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

Thomas P. Lyon†
University of Michigan

Eun-Hee Kim‡
University of Michigan

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Abstract

This paper presents the first empirical analysis of the causes and consequences of participation by electric utilities in the Department of Energy's voluntary greenhouse gas registry. Although participants report emissions reductions, we find they actually tend to have increasing emissions; ironically, non-participants tend to have decreasing emissions. Participants are generally larger, have higher emissions, lower capacity factors, faster growing demand ,and face greater pressure from environmental groups. Participating in the 1605b program has no measurable effect on a firm's carbon emissions per unit of electricity generated. Overall, the program appears to serve as a convenient greenwashing tool for industry.

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

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† 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 increasingly touts its reductions of greenhouse gas emissions, despite the lack of any federal mandate for emissions cuts.[1] Depending upon one's perspective, these reports may be viewed as evidence of 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, 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 hope of obtaining "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. Other motivations for participation might include preempting state regulations on greenhouse gas emissions, creating a favorable image with regulators, or forestalling attacks from environmental activists.

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 allows for self-certification, as proposed in the report.

A key feature 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, reporters can select any one year between 1987 and 1990 or use an average of any of those

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[3] The 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).

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 using nuclear and hydroelectric power, 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 and Southern Company represent fossil fuel-oriented companies and Exelon Corporation a nuclear-oriented one. American Electric Power participates at the project level and most of its projects involve carbon sequestration. Southern Company participates both at the entity and the project level but the sum of its project-level reductions is the same as the entity-level reduction. Exelon

[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 *VoluntaryReporting of Greenhouse Gases 2003*, EIA (2005).

Corporation participates at the project level and its projects include transportation-related ones. For all three companies generation at non-fossil fuel units powered by nuclear or hydroelectric sources accounts for the majority of their generation-related projects.

3. Literature Review and Testable Hypotheses

To formulate detailed hypotheses regarding the causes and consequences of 1605b participation, we begin with the observation that the 1605b program is a government-sponsored voluntary environmental program that focuses on environmental information disclosure. Hence, we draw on both the literature on public voluntary programs and the literature on environmental information disclosure.

Early Reduction Credits

Early reduction credits (ERCs) may be given for emissions reductions firms voluntarily undertake prior to the implementation of a mandatory system of tradable emissions permits. The literature on ERCs examines their comparative merits and demerits as a tool for cost-effectively achieving the Kyoto Protocol targets and discusses issues specifically related to granting credit to the 1605b participants.

The idea of granting ERCs for GHG reductions was first suggested in 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 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

[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. The Department of Energy, however, still indicated that there was a possibility that early reduction credits would be granted to 1605b participants. GAO/RCED-99-23.

abatement investment decisions towards those actions that have immediate reduction impacts, which ultimately leads to higher compliance cost (Kennedy, 2002). Granting ERCs also induces more early abatement than optimal (Parry and Toman, 2002).

From a positive perspective, firms with lower costs of participation are more likely to participate in the 1605b program since an ERC would have the same marginal value for all firms. *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.[8] (We create a variable called "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, we have

Hypothesis 1: A firm is more likely to participate in the 1605b program to obtain ERCs 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.

Public Voluntary Programs

Under public voluntary programs, participating firms agree to make good faith efforts to meet program goals established by a regulatory agency; in return, they may

[8] 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 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.

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 and the effectiveness of these program as regulatory tools.[9] 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.

The empirical literature 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, and/or have better access to capital markets and hence lower costs of new investments.[10] Dirtier firms are more likely to participate, perhaps because they face greater media scrutiny and pressure from environmental or citizens' groups.[11] The effect of greater external pressure suggests that firms are more likely to participate when they face greater pressure from environmental groups, communities, state politicians, or industry associations.[12] In particular, Sam and Innes (2005) find that state-level Sierra Club membership as a percentage of the population has a significant and positive effect on joining the 33/50 program. They also find evidence that firms participate to forestall potential boycotts. In the case of GHG emissions, Rabe (2004) discusses the relative significance of state-level pressures.

[9] See Lyon and Maxwell (2004) for an overview of this work.

[10] These results have been found for 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 Slopes Program (Rivera and de Leon, 2004).

[11] These results have been found for 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).

[12] These results have been found for the 33/50 Program (Khanna and Damon, 1999, Sam and Innes, 2005) and the Sustainable Slopes Program (Rivera and de Leon, 2004).

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

In the case of GHG related programs, another important factor to consider is firms' fuel mix. A plausible 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 factors discussed above seem consistent with the benefits touted to firms by the DOE. 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]

This statement of the benefits of participation suggests that they are primarily in the form of publicity and improved relationships with regulators, which is consistent with the literature on public voluntary programs. Thus, we have

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

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 or state politicians.

Greenwash

Greenwash refers to firms' attempts to appear more environmental friendly than is really the case. Academic literature on greenwash has only recently begun to emerge. Lyon and Maxwell (2006) provide the first economic model of greenwash, which they define as selective disclosure of positive information about a company's environmental performance without full disclosure of negative environmental impacts. They study how the threat of NGO punishment for greenwashing influences the firm's disclosure decisions. Firms with poor environmental reputations are more likely to fully disclose; they gain a lot from advertising a success and lose little by disclosing a failure, since they are already expected to fail. Conversely, firms with good reputations gain little by disclosing a success and lose a lot by disclosing a failure, so may refuse to disclose at all. Firms with moderate reputations are the most likely to greenwash. 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.[14] This suggests an additional hypothesis:[19]

[14] Ramus and Montiel (2005) study greenwash by examing the conditions under which firms commit to environmental policies in their public statements but fail to implement them. They find 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.

[19] Lyon and Maxwell (2006) also suggest that 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.

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

The hypotheses developed so far relate to why firms participate in the 1605b program. We now turn to hypotheses regarding what types of firms have better environmental performance. As our measure of performance, we focus on CO_2 emissions intensity, i.e. CO_2 emissions per net electric generation (lbs/MWh).[20] First of all, regardless of 1605b participation status, firms with a higher fraction of generation from hydroelectric or nuclear sources, which emit zero carbon, should have lower CO_2 emissions intensity. Also, firms with growing demand are likely to have lower CO_2 emissions intensity. As discussed before, during most of our sample period natural gas was the fuel of choice for new generating units because it was both clean and cheap. Hence, growing firms that currently rely on coal- or oil-fired generation can reduce their average CO_2 intensity by installing new gas units. In addition, growing firms can also increase their capacity factors, operating more efficiently and reducing their carbon intensity.

Hypothesis 4: A firm has better environmental performance, i.e., lower CO_2 emissions intensity, if it: a) has a higher fraction of hydroelectric or nuclear generation, or b) faces growing demand.

We also expect that 1605b participation status may affect the association between some of our independent variables and CO_2 emissions intensity. This is especially so for firms with high-cost oil-burning plants that could be displaced by cheaper, cleaner, gas-fired generating units. To capture this low-cost opportunity, we created a variable called "fuel switch saving."[21] Some 1605b participants reported that they took advantage of this low-cost opportunity: they decreased CO_2 emissions by switching fuels from high- to low-carbon sources. Thus, for 1605b participants, we expect that a large potential fuel

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[20] We use the intensity measure as our environmental performance indicator since the main product of the electric utilities is electricity, which is more or less a homogeneous good.
[21] See Table I for a detailed explanation.

switch saving in the previous period helps them to lower their CO_2 emissions intensity in the current period. For firms that did not take advantage of this low cost-opportunity, (who are more likely to be 1605b non-participants), we expect a large potential fuel switch saving leads to higher CO_2 emissions intensity than otherwise.

Hypothesis 5: A firm that participates in the 1605b program has better environmental performance, i.e., lower CO_2 emissions intensity, if it had a large potential fuel switch saving in the previous period. A firm that does not participate in the 1605b program has higher CO_2 emissions intensity if it had a large potential fuel switch saving in the previous period.

Some 1605b participants also reported that they reduced CO_2 emissions by improving plant efficiency, for example, increasing capacity factor or lowering heat rate. Thus, we suppose that firms with higher capacity factor or lower heat rate in the current period have lower CO_2 emissions intensity since their low excess capacity or heat rate 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. If these firms register their reductions with the DOE, then we have

Hypothesis 6: A firm that participates in the 1605b program has better environmental performance, i.e., lower CO_2 emissions intensity, if it: a) has higher capacity factor, or b) has lower heat rate in the current period.

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

4. Econometric Models

We use a random utility model to analyze the factors that lead electric utilities to participate in the 1605b program (Domencich and McFadden, 1975). In the model, a firm, the decision maker, makes a rational choice based on the information available to it, i.e., the firm chooses the alternative with the highest utility. Relative to the firm, we, the analysts, lack information about many factors relevant to the decision, and thus need to take our uncertainty about these factors into account. The sources of uncertainty include unobserved alternative attributes, unobserved individual attributes, and measurement errors. To reflect this uncertainty, we model the firm's utility as a random variable, which has a deterministic part and a stochastic part. Different assumptions about the stochastic part 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). We define a participation dummy variable D_{it} = 1 if firm *i* makes choice 1 in period *t* and D_{it} = 0 if firm *i* makes choice 0 in period *t*. The firm's utility is

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

where $\mathbf{X_{ijt}}$ is a matrix of independent variables that affect the costs and benefits of participation. We observe $D_{it} = 1$ *iff* $V_{i1t} > V_{i0t}$, or equivalently, if $\mathbf{X_{i1t}}\boldsymbol{\beta} + \varepsilon_{i1t} > \mathbf{X_{i0t}}\boldsymbol{\beta} + \varepsilon_{i0t}$, which we can rewrite as $\varepsilon_{i0t} - \varepsilon_{i1t} < (\mathbf{X_{i1t}} - \mathbf{X_{i0t}})\boldsymbol{\beta}$. Define $\mathbf{X_{it}} = [\mathbf{X_{i0t}}|\mathbf{X_{i1t}}]$. Then the probability of participation is

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

where F is cumulative distribution function of $\varepsilon_{i0t} - \varepsilon_{i1t}$.

If ε_{i0t} and ε_{i1t} are normally distributed with mean 0 such that $\varepsilon_{i0t} - \varepsilon_{i1t} \sim N(0, \sigma^2)$, then we can write

$$P_{it} = \Phi(\mathbf{Z_{it}}\boldsymbol{\gamma}) \qquad (2)$$

where Φ is the standard normal cdf and $\mathbf{Z_{it}}\boldsymbol{\gamma} = (\mathbf{X_{i1t}} - \mathbf{X_{i0t}})\boldsymbol{\beta}$.

We assume that firms participate in the 1605b program if their net benefit with participation is greater than their 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, we make use of a heterogeneous treatment effect model that takes into account selection on unobservables (Heckman, et al., 1999; 2003).[22] For estimation, we use a generalization of the bivariate normal selection model. Equation (3) and equation (4) are the second-stage outcome equations for the participants and non-participants, respectively, with y_{i1t} and y_{i0t} the CO_2 emissions intensity in the second stage for the 1605b participants and non-participants, respectively. Equation (5) is the first stage probit model.

$$y_{1it} = \mathbf{X_{it}\beta_1} + \varepsilon_{1it} \tag{3}$$

$$y_{i0t} = \mathbf{X_{it}\beta_0} + \varepsilon_{0it} \tag{4}$$

$$D_{it}^* = \mathbf{Z_{it}\gamma} + u_{it} \tag{5}$$

$$D_{it} = 1 \text{ if } D_{it}^* > 0 \text{ and } D_{it} = 0 \text{ otherwise,}$$

Here $\mathbf{X_{it}}$ is a matrix of independent variables that affect CO_2 emissions intensity. D_{it} is a participation dummy and D_{it}^* is a latent variable for participation. $\mathbf{Z_{it}}$ is a matrix of independent variables that affect firms' participation decisions.[23]

Under a trivariate normal distribution for the error terms (ε_{1it}, ε_{0it}, u_{it}), we have the following equations.

$$E(\varepsilon_{0it} \mid D_{it} = 1, \mathbf{X_{it}}, \mathbf{Z_{it}}) = \rho_{0u}\sigma_{\varepsilon_0}\lambda_{1it}(\mathbf{Z_{it}\gamma}) \tag{6}$$

$$E(\varepsilon_{0it} \mid D_{it} = 0, \mathbf{X_{it}}, \mathbf{Z_{it}}) = \rho_{0u}\sigma_{\varepsilon_0}\lambda_{0it}(\mathbf{Z_{it}\gamma}) \tag{7}$$

$$E(\varepsilon_{1it} - \varepsilon_{0it} \mid D_{it} = 1, \mathbf{X_{it}}, \mathbf{Z_{it}}) = \rho_{(\varepsilon_1-\varepsilon_0)u}\sigma_{(\varepsilon_1-\varepsilon_0)}\lambda_{1it}(\mathbf{Z_{it}\gamma}) \tag{8}$$

*w*here

$$\rho_{0u} = corr(\varepsilon_0, u) \text{ and } \rho_{(\varepsilon_1-\varepsilon_0)u} = corr((\varepsilon_1 - \varepsilon_0), u)$$

$$\lambda_{1it} = \frac{\phi(\mathbf{Z_{it}\gamma})}{\Phi(\mathbf{Z_{it}\gamma})} \text{ and } \lambda_{0it} = -\frac{\phi(\mathbf{Z_{it}\gamma})}{1-\Phi(\mathbf{Z_{it}\gamma})}$$

[22] We thank Arnaud Reynaud for suggesting that we use the heterogeneous version of the treatment effects model.

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

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

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\begin{aligned}
y_{it} &= D_{it} y_{1it} + (1-D_{it}) y_{0it} \\
&= D_{it}(\mathbf{X_{it}\beta_1} + \varepsilon_{1it}) + (1-D_{it})(\mathbf{X_{it}\beta_0} + \varepsilon_{0it}) \\
&= D_{it}(\mathbf{X_{it}\beta_1} + (\varepsilon_{1it} - \varepsilon_{0it}) + \varepsilon_{0it}) + (1-D_{it})(\mathbf{X_{it}\beta_0} + \varepsilon_{0it}) \\
&= D_{it}(\mathbf{X_{it}\beta_1} + \rho_{(\varepsilon_1-\varepsilon_0)u}\sigma_{(\varepsilon_1-\varepsilon_0)}\hat{\lambda}_{1it}(\mathbf{Z_{it}}\hat{\boldsymbol{\gamma}}) + \rho_{0u}\sigma_{\varepsilon_0}\hat{\lambda}_{1it}(\mathbf{Z_{it}}\hat{\boldsymbol{\gamma}})) \\
&\quad + (1-D_{it})(\mathbf{X_{it}\beta_0} + \rho_{0u}\sigma_{\varepsilon_0}\hat{\lambda}_{0it}(\mathbf{Z_{it}}\hat{\boldsymbol{\gamma}})) \\
&= \mathbf{X_{it}\beta_0} + D_{it}\mathbf{X_{it}}(\boldsymbol{\beta_1} - \boldsymbol{\beta_0}) + \rho_{0u}\sigma_{\varepsilon_0}(1 - \mathrm{D_{it}})\hat{\lambda}_{0it}(\mathbf{Z_{it}}\hat{\boldsymbol{\gamma}}) \\
&\quad + (\rho_{0u}\sigma_{\varepsilon_0} + \rho_{(\varepsilon_1-\varepsilon_0)u}\sigma_{(\varepsilon_1-\varepsilon_0)})D_{it}\hat{\lambda}_{1it}(\mathbf{Z_{it}}\hat{\boldsymbol{\gamma}}) + \nu_i \qquad (9)
\end{aligned}
$$

Based on the above equation, the independent variables included in the 2nd stage are $\mathbf{X_{it}}$, $D_{it}\mathbf{X_{it}}$, $(1-D_{it})\hat{\lambda}_{0it}$ and $D_{it}\hat{\lambda}_{1it}$, where $\hat{\lambda}_{1it}$ is the Inverse Mills Ratio. The coefficient for the second term, $(\hat{\boldsymbol{\beta}}_1 - \hat{\boldsymbol{\beta}}_0)$, indicates the average treatment effect for a randomly selected firm.

5. Data

The models are estimated using a pooled database of 83 investor-owned electric utilities (IOUs) over the period 1996-2003.[24] 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 participation data were collected from the DOE's Voluntary Registry website.[25] Financial, operational and environmental performance-related data were obtained from Platts, a company specializing in energy industry data.[26] Table I provides a list of explanatory

[24] The reason for pooling is discussed later in the section.
[25] http://www.eia.doe.gov/oiaf/1605/frntvrgg.html
[26] 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

variables used in this paper and their definitions. Some of the variables are lagged by one year to avoid endogeneity concerns.

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.[27] 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 adjusted CEMS estimates to increase the number of observations.[28]

Table I also includes two greenwash-related variables designed to capture Hypothesis 3: the absolute difference from the mean and the median CO_2 emissions for that year. We also include the interaction variable between lagged SO_2 emissions and Sierra magazine subscriptions, motivated by the finding of Maxwell, Lyon and Hackett (2000) that toxic reductions over time were 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 two of reasons for this. First, the 1605b program does not require that the IOUs make any long-term commitment. This implies that every year they are free to opt out or opt in, providing

available an integrated database, eGRID, which provides emissions and generation data. It has two key drawbacks, however. First, there is a considerable time lag. For example, the database now available covers the period only from 1996 to 2000. Second, there are no financial variables.

[27] www.nrdc.org/air/energy/rbr/append.asp.

[28] 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.

theoretical support for pooling.[29] 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 evidence that fixed effects are present.[30] This finding further supports pooled analyses (Cameron and Trivedi, 2005). We use panel-corrected standard errors and t-statistics for statistical inference.[31]

Table II provides summary statistics for the explanatory variables used in our pooled analyses, both in the aggregate and by participation category. We see that 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. Participation in 1605b is on average associated with larger and dirtier firms, as represented by higher revenue and higher lagged CO_2 emissions and SO_2 emissions, respectively. The table shows that CO_2 emissions intensity is also higher for the participants. Participation is associated with greater external pressure: greater number of Sierra magazine subscriptions and higher LCV scores for the House and the Senate. The interaction term between lagged SO_2 emissions and Sierra magazine subscription is also higher for participants, but the RPS index is higher for non-participants. The 1605b participants appear to 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 possibilities 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; the heat rate is about the same for participants and non-participants. Participation is also associated with greater non-fossil fuel use, measured by a higher fraction of hydro and nuclear. The lagged 1605b participation trend is the total number of the 1605b

[29] 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 the one-year lagged participation dummy is 1.
[30] We note a couple of qualifications to 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.
[31] We assume observations are independent across firms but not independent within firms. For details see Wooldridge (2002).

participants in the electric power sector in year t-1 and hence the same 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 lagged growth rates are on average higher for the participants, although one-year and two-year lagged growth rates are lower. The absolute difference from the mean or median lagged CO_2 emissions is higher for the participants.

[Table II about here]

Figures I and II show temporal aggregate trends in reported and actual reductions over the period 1996-2003. Figure I compares the total reductions reported to the 1605b program by IOUs to their total actual CO_2 reductions in the same year.[32] Figure II contrasts actual reductions of the participants with those of the non-participants. We find a large discrepancy between reported and actual reductions. Participants in the 1605b program reported reductions during 1996-2003, but their actual emissions rose.[33] Moreover, during the same period non-participants reduced their emissions. To check whether these results are driven by a few large firms, Figure III further breaks down Figure I. Figure III compares reported and actual reductions at the level of the firm-year. It shows that 68% of the reports to the 1605b program claimed positive reductions while actual emissions rose. Although the IOU behavior we uncover is not illegal *per se* since the 1605b program allows selective reporting, this appears to represent exactly the type of greenwash behavior described in section 3.

[Figure I about here]

[Figure II about here]

[32] The reported reductions data are collected from the DOE's Voluntary Registry website. The actual reductions are calculated against the base year 1995 using the data obtained from Platts. The year 1995 is the earliest available year for us.

[33] Firms might have reduced emissions compared to the 1605b benchmark years (1987-1990) but not compared to our benchmark year, 1995. For instance, this may be the case if firms increased renewable energy generation as a substitute for coal-based generation between the 1605b benchmark years and 1995.

[Figure III about here]

Table III presents the correlations between each variable. The correlations between lagged CO_2 emissions and the absolute difference from the mean or median lagged CO_2 emissions are particularly high. Thus, we include them sequentially in our regressions.

6. Results

We report in turn our results on firms' decisions regarding participation in the 1605b program, our treatment effects results, and finally the changes in our results when we make adjustments for indirect emissions reductions and sequestration.

Participation

We estimate four alternative specifications to analyze what factors motivate firms to participate in the 1605b program and whether a tendency to greenwash is present or not. The results are shown in Table IV.

[Table IV 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, 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, or growing 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 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, while we find a positive coefficient, we do not find statistically significant evidence that heat-rate 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.

Neither of the two greenwash variables proves to be statistically significant, although this may be because they are not sophisticated enough to capture the non-linearities in the hypotheses of Lyon and Maxwell (2006). However, we do find that the interaction between lagged SO_2 emissions and Sierra magazine subscription, is positive and significant. This suggests that a firm is more likely to participate if it is dirty and under greater external pressure.

Treatment Effects

Table V shows the estimation results of two alternative heterogeneous treatment effect models. The exclusion restriction is satisfied via the electric operating revenue variable. It has a significant effect on the participation decision, but not on CO_2 emissions intensity, which is already adjusted for the amount of net generation.[34] The first stage specifications of the treatment effect models do not include lagged CO_2 emissions. 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.

[34] We tested and confirmed that the electric operating revenue variable does not affect the 2nd stage outcome variable, CO_2 emissions intensity.

[Table V about here]

Examining Table V, we find strong support for Hypothesis 4. Regardless of 1605b participation status, firms that have a higher fraction of hydroelectric or nuclear generation, and firms that face growing demand, have lower CO_2 emissions intensity. It is not surprising that a higher fraction of non-fossil fuel sources such as hydro or nuke, which emit zero carbon, lowers CO_2 emissions intensity. Similarly, firms with growing demand may have increased their natural gas capacity or operated more efficiently, reducing CO_2 emissions intensity.

Consistent with Hypothesis 5, Table V shows that for 1605b participants, a large potential fuel switch saving in the previous period is associated with lower CO_2 emissions intensity in the current period, and for 1605b non-participants, a large potential fuel switch saving in the previous period is associated with higher CO_2 emissions intensity in the current period.

We find partial support for Hypothesis 6. For 1605b participants, a higher capacity factor in the current period is associated with lower CO_2 emissions intensity. This is consistent with our assumption that in the case of 1605b participants, firms with low excess capacity have already taken advantage of their relatively low-cost abatement opportunities, i.e., expanding effective capacity through improvement in operating efficiency. However, we do not find any evidence that relates to heat rate for 1605b participants.

Table V also shows whether 1605b participation has any effect on environmental performance, i.e., CO_2 emissions intensity. We find a positive but insignificant coefficient on 1605b participation, indicating that, if anything, participation is associated with worse environmental performance.

Regressions after adjusting for indirect reductions and sequestration

We turn now to exploring the role of indirect reductions and sequestration. The CO_2 emissions and emissions intensity variables we used in the participation probit and the treatment effect models are based on 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.[35] 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.[36] When indirect reductions and sequestration may also be reported, however, then 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 otherwise might not be 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 re-running the same participation probit and treatment effect models as before, but 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 sequestration as reported to the 1605b program from the fuel consumption-based CO_2 emissions estimates.[37] The adjusted CO_2 emissions intensity variable is obtained by dividing the adjusted CO_2 emissions by net generation.

[35] 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.
[36] Of course, this statement holds only when the benefit of retrieving the publicly available data and inferring CO_2 emissions exceeds the associated cost for interested parties, whomever they might be.
[37] Reductions reported to the 1605b program include greenhouse gases other than CO_2. The DOE's Voluntary Registry website reports total reductions in terms of CO_2 equivalent.

Tables VI and VII show the regression results for the probit and heterogeneous treatment effect models, respectively. They are virtually identical to those reported in Table IV and Table V 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, even with the adjusted CO_2 emissions and intensity variables, 1605b participation is still associated with lower environmental performance, i.e., higher CO_2 emissions intensity, although the difference is not statistically significant.[38]

[Table VI about here]

[Table VII 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 utilities' 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 robust effects on participation. Surprisingly, firms are less likely to participate if they are in states with stricter renewable portfolio standards, though the effect is not statistically significant. This may indicate that for electric utilities a state RPS is the main form of external threat, and firms participate in the 1605b program hoping to preempt an RPS.

[38] 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.

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 selective disclosure modeled by Lyon and Maxwell (2006). 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. Overall, our results support the notion that the voluntary reporting program has provided 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.[39] The revisions should make it much more difficult to use voluntary reporting of greenhouse gases as a form of greenwash.

[39] 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

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

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

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.

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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 SO_2 emissions and Sierra Subscription (greenwash tendency)	This is obtained by multiplying the values for lagged SO_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 SO_2 Emissions and Sierra subscription ((10^9 lbs)× (thousands))			
Mean	0.733	1.137	0.298
Standard Deviation	1.121	1.393	0.396
Min	0	0	0
Max	7.954	7.954	1.809

Table III. Variable Correlations

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
(1)	1																	
(2)	0.153	1																
(3)	0.131	-0.0944	1															
(4)	0.5034	-0.1936	0.4209	1														
(5)	0.1543	0.2869	-0.167	-0.1288	1													
(6)	0.0594	-0.2104	0.0921	-0.0068	0.0644	1												
(7)	-0.1291	-0.3506	0.1296	0.3588	-0.679	-0.1841	1											
(8)	-0.1508	-0.0582	0.3098	0.139	-0.1211	-0.096	0.1799	1										
(9)	-0.1079	-0.0351	0.4395	0.1409	-0.2019	-0.0486	0.1593	0.6624	1									
(10)	-0.0607	-0.0079	0.2142	0.1517	-0.0024	-0.0244	0.0379	0.0685	0.1208	1								
(11)	0.0953	-0.0123	0.0949	0.1545	-0.0201	-0.0325	0.0521	0.0604	0.0405	0.1284	1							
(12)	0.7395	-0.0218	0.2313	0.3656	0.0524	0.1656	-0.1183	-0.1208	-0.0678	-0.1442	0.058	1						
(13)	-0.0776	-0.0465	0.0019	-0.0503	0.0056	-0.013	-0.0047	0.0648	0.0401	-0.2183	-0.0627	0.0124	1					
(14)	-0.0524	-0.0997	-0.1027	-0.1031	-0.0171	0.0945	0.0105	-0.0535	-0.06	-0.0568	0.0031	0.0123	0.0506	1				
(15)	-0.0681	-0.1002	-0.1461	-0.1368	-0.0458	0.0488	0.0598	-0.0474	-0.0286	-0.0793	-0.0184	0.0039	0.0954	0.5757	1			
(16)	0.0005	0.0127	-0.0306	-0.0224	0.012	-0.0651	-0.0181	-0.0491	-0.0255	-0.0164	-0.0095	0.0139	-0.0292	-0.0126	0.0357	1		
(17)	0.9638	0.0739	0.1277	0.487	0.0459	0.02	-0.0184	-0.1131	-0.0737	-0.0946	0.076	0.7313	-0.0369	-0.0219	-0.0287	0.0001	1	
(18)	0.8341	-0.0127	0.1471	0.4197	-0.0668	0.0197	0.066	-0.0194	0.0237	-0.0927	0.0564	0.6663	-0.0378	0.0067	0.0058	-0.0165	0.9285	1
(19)	0.658	-0.0183	0.4246	0.3636	0.026	0.1794	-0.0965	-0.0419	0.0268	-0.0877	0.0216	0.9402	0.015	-0.0044	-0.0162	-0.0052	0.6506	0.6045

(1) Lagged CO_2 emissions (2) CO_2 emissions intensity (3) Sierra magazine subscription (4) Electric operating revenue (5) Heatrate (6) Capacity factor (7) Fraction of Hydro and Nuclear (8) LCV scores: Senate (9) LCV scores: House (10) RPS index (11) Lagged fuel switch saving (12) Lagged SO_2 emissions (13) Lagged 1605b participation trend (14) Growth in net generation (t-1) (15) Growth in net generation (t-2) (16)) Growth in net generation (t-3) (17) Absolute difference from mean lagged CO_2 emissions (18) Absolute difference from median lagged CO_2 emissions (19) Interaction between lagged SO_2 emissions and Sierra subscription

Table IV
1605b Participation Probit

Variable	Model 1	Model 2	Model 3	Model 4
Lag CO_2 Emissions	4.013e-02* (2.226e-02)			
Sierra Subscription	0.133 (8.764e-02)	0.130 (8.297e-02)	0.122 (8.404e-02)	-2.64e-02 (0.112)
Electric Operating Revenue	0.631* (0.358)	0.977*** (0.336)	0.848** (0.354)	0.945*** (0.323)
Heatrate	1.05e-04 (1.269e-04)	1.32e-04 (1.296e-04)	1.14e-04 (1.248e-04)	1.30e-04 (1.260e-04)
Capacity factor	-1.880 (1.170)	-2.100* (1.114)	-1.891* (1.138)	-2.055* (1.141)
Fraction of hydro & nuclear	0.439 (0.933)	0.298 (0.973)	0.142 (0.936)	0.312 (0.929)
LCV score: Senate	3.17e-03 (5.257e-03)	2.09e-03 (5.291e-03)	2.64e-03 (5.237e-03)	7.64e-04 (5.383e-03)
LCV score: House	8.59e-03 (9.240e-03)	6.32e-03 (8.747e-03)	6.45e-03 (8.938e-03)	8.80e-03 (8.442e-03)
RPS index	-0.799 (0.493)	-0.810 (0.511)	-0.775 (0.501)	-0.860 (0.531)
Lag Fuel Switch Saving	-7.40e-03 (0.933)	0.497 (1.036)	0.317 (0.974)	1.290 (1.084)
Lag SO_2 Emissions	-6.14e-02 (1.371)	1.730 (1.627)	0.919 (1.612)	-5.390 (4.153)
Lag 1605b reporting Trend	2.81e-03 (8.383e-03)	-2.60e-03 (7.936e-03)	-1.19e-03 (7.746e-03)	-5.40e-04 (7.293e-03)
Growth in net generation (t-1)	-6.44e-02 (0.184)	-0.112 (0.149)	-0.114 (0.157)	-0.149 (0.168)
Growth in net generation (t-2)	-8.96e-02 (0.192)	-7.45e-02 (0.190)	-9.12e-02 (0.189)	-0.135 (0.186)
Growth in net generation (t-3)	1.008e-02*** (2.453e-03)	9.776e-03*** (2.534e-03)	9.982e-03*** (2.507e-03)	1.048e-02*** (2.503e-03)
Absolute Difference from Mean Lag CO_2 Emissions		-1.77e-02 (2.357e-02)		
Absolute Difference from Median Lag CO_2 Emissions			1.56e-02 (2.357e-02)	
Interaction between Lag SO_2 Emissions and Sierra subscription				1.438* (0.841)
Constant	-2.66 (1.630)	-1.86 (1.624)	-2.03 (1.592)	-1.58 (1.609)
Observations	596	596	596	596
Count R^2	0.800	0.792	0.794	0.797
Adjusted Count R^2	0.585	0.568	0.571	0.578
Log Likelihood	-261.856	-268.789	-268.810	-261.003
$\chi^2[15]$	77.24 {0}	81.27 {0}	78.48 {0}	73.67 {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 V
Heterogeneous Treatment Effect Models

Variable	Model 1: 1st stage: 1605b Participation	Model 1: 2nd stage: CO_2 Intensity	Model 2: 1st stage: 1605b Participation	Model 2: 2nd stage: CO_2 Intensity
Sierra Subscription	0.122 (0.083)	-46.50 (51.33)	-2.64e-02 (0.112)	-52.60 (53.27)
Heatrate	1.23e-04 (1.263e-04)	4.823e-02* (2.638e-02)	1.30e-04 (1.260e-04)	4.40e-02 (2.762e-02)
Capacity factor	-1.997* (1.131)	-2.79e+02 (5.592e+02)	-2.055* (1.141)	-1.83e+02 (5.250e+02)
Fraction of hydro & nuclear	0.181 (0.949)	-5.750e+02** (2.670e+02)	0.312 (0.929)	-5.991e+02** (2.669e+02)
LCV score: Senate	2.36e-03 (5.270e-03)	-4.052* (2.427)	7.64e-04 (5.383e-03)	-4.08 (2.466)
LCV score: House	5.89e-03 (8.793e-03)	8.98 (6.090)	8.80e-03 (8.442e-03)	8.92 (6.222)
RPS index	-0.796 (0.504)	-1.60e+02 (2.031e+02)	-0.860 (0.531)	-1.42e+02 (2.042e+02)
Lag Fuel Switch Saving	0.421 (1.024)	1.009e+03*** (3.429e+02)	1.29 (1.084)	9.916e+02*** (3.420e+02)
Growth in net generation (t-1)	-0.120 (0.152)	-97.70 (1.046e+02)	-0.149 (0.168)	-93.20 (1.079e+02)
Growth in net generation (t-2)	-8.65e-02 (0.188)	-1.037e+02** (47.74)	-0.135 (0.186)	-99.11** (46.88)
Growth in net generation (t-3)	9.919e-03*** (2.520e-03)	-78.49* (39.65)	1.048e-02*** (2.503e-03)	-75.81** (37.99)
Lag SO_2 Emissions	1.43 (1.626)	3.59e+02 (7.931e+02)	-5.39 (4.153)	1.75e+02 (7.846e+02)
Electric Operating Revenue	0.934*** (0.317)		0.945*** (0.323)	
Lag 1605b reporting Trend	-1.58e-03 (7.724e-03)		-5.40e-04 (7.293e-03)	
Interaction between Lag SO_2 Emissions and Sierra Subscription			1.438* (0.841)	
1605b Participation (D_{it})		1.13e+03 (8.892e+02)		1.39e+03 (9.011e+02)
Sierra Subscription × D_{it}		45.40 (69.91)		48.00 (70.55)
Heatrate × D_{it}		-9.37e-03 (6.164e-02)		-1.66e-02 (6.457e-02)
Capacity factor × D_{it}		-1.995e+03** (7.744e+02)		-2.043e+03*** (7.636e+02)
Fraction of hydro & nuclear × D_{it}		-4.10e+02 (4.003e+02)		-4.80e+02 (4.130e+02)
LCV score: Senate × D_{it}		4.14 (3.304)		4.22 (3.360)
LCV score: House × D_{it}		-8.60 (8.111)		-9.58 (8.143)
RPS index × D_{it}		3.37e+02 (3.258e+02)		3.26e+02 (3.314e+02)

Lag Fuel Switch Saving × D_{it}		-1.114e+03*** (4.012e+02)		-1.124e+03*** (4.031e+02)
Growth in net generation (t-1) × D_{it}		-3.94e+02 (2.588e+02)		-4.13e+02 (2.635e+02)
Growth in net generation (t-2) × D_{it}		1.93e+02 (3.847e+02)		2.08e+02 (3.843e+02)
Growth in net generation (t-3) × D_{it}		76.97* (39.66)		74.00* (37.99)
Lag SO_2 Emissions × D_{it}		-2.21e+02 (8.427e+02)		-1.69e+02 (8.298e+02)
$(1-D_{it})\ \lambda_{0it}$ [1]		1.22e+02 (1.085e+02)		32.50 (1.165e+02)
Inverse Mills ratio × D_{it}		2.80e+02 (2.359e+02)		1.75e+02 (1.983e+02)
Constant	-1.97 (1.607)	8.865e+02** (4.210e+02)	-1.58 (1.609)	8.681e+02** (4.189e+02)
Observations	596	596	596	596
Count R^2	0.794		0.797	
Adjusted Count R^2	0.571		0.578	
Log likelihood	-269.933		-261.003	
χ^2[14]	78.77 {0}			
χ^2[15]			73.67 {0}	
F(27, 82)		15.44 {0}		14.61 {0}
R^2		0.30		0.29

[1] For explanation, refer to section 4, econometric models.
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
1605b Participation Probit after Adjusting for Indirect Reduction and Sequestration

Variable	Model 1	Model 2	Model 3	Model 4
Adjusted Lag CO_2 Emissions	3.810e-02* (2.231e-02)			
Sierra Subscription	0.133 (8.729e-02)	0.131 (8.312e-02)	0.122 (8.388e-02)	-2.64e-02 (0.112)
Electric Operating Revenue	0.652* (0.358)	0.979*** (0.337)	0.866** (0.355)	0.945*** (0.323)
Heatrate	1.01e-04 (1.264e-04)	1.30e-04 (1.296e-04)	1.16e-04 (1.250e-04)	1.30e-04 (1.260e-04)
Capacity factor	-1.89 (1.166)	-2.114* (1.115)	-1.909* (1.135)	-2.055* (1.141)
Fraction of hydro & nuclear	0.386 (0.928)	0.300 (0.970)	0.154 (0.937)	0.312 (0.929)
LCV score: Senate	3.09e-03 (5.258e-03)	2.09e-03 (5.291e-03)	2.60e-03 (5.249e-03)	7.64e-04 (5.383e-03)
LCV score: House	8.47e-03 (9.219e-03)	6.38e-03 (8.751e-03)	6.36e-03 (8.923e-03)	8.80e-03 (8.442e-03)
RPS index	-0.805 (0.491)	-0.814 (0.513)	-0.776 (0.503)	-0.860 (0.531)
Lag Fuel Switch Saving	1.19e-02 (0.940)	0.490 (1.024)	0.341 (0.982)	1.29 (1.084)
Lag SO_2 Emissions	2.22e-03 (1.380)	1.74 (1.615)	1.03 (1.613)	-5.39 (4.153)
Lag 1605b reporting Trend	2.41e-03 (8.291e-03)	-2.74e-03 (7.937e-03)	-1.12e-03 (7.752e-03)	-5.40e-04 (7.293e-03)
Growth in net generation (t-1)	-5.96e-02 (0.178)	-0.108 (0.149)	-0.119 (0.157)	-0.149 (0.168)
Growth in net generation (t-2)	-8.78e-02 (0.191)	-7.34e-02 (0.191)	-9.10e-02 (0.189)	-0.135 (0.186)
Growth in net generation (t-3)	1.010e-02*** (2.460e-03)	9.753e-03*** (2.537e-03)	9.924e-03*** (2.512e-03)	1.048e-02*** (2.503e-03)
Absolute Difference from Mean Lag CO_2 Emissions		-1.97e-02 (2.346e-02)		
Absolute Difference from Median Lag CO_2 Emissions			1.28e-02 (2.352e-02)	
Interaction between Lag SO_2 Emissions and Sierra subscription				1.438* (0.841)
Constant	-2.55 (1.611)	-1.82 (1.630)	-2.05 (1.597)	-1.58 (1.609)
Observations	594	594	594	594
Count R^2	0.800	0.788	0.795	0.796
Adjusted Count R^2	0.585	0.561	0.575	0.578
Log Likelihood	-262.641	-268.528	-269.190	-261.003
χ^2[15]	77.56 {0}	81.81 {0}	78.40 {0}	73.67 {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 VII

Heterogeneous Treatment Effect Models after Adjusting for Indirect Reductions and Sequestration

Variable	Model 1		Model 2	
	1st stage: 1605b Participation	2nd stage: CO_2 Intensity	1st stage: 1605b Participation	2nd stage: CO_2 Intensity
Sierra Subscription	0.122 (8.312e-02)	-46.60 (51.22)	-2.64e-02 (0.112)	-52.80 (53.16)
Heatrate	1.23e-04 (1.263e-04)	4.861e-02* (2.625e-02)	1.30e-04 (1.260e-04)	4.43e-02 (2.752e-02)
Capacity factor	-1.997* (1.131)	-2.87e+02 (5.582e+02)	-2.055* (1.141)	-1.89e+02 (5.242e+02)
Fraction of hydro & nuclear	0.181 (0.949)	-5.715e+02** (2.665e+02)	0.312 (0.929)	-5.959e+02** (2.664e+02)
LCV score: Senate	2.36e-03 (5.270e-03)	-4.02 (2.418)	7.64e-04 (5.383e-03)	-4.05 (2.459)
LCV score: House	5.89e-03 (8.793e-03)	8.99 (6.077)	8.80e-03 (8.442e-03)	8.94 (6.213)
RPS index	-0.796 (0.504)	-1.66e+02 (2.020e+02)	-0.860 (0.531)	-1.49e+02 (2.029e+02)
Lag Fuel Switch Saving	0.421 (1.024)	1.014e+03*** (3.423e+02)	1.29 (1.084)	9.971e+02*** (3.418e+02)
Growth in net generation (t-1)	-0.120 (0.152)	-97.80 (1.045e+02)	-0.149 (0.168)	-93.20 (1.078e+02)
Growth in net generation (t-2)	-8.65e-02 (0.188)	-1.042e+02** (47.67)	-0.135 (0.186)	-99.62** (46.85)
Growth in net generation (t-3)	9.919e-03*** (2.520e-03)	-78.70* (39.67)	1.048e-02*** (2.503e-03)	-75.95** (38.00)
Lag SO_2 Emissions	1.43 (1.626)	3.67e+02 (7.921e+02)	-5.39 (4.153)	1.79e+02 (7.838e+02)
Electric Operating Revenue	0.934*** (0.317)		0.945*** (0.323)	
Lag 1605b reporting Trend	-1.58e-03 (7.724e-03)		-5.40e-04 (7.293e-03)	
Interaction between Lag SO_2 Emissions and Sierra Subscription			1.438* (0.841)	
1605b Participation (D_{it})		8.64e+02 (8.895e+02)		1.16e+03 (9.073e+02)
Sierra Subscription × D_{it}		46.00 (69.86)		48.30 (70.49)
Heatrate × D_{it}		1.19e-02 (6.287e-02)		3.24e-03 (6.621e-02)
Capacity factor × D_{it}		-2.034e+03** (7.779e+02)		-2.075e+03*** (7.691e+02)
Fraction of hydro & nuclear × D_{it}		-3.31e+02 (3.928e+02)		-4.10e+02 (4.085e+02)
LCV score: Senate × D_{it}		4.32 (3.294)		4.42 (3.356)
LCV score: House × D_{it}		-8.47 (8.035)		-9.58 (8.098)

RPS index × D_{it}		3.41e+02 (3.291e+02)		3.30e+02 (3.354e+02)
Lag Fuel Switch Saving × D_{it}		-1.176e+03*** (4.025e+02)		-1.190e+03*** (4.041e+02)
Growth in net generation (t-1) × D_{it}		-3.96e+02 (2.616e+02)		-4.16e+02 (2.660e+02)
Growth in net generation (t-2) × D_{it}		2.09e+02 (3.860e+02)		2.25e+02 (3.865e+02)
Growth in net generation (t-3) × D_{it}		77.24* (39.68)		74.16* (38.00)
Lag SO_2 Emissions × D_{it}		-1.41e+02 (8.444e+02)		-1.00e+02 (8.320e+02)
$(1-D_{it})\ \lambda_{0it}$ [1]		1.28e+02 (1.082e+02)		38.10 (1.171e+02)
Inverse Mills ratio × D_{it}		2.96e+02 (2.358e+02)		1.80e+02 (1.982e+02)
Constant	-1.97 (1.607)	8.865e+02** (4.198e+02)	-1.58 (1.609)	8.681e+02** (4.177e+02)
Observations	594	594	594	594
Count R^2	0.793		0.797	
Adjusted Count R^2	0.571		0.578	
Log likelihood	-269.933		-261.003	
χ^2[14]	78.77 {0}			
χ^2[15]			73.67 {0}	
F(27, 82)		14.36 {0}		13.37 {0}
R^2		0.29		0.28

[1]For explanation, refer to section 4, econometric models.
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).

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

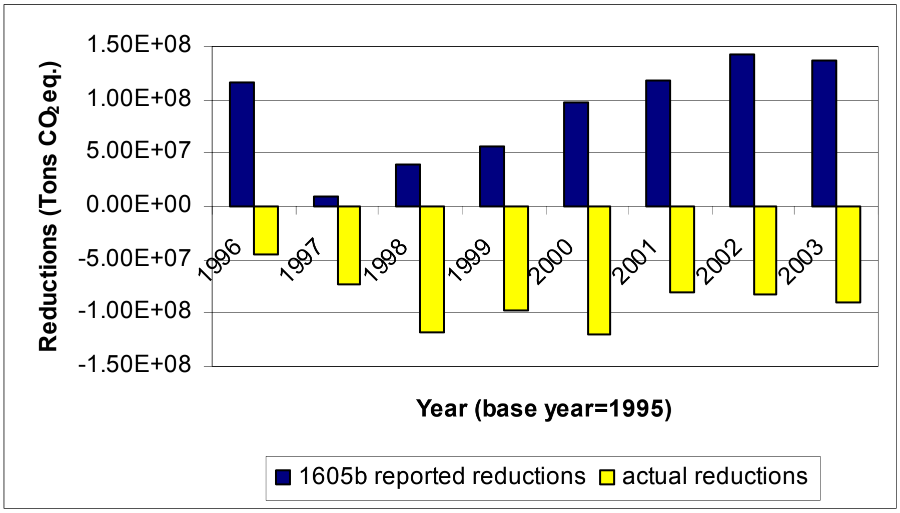


Figure II. Actual Reductions: IOU Participants vs. IOU Non-Participants

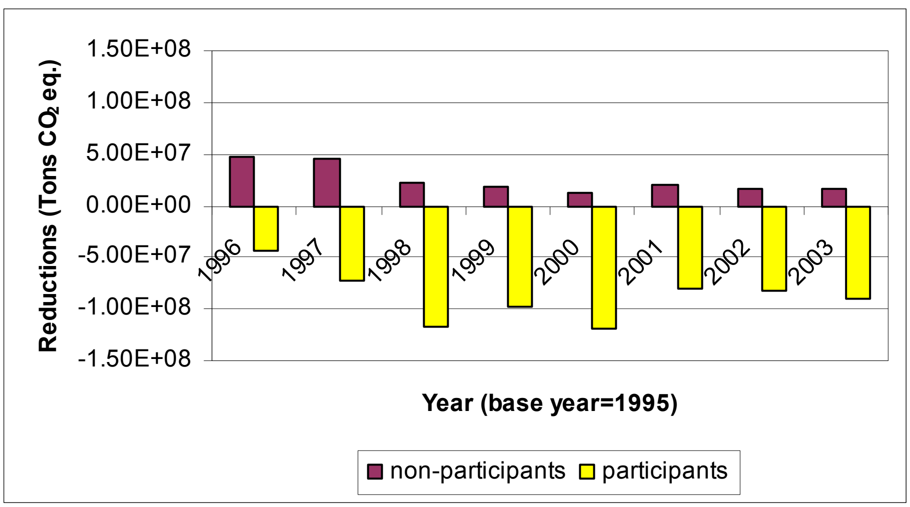
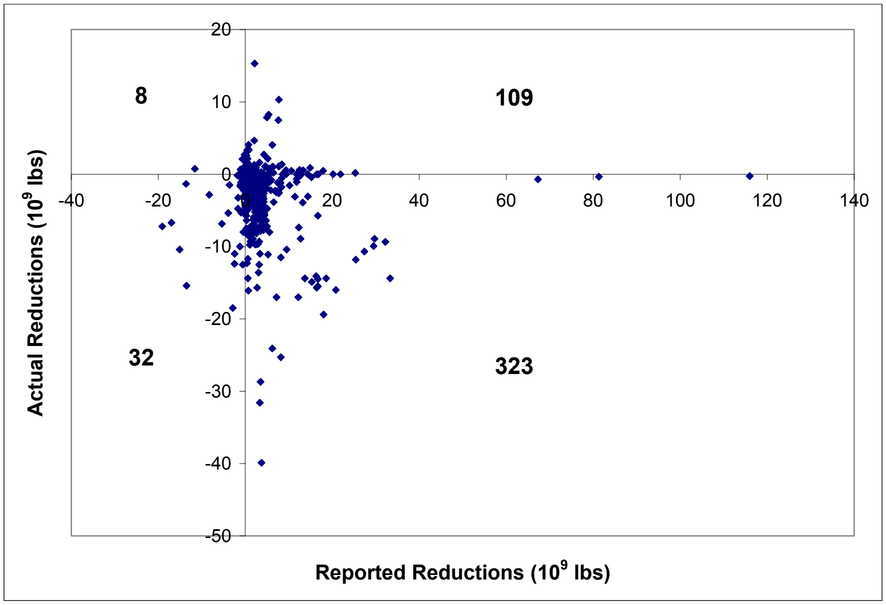


Figure III. Firm-level Reported vs. Actual Reductions*



* The graph includes firms that reported to the 1605b program and that have non-missing 1995 CO_2 emissions data or fuel consumption data. The numbers indicate firm-years (1996-2003) in each quadrant. The base year for actual reductions is 1995. Zeros are included in greater than zero quadrants.