Center for American Progress

Early Deployment

Maximizing Carbon Capture and Storage Under the Lieberman Warner Global Warming Bill

Ken Berlin and Robert Sussman

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A comparison of bonus allowances with an emission performance standard plus subsidies under S. 2191

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Introduction and Summary

The Lieberman-Warner Climate Security Act, S. 2191, sponsored by Sens. Joseph Lieberman (I-CT) and John Warner (R-VA), is a major leap forward in efforts to reduce emissions of carbon dioxide (CO_2) and other greenhouse gases that cause global warming. It would establish a cap-and-trade program that would reduce U.S. emission of greenhouse gases by nearly 20 percent to 25 percent by 2020, and by 65 percent to 70 percent by 2050. The Senate should enhance and pass this legislation.

A critical step in meeting S. 2191's targets is demonstration and deployment of technology that enables coal-fired power plants to capture and store their carbon emissions in underground formations rather than releasing them into the atmosphere. Rapid and widespread deployment of this carbon capture-and-storage, or CCS technology in new coal-fired plants would greatly reduce the carbon footprint of coal-fired electricity generation in the United States and developing countries such as China. This would preserve the viability of coal as an important energy source in a world that must constrain carbon emissions to combat global warming.

Without rapid CCS deployment, the future role of coal will become increasingly uncertain.[1] If built, a new generation of uncontrolled coal plants would remain in service for several decades, emitting billions of additional tons of CO_2 that would compromise our ability to achieve the deep reductions required under S. 2191. Investors may well be reluctant to finance these plants because of uncertainties in the future price of allowances and the large costs required to control their emissions at a later date.

Moreover, heightened opposition to new, uncontrolled coal plants could motivate utilities to turn to other sources of electricity generation. Storing and capturing the CO_2 emissions of new coal plants from the outset would increase their acceptability to the public and provide greater certainty to investors. This would ensure that America's coal reserves could continue to play a major role in our energy mix.

Incentives for CCS under S. 2191

S. 2191 contains a number of provisions to encourage CCS. While these provisions will help CCS deploy earlier than in the absence of subsidies, a careful analysis demonstrates that they will achieve less deployment than is possible, and at a higher cost than is necessary. More effective and less costly would be an emission performance standard for all new coal plants based on the current CO_2 capture capabilities of the best available CCS technology.

In conjunction with this standard, Congress should provide subsidies to accelerate CCS deployment and offset its increased costs. This two-fold approach was first described in "Global Warming and the Future of Coal."[2] The combination of assured financial support for new coal plants with tight emission standards would provide a secure path forward for coal-fired electricity—even with increasingly stringent limits on CO_2 emissions.

S. 2191 does not have a performance standard that would require new coal plants to install CCS, or achieve equivalent reductions. Instead, it uses a variety of financial incentives as inducements for CCS adoption. One such inducement, embodied in Title III, is to award "bonus allowances" to plant owners who capture and store their carbon emissions. A second inducement, embodied in several provisions of Title IV, is to provide direct financial support to CCS demonstration and deployment projects, drawn from the proceeds of annual auctions of emission allowances under that Title.

These measures—bonus allowances and direct financial subsidies from auction revenues—would provide markedly different levels of assistance to plant developers, reflecting different premises about how best to spur CCS deployment.

The bonus allowance program in Title III would award free allowances to plant owners starting at a rate of 4.5 allowances for each ton of CO_2 captured and sequestered, with the bonus allowance rate diminishing over time to zero in 2040. Four percent of all allowances would be set aside for the program, and individual plants would receive bonus allowances for the first 10 years of operation.

The formula for subsidizing CCS under Title IV varies across provisions. Of most interest is Section 4403, which creates a program to stimulate CCS deployment. Under this program, grants would be provided that cover the incremental costs of building and operating a CCS plant as compared with a conventional uncontrolled coal plant.

The incentives in Section 4403 are based on a formula similar to one proposed in our previous report, "Global Warming and the Future of Coal." That paper argues that subsidies would complement a new source emission performance standard by encouraging investment in new coal plants, protecting consumers and businesses in coal-dependent regions from undue energy cost increases, and preventing a decline in coal mining employment. However, we recommend that such subsidies only seek to offset the higher costs of building and operating new coal plants with CCS, not confer additional financial benefits on plant owners.

The combination of assured financial support for new coal plants with tight emission standards would provide a secure path forward for coal-fired electricity—even with increasingly stringent limits on CO_2 emissions

Comparing the Bonus Allowance and Performance Standard Subsidy Mechanisms

This paper presents a detailed analysis of the cost-effectiveness and overall impact on CCS deployment of the bonus allowance and incremental cost (performance standard) subsidy mechanisms. It concludes that the latter approach will result in greater deployment of CCS at a lower per plant cost but *only if an emission performance standard is adopted to require CCS at all new coal plants—as proposed in our May 2007 paper.* This is because an emission performance standard will eliminate the need

to pay plant developers a sizable premium to choose CCS over conventional coal combustion technology.

In comparing the two approaches, our analysis examines two allowance-price scenarios. The first is a low price scenario (similar to the Environmental Protection Agency's carbon price projections for S. 1766 and S. 280) that assumes the cost of allowances begins at $12 per ton in 2012, increasing by 50 cents per year until 2016, and then by $1 per year thereafter to $30 per ton in 2030.[3] The second is a high price scenario (corresponding closely to the EPA carbon price projections for scenario 10 in S. 2191). It assumes that the cost of allowances is $17.50 in 2012, $23.50 in 2016, $32.50 in 2022 and $46 in 2030.[4]

Methodology for Comparing the Two Approaches

To determine the value of the bonus allowances, we first calculate for each year from 2012 to 2030 how many plants would be eligible to receive these allowances before the 4 percent ceiling is reached (see Appendix beginning on page 21). To determine the value of the allowances available for each year, we multiply the total number of allowances in that year by 4 percent and then multiply that amount by the price of the allowances in the year under each scenario. For plants that begin operation in 2012 and 2022, when each 10-year period starts running, we then calculate the total value of the bonus allowances that each plant would receive as well as the total value of the allowances for all plants.

We do a similar calculation to determine the cost of an incremental cost subsidy like the one in Title IV and our performance-standard proposal. To make this calculation, we first assume that the cost differential between CCS plants and conventional coal plants (including both construction and operating costs) is $45 per ton for plants that begin operation in 2016 (the first year when the performance standard would be in effect under our proposal), $38 per ton for plants that begin operation in 2021, and $30 per ton for plants that begin operation in 2026.

We then on a yearly basis multiply the price differential for the specific plant ($45 per ton for plants that go into operation between 2016 and 2020) by the number of tons captured, and subtract from that number the cost that a non-CCS plant would incur in that year to purchase allowances under the two price scenarios.

We next assume that 10 gigawatts of new plants will go into operation for each year from 2016 to 2030 and calculate the total subsidy in each year. For each plant, we calculate the total value of subsidies from the date the plant goes into operation until 2030.

These calculations enable us to compare the value of the bonus allowances and performance standard subsidy on a per plant basis and on an aggregate cost basis. This analysis shows that the bonus allowance program would result in substantial windfalls to plant developers. In the case of scenario 2, the windfall would be well above even conservative estimates of the per ton incremental costs of building and operating plants with CCS.

The bonus allowance program would result in substantial windfalls to plant developers

Overview of Key Findings

In sum, the key findings of our analysis are:

- Bonus allowances issued from 2012 (when the program begins) to 2030 would be worth a total of $68.6 billion under our scenario 1 and $110 billion under our scenario 2.

- Between 2012 and 2028, the bonus allowances would subsidize only 38 GW of coal-fired plants with CCS, with an additional 10 GW becoming eligible for allowances in 2029 and 2030. Thus, bonus allowances would be made available to only a third of the 145 GW of new coal plants projected by DOE to be built during this period.

- The bonus allowances would provide subsidies of between $2.8 billion (scenario 1) and $4.6 billion (scenario 2) to some plants. In the latter case, this would be far more than the cost of constructing a coal plant with CCS.

- If allowance prices turn out to be greater than estimated, the value of total bonus allowances issued *would increase* as would the amount of the subsidy for each plant.

- Under the performance standard approach, the cost of the subsidy for 150 GW of new coal capacity between 2016 (when the performance standard would go into effect) and 2030 would be $95.9 billion (scenario 1) and only $28.7 billion (scenario 2).

- *Thus, for a cost of 40 percent more at a low allowance price(scenario 1) and almost 4 times less at a high allowance price (scenario 2), the performance standard incentives would subsidize three times as many CCS facilities as the bonus allowance approach. In other words, the bonus allowance system would provide much larger benefits to many fewer plants.*

- Comparing the size of the subsidy on an individual plant basis from 2012 to 2030, the bonus allowance approach would be between 1.7 times (scenario 1) and 6 times (scenario 2) more expensive per GW than the performance standard approach for plants that begin operation in 2012 and 2016, respectively, and between 4.5 and 9.6 times more expensive for plants that begin construction in 2022.

- Bonus allowances also provide far greater monetary benefits per ton sequestered than the performance standard subsidies. For example, in 2012, the bonus allowances are worth 80 percent more per ton under scenario 1, and three times as much under scenario 2. In 2020, the value of bonus allowances per ton is more than twice as great as the subsidy under scenario 1 and over seven times greater for scenario 2. This is another telling measure of the windfall provided by bonus allowances when compared with the actual incremental costs of a CCS plant.

- Under the performance standard approach, the cost of the subsidy *would drop* if the price of allowances increased or the price differential between plants with and without CCS decreased because of improvements in technology.

Bonus allowances also provide far greater monetary benefits per ton sequestered than the performance standard subsidies.

Why Are Bonus Allowance Costs Higher?

The principal explanation of the dramatic cost differences between the two approaches is that the bonus allowance program pays a generous premium to

plant developers whereas the incremental cost subsidy does not. Where controlling carbon emissions from new coal plants is optional, such a premium would be necessary to overcome the non-price barriers to building CCS plants.

These non-price barriers include the risks of investing in a technology of uncertain cost and effectiveness as compared to a proven technology with known cost and performance characteristics. In an industry as cautious as the power industry, such non-price barriers are likely to be substantial. This would slow down the deployment and commercialization of CCS technology.

Non-price barriers, however, would no longer come into play if, as a result of an emission performance standard, CCS (or an equivalent level of emission control) were *required* for all new coal plants and, thus, construction of conventional uncontrolled plants no longer remained an option. With such a standard in place, there would be no need to offer a financial premium to persuade plant developers to choose CCS over conventional coal technology. This would speed the development of CCS.

In sum, if the goal is to spur the largest possible number of coal plants with CCS at the lowest overall cost in the shortest amount of time, the best approach is an emission performance standard for all such plants, coupled with the use of allowance auction proceeds to cover the incremental costs of building plants with CCS.

The current provisions of S. 2191, by contrast, would result in substantially fewer CCS plants built at a higher cost. Additional coal plants either would not be built because bonus allowances are unavailable to finance CCS, or new plants would be built without controlling their CO_2 emissions, which would magnify the task of achieving substantial emission reductions overall from all sources.

In addition, if current state and community opposition to new coal plants persists, plant developers who are unable to obtain bonus allowances may simply turn to different fuel sources altogether rather than bear the additional costs of CCS themselves.

Adding to the Distribution of Free Allowances Through the Bonus Allowance Program

There are additional consequences of indirectly subsidizing CCS through free allowances as compared with using auction revenues to provide direct subsidies. Both approaches confer financial benefits on utilities. Allowances can be monetized by selling them in the credit-trading market. In this sense, free allowances are no different from direct subsidies. However, under S. 2191, the value of the bonus allowances could far exceed the incremental cost of constructing and operating a new CCS plant, and the excess revenue from these free allowances could be used to offset the emissions of existing plants. This would allow utilities to delay or avoid emission reductions that the coal plant fleet would otherwise need to achieve as the annual emission cap declines.

In addition, unlike direct subsidies, bonus allowances would augment the allocation of free allowances to utilities, enabling them to purchase fewer allowances through the auction process and reducing auction revenues as a result. This shortfall would need to be rectified—either by burdening other regulated entities with higher allowance purchase costs or by increasing the percentage of allowances sold at auction and reducing the number given away for free. In contrast,

direct subsidies from auction revenues would not alter the relative proportion of allowances that utilities and other sectors receive for free and purchase at auction and, as a result, would not distort the allowance allocation process.

CCS Incentive Provisions in Lieberman-Warner Title IV

While the direct subsidy approach in Title IV is preferable to the Title III bonus allowance program, the current CCS incentive provisions in Title IV are unwieldy and could benefit from reworking. Sections 4402 and 4403 contain five different programs to provide assistance for demonstration and deployment of CCS. These programs are funded at different levels and establish different eligibility and performance criteria for CCS projects but do not have clearly differentiated goals.

To reduce redundancy and confusion, the various CCS provisions in Subtitle D of Title IV should be simplified into two programs. The first program would focus on subsidizing large-scale CCS deployment after an emission performance standard takes effect. This program should receive 80 percent of total CCS funding and should provide sufficient revenue to support 150 GW of new coal capacity as well as the retrofit of many existing plants.

The goal of the second program, which would receive the remaining 20 percent of CCS funding, would be to encourage research and development for new capture-and-combustion technology at coal plants, as well as CCS pilot and demonstration projects for these new technologies, and testing of sequestration sites. With these programs in place along with an emission performance standard, the Title III bonus allowance program would be redundant and could be eliminated.

Our analysis shows that the current CCS provisions in Title IV would provide more than sufficient funding for these two programs. Under Title IV, CCS would receive approximately 45 percent of the auction proceeds that would flow into the Title IV Technology Deployment Program, which would in turn be allocated 52 percent of total auction proceeds. Funding of these CCS provisions would increase over time because auction revenues would grow as the percent of allowances auctioned and the market price of allowances increase.

We estimate that between 2016 and 2030, the CCS incentive provisions would receive in the range of $149.2 billion under the lower allowance price scenario 1, and $237.8 billion under the higher price scenario 2. This is substantially greater than the predicted price tag under these scenarios of $95.9 billion and $28.7 billion, respectively, to subsidize the incremental costs of 150 GW of new CCS capacity over the same period.

Thus, it would be possible to use the auction revenues not only for CCS deployment at new plants but for CCS retrofits at existing plants as well as a subsidy program for early demonstration projects, sequestration site testing, and R&D.

In the pages that follow, we present a more detailed cost analysis of both the bonus allowance provisions of S. 2191 and the performance standard/incremental cost subsidy approach—alongside a complete explanation of our recommendations to ensure the Lieberman-Warner bill achieves the greatest deployment of CCS technology at the lowest possible cost as soon as possible.

We estimate that between 2016 and 2030, the CCS incentive provisions would receive in the range of $149.2 billion under the lower allowance price scenario 1, and $237.8 billion under the higher price scenario 2

Early Deployment Strategies: Two Mechanisms for Accelerating CCS and How They Compare

The Bonus Allowance Provisions in S. 2191

Subtitle F of Title III of S. 2191 is entitled "Bonus Allowances for Carbon Capture and Sequestration." It creates a "bonus allowance account" consisting of 4 percent of total allowances for covered entities for the years 2012 to 2039. Facilities that capture and sequester CO_2 would be eligible to receive a distribution of allowances from this account. The number of allowances awarded would be proportional to the tons of pollution sequestered, starting out at a rate of 4.5-to-1 in the initial years, and gradually decreasing until reaching zero in 2040.

Facilities that begin construction prior to 2018 would be required to capture at least 60 percent of their CO_2 emissions. At least 85 percent capture would be required for facilities that commence construction after 2018.[5] Eligible facilities would receive bonus allowances for the first 10 years of operation.

Capital and operating costs for plants with CCS are expected to be substantially higher than those of traditional coal plants, although the cost differential should narrow as the technology improves. Experts project that capturing and storing CO_2 emissions at a new state-of-the-art coal plant will cost between $30 and $45 per ton, and perhaps more depending on the type of coal combustion technology employed. Given the likely price of CO_2 allowances under S. 2191, coal plants with CCS would probably not be cost-competitive with uncontrolled plants that purchase allowances under the S. 2191 cap-and-trade program until between 2025 and 2030 at the earliest.

The premise of the bonus allowance program is that deployment of CCS technology will be accelerated because the monetary value of bonus allowances will close the cost gap between CCS-equipped and uncontrolled new coal plants earlier than otherwise would be the case. The Center for American Progress shares this worthy goal, but as shown below the proposed program would likely result in installation of CCS systems at only a minority of the new coal plants projected to be built between now and 2030.

This would leave additional plants in limbo. The reason: Without the availability of bonus allowances, these plants would be cancelled or, if built without CCS, face uncertain and open-ended future costs for allowances and retrofits. Moreover, plants receiving bonus

allowances will get a windfall far larger than necessary to offset the additional costs of building CCS plants as opposed to conventional coal units. The owners of these plants will therefore have a competitive advantage relative to plant owners who cannot obtain bonus allowances.

Number of CCS Plants Built Under the Bonus Allowance Program

Table 1 (see page 21) calculates the number of new 1 gigawatt (GW) CCS plants that could be built through 2030 under the bonus allowance program.

In 2012, the first year in which the allowance trading program is in effect, 5.75 billion allowances will be auctioned or distributed for free by Environmental Protection Agency. Four percent of these allowances will be transferred to the bonus allowance account so it will have 231 million allowances. A 1 GW coal plant produces 5.4 million metric tons of CO_2. At a capture rate of 85 percent, up to 4.6 million tons would be sequestered.[6] Since the plant would receive 4.5 allowances per ton of CO_2 sequestered, it would net 20.7 million allowances in 2012 (4.6 million tons x 4.5 allowances per ton sequestered).

As a result, the bonus allowances would support 11 GW of CCS plants in 2012 (231 million allowances divided by 14.6 million bonus allowance per GW). We assume that all the available bonus allowances will be taken by plants that begin construction in that year. Thus, in 2012, the bonus allowance provision would fund 22 CCS plants that generate 500 megawatts (MW) each.

These 11 GW of CCS-equipped plants would continue to receive allowances for 10 years (in the case of a plant that starts operation in 2012, this would be until 2021). Although each plant would receive fewer bonus allowances over time, the size of the bonus allowance account would also decline with overall lowering of the emission cap. These numbers would roughly balance out, enabling only one additional GW to be supported by bonus allowances beginning in 2021.

By 2022, the total allowance pool would decline to 4.71 billion allowances. Thus, the bonus allowance account would have 188 million allowances (4 percent of 4.71 billion is 188 million). By 2022, the 10-year period for the 11 GW of plants that began operation in 2012 would have ended so the bonus allowances in 2022 could be allocated to new plants that begin operation in that year.

A CCS plant beginning operation in 2022 would receive 3.0 allowances for each ton of CO_2 sequestered. For a 1 GW plant with 85 percent capture, this would translate into a total of about 13.8 million allowances (4.6 million tons x 3.0 allowances per ton sequestered). Dividing the pool of 197 million allowances by 13.8 million would result in sufficient allowances to support 15 GW of CCS plants (including the 1 GW that became eligible for support in 2021 or a net of 14 new GW) or 28 new 500 MW coal plants. By 2028, the bonus allowances would support an additional 12 GW of CCS plants or 24 additional new coal plants. Another 10 GW could be supported in 2029 and 2030 (the bonus allowance allocation for the additional GW that qualify after 2022 would extend well beyond 2030).

Thus, the bonus allowance account will support 48 GW of CCS plants between 2012 and 2030, with many of these plants beginning oper-

Plants receiving bonus allowances will get a windfall far larger than necessary to offset the additional costs of building CCS plants as opposed to conventional coal units

ation toward the end of this period and receiving bonus allowances well after 2030.

The Department of Energy projected that 145 GW of new coal capacity will be built by 2030 in the United States.[7] The bonus allowance program would only enable about one-third of these plants to be equipped with CCS. Some portion of the remaining 97 GW of new coal capacity could be cancelled because they could not afford CCS and could not receive investor support or public acceptance in the absence of CO_2 controls. If 97 GW of uncontrolled coal plants were in fact built, they would emit about 540 million metric tons of CO_2 per year on top of the emissions from the existing power plant fleet. And these CO_2 emissions could continue for 60 to 80 years.

The bottom line: The bonus allowance program would reward a small number of new coal plants, while creating uncertainty about the fate of additional coal fired power plants built without CCS.

Total and Annual Costs of the Bonus Allowance Program as Compared to Performance Standard Subsidies

Our previous report, "Global Warming and the Future of Coal," proposes to provide subsidies to plant developers that would erase the gap in capital and operating costs between plants with CCS and conventional coal plants. A similar approach is embodied in provisions of Subtitle D of Title IV of S. 2191. This Subtitle, "Energy Technology Deployment," creates a series of financial incentive programs to accelerate development and deployment of low-carbon energy technologies. These programs are to be funded from the proceeds of the annual allowance auctions conducted by the Climate Change Credit Corporation under Subtitle C.[8] Fifty-two percent of auction revenues would be set aside for this purpose.

While CCS is addressed in a variety of Subtitle D provisions, of immediate interest is the Advanced Coal and Sequestration Technologies Program established under Section 4403. This program would receive 13 percent of the proceeds of allowance auctions (or 25 percent of Energy Technology Deployment funding). Of this amount, 25 percent (or 3.25 percent of total auction revenues) would be used under paragraph (a) (4) to provide incentives for deployment of advanced coal technologies (presumably CCS) up to a limit of 20 GW of new capacity.[9]

Among the financial incentives available would be "cost-sharing grants to cover the incremental cost of installing and operating carbon capture and storage equipment" over a ten-year period.[10]

Since (like our CAP proposal) this program is aimed at offsetting the increased cost of CCS, it is instructive to examine the size of the subsidy individual plants would receive and to determine the overall cost of subsidizing 150 GW of new coal capacity. These cost projections can then be compared to the projected costs of the Title III bonus allowance program.

To determine the costs of the performance standard subsidy, we made the conservative assumption that the incremental cost per ton of building and operating a CCS facility would be $45 for plants going into production during 2016–2020, $38 for plants going into production during 2021–2025, and $30 for plants going into production dur-

ing 2026–2030.[11] We then adjusted this differential by subtracting the allowance price that an uncontrolled coal plant would pay to emit each ton of CO_2 that would be sequestered at the CCS facility.[12] Finally, we multiplied this differential by 4.6 million, representing the total tons of CO_2 that would be sequestered at an 85 percent capture rate.

We conducted this analysis using two carbon price scenarios—one which assumed that the allowance price would be $14 in 2016 and increase to $30 by 2030 (scenario 1) and the other which assumed that the price would be $23.50 in 2016 and increase to $46 in 2030 (scenario 2).

Unlike bonus allowances, the performance standard incentives would not be limited to 10 years per plant. They would continue until there is no longer a differential in construction and operating costs between a CCS facility and a non-CCS plant that purchases allowances. Although the subsidies would last longer under the performance standard approach than under the bonus allowance provisions, the total performance standard subsidy would still be far less per plant than the value of the bonus allowances.

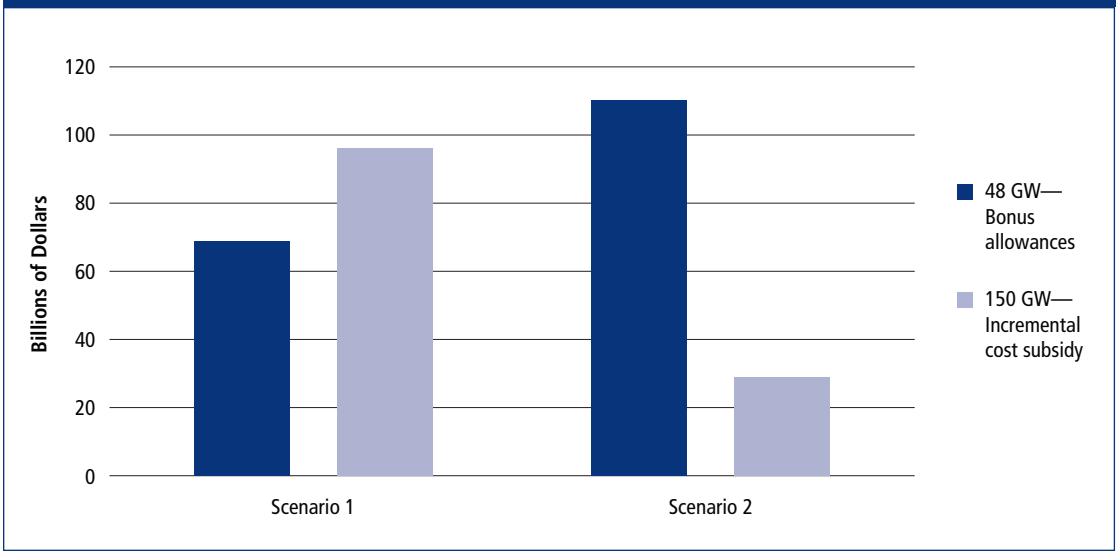
Tables 2, 3, and 4 on pages 22 and 23 show the cost of the performance standard subsidy per year between 2016 and 2030 for a 1 GW plant that begins production in each of the three periods (2016–2020, 2021–2025, and 2026–2030). For each time period, we assume that the price differential remains the same throughout the life of the plant. Table 5 (see page 24) shows the total subsidy on a year-by-year basis between 2016 and 2030 for 150 GW of new coal plants, assuming that 10 GW of new coal plants are added in each year beginning in 2016.

Under the first carbon price scenario, the subsidies have a total cost of $95.9 billion. Under the second scenario, the subsidies have a total cost of only $28.7 billion.

The contrast with the cost of the bonus allowances is striking. As described above,

Although the subsidies would last longer under the performance standard approach than under the bonus allowance provisions, the total performance standard subsidy would still be far less per plant than the value of the bonus allowances

FIGURE 1: TOTAL VALUE OF BONUS ALLOWANCES AND INCREMENTAL COST SUBSIDIES AS PROPOSED BY CAP THROUGH 2030 (48 GW AND 150 GW RESPECTIVELY)



bonus allowances would cover only 38 GW until 2028, and an additional 10 GW in 2029 and 2030 for a total of 48 GW, not 150 GW, of new plants. Table 6 (see page 25) shows the year-by-year costs of the bonus allowance program for the period 2012–2030 under the two carbon price scenarios. Under the first scenario, the bonus allowances have a total value of $68.6 billion. Under the second scenario, the total value of bonus allowances increases to $110.1 billion.

Thus, at a cost 40 percent higher under the first scenario and 4 times lower under the second, 150 GW of CCS plants can be subsidized under the performance standard approach, but only 48 GW under the bonus allowance provisions (see Table 7 on page 26). While plants receiving bonus allowances will enjoy substantially larger subsidies than under the performance standard approach, coal plants that do not obtain these allowances will be at a disadvantage and may either be built without CCS or simply cancelled.

The same contrast is evident when examining the annual costs of the two programs. Under the first allowance price scenario, annual costs for the bonus allowance program for the 19 years between 2012 (when the bonus allowances become available) and 2030 average $3.6 billion. The performance standard incentives cost more under this scenario—on average $6.4 billion per year for the 15 years between 2016 (when the emissions performance standard goes into effect) and 2030—but would subsidize three times as many plants as the bonus allowances.

Moreover, the performance standard subsidy is substantially less costly per year than the bonus allowance program under the higher carbon price scenario. Under that scenario, the average annual cost of the bonus allowances for 19 years is $5.8 billion but only $1.9 billion under the performance standard approach for 15 years.

As this comparison illustrates, if the price of allowances rises, then the value of the bonus allowances increases, but the cost of the performance standard subsidy declines. This inverse correlation between the price of allowances and the amount of the subsidy under the performance standard approach provides an important protection against windfalls that is lacking under the bonus allowance program.

Logically, the subsidy should decline with each successive year since the price of allowances will rise and, at the same time, the cost differential between CCS and non-CCS plants will narrow as the technology improves and becomes less costly, making CCS plants more cost-competitive with conventional plants. By contrast, the rising price of allowances will keep the cost of the bonus allowance program high even though the cost differential between CCS and non-CCS plants will be declining.

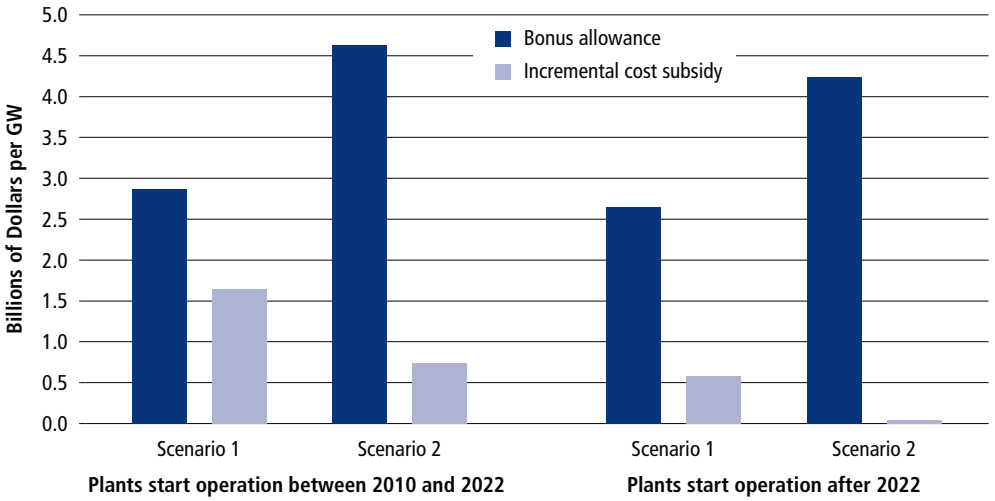
This inverse correlation between the price of allowances and the amount of the subsidy under the performance standard approach provides an important protection against windfalls that is lacking under the bonus allowance program

The Value Per GW of Bonus Allowances and the Cost of a Performance Standard Subsidy

What will be the value of bonus allowances to owners of plants with CCS systems? And how does this compare to the value of the performance standard subsidy?

To determine the dollar value of bonus allowances to an individual plant, it is useful to consider two cases: first, a 1 GW plant becomes operational in 2012 and receives bonus allowances until 2021; and second, a 1 GW plant becomes operational in 2022 and is entitled to bonus allowances until 2031.[13] Table 8

FIGURE 2: SUBSIDY FOR 1 GW PLANT WITH CCS
Bonus Allowance Program vs. Incremental Cost Incentives



(see page 27) calculates the value of the bonus allowances for a 1 GW plant that begins operation in each of those years.

The numbers are again striking. A plant that goes into operation in 2012 would receive over 10 years bonus allowances worth $2.86 billion under scenario one, and bonus allowances worth $4.62 billion under scenario two. By contrast, a plant that starts operation in 2016 under the performance standard approach would receive subsidies over a 15-year period (from 2016 to 2030) of $1.646 billion under the lower allowance price scenario and only $731 million under the higher price scenario. (See Tables 8 and 9 on pages 27 and 28, respectively).

Thus, during this time period, the bonus allowance approach would be between 1.7 times to 6 times more costly per GW than the performance standard approach while benefiting fewer plants.

Similarly, a plant that starts construction in 2022 would receive bonus allowances over a nine year period (2022 to 2030) valued at $2.64 billion or $4.23 billion, depending on the allowance price, whereas the same plant would receive subsidies of only $580 million or $43.7 million over that period under the performance standard approach.

Thus, on an individual plant basis, the bonus allowance program is between 4.5 times to 9.6 times more costly per GW than the performance standard subsidy.

Assuming the construction of one GW of CCS capacity costs $3 billion, the cumulative dollar value of bonus allowances would represent between almost 100 to more than 150 percent of plant construction costs for the 2012–21 scenario, and only a slightly lower percent of construction costs for the 2022–2031 scenario. This is much higher than under the performance standard approach, which would cover between 24 percent and 55 percent of the plant's capital costs for plants that start operation in 2016, and between 1.4 percent and 19 percent for plants that start operation in 2022.

CHART 1: PER TON VALUE OF BONUS ALLOWANCES COMPARED TO PER TON PERFORMANCE STANDARD SUBSIDY

Year	Bonus Ratio	Carbon Price (Scenario 1)	Carbon Price (Scenario 2)	Value of Bonus Allowances Per Ton (Scenario 1)	Value of Bonus Allowances Per Ton (Scenario 2)	Incremental Cost Subsidy Per Ton (Scenario 1)*	Incremental Cost Subsidy Per Ton (Scenario 2)
2012	4.5	$12	$17.50	$54	$78.75	$33	$27.50
2016	4.5	$14	$23.50	$63	$105.75	$31	$21.50
2020	3.6	$18	$29.50	$64.8	$106.2	$27	$15.50
2024	2.4	$22	$35.50	$52.8	$85.2	$16	$2.50
2028	1.3	$26	$41.50	$33.8	$53.95	$4	–$11.50
2030	0.9	$30	$46.00	$27	$41.4	$0	–$15.00

* Reflects cost of allowance to uncontrolled coal plants.

Not surprisingly, this level of cost recovery in 2016 is consistent with recent estimates that capital costs will increase by 32 percent to 47 percent for Integrated Gasification Combined Cycle plants with CCS systems as compared to conventional plants.[14] This again illustrates how bonus allowances will provide a windfall to developers of a small number of CCS plants.

Yet another measure of this windfall is to compare the value of bonus allowances per ton of carbon sequestered with the value per ton sequestered under performance standard subsidies. As shown in Chart 1 (see above), there is a wide differential between the two approaches, with bonus allowances providing far greater monetary benefits per ton than subsidies based on the actual incremental costs of building CCS plants.

For example, in 2016, bonus allowances are worth $63 per ton under scenario one, and $105.75 per ton under scenario two, whereas the subsidies are worth $33 and $27.50, respectively. This gap widens in later years. For example, in 2024, bonus allowances are worth $52.80 per ton (scenario one) and $85.20 (scenario two). The comparable per ton figures for the subsidies are $16 and $2.50.

In short, bonus allowances awarded under S. 2191 would provide a handful of plant developers with a windfall much greater—on a per ton or total cost basis—than the cost differential between conventional coal plants and those with CCS. In other words, the subsidy to plant developers would be far larger than necessary to offset the increased cost of building a CCS facility. Moreover, while developers of CCS plants would receive a handsome premium, the benefits would accrue to only a small number of plants—approximately 48 GW out of the 145 GW of new coal plants projected by DOE through 2030.

Relative Merits of the Bonus Allowance and Incremental Cost Subsidies

In the absence of a performance standard, it is likely that because CCS is a new technology with a limited track record, conservative utilities will be reluctant to commit to CCS unless they receive a substantial premium offsetting its perceived financial and operational risks. On this premise, a subsidy program that merely closed the cost gap between traditional coal plants and those with CCS would provide insufficient financial rewards for building CCS plants. Faced with equal costs, utilities would opt to build less complex and risky

Bonus allowances provide far greater monetary benefits per ton than subsidies based on the actual incremental costs of building CCS plants

plants using known but higher emitting coal combustion technology.

Yet a "risk premium" to encourage investors would only be necessary under a cap-and-trade framework that allows utilities to *choose* between conventional coal plants and facilities that capture and store their emissions. Such a premium would not be required *if only coal plants with CCS could be constructed under cap-and-trade legislation*. This would be the situation if S. 2.191 were amended to include the emissions performance standard proposed by CAP.

This standard would require all new coal plants to meet an emission rate limit corresponding to the capture efficiency of available CCS technology. It would apply to new plants for which construction begins after the legislation takes effect in 2009, and would provide these plants with a phase-in period to allow for further testing and improvement of the technology before fully implementing it. Under this timeline, CCS systems at covered plants would need to meet the performance standard in 2016 or within four years after the plant becomes operational, whichever occurs later.

With an emission performance standard in place, CCS would no longer be competing with conventional coal technology so it would be unnecessary to provide a sizable risk premium to plant developers to motivate them to adopt CCS.

Although an emission performance standard would eliminate the need for a premium for CCS adoption, a strong case would still exist for providing subsidies to plant developers. The performance standard is designed to speed the introduction of a new technology with higher costs and uncertainties than conventional pulverized coal plants. These drawbacks will decline as the technology matures.

Case in point: The Electric Power Research Institute, the utility industry's leading energy research organization, recently concluded that capital cost reductions for CCS plants could reach 30 percent by 2030 relative to 2005 costs, with operating efficiencies climbing from 30 percent today to the 45 percent range with CCS.[15] However, realizing these cost and efficiency improvements will only occur if the first generation of CCS plants is built as soon as possible. Subsidies would enable CCS to be cost-competitive in the early years of the cap-and-trade program rather than waiting for increases in allowance prices and cost reductions to reach levels where CCS is self-sustaining financially—a circumstance that may not occur until 2025–2030 or later.

Subsidies would encourage construction of new coal plants, which otherwise might be at an economic disadvantage compared to other types of generation

In addition, subsidies would encourage construction of new coal plants, which otherwise might be at an economic disadvantage compared to other types of generation. This in turn would protect consumers and businesses in coal-dependent regions from undue energy cost increases, as well as prevent rapid declines in coal mining employment.

In sum, subsidies would go far to preserve the viability of coal after a cap-and-trade system is in place. Without subsidies or bonus allowances, few utilities may be willing or able to build coal plants with CCS, and uncontrolled plants may be derailed by investor reluctance and public opposition.

The goals of a subsidy program can be met by enabling utilities to recover the added costs they would incur to build new plants with CCS rather than uncontrolled coal plants. This will level the playing field for CCS but not provide financial benefits beyond the incremen-

tal construction and operational costs of CCS itself. As noted below, auction revenues that are now earmarked for CCS-related programs under S. 2191 should be more than sufficient to provide subsidies to install CCS on all of the new coal plants projected for the 2008–2030 period. In contrast, bonus allowances would enrich a small number of utilities but put others at a disadvantage, resulting in much fewer plants with CCS and quite possibly fewer coal plants overall.

How Best to Provide Incentives for CCS: Bonus Allowances Versus Direct Subsidies

Bonus allowances and direct subsidies are each a mechanism for encouraging plants to be built with CCS by conferring financial benefits on developers who invest in the technology. While subsidies entail a direct payment, allowances can be monetized if sold in the allowance trading market. Assuming bonus allowances and subsidies are equivalent in monetary terms, they should have the same economic value to utilities.

The bonus allowance program in Section 3901, however, could have distorting effects on the operation of the cap-and-trade program because of the sheer number of additional allowances to be distributed for free to a small number of utilities who receive bonus allowances. Under section 3901 of S. 2191, 19 percent of total allowances would be allocated without cost to fossil-fueled power plants in 2012; this free allocation would decline to 10 percent in 2025 and 1 percent in 2030.

Thus, the 4 percent bonus allowance allocation would increase the allowances distributed for free to the utility sector by nearly 20 percent in 2012 and by a higher percentage in later years as the free allowance allocation for the sector is reduced. For example, the bonus allowances would represent 40 percent of the free utility allocation in 2025 and 80 percent in 2030.

The portion of bonus allowance awards that simply covers the added costs of CCS as compared to an uncontrolled plant would not represent a net financial benefit to the utility. However, the portion that provides a premium above these costs could be of significant value. These allowances could be used to avoid emission reductions that would otherwise be required to meet the declining caps under the bill.[16] For example, with a bonus allowance rate of 3.5, a utility building a 1 GW CCS plant would receive enough allowances to offset 16.1 million tons (3.5 x 4.6 million) of CO_2 emissions at its existing plants. This offset would represent roughly 15 percent of the emissions from 20 GW of coal capacity.

Given that overall emissions in covered sectors must decline by 15 percent by 2020 under S. 2191, the bonus allowance cushion would enable these plants to comply with the bill's requirements without making investments to reduce emissions and/or purchasing allowances offsetting those emissions. And importantly, these benefits could not be realized by all coal-fired utilities, but rather only by the minority that are able to obtain bonus allowances. The use of these allowances to create a compliance cushion for some but not all utilities owning coal plants could result in serious competitive inequities, which in turn would aggravate rate differences among utility service areas.

Thus, the effect of the bonus allowance program would be to augment the free allowance allocation for utilities and reduce the pool of allowances remaining

The use of bonus allowances to create a compliance cushion for some but not all utilities owning coal plants could result in serious competitive inequities, which in turn would aggravate rate differences among utility service areas

for auctioning. This shortfall would need to be addressed elsewhere in the cap-and-trade system. With more allowances allocated to the utility sector, other sectors of the economy would have to achieve deeper reductions or make greater outlays to purchase allowances. The consequence would be higher costs to non-utility allowance holders and their customers. Alternatively, the number of allowances auctioned could be increased in order to offset the additional free allowances distributed to utilities from the auction allowance pool.

Even if bonus allowances were no greater than needed to offset the incremental costs of CCS, subsidies to plant developers of a magnitude sufficient to offset these costs would be a more transparent mechanism for incentivizing CCS than bonus allowances because they would be funded directly from auction proceeds and thus would not alter the relative proportion of allowances that utilities receive for free and purchase through the auction process.

In addition, the subsidy can be adjusted over time to reflect actual allowance prices and CCS-related costs and can be more precisely targeted to the cost differential between CCS and uncontrolled plants at a specific point in time. By contrast, the bonus allowance ratios are an imprecise tool for accounting for future carbon price and cost trends and could in practice undershoot or overshoot the actual cost differential.

Combining and Streamlining the CCS Subsidy Programs in Title IV of S. 2191

If direct subsidies coupled with an emission performance standard are indeed the preferred mechanism for accelerating CCS deployment as proposed by CAP, then it is important to examine whether Title IV of S. 2191 provides a sound framework for subsidizing CCS. As described below, the Title IV provisions are sound in concept but unwieldy and confusing and should be reworked.

Sections 4402 and 4403 currently contain five different programs to provide assistance for demonstration and deployment of CCS. These programs would be funded at differing levels and establish different eligibility and performance criteria for CCS projects but would not serve clearly differentiated objectives.

Under Subtitle C of Title IV, 52 percent of the auction proceeds would be devoted to an "Energy Technology Deployment Program" created under Subtitle D. Within that Subtitle, Section 4402 creates a program for "Zero-or Low-Carbon Energy Technologies Deployment," and Section 4403 creates an "Advanced Coal and Sequestration Technologies Program." These programs are to receive 32 and 25 percent, respectively, of the funds allocated to the Energy Technology Deployment Program.

Section 4402 would competitively award financial incentives for the:

- Production of electricity from new zero- or- low-carbon generation[17]
- Manufacture of high-efficiency consumer products
- Manufacture of zero- or low-carbon generation equipment and components

Bidders for these incentives would be judged against several criteria. The bill does not specify the size of awards to successful bidders, but it does provide that awards for low-carbon genera-

With more allowances allocated to the utility sector, other sectors of the economy would have to achieve deeper reductions or make greater outlays to purchase allowances

tion will take the form of a production payment for the first 10 years of commercial service of the unit, based on the magnitude of projected electricity generation. Section 4402 does not apportion funding among the three types of eligible projects except to reserve at least 25 percent for manufacturers of low-carbon generation technology.

Section 4403 authorizes three separate advanced coal technologies programs:

- Twenty-five percent of the funding is to be devoted to demonstration projects using advanced coal generation technology, including retrofit technology that could be deployed on existing coal generation facilities.

- An additional 25 percent is to be devoted to incentives for the deployment of not more than 20 GW of advanced coal technologies. These plants must achieve at least a 60 percent capture rate (where construction is commenced before July 1, 2018), and at least an 85 percent capture rate (for plants beginning construction after that date).[18] Projects receiving assistance can elect a loan guarantee, a cost-sharing grant covering incremental CCS installation and operating costs for the first 10 years of facility operation, or production payments of not more than 1.5 cents per kilowatt hour for the first 10 years the unit is commercial service.

- The remaining 50 percent of funding would be made available to large-scale carbon storage demonstration projects that store CO_2 captured from electric generation units using coal gasification or other advanced combustion processes. The project owner would be reimbursed for a percentage of the incremental capital and operating costs that are attributable to carbon capture and sequestration as appropriate.[19]

To determine how much funding would be devoted to CCS under these provisions, the first step is to estimate the proceeds from allowance auctions. Chart 2 (see below) shows the total auction revenues that would be raised by the Climate Change Credit Corporation in 2016, 2022, and 2030 under our two allowance price scenarios.[20] We then project the portion of auction revenues that would be allocated to the Technology Deployment Program and then to the five programs in Sections 4402 and 4403 that subsidize CCS.

As shown in Charts 3 and 4 (see page 18), this analysis indicates that these programs would receive approximately 45 percent of total Technology Deployment funding. The dollar amounts devoted to CCS incentives would increase over time because auction revenues will grow as the percent of allowances auctioned and the market price of allowances both increase.

CHART 2: TOTAL AUCTION REVENUES COLLECTED UNDER LIEBERMAN-WARNER (IN BILLIONS)

Year	Total # Allowances	Percent Auctioned	#Allowances Auctioned	Scenario 1 Allowance Price	Scenario 1 Auction Revenue	Scenario 2 Allowance Price	Scenario 2 Auction Revenue
2016	5349	30.5%	1631	$14	$22.834	$23.50	$38.32
2022	4711	41%	1931	$20	$38.620	$32.50	$62.757
2030	3860	62.75%	2422	$30	$72.664	$46	$111.412

CHART 3: ALLOCATION OF AUCTION REVENUES FOR CCS PROGRAMS UNDER TITLE IV OF LIEBERMAN WARNER (SCENARIO 1)

Program	Percent	2016 Revenues (Billions)	2022 Revenues (Billions)	2030 Revenues (Billions)
Energy Technology Deployment (Section 4302, Subtitle D)	**52**[1]	**$11.873**	**$20.082**	**$37.785**
Zero or Low Carbon Energy Technologies (Section 4402)	**32**[2]	**$3.799**	**$ 6.426**	**$12,091**
Zero and Low Carbon Generators	33[3]	$1.265	$ 2.139	$4.026
Zero or Low Carbon Generation Technology	33[3]	$1.265	$ 2.139	$4.026
Advanced Coal Sequestration Technologies Program (Section 4403)	**25**[2]	**$2.968**	**$ 5.020**	**$9.446**
Demonstration Projects	25[4]	$742	$ 1.255	$2.361
Deployment	25[4]	$742	$ 1.255	$2.361
Large Scale Storage	50[4]	$1.484	$ 2.510	$4.723

1 Percent of total auction revenues
2 Percent of technology deployment funding
3 Percent of Section 4402 funding (presumed)
4 Percent of Section 4403 funding

CHART 4: ALLOCATION OF AUCTION REVENUES FOR CCS PROGRAMS UNDER TITLE IV OF LIEBERMAN WARNER (SCENARIO 2)

Program	Percent	2016 Revenues (Billions)	2022 Revenues (Billions)	2030 Revenues (Billions)
Energy Technology Deployment (Section 4302, Subtitle D)	**52**[1]	**$19.930**	**$32.637**	**$57.934**
Zero or Low Carbon Energy Technologies (Section 4402)	**32**[2]	**$6.378**	**$10.443**	**$18. 539**
Zero and Low Carbon Generators	33[3]	$2.105	$ 3.446	$6.118
Zero or Low Carbon Generation Technology	33[3]	$2.105	$ 3.446	$6.118
Advanced Coal Sequestration Technologies Program (Section 4403)	**25**[2]	**$4.982**	**$8.159**	**$14.483**
Demonstration Projects	25[4]	$1.245	$2.039	$3.620
Deployment	25[4]	$1.245	$2.039	$3.620
Large Scale Storage	50[4]	$2.491	$4.080	$7.241

1 Percent of total auction revenues
2 Percent of technology deployment funding
3 Percent of Section 4402 funding
4 Percent of Section 4403 funding

CHART 5: AUCTION REVENUES UNDER TITLE IV ALLOCATED TO CCS (IN BILLIONS)

ALLOWANCE PRICE (SCENARIO 1)			ALLOWANCE PRICE (SCENARIO 2)		
2016	2022	2030	2016	2022	2030
$5.498	$9.298	$17.499	$9.191	$15.51	$26.719
Fourteen Year Average		$10.6	Fourteen Year Average		$16.99
Total CCS Funding Over 2016–2030		**$149.2**	**Total CCS Funding Over 2016–2030**		**$237.818**

As shown in Chart 5 (see page 18), between 2016 and 2030, the CCS incentive provisions would receive in the range of $149.2 billion (lower allowance price scenario) and $237.8 billion (higher price scenario). This is substantially greater than the predicted price tags of $95.9 billion (scenario one) and $28.7 billion (scenario two) to subsidize the incremental costs of 150 GW of new CCS capacity over the same period, leaving ample funding for other purposes.

The multiple CCS incentive provisions in Title IV create the potential for overlapping or redundant programs. To avoid this problem, the Title IV subsidies for CCS should be simplified and consolidated into two basic programs:

Commercial Deployment of CCS at New and Existing Coal Plants

This program would cover the full incremental costs of installing and operating CCS systems at existing and new coal plants for the first 10 years of their operation. All new plants would need to meet an emission performance standard based on the best commercially available technology per the CAP proposal.[21] A somewhat lower standard would be established by EPA for existing plants.

The size of the subsidy would be based on the cost differential between CCS and non-CCS plants and thus would decline as allowance prices increase and CCS technology becomes more cost-effective. This program would continue until all CCS plants were cost-competitive. Eighty percent of the auction proceeds allocated to supporting CCS under Subtitle D would be devoted to supporting commercial deployment of CCS at new and existing coal plants under this program.

CCS Demonstration Plants and Technology R&D

This program would be for three activities:

- R&D projects to develop new low-carbon coal technologies, including crucial new post-combustion capture technologies that can be used for CCS retrofits;
- pilot and demonstration programs for the new technologies, particularly in the early years of the cap-and-trade program; and
- testing of sequestration sites.[22]

A competitive bidding process would be used to choose qualifying projects.

Awards could be larger than necessary to cover the incremental costs of CCS in order to encourage early deployment and technology risk-taking. Twenty percent of auction proceeds allocated to supporting CCS under Subtitle D would be used to support this program. This amount could decline over time as CCS technology matures.

With these two Title IV programs providing ample subsidies for CCS and an emission performance standard in place, the Title III bonus allowance program would be redundant and should be eliminated.

Conclusion: The Path Toward CCS Implementation

Sens. Joseph Lieberman (I-CT) and John Warner (R-VA), along with Senate Environment Committee Chairwoman Barbara Boxer (D-CA) and others, deserve applause for their ambitious efforts to reduce emissions of CO_2 and other global warming pollutants. This is one of the most urgent tasks that face our nation and world. The Lieberman-Warner Climate Security Act provides a solid foundation for action.

The Senate should promptly pass the Lieberman-Warner Climate Security Act with some essential enhancements to make its cap-and trade program more economical and effective.[23]

In particular, the development, deployment, and commercialization of carbon capture-and-storage systems—the most promising technology for GHG reductions from power plants—must be accelerated. This is imperative to achieve emissions reductions in the United States, as well as for technology transfer to reduce emissions from China, India, and other developing nations.

Accordingly, S. 2191 should be revised to establish a two-track process for accelerating deployment of CCS at coal plants consistent with the framework proposed by CAP:

- An emission performance standard should be put in place that ensures that all new coal plants (not simply the small number receiving bonus allowances) capture and sequester their carbon emissions. This would prevent a substantial addition to atmospheric CO_2 levels from new coal plants at a time when the national goal under S. 2191 is to sharply reduce overall emissions. It would also provide a reasonable phase-in period which allows for the further development and improvement of CCS technology.

- Congress should provide subsidies to offset the increased capital and operational costs of CCS plants and enhance the likelihood that new coal plants with CCS will be built once S. 2191 takes effect. Unlike the bonus allowance program, all new coal plants would receive these subsidies and they would be no larger than necessary for CCS plants to be cost-competitive, which means individual plants would not receive a windfall. Subsidies would be financed out of the proceeds of allowance auctions under Title IV. The multiple CCS subsidy programs in Title IV would be simplified to two programs—one for large-scale CCS deployment at new and existing plants and the other for early CCS demonstration projects and R&D. Since ample funding would be available to support these programs, the Title III bonus allowance program would be redundant and should be deleted.

These changes would provide coal a secure role in the 21st century electricity mix under S. 2191's increasingly stringent caps on CO_2 emissions.

Appendix

TABLE 1: WARNER-LIEBERMAN—NUMBER OF 1 GW PLANTS RECEIVING BONUS ALLOWANCES[1]

1	2	3	4	5	6	7	8
Calendar Year	Number of Emission Allowances (millions)[2]	Warner-Lieberman Bonus Allowance Set Aside	Total Number of Allowances Per Year (millions)[3]	Bonus Allowance Rate[4]	Number of Tons Sequestered per GW (85% Capture Rate) (millions)	Bonus Allowance Total Per Plant[5]	Number of MW Eligible to Receive Bonus Allowances[6, 7]
2012	5,775	0.04	231.00	4.50	4.6	20.70	11.16
2013	5,669	0.04	226.76	4.50	4.6	20.70	10.95
2014	5,562	0.04	222.48	4.50	4.6	20.70	10.75
2015	5,456	0.04	218.24	4.50	4.6	20.70	10.54
2016	5,349	0.04	213.96	4.50	4.6	20.70	10.34
2017	5,243	0.04	209.72	4.50	4.6	20.70	10.13
2018	5,137	0.04	205.48	4.20	4.6	19.32	10.64
2019	5,030	0.04	201.20	3.90	4.6	17.94	11.22
2020	4,924	0.04	196.96	3.60	4.6	16.56	11.89
2021	4,817	0.04	192.68	3.30	4.6	15.18	12.69
2022	4,711	0.04	188.44	3.00	4.6	13.80	13.66
2023	4,605	0.04	184.20	2.70	4.6	12.42	14.83
2024	4,498	0.04	179.92	2.40	4.6	11.04	16.30
2025	4,392	0.04	175.68	2.10	4.6	9.66	18.19
2026	4,286	0.04	171.44	1.80	4.6	8.28	20.71
2027	4,179	0.04	167.16	1.50	4.6	6.90	24.23
2028	4,073	0.04	162.92	1.30	4.6	5.98	27.24
2029	3,966	0.04	158.64	1.10	4.6	5.06	31.35
2030	3,860	0.04	154.40	0.90	4.6	4.14	37.29

1 All information taken from S. 2191 version reported by Environment and Public Works Committee

2 Section 1201(d) of S. 2191

3 Column 2 times column 3

4 Section 3603(a)(3)

5 Column 5 times column 6

6 Column 4 divided by column 7

7 Because a plant receives bonus allowances for ten years, if 11 GW of plants receive allowances in 2012, they will tie up 11 GW through 2021. Thus, no other plants will be able to receive bonus allowances during this ten-year period until more than 11 GW are eligible to receive allowances - in this case in 2021 when 1 more GW of plants becomes eligible. A similar analysis applies to plants that begin operation in 2022 when 13.66 additional GW become eligible for bonus allowances (including the one GW that became eligible in 2021). These plants will tie up allowances for 13.66 GW of plants until 2031 (2030 in the case of the 1 GW that becomes eligible in 2021). Thus, in 2023 another GW becomes eligible, in 2024 an additional 1–5 GW become eligible, etc.

TABLE 2: PERFORMANCE STANDARD SUBSIDY
New Plants That Go Into Production in 2016–2020, Subsidy for Each GW of Production

	ALLOWANCE PRICE STARTING AT $14.00 IN 2016 (SCENARIO 1)					ALLOWANCE PRICE STARTING AT $23.50 IN 2016 (SCENARIO 2)			
1	2	3	4	5	6	7	8	9	10
Year	CCS Price Differential[1]	Allowance Price Starting at $14.00	Net CCS Price Differential[2]	Number of Tons Sequestered per GW (85% Capture Rate) (millions)	Cost of Subsidy (millions)[3]	Allowance Price Starting at $23.50[4]	Difference from CCS Price Differential[5]	Number of Tons Sequestered per GW (85% Capture Rate) (millions)	Cost of Subsidy (millions)[6]
2016	$45.00	$14.00	$31.00	4.6	$142.60	$23.50	$21.50	4.6	$98.90
2017	$45.00	$15.00	$30.00	4.6	$138.00	$25.00	$20.00	4.6	$92.00
2018	$45.00	$16.00	$29.00	4.6	$133.40	$26.50	$18.50	4.6	$85.10
2019	$45.00	$17.00	$28.00	4.6	$128.80	$28.00	$17.00	4.6	$78.20
2020	$45.00	$18.00	$27.00	4.6	$124.20	$29.50	$15.50	4.6	$71.30
2021	$45.00	$19.00	$26.00	4.6	$119.60	$31.00	$14.00	4.6	$64.40
2022	$45.00	$20.00	$25.00	4.6	$115.00	$32.50	$12.50	4.6	$57.50
2023	$45.00	$21.00	$24.00	4.6	$110.40	$34.00	$11.00	4.6	$50.60
2024	$45.00	$22.00	$23.00	4.6	$105.80	$35.50	$9.50	4.6	$43.70
2025	$45.00	$23.00	$22.00	4.6	$101.20	$37.00	$8.00	4.6	$36.80
2026	$45.00	$24.00	$21.00	4.6	$96.60	$38.50	$6.50	4.6	$29.90
2027	$45.00	$25.00	$20.00	4.6	$92.00	$40.00	$5.00	4.6	$23.00
2028	$45.00	$26.00	$19.00	4.6	$87.40	$41.50	$0.00	4.6	$0.00
2029	$45.00	$27.00	$18.00	4.6	$82.80	$43.00	$0.00	4.6	$0.00
2030	$45.00	$30.00	$15.00	4.6	69.00	$46.00	$0.00	4.6	0.00

1 $45 is a conservative estimate of price differential for IGCC plants with CCS as compared to conventional PC plants based on review of available literature. Note that $45 is a 50% higher than the estimate for IGCC in *Global Warming and the Future of Coal, the Path to Carbon Capture and Storage*.

2 Column 2 minus column 3. Note we assume that new uncontrolled plants would need to purchase allowances to cover 85 percent of their emissions. We discuss the basis for this assumption in the text at note 13.

3 Column 4 times column 5

4 Taken from the EPA analysis scenario 10, ADAGE estimate, page 27

5 Column 2 minus column 7

6 Column 8 times column 9

TABLE 3: PERFORMANCE STANDARD SUBSIDY
New Plants That Go Into Production in 2021–2025, Subsidy for Each GW of Production

	ALLOWANCE PRICE STARTING AT $19.00 IN 2021 (SCENARIO 1)					ALLOWANCE PRICE STARTING AT $31.00 IN 2021 (SCENARIO 2)			
1	2	3	4	5	6	7	8	9	10
Year	CCS Price Differential[1]	Allowance Price Starting at $19.00	Net CCS Price Differential[2]	Number of Tons Sequestered per GW (85% Capture Rate) (millions)	Cost of Subsidy (millions)[3]	Allowance Price of Starting at $31.00[4]	Difference from CCS Price Differential[5]	Number of Tons Sequestered per GW (85% Capture Rate) (millions)	Cost of Subsidy (millions)[6]
2021	$38.00	$19.00	$19.00	4.6	$87.40	$31.00	$7.00	4.6	$32.20
2022	$38.00	$20.00	$18.00	4.6	$82.80	$32.50	$5.50	4.6	$25.30
2023	$38.00	$21.00	$17.00	4.6	$78.20	$34.00	$4.00	4.6	$18.40
2024	$38.00	$22.00	$16.00	4.6	$73.60	$35.50	$0.00	4.6	$0.00
2025	$38.00	$23.00	$15.00	4.6	$69.00	$37.00	$0.00	4.6	$0.00
2026	$38.00	$24.00	$14.00	4.6	$64.40	$38.50	$0.00	4.6	$0.00
2027	$38.00	$25.00	$13.00	4.6	$59.80	$40.00	$0.00	4.6	$0.00
2028	$38.00	$26.00	$12.00	4.6	$55.20	$41.50	$0.00	4.6	$0.00
2029	$38.00	$27.00	$11.00	4.6	$50.60	$43.00	$0.00	4.6	$0.00
2030	$38.00	$28.00	$10.00	4.6	$46.00	$46.00	$0.00	4.6	$0.00

1 Assumes price differential dips from $45 to $38 in 2021. Assumes price differential will continue for life of plants built from 2021–2025.

2 Column 2 minus column 3

3 Column 4 times column 5

4 Taken from the EPA analysis scenario 10, ADAGE estimate, page 27

5 Column 2 minus column 7

6 Column 8 times column 9

TABLE 4: PERFORMANCE STANDARD SUBSIDY
New Plants That Go Into Production in 2026–2030, Subsidy for Each GW of Production

	ALLOWANCE PRICE STARTING AT $24.00 IN 2026 (SCENARIO 1)					ALLOWANCE PRICE STARTING AT $38.50 IN 2026 (SCENARIO 2)			
1	2	3	4	5	6	7	8	9	10
Year	CCS Price Differential[1]	Allowance Price Starting at $24.00	Net CCS Price Differential[2]	Number of Tons Sequestered per GW (85% Capture Rate) (millions)	Cost of Subsidy (millions)[3]	Allowance Price of Starting at $38.50[4]	Difference from CCS Price Differential[5]	Number of Tons Sequestered per GW (85% Capture Rate) (millions)	Cost of Subsidy (millions)[6]
2026	$30.00	$24.00	$6.00	4.6	$27.60	$38.50	$0.00	4.6	$0.00
2027	$30.00	$25.00	$5.00	4.6	$23.00	$40.00	$0.00	4.6	$0.00
2028	$30.00	$26.00	$4.00	4.6	$18.40	$41.50	$0.00	4.6	$0.00
2029	$30.00	$27.00	$3.00	4.6	$13.80	$43.00	$0.00	4.6	$0.00
2030	$30.00	$28.00	$2.00	4.6	$9.20	$46.00	$0.00	4.6	$0.00

1 Assumes price differential drops to $30 in 2021. Assumes price differential will continue for life of plants built from 2025–2030.

2 Column 2 minus column 3

3 Column 4 times column 5

4 Taken from the EPA analysis scenario 10, ADAGE estimate, page 27

5 Column 2 minus column 7

6 Column 8 times column 9

TABLE 5: TOTAL PERFORMANCE STANDARD SUBSIDY PER YEAR

1	2	3	4	5	6	7
Year	Year Plant Starts Operation	Number of 1 GW Plants	Cost Differential per GW Starting at $14.00 Allowance Price (Scenario 1)[1]	Total Cost Differential at $14 Starting Price (million dollars)[2]	Cost Differential per GW Starting at $23.5 Allowance Price (Scenario 2)[3]	Total Cost Differential at $23.50 Starting Price (million dollars)[4]
2016	2016	10	$142.60	$1,426.00	$98.90	$989.00
2017	2017	20	$138.00	$2,760.00	$92.00	$1,840.00
2018	2018	30	$133.40	$4,002.00	$85.10	$2,553.00
2019	2019	40	$128.80	$5,152.00	$78.20	$3,128.00
2020	2020	50	$124.20	$6,210.00	$71.30	$3,565.00
2021						
	2016–2020	50	$119.60	$5,980.00	$64.40	$3,220.00
	2021–2021	10	$87.40	$874.00	$32.20	$322.00
				$6,845.00		**$3,542.00**
2022						
	2016–2020	50	$115.00	$5,750.00	$57.50	$2,875.00
	2021–2022	20	$82.80	$1,656.00	$25.30	$506.00
				$7,406.00		**$3,381.00**
2023						
	2016–2020	50	$110.40	$5,520.00	$50.60	$2,530.00
	2021–2023	30	$78.20	$2,346.00	$18.40	$552.00
				$7,866.00		**$3,082.00**
2024						
	2016–2020	50	$105.80	$5,290.00	$43.70	$2,185.00
	2021–2024	40	$73.60	$2,944.00	$0.00	$0.00
				$8,234.00		**$2,185.00**
2025						
	2016–2020	50	$101.20	$5,060.00	$36.80	$1,840.00
	2021–2025	50	$69.00	$3,450.00	$0.00	$0.00
				$8,510.00		**$1,840.00**
2026						
	2016–2020	50	$96.60	$4,830.00	$29.90	$1,495.00
	2021–2025	50	$64.40	$3,220.00	$0.00	$0.00
	2026	10	$27.60	$276.00	$0.00	$0.00
				$8,326.00		**$1,495.00**
2027						
	2016–2020	50	$92.00	$4,600.00	$23.00	$1,150.00
	2021–2025	50	$59.80	$2,990.00	$0.00	$0.00
	2026–2027	20	$23.00	$460.00	$0.00	$0.00
				$8,050.00		**$1,150.00**
2028						
	2016–2020	50	$87.40	$4,370.00	$0.00	$0.00
	2021–2025	50	$55.20	$2,760.00	$0.00	$0.00
	2026–2028	30	$18.40	$552.00	$0.00	$0.00
				$7,682.00		**$0.00**
2029						
	2016–2020	50	$82.80	$4,140.00	$0.00	$0.00
	2021–2025	50	$50.60	$2,530.00	$0.00	$0.00
	2026–2029	40	$13.80	$552.00	$0.00	$0.00
				$7,222.00		**$0.00**
2030						
	2016–2020	50	$69.00	$3,450.00	$0.00	$0.00
	2021–2025	50	$46.00	$2,300.00	$0.00	$0.00
	2026–2030	50	$9.20	$460.00	$0.00	$0.00
				$6,210.00		**$0.00**

1 Taken from column 6 in charts 4, 5 and 6, respective of the appropriate year

2 Column 3 times column 4

3 Taken from column 10 in charts 4, 5 and 6, respective of the appropriate year

4 Column 3 times column 6

TABLE 6: COST OF WARNER-LIEBERMAN BONUS ALLOWANCES

1 Year	2 Total Numbers of Allowances in Warner-Lieberman (million tons)[1]	3 Percent Allocated to CO_2 Bonus Allowances	4 Total CCS Bonus Allowances (millions)[2]	5 Price of Allowance Starting at $12 in 2012 $14 in 2016 (Scenario 1)[3]	6 Total Value of CCS Bonus Allowances starting at $12.00 (millions)[4, 7]	7 Price of Allowance Starting at $17.5 in 2012 $23.5 in 2016 (Scenario 2)[5]	8 Total Value of CCS Bonus Allowances Starting at $17.50 (millions)[6, 7]
2012	5,775	0.04	231	$12.00	$2,772	$17.50	$4,043
2013	5,669	0.04	227	$12.50	$2,835	$19.00	$4,308
2014	5,562	0.04	222	$13.00	$2,892	$20.50	$4,561
2015	5,456	0.04	218	$13.50	$2,946	$22.00	$4,801
2016	5,349	0.04	214	$14.00	$2,995	$23.50	$5,028
2017	5,243	0.04	210	$15.00	$3,146	$25.00	$5,243
2018	5,137	0.04	205	$16.00	$3,288	$26.50	$5,445
2019	5,030	0.04	201	$17.00	$3,420	$28.00	$5,634
2020	4,924	0.04	197	$18.00	$3,545	$29.50	$5,810
2021	4,817	0.04	193	$19.00	$3,661	$31.00	$5,973
2022	4,711	0.04	188	$20.00	$3,769	$32.50	$6,124
2023	4,605	0.04	184	$21.00	$3,868	$34.00	$6,263
2024	4,498	0.04	180	$22.00	$3,958	$35.50	$6,387
2025	4,392	0.04	176	$23.00	$4,041	$37.00	$6,500
2026	4,286	0.04	171	$24.00	$4,115	$38.50	$6,600
2027	4,179	0.04	167	$25.00	$4,179	$40.00	$6,686
2028	4,073	0.04	163	$26.00	$4,236	$41.50	$6,761
2029	3,966	0.04	159	$27.00	$4,283	$43.00	$6,822
2030	3,860	0.04	154	$30.00	$4,632	$46.00	$7,102

1 Section 1201(d) of S. 2191

2 Column 2 times column 3

3 Estimated lowest case scenario

4 Column 4 times column 5

5 Taken from EPA cost analysis, scenario 10 of ADAGE estimate, page 27

6 Column 4 times column 7

7 Funds a total of 38 GW of CCS Plants from 2012–2028 and 10 GW in 2029 and 2030

TABLE 7: COMPARISON OF VALUE OF SUBSIDY
Warner-Lieberman Bonus Allowance Versus CAP Performance Standard Subsidy (48 GW vs. 150 GW)

	ALLOWANCE PRICES START AT $14.00 IN 2016 (SCENARIO 1)		ALLOWANCE PRICES START AT $23.50 IN 2016 (SCENARIO 2)	
1	2	3	4	5
Year	Warner-Lieberman Value of Bonus Allowances (48 GW) (million dollars)[1]	Value of Cap Performance Standard Subsidy (150 GW) (million dollars)[2]	Warner-Lieberman Value of Bonus Allowances (48 GW) (million dollars)[3]	Value of Cap Performance Standard Subsidy (150 GW) (million dollars)[4]
2012	$2,772	$0.00	$4,043	$0.00
2013	$2,835	$0.00	$4,308	$0.00
2014	$2,892	$0.00	$4,561	$0.00
2015	$2,946	$0.00	$4,801	$0.00
2016	$2,995	$1,426.00	$5,028	$989.00
2017	$3,146	$2,760.00	$5,243	$1,840.00
2018	$3,288	$4,002.00	$5,445	$2,553.00
2019	$3,420	$5,152.00	$5,634	$3,128.00
2020	$3,545	$6,210.00	$5,810	$3,565.00
2021	$3,661	$6,854.00	$5,973	$3,542.00
2022	$3,769	$7,406.00	$6,124	$3,381.00
2023	$3,868	$7,866.00	$6,263	$3,082.00
2024	$3,958	$8,234.00	$6,387	$2,185.00
2025	$4,041	$8,510.00	$6,500	$1,840.00
2026	$4,115	$8,326.00	$6,600	$1,495.00
2027	$4,179	$8,050.00	$6,686	$1,150.00
2028	$4,236	$7,682.00	$6,761	$0.00
2029	$4,283	$7,222.00	$6,822	$0.00
2030	$4,632	$6,210.00	$7,102	$0.00
TOTALS	**$68,581**	**$95,910.00**	**$110,092.70**	**$28,750.00**

1 Taken from column 6 of Table 6
2 Taken from column 5 of Table 5
3 Taken from column 8 of Table 6
4 Taken from column 7 of Table 5

TABLE 8: TOTAL VALUE OF BONUS ALLOWANCES PER 1 GW PLANT

1 Plants that begin operation in 2012 (11 GW)	2 Value of Subsidy per GW Scenario 1 (millions)[1]	3 Value of Subsidy per GW Scenario 2 (millions)[2]	4 Plants that begin operation in 2022 (14 GW)[3]	5 Value of Subsidy per GW Scenario 1 (millions)	6 Value of Subsidy per GW Scenario 2 (millions)[4]
2012	$252.00	$367.50	2022	$269	$437.45
2013	$257.68	$391.68	2023	$276	$447.34
2014	$262.93	$414.62	2024	$283	$456.23
2015	$267.84	$436.48	2025	$289	$464.30
2016	$272.31	$457.10	2026	$294	$471.46
2017	$285.98	$476.64	2027	$299	$477.60
2018	$298.88	$495.02	2028	$303	$482.94
2019	$310.95	$512.15	2029	$306	$487.25
2020	$322.30	$528.21	2030	$331	$507.31
2021	$332.81	$543.01	2022–2030 (Total)	$2,649	$4,232
2012–2021 (Total)	$2,863.68	$4,622.39			

1 Column 6 of Table 6 divided by 11

2 Column 8 of Table 6 divided by 11

3 Column 6 of Table 6 divided by 14

4 Column 8 of Table 6 divided by 14

TABLE 9: PERFORMANCE STANDARD SUBSIDY—TOTAL SUBSIDY FOR EACH GW OF PRODUCTION
Based on Year That Plant Goes Into Operation

Year Operation Begins	Subsidy Per Plant Allowance Price Starting at $14 (Scenario 1)[1]	Subsidy Per plant Allowance Price Starting at $23.5 (Scenario 2)[2]
2016	$1,646.80	$731.40
2017	$1,504.20	$632.50
2018	$1,366.20	$540.50
2019	$1,232.80	$455.40
2020	$1,104.00	$377.20
2021	$667.00	$75.90
2022	$579.60	$43.70
2023	$496.80	$18.40
2024	$418.60	$0.00
2025	$345.00	$0.00
2026	$92.00	$0.00
2027	$64.40	$0.00
2028	$41.40	$0.00
2029	$23.00	$0.00
2030	$9.20	$0.00

1 Computed by adding together the subsidy for each GW in column 6 in tables 2, 3, and 4 for each year beginning in the year the GW of plants starts operation until 2030.

2 Computed as described in footnote, substituting column 10 for column 6 values.

Endnotes

1 A vital aspect of early deployment of CCS is an aggressive program of demonstration projects at commercial scale and large-scale testing of sequestration sites reflecting a range of geologic formations. Although not addressed in this paper, the authors are concerned that these efforts are not receiving sufficient priority and funding and need to be significantly intensified for a rapid CCS deployment timetable to be feasible.

2 Ken Berlin and Robert M. Sussman, "Global Warming and the Future of Coal, the Path to Carbon Capture and Storage" (Washington: Center for American Progress, 2007).

3 See United States Environmental Protection Agency, Analysis of Senate Bill S.280 in the 110th Congress (June 2007) and Environmental Protection Agency, Analysis of the Low Carbon Economy Act of 2007 (January 15, 2008).

4 See Environmental Protection Agency, Analysis of the Lieberman-Warner Climate Security Act of 2008, S. 2191 in 110th Congress (March 14, 2008). Scenario 10 models the provisions of S. 2191 against a "high technology reference case" assuming early adoption of energy-efficient and low-emitting technology. This scenario (which is expected to be directionally similar to modeling reflecting the impact of the Energy Independence and Security Act of 2007 that EPA will soon undertake) is viewed by S. 2191's sponsors as the most realistic of the 10 scenarios examined in EPA's analysis. EPA projected the price of emission allowances using the ADAGE and IGEM models. In this report, we use the results of ADAGE modeling, which project lower costs for allowances than those from IGEM.

5 Under Section 3602(c), this "emission performance standard" could be further adjusted for plants that use sub-bituminous coal, lignite or petroleum coke in significant quantities but the adjusted performance standard must prescribe an emission rate that achieves an equivalent emission reduction to that achieved by a plant burning only bituminous coal.

6 Even though plants beginning construction before 2018 that capture 60 percent of their emissions would be eligible for bonus allowances, we assume that all plants will capture at the 85 percent level because of the added financial benefits of obtaining bonus allowances as opposed to purchasing allowances for the uncaptured portion of emissions. As we interpret Section 3603(b), a "bonus allowance adjustment ratio" would be applied to plants with lower rates of capture that would further reduce the number of bonus allowances allocated to such plants so that, at a 60% capture rate, the number of bonus allowances awarded per ton captured would be reduced by more than 50%. Thus, as shown on Table 8, the value of the bonus allowances to a plant that captures at a 60% rate would be decreased over the ten year eligibility period by more than between $1.3 billion in the lower price scenario (column 5 of Table 8) and $2.3 billion in the higher price scenario (column 3 of Table 8).

7 DOE National Energy Technology Laboratory, "Tracking New Coal-fired Power Plants: Coal's Resurgence in Electric Power Generation" (May 1, 2007). The latest update to this report, published on February 18, 2008, indicates that several proposed plants have been cancelled or delayed because of regulatory uncertainty regarding climate change or strained project economics due to escalating costs in the industry.

8 Obviously, auctioning a larger proportion of allowances rather than giving them away would create a larger revenue stream for energy technology deployment.

9 To be eligible for subsidies, Section 4403(a) (4) (C) provides that plants must meet one of the performance standards in clause (ii) or (iii) of paragraph (1) (A). Under these clauses, plants entering construction before July 1, 2018 would need to capture and sequester at least 60 percent of their CO_2 emissions while plants entering construction after that date would need to capture and sequester at the 85 percent level. These are the same performance standards as in the Title III bonus allowance program (although the zero- or low-carbon generation incentives in Section 4402 require 90 percent capture). To simplify our analysis, we again assume that utilities would opt for 85 percent capture in obtaining the Section 4403 subsidies because the amount of the subsidy would be higher.

10 Section 4403(a)(6)(B)(ii).

11 We started this analysis in 2016 since this would be the earliest year in which coal plants entering construction after 2009 would need to meet an emission performance standard.

12 New entrants would receive some free allowances under Section 3903(a). However, we assume that these free allowances would probably only cover around 15 percent of the emissions of a non-CCS facility because: (1) like existing plants, new entrants would be able to cover only a minority of their emissions with free allowances and this amount would decline over time; and (2) the number of allowances distributed would be based on the emission rate for a gas-fired plant per Section 3902(a)(2)(A), which is approximately one-third of the rate for an uncontrolled coal plant. For this reason, our analysis assumes that uncontrolled new coal plants would need to purchase allowances for 85 percent of their emissions. The remaining 15 percent would be equal to the remaining CO_2 emissions at a CCS plant with 85 percent capture; presumably the CCS plant would also receive free allowances for these emissions but that is not clear from the text of S. 2191.

13 This analysis again assumes that 1 GW plant emits 5.4 million metric tons of CO_2 per year and sequesters 85 percent or 4.59 million metric tons.

14 Berlin and Sussman, "Global Warming and the Future of Coal" at 18.

15 EPRI, "The Power to Reduce CO_2 Emissions" (2007) at 3.11

16 The utility could both hold the bonus allowances and use them to cover its emissions or sell the allowances and use the proceeds to purchase additional allowances at future auctions, whichever was most advantageous.

17 Defined to include fossil-fueled generation that emits no more than 250 pounds of CO_2 per megawatt hour, after adjustment for CO_2 emissions that are geologically sequestered.

18 Section 4403 also sets a lower emission performance standard for retrofits of existing plants but facilities (new and existing) receiving deployment incentives would need to meet the higher 60 and 85 percent capture rates.

19 Note that this program would not provide for full recovery of the incremental costs of CCS and thus would be less attractive to developers than either the Section 4403 deployment program (which would provide grants covering incremental costs) and the Title III bonus allowance program (which would provide financial benefits greatly in excess of the incremental costs of CCS).

20 Obviously more funding would be available if the number of auctioned allowances increased and the number distributed for free decreased, as CAP has elsewhere recommended.

21 The bonus allowance and CCS subsidy provisions require a performance standard of 60 percent for carbon capture and storage at plants entering construction before 2018. Insofar as this standard is the best achievable for certain types of coals (i.e. lignite), it would be consistent with the CAP approach.

22 This program would not subsidize manufacturing of low-carbon equipment and components, unlike Section 4042 of S. 2191. With an emission performance standard and subsidies for CCS costs, equipment vendors should have ample commercial incentives for investments at the manufacturing level. While the program would cover CO_2 sequestration tests, it would augment the program of large-scale sequestration testing Congress authorized in the recently enacted energy legislation, which presumably will be separately funded through the normal appropriations process.

23 As previously recommended by CAP, GHG emitters should purchase all of their allowances, rather than receive a large portion of them for free until 2031. In addition, more of the auction revenues from these allowances must go for international adaptation to assist developing nations in coping with the coming impacts of global warming.

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