

SUPPORTING STATEMENT
Business Technology Investment Decisions Exploratory Study

(1) Title of the Information Collection

Exploring Barriers to Business Investment in Emission Reduction Technologies

(2) Short Characterization/Abstract

In conducting regulatory impact analyses to assess the costs and benefits of taking action to reduce emissions, it is generally assumed that the private market is better at aligning private costs and benefits than government. In other words, profit maximizing firms should have every incentive to incorporate technologies into their products that are cost-effective absent consideration of externalities. Even in the presence of uncertainty and imperfect information – conditions that hold to some degree in every market – we expect that firms will make decisions that are in the best interest of the company and its owners and/or shareholders. And yet, in conducting regulatory impact analyses the U.S. EPA and other agencies have found that private firms do not always appear to take advantage of existing cost-effective opportunities, even when they pay off over relatively short time periods. This has led to the prediction that there will be private benefits, sometimes very large in magnitude, attributable to a government regulation motivated by other goals.

This puzzle has been observed in the context of energy efficiency for some time and is commonly referred to as the “Energy Paradox.” While empirical studies in the peer-reviewed literature examine why households may under-invest in energy efficiency, to our knowledge, no study has examined whether similar undervaluation occurs on the part of businesses. While a variety of hypotheses could explain this behavior, lack of empirical evidence on why businesses do not always invest in seemingly cost-effective energy saving technologies limits EPA’s ability to judge whether and when a given hypothesis is likely to be valid. This dilemma affects the ability of EPA program managers to determine how best to structure regulatory and non-regulatory approaches to protecting the environment. It also limits EPA’s ability to analyze and understand the economic or environmental impact of regulations and programs.

To begin to address this paucity of information, NCEE plans to conduct up to five pilot case studies. Each pilot study will explore how capital investment decisions within a particular industry are made when a present value calculation suggests that a cost-effective emission-reducing technology (or set of technologies) is available but the industry has largely refrained from investing. A preliminary, though not exhaustive, list of candidate industries from which the pilot cases will be drawn includes trucking, oil and gas, commercial buildings, manufacturing, food, materials processing, and sewage treatment. Each pilot case study will rely on information gathered through a combination of focus groups and one-on-one interviews with individuals making a firm’s capital investment decisions. While the pilot studies are exploratory, the goal is to gain insight

into what factors might explain apparent underinvestment in emission reducing technologies absent government regulation.

The focus group and one-on-one interviews are an important first step in determining the most fruitful means of collecting and analyzing information with enough detail across a wide enough set of industries to eventually identify whether there are any systematic determinants of capital underinvestment by firms. It is unclear at this early stage in the process whether the initial set of pilot cases will yield useful insights. It is also unclear whether future work would build on an industry or investment-specific approach or take a more general approach. For instance, based on what we learn from the exploratory work, the study could be expanded to include additional cases in other industries, though it is also possible that a more statistically representative approach, such as a more comprehensive field study or survey, could be used to broaden our understanding of capital investment decisions. Ultimately, it is NCEE's hope that any insights gained through this and any follow-on work will be useful for helping EPA understand business investment decisions in emission reduction technologies and could help EPA to determine whether and why there may be private benefits attributable to a regulation.

Background

As previously stated, while the academic literature has examined how households make tradeoffs between up-front costs and fuel savings further out in the future when purchasing long-lived durable goods,¹ very little research to-date has focused on reasons why such a paradox may exist in private firms' investment decisions. This may be due to lack of detailed transaction data as well as the complications of modeling what are often concentrated markets in which imports play an important role.

That said, the debate over the Energy Paradox is relevant when examining firms' investment decisions in emission-reducing technologies. For instance, the McKinsey abatement cost curve for GHG abatement in the United States (2007) shows that there are many seemingly negative or zero cost energy efficiency investments that would also lower GHG emissions. However, these opportunities are not being adopted. Critics of the McKinsey approach (e.g. Huntington 2009; Jaccard 2010) have paired bottom-up analyses that retain the level of detail of the McKinsey studies with general equilibrium models to account for a host of indirect costs such as quality trade-offs, adoption costs,

¹ Studies of household purchasing behavior do not offer a clear explanation of whether and why the Energy Paradox exists. Some studies demonstrate that "undervaluation" can be explained by uncertainty and irreversibility of investment (e.g., Metcalf and Rosenthal 1995; Metcalf and Hassett 1995; Dasgupta et al. 2007; Greene et al. 2009). Other studies find evidence that realized returns from energy efficiency investments are substantially lower than what is estimated by engineers and product manufacturers (e.g., Metcalf and Hassett 1999; Greene et al. 2006), though this finding is not universal (e.g., Greene et al. 2009). Some studies suggest that households may undervalue future energy savings due to the use of rules of thumb to evaluate trade-offs, mistakes made in calculating fuel savings, or lack of information (e.g., Kempton and Montgomery 1982; Yates and Aronson 1983; Kempton 1986; Sanstad and Howarth 1994; Larrick and Soll 2008; Allcott 2010). Other studies point to classic market failures in specific markets. For instance, households may underinvest due to the principal-agent problem. If it is not possible for the owner or landlord to pass through the full cost of energy investments to the tenant, he or she will under invest in energy efficiency (e.g., Levinson and Niemann 2004; Murtishaw and Sathaye 2006).

and heterogeneity in use. They find that costs are, in general, substantially higher than what is estimated by McKinsey using the bottom-up approach alone.

There are a wide variety of possible hypotheses discussed by McKinsey (2007) and others that could explain the seeming reticence on the part of businesses to invest in cost-effective technologies that involve balancing upfront investments against a stream of returns over a longer time period. These include classic market failures (e.g., asymmetric or incomplete information in original or resale markets; principle-agent or split incentive problems), market barriers (e.g. understated estimates of fuel savings and costs in real-world applications; adjustment or transaction costs; borrowing constraints in capital markets; other institutional or behavioral rigidities in the industry such as union rules or statutory requirements), and other factors not currently accounted for by the analyst in a present-value calculation that would change the assessment of what is cost effective (e.g., irreversibility of investment; uncertainty in future returns; perception of risk or loss aversion). The lack of empirical evidence regarding under which circumstances these hypotheses are potentially valid leaves the analyst with little ability to judge whether one or more apply in a given market.

Potential Pilot Studies

There are two types of business investment decisions that are of particular interest for EPA. The first type pertains to reticence to invest in seemingly cost-effective equipment or technology when it is the direct line of business in which a company engages. The second type pertains to investment decisions that could lower overall expenses for the firm but are well outside the main line of business, such as decisions of whether to invest in energy efficient cooling equipment. It is NCEE's intent to explore how these types of business investment decisions are made and whether barriers to technology adoption exist by examining industry-specific cases in the baseline absent any government intervention. Several potential pilot cases that either relate to the main line of business or are outside the main line of business are discussed below.

Main Line of Business

For the type of investment decision that falls within a company's main line of business, we have identified two potential pilot cases thus far:

- Investments in technologies that improve fuel efficiency in medium and heavy duty trucks and buses
- Investments in specific emission reduction technologies in the oil and natural gas industries

These two cases have been identified by McKinsey (2007) as potential negative or zero cost opportunities for greenhouse gas abatement in the United States. EPA has also begun to regulate these industries and estimated similarly large cost savings that are not currently being exploited by private firms.

In the case of the medium- and heavy-duty trucks and buses, present value calculations suggest that fleets should invest in a variety of seemingly cost effective technologies (e.g.

tires, aerodynamic fairings, auxiliary power units) absent any government intervention. Yet, EPA finds evidence that they have not done so. Most medium and heavy-duty trucks are purchased and operated by businesses with narrow profit margins, and for which fuel costs represent a substantial operating expense. Why are such investments not undertaken when it appears they could save the company substantial amounts of money in fuel savings? A recent National Research Council report points out that the bus and trucking industries are cognizant of the role that fuel costs play in their business decisions but suggests that there may be split incentives between owners and operators in some markets, and reticence to invest in fuel efficiency upgrades when payback periods exceed 18 months to 2 years (National Research Council 2010).² No reason is posited for why industry prefers such short payback periods on its investment.

In the case of the oil and natural gas industries, EPA found that most firms were not adopting seemingly profitable environmental controls that would reduce emissions during production and processing. For example, EPA estimates that only 15 percent of hydraulically fractured well completions use emission reducing techniques absent environmental regulation even though they are expected to be cost-effective on average.³ In addition to imperfect information, another possible explanation for why such negative cost improvements are not adopted is that many producers in these industries may view the financial opportunities of emission capture technologies as relatively small on average.

Outside the Main Line of Business

For the type of investment decision that falls outside a company's main line of business, we relied on McKinsey (2007) to identify a number of energy-efficiency and emission-reducing investments within the industrial and commercial building sectors that could serve as pilot cases:

- Combined heat and power in hospitals, universities, and large office buildings;
- Upgrading electric motors in specific industrial applications;
- Lighting upgrades (CFLs and LEDs) in commercial buildings;
- Management of hydro fluorocarbon (HFC) and other substitutes for ozone-depleting substances in manufacturing;
- Investments in electronic equipment (e.g. computers, other office equipment)
- Refrigeration equipment
- Methane capture at coal mines

There are a variety of hypotheses for why these investment opportunities have not been taken advantage of, in spite of zero or negative cost estimates. For instance, the commercial building sector is often characterized by split incentives between the owners and users of the building. Hypotheses for why methane capture does not occur during

² "In many cases, the commercial vehicle market is sophisticated, driven by knowledgeable purchasers who focus on the efficiency of their operations, including the fuel costs associated with accomplishing their tasks." NRC, 2010. P. S-12.

³ Regulatory Impact Analysis for Proposed New Source Performance Standards and Amendments to the National Emissions Standards for Hazardous Air Pollutants for the Oil and Natural Gas Industry. 2011.

coal mining include volatility in gas prices, uncertainty about the total amount, flow, and quality of methane expected, and large upfront capital costs.⁴

Focus Group and One-on-One Interview Approach

Various methodologies exist for collecting information, ranging from expert elicitation to focus groups to a comprehensive survey. Given the paucity of peer-reviewed studies regarding whether and why the Energy Paradox would apply to business technology investment decisions, we have elected to start with a combination of focus group and one-on-one protocol interviews. These methods are flexible: they allow the investigator to adapt the questions along the way to incorporate information learned from earlier focus groups and interviews regarding the applicability of particular hypotheses in a specific industry and technology-investment setting. We also plan to use the two methods for eliciting information in a way that is complementary. For instance, in an industry with many heterogeneous firms, a focus group may elicit insights into key similarities and differences across firms. Subsequent one-on-one interviews may then drill down into a subset of factors that were highlighted as important in the focus group context. A key challenge will be to engage individuals with enough knowledge and expertise in the way purchasing and investment decisions are made within a firm to shed light on possible reasons why a seemingly cost-effective technology or practice is not pursued.

To ensure that NCEE selects participants that reflect industry heterogeneity in terms of firm size, breadth of activities, and regional scale, it will rely on contractor support as well as input from EPA voluntary program coordinators and industry trade associations. Individuals at these respective organizations will be recruited by the contractor by phone to gauge their interest and willingness to participate in protocol interviews or focus groups. Should they agree to participate, the contractor will share any relevant pre-interview information with them via mail (either by USPS or by email).

With input from the relevant EPA program offices, NCEE will tailor questions to focus groups and one-on-one interviews for each of the selected pilot case studies that can then be gauged for their usefulness using pre-test methods. It is expected that these questions will evolve over time as NCEE learns from initial focus groups and interviews. Facilitators to conduct focus groups and interviews will be identified by a contractor.

Generic sample focus group and interview questions for investment in emission reduction technologies are attached. These materials will be embedded in a moderator's guide along with a reminder to the participants of the purpose of the study and warm-up questions to prime them for discussing technology investment decisions in greater detail, adapted to the specific case being studied.

(3) Need for the Collection

The goal of NCEE's pilot case studies is to evaluate how businesses make investment decisions to gain insight into what factors could explain apparent underinvestment in

⁴ These reasons for non-adoption are listed on the website for EPA's voluntary Coalbed Methane Outreach Program, which has as its primary goal to encourage "profitable recovery and use of coal mine methane."

emission reducing technologies absent government regulation. Although a number of studies examine why households may underinvest in energy efficiency, no studies have examined whether similar undervaluation occurs on the part of businesses. This topic is of great interest to EPA given its development of programs and regulations intended to spur the adoption of emission-reducing technologies by private firms.

This project is exploratory in nature. The focus group and one-on-one interviews are an important first step in determining the most fruitful means of collecting and analyzing information with enough detail across a wide enough set of industries to eventually identify whether there are any systematic determinants of capital underinvestment by firms. It is unclear at this early stage in the process whether the initial set of pilot case studies will yield useful insights. It is also unclear whether future work would build on an industry or investment-specific approach or take a more general approach. For instance, based on what we learn from the exploratory work, the study could be expanded to include additional cases in other industries, though it is also possible that a different approach, such as a more comprehensive field study or survey, could be used to broaden our understanding of capital investment decisions. Ultimately, it is NCEE's hope that any insights gained through this and any follow-on work will be useful for helping EPA understand business investment decisions in emission reduction technologies and could help EPA to determine whether and why there may be private benefits attributable to a regulation. As EPA's understanding of the firm investment process improves, this knowledge may be used to identify areas for methodological improvement and eventually could also inform future revisions to the *Guidelines for Preparing Economic Analyses*.

(4) Non-duplication

To the best of our knowledge this study is unique and does not duplicate other efforts. As mentioned in sections (2) and (3), while other studies do examine why households may underinvest in energy efficiency, none have examined whether similar undervaluation occurs in a business setting. Specifically, this collection will allow us to begin to explore whether there are any systematic determinants of business investment decisions that explain whether and why there may be private benefits attributable to an EPA rule as well as reason why these determinants may vary across sectors or even within a sector.

(5) Consultations

This is a new collection so no periodic consultations have been conducted for this effort. This collection, however, is of interest to other Agencies including the Department of Energy, the Office of Management and Budget [and the Council of Economic Advisers]. NCEE has made concerted efforts to keep interested parties informed of the progress of this project and to solicit feedback and will continue to do so going forward.

(6) Peer Review Plans

Protocol and focus group interview questions developed will be subject to routine internal review by the relevant program offices. External peer review is beyond the scope of this initial effort, but would be conducted prior to any comprehensive field study.

(7) Confidentiality

The focus group or interview questions and framework will fully conform to federal regulations – specifically the Privacy Act of 1974 (5 U.S.C. 552a), the Hawkins-Stafford Amendments of 1988 (P.L 100-297), and the Computer Security Act of 1987. Each prospective respondent will be informed that their participation in the exercise is voluntary. While responses may be associated with a type of organization, the identities of the individuals will be kept confidential by the investigators and not associated with their responses in any report.

(8) Sensitive Questions

There are no questions in the focus group or interview materials on sexual behavior and attitudes, religious beliefs, and other matters that are commonly considered private or sensitive material.

(9) Respondents

Respondents will vary with the pilot case but may include industry, trade organizations, and other industry experts. We expect to engage in this kind of collection for each selected pilot study to explore potential differences by sector.

(10) Collection Schedule

The proposed timeline for the data collection is over a 2 year period and is as follows.

Task:	Beginning Date:
Contact potential respondents for first pilot study	1 month after approval of ICR
Pre-test focus group questions for first pilot study	3 months after approval of ICR
Conduct focus groups and evaluate the usefulness of the initial set of questions.	4 months after approval of ICR
Conduct one-on-one interviews	5 months after approval of ICR
Second pilot study	6 months after approval of ICR
Third pilot study	12 months after approval of ICR
Fourth pilot study	18 months after approval of ICR
Fifth pilot study	24 months after approval of ICR

Please note that each stage is expected to inform the design of the questions. We expect that the first pilot study will help NCEE determine how the initial set of questions should vary in detail and design in subsequent pilot studies.

(11) Respondent Burden

To estimate burden, we have assumed we will conduct up to five pilot studies, with each consisting of a combination of, on average, 6 focus groups and 10 one-on-one protocol interviews that are regionally distributed. We assume there are 6 participants per focus group. Focus groups are expected to take approximately 2.5 hours. We assume that only one person from each identified organization will participate in a focus group. For the protocol interviews, we recognize that several people within an organization may be asked to participate depending on their expertise. Here, we assume there will be two participants from a firm for each protocol interview. We expect that each interview will take approximately 2 hours to complete. Recruitment and screening of participants is estimated to take about 20 minutes per participant. Follow-up discussions for the one-on-one protocol interviews with the primary contact within each participating organization are estimated to take approximately 1 hour.

With these assumptions in mind, we calculate the expected burden as follows:

For focus groups, 6 focus groups x 6 entities/group x 1 person x 5 cases x 2 hours 50 minutes = 510 hours

For protocol interviews, 10 interviews x 2 persons/interview x 5 cases x 3 hours 20 minutes = 333.3 hours.

In total, the total expected burden is the sum of these two parts, 510 hours + 333.3 hours = 843.3 hours.

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