Greenhouse Gas Reductions or Greenwash?: The DOE's 1605b Program*

Thomas P. Lyon†
University of Michigan

Eun-Hee Kim‡
University of Michigan

DRAFT
APRIL 2007

Abstract

This paper presents the first empirical analysis of the factors that lead electric utilities to participate in the Department of Energy's voluntary greenhouse gas registry, and the impact of participation on their actual emissions performance. Firms that participate tend to be larger and have higher emissions. Firms are more likely to participate when the cost of participation is lower and when the pressure to participate and the expected value of ERCs are higher. Participating in the 1605b program has no measurable effect on a firm's carbon intensity, i.e., carbon emissions per unit of electricity generated. Firms that participate tend to have increasing emissions but report reductions; non-participants tend to have decreasing emissions. Firms' participation may be a form of greenwash, that is, an attempt to appear more environmentally friendly than is really the case.

Keywords: greenwash, information, public voluntary programs, early reduction credits, greenhouse gas, electric utilities, the 1605b program

JEL No.

Q58 – Environmental Economics: Government Policy;
D21 – Firm Behavior;
D83 – Search; Learning; Information and Knowledge; Communication; Belief

---

* We would like to thank participants in the Business Economics seminar at the University of Michigan, the first annual Conference on Institutional Mechanisms for Industry Self-Regulation at Dartmouth, Berkeley UCEI, and Harvard for helpful comments.

† Dow Chair of Sustainable Science, Technology and Commerce, Director, Erb Institute for Global Sustainable Enterprise, Stephen M. Ross School of Business and School of Natural Resources and Environment, University of Michigan, 701 Tappan Street, Ann Arbor, MI 48109, tplyon@umich.edu.

‡ PhD Candidate, Stephen M. Ross School of Business, University of Michigan, 701 Tappan Street, Ann Arbor, MI 48109, eunheek@umich.edu.

1. Introduction

Corporate America is increasingly cutting its greenhouse gas emissions, despite the lack of any federal mandate to do so.[1] Depending upon one's perspective, these actions can be viewed as meaningful steps to combat global warming, or as mere "greenwash" designed to fool a gullible public into directing its attention toward other issues.[2] There has been little systematic empirical work attempting to test these alternative hypotheses, however. In this paper, we tackle this challenge using detailed data from the industry sector that emits the greatest amount of greenhouse gases: electric utilities.

Our topic presents a rare opportunity to compare what companies *actually* do with what they *claim* to do, thereby providing unusually sharp insight into whether firms are engaged in "greenwash." We make use of a program created by section 1605b of the Energy Policy Act of 1992, which directed the Department of Energy to create a registry in which companies could record their voluntary reductions of greenhouse gas (GHG) emissions. Since electric utilities must report detailed fuel use data to the Federal Energy Regulatory Commission (FERC), we can compare their actual reductions in emissions against what they report through the 1605b program.

As can be seen in Figure 1, in the aggregate there is a large gap between actual and reported aggregate emissions reductions over the period 1996-2003. Indeed, participants in the 1605b program reported significant reductions while actually increasing their emissions. Ironically, firms that did *not* participate in the program reduced their emissions. On the surface, then, the voluntary reporting program appears to provide a convenient "greenwashing" tool for industry.

To explore the issue more deeply, we formulate a series of testable hypotheses regarding why firms participate in the 1605b program, and which types of firms are more likely to participate. Perhaps the clearest economic motivation for participation is the chance to obtain "early reduction credits" that would have value if the U.S. were to

[1] Various explanations for these moves have been offered, including pre-empting legislative action; preparing for anticipated future legislation; cutting costs; currying favor with "green" consumers, investors and regulators; and jockeying for a seat at the table whenever future legislation finally is drafted. See Hoffman (2005; 2006).

[2] For a formal model of "greenwash," see Lyon and Maxwell (2006).

impose an emissions cap in the future. We also test hypotheses from Lyon and Maxwell (2006) regarding which firms are more likely to engage in "greenwash." In particular, we test their hypothesis that firms with middling environmental records are more likely to greenwash than are firms that are particularly clean or particularly dirty.

The remainder of the paper is organized as follows. Section 2 describes the 1605b program, and illustrates the sort of reports firms file with the Department of Energy. Section 3 surveys the relevant literature, and develops a set of testable hypotheses. Section 4 describes our econometric model, and section 5 describes our data. Section 6 reports results and section 7 concludes.

2. The 1605b program

The voluntary registry program was established by section 1605b of the Energy Policy Act of 1992. The general features of the 1605b program align well with the proposals laid out in former President Bill Clinton and former Vice President Al Gore's report titled, "Reinventing Environmental Regulation" (Clinton and Gore, 1995). One of the proposals is to take full advantage of the power of information. The 1605b program allows public electronic access, so the public as well as government and firms can access the program's database. The 1605b program also has a self-certification feature proposed in the report.

The unique nature of the 1605b program is that there are no hard and fast rules about how to report reductions.[3] First of all, voluntary reporters can choose to report reductions at the entity or at the project level. Moreover, reporters can define the boundary of the entity or project.[4] Reporters are even allowed to report entity-level reductions just as the sum of project-level reductions. Secondly, voluntary reporters also have leeway in choosing baseline emissions against which to measure their reductions: historical or hypothetical. In the case of historical emissions,

[3] The unique features described here do not reflect the recently revised guidelines (effective date: June 1, 2006). This is because our analysis is based on the data firms reported to the 1605b program during 1995-2003, which is before the revised guidelines were introduced.
[4] This information is based on personal correspondence with EIA's 1605b project manager, Mr. Stephen E. Calopedis (October 18, 2005).

reporters can select any one year between 1987 and 1990 or use an average of any of those years. In the case of hypothetical emissions, reporters estimate what emissions would have been without entity- or project-level reductions. Thirdly, reporters can report either reductions in absolute emissions or reductions in emissions intensity. Fourthly, voluntary reporters can report indirect reductions or sequestration as well as direct reductions.[5]

In 2003, the latest year covered in this paper, the 1605b program received a total of 98 reports from the electric power sector and the reports provided information on 485 GHG emissions projects. The projects covered a wide range from reducing emissions at the electric power generation, transmission and distribution stages to demand-side management and carbon sequestration.

Abatement strategies at the generation stage include fuel switching from high to low carbon fuel sources, improving plant availability at low-carbon generators such as nuclear and hydro, plant efficiency improvement, increases in low- or zero-emitting generation capacity, decreases in high-emitting capacity, and retirement of high-emitting plants. Reductions at the transmission and distribution stages involve reduced losses in the delivery of electricity from power plants to end use through the use of high-efficiency transformers, transmission line improvements, etc. Demand side management projects aim to improve end-use energy efficiency of both stationary and mobile sources in the industrial, commercial, residential, agricultural, and transportation sectors. Carbon sequestration projects report carbon fixing through afforestation, reforestation, etc. Projects on other GHGs such as methane are also reported to the 1605b program.

Three case studies in the appendix illustrate what kinds of projects are actually reported to the program. American Electric Power (AEP) and Southern Company (SO) represent fossil fuel-oriented companies and Exelon Corporation (EXC) nuclear-oriented ones. AEP participates at the project level and most of its projects involve carbon sequestration. SO participates both at the entity and the project level but the sum of the

[5] Direct reductions refer to reductions from sources owned by the reporter. Indirect reductions refer to reductions from sources not owned by the reporter but somehow affected by reporter actions. An example of indirect reductions is a decrease in power plant emissions due to a decrease in end-use electricity consumption, which in turn is at least partly attributable to electric utilities' demand side management programs. Sequestration refers to the removal and storage of carbon from the atmosphere in carbon sinks such as trees, plants, or underground reservoirs. See *Voluntary reporting of Greenhouse Gases 2003*, EIA (2005).

project level reduction is the same as the entity level reduction. EXC participates at the project level and its projects include transportation-related ones. For all three companies generation at non-fossil fuel units such as nuclear or hydro accounts for the majority of their generation-related projects.

3. Testable Hypotheses

This paper draws on and contributes to three areas of research: early reduction credits, public voluntary programs, and greenwash. Early reduction credits refer to giving credits for emissions reductions firms voluntarily undertake prior to the implementation of a mandatory program. The literature on early reduction credits (ERCs) examines the comparative merits and demerits of early reduction credits as a tool for cost-effectively achieving the Kyoto target and discusses issues specifically related to granting credit to the 1605b participants. Under public voluntary programs, participating firms agree to make good faith efforts to meet program goals established by the regulatory agency; in return, they may receive technical assistance and/or favorable publicity from the government. The growing body of literature on public voluntary programs ranges from theoretical evaluations of their welfare implications to empirical examination of firms' participation in various voluntary programs.[6] Greenwash refers to firms' attempt to appear more environmental friendly than is really the case. The emerging literature on greenwash identifies both theoretically and empirically the conditions under which firms are more likely to engage in greenwash.

The idea of granting ERCs for GHG reductions was first suggested in the President Clinton's Climate Change Proposal of October 1997. It was intended to increase political support and make any subsequent mandatory GHG reduction targets easier to achieve by encouraging early reductions.[7] The advantages include a gradual (rather than abrupt) adjustment to a carbon constrained world, reduced risk of hitting

[6] See Lyon and Maxwell (2004).
[7] The General Accounting Office's report (1999) examines issues specifically related to granting credit to the 1605b participants and concludes that the 1605b guidelines are too flexible to warrant early reduction credits. Department of Energy, however, still indicated that there is the possibility that early reduction credits are granted to the 1605b participants. GAO/RCED-99-23.

thresholds that trigger climate change, and an increased probability of complying with regulations, e.g. Kyoto Protocol (Michaelowa and Rolfe, 2001). The disadvantages include distortion of abatement investment decisions towards those actions that have immediate reduction impacts, which ultimately leads to higher compliance cost (Kennedy, 2002). Granting ERCs also induces too much early abatement than optimal (Parry and Toman, 2002).

The empirical literature on public voluntary programs examines what factors affect the decision to participate and how effective the voluntary programs are as regulatory tools. The program that has received the most attention is the EPA's "33/50" program, which encouraged firms to reduce their emissions of seventeen key toxic chemicals, relative to a 1988 baseline, by 33 percent by 1992 and 50 percent by 1995. Other programs studied include the DOE's Climate Challenge program and EPA's WasteWise program and Green Lights program.

Research finds that firm size, poor environmental performance and greater external pressure have consistently significant and positive effects on voluntary program participation. The effect of firm size suggests that larger firms face greater pressure from environmental or citizens' groups to take action, enjoy economies of scale in compliance, or have better access to capital markets and hence lower costs of new investments.[8] Dirtier firms are more likely to participate, probably because they face greater media scrutiny and pressure from environmental or citizens' groups.[9] The effect of greater external pressure suggests that firms are more likely to participate when they face greater external pressure from environmental groups, communities, state politicians, or industry associations.[10] In particular, Sam and Innes (2005) find that the number of state-level Sierra Club membership has a significant and positive effect on joining the 33/50 program. Sam and Innes (2005) also find evidence that firms participate to forestall

[8] The EPA's 33/50 program (Arora and Cason, 1995; 1996; Khanna and Damon, 1999; Videras and Alberini, 2000; Sam and Innes, 2005), the EPA's Green Lights program (DeCanio and Watkins, 1998; Videras and Alberini, 2000), the EPA's WasteWi$e program (Videras and Alberini, 2000), the DOE's Climate Challenge program (Karamanos, 1999; Welch, Mazur, and Bretschneider, 2000), and the Sustainable Slope Program (Rivera and de Leon, 2004).

[9] The 33/50 program (Arora and Cason, 1995; 1996; Khanna and Damon, 1999; Videras and Alberini, 2000; Sam and Innes, 2005), the Green Lights program (Videras and Alberini, 2000), the Sustainable Slopes Program (Rivera and de Leon, 2004) and the WasteWi$e program (Videras and Alberini, 2000).

[10] The 33/50 Program (Khanna and Damon, 1999, Sam and Innes, 2005) and the Sustainable Slopes Program (Rivera and de Leon, 2004).

potential boycotts. In the case of GHG emissions, Rabe (2004) discusses the relative significance of state-level pressures.

Evidence on the effect of growth rate on participation is limited. Videras and Alberini (2000) find that the firm-specific growth rate is in general not significant. For the Green Lights and WasteWi$e programs, they do not find any significant effect of firm-level growth rate. For the 33/50 program, they find a significant negative effect, but in only one out of three model specifications. DeCanio and Watkins (1998) examine how the industry-specific growth rate affects the probability of participating in the Green Lights program and find that the effect is positive and significant.

In the case of GHG related programs, another important factor to consider is firms' fuel mix. A hypothesis is that firms that rely heavily on GHG emitting fuels (fossil fuels) are subject to greater pressure to reduce emissions, thus more likely to join voluntary programs. Karamanos (1999) examines this hypothesis for the Climate Challenge program, using a fraction of electricity generated from fossil fuels. He finds a significant positive effect of fossil fuel use on participation.

The literature surveyed above suggests a couple of hypotheses regarding why firms participate in the 1605b program.

First, the literature on ERCs suggests that firms with lower cost of participation are more likely to participate in the 1605b program since ERC would have same marginal value for all firms.[11] *Large firms* are more likely to have enough potential ERCs to outweigh the cost of participating in a voluntary registry. Firms with *low-cost opportunities* to reduce emissions are also more likely to participate. This would include firms with inefficient older coal-burning plants that could benefit from a retrofit (proxied for by a high heat rate, or heat input per unit of electricity generated), and firms with nuclear or hydroelectric plants that are currently operating at low capacity factors. This category would also include firms with high-cost oil-burning plants that could be displaced by cheaper, cleaner, gas-fired generating units.[12] (We create a variable called

[11] Unfortunately, the literature on ERCs does not suggest a hypothesis on ERCs that we can directly test.
[12] During most of our sample period, natural gas was the fuel of choice for new generating units because it was both clean and cheap. As of September 2002, the Energy Information Administration reported that the average wellhead price of natural gas remained below $3.00 per thousand cubic feet (MCF). Since that

"fuel switch saving" that measures the difference between the cost per kwh of the firm's most expensive fuel source and the cost per kwh of natural gas.) Utilities with *growing demand* can increase their capacity factors, operating more efficiently and reducing their carbon intensity, that is, their emissions per unit of generation. Growing firms can also justify building new plants, which during our sample period tended to be relatively low-emission gas-fired plants; adding new, clean capacity also reduces a firm's overall carbon intensity. To summarize,

Hypothesis 1: A firm is more likely to participate in the 1605b program if it: a) is large, b) has a high heat rate, c) has a low capacity factor, d) has a large potential fuel switch saving, or e) faces growing demand.

Second, as summarized by Lyon and Maxwell (2004), the literature on public voluntary programs has found a number of empirical regularities that we might expect to hold here as well. The benefits of participating in public voluntary programs are typically thought to include favorable publicity, improved relationships with regulators, information exchange with other participating firms, and technical assistance from environmental specialists. According to the DOE's Voluntary Registry website,

> "The voluntary reporting program provides an opportunity for you to gain recognition for the good effects of your actions-recognition from your customers, your shareholders, public officials, and the Federal government. Reporting the results of your actions adds to the public groundswell of efforts to deal with the threat of climate change. Reporting can show that you are part of various initiatives under the President's Climate Change Action Plan. Your reports can also record a baseline from which to measure your future actions. Finally, your reports, along with others, can contribute to the growing body of information on cost-effective actions for controlling greenhouse gases."[13]

---

time, prices have risen sharply, with the price in December 2005 over $10 per MCF. Utilities now face much more difficult choices when they expand capacity than they did during our sample period.

[13] http://www.eia.doe.gov/oiaf/1605/1605b.html

This statement of the benefits of participation suggests that they are primarily in the form of publicity and improved relationships with regulators.

The most consistent finding in the literature on participation in voluntary programs is that *larger firms* are more likely to participate. Such firms may face greater pressure from environmental or citizens' groups to take action, enjoy economies of scale in compliance, or have better access to capital markets and hence lower costs of new investments, all of which encourage participation. Second, *dirtier firms* are more likely to participate, presumably because they face greater media scrutiny and pressure from citizens' groups. A third and related finding is that firms are more likely to participate when they face *greater external pressure* from environmental groups, communities, state politicians, or industry associations.

Hypothesis 2: A firm is more likely to participate in the 1605b program to obtain favorable publicity and improve regulatory relationships if it: a) is large, b) emits more greenhouse gases, or c) faces greater external pressure from environmental groups, local communities, state politicians or industry associations.

Academic literature on greenwash has only recently begun to emerge. Lyon and Maxwell (2006) provide the first formal model of greenwash.[14] They note that greenwash is different from other disinformation strategies in that firms' environmental claims are typically not false. The problem of greenwash is rather that firms do not fully disclose their environmental performance. Anecdotal evidence suggests that firms often hesitate to publicize even good environmental practice for fear of being accused of greenwash by non-governmental organizations (NGOs). Lyon and Maxwell (2006) develop a model that focuses on this relationship. They characterize how the possibility of NGO punishment influences the firm's disclosure decisions, and show how these effects depend upon the firm's probability of success in its environmental activities, and the

[14] Lyon and Maxwell (2006) define greenwash as the selective disclosure of positive information about a company's environmental performance, without full disclosure of negative information on these dimensions.

probability the firm is informed about the outcome of its activities at the time it makes a disclosure.

They find that punishing greenwash motivates firms with a low probability of success and high probability of being informed to fully disclose. These firms gain a lot from advertising a success and lose little by disclosing a failure since they are already expected to fail. Conversely, firms with high probability of success but low probability of being informed are likely to shift towards non-disclosure. They gain little by disclosing a success and lose a lot by disclosing a failure. For firms with moderate probability of success, partial disclosure is attractive as long as expected punishment is not prohibitively high. For them disclosing a success can bring about significant improvement in public perception, while withholding a failure can prevent significant damage. Thus, they are willing to risk public backlash by disclosing only partially. As expected punishment increases, however, partial disclosure is no longer profitable for any type of firms. Instead, dirtier firms are more likely to fully disclose and cleaner firms not disclose at all.

Ramus and Montiel (2005) empirically examine conditions under which firms are more likely to greenwash. In the context of their paper, firms engage in greenwash when they commit to environmental policies in their public statements but do not implement them. Ramus and Montiel (2005) find evidence that firms are more likely to greenwash when they face institutional pressures to commit but the expected benefit from implementing their commitment is slim. In particular, service firms are more likely to greenwash than are manufacturing firms.

The nascent academic literature on greenwash suggests an additional hypothesis: firms with moderate levels of environmental performance are the most likely to engage in greenwash.[15] Firms seen as already very clean have little incentive to disclose information, as they already have favorable perceptions from investors; firms seen as very dirty have little incentive not to disclose, as they are already expected to fail. It is

[15] Lyon and Maxwell (2006) also suggest that a) firms with more complete environmental management systems (EMSs) are more likely to disclose fully (unfortunately, we are unable to test this hypothesis as we do not have EMS data), and b) dirty firms facing increased external pressure (e.g., from environmental non-governmental organizations) disclose more, but clean firms facing increased external pressure disclose less.

firms that are moderately clean that stand to enhance their image by increasing disclosure of their environmental successes. We summarize the hypothesis below:

Hypothesis 3: A firm is more likely to participate in the 1605b as a form of greenwash if it has a moderate level of greenhouse emissions.

The hypotheses developed above relate to why firms participate in the 1605b program. We now turn to hypotheses regarding what types of firms are more likely to have better environmental performance. Our environmental performance variable of interest is CO_2 emissions intensity, i.e., CO_2 emissions per net generation (lbs/MWh). First of all, if relatively clean firms participate in the 1605b program, we should observe a significant negative association between 1605b participation and firms' CO_2 emissions intensity. If 1605b participation is just a form of greenwash, however, we would not observe the negative association, at least not in a level of significance. Secondly, firms with higher fraction of generation from hydro or nuke, which emits zero carbon, should have lower CO_2 emissions intensity than otherwise. Thirdly, firms with higher capacity factor should have lower CO_2 emissions intensity since their low excess capacity indicates that they have already taken advantage of relatively low-cost abatement opportunities available to them, i.e., expanding effective capacity through improvement in operating efficiency.

Hypothesis 4: A firm has better environmental performance, i.e., lower CO_2 emissions intensity, *if it: a) participates in the 1605b program b) has higher fraction of hydro or nuke, or c) has higher capacity factor.*

Section 5 discusses the precise variables we use to test these hypotheses.

4. Econometric Models

We use Probit models to analyze the factors that lead electric utilities to participate in the 1605b program. The theoretical basis for the Probit models is the Run of

Domencich and McFadden (1975). The decision maker has complete information and makes a rational choice based on the information. We the analysts, however, have incomplete information. Therefore, we need to take uncertainty into account. The sources of uncertainty include unobserved alternative attributes, unobserved individual attributes, and measurement errors. To reflect this uncertainty, the firm's utility is modeled as a random variable, which has a deterministic part and a stochastic part. The alternative with the highest utility is chosen. Different assumptions about the random terms lead to different models. We assume a normal distribution, and use a Probit model. In this model, let *i* denote the firm and *j* denote the choice to participate in the program (*j*=1) or not (*j*=0).

Let D_{it} = 1 if firm *i* makes choice 1 in period t

D_{it} = 0 if firm *i* makes choice 0 in period t

The firm's utility is

$$V_{ijt} = \beta \mathbf{X_{ijt}} + \varepsilon_{ijt} \qquad (1)$$

We observe

$$y_{it} = 1 \text{ iff } V_{i1t} > V_{iot}$$

This is equivalent to

$$\beta \mathbf{X_{i1t}} + \varepsilon_{i1t} > \beta \mathbf{X_{i0t}} + \varepsilon_{i0t}$$

or

$$\varepsilon_{i0t} - \varepsilon_{i1t} < \beta(\mathbf{X_{i1t}} - \mathbf{X_{i0t}})$$

Then the probability of participation is

$$\begin{aligned} P_{it} &= Prob\ (y_{it}=1 \mid \mathbf{X_{it}}) \\ &= Prob\ (\varepsilon_{i0t} - \varepsilon_{i1t} < \beta(\mathbf{X_{i1t}} - \mathbf{X_{i0t}})) \\ &= F[\beta(\mathbf{X_{i1t}} - \mathbf{X_{i0t}})] \end{aligned}$$

where F is cdf of ε_{i0t} - ε_{i1t}.

If ε_{i0t} and ε_{i1t} are normally distributed with mean 0, so

$\varepsilon_{i0t} - \varepsilon_{i1t} \sim N(0, \sigma^2)$, then

$$P_{it} = \Phi[\beta(\mathbf{X_{i1t}} - \mathbf{X_{i0t}})] \quad (2)$$

where Φ is the standard normal cdf.

We assume that firms participate in the 1605b program if the net benefit with participation is greater than the net benefit without participation. Thus, we include the variables that affect the benefit and cost of 1605b participation as regressors in our Probit models.

To estimate the impact of a firm's 1605b participation on our outcome variable of interest, CO_2 emissions intensity (CO_2 emissions per net generation (lbs/MWh)), we use a treatment effects model that takes into account selection on unobservables.[16] The analysis has two stages, 1) participation and 2) outcome. We make a couple of assumptions. Both in the first and second stages, the coefficients of the independent variables are the same for the participants and non-participants. There is no good reason to believe that marginal effects of the regressor variables on carbon intensity are any different between the 1605b participants and the non-participants. They are also exposed to a common unobservable shock. Equation (3) and equation (4) are the second-stage outcome equations for the participants and non-participants, respectively.[17] The approach is fully parametric and the model is estimated by maximum likelihood. The full model is

$$y_{1it} = \alpha_1 + \mathbf{Z_{it}}\boldsymbol{\gamma} + \mu_{it} \quad (3)$$

$$y_{2it} = \alpha_2 + \mathbf{Z_{it}}\boldsymbol{\gamma} + \mu_{it} \quad (4)$$

$$D_{it}^{*} = \mathbf{X_{it}}\boldsymbol{\delta} + \varepsilon_{it}, \quad (5)$$

---

[16] We follow Cameron and Trivedi (2005).

[17] The variables in **Z** may overlap with those in **X**, but it is assumed that there exist at least one component of **X** that is a nontrivial determinant of the participation dummy and not a part of **Z**, that is, significantly correlated with the endogenous participation variable, but uncorrelated with the outcome variable, except through the participation dummy.

$D_{it} = 1$ if $D^*_{it} > 0$ and $D_{it} = 0$ otherwise,

where y_{1it} and y_{2it} are CO_2 emissions intensity in the second stage for the 1605b participants and non-participants, respectively. $\mathbf{Z_{it}}$ is independent variables that affect CO_2 emissions intensity. D_{it} is a participation dummy and D^*_{it} is a latent variable for participation. $\mathbf{X_{it}}$ is independent variables that affect firms' participation decision.

We allow for the possibility of correlation between the error terms in the first and the second stage. The nonzero correlation coefficient, ρ, reflects the endogeneity of the participation variable.

$\mu_{it} \sim N(0,\sigma)$

$\varepsilon_{it} \sim N(0,1)$

$\text{corr}(\mu_{it}, \varepsilon_{it}) = \rho$

Using the participation dummy, the two outcome equations, equation (3) and equation (4), can be written in one equation.

$$\begin{aligned} y_{it} &= D_{it}y_{1it} + (1-D_{it})y_{2it} \\ &= D_{it}(\alpha_1 + \mathbf{Z_{it}}\boldsymbol{\gamma} + \mu_{it}) + (1-D_{it})(\alpha_2 + \mathbf{Z_{it}}\boldsymbol{\gamma} + \mu_{it}) \\ &= \alpha_2 + \mathbf{Z_{it}}\boldsymbol{\gamma} + (\alpha_1 - \alpha_2)\, D_{it} + \mu_{it} \\ &= \alpha_2 + \mathbf{Z_{it}}\boldsymbol{\gamma} + \eta D_{it} + \mu_{it} \qquad (6) \end{aligned}$$

where $\eta = \alpha_1 - \alpha_2$

The coefficient of the participation dummy variable in equation (6), η, represents the effect of participation on outcome upon random selection.

The expected difference in outcome conditional on participation, that is, the expected difference in CO_2 emissions intensity between the 1605b participants and non-participants, needs to take into account the selection effect. This requires estimating the expected value of μ_{it} conditional on participation, i.e., $E(\mu_{it} \mid \varepsilon_{it} \geq -\mathbf{X_{it}\delta})$ and $E(\mu_{it} \mid \varepsilon_{it} < -\mathbf{X_{it}\delta})$. To estimate this, we assume that μ_{it} and ε_{it} has a joint normal distribution. Under this assumption, the expected values of μ_{it} for the participants and non-participants are represented by:

$$E(\mu_{it} \mid \varepsilon_{it} \geq -\mathbf{X_{it}\delta}) = f(\mathbf{X_{it}}\hat{\boldsymbol{\delta}})/F(\mathbf{X_{it}}\hat{\boldsymbol{\delta}}) \qquad \text{if } D_i=1 \qquad (7)$$

$$E(\mu_{it} \mid \varepsilon_{it} < -\mathbf{X_{it}\delta}) = -f(\mathbf{X_{it}}\hat{\boldsymbol{\delta}})/[1-F(\mathbf{X_{it}}\hat{\boldsymbol{\delta}})] \qquad \text{if } D_i=0 \qquad (8)$$

where f is the standard normal pdf and F is the standard normal cdf. The expected difference in outcome conditional on participation can then be calculated as follows.

$$\begin{aligned} &E(y_{it} \mid D_{it}=1) - E(y_{it} \mid D_{it}=0) \\ &= \{\alpha_2 + \mathbf{Z_{it}}\boldsymbol{\gamma} + \eta + E(\mu_{it} \mid \varepsilon_{it} \geq -\mathbf{X_{it}\delta})\} - \{\alpha_2 + \mathbf{Z_{it}}\boldsymbol{\gamma} + E(\mu_{it} \mid \varepsilon_{it} < -\mathbf{X_{it}\delta})\} \\ &= \eta + E(\mu_{it} \mid \varepsilon_{it} \geq -\mathbf{X_{it}\delta}) - E(\mu_{it} \mid \varepsilon_{it} < -\mathbf{X_{it}\delta}) \qquad (9) \end{aligned}$$

Thus, the unconditional and conditional expected differences in CO_2 emissions intensity between the 1605b participants and non-participants can be estimated using equations (6) and (9), respectively. If ρ, the correlation coefficient between μ_{it} and ε_{it}, is significantly different from zero, estimating the conditional expected difference between the 1605b participants and non-participants can provide additional insight into the impact of the 1605b program.

5. Data

The models are estimated using a pooled database of 83 investor-owned electric utilities (IOUs) over the period 1996-2003.[18] The total number of observations in the sample is 596, and thus a firm is in the sample on average for 7 years. The 1605b

[18] The reason for pooling is discussed later in the section.

participation data were collected from the DOE's Voluntary Registry website.[19] Financial, operational and environmental performance-related data were obtained from Platts, a company specializing in energy industry data.[20] Table I provides a list of explanatory variables used in this paper and their definitions. Some of the variables are lagged by one year to avoid endogeneity.

As described in Table I, CO_2 emissions are calculated based on fuel consumption. We take this approach rather than using direct observations from the continuous emissions monitoring system (CEMS) for several reasons. First, the Natural Resources Defense Council (NRDC) reported that turbulent flow in the stack could bias the CEMS estimates upward by 10-30 percent.[21] Second, NRDC also found cases where the CEMS data deviate from the EIA and FERC estimates when the latter two agreed for the most part. In these cases of discrepancies, NRDC used the FERC-based estimates. Third, we were able to obtain a more complete dataset using the fuel consumption data than would have been possible using the CEMS data alone. In cases where fuel consumption data were not available, we supplemented our fuel consumption-based estimates with adjustede CEMS estimates to increase the number of observations.[22]

Table I also includes two greenwash-related variables: the absolute difference from the mean and the absolute difference from the median CO_2 emissions for that year. They are designed to capture Hypothesis 3, that firms most likely to engage in greenwash are those with an intermediate probability of producing positive environmental outcomes. We approximate this probability with firms' CO_2 emissions levels and measure closeness to an intermediate probability by calculating the distance from the mean or the median level of CO_2 emissions for that year.

[19] http://www.eia.doe.gov/oiaf/1605/frntvrgg.html
[20] Collecting financial and operational data for electric operating companies, especially those of investor-owned, has become very difficult since the mid-1990s when the Energy Information Administration (EIA), the statistical agency of DOE, stopped organizing in a convenient format the raw data that electric operating companies report to FERC. More recently EPA has made publicly available an integrated database, eGRID, which provides emissions and generation data. There are a couple of drawbacks, however. There is a considerable time lag. For example, the database now available covers the period only from 1996 to 2000. Also, there are no financial variables.
[21] www.nrdc.org/air/energy/rbr/append.asp.
[22] Although we ultimately chose not to use the CEMS data as our primary data source, we did run our estimations using this data as a robustness check. Results were qualitatively similar to what we obtained from the fuel consumption data.

The interaction variable between lag CO_2 emissions and Sierra magazine subscription is constructed based on Maxwell, Lyon and Hackett (2000), who find that toxic reductions over time are greater in states with high emissions levels and strong environmental group membership.

[Table I about here]

To investigate firms' participation decisions in the 1605b program and their effect on CO_2 emissions intensity, we pool our dataset across years. There are a couple of reasons for this. First, the 1605b program does not require that the IOUs make any short- or long- term commitment. This implies that every year they can opt out or opt in, providing theoretical support for pooling.[23] Second, the Hausman test result demonstrates that we cannot reject the null hypothesis that the firm-specific effects are uncorrelated with the independent variables. In other words, we do not find any evidence that fixed effects are present.[24] This finding further supports pooled analyses (Cameron and Trivedi, 2005). We use panel-corrected standard errors and t-statistics for statistical inference.[25]

Table II provides summary statistics for the explanatory variables used in our pooled analyses, both in aggregate and by participation category. 309 out of 596 observations, 52% of our sample, have a participation dummy which equals 1. Thus, approximately 44 out of 83 firms participated in the program. 1605b participation is on average associated with larger and dirtier firms represented by higher revenue and higher lag CO_2 emissions and SO_2 emissions, respectively. CO_2 emissions intensity is also higher for the participants. 1605b participation is associated with greater external pressure: greater number of Sierra magazine subscriptions and higher LCV scores for the

[23] This approach is different from how Khanna and Damon (1999) analyzed their data for the 33/50 program. Noticing that once a firm participates, it stays in, they dropped those observations for which one-year lag participation dummy is 1.

[24] We note a couple of qualification in this statement. First, only three firms in our sample show variation in participation status during 1996-2003. Accordingly, fixed effect estimates are based only on these three firms, whereas random effect estimates are based on our full sample. Second, due to convergence problems, we could conduct the Hausman test using a model only with three independent variables deemed most important in making participation decisions (lag CO_2 emissions, electric operating revenue, and Sierra magazine subscription). We obtain $\chi^2(2)=2.12$ and p-value of 0.346.

[25] We assume observations are independent across firms but not independent within firms. For details see Wooldridge (2002).

House and the Senate. The interaction term between lag CO_2 emissions and Sierra magazine subscription is also more than three times higher for the 1605b participants. The RPS index, however, is a little higher for the non-participants. The 1605b participants have more low-cost abatement opportunities such as nuclear or hydro availability improvement as opposed to costly new capacity building, proxied by lower capacity factor (higher excess capacity), and higher savings possibilites from switching to natural gas. Heat rate is another measure for low hanging fruit because it measures inefficiency in using fossil fuels, representing heat rate improvement opportunities. Yet, heat rate is about the same for the participants and non-participants. 1605b participation is also associated with greater non-fossil fuel use, proxied by a fraction of hydro and nuclear. Lag 1605b participation trend is the total number of the 1605b participants in the electric power sector in year t-1 and hence similar for both the participants and non-participants. This variable represents the idea that a firm takes other firms' actions into account when making a participation decision. Three-year growth rates are on average higher for the participants, although one-year and two-year growth rates are lower. The greenwash variables are higher for the participants.

[Table II about here]

As mentioned in the Introduction, Figure 1 and figure 2 show temporal trends in reported and actual reductions over the period 1996-2003. Figure 1 compares the total reductions reported to the 1605b program by IOUs to their actual CO_2 reductions in the same year.[26] Figure 2 contrasts actual reductions of the participants with those of the non-participants. We find that there is a large discrepancy between reported and actual reductions. Participants in the 1605b program reported positive reductions during 1996-2003, but their actual emissions rose. Moreover, during the same period the non-participants reduced their emissions. Although the IOU behavior we uncover is not illegal per se since the 1605b program allows selective reporting, this appears to represent the type of greenwash behavior described in section 3.

[26] The reported reductions data are obtained from the DOE's Voluntary Registry website and the actual emissions (thus reductions against base year=1995) data are obtained from Platts.

[Figure I and about here]

[Figure II and about here]

6. Results

Participation

We estimate four alternative specifications to analyze what factors motivate participation in the 1605b program and whether a tendency to greenwash is present or not. The results are shown in Table III. Models differ in terms of which greenwash variable is included: the absolute difference from the mean or the median CO_2 emissions and the interaction between lag CO_2 emissions and Sierra magazine subscription.

[Table III about here]

The estimated coefficients of the participation probit equation generally conform to our a priori expectations. We find that firms are more likely to participate if they emit a lot of CO_2, face greater NGO pressure, have greater revenue, have lower capacity factor, and have greater lagged generation growth (t-3). This is consistent with our hypotheses that firms that are big, dirty, growing, or under pressure are more likely to participate in the 1605b program. We also find support for the hypothesis that firms with low-cost abatement opportunities are more likely to participate. A consistently significant and negative effect of capacity factor on participation supports this hypothesis. Lower capacity factor means greater excess capacity, which implies that a firm can expand its effective capacity with a relatively low expenditure to improve efficiency of operating practices. The negative sign thus indicates that a low-cost abatement opportunity increases the participation rate, holding everything else constant. Firms with inefficient older coal-burning plants that could benefit from a retrofit (proxied by a high heat rate) also have low-cost opportunities. However, we do not find evidence that specifically carbon-related low cost opportunities increase the likelihood of participation in the 1605b program. This may be because the effect of heat rate-related opportunities on participation dies down once we account for differences in capacity factor. Similarly, we do not find evidence that firms with high-cost oil-burning plants that could be displaced by cheaper, cleaner, and gas-fired generating units are more likely to participate in the 1605b program.

Contrary to expectations, we find that firms that do not face a strong RPS in their state have a higher probability of joining the 1605b program. One possible explanation is that an RPS may drive firms to substitute inefficient for efficient GHG reduction approaches.[27] For example, firms may forgo relatively cheaper heat rate improvement or nuclear uprate opportunities to build a new renewable capacity just to meet the RPS. Although this is highly plausible, it is still a little puzzling why an RPS decreases participation likelihood because IOUs do report the kinds of projects associated with increases in low or zero emitting capacity. It might be that firms do not report renewable projects until they have actual impact on GHG reductions. The finding might also indicate that for electric utilities state RPS is the main form of external threat and firms participate in the 1605b program hoping to preempt RPS. We also do not find evidence that state-level political factors, represented by LCV scores, have significant effects on 1605b participation.

Regarding the greenwash hypothesis, we find that firms are more likely to participate if their CO_2 emissions are closer to the mean or median CO_2 emissions. Both greenwash variables are significant at the 5% level across alternative model specifications, implying that we cannot reject the greenwash hypothesis.[28]

Our findings that both dirty firms and firms with middling environmental records are more likely to participate in the 1605b program may be similar to those of Eesley and Lenox (2005). They examine NGOs' firm targeting behavior and find that both firms' absolute emissions and firms' relative emissions within-industry significantly affect passive NGO's firm targeting behavior.

---

[27] Parmer and Burtraw (2005) find that RPS substitutes for gas.

[28] The results are robust to the inclusion of the square of the lag CO_2 emissions variable.

Treatment Effects

Table IV shows the estimation results of three alternative treatment effect models. The exclusion restriction is satisfied via the electric operating revenue variable. It has an impact on participation decision, but not on CO_2 emissions intensity, which is already adjusted for the amount of net generation. The first stage specifications of the treatment effect models are a little different from those of the stand-alone participation probit models. First of all, we do not include lagged CO_2 emissions (t-1) in the first stage. This is because CO_2 emissions intensity, our dependent variable in the second stage, is calculated by dividing the current CO_2 emissions level by net generation and the current and lagged CO_2 emissions are highly correlated with each other. Including the CO_2 emissions variable is likely to create an endogeneity problem. We also do not include any other CO_2 related variables such as the greenwash variables.

[Table IV about here]

In Table IV, we see that firms are more likely to participate in the 1605b program if they have low capacity factor, have high revenue and have growth in net generation (t-3), which is consistent with what we find in the stand-alone participation probit models. As we would expect, we also find that firms with higher capacity factor and higher fraction of power from hydro or nuclear have lower CO_2 emissions intensity. High capacity factor means low excess capacity. Firms with low excess capacity are assumed to have already taken advantage of relatively low-cost abatement opportunities available to them, i.e., expanding effective capacity through improvement in operating efficiency. This leads to lower carbon intensity than otherwise. It is not surprising that a higher fraction of non-fossil fuel sources such as hydro and nuclear, which emit zero carbon, lowers firm-level CO_2 emissions intensity. Regarding the impact of 1605b participation on firms' actual emissions performance, we find that 1605b participation has a positive but insignificant effect on CO_2 emissions intensity.[29]

---

[29] The correlation coefficient between the first and second stage equations, ρ, is consistently positive across alternative model specifications. This indicates that we would overestimate the impact of the 1605b

Next, we explore the role of indirect reductions and sequestration. The CO_2 emissions and the CO_2 emissions intensity variables as used in the participation probit and the treatment effect models are based on the fuel consumption data and hence do not reflect the indirect reductions and sequestration reported to the 1605b program. We are particularly interested in finding out whether the opportunity to report indirect reductions and sequestration provides firms with added or possibly different incentives to participate in the 1605b program than the case of reporting direct reductions alone. This question arises because, as described in section 1, firms are required to file their operational and financial performance to FERC including their fossil fuel consumption. This fossil fuel consumption data, which is publicly available, indirectly reveals firms' direct CO_2 emissions.[30] Thus, if only direct reductions are reported and the public is fully informed, then it is hard to see why firms bother to report; since 1) truthful reporting will provide only redundant information and 2) greenwash will not fool anyone due to the presence of true information. Of course, this statement holds only when the benefit of retrieving the publicly available data and inferring CO_2 emissions exceeds the accompanying cost for interested parties, whoever they might be. If indirect reductions and sequestration are also allowed to be reported, however, regardless of the relative benefit and cost, firms do have an incentive to participate in the program. They can take advantage of the opportunity to report indirect reductions and sequestration that may not be otherwise publicized. Examining the role of indirect reductions and sequestration also allows us to examine whether 1605b participation does indeed make a difference in CO_2 emissions intensity, if all types of reductions reported to the program, including direct and indirect reductions and sequestration, are taken into account.

We examine the impact of indirect reductions and sequestration by rerunning the same participation probit and the treatment effect models with two new variables: adjusted CO_2 emissions and adjusted CO_2 emissions intensity. The adjusted CO_2 emissions variable is created by subtracting the sum of indirect reductions and

---

program, if we do not control for selection on unobservables. Yet, the chi-square test statistic shows that we cannot reject the hypothesis that ρ is not significantly different from zero. This in turn tells us that the degree of overestimation due to selection on unobservables, if any, is insignificant.

[30] Fossil fuel consumption broken down by fuel types reveals CO_2 emissions level because there is no commercialized end-of-pipe CO_2 removal technology yet.

sequestration as reported to the 1605b program from the fuel consumption-based CO_2 emissions estimates. The adjusted CO_2 emissions intensity variable is obtained by dividing the adjusted CO_2 emissions by net generation.

Table V and Table VI show the regression results for the probit and treatment effect models, respectively. They are virtually identical to those reported in Table III and Table IV in terms of the significance of the coefficients and their signs. This suggests that the opportunity to report indirect and sequestration projects did not provide much in the way of added or different incentives to participate in the program. In addition, with the adjusted CO_2 emissions and intensity variables, 1605b participation has a negative effect on CO_2 emissions intensity in two out of three model specifications, but its effect is still not significant.[31]

[Table V about here]

[Table VI about here]

7. Conclusion

We have presented the first empirical analysis of the factors that lead electric utilities to participate in the Department of Energy's voluntary greenhouse gas registry, and the impact of participation on their actual emissions performance.

We find that firms that participate tend to be large (both in terms of revenues and carbon dioxide emissions), have low capacity factors, face growing demand, and be in states with large numbers of environmental group members per capita. These results suggest that firms are more likely to participate when the cost of participation is lower, and when the pressure to participate is higher.

State-level political factors appear to play little role in participation; in particular, neither House nor Senate attitudes on environmental issues had measurable effects on participation. Surprisingly, firms are less likely to participate if they are in states with

[31] We also examined whether 1605b participation had any measurable effect on reductions in CO_2 emissions intensity over the period 1995-2003. We did not find any significant effect of 1605b participation.

stricter renewable portfolio standards. This suggests that RPS may cause utilities to substitute away from cost-effective means of reducing greenhouse gas emissions and toward costly renewable power supplies. The finding might also indicate that for electric utilities state RPS is the main form of external threat and firms participate in the 1605b program hoping to preempt RPS.

Participating in the 1605b program has no statistically significant effect on a firm's carbon intensity, i.e. its carbon emissions per unit of electricity generated. This suggests that firms' participation may be a form of greenwash, that is, an attempt to appear more environmentally friendly than is really the case. The program allows firms to report on successful emissions reduction projects, while remaining silent on whether their overall emissions levels have increased or decreased. This is exactly the notion of greenwash as modeled by Lyon and Maxwell (2006), and we find support for their hypothesis that firms are more likely to greenwash when they have average levels of emissions. In this respect, our findings are similar to those of King and Lenox (2000), who find that the participants in the chemical industry's Responsible Care Program were less likely to reduce their emissions than the non-participants during the program period. This further strengthens the case for the finding of our study that the voluntary reporting program appears to provide a convenient greenwashing tool for industry.

Our relatively pessimistic evaluation of the program is apparently consistent with the views of many practitioners in government and industry. The Department of Energy (DOE) has conducted numerous surveys and workshops to solicit feedback on the 1605b program's strengths and weaknesses. Respondents tended to be quite critical of the laxity of the program's reporting requirements, and on April 17, 2006, the DOE issued a revised set of guidelines for the program. Perhaps the most important change is that emitters must now report entity-wide reductions, rather than selectively reporting on only the most favorable projects.[32] The revisions should make it much more difficult to use voluntary reporting of greenhouse gases as a form of greenwash.

[32] For details, visit http://www.pi.energy.gov/pdf/library/FinalGenGuidelines041306.pdf

APPENDIX

In this appendix we present three case studies (American Electric Power, Southern Company, and Exelon Corporation) on projects reported to the 1605b program.

American Electric Power (AEP) participates at the project level and reported a total of 100 projects in 2003. 15 of them are about electricity generation, transmission, and distribution, 4 about energy end use, and 77 about carbon sequestration. AEP also reported 1 halogenated substance and 4 other emission reduction projects.

More than half of the electricity generation, transmission and distribution projects relate to non-fossil fuel units, such as increases in solar and wind power capacity and availability, and efficiency improvement at nuclear and hydro units. For example, the nuclear projects improve availability by decreasing the length of refueling outages and reducing forced outage rates by enabling certain maintenance activities, which used to be performed only during outages, to be performed with the unit online. The hydro projects improve efficiency and extend the life of aging equipment through facility improvement. A few projects report activities related to coal-fired units: improving heatrate via non-routine activities such as operational changes, equipment replacement and load optimization, and adding gas capability to previously coal-fired units.

The energy end use projects encourage efficient energy use by providing incentives for homeowners, commercial and industrial customers to adopt more efficient equipment and to use lighting more efficiently. Of AEP's projects, 77% involve carbon sequestration, most of which is accomplished by afforestation and reforestation through tree planting. The halogenated substance project involves sulfur hexafluoride (SF_6) gas reduction. SF_6 is a GHG that has about 22,000 times higher global warming potential per unit than carbon dioxide (CO_2), the most abundant GHG (EIA, 2004). AEP achieved SF_6 reduction by replacing high-volume leaky circuit breakers with low-volume ones. Other emission reduction projects are fly ash utilization and Enviro Tech Investment funds. The fly ash program recycles fly ash (a coal combustion byproduct) as a substitute for Portland cement in concrete production. This eliminates the need to dispose of the fly ash and at the same time reduces CO_2 emissions from manufacturing Portland cement. Enviro

Tech Investment funds refer to funds that are exclusively used for investment in companies, both US and foreign, that perform R&D on products that reduce energy consumption.

Southern Company (SO) participates both at the entity and the project level, although the sum of the project level reductions is the same as the entity level reduction. In 2003 SO reported a total of 35 projects. Fifteen involve electricity generation, transmission, and distribution, 3 involve cogeneration and waste heat recovery, 1 affects energy end use, 2 are about transportation and off-road vehicles, and 12 about sequestration. SO also reported halogenated substance and “other” emissions reduction projects.

About half of the electricity generation, transmission and distribution projects are similar to those reported by AEP, but SO also reported seven “other” projects. They include nuclear capacity uprating, natural gas-based combustion turbine and combined cycle units, biomass and switchgrass projects. Nuclear capacity uprating refers to increasing the maximum power level at which nuclear power units operate, which requires NRC approval. Nuclear capacity uprating is equivalent to increasing low carbon emitting capacity. The increases in natural gas fired units (new combustion turbine and combined cycle units) represent CO_2 reductions compared to coal-fired generation. SO was also investigating the feasibility and profitability of co-firing biomass and switchgrass with coal. Two of its subsidiaries, Georgia Power and Mississippi Power, have co-fired biomass with coal. Cofiring with switchgrass is still at an experimental stage.

The cogeneration and waste heat recovery projects report the use of natural gas at cogeneration plants, that is, plants that produce both electricity and steam. CO_2 reduction is achieved in two ways. One is by using a low emitting fuel source, natural gas, instead of coal. The other is by utilizing heat that would otherwise have been discarded. Had the same amount of heat been generated separately, CO_2 emissions would have been greater no matter what fuel sources were used. The energy end-use project promotes energy efficiency in residential, commercial and industrial sectors. The transportation and off-road vehicles projects report how SO supports the operation of alternative fuel vehicles, and promotes carpooling and mass transit use for its employees. The projects on carbon sequestration, halogenated substances and other emissions reduction are similar to those reported by AEP.

Exelon Corporation (EXC) participates at the project level and reported a total of 42 projects in 2003. Twenty six involve electricity generation, transmission, and distribution, 1 involve cogeneration and waste heat recovery, 4 affects energy end use, 2 are about transportation and off-road vehicles, 3 about waste treatment and disposal, 1 about oil and natural gas systems and coal mining, and 4 about carbon sequestration. EXC also reported one "other" emission reduction project.

All of the electricity generation, transmission and distribution projects are about non-fossil fuel units. Eleven projects reported nuclear uprating, 9 reported wind and solar energy-related efforts, 5 reported hydro facility overhauls, and 1 reported improvement in distribution efficiency. Wind and solar energy related projects cover a wide range of applications from installing new facilities to raising public awareness of alternative energy resources and renewable energy markets. EXC overhauled seven hydro units to improve unit efficiency and overall plant capacity.

The cogeneration and waste heat recovery project reported fuel switching from coal to natural gas and installing heat exchange equipment. In addition to typical efficiency improvement projects, the energy end-use projects include a load control program which provides incentives for large commercial and industrial customers to cut electric loads upon request during peak periods. Transportation and off-road vehicle projects report how widely EXC invests in alternative fuel vehicles and uses them in its facilities. The waste treatment and disposal projects are about using landfill gas to generate energy; this reduces emissions of methane, which has 23 times higher global warming potential than CO_2 (EIA, 2004). The project on oil and natural gas systems and coal mining reports improvement of the natural gas distribution system. Carbon sequestration was mostly done by tree planting but also by recycling some wood utility poles. Each pole reused represents a tree that was not cut down to manufacture a new utility pole. The "other" emission reduction project reported recycling of materials including paper and metals, which can reduce GHG emissions by displacing the production of these products from alternative sources, which may require more energy intensive production processes.

REFERENCES

1. S. Arora and T. N. Cason, “An experiment in voluntary environmental regulation: Participation in EPA’s 33/50 Program,” *J. Environ. Econom. Management*, **28**, 271-286 (1995).
2. S. Arora and T. N. Cason, “Why do firms volunteer to exceed environmental regulations? Understanding participation in EPA’s 33/50 program,” *Land Econom*., **72**, 413-432 (1996).
3. A. C. Cameron and P. K. Trivedi, *Microeconometrics: Methods and Applications*, Cambridge University Press, NY (2005).
4. B. Clinton and A. Gore, “Reinventing Environmental Regulation” National Performance Review (1995).
5. S. J. DeCanio and W. E. Watkins, “Investment in Energy Efficiency: Do the Characteristics of Firms Matter?,” *The Review of Economics and Statistics*, **80**, 95-107 (1998).
6. T. Domencich and D. McFadden, *Urban Travel Demand – A Behavioral Analysis*, North-Holland, Amsterdam (1975).
7. C. Eesley and M. J. Lenox, “Secondary Stakeholder Actions and the Selection of Firm Targets,” working paper, Fuqua School of Business, Duke University, Durham (2005).
8. A. Hoffman, “Climate Change Strategy: The Business Logic behind Voluntary Greenhouse Gas Reductions,” *California Management Review*, **47**, 21-46 (2005).
9. A. Hoffman, *Getting Ahead of the Curve: Corporate Strategies That Address Climate Change*, The Pew Center on Global Climate Change, Arlington, VA (2006).
10. P. Karamanos, “Voluntary Environmental Agreements for the Reduction of Greenhouse Gas Emissions: Incentives and Characteristics of Electric Utility Participants in the Climate Challenge Program” working paper, School of Public and Environmental Affairs, Indiana University, Bloomington (1999).
11. M. Khanna and L. A. Damon, “EPA’s voluntary 33/50 program: Impact on Toxic Releases and Economic Performance of firms,” *J. Environ. Econom. Management*, **37**, 1-25 (1999).

12. P. W. Kennedy, "Optimal early action on greenhouse gas emissions," *Canadian Journal of Economics*, **35**, 16-35 (2002).
13. A. A. King and M. J. Lenox, "Industry Self-Regulation without Sanctions: The Chemical Industry's Responsible Care Program," *The Academy of Management Journal*, **43**, 698-716 (2000).
14. S. Konar and M. A. Cohen, "Information as regulation: The effect of community right to know laws on toxic emissions," *J. Environ. Econom. Management*, **32**, 109-124 (1997).
15. J. W. Maxwell, T. P. Lyon and S. C. Hackett, "Self-Regulation and Social Welfare: The Political Economy of Corporate Environmentalism," *Journal of Law and Economics*, **43**, 583-617 (2000).
16. T. P. Lyon and J. W. Maxwell, *Corporate Environmentalism and Public Policy*, Cambridge Univ. Press, Cambridge (2004).
17. T. P. Lyon and J. W. Maxwell, "Greenwash: corporate environmental disclosure under threat of audit," Working paper, Ross School of Business, University of Michigan (2006).
18. A. Michaelowa and C. Rolfe, "Early Action to Reduce Greenhouse Gas Emissions Before the Commitment Period of the Kyoto Protocol: Advantages and Disadvantages," *Environmental Management*, **28**, 281-292 (2001).
19. K. Palmer and D. Burtraw, "Cost-Effectiveness of Renewable Electricity Policies," RFF Discussion Paper, RFF DP 05-01 (2005).
20. I. W. H. Parry and M. Toman, "Early Emission Reduction Programs: An Application to CO_2 policy," *The Energy Journal*, **23**, 73-95 (2002).
21. B. G. Rabe, *Statehouse and greenhouse: the Emerging Politics of American Climate Change Policy*, Broookings Institution Press, Washington, D.C. (2004).
22. C. A. Ramus and I. Montiel, "When are corporate environmental policies a form of greenwashing?," *Business and Society*, **44**, 377-415 (2005).
23. J. Rivera and P. de Leon, "Is Greener Whiter? Voluntary Environmental Performance of Western Ski Areas," *The Policy Studies Journal*, **32**, 417-437 (2004).

24. A. G. Sam and R. Innes, "Voluntary Pollution Reductions and the Enforcement of Environmental Law: An Empirical Study of the 33/50 Program," Working paper, University of Arizona (2005).
25. U.S. Energy Information Administration, "Emissions of Greenhouse Gases in the United States 2003," DOE/EIA-0573(2003), Office of Integrated Analysis and Forecasting (2004).
26. U.S. Energy Information Administration, "Documentation for Emissions of Greenhouse Gases in the United States 2003," DOE/EIA-0638(2003), Office of Integrated Analysis and Forecasting (2005).
27. U.S. Energy Information Administration, "Voluntary Reporting of Greenhouse Gases 2003," DOE/EIA-0608(2003), Office of Integrated Analysis and Forecasting (2005).
28. U.S. General Accounting Office, "Basic Issues in Considering a Credit for Early Action Program," Reporting to the Ranking Minority Member, Committee on Government Reform and Oversight, House of Representatives, GAO/RCED-99-23, Resources, Community, and Economic Development Division (1998).
29. J. Videras and A. Alberini, "The appeal of voluntary environmental programs: which firms participate and why?," *Contemporary Economic Policy*, **18**, 449-461 (2000).
30. E. W. Welch, A. Mazur and S. Bretschneider, "Voluntary Behavior by Electric Utilities: Levels of Adoption and Contribution of the Climate Challenge Program to the Reduction of Carbon Dioxide," *Journal of Policy Analysis and Management*, **19**, 407-425 (2000).
31. J. M. Wooldridge, *Econometric Analysis of Cross Section and Panel Data*, MIT Press, MA (2002).

Table I. Explanatory variables and their definitions

Variables (proxy for)	Definition (unit of measurement)
Lagged CO_2 emissions (program-specific emissions)	Lagged (t-1) total carbon dioxide (CO_2) emissions (10^9 lbs) This is calculated based on fuel consumption data. First, total carbon input is calculated using carbon coefficients 25.97 for Coal, 14.47 for Natural Gas, 17.51 for Refinery Gas (Still Gas), 19.95 for Distillate fuel (Oil-L), 21.49 for Residual fuel (Oil-H) and 27.85 for Petroleum Coke (The units for carbon coefficients are Million Metric Tons per Quadrillion Btu).* The total carbon input estimates are then converted to total CO_2 emissions output estimates by multiplying them by 3.7 (=44/12). When carbon input data is missing but Platts' emission data are non-missing, Platts' emission data are used instead.**
CO_2 emissions intensity (CO_2 emissions to output ratio)	CO_2 emissions per net generation (lbs/MWh). Net generation (MWh) is defined by the amount of gross generation less the electrical energy consumed at the generating stations.
Sierra magazine subscription (state-level interest group pressure)	Number of subscriptions to Sierra magazines at the state level in 2000 (thousands).
Electric operating revenue (firm size)	Revenue from sales of electricity (10^9 \$).
Heatrate (inefficiency)	A ratio of heat input to net energy generated (Btu/kWh).
Capacity factor (excess capacity)	A ratio of energy generated to maximum that could have been generated. It is calculated by dividing net generation (MWh) by (nameplate capacity (MW)×8760(hours)).
Fraction of hydro and nuclear (fossil fuel independence)	A ratio of energy generated from hydro and nuclear units to total energy generated.
LCV scores (state-level pressure)	The League of Conservation Voters (LCV)'s scorecards for Senate and House.
RPS index (State-level regulation)	State Renewable Portfolio Standard index. It is calculated by dividing % goal by the difference between the goal year and the enacted or effective year, whichever comes first.***
Lagged fuel switch saving (low cost abatement opportunity)	Lagged (t-1) low cost and low carbon fuel switching opportunity (10^6 \$). For each electric operating company fuel switch saving is estimated based on the data of the month with the highest generation for the year. It is calculated by multiplying the amount of oil-based generation with the difference in fuel costs between oil and natural gas if oil-based and natural gas-based are juxtaposed when ordered from low cost to high cost generation and the cost of natural gas is lower.
Lagged SO_2 emissions (general environmental performance)	Lagged (t-1) sulfur dioxide (SO_2) emissions (10^9 lbs).
Lagged 1605b participation trend (taking other firms' actions into account)	Lagged (t-1) total number of 1605b participants in the electric power sector****
Growth in generation (t-1, t-2, and t-3) (firm growth)	Percentage growth compared to base year (t-1, t-2, and t-3).
Absolute difference from mean or median lagged CO_2 emissions (greenwash tendency)	This is calculated by taking the absolute value of the difference between the mean or median lagged CO_2 emissions for the year and lagged CO_2 emissions (10^9 lbs)
Interaction between lagged CO_2 emissions and Sierra Subscription (greenwash tendency)	This is obtained by multiplying the values for lagged CO_2 emissions (10^9 lbs) and Sierra Subscription (thousands).

* *Documentation for Emissions of Greenhouse Gases in the U.S. 2003*, EIA (2005), p. 189.
** An adjustment factor is calculated to convert Platts' CO_2 emissions data to fuel-based CO_2 estimates. The fuel-based estimates are regressed on Platts' reported emissions data and the inverse of the coefficient, 0.7527, is used as an adjustment factor. This aligns well with NRDC's report that continuous emissions monitoring data could be biased upward by 10-30 percent relative to fuel-based estimates. www.nrdc.org/air/energy/rbr/append.asp.
*** State Renewable Portfolio Standards data are obtained from www.dsireusa.org.
**** *Voluntary reporting of Greenhouse Gases 2003*, EIA (2005), p. 4.

Table II. Descriptive statistics for explanatory variables

Variable (unit)	Entire sample N=596	1605b Participants N=309	1605b Non-Participants N=287
Lagged CO_2 emissions (10^9 lbs)			
Mean	17.751	24.966	9.984
Standard Deviation	16.817	19.096	8.883
Min	0.006	0.130	0.006
Max	109.224	109.224	30.203
CO_2 emissions intensity (lbs/MWh)			
Mean	1172.405	1246.034	1093.133
Standard Deviation	690.168	740.465	623.171
Min	0.351	7.201	0.351
Max	4659.061	4659.061	3590.840
Sierra magazine subscription (thousands)			
Mean	4.598	5.364	3.774
Standard Deviation	2.504	2.663	2.023
Min	0.404	1.007	0.404
Max	10.767	10.767	10.767
Electric operating revenue (10^9 $)			
Mean	1.431	2.158	0.649
Standard Deviation	1.596	1.874	0.576
Min	0.011	0.226	0.011
Max	8.906	8.906	3.626
Heatrate (Btu/kWh)			
Mean	9899.740	9900.724	9898.682
Standard Deviation	1801.146	1332.374	2199.402
Min	0	1103.420	0
Max	14379.810	11859.420	14379.810
Capacity Factor			
Mean	0.529	0.514	0.545
Standard Deviation	0.140	0.133	0.145
Min	0.065	0.154	0.065
Max	0.880	0.821	0.880
Fraction of Hydro and Nuclear			
Mean	0.141	0.174	0.105
Standard Deviation	0.273	0.270	0.272
Min	0	0	0
Max	1.392	1.392	1.000
LCV scores: Senate			
Mean	39.242	42.634	35.589
Standard Deviation	31.537	31.056	31.696
Min	0	0	0
Max	100	100	100
LCV scores: House			
Mean	39.773	42.922	36.383
Standard Deviation	19.628	18.148	20.604
Min	0	4	0
Max	100	94	100

RPS index			
Mean	0.085	0.082	0.088
Standard Deviation	0.270	0.268	0.271
Min	0	0	0
Max	1.833	1.833	1.429
Lagged fuel Switch Saving (10^6 $)			
Mean	0.020	0.028	0.010
Standard Deviation	0.088	0.099	0.073
Min	0	0	0
Max	1.205	0.815	1.205
Lagged SO_2 emissions (10^9 lbs)			
Mean	0.137	0.195	0.075
Standard Deviation	0.178	0.221	0.078
Min	0	0	0
Max	1.148	1.148	0.466
Lagged 1605b participation trend			
Mean	106.292	106.220	106.369
Standard Deviation	5.226	5.192	5.271
Min	99	99	99
Max	115	115	115
Growth in net generation (t-1)			
Mean	0.023	0.007	0.040
Standard Deviation	0.206	0.157	0.248
Min	-0.933	-0.933	-0.317
Max	3.207	1.067	3.207
Growth in net generation (t-2)			
Mean	0.053	0.027	0.082
Standard Deviation	0.289	0.205	0.357
Min	-0.930	-0.930	-0.412
Max	3.628	1.233	3.628
Growth in net generation (t-3)			
Mean	0.528	0.887	0.141
Standard Deviation	10.653	14.789	0.513
Min	-0.917	-0.917	-0.452
Max	259.973	259.973	4.423
Absolute Difference from Mean lagged CO_2 Emissions (10^9 lbs)			
Mean	13.232	18.953	7.073
Standard Deviation	14.828	17.941	6.112
Min	0	0	0
Max	101.145	101.145	25.583
Absolute Difference from Median lagged CO_2 Emissions (10^9 lbs)			
Mean	12.295	15.724	8.602
Standard Deviation	12.220	15.842	3.742
Min	0.024	0.024	0.081
Max	94.969	94.969	18.963
Interaction between lagged CO_2 Emissions and Sierra subscription ((10^9 lbs)× (thousands))			
Mean	87.135	133.600	37.108
Standard Deviation	104.083	122.511	39.120
Min	0.009	0.371	0.009
Max	514.013	514.013	170.394

Table III
1605b Participation Probit

Variable	Model 1	Model 2	Model 3	Model 4
Lag CO_2 Emissions	0.062**	0.116***	0.058	0.118***
	(0.026)	(0.038)	(0.041)	(0.045)
Sierra Subscription	0.156*	0.148*	0.145	0.153
	(0.089)	(0.089)	(0.125)	(0.127)
Electric Operating Revenue	0.598*	0.578	0.603	0.575
	(0.358)	(0.355)	(0.368)	(0.362)
Heatrate	1.195e-04	1.204e-04	1.212e-04	1.198e-04
	(1.350e-04)	(1.352e-04)	(1.338e-04)	(1.343e-04)
Capacity factor	-2.218*	-2.356*	-2.204*	-2.364*
	(1.222)	(1.230)	(1.221)	(1.230)
Fraction of hydro & nuclear	0.925	1.105	0.939	1.101
	(0.985)	(1.005)	(0.975)	(1.003)
LCV score: Senate	2.638e-03	2.865e-03	2.684e-03	2.846e-03
	(5.200e-03)	(5.383e-03)	(5.152e-03)	(5.348e-03)
LCV score: House	0.013	0.011	0.012	0.011
	(9.797e-03)	(9.524e-03)	(9.904e-03)	(9.715e-03)
RPS index	-0.850*	-0.934*	-0.865*	-0.927*
	(0.500)	(0.492)	(0.513)	(0.501)
Lag Fuel Switch Saving	0.074	-0.154	0.114	-0.171
	(0.950)	(0.985)	(0.987)	(1.012)
Lag SO_2 Emissions	0.288	0.191	0.253	0.208
	(1.228)	(1.307)	(1.249)	(1.317)
Lag 1605b reporting Trend	2.512e-03	9.936e-03	2.211e-03	1.007e-02
	(9.138e-03)	(9.706e-03)	(9.250e-03)	(9.472e-03)
Growth in net generation (t-1)	-0.021	-0.005	-0.021	-0.005
	(0.234)	(0.247)	(0.233)	(0.248)
Growth in net generation (t-2)	-0.072	-0.089	-0.077	-0.087
	(0.211)	(0.210)	(0.201)	(0.211)
Growth in net generation (t-3)	9.552e-03***	9.968e-03***	9.568e-03***	9.955e-03***
	(2.566e-03)	(2.369e-03)	(2.562e-03)	(2.386e-03)
Absolute Difference from Mean	-0.059**		-0.060**	
Lag CO_2 Emissions	(0.029)		(0.029)	
Absolute Difference from Median		-0.093**		-0.093**
Lag CO_2 Emissions		(0.040)		(0.040)
Interaction between Lag CO_2			8.443e-04	-3.815e-04
Emissions and Sierra subscription			(5.850e-03)	(6.050e-03)
Constant	-2.690	-3.726**	-2.617	-3.761**
	(1.693)	(1.714)	(1.843)	(1.823)
Observations	596	596	596	596
Count R^2	0.800	0.799	0.799	0.795
Adjusted Count R^2	0.585	0.582	0.582	0.575
Log Likelihood	-253.759	-253.517	-253.713	-253.508
χ^2[16]	76.400 {0}	79.510 {0}		
χ^2[17]			76.540 {0}	80.080 {0}

The dependent variable is a dummy variable indicating 1605b participation.
Robust standard errors are in parenthesis. Degrees of freedom are in square brackets. P values are in curly brackets. χ^2 is a chi-square test of the assumption that all coefficients are jointly equal to zero.
* Significant at 10%; ** Significant at 5%; *** Significant at 1% (all two-tailed tests).

Table IV
Treatment Effect Models

Variable	Model 1: 2nd stage: CO_2 Intensity	Model 1: 1st stage: 1605b Participation	Model 2: 2nd stage: CO_2 Intensity	Model 2: 1st stage: 1605b Participation	Model 3: 2nd stage: CO_2 Intensity	Model 3: 1st stage: 1605b Participation
Sierra Subscription	-9.618	0.121	-6.943	0.122	-7.248	0.121
	(33.72)	(0.082)	(33.03)	(0.083)	(32.87)	(0.082)
Heatrate	0.024	1.274e-04	0.023	1.271e-04	0.025	1.280e-04
	(0.032)	(1.284e-04)	(0.031)	(1.284e-04)	(0.031)	(1.286e-04)
Capacity factor	-1.320e+03***	-1.918*	-1.344e+03***	-1.936*	-1.375e+03***	-1.933*
	(4.455e+02)	(1.102)	(4.301e+02)	(1.101)	(4.255e+02)	(1.097)
Fraction of hydro & nuclear	-9.011e+02***	0.178	-9.230e+02***	0.170	-9.002e+02***	0.177
	(2.320e+02)	(0.942)	(2.206e+02)	(0.945)	(2.153e+02)	(0.944)
LCV score: Senate	-1.162	2.486e-03	-1.089	2.504e-03	-1.037	2.549e-03
	(1.773)	(5.216e-03)	(1.776)	(5.225e-03)	(1.778)	(5.204e-03)
LCV score: House	2.227	5.497e-03	2.058	5.495e-03	2.232	5.437e-03
	(4.125)	(8.757e-03)	(3.958)	(8.753e-03)	(3.833)	(8.753e-03)
RPS index	-17.440	-0.802	-7.655	-0.800	0.630	-0.791
	(1.768e+02)	(0.501)	(1.771e+02)	(0.501)	(1.727e+02)	(0.499)
Lag Fuel Switch Saving	19.340	0.349	6.458	0.351		0.333
	(1.845e+02)	(0.963)	(1.811e+02)	(0.972)		(0.978)
Growth in net generation (t-1)	-1.627e+02	-0.182		-0.111		-0.116
	(1.368e+02)	(0.199)		(0.198)		(0.205)
Growth in net Generation (t-2)	-93.19	-0.095		-0.058		-0.053
	(1.244e+02)	(0.186)		(0.170)		(0.169)
Growth in net generation (t-3)	-0.877*	9.503e-03***		9.902e-03***		9.834e-03***
	(0.504)	(2.357e-03)		(2.322e-03)		(2.299e-03)
Lag SO_2 Emissions	-89.60	1.313	-119.90	1.312		1.343
	(2.370e+02)	(1.559)	(2.226e+02)	(1.568)		(1.556)
1605b Participation	24.62		46.05		6.319	
	(1.765e+02)		(1.725e+02)		(1.600e+02)	
Electric Operating Revenue		0.947***		0.949***		0.944***
		(0.316)		(0.317)		(0.317)
Lag 1605b reporting Trend		6.813e-04		5.433e-04		7.950e-04
		(7.600e-03)		(7.560e-03)		(7.413e-03)
Constant	1.774e+03***	-2.283	1.772e+03***	-2.267	1.758e+03***	-2.302
	(4.217e+02)	(1.649)	(4.068e+02)	(1.646)	(4.069e+02)	(1.644)
Observations	596	596	596	596	596	596
Log likelihood	-4929.054		-4931.330		-4931.541	
$\chi^2[13]$	203.410 {0}					
$\chi^2[10]$			63.060 {0}			
$\chi^2[8]$					60.670 {0}	
Ρ	0.256		0.238		0.272	
	(0.130)		(0.132)		(0.143)	
$\chi^2[1]$, ρ=0	3.52 {0.06}		3.02 {0.08}		3.27 {0.07}	

Robust standard errors are in parenthesis. Degrees of freedom are in square brackets. P values are in curly brackets. χ^2 is a chi-square test of the assumption that all coefficients are jointly equal to zero. ρ is the correlation coefficient between the error terms of the first-stage participation and the second-stage outcome equations. $\chi^2[1]$, ρ=0 tests the independence of the two equations.

* Significant at 10%; ** Significant at 5%; *** Significant at 1% (all two-tailed tests).

Table V
1605b Participation Probit after Adjusting for Indirect Reduction and Sequestration

Variable	Model 1	Model 2	Model 3	Model 4
Adjusted Lag CO_2 Emissions	0.060**	0.107***	0.052	0.105**
	(0.026)	(0.037)	(0.041)	(0.044)
Sierra Subscription	0.156*	0.149*	0.136	0.143
	(0.089)	(0.089)	(0.125)	(0.126)
Electric Operating Revenue	0.623*	0.614*	0.632*	0.617*
	(0.358)	(0.355)	(0.368)	(0.362)
Heatrate	1.120e-04	1.060e-04	1.162e-04	1.070e-04
	(1.344e-04)	(1.340e-04)	(1.332e-04)	(1.327e-04)
Capacity factor	-2.223*	-2.337*	-2.196*	-2.327*
	(1.215)	(1.220)	(1.212)	(1.216)
Fraction of hydro & nuclear	0.835	0.919	0.869	0.926
	(0.974)	(0.984)	(0.966)	(0.983)
LCV score: Senate	2.546e-03	2.733e-03	2.643e-03	2.757e-03
	(5.207e-03)	(5.383e-03)	(5.153e-03)	(5.344e-03)
LCV score: House	0.012	0.011	0.012	0.011
	(9.760e-03)	(9.465e-03)	(9.801e-03)	(9.577e-03)
RPS index	-0.857*	-0.938*	-0.885*	-0.945*
	(0.497)	(0.489)	(0.511)	(0.499)
Lag Fuel Switch Saving	0.089	-0.130	0.162	-0.110
	(0.968)	(0.994)	(1.009)	(1.026)
Lag SO_2 Emissions	0.325	0.212	0.262	0.194
	(1.233)	(1.310)	(1.259)	(1.326)
Lag 1605b reporting Trend	2.019e-03	8.537e-03	1.501e-03	8.398e-03
	(9.016e-03)	(9.411e-03)	(9.092e-03)	(9.200e-03)
Growth in net generation (t-1)	-0.009	0.017	-0.011	0.016
	(0.224)	(0.229)	(0.224)	(0.228)
Growth in net generation (t-2)	-0.069	-0.083	-0.079	-0.086
	(0.210)	(0.208)	(0.208)	(0.208)
Growth in net generation (t-3)	9.608e-03***	1.003e-02***	9.631e-03***	1.004e-02***
	(2.580e-03)	(2.383e-03)	(2.562e-03)	(2.395e-03)
Absolute Difference from Mean	-0.058**		-0.058**	
Lag CO_2 Emissions	(0.029)		(0.029)	
Absolute Difference from Median		-0.085**		-0.085**
Lag CO_2 Emissions		(0.039)		(0.039)
Interaction between Lag CO_2			1.566e-03	4.442e-04
Emissions and Sierra subscription			(5.852e-03)	(5.990e-03)
Constant	-2.538	-3.383**	-2.419	-3.349*
	(1.667)	(1.664)	(1.783)	(1.741)
Observations	594	594	594	594
Count R^2	0.800	0.801	0.796	0.801
Adjusted Count R^2	0.585	0.589	0.578	0.589
Log Likelihood	-254.944	-255.656	-254.784	-255.644
χ^2[16]	76.65 {0}	79.81 {0}		
χ^2[17]			76.70 {0}	80.14 {0}

The dependent variable is a dummy variable indicating 1605b participation.
Robust standard errors are in parenthesis. Degrees of freedom are in square brackets. P values are in curly brackets. χ^2 is a chi-square test of the assumption that all coefficients are jointly equal to zero.
* Significant at 10%; ** Significant at 5%; *** Significant at 1% (all two-tailed tests).

Table VI
Treatment Effect Models after Adjusting for Indirect Reduction and Sequestration

Variable	Model 1		Model 2		Model 3	
	2nd stage: Adjusted CO_2 intensity	1st stage: 1605b Participation	2nd stage: Adjusted CO_2 intensity	1st stage: 1605b Participation	2nd stage: Adjusted CO_2 intensity	1st stage: 1605b Participation
Sierra Subscription	-8.754 (33.85)	0.121 (0.082)	-6.269 (33.26)	0.123 (0.082)	-6.449 (33.04)	0.122 (0.082)
Heatrate	0.030 (0.031)	1.257e-04 (1.276e-04)	0.030 (0.030)	1.256e-04 (1.278e-04)	0.031 (0.031)	1.259e-04 (1.279e-04)
Capacity factor	-1.330e+03*** (4.480e+02)	-1.924* (1.100)	-1.356e+03*** (4.330e+02)	-1.942* (1.099)	-1.373e+03*** (4.250e+02)	-1.941* (1.096)
Fraction of hydro & nuclear	-8.534e+02*** (2.306e+02)	0.167 (0.942)	-8.772e+02*** (2.209e+02)	0.159 (0.945)	-8.655e+02*** (2.156e+02)	0.162 (0.944)
LCV score: Senate	-1.005 (1.775)	2.513e-03 (5.216e-03)	-0.944 (1.780)	2.526e-03 (5.225e-03)	-0.926 (1.774)	2.548e-03 (5.212e-03)
LCV score: House	2.066 (4.140)	5.482e-03 (8.754e-03)	1.921 (3.986)	5.487e-03 (8.750e-03)	2.026 (3.866)	5.458e-03 (8.752e-03)
RPS index	-21.85 (1.795e+02)	-0.808 (0.501)	-11.28 (1.799e+02)	-0.806 (0.501)	-8.233 (1.744e+02)	-0.802 (0.499)
Lag Fuel Switch Saving	-16.01 (1.960e+02)	0.321 (0.958)	-28.78 (1.913e+02)	0.324 (0.966)		0.327 (0.980)
Growth in net generation (t-1)	-166.7 (1.369e+02)	-0.188 (0.204)		-0.113 (0.202)		-0.116 (0.205)
Growth in net Generation (t-2)	-92.52 (1.256e+02)	-0.096 (0.186)		-0.058 (0.169)		-0.056 (0.169)
Growth in net generation (t-3)	-0.821 (0.508)	9.474e-03*** (2.353e-03)		9.866e-03*** (2.315e-03)		9.826e-03*** (2.299e-03)
Lag SO_2 Emissions	-34.75 (2.472e+02)	1.306 (1.550)	-63.30 (2.341e+02)	1.305 (1.559)		1.320 (1.555)
1605b Participation	-6.348 (1.805e+02)		14.790 (1.768e+02)		-7.734 (1.613e+02)	
Electric Operating Revenue		0.949*** (0.316)		0.951*** (0.317)		0.948*** (0.316)
Lag 1605b reporting Trend		6.551e-04 (7.596e-03)		5.278e-04 (7.559e-03)		6.631e-04 (7.411e-03)
Constant	1.705e+03*** (4.148e+02)	-2.261 (1.640)	1.703e+03*** (4.019e+02)	-2.248 (1.638)	1.696e+03*** (4.033e+02)	-2.265 (1.635)
Observations	594	594	594	594	594	594
Log likelihood	-4915.772		-4918.052		-4918.114	
$\chi^2[13]$	197.150					
$\chi^2[10]$			58.830			
$\chi^2[8]$					56.920	
ρ	0.266 (0.132)		0.249 (0.134)		0.268 (0.143)	
$\chi^2[1]$, ρ=0	3.67 {0.06}		3.17 {0.07}		3.17 {0.07}	

Robust standard errors are in parenthesis. Degrees of freedom are in square brackets. P values are in curly brackets. χ^2 is a chi-square test of the assumption that all coefficients are jointly equal to zero. ρ is the correlation coefficient between the error terms of the first-stage participation and the second-stage outcome equations. $\chi^2[1]$, ρ=0 tests the independence of the two equations.
* Significant at 10%; ** Significant at 5%; *** Significant at 1% (all two-tailed tests).

Figure I. 1605b Reported Reductions (IOUs) vs. Actual Reductions (IOUs)

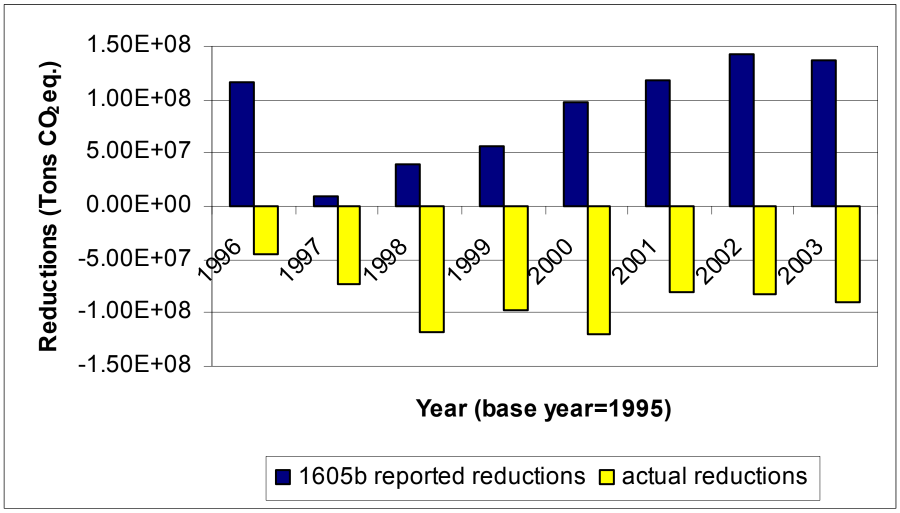

Figure II. Actual Reductions: IOU Participants vs. IOU Non-Participants