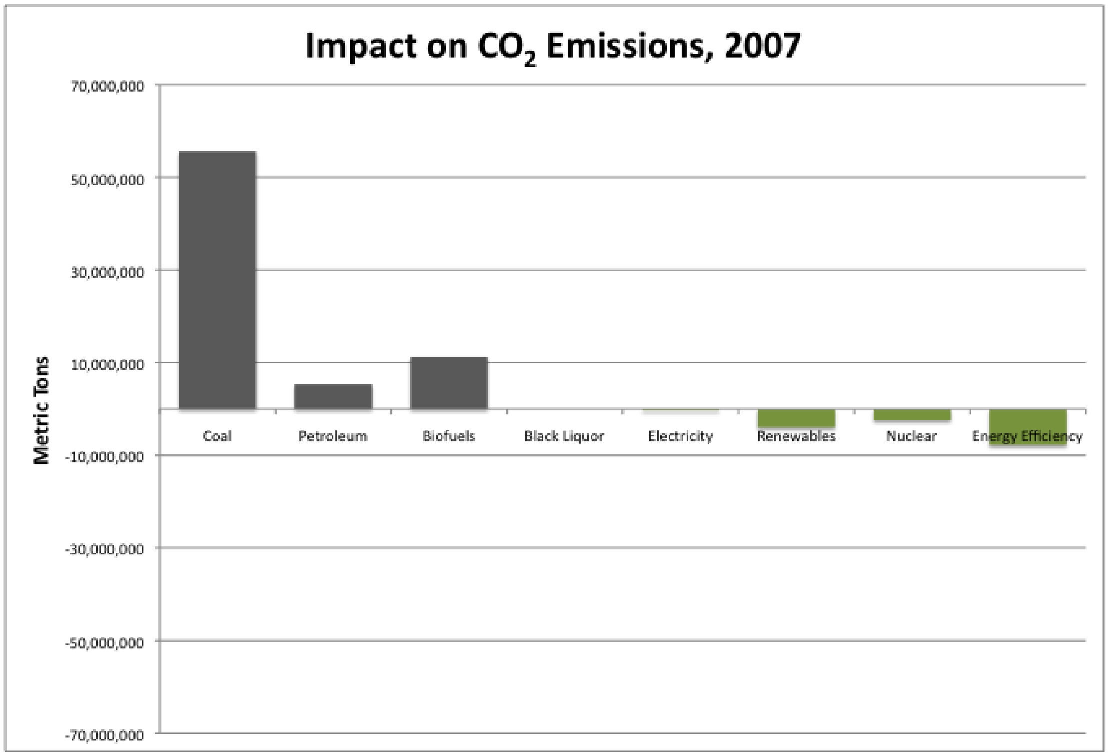


Figure 2. Effects of Subsidies on CO_2 Emissions (continued)



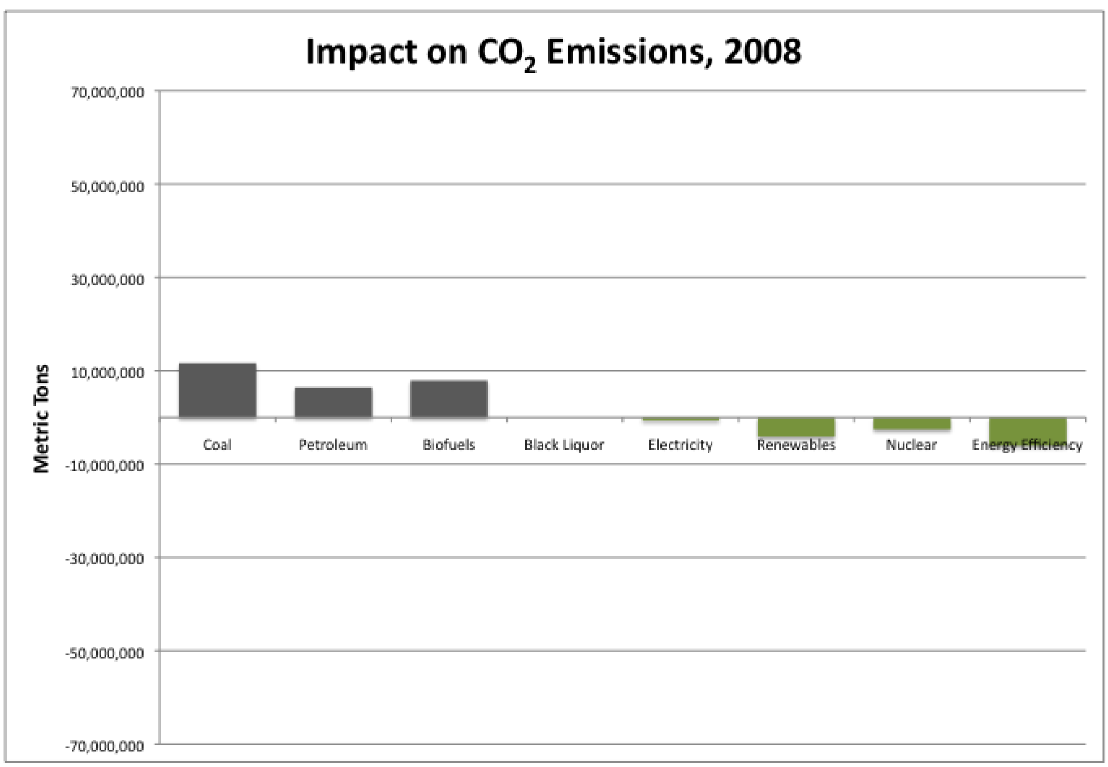
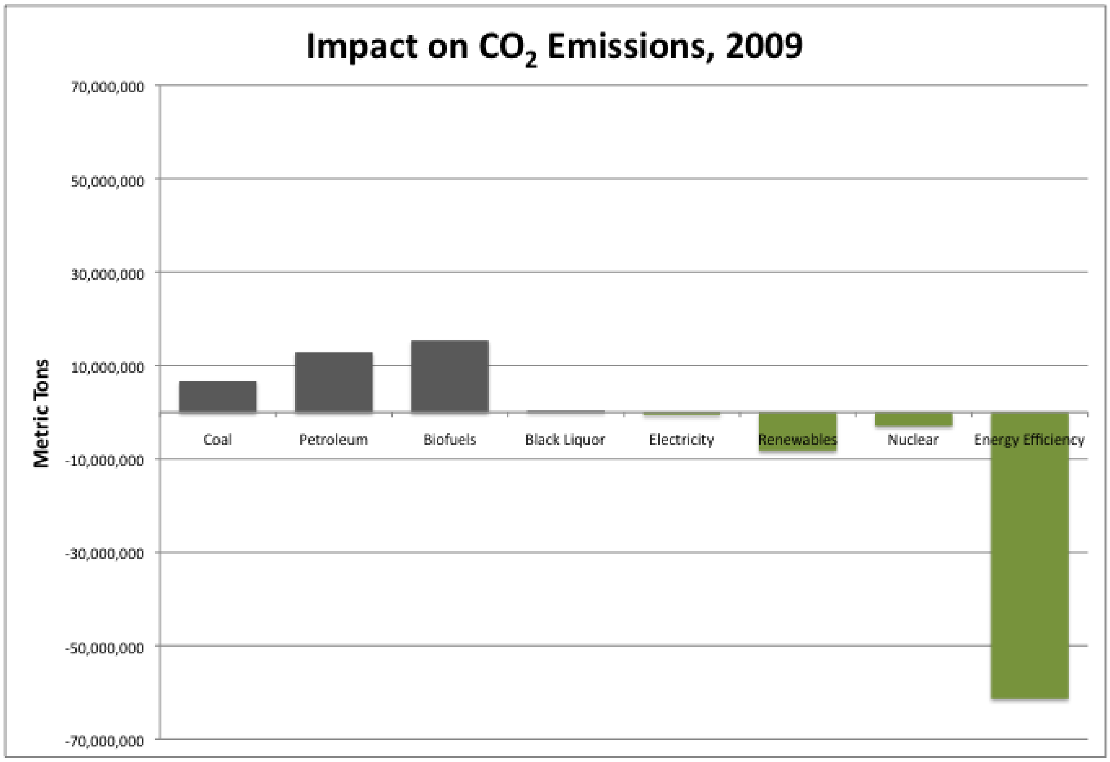
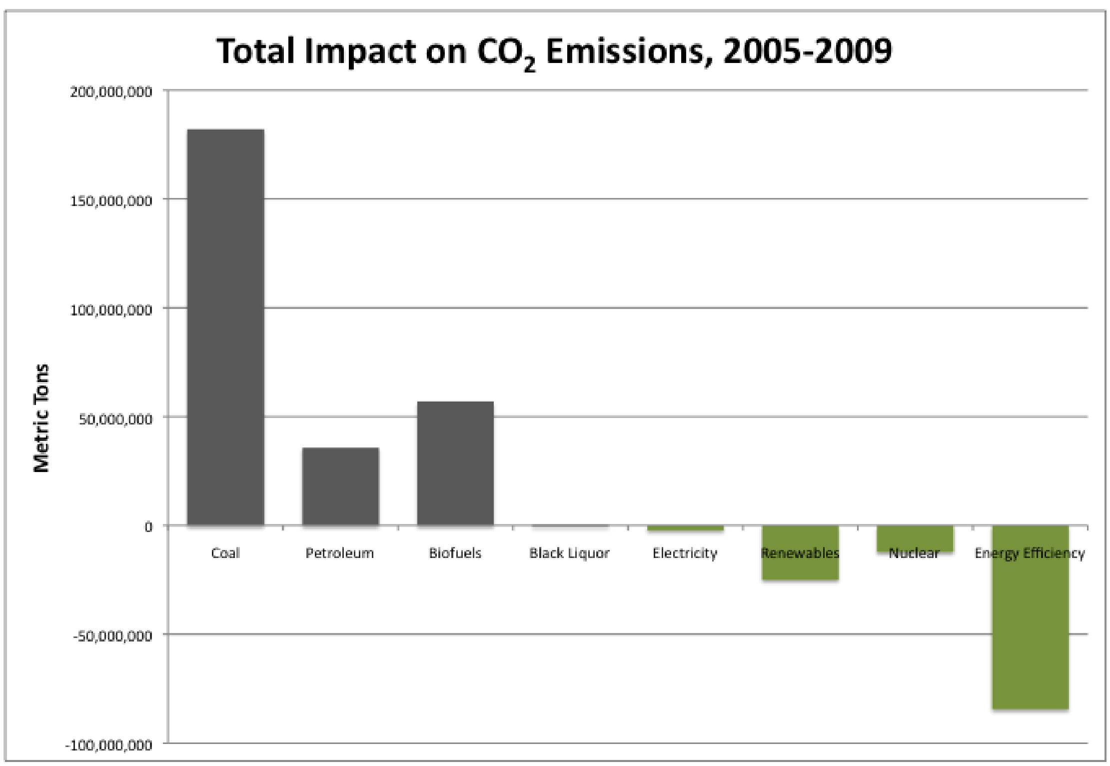


Figure 2. Effects of Subsidies on CO_2 Emissions (continued)





Note: Categories accounting for less than 1 percent of CO_2 effects are not identified in Figure 2.

Table 1.A Overview of Subsidy Programs

	Expenditures (millions of 2009 $)					
	2005	2006	2007	2008	2009	Total 2005-2009
CO_2 Reducing	3,386	4,198	4,380	5,443	18,462	35,869
CO_2 Increasing	9,058	12,356	11,744	11,255	15,370	59,784
Total	12,444	16,554	16,124	16,698	33,832	95,653

Table 1.B Overview of Subsidy Programs

	Change in CO_2 Emissions (metric tons)					
	2005	2006	2007	2008	2009	Total 2005-2009
CO_2 Reducing	-9,513,452	-13,363,631	-14,776,985	-14,655,174	-75,109,864	-127,419,105
CO_2 Increasing	62,660,639	79,086,652	72,370,728	27,261,751	37,226,066	278,605,836
Net Effect	53,147,187	65,723,021	57,593,743	12,606,577	-37,883,798	151,186,731

Table 1.C Overview of Subsidy Programs

	Percent Change in U.S. CO_2 Emissions					
	2005	2006	2007	2008	2009	Total 2005-2009
CO_2 Reducing	-0.2	-0.2	-0.2	-0.3	-1.4	-0.4
CO_2 Increasing	1.0	1.3	1.2	0.5	0.7	1.0
Net Effect	0.8	1.1	1.0	0.2	-0.7	0.5

Table 1.D Overview of Subsidy Programs

	2009 $1 per Metric Ton Increased					
	2005	2006	2007	2008	2009	Total 2005-2009
CO_2 Reducing	-356	-314	-296	-371	-246	-282
CO_2 Increasing	145	156	162	413	413	215
Net Effect	234	252	280	1,325	-893	633

Table 2A. Energy Subsidies that Most Reduced Carbon Dioxide Emissions

	Estimated Decrease in CO_2 Emissions (metric tons)					
Subsidy	**2005**	**2006**	**2007**	**2008**	**2009**	**Total**
Low-Cost Residential Weatherization	1,882,126	2,422,068	1,529,604	1,612,729	21,115,872	28,562,398
Energy Efficiency Block Grant Program	-	-	-	-	17,695,746	17,695,746
USDA Rural Energy for America Program	3,748,948	3,461,129	3,292,667	2,566,455	3,723,225	16,792,424
DOE State Energy Program	223,599	155,176	225,405	166,799	13,833,822	14,604,800
Special Tax Rate for Nuclear Decommissioning Reserve Funds	2,284,265	2,056,156	2,395,746	2,556,309	2,895,020	12,187,496
Credit for Energy Efficiency Improvements of Existing Homes	-	1,690,249	2,679,642	1,397,177	4,164,963	9,932,031
Production Tax Credit, Investment Tax Credit and Grants for Renewable Energy	396,021	762,578	592,869	1,295,739	2,346,443	5,393,649
Credit for Energy Efficient Appliances	-	886,233	956,815	742,079	1,540,300	4,125,428
Exclusion for Utility-Sponsored Conservation Measures	674,042	807,752	845,600	728,492	1,023,263	4,079,148
Biodiesel Excise Tax and Small Agri-Biodiesel Producer Tax Credits	-	-	327,242	1,289,468	1,775,848	3,392,557
Deduction for Certain Energy-Efficient Commercial Building Property	-	560,973	1,276,329	988,634	405,793	3,231,730
Energy Efficient Appliance Rebate Program	-	-	-	-	1,719,006	1,719,006
USDA Electric Programs	145,466	235,595	187,103	546,712	503,091	1,617,967
Subtotal	**9,354,467**	**13,037,909**	**14,309,021**	**13,890,594**	**72,742,392**	**123,334,382**

Source: Authors' calculations based on model runs.

Table 2B. Energy Subsidies that Most Reduced Carbon Dioxide Emissions

	Expenditures (millions of $2009)					
Subsidy	**2005**	**2006**	**2007**	**2008**	**2009**	**Total**
Low-Cost Residential Weatherization	258	343	234	263	5,393	6,491
Energy Efficiency Block Grant Program	0	0	0	0	2,842	2,842
USDA Rural Energy for America Program	24	25	24	40	67	181
DOE State Energy Program	49	38	51	44	3,135	3,316
Special Tax Rate for Nuclear Decommissioning Reserve Funds	549	532	621	698	800	3,200
Credit for Energy Efficiency Improvements of Existing Homes	0	245	393	229	570	1,437
Production Tax Credit, Investment Tax Credit and Grants for Renewable Energy	264	543	424	967	1,750	3,947
Credit for Energy Efficient Appliances	0	128	83	120	130	460
Exclusion for Utility-Sponsored Conservation Measures	88	117	124	120	140	589
Biodiesel Excise Tax and Small Agri-Biodiesel Producer Tax Credits	0	0	186	977	840	2,003
Deduction for Certain Energy-Efficient Commercial Building Property	0	85	197	169	60	511
Energy Efficient Appliance Rebate Program	0	0	0	0	299	299
USDA Electric Programs	40	71	52	160	147	469
Subtotal	**1,271**	**2,126**	**2,389**	**3,786**	**16,171**	**25,743**

Sources: OMB Analytical Perspectives (2006-2010), Joint Committee on Taxation (2005-2010). Sources for data on direct spending programs are described in Appendix B.

Table 2C. Energy Subsidies that Most Reduced Carbon Dioxide Emissions

	Expenditures per CO_2 Emissions Reduced ($2009 per metric ton)					
Subsidy	**2005**	**2006**	**2007**	**2008**	**2009**	**Total**
Low-Cost Residential Weatherization	137	141	153	163	255	227
Energy Efficiency Block Grant Program	-	-	-	-	161	161
USDA Rural Energy for America Program	6	7	7	16	18	11
DOE State Energy Program	217	244	227	263	227	227
Special Tax Rate for Nuclear Decommissioning Reserve Funds	240	259	259	273	276	263
Credit for Energy Efficiency Improvements of Existing Homes	-	145	147	164	137	145
Production Tax Credit, Investment Tax Credit and Grants for Renewable Energy	666	712	716	746	746	732
Credit for Energy Efficient Appliances	-	144	87	161	84	112
Exclusion for Utility-Sponsored Conservation Measures	130	145	147	164	137	144
Biodiesel Excise Tax and Small Agri-Biodiesel Producer Tax Credits	-	-	569	757	473	590
Deduction for Certain Energy-Efficient Commercial Building Property	-	152	154	171	148	158
Energy Efficient Appliance Rebate Program					174	174
USDA Electric Programs	277	301	276	292	291	290
Average Across Programs	**136**	**163**	**167**	**273**	**222**	**209**

Source: Authors' calculations based on data in Tables 2A and 2B.

Table 3A. Other Energy Subsidies that Reduced Carbon Dioxide Emissions

	Estimated Decrease in CO_2 Emissions (metric tons)					
Subsidy	**2005**	**2006**	**2007**	**2008**	**2009**	**Total**
Credit for Investment in Clean Coal Facilities	-	-	133,946	122,435	729,206	985,586
Five-Year MACRS for Solar, Wind, Biomass, and Ocean Thermal Electric Power Generation	-	-	-	262,292	390,163	652,454
Credit for the Construction of New Energy-Efficient Homes	-	74,109	141,257	181,900	219,156	616,422
USDA High Energy Cost Grants	87,281	138,590	71,965	65,096	64,509	427,441
Credit for Holding Clean Renewable Energy Bonds	-	29,380	28,654	52,298	90,566	200,898
Credit for Residential Purchases and Installation of Solar and Fuel Cells	-	14,755	14,323	26,137	142,535	197,750
USDA Biorefinery Assistance Loan Guarantees	-	-	-	-	169,078	169,078
DOE Residential Buildings Program	-	-	-	-	165,586	165,586
DOE Loan Guarantees for Energy Efficiency Improvements	-	-	-	5,859	151,144	157,003
DOE subsidies in support of the commercial buildings initiative	-	-	-	-	112,158	112,158
Federal Interest Rate Support for Public Utilities Involved in Electricity Generation, Transmission and Distribution	32,738	20,709	19,054	19,899	18,167	110,567
USDA Renewable Energy Program	16,327	13,223	22,891	22,175	34,845	109,462
USDA Repowering Assistance Payments					73,976	73,976
Deferral of Gain from Dispositions of Transmission Property to Implement FERC Restructuring Policy	14,547	27,719	28,786	-	-	71,052
Renewable Energy Production Incentive	8,092	7,237	7,087	6,492	6,382	35,291
Subtotal	**158,985**	**325,722**	**467,964**	**764,580**	**2,367,472**	**4,084,723**

Source: Authors' calculations based on model runs.

Table 3B. Other Energy Subsidies that Reduced Carbon Dioxide Emissions

	Expenditures (millions of $2009)					
Subsidy	**2005**	**2006**	**2007**	**2008**	**2009**	**Total**
Credit for Investment in Clean Coal Facilities	0	0	31	30	180	241
Five-Year MACRS for Solar, Wind, Biomass, and Ocean Thermal Electric Power Generation	-	-	-	199	300	499
Credit for the Construction of New Energy-Efficient Homes	0	11	21	30	30	91
USDA High Energy Cost Grants	23	42	21	19	18	122
Credit for Holding Clean Renewable Energy Bonds	0	21	21	40	70	152
Credit for Residential Purchases and Installation of Solar and Fuel Cells	0	11	10	20	110	151
USDA Biorefinery Assistance Loan Guarantees	0	0	0	0	80	80
DOE Residential Buildings Program	0	0	0	0	23	23
DOE Loan Guarantees for Energy Efficiency Improvements	0	0	0	4	117	121
DOE subsidies in support of the commercial buildings initiative	0	0	0	0	17	17
Federal Interest Rate Support for Public Utilities Involved in Electricity Generation, Transmission and Distribution	1,537	1,314	1,235	1,323	1,290	6,698
USDA Renewable Energy Program	11	10	17	17	27	81
USDA Repowering Assistance Payments	-	-	-	0	35	35
Deferral of Gain from Dispositions of Transmission Property to Implement FERC Restructuring Policy	538	660	631	-30	-10	1,789
Renewable Energy Production Incentive	5	5	5	5	5	26
Subtotal	**2,115**	**2,072**	**1,991**	**1,657**	**2,291**	**10,126**

Sources: OMB Analytical Perspectives (2006-2010), Joint Committee on Taxation (2005-2010). Sources on data for direct spending programs are described in Appendix B.

Table 3C. Other Energy Subsidies that Reduced Carbon Dioxide Emissions

	Expenditures per CO_2 Emissions Reduced ($2009 per metric ton)					
Subsidy	**2005**	**2006**	**2007**	**2008**	**2009**	**Total**
Credit for Investment in Clean Coal Facilities	-	-	232	244	247	244
Five-Year MACRS for Solar, Wind, Biomass, and Ocean Thermal Electric Power Generation	-	-	-	760	769	765
Credit for the Construction of New Energy-Efficient Homes		144	146	164	137	148
USDA High Energy Cost Grants	264	299	288	291	279	286
Credit for Holding Clean Renewable Energy Bonds	-	724	722	762	773	756
Credit for Residential Purchases and Installation of Solar and Fuel Cells	-	721	722	762	772	763
USDA Biorefinery Assistance Loan Guarantees	-	-	-	-	473	473
DOE Residential Buildings Program	-	-	-	-	137	137
DOE Loan Guarantees for Energy Efficiency Improvements	-	-	-	758	771	771
DOE subsidies in support of the commercial buildings initiative	-	-	-	-	148	148
Federal Interest Rate Support for Public Utilities Involved in Electricity Generation, Transmission and Distribution	46,941	63,432	64,794	66,477	71,035	60,581
USDA Renewable Energy Program	673	724	723	764	775	741
USDA Repowering Assistance Payments	-	-	-	-	473	473
Deferral of Gain from Dispositions of Transmission Property to Implement FERC Restructuring Policy	37,001	23,803	21,926	-	-	25,183
Renewable Energy Production Incentive	673	728	722	760	783	730
Average Across Programs	**13,300**	**6,362**	**4,254**	**2,167**	**968**	**2,479**

Source: Authors' calculations based on data in Tables 3A and 3B.

Table 4A. Energy Subsidies that Most Increased Carbon Dioxide Emissions

	Estimated Increase in CO_2 Emissions (metric tons)					
Subsidy	**2005**	**2006**	**2007**	**2008**	**2009**	**Total**
Alternative Fuel Production Credit	45,572,860	56,133,476	51,129,099	8,204,009	822,898	161,862,342
Alcohol Fuels Excise Tax and Credit	4,590,483	6,484,151	7,310,724	7,055,203	13,357,604	38,798,165
USDA Corn Payments Attributable to Ethanol	4,858,024	6,447,947	4,255,067	2,144,936	4,019,418	21,725,392
Expensing of Exploration and Development Costs	1,362,975	1,359,220	1,138,466	2,386,924	5,035,239	11,282,823
Low-Income Home Energy Assistance Plan	1,307,458	2,006,456	1,385,495	1,321,261	5,031,961	11,052,631
Excess Percentage over Cost Depletion	1,528,722	2,672,509	2,429,719	2,098,241	1,126,946	9,856,137
Capital Gains Treatment of Royalties in Coal	1,641,312	2,821,976	2,940,141	1,396,979	873,504	9,673,912
Exclusion of Special Benefits for Disabled Coal Miners	913,020	883,874	817,886	508,842	498,488	3,622,110
Special Rules for Refund of the Coal Excise Tax	-	-	-	-	3,239,651	3,239,651
84-Month Amortization of Pollution-Control Equipment	37,545	176,876	490,840	1,270,987	1,247,069	3,223,317
Temporary 50% Expensing for Equipment Used in the Refining of Liquid Fuels	-	18,795	50,191	423,347	1,509,076	2,001,408
Subtotal	**61,812,399**	**79,005,280**	**71,947,627**	**26,810,729**	**36,761,854**	**276,337,889**

Source: Authors' calculations based on model runs.

Table 4B. Energy Subsidies that Most Increased Carbon Dioxide Emissions

	Expenditures (millions of $2009)					
Subsidy	**2005**	**2006**	**2007**	**2008**	**2009**	**Total**
Alternative Fuel Production Credit	2,549	3,171	3,021	588	60	9,388
Alcohol Fuels Excise Tax and Credit	1,692	2,788	3,477	4,444	5,210	17,611
USDA Corn Payments Attributable to Ethanol	1,790	2,773	2,023	1,351	1,567	9,503
Expensing of Exploration and Development Costs	428	724	548	1,644	1,640	4,985
Low-Income Home Energy Assistance Program	1,367	1,773	1,224	1,379	2,710	8,453
Excess Percentage over Cost Depletion	648	809	817	917	340	3,531
Capital Gains Treatment of Royalties in Coal	99	170	186	110	70	635
Exclusion of Special Benefits for Disabled Coal Miners	55	53	52	40	40	240
Special Rules for Refund of the Coal Excise Tax	-	-	-	-	260	260
84-Month Amortization of Pollution-Control Equipment	2	11	31	100	100	244
Temporary 50% Expensing for Equipment Used in the Refining of Liquid Fuels	0	11	31	349	770	1,160
Subtotal	**8,630**	**12,282**	**11,411**	**10,921**	**12,766**	**56,010**

Sources: OMB Analytical Perspectives (2006-2010), Joint Committee on Taxation (2005-2010). Sources for data on direct spending programs are described in Appendix B.

Table 4C. Energy Subsidies that Most Increased Carbon Dioxide Emissions

	Expenditures per CO_2 Emissions Increased ($2009 per metric ton)					
Subsidy	**2005**	**2006**	**2007**	**2008**	**2009**	**Total**
Alternative Fuel Production Credit	56	56	59	72	73	58
Alcohol Fuels Excise Tax and Credit	369	430	476	630	390	454
USDA Corn Payments Attributable to Ethanol	369	430	475	630	390	437
Expensing of Exploration and Development Costs	314	532	482	689	326	442
Low-Income Home Energy Assistance Program	1,045	884	884	1,044	538	765
Excess Percentage over Cost Depletion	424	303	336	437	302	358
Capital Gains Treatment of Royalties in Coal	60	60	63	78	80	66
Exclusion of Special Benefits for Disabled Coal Miners	60	60	63	78	80	66
Special Rules for Refund of the Coal Excise Tax	80	80	-	-	-	80
84-Month Amortization of Pollution-Control Equipment	59	60	63	78	80	76
Temporary 50% Expensing for Equipment Used in the Refining of Liquid Fuels	566	618	824	510	580	580
Average Across Programs	**140**	**155**	**159**	**407**	**347**	**203**

Source: Authors' calculations based on data in Tables 4A and 4B.

Table 5A. Other Energy Subsidies that Increased Carbon Dioxide Emissions

	Estimated Increase in CO_2 Emissions (metric tons)					
Subsidy	**2005**	**2006**	**2007**	**2008**	**2009**	**Total**
Enhanced Oil Recovery Credit	687,050	-	-	-	-	687,050
Partial Expensing for Advanced Mine Safety Equipment	-	-	163,649	253,704	-	417,354
Black Liquor	-	-	-	-	282,249	282,249
Treatment of Natural Gas Distribution Pipelines as Property with a 15-year Lifespan	-	12,172	38,568	44,409	124,479	219,628
Exception from Passive Loss Limitation for Working Interests in Oil and Gas Properties	55,622	41,926	37,925	9,564	36,587	181,623
Amortization of All Geological and Geophysical Expenditures over Two Years	-	13,637	64,677	19,128	73,175	170,617
Alternative Fuel Excise Tax Credit	-	-	105,472	95,868	-71,954	129,386
Pass Through of Low Sulfur Diesel to Cooperative Owners	91,663	-	-	-	-	91,663
Expensing of Capital Costs for Compliance with EPA Sulfur Regulations	13,905	13,637	12,809	28,350	19,677	88,378
Subtotal	**848,240**	**81,372**	**423,101**	**451,022**	**464,212**	**2,267,947**

Source: Authors' calculations based on model runs.

Table 5B. Other Energy Subsidies that Increased Carbon Dioxide Emissions

	Expenditures (millions of $2009)					
Subsidy	**2005**	**2006**	**2007**	**2008**	**2009**	**Total**
Enhanced Oil Recovery Credit	330	-	-	-	0	330
Partial Expensing for Advanced Mine Safety Equipment	44	0	0	0	0	44
Black Liquor	0	0	0	0	2,500	2,500
Treatment of Natural Gas Distribution Pipelines as Property with a 15-year Lifespan	0	21	62	80	80	243
Exception from Passive Loss Limitation for Working Interests in Oil and Gas Properties	44	32	31	10	20	137
Amortization of All Geological and Geophysical Expenditures over Two Years	0	11	52	20	40	122
Alternative Fuel Excise Tax Credit	-	-	168	174	-46	296
Pass Through of Low Sulfur Diesel to Cooperative Owners	44	-	-	-	0	44
Expensing of Capital Costs with Respect to Complying with EPA Sulfur Regulations	11	11	10	30	10	72
Subtotal	**428**	**74**	**333**	**334**	**2,604**	**3,774**

Sources: OMB Analytical Perspectives (2006-2010), Joint Committee on Taxation (2005-2010). Sources for data on direct spending programs are described in Appendix B.

Table 5C. Other Energy Subsidies that Increased Carbon Dioxide Emissions

	Expenditures per CO_2 Emissions Increased ($2009 per metric ton)					
Subsidy	**2005**	**2006**	**2007**	**2008**	**2009**	**Total**
Enhanced Oil Recovery Credit	480	-	-	-	-	480
Partial Expensing for Advanced Mine Safety Equipment	-	-	63	79	-	73
Black Liquor	-	-	-	-	8,857	8,857
Treatment of Natural Gas Distribution Pipelines as Property with a 15-year Lifespan	-	1,749	1,610	1,795	643	1,107
Exception from Passive Loss Limitation for Working Interests in Oil and Gas Properties	790	761	818	1,042	547	754
Amortization of All Geological and Geophysical Expenditures over Two Years	-	780	800	1,042	547	717
Alternative Fuel Excise Tax Credit	-	-	1,589	1,819	639	2,288
Pass Through of Low Sulfur Diesel to Cooperative Owners	479	-	-	-	-	479
Expensing of Capital Costs with Respect to Complying with EPA Sulfur Regulations	790	780	808	1,054	508	813
Average Across Programs	**505**	**915**	**787**	**740**	**5,610**	**1,664**

Source: Authors' calculations based on data in Tables 5A and 5B.

Table 6. Additional Energy Subsidies Not Evaluated

	Expenditures (millions of $2009)					
Subsidy	**2005**	**2006**	**2007**	**2008**	**2009**	**Total**
Exclusion of Interest on Various Bonds for Energy Facilities	88	128	114	10	10	349
Accelerated Depreciation of Electricity Transmission Facilities	-	3	19	18	100	140
Five-Year Carryover of Net Operating Losses for Electric Transmission Equipment	-	79	44	-	0	123
Smart Grid Implementation Program	-	-	-	-	18	18
Preferential Treatment of the Income of Certain Electric Cooperatives	-	-	14	-	0	14
DOE State Energy Activities	3	1	10	-	0	13
Credit for Production from Advanced Nuclear Power Facilities	0	-	-	-	0	0
Expensing of Tertiary Injectants Used in Mining	0	0	0	0	0	0
Preferential Treatment of Natural Gas Gathering Lines	-	-	-	-	0	0
Qualified Energy Conservation Bonds	-	-	-	0	0	0
Subtotal	**91**	**211**	**201**	**28**	**128**	**657**

Sources: OMB Analytical Perspectives (2006-2010), Joint Committee on Taxation (2005-2010). Sources for data on direct spending programs are described in Appendix B.

TOTAL EXPENDITURES (ALL ENERGY SUBSIDIES)	**12,535**	**16,766**	**16,325**	**16,725**	**33,960**	**96,311**

Table 7. Other Provisions Not Included in Study

Provision	Description
Credit and Deduction for Clean Fuel Vehicles and Refuel Property (IRC Sec. 179A and 30C)	Although a somewhat arbitrary decision, we considered this to be a transportation subsidy rather than an energy subsidy because the benefits are to vehicles—rather than fuel use or fuel efficiency (JCT 2010)
Deduction for domestic production activities (Sec. 199)	Established under the American Jobs Creation Act of 2004, this provision applies broadly throughout the economy, not just to energy producers.
Foreign Tax Credit (Sec. 901)	This credit does not specifically target energy production and is intended to avoid double taxations for taxpayers earning income abroad. There is a special limitation for taxes on foreign oil and gas income that ensures payments are not royalties disguised as tax payments (JCT 2010).
Imported Ethanol Tariff	Although this tariff creates an energy market distortion that is beneficial to domestic ethanol producers, it is neither a direct government expenditure nor a tax expenditure.
Mandates	We did not consider the economic value of mandates (i.e. ethanol production mandate, state-level renewable portfolio standards, etc.)
Oil Spill Liability Cap ($75 million)	Established under the Oil Pollution Act of 1990, this liability cap represents an implied subsidy rather than a Treasury expenditure. Recent events suggest that the liability cap may not be applied.
Research and Development	We did not consider any research and development provisions since they are not direct subsidies to energy efficiency or to energy production or consumption.
Training Programs	We did not consider programs providing training for such activities as the installation of weatherization installation or monitoring of compliance with state energy assurance programs.

Appendix A. The U.S. Energy Market Simulation Model

As generally described above, we developed a simulation model of U.S. energy markets to evaluate the various energy subsidies offered by the U.S. government. Taking cues from the National Energy Modeling System (NEMS), developed by the U.S. Energy Information Administration, we constructed the model to represent the end-use consumption of oil, natural gas, coal and electricity in four sectors (residential, commercial, industrial and transportation); the primary energy production of a number of different sources of energy; and the transformation of primary energy into electricity.

As with NEMS, the model emphasizes U.S. energy markets, but it also captures some interaction with world energy markets—with the degree of interaction varying by energy source. The model represents an integrated world oil market with limited detail outside of the United States. Because natural gas markets are less integrated on a global basis, the model represents interaction with the rest of the world through imports and exports. The limited interaction of the U.S. coal market with the rest of the world is also represented through imports and exports. The interaction with Canada and Mexico in the electric power sector is represented by net imports.

We calibrated the model so that the prevailing U.S. energy market conditions for each year from 2005 through 2009 are considered business as usual with all of the subsidies in place. The effects of each subsidy are quantified through a counterfactual simulation exercise that assessed how the market would have looked in the absence of the particular subsidy being examined.

Wanting to evaluate how the market might have looked had the subsidy not existed, we took the approach that both the business as usual cases and the counterfactuals represent complete long-run adjustment to two different sets of market conditions. As such, we built the model with long-run elasticities of supply demand that we developed by reviewing the relevant economic research, by making comparisons across existing runs of NEMS and by using modelers' judgment (as explained in Section A.6 below).

A.1 Oil Demand and Supply

We represent the world oil market with sectoral detail for the United States and single supply and demand equations for non-U.S. oil supply and demand. Oil use for electricity generation is represented in the electricity sector below.

U.S. oil demand in each end-use sector can be represented as follows:

$$Q_{Do\,i} = A_{o\,i} \cdot P_o^{\eta_{oi}} \cdot \prod_j P_j^{\eta_{oj\,i}} \qquad \text{for each U.S. end-use sector } i\text{; and } j = g, c \text{ and } e \qquad \textbf{(1)}$$

where Q_{Doi} represents the quantity of oil demanded in sector i, A_{oi} is a constant, P_o is the price of oil, η_{oi} is the long-run price elasticity of oil demand in sector i, P_j is the price of energy source j, and η_{oji} is the long-run elasticity of demand for oil with respect to the price of energy source j in sector i. The four U.S. end use sectors are residential, commercial, industrial and transportation, and the subscripts o, g, c, and e represent oil, natural gas, coal and electricity, respectively.

Non-U.S. oil demand is represented as follows:

$$Q_{Dox} = A_{ox} \cdot P_o^{\eta_{ox}} \qquad \textbf{(2)}$$

where Q_{Dox} represents the quantity of oil demanded outside the United States, A_{ox} is a constant and η_{ox} is the long-run price elasticity of oil demand outside the United States. Oil consumption outside the United States is dependent only upon the world oil price—not those for other energy sources.

U.S. oil supply from each of several domestic sources can be represented as follows:

$$Q_{Sou} = B_{ou} \cdot P_o^{\eta_{ou}} \qquad \text{for each domestic source, } u \tag{3}$$

where Q_{Sou} represents the quantity of oil supplied from U.S. source u, B_{ou} is a constant, and η_{ou} is the long-run elasticity of oil supply from source u.[24]

Non-U.S. oil supply is represented as follows:

$$Q_{Soy} = B_{oy} \cdot P_o^{\eta_{oy}} \tag{4}$$

where Q_{Soy} represents the quantity of oil supplied outside the United States, B_{oy} is a constant, and η_{oy} is the long-run elasticity of non-U.S. oil supply.

A.2 Natural Gas Demand and Supply

We represent the U.S. natural gas market with sectoral detail and the addition of exports and imports. Natural gas use for electricity generation is represented in the electricity sector below.

U.S. natural gas demand for each end-use sector can be represented as follows:

$$Q_{Dg\,i} = A_{g\,i} \cdot P_g^{\eta_{gi}} \cdot \prod_j P_j^{\eta_{gj\,i}} \qquad \text{for each U.S. end-use sector } i\text{; and } j = o, c \text{ and } e \tag{5}$$

where Q_{Dgi} represents the quantity of natural gas demanded in sector i, A_{gi} is a constant, P_g is the price of natural gas, η_{gi} is the long-run price elasticity of natural gas demand in sector i, P_j is the price of energy source j, and η_{gji} is the long-run elasticity of demand for natural gas with respect to the price of energy source j in sector i.

Demand for natural gas exports from the United States are represented as follows

$$Q_{Dgx} = A_{gx} \cdot P_g^{\eta_{gx}} \tag{6}$$

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[24] Consistent with the EIA classification, the term "oil" includes any liquid fuels that are close substitutes for petroleum products.

where Q_{Dgx} represents the quantity of U.S. natural gas exports, A_{gx} is a constant and η_{gx} is the long-run price elasticity of export demand for U.S. natural gas. Exports are dependent only upon the domestic price of natural gas—not other energy prices, domestic or international.

U.S. natural gas supply from each of several domestic or imported sources can be represented as follows:

$$Q_{Sgu} = B_{gu} \cdot P_g^{\eta_{gu}} \qquad \text{for domestic and imported sources, } u \qquad \textbf{(7)}$$

where Q_{Sgu} represents the quantity of natural gas supplied to the U.S. market from domestic or imported source u, B_{gu} is a constant, and η_{gu} is the long-run elasticity of natural gas supply to the U.S. market from source u.

A.3 Coal Demand and Supply

We represent the U.S. coal market with exports and imports. Coal use for electricity generation is represented in the electricity sector below.

U.S. coal demand for each end-use sector can be represented as follows

$$Q_{Dci} = A_{ci} \cdot P_c^{\eta_{ci}} \cdot \prod_j P_j^{\eta_{cji}} \qquad \text{for each U.S. end-use sector } i\text{; and } j = o, g \text{ and } e \qquad \textbf{(8)}$$

where Q_{Dci} represents the quantity of coal demanded in sector i, A_{ci} is a constant, P_c is the price of coal, η_{ci} is the long-run price elasticity of coal demand in sector i, P_j is the price of energy source j, and η_{cji} is the long-run elasticity of demand for coal with respect to the price of energy source j in sector i.

Demand for coal exports from the United States are represented as follows:

$$Q_{Dcx} = A_{cx} \cdot P_c^{\eta_{cx}} \qquad \textbf{(9)}$$

where Q_{Dcx} represents the quantity of U.S. coal exports, A_{cx} is a constant and η_{cx} is the long-run price elasticity of export demand for U.S. coal. Exports are dependent only upon the domestic price of coal—not other energy prices, domestic or international.

U.S. coal supply from each of several domestic or imported sources can be represented as follows:

$$Q_{Scu} = B_{cu} \cdot P_c^{\eta_{cu}} \quad \text{for a variety of domestic and imported sources, } u \tag{10}$$

where Q_{Scu} represents the quantity of coal supplied to the U.S. market from either domestic or imported source u, B_{cu} is a constant, and η_{cu} is the long-run elasticity of coal supply to the U.S. market from source u.

A.4 Electricity Demand and Supply

We represent the U.S. electricity market with the addition of net imports. The electricity sector also represents additional demand for oil, natural gas and coal, which are used for the production of electricity.

U.S. electricity demand for each end-use sector can be represented as follows:

$$Q_{Dei} = A_{ei} \cdot P_e^{\eta_{ei}} \cdot \prod_j P_j^{\eta_{eji}} \quad \text{for each U.S. end-use sector } i\text{; and } j = o, g \text{ and } c \tag{11}$$

where Q_{egi} represents the quantity of electricity demanded in sector i, A_{ei} is a constant, P_e is the price of electricity, η_{ei} is the long-run price elasticity of electricity demand in sector i, P_j is the price of energy source j, and η_{eji} is the long-run elasticity of demand for electricity with respect to the price of energy source j in sector i.

U.S. electricity supply from each of several domestic or imported sources can be represented as follows:

$$Q_{Sej} = C_j \cdot (P_e / P_j)^{\eta_{ej}} \quad \text{for } j = \text{o,g and } c \tag{12}$$

$$Q_{Sel} = C_l \cdot P_e^{\eta_{el}} \qquad \text{for } l = \text{nuclear, hydro, wind, solar, net imports} \qquad \textbf{(13)}$$

where Q_{Sej} represents the quantity of electricity supplied from fossil energy source j, Q_{Sel} represents the quantity of electricity supplied from source l, C_j and C_l are constants, P_e is the price of electricity, P_j is the price of fossil energy source j, η_{ej} is the long-run elasticity of electricity supply from fuel j, and η_{el} is the long-run elasticity of electricity supply from source l.

In addition, we represent the consumption of fossil energy to produce electricity as follows:

$$Q_{Dje} = K_j \cdot Q_{Sej} \qquad \text{for } j = o,g \text{ and } c \qquad \textbf{(14)}$$

where Q_{Dje} represents the quantity of energy source j used to produce electricity and K_j is a constant expressing the rate at which energy source j is converted to electric power. Thus, the demand for a particular fossil energy source to produce electricity is a function of its conversion rate, the supplies electric power from other sources, and the overall demand for electricity.

A.5 Energy Market System Equilibrium

To bring the energy market system to equilibrium, we set four energy market prices—P_o, P_g, P_c and P_e—such that the quantities of oil, natural gas, coal, and electricity demanded equals the quantities supplied in each respective market:

$$Q_{Doe} + Q_{Dox} + \sum_i Q_{Doi} = Q_{Soy} + \sum_u Q_{Sou} \qquad \textbf{(15)}$$

$$Q_{Dge} + \sum_i Q_{Dgi} + Q_{Dgx} = \sum_u Q_{Sgu} \qquad \textbf{(16)}$$

$$Q_{Dce} + \sum_i Q_{Dci} + Q_{Dcx} = \sum_u Q_{Scu} \qquad \textbf{(17)}$$

$$\sum_i Q_{Dei} = \sum_j Q_{Sej} + \sum_l Q_{Sel} \quad \textbf{(18)}$$

where the subscript on the quantities, Q, are defined as follows: D represents the demand, S represents supply, o represents oil, g represents natural gas, c represents coal, e represents electricity, x variously represents either consumption in the rest of the world or exports, i represents a domestic sector (residential, commercial, industrial, transportation or electric power generation) in which energy is used, u represents various sources of a particular form of energy—either domestic, imported or globally, j represents various fossil energy sources (oil, natural gas and coal) used to produce electricity, and l represents electricity provided through various non-fossil sources or net imports.[25]

A.6 Model Elasticities

As described above, the model is built with supply and demand functions that rely on long-run elasticities. To develop these elasticities, we conducted a review of the economics literature with empirical estimates of the requisite elasticities, consulted Dahl's (2009, 2010a, 2010b, 2010c, 2010d, 2010e) extensive surveys of international energy demand elasticities, investigated various scenarios run with NEMS and NEMS-RFF, and used modelers' judgment.[26]

As shown in Table A.1, Serletis et al. (2010) provides a point of departure for residential and commercial demand elasticities. The Serletis et al. estimates of the elasticities of U.S. energy demand by fuel for the residential and commercial sectors with cross elasticities, with the own price elasticities generally conforming to those found in the

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[25] We assume no CO_2 emissions are associated with the small amount of U.S. net electricity imports.
[26] NEMS-RFF is a version of NEMS developed by Resources for the Future in cooperation with OnLocation, Inc.

Dahl surveys. In a number of cases, however, the Serletis et al. estimates of cross elasticities yield results we consider improbable. For instance, using of the raw estimated cross elasticities for residential natural gas and electricity consumption with respect to the price of oil (as estimated by Serletis et al.) yielded an increase in total residential energy consumption when the price of oil is increased, because the estimated gains in natural gas and electricity consumption were greater than the estimated decline in petroleum product consumption. As a result, we adjusted the cross elasticities to eliminate these untoward effects. We also use a composite of the Serletis et al. estimates for residential and commercial sector demand for petroleum products because the quantity of oil products consumed in these two sectors is relatively small.

For the industrial sector, we relied on modeler judgment, scaling the cross elasticities to yield probable interfuel substitution. For the transportation sector, the elasticities are drawn from Dahl, inferences from runs of NEMS and NEMS-RFF and modeler judgment. Demand elastiticies for interaction with international energy markets come from Dahl or are set by modeler judgment to produce what seem to be reasonable market responses.

The economics literature provides no recent empirical estimates of energy supply elasticities. As a consequence, we rely heavily on inferences from NEMS-RFF supplemented with information from Brown and Huntington (2003) and modeler judgment as is shown in Tables A.2 and A.3. These estimates include elasticities of primary energy supply as well as those for producing electricity with various energy sources.

A.7 Model Calibration and Use

For a given set of elasticities and market prices and quantities representing each year 2005 and 2009, the parameters A, B, C and K are set so that each equation meets the conditions in the reference year and each energy market clears under business as usual. For each subsidy, we calculate how the subsidy directly affects a given supply or demand curve for each year 2005-2009—by altering the price or quantity.

A.8 Modeling the Energy Subsidies

The energy subsidies we evaluate fall into three broad categories: those increasing energy supply, those increasing energy demand and those promoting energy efficiency. Each of these subsidies can increase or decrease CO_2 emissions. Subsidies for the consumption or production of energy sources with low CO_2 emissions can result in an overall reduction in CO_2 emissions, while subsidies for the consumption or production of energy sources with high CO_2 emissions can result in an overall increase in CO_2 emissions. We treat energy efficiency subsidies as stimulating investments that yield a payback in reduced energy consumption.

A.8.1 Fuel Subsidies

Although fuel subsidies are offered to both producers and consumers, we exploit a principle of economics that subsidies to consumers and producers have equivalent market effects, and model all fuel subsidies as increases in supply.[27] Accordingly, we treated the fuel subsidies as increasing the price received by the producer(s) of the relevant fuel(s) at the market equilibrium. We calculated the per unit subsidy for each fuel by dividing the total subsidy amount by relevant fuel production and/or relevant electricity generation. (Details of the subsidy estimates can be found at the end of this appendix.)

[27] See Gruber (2011).

To determine the effect of an individual fuel subsidy on market prices and quantities and CO_2 emissions, we subtracted the per unit subsidy at the existing market price and quantity and generated a new supply curve for the fuel in question. We then used the altered supply curve in the simulation model to determine what energy-market prices and quantities would have prevailed in the absence of the subsidy. For a subsidy affecting multiple fuels, we made changes to several supply curves before using the model to determine what energy-market prices and quantities would have been without the subsidy.

A.8.2 Energy Efficiency Subsidies

We modeled energy efficiency subsidies as increasing residential or commercial efficiency in the form of an annuity of reduced expenditure on relevant fuels (typically, oil, gas, and electricity). Two important issues arise in the examination of subsidies for energy efficiency investments. A substantial percentage of government subsidy payments go to individuals who would have made the investments anyway, and many end users seem to demand unusually high rates of return on their investments.

After consulting a number of the participants in a recent Energy Modeling Forum study on energy efficiency, we make several adjustments to the annuity calculations to reflect actual decisions rather than estimates of the engineering potential for energy efficiency. First, we assume that half the government spending has no effect in reducing energy consumption because that number of end user would have undertaken the activity anyway. Second, we reflect the idea that consumers who actually undertake the energy efficiency investments demand short payback periods by calculating the annuity with a discount rate of 18 percent and a projected lifetime of 20 years for buildings and 15 years for appliances.[28]

We then shared out the reduction in energy expenditures across relevant fuels in proportion to residential or commercial expenditures on these energy sources. Using average prices, we then calculated by how much the subsidy reduced the quantity demanded of relevant fuels at the prevailing market prices.[29] (Details of these estimates can be found in Appendix C.) For each fuel in the sector, we then added the quantity at the prevailing market quantity and price and generated a new demand curve for the fuel. We then used the altered demand curve in the simulation model to determine what the energy-market prices and quantities would have been in the absence of the energy-efficiency subsidy. For a subsidy affecting multiple fuels, we made changes to several demand curves before using the model to determine what the energy-market prices and quantities would have been without the subsidy.

A.9 CO_2 Emissions

For each subsidy, the change in CO_2 emissions is the result of the total effects of changes throughout the U.S. energy market.

$$\Delta CO_2 Emissions = \sum_{j=1}^{n} E_j \cdot \Delta Q_{Dj} \tag{19}$$

where E_j is the CO_2 emissions associated with one unit of primary fuel j and Q_{Dj} is the quantity of primary fuel j consumed in the United States. For each subsidy, we calculate the differences between the baseline case with the subsidy in place and the case with the

[28] See EMF (2011) and McKibbin et al. (2010).

[29] Because our model is strictly of energy demand and supply, it excludes consideration of a rebound effect in which the gains in energy efficiency create an incentive for expansion of the application in such a way that energy consumption and CO_2 emissions decrease by less than might be initially expected.

subsidy removed for each primary energy source. We sum the change in emissions across all primary fuels represented in the model.

For each primary fuel source, we use the CO_2 emissions coefficient shown in Table A.4 to quantify the change in emissions. The coefficients for oil, natural gas and coal are from the U.S. Energy Information Administration. The coefficients for biodiesel and ethanol are calculated as adjustments to coefficients for diesel and gasoline, respectively—reflecting differences in life-cycle emissions between biodiesel and diesel and between ethanol and gasoline. In the former case, we used data from the U.S. Energy Information Administration to make the adjustment. In the latter case, we used data from Tyner et al. (2010) to make the adjustment.

Table A.1. Long-Run Demand Elasticities

Elasticity of demand for fuel on left with respect to price of Sector				
	Oil	Natural Gas	Coal	Electricity
Residential				
Oil	-0.6[b]	0.2346[b]	0.0[e]	0.5867[b]
Natural Gas	0.0619[b]	-0.313[a]	0.0[e]	0.2652[b]
Coal	-	-	-	-
Electricity	0.0619[b]	0.2263[b]	0.0[e]	-0.41[d]
Commercial				
Oil	-0.6[b]	0.2346[b]	0.0[e]	0.5867[e]
Natural Gas	0.0378[b]	-0.296[a]	0.0[e]	1.2407[e]
Coal	-	-	-	-
Electricity	0.0378[b]	0.2516[b]	0.0[e]	-1.2[e]
Industrial				
Oil	-0.4[e]	0.4366[e]	0.1305[e]	0.0684[e]
Natural Gas	0.2298[e]	-0.84[e]	0.1305[e]	0.0684[e]
Coal	0.2298[e]	0.4366[e]	-0.87[e]	0.0684[e]
Electricity	0.2298[e]	0.4366[e]	0.1305[e]	-0.82[e]
Transportation				
Oil	-0.52[d]	0.0[e]	0.0[e]	0.0[e]
Natural Gas	0.0[e]	-0.2[c]	0.0[e]	0.0[e]
Coal	-	-	-	-
Electricity	0.0[e]	0.0[e]	0.0[e]	-0.01[e]
Other				
Non-U.S. Oil Demand	-0.45[d]			
Natural Gas		-		
Net Coal Exports			-6.51[e]	
Distributed Electricity Use				-0.204[e]

Sources: [a] Serletis et al (2010), [b] Author modification of Serletis et al estimates, [c] Author estimates based on NEMS-RFF, [d] Dahl 2010, [e] Author judgment.

Table A.2. Long-Run Supply Elasticities of Primary Energy

Fuel	Elasticity
Oil	
Domestic Prod	0.51[f]
Ethanol	1.0[e]
Biodiesel	1.0[e]
Non-U.S. Prod	0.4[e]
Natural Gas	
Domestic Prod	0.51[c]
Net Pipeline Imports	1.53[e]
Net LNG Imports	2.295[e]
Coal	
Domestic Prod	1.86[f]

Sources: [c] Author estimates based on NEMS-RFF, [e] Author judgment, [f] Brown and Huntington (2003).

Table A.3. Long-Run Supply Elasticities of Electricity by Fuel Source

Fuel	Elasticity
Oil	0.05[e]
Natural Gas	3.62[c]
Coal	0.39[c]
Nuclear	1.26[c]
Hydro	0.03[c]
Wind	0.18[c]
Solar	0.70[c]
Net Imports	2.26[c]

Sources: [c] Author estimates based on NEMS-RFF, [e] Author judgment.

Table A.4. CO_2 Emissions Coefficients

Fuel	CO_2 Emissions kg per Million Btu
Oil	74.43
Biodiesel (B-100)	15.76
Ethanol	61.74
Natural Gas	53.06
Coal	95.26

Sources: U.S. Energy Information Administration, Tyner et al. (2010). The coefficients for biodiesel and ethanol are calculated as adjustments to coefficients for diesel and gasoline, respectively—reflecting differences in life-cycle emissions between biodiesel and diesel and between ethanol and gasoline.

Appendix B. The Subsidies: Descriptions and Treatment

For purposes of evaluation, we consider only what can be considered energy-market subsidies. We exclude general subsidies, such as foreign trade assistance, that benefit energy and other companies. We also exclude research and development subsidies that cannot be linked directly to market outcomes and indirect subsidies that might affect energy markets. Using work from the Joint Committee on Taxation and the U.S. Energy Information Administration, we identified 59 different categories of subsidies that could be analyzed. Of these, 11 subsidies—representing a combined total of less than 1 percent of the spending on energy subsidies—proved to have such small effects on energy markets that we excluded them from the analysis.

B.1 Energy Subsidies that Most Reduced CO_2 Emissions

We find that 13 energy subsidies most greatly reduced U.S. CO_2 emissions over the five-year interval from 2005 to 2009. These include:

- low-cost residential weatherization;
- energy efficiency and conservation block grant program;
- USDA rural energy for America program;
- DOE state energy program;
- special tax rate for nuclear decommissioning reserve funds;
- credit for energy efficiency improvements of existing homes;
- production tax credit, investment tax credit and grants for renewable power generation;
- credit for energy efficient appliances;
- exclusion for utility-sponsored conservation measures;
- biodiesel excise tax and small agri-biodiesel producer tax credits;
- deduction for certain energy-efficient commercial building property; and
- energy efficient appliance rebate program; and
- USDA electric programs.

All of these subsidies, other than those for biodiesel, are for improvements in energy efficiency. Over the five years examined, these 13 programs reduced U.S. CO_2 emissions by about 123.3 million metric tons at a cost of $25.7 billion, for an average of $209 per metric ton of CO_2 reduced.

B.1.1 Low-Cost Residential Weatherization

Low-cost residential weatherization, including the DOE Weatherization Assistance Program (WAP), is a direct spending program that provides energy efficiency measures for existing residential and multifamily housing with low-income residents. Services are provided free of charge and include improvements to the building envelope, heating and cooling systems, electrical systems, and electric appliances.[30] WAP was created under Title IV of the Energy Conservation and Production Act of 1976, which was intended to reduce consumption of imported oil and decrease heating costs for low-income households. Under the American Recovery and Reinvestment Act of 2009 (ARRA), WAP received about $5 billion to weatherize approximately 600,000 homes.[31] In addition, ARRA increased the maximum dollar limit per dwelling from $2,500 to $6,500.

Using data from EIA, we modeled this subsidy as a residential energy efficiency subsidy, as described in Section A.8.2. We assumed this subsidy would increase residential energy efficiency in the form of an annuity of reduced residential expenditure on oil, gas, and electricity. We find the subsidy reduced U.S. CO_2 emissions by about 28.6 million metric tons at a cost of $6.5 billion, for an average of $227 per metric ton reduced.

B.1.2 Energy Efficiency and Conservation Block Grant (EECBG) Program

While the EECBG Program was created in 2007 by the Energy Independence and Security Act (EISA), it received funding for the first time in 2009 under ARRA. Formula and

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[30] See EERE 2010a.
[31] See EERE 2010a.

competitive grants assist states, cities, territories, and Indian tribes to develop energy efficiency and conservation projects.[32] Using data available during summer 2010, the authors estimated the amount of funds allocated in 2009 to be $2,842 million, which is the figure used in the analysis.[33] The breakdown between residential and commercial projects was estimated to be 10 percent and 90 percent. Retrofits and renewable energy installations on government buildings were categorized as commercial projects for purposes of simulation modeling.

Using data from the U.S. Department of Energy, we modeled the subsidy as reducing residential and commercial demand for oil, gas, and electricity using the energy efficiency subsidy methodology described in Section A.8.2. We find the subsidy reduced U.S. CO_2 emissions by about 17.7 million metric tons at a cost of $2.8 billion, for an average of $161 per metric ton reduced.

B.1.3 USDA Rural Energy for America Program (Sec. 9007)[34]

The Rural Energy for America Program, run by the USDA Rural Business Cooperative Service provides grants and guaranteed loans to assist rural small businesses and agricultural producers with renewable energy and energy efficiency projects.[35] The

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[32] Eligible projects include building retrofits, energy efficiency financial incentive programs, building code development, installation of distributed energy technologies (including renewable energy technologies on government buildings), installation of energy efficient traffic signals and street lighting, and material conservation programs (such as recycling). See http://www1.eere.energy.gov/wip/eecbg.html.

[33] According to data available in 2010, funding through the Recovery Act totaled $3.2 billion. Approximately $2.7 billion of this was to be awarded through formula grants, while about $454 million was allocated through competitive grants. All the formula grants were allocated in 2009, and $56 million of the competitive grant money was awarded in 2009. Current data information about recovery act recipients is available on a spreadsheet located at http://energy.gov/downloads/recovery-act-recipient-data (December 30, 2011). Data available in late 2011 shows that $2,963 million was awarded.

[34] Except where stated otherwise, section references are to the Internal Revenue Code of 1986.

[35] Eligible renewable technologies include wind, biomass, anaerobic digester, solar, geothermal, and hydrogen. Projects can produce energy in the form of heat, electricity, or fuel. Eligible energy efficiency

2008 Farm Bill authorized funding for the program for five years through 2012. Prior to 2008, the USDA Renewable Energy Program (Sec. 9006) provided support primarily for the purchase and installation of renewable energy systems.[36] Grants were restricted to the lesser of 25 percent of the project cost or $500,000. Loan guarantees were offered after 2005, although the estimated interest rate support was not substantial until 2008.

Using data from USDA, we modeled the subsidy as reducing the supply costs of renewable electric power generation, using the fuel subsidy methodology described in Section A.8.1. We find the subsidy reduced U.S. CO_2 emissions by about 16.8 million metric tons at a cost of $0.18 billion, for an average of $11 per metric ton reduced.

B.1.4 DOE State Energy Program

The State Energy Program, run by DOE Energy Efficiency and Renewable Energy, provides formula and competitive grants to assist states with energy efficiency and renewable energy projects. Formula grants assist the development of state energy strategies, while competitive grants provide incentives for the adoption of energy efficient and renewable technologies. States provide matching funds equal to 20 percent of formula allocations.[37]

We modeled the subsidy as increasing the production of renewable electric power, the production of biofuels, and increasing residential and commercial building efficiency. The authors estimated the spending for different aspects of the program by referring to the ARRA State Energy Program Plans for 11 states. Renewables represented about 33 percent

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projects include building retrofits, lighting, insulation improvements, and purchasing more efficient equipment.

[36] Eligible technologies included wind, solar, biomass, biofuels, geothermal, and anaerobic digesters. See http://www.rurdev.usda.gov/or/biz/9006_RESoverview.pdf.

[37] See EERE 2010b.

of allocations, while building efficiency accounted for about 58 percent and biofuels two percent. The rest of the allocations were associated with transportation efficiency, administration costs, and educational programs.[38]

After breaking out the expenditures using data from DOE, we modeled the program as both a residential efficiency subsidy using the methodology described in Section A.8.2 and as a fuel subsidy (for renewable electricity and ethanol), using the fuel subsidy methodology described in Section A.8.1. We find the subsidy reduced U.S. CO_2 emissions by about 14.6 million metric tons at a cost of $3.3 billion, for an average of $227 per metric ton reduced.

B.1.5 Special Tax Rate for Nuclear Decommissioning Reserve Funds (Sec. 468A)

The Deficit Reduction Act of 1984 enacted special tax rules for nuclear decommissioning reserve funds. A tax deduction is allowed for contributions to a qualified nuclear decommissioning fund and the income from the fund is taxed at a reduced rate of 20 percent (JCT 2010). Funds are limited to the amount sufficient to cover the present value of a generation facility's estimated decommissioning costs. There is currently no expiration for this provision.

The program amounts to a subsidy for nuclear power generation, which increases the supply of electric power. Using data from DOE, we modeled the program using the fuel subsidy methodology described in Section A.8.1. We find the subsidy reduced U.S. CO_2

[38] See http://www1.eere.energy.gov/wip/project_map/. The 11 representative states were Texas, New York, Illinois, Florida, Michigan, Ohio, Pennsylvania, Georgia, North Carolina, Massachusetts, and Indiana. ARRA Spending Plans were not available for California at the time this analysis was conducted. The same proportions from these 11 states in 2009 were assumed for all states and across all years 2005-2009. This was the best available information on State Energy Program spending at the time of this analysis.

emissions by about 12.2 million metric tons at a cost of $3.2 billion, for an average of $263 per metric ton reduced.

B.1.6 Credit for Energy Efficiency Improvements of Existing Homes (Sec. 25C)

The tax credit for energy efficiency improvements of existing homes provides a 30 percent credit for envelope improvements and the purchase of qualified insulation, windows, doors, main air circulating fans, furnaces, and hot water boilers. Property must be installed after December 31, 2008, and prior to January 1, 2011. The credit is limited to $1,500 per taxpayer per year (JCT 2010). Because installation of energy efficient equipment allows homeowners to reduce consumption of energy, we modeled the subsidy as reducing residential demand for oil, gas, and electricity consumption, using the energy efficiency subsidy methodology described in Section A.8.2. Using data from OMB *Analytical Perspectives*, we find the tax expenditure reduced U.S. CO_2 emissions by about 9.9 million metric tons at a cost of $1.4 billion, for an average of $145 per metric ton reduced.

B.1.7 Production Tax Credits, Investment Tax Credit and Grants for Renewable Power Generation (Sec. 45 and 48)

For renewable electric power generation, the combination of the production tax credit (PTC), investment tax credit (ITC), and grants constitutes the largest set of subsidies. We combined these credits because it is uncertain from which of these three categories firms have elected to take funding. Together, these subsidies have grown from $240 million in 2005 to nearly $1.8 billion in 2009 (in 2009 dollars). In 2009, ARRA allowed taxpayers to receive a grant from the Treasury Department instead of taking the ITC or PTC for new installations. This provision amounted to just over $1 billion in 2009 (OMB 2010).

The PTC is generally available for electricity production in the first 10 years after a facility is built (JCT 2010) and is estimated to primarily benefit wind generation (EIA

2008). Other eligible technologies include biomass, geothermal, solar, certain hydroelectric facilities, municipal solid waste, and landfill gas. Wind facilities can receive the credit until December 31, 2012, but most other technologies are eligible until the end of 2013. The ITC was created as a 10 percent credit for solar, wind, geothermal, and ocean thermal technologies under the Energy Tax Act of 1978 (EIA 2008).

Using data from OMB *Analytical Perspectives*, we modeled these tax expenditures as an increase in renewable electricity supply, using the fuel subsidy methodology described in Section A.8.1. The subsidy rates used in the model are shown in Tables B.1 and B.2. We find the subsidy reduced U.S. CO_2 emissions by about 5.4 million metric tons at a cost of $3.9 billion, for an average of $732 per metric ton reduced.

B.1.8 Credit for Energy Efficient Appliances (Sec. 45M)

Manufacturers are eligible to receive a tax credit for producing energy efficient dishwashers, clothes washers, and refrigerators. Established as part of the Energy Policy Act of 2005 (EPACT 2005), this credit applies to higher efficiency models until Dec 31, 2010, while the credit for lower efficiency models expires at the end of 2009 (JCT 2010). We modeled the subsidy as reducing residential demand for oil, gas, and electricity consumption, using the energy efficiency subsidy methodology described in Section A.8.2. Using data from OMB *Analytical Perspectives*, we find the tax expenditure reduced U.S. CO_2 emissions by about 4.1 million metric tons at a cost of $0.5 billion, for an average of $112 per metric ton reduced.

B.1.9 Exclusion for Utility-Sponsored Conservation Measures (Sec. 136)

As enacted by the Energy Policy Act of 1992 (EPACT 1992), energy conservation subsidies provided by public utilities are excluded from gross income (EIA 2008). Such subsidies can be provided directly or indirectly by public utilities to customers for the purchase or installation of energy efficiency measures. This provision does not have an expiration date (JCT 2010). We modeled the subsidy as reducing residential demand for oil, gas, and electricity consumption, using the energy efficiency subsidy methodology described in Section A.8.2. Using data from OMB *Analytical Perspectives*, we find the tax expenditure reduced U.S. CO_2 emissions by about 4.1 million metric tons at a cost of $0.6 billion, for an average of $144 per metric ton reduced.

B.1.10 Biodiesel Excise and Small Agri-Biodiesel Producer Tax Credit (Sec. 40A(f), 6426(c), and 6427(e))

Qualifying biodiesel is derived from plant or animal material and has certification from the biodiesel producer or importer that identifies the percentage of biodiesel and agri-biodiesel in the fuel.[39] The biodiesel fuels credit consists of four individual provisions, listed in Table B.3. Each of these provisions may be taken as an income tax credit (Sec. 40A(f)), excise tax credit (Sec 40A 6426(c)), or as a payment (Sec 40A 6427(e)) (JCT 2010).

We modeled the subsidy as increasing production of biodiesel, which is a component of overall petroleum supply. We used the fuel subsidy methodology described in Section A.8.1 applied only to biodiesel. Using data from OMB *Analytical Perspectives*, we find the tax expenditure reduced U.S. CO_2 emissions by about 3.4 million metric tons at a cost of $2.0 billion, for an average of $590 per metric ton reduced.

B.1.11 Deduction for Certain Energy-Efficient Commercial Building Property (Sec. 179D)

[39] Biofuel material must meet the requirements of the Clean Air Act or the American Society of Testing and Materials (ASTM) D6751 (JCT 2010).

Established under EPACT 2005, this provision allows a deduction of $1.80 per square foot on new commercial property (EIA 2008). Annual energy costs of interior lighting systems, heating, cooling, ventilation, and hot water systems must be at least half of the standards set by the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) (EIA 2008). We modeled the subsidy as reducing commercial demand for oil, gas, and electricity consumption, using the energy efficiency subsidy methodology described in Section A.8.2. Using data from OMB *Analytical Perspectives*, we find the tax expenditure reduced U.S. CO_2 emissions by about 3.2 million metric tons at a cost of $0.5 billion, for an average of $158 per metric ton reduced.

B.1.12 Energy Efficient Appliance Rebate Program

DOE provides ARRA funds for states to set up new or augment existing energy and water efficient appliance rebate programs. Nearly $300 million in ARRA funds was divided up by state, according to population. The rebate amounts and eligible ENERGY STAR products vary by state. States determine which appliances are eligible. Appliances typically covered include clothes washers, dishwashers, refrigerators, freezers, room air conditioners, and water heaters. We modeled the subsidy as reducing residential demand for oil, gas, and electricity consumption, using the energy efficiency subsidy methodology described in Section A.8.2. Using data from DOE, we find the subsidy reduced U.S. CO_2 emissions by about 1.7 million metric tons at a cost of $0.3 billion, for an average of $174 per metric ton reduced.

B.1.13 USDA Electric Programs

The USDA Rural Utilities Service Electric Programs provide both direct loans and loan guarantees to electric utilities that serve customers in rural areas. Created under the

Rural Electrification Act of 1936, the Electric Programs support the construction of electric distribution, transmission, and generation facilities.[40] Loans also support system improvements, energy efficiency programs, and renewable energy. We modeled the subsidy as increasing electricity supply, using the fuel subsidy methodology described in Section A.8.1. Using USDA data, we find the subsidy reduced U.S. CO_2 emissions by about 1.6 million metric tons at a cost of $0.5 billion, for an average of $290 per metric ton reduced.

B.2 Other Energy Subsidies that Reduced CO_2 Emissions

We find that another 15 energy subsidies also reduced CO_2 emissions from 2005 to 2009. These included:

- credit for investment in clean coal facilities;
- five-year modified accelerated cost recovery system for solar, wind, biomass, and ocean thermal electric power generation;
- credit for the construction of new energy-efficient homes;
- USDA high energy cost grants;
- credit for holding clean renewable energy bonds;
- credit for residential purchases and installation of solar and fuel cells;
- USDA biorefinery assistance loan guarantees;
- DOE residential buildings program;
- DOE loan guarantees for energy efficiency improvements;
- DOE subsidies in support of the commercial buildings initiative;
- federal interest rate support for public utilities;
- USDA renewable energy program;
- USDA repowering assistance payments;
- deferral of gain from dispositions of transmission property to implement FERC restructuring policy; and
- renewable energy production incentive.

[40] See USDA Rural Development, 2010.

Over the five years examined, these 15 programs reduced in U.S. CO_2 emissions by about 4.1 million metric tons at a total cost of $10.1 billion, for an average of $2,479 per metric ton of CO_2 reduced.

B.2.1 Credit for Investment in Clean Coal Facilities (IRC Sec 48A and 48B)

The Energy Policy Act of 2005 authorized support for integrated gasification combined cycle (IGCC) or pulverized coal (PC) plants containing advanced technology projects. In the first round of funding, an advanced coal technology was required to significantly reduce mercury and sulfur dioxide (SO_2) emissions.[41] Second round projects must sequester 65 percent of total CO_2 emissions (JCT 2010). IGCC technology is 12 percent more efficient than conventional PC and produces 11 percent less CO_2 emissions.[42]

This subsidy consists of both the advanced coal project credit (Sec. 48A) and gasification credit (Sec. 48B). The advanced coal credit supports IGCC or other advanced coal electricity generation. The first round begins no later than February 2006 and applications can be submitted over a three-year period. First round allocations are limited to $800 million for IGCC projects and $500 million for other projects. The credit is 20 percent for IGCC projects and 15 percent for other projects. Although beyond the scope of this study, second round projects receive a 30 percent credit and allocations are limited to $1.25 billion.

The gasification credit covers projects that convert coal, petroleum residue, or biomass into gas for direct use. In the first round, industrial facilities can receive a 20

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[41] Advanced technology must be designed to reduce SO_2 emissions 99 percent and mercury 90 percent (JCT 2010).

[42] IGCC without CO_2 capture has a higher heating value of 38.4 percent, compared to 34.3 percent for conventional pulverized coal. In addition, IGCC without CO_2 capture emits 832 grams of CO_2/kwh, while conventional PC emits 931 g/kwh. See MIT (2007), *The Future of Coal*.

percent credit and allocations are limited to $350 million. Second round projects receive a 30 percent credit, allocations are limited to $250 million, and motor fuel projects are eligible.

Using data from OMB *Analytical Perspectives*, we modeled the tax expenditure as increasing electricity supply from efficient coal plants using the method described in section A.8.1. We calibrated the model so that it could accommodate more efficient electric power generation from coal, efficient and conventional electric power generation of coal. The efficient, IGCC technology was assumed to use 12 percent less coal. We estimated from EIA's NEMS model that 1 percent of coal plants used new coal technology in 2009, while 99 percent used conventional coal technology. We find the subsidy reduced U.S. CO_2 emissions by about 0.99 million metric tons at a cost of $0.24 billion, for an average of $244 per metric ton reduced.

B.2.2 Five-Year MACRS for certain energy property (Sec. 168(e))

A five-year Modified Accelerated Cost Recovery System (MACRS) period is allowed for electricity generation and heating and cooling equipment using solar, wind, ocean thermal, fuel cell, or geothermal technology. Effective since 1986, this provision allows businesses to recover investments through depreciation deductions. This provision expires December 31, 2016 (JCT 2010).

Using JCT data, we modeled the tax expenditure as increasing renewable electricity supply, using the fuel subsidy methodology described in Section A.8.1. Subsidy expenditure data was only available from the JCT for years 2008 and 2009. We find the subsidy reduced U.S. CO_2 emissions by about 0.65 million metric tons at a cost of $0.50 billion, for an average of $765 per metric ton reduced.

B.2.3 Credit for Construction of New Energy-Efficient Homes (Sec. 45L)

Established by the EPACT 2005, this provision allows contractors to claim a tax credit for the construction of a new energy-efficient home. The new home must be 30 or 50 percent more energy efficient that a similar unit constructed in compliance with the International Energy Conservation code. Homes that are 30 percent more efficient than this standard are eligible for a $1,000 credit, while homes that are 50 percent more efficient may receive a $2,000 credit (JCT 2010). This provision applies to homes built after August 8, 2005 and expires December 31, 2009.

Using data from OMB *Analytical Perspectives*, we modeled the tax expenditure as reducing residential demand for oil, gas, and electricity consumption, using the energy efficiency subsidy methodology described in Section A.8.1. We find the subsidy reduced U.S. CO_2 emissions by about 0.62 million metric tons at a cost of $0.09 billion, for an average of $148 per metric ton reduced.

B.2.4 USDA High Energy Cost Grants

The USDA Rural Utilities Service offers High Energy Cost Grants for energy generation, transmission and distribution facilities serving communities with average home energy costs above 275 percent of the national average. Grants can be used for electric power and distributed renewable energy and energy efficiency projects. We modeled the subsidy as increasing electricity supply, using the fuel subsidy methodology described in Section A.8.1. Using USDA data, we find the subsidy reduced U.S. CO_2 emissions by about 0.43 million metric tons at a cost of $0.12 billion, for an average of $286 per metric ton reduced. The estimated reduction in CO_2 emissions is the result of the substitution of electricity for the direct use of fossil fuels.

B.2.5 Credit for Holding Clean Renewable Energy Bonds (Sec. 54 and 54C)

Clean Renewable Energy Bonds (CREBs) and New CREBs are tax credit bonds that can be used for renewable generation facilities. A taxpayer holding a CREB is eligible for a credit against income taxes. CREBs allow utilities that are not investor-owned to issue interest-free bonds to finance qualified energy projects. CREBS were established by EPACT 2005 and must be issued by December 31, 2009 (JCT 2010). Prior to EPACT 2005, only investor-owned utilities were eligible for tax incentives for renewable generation (EIA, 2008). New CREBs were established by the Energy Improvement and Extension Act of 2008. CREBs are equal to the amount that would allow them to be issued "at par and without interest," while new CREBs are equal to 70 percent of this amount (JCT 2010).

Using data from OMB *Analytical Perspectives*, we modeled the tax expenditure as increasing renewable electricity supply, using the fuel subsidy methodology described in Section A.8.1. We find the subsidy reduced U.S. CO_2 emissions by about 0.20 million metric tons at a cost of $0.15 billion, for an average of $756 per metric ton reduced.

B.2.6 Tax Credit for Residential Purchases and Installation of Solar and Fuel Cells (Sec. 25D)

Established by EPACT 2005, this provision allows for a 30 percent personal tax credit for qualified solar electric and solar water heating property, geothermal heat pumps, small wind energy, and fuel cells that are installed on residential property. The equipment must be placed in service before January 1, 2017 (JCT 2010). Credits are limited to $2,000 for solar property and $500 per 0.5 kilowatt (kW) for fuel cell, geothermal heat pump, and small wind capacity (JCT 2010). We modeled this as a subsidy reducing the demand for energy from conventional sources using the energy efficiency subsidy methodology described in section A.8.2. Using data from OMB *Analytical Perspectives*, we find the tax expenditure reduced U.S. CO_2 emissions by about 0.20 million metric tons at a cost of $0.15 billion, for an average of $763 per metric ton reduced.

B.2.7 USDA BioRefinery Assistance Loan Guarantees (Sec. 9003)

The USDA Rural Business Service provides loan guarantees to support the development, construction, and retrofitting of commercial-scale advanced bio-refineries. Eligible technologies do not involve corn kernel starch as the feedstock or standard biodiesel technology.[43] Loan guarantees have a maximum limit of $250 million and mandatory funding is available through 2012. We modeled the subsidy as increasing biodiesel production, using the fuel subsidy methodology described in Section A.8.1. Using USDA data, we find the subsidy reduced U.S. CO_2 emissions by about 0.17 million metric tons at a cost of $0.08 billion, for an average of $473 per metric ton reduced.

B.2.8 DOE Residential Buildings Program

Established under ARRA, the DOE Residential Buildings program comprises three sub-programs: Building America, Builders Challenge, and Existing Home Retrofits. Building America is an industry research program that seeks to advance the development and adoption of efficient building energy technologies by supporting the construction of efficient homes. The DOE Builders Challenge supports the construction of homes that achieve at least 30 percent energy savings compared to a typical new home built to code.[44] Existing home retrofits provides payments for qualified purchases, such as insulation, that reduce energy consumption in existing residences.

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[43] See USDA Rural Business-Cooperative Service. 2010.
[44] See EERE 2009.

Using DOE data, we modeled the subsidy as reducing residential demand for oil, gas, and electricity consumption, using the energy efficiency subsidy methodology described in Section A.8.2. We find the subsidy reduced U.S. CO_2 emissions by about 0.17 million metric tons at a cost of $0.02 billion, for an average of $137 per metric ton reduced.

B.2.9 DOE Loan Guarantees for Energy Efficiency Improvements

The EPACT 2005 authorized the DOE to issue loan guarantees under Title 17, Section 1703. The DOE's loan guarantee program awards loan guarantees for projects that use advanced technologies to reduce air pollutants or man-made greenhouse gases. In 2009, Section 1705 was created under ARRA as a temporary program to provide loan guarantees to qualified renewable energy, electric transmission, and biofuels projects that begin construction by September 30, 2011. Unlike the Section 1703 program, projects under Section 1705 do not have to use innovative technologies. Eligible projects under Section 1705 include commercial or advanced renewable energy systems, electric transmission systems, and advanced biofuel projects. Eligible projects under Section 1703 include innovative biomass, hydrogen, solar, wind, hydropower, advanced coal, carbon sequestration, electricity delivery, alternative fuel vehicles, industry energy efficiency, and pollution control equipment.

In 2009, the only projects to be awarded loan guarantees under Section 1705 were three renewable energy projects. (Other projects were funded in later years.) Therefore, we modeled the loan guarantee program in 2009 as a subsidy that increased renewable energy generation. The total loan guarantee subsidy was the sum of Section 1703 funding, Section 1705 Credit Subsidy Costs of loan guarantees, and Section 1705 estimated subsidy associated with the guarantee. ARRA provided nearly $4 billion to the DOE loan guarantee program, to be awarded over several years.

To estimate the subsidy associated with the guarantee, we took the difference between the market yield on U.S. Treasury securities (1-year constant maturity) and Moody's yield on Aaa corporate bonds. We also estimated the difference between U.S. Treasury securities and Baa corporate bonds.[45] We then multiplied each of these differences in interest rates by the program level of a particular loan guarantee to approximate the subsidy provided by the loan guarantee. We then averaged these two calculations, since borrowers would likely have a rating between Aaa and Baa. These calculations determine what would happen if top-rated companies could borrow at the government rate. Such loan guarantees have an economic cost to society even if they don't require any government expenditure.

Using DOE data, we modeled the subsidy as increasing renewable electricity supply, using the fuel subsidy methodology described in Section A.8.1. We find the subsidy reduced U.S. CO_2 emissions by about 0.16 million metric tons at an estimated cost of $0.12 billion to society, for an average of $771 per metric ton reduced.[46]

B.2.10 DOE Subsidies in Support of the Commercial Buildings Initiative

A goal of the U.S. Department of Energy's Commercial Buildings Initiative is to achieve zero net CO_2 emissions from new commercial buildings by 2030 and to realize zero net CO_2 emissions from all commercial buildings by 2050. As it is administered, the program subsidizes companies that build, own, or manage a large number of buildings to

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[45] Yield data obtained from Federal Reserve 2010.

[46] We note that the estimated cost represents the economic cost of the program rather than government expenditures.

reduce energy consumption. To obtain the subsidies, the companies must commit to achieving exemplary energy performance goals set in the Commercial Buildings Initiative.

Using DOE data, we modeled the subsidy as reducing commercial demand for oil, gas, and electricity consumption, using the energy efficiency subsidy methodology described in Section A.8.2. We find the subsidy reduced U.S. CO_2 emissions by about 0.11 million metric tons at a cost of $0.02 billion, for an average of $148 per metric ton reduced.

B.2.11 Federal Interest Rate Support to Public Utilities

The effect of federal electricity interest rate support was calculated for federally operated utilities and electric utilities within the Rural Utility Service electric program. These utilities have access to capital at reduced interest rates. Federal utilities include the Tennessee Valley Authority (TVA) and four Power Marketing Administrations.[47] Although the four Power Marketing Administrations are not federally owned, their creditworthiness is enhanced by the ability to borrow from the Treasury and perceived implicit government support.

Federal support for these utilities does not include direct spending by the Federal government. Therefore, the value of interest subsidies provided to Federal utilities is not calculated by the Treasury or reported in the Federal budget. However, these interest subsidies impose a cost on society and they can boost interest rates on Treasury securities and the annual interest expense on Federal debt.

We followed EIA 2008 methodology to estimate Federal electricity interest rate support as follows:

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[47] Bonneville Power Administration (BPA), Western Area Power Administration (WAPA), Southeastern Power Administration (SEPA), and Southwestern Power Administration (SWPA).

*Estimated Interest Support = (Benchmark Interest Rate * Outstanding Debt) – Actual Interest Expense*

We included both government and private-sector interest rates as benchmarks to estimate the level of interest rate support. The government benchmark is the yield on Treasury securities at 30-year constant maturity. Private sector benchmarks included the yield on corporate bonds rated by Moody's as Aaa and Baa. These interest rates were obtained from the Federal Reserve System.[48]

Values of utility outstanding debt and actual interest expense were obtained from the SEC 10-K filings for the TVA, and annual reports of Bonneville Power Administration (BPA), Western Area Power Administration (WAPA), Southeastern Power Administration (SEPA), and Southwestern Power Administration (SWPA).[49]

By using the combined generation mix for the TVA and the four power administrations, as described in their annual reports, we were able to calculate a per unit subsidy for the electricity generated from oil, natural gas, coal, nuclear, renewables, and hydropower. The subsidy affects many different types of generation, and mostly benefits fossil energy for the TVA. Taken together, however, the five government power organizations mostly use hydropower and nuclear power to produce electricity, so the net effect of the subsidy is to reduce CO_2 emissions in the electric power sector.[50]

We modeled the subsidy as increasing electricity supply across a number of sources, using the fuel subsidy methodology described in Section A.8.1. We find the subsidy

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[48] Board of Governors of the Federal Reserve System, 2010.
[49] We used the 2009 TVA SEC 10-K for years 2005-2009; BPA Annual Reports for years 2006 and 2009; WAPA Annual Reports for years 2006-2009; SEPA Annual Reports for years 2006-2009; and SWPA Annual Reports for 2005-2009.
[50] See recent annual reports for BPA, SEPA, SWPA, TVA and WEPA.

reduced U.S. CO_2 emissions by about 0.11 million metric tons at an estimated cost of $6.70 billion to society, for an average of $60,581 per metric ton reduced. These estimates reflect the increased use of non-CO_2 producing sources in the electric power sector as well as some end-use substitution of electricity for CO_2-producing fuels.

B.2.12 USDA Renewable Energy Program

The USDA rural business cooperative service provides support for rural renewable energy projects. We modeled the subsidy as increasing renewable electricity supply, using the fuel subsidy methodology described in Section A.8.1. Using USDA data, we find the subsidy reduced U.S. CO_2 emissions by about 0.11 million metric tons at a cost of $0.08 billion, for an average of $741 per metric ton reduced.

B.2.13 USDA Repowering Assistance Payments (Sec 9004)

Established by the 2008 Farm Bill, these payments from the USDA Rural Business – Cooperative Service provide incentives for biorefineries to replace the use of fossil fuels at their facilities or to produce new energy from feedstocks that are not feed grains.[51] A biorefinery can receive a payment equal to 50 percent of installation costs, with a limit of $5 million on payments. The first payment is equal to 20 percent of the total award, while the remainder is paid at the rate of $0.50 per million British thermal units of energy produced from renewable biomass.[52]

Using USDA data, we modeled the subsidy as increasing production of biodiesel, which is a component of petroleum supply, using the fuel subsidy methodology described

[51] See http://www.rurdev.usda.gov/bcp_repoweringassistance.html.
[52] See http://www.rurdev.usda.gov/BCP_RepoweringAssistance.html.

in Section A.8.1. We find the subsidy reduced U.S. CO_2 emissions by about 0.07 million metric tons at a cost of $0.04 billion, for an average of $473 per metric ton reduced.

B.2.14 Deferral of Gain from Disposition of Transmission Property to Implement FERC Restructuring Policy

This subsidy is the largest tax credit directly affecting the provision of electricity, rather than an electricity-related fuel. Generally, taxes are due when a taxpayer makes a capital gain in selling an asset. This tax expenditure, provided for in Section 1305 of EPACT 2005, allows the taxpayer to recognize the gain from the sale of electricity transmission property over an 8-year period. Like all tax deferrals, this subsidy creates a frontloaded benefit by deferring tax payments to a later year.

Using data from OMB Analytical Perspectives, we modeled the tax expenditure as increasing electricity supply from all sources—including nuclear power, hydropower, renewables, coal, natural gas and oil—using the fuel subsidy method described in section A.8.1. We find the subsidy contributed a small estimated reduction in U.S. CO_2 emissions (about 0.07 million metric tons) at a cost of $1.79 billion, for an average of $25,183 per metric ton reduced. Although all sources of electric power generation are increased, the subsidy results in some end-use substitution of electricity for CO_2-producing fuels, which reduces CO_2 emissions.

B.2.15 Renewable Energy Production Incentive (REPI)

The renewable energy production incentive (REPI) is part of an integrated strategy to promote the generation of electricity from renewable energy sources and to advance renewable energy technologies. The program was authorized under Section 1212 of EPACT 1992. It provides financial incentive payments for electricity produced and sold by new solar, wind and geothermal electric generation facilities.

Using DOE data, we modeled the subsidy as increasing the supply of renewable electricity, using the fuel subsidy method described in section A.8.1. We find the subsidy reduced U.S. CO_2 emissions by about 0.04 million metric tons at a cost of $0.03 billion, for an average of $730 per metric ton reduced.

B.3 Subsidies that Most Increased CO_2 Emissions

The 11 most prominent energy subsidies that most greatly increased CO_2 emissions from 2005 to 2009 are:

- alternative fuel production credit;
- alcohol fuels tax credit and alcohol fuels excise tax credit;
- USDA corn payments attributable to ethanol;
- expensing of exploration and development costs;
- low-income home energy assistance program;
- excess percentage over cost depletion;
- capital gains treatment of royalties in coal;
- exclusion of special benefits for disabled coal miners;
- special rules for refund of the coal excise tax;
- 84-month amortization of pollution control equipment; and
- temporary 50 percent expensing for equipment used in the refining of liquid fuels.

Over the five years examined, these 11 programs increased U.S. CO_2 emissions by about 276.3 million metric tons at a total cost of $56.0 billion, for an average of $203 per metric ton of CO_2 increased.

B.3.1 Alternative Fuel Production Credit (Sec. 45K)

The Alternative Fuel Production Credit existed in several forms before expiring in January 2010. Established under the Windfall Profits Tax of 1980, it primarily benefitted coalbed methane producers from 1999 until the end of 2002, when the eligibility of coalbed methane expired (EIA 2008).[53]

After 2002, the credit primarily benefitted synthetic coal (EIA 2008).[54] The definition of synthetic coal became stricter with the passage of the American Jobs Creation Act of 2004 (AJCA) and the credit was recodified as Section 45K.[55] The eligibility of most fuels expired prior to 2005, with the exception of biomass gas and synthetic fuels. The AJCA created a credit of $3 per oil-equivalent barrel of coke or coke gas production (in 2004 dollars) for qualified facilities placed in service between January 1, 2006 and January 1, 2010 (OMB 2010).[56]

Using data from OMB *Analytical Perspectives*, we modeled the tax expenditure as an increase in coal production, using the fuel subsidy methodology described in Section A.8.1. We find the subsidy increased U.S. CO_2 emissions by about 161.9 million metric tons at a cost of $9.4 billion, for an average of $58 per metric ton increased.

B.3.2 Alcohol Fuels Credit (Sec. 6427) and Alcohol Fuels Excise Tax Credit (Sec. 6426)

The Alcohol Fuels Credit and Alcohol Fuels Excise Tax Credit provide incentives for the sale, consumption, and production of alcohol fuels, including ethanol and methanol.

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[53] Other qualifying fuels included oil produced from shale and tar sands, gas produced from tight formations, and synthetic fuels produced from coal (JCT 2005a).
[54] Prior to the American Jobs Creation Act of 2004, coal was eligible only if the refining process resulted in a “significant chemical change” (EIA 2008).
[55] Synthetic coal (or refined coal) facilities with the passage of AJCA must 1) achieve a 20 percent reduction in nitrogen oxide, sulfur dioxide, or mercury emissions compared to original feedstock and 2) refined coal must have at least a 50 percent greater economic value than the feedstock (EIA 2008). Previously, the credit was codified as Section 29.
[56] Facilities that previously claimed the Section 29 credit were not eligible for the Section 45K credit and credit-eligible coke production was limited to an average barrel-of-oil equivalent of 4,000 barrels per day (JCT 2005a).

The credit consists of four individual provisions, listed in Table B.4 which combined amounted to a tax expenditure of $17.611 billion over the 2005-2009 period.[57]

Using data from OMB *Analytical Perspectives*, we modeled the tax expenditure as increasing the production of alcohol fuels, which are a component of petroleum supply. We used the fuel subsidy methodology described in Section A.8.1. We find the subsidy increased U.S. CO_2 emissions by about 38.8 million metric tons at a cost of $17.6 billion, for an average of $454 per metric ton increased.

Although alcohol fuels yield lower life-cycle emissions than gasoline, subsidies for their production increase CO_2 emissions. The substitution of an alcohol fuel for gasoline reduces emissions, but the subsidy increases overall fuel consumption and increases CO_2 emissions.[58]

B.3.3 USDA Corn-Payments Attributable to Ethanol

We considered the portion of USDA corn payments associated with ethanol to be a subsidy to corn ethanol. Crop production payments have existed since 1933, when the Agricultural Adjustment Act was passed. The portion of USDA corn payments associated with ethanol was calculated as:

*Ethanol-Related Payment = Total USDA Corn Payment * (Amount of corn used for alcohol/ Total corn used in U.S.)*

[57] Black liquor, which is a byproduct of wood pulp and used as a fuel in the pulp and paper industry, was eligible for credits under the biofuel credit until January 2010, when the Health Care and Education Affordability Reconciliation Act of 2010 (H.R.4872) eliminated its eligibility for the cellulosic biofuel credit. Because no payments were made for black liquor in FY 2009 under the cellulosic biofuel credit, the only black liquor credits accounted for in this study are under the Alternative Fuel Excise Tax Credit, which is examined in Section B.4.3 below.

[58] Subsidies for biodiesel also stimulate overall diesel consumption, but the reduced emissions from substituting biodiesel for conventional diesel more than offsets the gains in overall diesel fuel consumption. See the discussion in Section 4.5 above.

The proportion of corn used to produce alcohol for fuel was obtained from the USDA Economic Research Service.[59] Total corn payments from the Commodity Credit Corporation (CCC) programs were obtained from the USDA Farm Service Agency.[60] Total corn payments were calculated as a sum of CCC Direct Payments, Counter Cyclical Payments, CCC Production Flexibility Payments, CCC Marketing Loan Write-Offs, CCC Certificate Gains, CCC Loan Deficiency Payments, and Marketing Loss Assistance Payments.

Using USDA data, we modeled the subsidy as increasing the production of alcohol fuels, which are a component of the petroleum supply. We used the fuel subsidy methodology described in Section A.8.1. Although corn ethanol has lower lifecycle CO_2 emissions than gasoline, we find the subsidy increased U.S. CO_2 emissions by about 21.7 million metric tons at a cost of $9.5 billion, for an average of $437 per metric ton increased.

Similar to the analysis reported in section B.3.2 above, we find that an increased supply of corn ethanol reduces the cost of liquid fuels and increases the overall consumption of such fuels. The increased consumption dominates the modest reduction in CO_2 emissions that results from the substitution of ethanol for gasoline.

B.3.4 Expensing of Exploration and Development Costs (Sec. 617)

Since 1916, energy producers have been able to expense exploration and development costs instead of capitalizing and depreciating such expenditures (EIA 2008). This provision primarily benefits oil and gas producers; however, coal producers also receive benefits. The most significant expenditures producers can expense are intangible drilling and development costs (IDCs). IDCs are costs that have no salvage value and are

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[59] USDA Economic Research Service, 2010.
[60] USDA Farm Service Agency, 2010.

necessary for drilling wells and preparing them for production. These expenditures include wages, fuel, repairs, hauling, and supplies. Allowing for IDC is intended to attract capital (Kleemeier, 2009). Independent producers can fully expense IDCs, while integrated companies that expense IDCs must capitalize 30 percent of the IDCs on productive wells (EIA 2008).

Using data from OMB *Analytical Perspectives*, we modeled the tax expenditure as increasing production of oil, gas, and coal, using the fuel subsidy methodology described in Section A.8.1. Because data for expenditures on coal is only available as a single figure for a five-year period, we estimated the portion of the subsidy associated with coal for each year by using annual Joint Committee on Taxation (JCT) reports.[61] We divided the five-year total of the reported other fuels component (which is primarily coal) by the five-year total of oil and natural gas component, and then used that ratio to estimate the annual expenditures on coal subsidies. We further subdivided the expenditures on oil and natural gas by assuming proportionality with yearly values of oil and natural gas production.[62] We find the subsidy increased U.S. CO_2 emissions by about 11.3 million metric tons at a cost of $5.0 billion, for an average of $442 per metric ton increased.

B.3.5 Low Income Home Energy Assistance Program (LIHEAP)

The Low Income Home Energy Assistance Program (LIHEAP) primarily subsidizes home heating and cooling costs for low-income households. LIHEAP was established as a block grant program in 1981 and is run by the Department of Health and Human Services.

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[61] The FY2005 ratio was from JCT 2005c. The FY2006 ratio was from JCT 2006; The FY2007 ratio was from JCT 2007a. The FY2008 ratio was from JCT 2009b. The FY2009 ratio was from JCT 2010.

[62] Value of oil and gas production is calculated from oil and gas prices and production reported in EIA's AEO reports.

Payments are generally made to energy providers rather than households. Only a portion of eligible households participate in the program.[63]

The energy use effects of potentially removing LIHEAP assistance seem unclear. Many utilities are required by state regulations to provide heating and cooling service to consumers during periods of extreme temperatures.[64] If removing LIHEAP assistance did not result in changes in consumption (i.e. service cut-offs), then increased rates to all customers would likely occur.

Using EIA data, we modeled the subsidy as increasing residential consumption of oil, gas, and electricity, using a modified version of the fuel subsidy methodology described in Section A.8.1. Although only a portion of households benefit from LIHEAP assistance, utilities will pass cost onto other customers if this subsidy is removed.

Because LIHEAP benefits more than one fuel, we estimated the proportional tax break to each fuel category. The oil and natural gas portions of LIHEAP were estimated using the program's annual appropriations for heating assistance. Actual heating and cooling expenditure data was available for 1999-2006, while 2007-2009 heating and cooling expenditures were approximated with 1999-2006 average percent expenditures.[65] For example, heating represented an average of 52 percent of total LIHEAP spending from 1999-2006.

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[63] In 2004, 5 to 6 million households received LIHEAP assistance, while 35.4 million households were eligible under the Federal LIHEAP income maximum standard (EIA 2008).

[64] Heating services can be terminated during cold weather periods in only a few states, including Alaska, California, Colorado, Nevada, New York, North Dakota, Oregon, and Virginia. See the seasonal termination protection regulations summarized by the U.S. Department of Health and Human Services at http://liheap.ncat.org/Disconnect/SeasonalDisconnect.htm.

[65] FY 2005-2006 detailed expenditures from U.S. DHHS 2006a. FY 2007 detailed expenditures from EIA 2008. FY 2008-2009 detailed expenditures from U.S. DHHS 2010 FY2010 detailed expenditures from NEADA 2009.

Therefore, we estimated 2007-2009 LIHEAP heating expenditures as 52 percent of the total LIHEAP budget. Once heating expenditures were known, we approximated the portion of heating expenditures for oil and natural gas and electricity. Data on percentage of LIHEAP households by type of heating fuels in 2001 was available from the U.S. Department of Health and Human Services.[66] Because 2001 was the latest available year for date on residential fuel use and the previous survey was conducted in 1997, we relied on the 2001 proportions of electricity and fossil fuels for all years in our study. The electricity portion of LIHEAP was assumed to be all LIHEAP cooling assistance plus the share of electricity within LIHEAP heating assistance.

We find the LIHEAP program increased U.S. CO_2 emissions by about 11.1 million metric tons at a cost of $8.5 billion, for an average of $765 per metric ton increased. These gains come primarily from the direct use of fossil energy in the homes.

B.3.6 Excess of Percentage over Cost Depletion (Sec. 613)

Capital costs of oil and gas wells can be recovered through depletion deduction. Percentage depletion for oil and gas has been in the tax code since the 1926 Revenue Act, and applies to all mineral resources in order to attract capital to a risky and capital-intensive industry (Kleemeier 2009). Under the current method of percentage depletion, 15 percent of revenue from oil and gas extraction may be excluded from tax (JCT 2010). Only independent producers and royalty owners currently qualify for percentage depletion, and producers may only claim percentage depletion on 1,000 barrels of average

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[66] 52.4 percent of LIHEAP recipient households relied on natural gas for heating in 2001, while 21.3 percent used electricity, 10.0 percent used fuel oil, 11.0 percent used LPG, 2.2 percent used kerosene, and 2.8 percent used other fuels or did not report. These data are derived from the Energy Information Administration 2001 Residential Energy Consumption Survey (RECS). See U.S. DHHS 2006b.

daily production. For coal and lignite, the percentage depletion rate is 10 percent (JCT 2010).

Because percentage depletion is calculated without taking into account the taxpayer's depletable property basis, a claim can continue to be made after all expenses related to acquiring and developing the property have been recovered (Treasury 2009). Typically costs are fully or mostly recovered due to expensing intangible drilling and development costs (IDCs), pool of capital doctrine and short period amortization for geological and geophysical costs (Johnson 2009).

Using data from OMB *Analytical Perspectives*, we modeled the tax expenditure as increasing production of oil, gas, and coal, using the fuel subsidy methodology described in Section A.8.1. We estimated the proportion associated with coal, oil, and gas. The ratio of coal to oil and gas tax expenditure was estimated for each year using the same method as for Expensing of Exploration and Development Costs, using JCT and EIA data as described above (and cited in footnotes 64 and 65). We find the subsidy increased U.S. CO_2 emissions by about 9.9 million metric tons at a cost of $3.5 billion, for an average of $358 per metric ton increased.

B.3.7 Capital Gains Treatment of Royalties in Coal (Sec. 631c)

This provision was established under the 1951 Revenue Act. Individuals who own coal mining rights can have coal royalties taxed at a lower individual capital gains tax rate instead of at a higher individual top tax rate (EIA 2008). We modeled the subsidy as increasing production of coal, using the fuel subsidy methodology described in Section A.8.1. Using data from OMB *Analytical Perspectives*, we find the tax expenditure increased

U.S. CO_2 emissions by about 9.7 million metric tons at a cost of $0.6 billion, for an average of $66 per metric ton increased.

B.3.8 Exclusion of Special Benefits for Disabled Coal Miners (20 USC 922c)

This provision allows for payments to disabled miners out of the Black Lung Trust Fund for medical-related travel expenses. Such payments are excluded from taxable income. This exclusion was enacted under the Department of Labor, Health and Human Services, and Education and Related Agencies Appropriation Act, 1986 (EIA 2008). We modeled the subsidy as increasing production of coal (because government payments to disabled coal miners reduces the salaries the coal companies must pay the miners to compensate them for health risks), using the fuel subsidy methodology described in Section A.8.1. Using data from OMB *Analytical Perspectives*, we find the tax expenditure increased U.S. CO_2 emissions by about 3.6 million metric tons at a cost of $0.2 billion, for an average of $66 per metric ton increased.

B.3.9 Special Rules for Refund of the Coal Excise Tax

The Energy Improvement and Extension Act of 2008 allowed coal producers and exporters to receive a refund of the coal excise tax. Coal producers and exporters were eligible for the refund if they filed an excise tax return after October 1, 1990 and before the enactment of this Act.[67] Coal producers are eligible for a full refund, while coal exporters may receive $0.825 per ton of coal exported. We modeled the subsidy as increasing production of coal, using the fuel subsidy methodology described in Section A.8.1. Using JCT data, we find the tax expenditure increased U.S. CO_2 emissions by about 3.2 million metric tons at a cost of $0.3 billion, for an average of $80 per metric ton increased.

[67] See Govtrack.us 2008.

B.3.10 84-Month Amortization of Pollution Control Equipment (Sec. 169 and 291)

This provision allows a taxpayer to recover the cost of an eligible pollution control facility over a period of 84 months. Such facilities include industrial and electric power facilities using coal as a fuel that are required to purchase new pollution control equipment. Even though the new amortization rules specify a longer time period than the old rules, which allowed for 60-month amortization, accelerated depreciation represents a subsidy.

Using JCT data, we modeled the subsidy as increasing the supply of coal using the fuel subsidy methodology described in Section A.8.1. We find the subsidy increased U.S. CO_2 emissions by about 3.2 million metric tons at a cost of $0.2 billion, for an average of $76 per metric ton increased.[68]

B.3.11 Temporary 50 Percent Expensing for Equipment Used in the Refining of Liquid Fuels (Sec. 179C)

Established by the EPACT 2005, this provision allows taxpayers to expense 50 percent of the cost of qualified refinery property used for processing liquid fuel. This provision is set to expire on December 31, 2013 (JCT 2010). We modeled the subsidy as increasing oil and biofuels production using the fuel subsidy methodology described in Section A.8.1. Using data from OMB *Analytical Perspectives*, we find the tax expenditure increased U.S. CO_2 emissions by about 2.0 million metric tons at a cost of $1.2 billion, for an average of $580 per metric ton increased.

B.4 Other Subsidies that Increased CO_2 Emissions

[68] By focusing on the effects of the subsidy only, our analysis ignores the fact that a regulatory requirement to purchase the equipment may reduce the supply of electricity from coal-fired plants.

We find another nine energy subsidies also increased CO_2 emissions from 2005 to 2009. These include:

- enhanced oil recovery credit;
- partial expensing for advanced mine safety equipment;
- black liquor;
- the treatment of natural gas distribution pipelines as property with a 15-year lifespan;
- exception from passive loss limitation for working interests in oil and gas properties;
- amortization of all geological and geophysical expenditures over two years;
- alternative fuel excise tax credit;
- pass through of credits for low sulfur diesel to cooperative owners; and
- expensing of capital costs for compliance with EPA sulfur regulations.

Over the five years examined, these nine programs increased U.S. CO_2 emissions by about 2.3 million metric tons at a total cost of $3.8 billion, for an average of $1,664 per metric ton of CO_2 increased.

B.4.1 Enhanced Oil Recovery Credit (Sec. 43)

The enhanced oil recovery tax credit allows a taxpayer to claim a general business credit for 15 percent of the costs of an enhanced oil recovery (EOR) project. EOR projects use tertiary recovery methods to increase the amount of recoverable oil. The credit was established under the Omnibus Budget Reconciliation Act of 1990. The credit also benefits the construction of treatment plants in Alaska that process natural gas for pipeline delivery. In our study period, this credit was only available in 2005. The credit is available when the inflation-adjusted price of oil is under $39 per barrel (in 2007 dollars) in the preceding year (EIA 2008). Since the average price of oil exceeded this threshold in 2006-2009, the credit was zero in these years.

Using data from OMB *Analytical Perspectives*, we modeled the tax expenditure as increasing oil production, using the fuel subsidy methodology described in Section A.8.1.

We find the subsidy increased U.S. CO_2 emissions by about 0.69 million metric tons at a cost of $0.33 billion, for an average of $480 per metric ton increased.

B.4.2 Partial Expensing for Advanced Mine Safety Equipment (Sec. 179E)

Enacted under the Tax Relief and Welfare Act of 2006, this provision allows eligible mine safety equipment to be expensed instead of capitalized (EIA 2008). We modeled the subsidy as increasing coal production, using the fuel subsidy methodology described in Section A.8.1. Using data from OMB *Analytical Perspectives*, we find the tax expenditure increased U.S. CO_2 emissions by about 0.42 million metric tons at a cost of $0.04 billion, for an average of $73 per metric ton increased.

B.4.3 Black Liquor

Black liquor is a wood byproduct from pulp making, which has been used to power paper mills for over 70 years (JCT 2009a). Black liquor producers began claiming the Alternative Fuel Tax Credit in 2009 because black liquor qualified as a liquid fuel derived from biomass. To qualify for the credit, paper manufacturers mixed black liquor with diesel fuel (JCT 2009a). Therefore, the alternative fuel mixture credit served as a negative incentive (in terms of carbon emissions) because paper manufacturers altered their practices to consume more diesel fuel. Because paper manufacturers have no excise tax liability, they received their claims as cash payments (JCT 2009a).

The JCT estimates that black liquor claimed $2.5 billion in cash payments for the first half of 2009 (JCT 2009a). The total credit claimed for black liquor in 2009 is likely to be much higher. TerraChoice Market Services Inc., a pulp market data provider, estimates that government credits may exceed revenue for companies that claim the credit (Ivry and Donville 2009).

Using JCT data, we calculated the effects of this unintended black liquor subsidy outside our simulation model. We estimated the amount of diesel fuel that paper manufacturers added to black liquor by assuming they added just enough diesel to meet the minimum 0.1 percent requirement. Because the total subsidy claimed in the first half of 2009 was $2.5 billion, and the subsidy was $0.5 per gallon, black liquor producers consumed 5.0 billion gallons of black liquor combined with diesel fuel. Of this, 5 million gallons would have been diesel. A CO_2 coefficient was used for diesel to determine the effects of the black liquor subsidy. We find the subsidy increased U.S. CO_2 emissions by about 0.28 million metric tons at a cost of $2.50 billion, for an average of $8,857 per metric ton increased.

B.4.4 Treatment of Natural Gas Distribution Pipelines as Property with a 15-Year Lifespan (Sec. 168(e))

A 15-year MACRS recovery period is allowed for natural gas distribution lines if the original use of the property starts with the taxpayer. Lines must be put in service after April 11, 2005 and before January 1, 2011 (JCT 2010). This provision was part of EPACT 2005. Because the subsidy reduces the cost of delivering natural gas, we modeled it as increasing natural gas supply, using the fuel subsidy methodology described in Section A.8.1. Using data from OMB *Analytical Perspectives*, we find the tax expenditure increased U.S. CO_2 emissions by about 0.22 million metric tons at a cost of $0.24 billion, for an average of $1,107 per metric ton increased.

B.4.5 Exception from Passive Loss Limitation for Working Interests in Oil and Gas Properties (Sec. 469)

Applying principally to partnerships and individuals, this program provides an exception for limits on passive losses for working interests in oil and natural gas properties. Such taxpayers can offset their losses from passive activities against active income. Without this exception, passive losses could only be carried forward to offset passive income in future years. Established with the Tax Reform Act of 1986, this provision has no expiration date (EIA 2008). We modeled the subsidy as increasing oil and gas production, using the fuel subsidy methodology described in Section A.8.1. Using data from OMB *Analytical Perspectives*, we find the tax expenditure increased U.S. CO_2 emissions by about 0.18 million metric tons at a cost of $0.14 billion, for an average of $754 per metric ton increased.

B.4.6 Amortization of All Geological and Geophysical Expenditures Over Two Years (Sec. 167(h))

Independent producers and smaller integrated oil companies may amortize over two years their geological and geophysical expenditures that are related to domestic oil and gas exploration. Integrated oil companies may amortize such expenses over seven years (JCT 2010). This provision was established under EPACT 2005 and does not have an expiration date. We modeled the subsidy as increasing oil and gas production, using the fuel subsidy methodology described in Section A.8.1. Using data from OMB *Analytical Perspectives*, we find the tax expenditure increased U.S. CO_2 emissions by about 0.17 million metric tons at a cost of $0.12 billion, for an average of $717 per metric ton increased.

B.4.7 Alternative Fuel Excise Tax Credit

The Alternative Fuel Tax Credit includes both the alternative fuel credit and the alternative fuel mixture credit. The alternative fuel credit is $0.50 per gallon of alternative fuel sold for use as a motor fuel in a highway vehicle. The alternative fuel credit is $0.50 per gallon of alternative fuel used by the taxpayer in producing an alternative fuel mixture for sale or business use (JCT 2010). An alternative fuel mixture is defined as a mixture of alternative fuel and at least one-tenth of one percent taxable fuel (e.g. gasoline, diesel fuel, or kerosene).[69]

The credit primarily benefitted natural gas producers before black liquor producers began claiming the credit in 2009. The alternative fuel mixture credit generally expired after December 31, 2009, except in the case of liquefied hydrogen, which expires September 30, 2014. Treating black liquor separately as described in section B.4.3 above, we modeled the remaining portion of the subsidy as increasing the demand for natural gas in the transportation sector. Because there is relatively little interfuel substitution between gasoline and natural gas in the transportation sector, the effect of the subsidy was to increase the consumption of natural gas considerably more than oil consumption was reduced. Consequently, using JCT data we find the tax expenditure increased U.S. CO_2 emissions by about 0.13 million metric tons at a cost of $0.30 billion, for an average of $2,288 per metric ton increased—even though natural gas has about 30 percent lower CO_2 emissions per Btu than oil.

Under the program, the government obtained a small amount of revenue in 2009 through claw-back provisions that reduced natural gas consumption. For that year, we estimate the program reduced CO_2 emissions.

B.4.8 Pass Through of Credits for Low Sulfur Diesel to Cooperative Owners (Sec. 179B)

Investments undertaken to comply with EPA low sulfur diesel regulations can be expensed. This provision allows cooperatives to pass through the deductions they obtain

[69] Alternative fuel includes liquefied petroleum gas, P Series Fuels compressed or liquefied natural gas, liquefied hydrogen, any liquid fuel derived from coal through the Fischer-Tropsch process, compressed or liquefied gas derived from biomass, and liquid fuel derived from biomass.

from expensing the capital costs of EPA sulfur regulations to members of the cooperative. This provision was enacted under the Energy Tax Incentives Act of 2005 (JCT 2006) and applies to investments made between January 1, 2003 and December 31, 2009 (JCT 2007b). For our study period, this subsidy was only in effect for one year—2005.

Using data from OMB *Analytical Perspectives*, we modeled the subsidy as increasing oil supply, using the fuel subsidy methodology described in Section A.8.1. We find the subsidy increased U.S. CO_2 emissions by about 0.09 million metric tons at a cost of $0.04 billion, for an average of $479 per metric ton increased.

B.4.9 Expensing of Capital Costs for Complying with EPA Sulfur Regulations (Sec. 179B)

Small refiners can deduct 75 percent of capital costs related to complying with the Highway Diesel Fuel Sulfur Control requirement of the EPA. This provision was enacted under the American Jobs Creation Act in 2004 (JCT 2010). We modeled the subsidy as increasing oil and gas production, using the fuel subsidy methodology described in Section A.8.1. Using data from OMB *Analytical Perspectives*, we find the tax expenditure increased U.S. CO_2 emissions by about 0.09 million metric tons at a cost of $0.07 billion, for an average of $813 per metric ton increased.

Table B.1. Production Credit (sec. 45)

Generation type	Credit amount for 2010 (cents per kwh)	Expiration
Wind	2.2	December 31, 2012
Closed-loop biomass	2.2	December 31, 2013
Open-loop biomass (including agricultural livestock waste nutrient facilities)	1.1	December 31, 2013
Geothermal	2.2	December 31, 2013
Solar (pre-2006 facilities only)	2.2	December 31, 2005
Small irrigation power	1.1	December 31, 2013
Municipal solid waste	1.1	December 31, 2013
Qualified hydropower	1.1	December 31, 2013
Marine and hydrokinetic	1.1	December 31, 2013

Source: JCT 2010

Table B.2. Investment Tax Credit (sec. 48)

	Credit rate	Maximum credit	Expiration
Equipment to produce a geothermal deposit	10%	none	None
Equipment to use ground or ground water for heating or cooling	10%	none	December 31, 2016
Microturbine property (< 2 Mw electrical generation power plants of >26% efficiency)	10%	$200 per Kw of capacity	December 31, 2016
Combined heat and power property	10%	none	December 31, 2016
Solar electric or solar hot water property	30% (10% after December 31, 2016)	none	None
Fuel cell property	30%	$1,500 for each ½ Kw of capacity	December 31, 2016
Small (<100 Kw capacity) wind electrical generation property	30%	none	December 31, 2016

Source: JCT 2010

Table B.3. Components of the Biodiesel Fuels Credit

Tax Provision	Per Gallon Credit	Expiration	Description
Biodiesel credit	$1.00	Extended to December 31, 2011	Available for 100 percent of biodiesel fuel used as a fuel in taxpayer's business or sold at retail and used as a fuel by retail buyer.
Biodiesel mixture credit	$1.00	Extended to December 31, 2011	Available to producers of a mixture of biodiesel and at least one-tenth of one percent of diesel fuel. Mixture must be sold as a fuel or used as a fuel. Credit is not allowed for casual off-farm production.
Small agri-biodiesel producer credit[a]	$0.10 (in addition to biodiesel credit)	Extended to December 31, 2011	Available in addition to the biodiesel credit. Agri-biodiesel must be sold for use as a fuel in a business, sold at retail for use as a fuel, or sold for use in the production of a qualified biodiesel fuel mixture.
Renewable diesel credit[b]	$1.00	Extended to December 31, 2011	Available to producers of a qualified mixture with diesel fuel. In the case of aviation fuel, kerosene is treated as diesel fuel.

Information assembled from JCT 2010.

[a] Agri-biodiesel is defined as biodiesel derived only from virgin oils, such as corn, soybeans, sunflower seeds, cottonseeds, canola, crambe, rapeseeds, safflowers, flaxseeds, rice bran, mustard seeds, camelina, or animal fats. A small producer is defined as one whose agri-biodiesel production capacity does not exceed 60 million gallons per year. The credit is available up to a maximum of 15 million gallons.

[b] Renewable diesel is defined as liquid fuel that is derived from biomass and meets the requirements of the Clean Air Act, American Society of Testing and Materials (ASTM) D975, or ASTM D396.

Table B.4. Components of the Alcohol Fuels Excise Tax Credit

Tax Provision	Per Gallon Credit	Expiration	Description
Alcohol fuel credit	$0.45 for ethanol $0.60 for other alcohol	December 31, 2010	Available for alcohol used as a fuel in taxpayer's business or sold at retail and used as a fuel by retail buyer. Cannot be claimed for alcohol bought at retail.
Alcohol mixture credit	$0.45 for ethanol $0.60 for other alcohol	December 31, 2010	Available to producers of a mixture of alcohol and a taxable fuel and must be sold as a fuel or used as a fuel. Can be taken as an excise tax credit (Sec. 6426) or as a payment (Sec. 6427)
Small ethanol producer credit[a]	$0.10 (in addition to credits above)	December 31, 2010	Available in addition to the alcohol fuel and mixture credits. Ethanol must be sold for use as a fuel in a business, sold at retail for use as a fuel, or sold for use in the production of a qualified alcohol fuel mixture.
Cellulosic biofuel producer credit[b]	$1.01[c]	December 31, 2012	Available to cellulosic biofuel producers that are registered with the IRS. Biofuel must be sold for use as a fuel in a business, sold at retail for use as a fuel, or sold for use in the production of a qualified biofuel fuel mixture. Fuel must be produced and used as fuel in the U.S.

Information assembled from JCT 2010.

[a] Small producer is defined as one whose alcohol production capacity does not exceed 60 million gallons per year. The credit is available up to a maximum of 15 million gallons, however, this limitation is waived for cellulosic ethanol.

[b] These credits do not extend to advanced biofuels, such as those derived from algae.

[c] Except for alcohol, which is $1.01 less the alcohol fuel mixture credit and small ethanol producer credit. When these additional credits expire, cellulosic biofuel from alcohol will receive the full $1.01 per gallon credit.

Appendix C. Financial Details of the Energy Subsidies

Table C1. Pricing the Energy Subsidies

		Nominal Price per Unit or Unit Saved via Efficiency				
Subsidy	**Fuel**	**2005**	**2006**	**2007**	**2008**	**2009**
Low-cost Residential Weatherization	Residential Efficiency					
	Gas Share (Tcf)	0.00061	0.00076	0.00054	0.00057	0.01403
	Oil Share (mmpd)	0.00015	0.00019	0.00012	0.00011	0.00288
	Electricity Share (billion kwh)	0.17206	0.23622	0.15885	0.16072	0.77760
EE Conservation Block Grant Program	Residential Efficiency					
	Gas Share (Tcf)	-	-	-	-	0.00068
	Oil Share (mmpd)	-	-	-	-	0.00014
	Electricity Share (billion kwh)	-	-	-	-	0.19638
	Commercial Efficency					
	Gas Share (Tcf)	-	-	-	-	0.00421
	Oil Share (mmpd)	-	-	-	-	0.00134
	Electricity Share (billion kwh)	-	-	-	-	1.81877
USDA Rural Energy for America Program	Electricity from Renewables (cents per kwh)	0.02578	0.02498	0.02291	0.01895	0.02730
	Residential Efficiency					
	Gas Share (Tcf)	-	-	-	0.00004	0.00007
	Oil Share (mmpd)	-	-	-	0.00001	0.00002
	Electricity Share (billion kwh)	-	-	-	0.01072	0.02116
DOE State Energy Program	Biodiesel ($ per Barrel)	0.00940	0.00606	0.00628	0.00395	0.24933
	Electricity from Renewables (cents per kwh)	0.01708	0.01243	0.01579	0.01200	0.73346
	Residential Efficiency					
	Gas Share (Tcf)	0.00001	0.00000	0.00001	0.00001	0.00047
	Oil Share (mmpd)	0.00000	0.00000	0.00000	0.00000	0.00010
	Electricity Share (billion kwh)	0.00188	0.00152	0.00202	0.00155	0.13656
	Commercial Efficency					
	Gas Share (Tcf)	0.00004	0.00003	0.00004	0.00003	0.00293
	Oil Share (mmpd)	0.00002	0.00001	0.00002	0.00001	0.00093
	Electricity Share (billion kwh)	0.01822	0.01437	0.01916	0.01500	1.26481
Special Tax Rate for Nuclear Decommissioning Reserve Funds	Electricity from Nuclear (cents per kwh)	0.06503	0.06469	0.07584	0.08899	0.10135
Credit for Energy Efficiency Improvements of Existing Homes	Residential Efficiency					
	Gas Share (Tcf)	-	0.00055	0.00090	0.00049	0.00148
	Oil Share (mmpd)	-	0.00013	0.00020	0.00010	0.00030

	Electricity Share (billion kwh)	-	0.16873	0.26710	0.13980	0.42817
Renewables PTC+ITC+Grants	Electricity from Renewables (cents per kwh)	0.28120	0.53884	0.39675	0.79992	1.24088

Nominal Price per Unit or Unit Saved via Efficiency

Subsidy	Fuel	2005	2006	2007	2008	2009
Credit for Energy Efficient Appliances	Residential Efficiency					
	Gas Share (Tcf)	-	0.00057	0.00095	0.00052	0.00156
	Oil Share (mmpd)	-	0.00007	0.00004	0.00005	0.00007
	Electricity Share (billion kwh)	-	0.09255	0.05912	0.07668	0.10266
Exclusion for Utility Sponsored Conservation Measures	Residential Efficiency					
	Gas Share (Tcf)	0.00021	0.00026	0.00028	0.00026	0.00036
	Oil Share (mmpd)	0.00005	0.00006	0.00006	0.00005	0.00007
	Electricity Share (billion kwh)	0.05857	0.08070	0.08435	0.07294	0.10516
Deduction for Certain Energy-Efficient Commercial Property	Commericial Efficiency					
	Gas Share (Tcf)	-	0.00014	0.00032	0.00026	0.00011
	Oil Share (mmpd)	-	0.00005	0.00011	0.00008	0.00003
	Electricity Share (billion kwh)	-	0.06178	0.14102	0.11077	0.04638
Biodiesel Excise Tax and Small Agri-Biodiesel Producer Tax Credits	Biodiesel ($ per barrel)	-	-	15.21735	58.58951	59.37669
EE Appliance Rebate Program	Residential Efficiency					
	Gas Share (Tcf)	-	-	-	-	0.00082
	Oil Share (mmpd)	-	-	-	-	0.00017
	Electricity Share (billion kwh)	-	-	-	-	0.23573
USDA Electric Programs	Electricity (cents per kwh)	0.00097	0.00175	0.00128	0.00417	0.00393
Credit for Investment in Clean Coal Facilities	Coal ($ per ton)	-	-	0.02610	0.02570	0.17121
Five-Year MACRS for Solar, Wind, Biomass, and Ocean Thermal	Electricity from Renewables (cents per kwh)	-	-	-	0.16493	0.21272
Credit for Construction of New Energy-Efficient Homes	Residential Efficiency					
	Gas Share (Tcf)	-	0.00002	0.00005	0.00006	0.00008
	Oil Share (mmpd)	-	0.00001	0.00001	0.00001	0.00002
	Electricity Share (billion kwh)	-	0.00734	0.01406	0.01823	0.02254
USDA High Energy Cost Grants	Electricity (cents per kwh)	0.00055	0.00102	0.00051	0.00049	0.00048
Credit for Holding Clean Renewable Energy Bonds	Electricity from Renewables (cents per kwh)	-	0.02113	0.1935	0.03299	0.04964
30% Credit for Residential Purchases/ Installations of Solar and Fuel Cells	Electricity from Renewables (cents per kwh)	-	0.01057	0.00968	0.01649	0.07800
USDA Biorefinery Assistance Guaranteed Loans	Biodiesel ($ per barrel)	-	-	-	-	5.65457
DOE Residential Buildings	Residential Efficiency					
	Gas Share (Tcf)	-	-	-	-	0.00006

	Oil Share (mmpd) Electricity Share (billion kwh)	- -	- -	- -	- -	0.00001 0.01704
DOE Loan Guarantees	Electricity from Renewables (cents per kwh)	-	-	-	0.00368	0.08267

Nominal Price per Unit or Unit Saved via Efficiency

Subsidy	Fuel	2005	2006	2007	2008	2009
National Accounts Acceleration in Support of the Commercial Buildings Initiative	Commericial Efficiency					
	Gas Share (Tcf)	-	-	-	-	0.00003
	Oil Share (mmpd)	-	-	-	-	0.00001
	Electricity Share (billion kwh)	-	-	-	-	0.01286
Federal Electricity Interest Rate Support to Public Utilities	Residential Efficiency					
	Gas Share (Tcf)	0.00061	0.00076	0.00054	0.00057	0.01403
	Oil Share (mmpd)	0.00015	0.00019	0.00012	0.00011	0.00288
	Electricity Share (billion kwh)	0.17206	0.23622	0.15885	0.16072	0.77760
Federal Electricity Interest Rate Support to Public Utilities	Electricity (cents per kwh)	0.00018	0.00008	0.00007	0.00009	0.00007
	Electricity Produced from					
	Coal (cents per kwh)	0.00006	0.00011	0.00009	0.00009	0.00009
	Natural Gas (cents per kwh)	0.00000	0.00000	0.00000	0.00000	0.00001
	Hydropower (cents per kwh)	0.00193	0.00201	0.00244	0.00274	0.00274
	Nuclear (cents per kwh)	0.00014	0.00019	0.00018	0.00019	0.00023
	Renewables (cents per kwh)	0.00000	0.00000	0.00000	0.00000	0.00000
USDA Renewable Energy Program Account	Electricity from Renewables (cents per kwh)	0.01172	0.00951	0.01548	0.01402	0.01914
USDA Repowering Assistance Payments	Biodiesel ($ per barrel)	-	-	-	-	2.47403
Deferral of Gain from Dispositions of Transmission Property to Implement FERC Restructuring Policy	Electricity (cents per kwh)	0.00013	0.00016	0.00016	-0.00001	0.00000
Renewable Energy Production Incentive (REPI)	Electricity from Renewables (cents per kwh)	0.00581	0.00523	0.00479	0.00409	0.00355
Expensing of Capital Costs with Respect to Complying with EPA Sulfur Regulations	Natural Gas ($ per million Btu)	0.00030	0.00024	0.00022	0.00062	0.00015
	Oil ($ per barrel)	0.00169	0.00209	0.00208	0.00653	0.00250
Pass Through Low Sulfur Diesel to Cooperative Owners	Oil ($ per barrel)	0.01359	-	-	-	-
Alternative Fuel Excise Tax Credit	Natural Gas ($ per million Btu)	-	-	0.00929	0.00952	-0.00257
Amortize All Geological and Geophysical Expenditures over 2 Years	Natural Gas ($ per million Btu)	-	0.00024	0.00108	0.00042	0.00062
	Oil ($ per barrel)	-	0.00209	0.01038	0.00435	0.01001
Exception from Passive Loss Limitation for Working Interests in Oil and Gas Properties	Natural Gas ($ per million Btu)	0.00120	0.00071	0.00065	0.00021	0.00031
	Oil ($ per barrel)	0.00677	0.00626	0.00623	0.00218	0.00501
Natural Gas Distribution Pipelines Treated as 15-Year Property	Natural Gas ($ per million Btu)	-	0.00121	0.00344	0.00435	0.00446

		Nominal Price per Unit or Unit Saved via Efficiency				
Subsidy	**Fuel**	**2005**	**2006**	**2007**	**2008**	**2009**
Black Liquor		Separate Calculation				
Partial Expensing for Advanced Mine Safety Equipment	Coal ($ per ton)	-	-	0.00870	0.01713	-
Enhanced Oil Recovery Credit	Oil ($ per barrel)	0.10190	-	-	-	-
Temporary 50% Expensing for Equipment Used in the Refining of Liquid Fuels	Oil ($ per barrel)	-	0.00343	0.00996	0.12344	0.26654
84-Month Amortization of Pollution Control Equipment	Coal ($ per ton)	0.00175	0.00889	0.02610	0.08565	0.09512
EIEA Stimulus: Special Rules for Refund of the Coal Excise Tax	Coal ($ per ton)	-	-	-	-	0.24730
Exclusion of Special Benefits for Disabled Coal Miners	Coal ($ per ton)	0.04377	0.04447	0.04351	0.03426	0.03805
Capital Gains Treatment of Royalties in Coal	Coal ($ per ton)	0.07878	0.14230	0.15663	0.09422	0.06658
Excess of Percentage over Cost Depletion	Coal ($ per ton)	0.03689	0.08816	0.08156	0.08879	0.04478
	Natural Gas ($ per million Btu)	0.01645	0.01571	0.01497	0.01700	0.00453
	Oil ($ per barrel)	0.09279	0.13795	0.14455	0.17770	0.07332
UHEAP Heating and Cooling Assistance	Natural Gas ($ per million Btu)	0.13232	0.19190	0.12714	0.14377	0.28726
	Oil ($ per barrel)	0.65012	0.95749	0.69327	0.86219	1.69962
	Electricity ($ per kwh)	0.02368	0.03380	0.02302	0.02719	0.05333
Expensing of Exploration and Development Costs	Coal ($ per ton)	0.04267	0.02240	0.02635	0.05889	0.17999
	Natural Gas ($ per million Btu)	0.01024	0.01556	0.01075	0.03293	0.02241
	Oil ($ per barrel)	0.05779	0.13668	0.10374	0.34420	0.36312
USDA Corn Payments Attributable to Ethanol	Ethanol ($ per barrel of alcohol fuel)	17.333957	22.16164	12.41798	6.07007	6.23042
Alcohol Fuels Excise Tax and Credit	Ethanol ($ per barrel of alcohol fuel)	16.38434	22.28606	21.34101	19.97395	20.72123
Alternative Fuel Production Credit	Coal ($ per ton)	2.03087	2.65026	2.54081	0.50536	0.05707

Table C2. Federal Energy Subsidy Expenditures in 2005 and 2009

Fuel	Tax Expenditures	Direct Spending	Interest Rate Support	Total
2005 Subsidies				
Biofuel	1,692	1,790	-	3,482
Black liquor	-	-	-	-
Petroleum (natural gas and oil)	1,405	1,013	-	2,418
Coal	2,804	-	-	2,804
Conservation and Efficiency	88	309	-	397
Electricity	626	382	1,572	2,580
Nuclear	549	-	-	549
Renewables	264	41	-	304
Total	7,428	3,535	1,572	**12,535**

	Tax Expenditures	Direct Spending	Interest Rate Support	Total
2009 Subsidies				
Biofuel	6,050	1,677	5	7,732
Black liquor	2,500	-	-	2,500
Petroleum (natural gas and oil)	2,618	1,976	-	4,593
Coal	946	-	-	946
Conservation and Efficiency	930	11,752	-	12,682
Electricity	100	752	1,437	2,289
Nuclear	800	-	-	800
Renewables	2,230	167	20	2,417
Total	16,174	16,324	1,462	**33,960**

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