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Valuing energy policy attributes for environmental management: Choice experiment evidence from a research institution

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ABSTRACT

Many governments, firms, institutions and individuals have become increasingly cognizant of their impact on the environment, most notably with respect to global climate change. Coupled with the possibility of future regulations aimed at curbing greenhouse gas emissions, firms and institutions have begun to critically evaluate their own carbon footprint. This paper examines the preferences of stakeholders within a large academic institution for attributes of alternative greenhouse gas (GHG) reduction strategies. The attributes considered by constituents include: the fuel portfolio mix, effort for conserving energy use, carbon emissions reduction, timeframe for emissions reduction to be achieved and cost. We use a choice experiment technique that enables the examination of greenhouse gas reduction program attribute preferences across three constituent groups. The results show that each of the constituent groups have a positive WTP for carbon emissions reductions and prefer investments in reductions in the shorter- rather than longer-term. The results also suggest differences between the constituent groups in their WTP for types of fuels in the fuel portfolio. Finally, we use the results to examine the welfare implications of different combinations of the policy attributes that coincide with alternative GHG program strategies.

1. Introduction

Public awareness regarding global climate change has increased in recent years, and with it has come rising concern for greenhouse gas (GHG) emissions. Countries around the world are developing policies and regulations such as the Kyoto protocol and European Union Emissions Trading Scheme aimed at curbing greenhouse gas emissions. The threat of future regulation along with a desire for a 'green' image, among other reasons, has led firms and individuals to begin critically evaluating and managing their own "carbon footprint". A firm or individual's carbon footprint can be separated into the direct (primary) footprint and the indirect (secondary) footprint. The direct footprint is a measure of energy from fossil fuels used in the production of a good or service, while the indirect footprint measures fossil fuel energy used during the life-cycle of a product or service (Tukker and Jansen, 2006). The direct carbon footprint is often used in policy analyses because it is more straightforward and transparent. While strategies for managing or reducing one's carbon footprint differ across individuals, firms, and institutions, voluntary yet legally binding programs for individual firms and small government entities provide economic incentives for them to reduce their carbon footprint.

In this paper, we present results of a study into constituents' (members of an institution) preferences for attributes of alternative carbon management strategies at their institution. Using a choice experiment survey, members of a large university campus community were asked about alternative greenhouse gas reduction strategies for the institution. Study participants revealed their preferences for alternative strategy attributes. The strategies consist of different bundles of attributes of greenhouse gas reduction strategies that include: alternative mixes of fuels, varying levels of energy conservation effort, alternative carbon emissions targets, and cost. The results also allow for examination of welfare implications for different combinations of GHG reduction program attributes that make up potential investment plans. Our results show that the three groups of constituents share some preferences for attribute types, such as the desirability for lower carbon emitting fuels and shorter investment time frames. Conversely, we find significant heterogeneity between segments of our study population in terms of their willingness to pay (WTP) for increased levels of some attributes of the carbon reduction

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strategies. Perhaps in line with expectations that faculty earn more than staff, faculty respondents appear willing to pay almost twice as much as staff for additional carbon emissions reduction.

2. Review of the literature

Researchers have used stated preference techniques to understand underlying preferences for carbon emissions. Typically this branch of valuation research has focused on consumer WTP for either climate change mitigation programs or attributes of renewable energy policy, both of which often incorporate the examination of some carbon equivalent for greenhouse gas emissions. Climate change mitigation research has examined WTP to avoid negative effects on ecosystems (Fleischer and Sternberg, 2006; Layton and Brown, 2000; Ready et al., 2006; Turpie, 2003), and animal populations (Pendleton and Mendelsohn, 1998; Tseng and Chen, 2008). Lee and Cameron (2008) considered the attributes of a carbon reduction policy by examining preferences for programs that keep climate conditions at their current levels. Those authors found that individuals are more supportive of programs that use an energy tax as well as programs that have cost shares distributed internationally.

Several studies that have examined renewable energy policy focus on the external effects such as on the environment (Alvarez-Farizo and Hanley, 2002), as well as non-environmental effects such as jobs (Bergman et al., 2006; Johnson and Desvousges, 1997), and energy security (Hartmann et al., 1991; Layton and Moeltner, 2005). Several other studies examined the payment scheme for green energy programs. For example, Kotchen and Moore (2007) used market data on green electricity programs to compare two different contribution mechanisms, and Wiser (2007) used contingent valuation methods to compare collective and voluntary payment schemes for renewable energy generation.

The type of energy production technology has been a carbon policy attribute often examined in previous research. A variety of studies considered a specific technology such as wind (Alvarez-Farizo and Hanley, 2002; Ek, 2005), or underground coal gasification (Shackley et al., 2006), and still yet others used renewable energy generation in general terms (Bergman et al., 2006; Bollino, 2009; Menges et al., 2005). Several studies have extended this literature by considering multiple technologies concurrently. Roe et al. (2001) used an experimental design that includes a mix of fuels, but they do not estimate the WTP for each energy source individually. Instead, they estimated the tradeoff for replacing fossil fuels with renewable fuels and nuclear power. On the other hand, Borchers et al. (2007) compared respondents' WTP for generic or undistinguished renewable energy with that of specific technologies such as wind, solar, farm methane, and biomass. They found a positive WTP for both generic 'green' energy as well as several individual types of renewable technologies. The only specific technology respondents preferred to generic 'green' energy was solar power.

The majority of carbon emissions research appears to examine individual or household preferences, while limited work has considered firms or institutions. The recent trend in corporate environmental management (see Besley and Ghatak, 2007) has seen businesses, non-profits, and the public sector pay increasingly more attention to their carbon footprint. Therefore, institutions and firms can benefit from feedback about their own members' preferences for environment-friendly activities, such as carbon footprint reduction strategies. Some studies have examined voluntary purchases of green power by firms and institutions. First, Wiser et al. (2001) surveyed 464 firms, and found that altruism and employee morale were important motivating factors for the firms' renewable energy purchase. However, Haar and Stanciu (2002) critiqued this finding by noting deficiencies in the survey techniques of Wiser et al., data analysis, and the difficulty of mapping individual preferences into an aggregate organizational preference function. Goett et al. (2000) used conjoint style experiments to analyze commercial and industrial customers WTP for service attributes, which included renewable energy sources. They found that consumers were willing to pay price premiums for renewable technologies, for example as much as 2 cents/kWh for a change to 100% hydroelectric power.

This paper builds upon and extends the previous literature. First, we examine the preferences for carbon management policies among various types of constituents of a large institution. Specifically, students, faculty, and staff of a large, tier 1 university that generates its own electricity and steam. These three population segments parallel both the constituencies of large private and non-profit firms as well as that of small municipalities. Furthermore, similarities can be seen in the types of mechanisms available to the university as those available to firms, institutions, and small municipalities for managing their carbon footprint. Second, we examine attributes of carbon management programs generally available to firms and institutional decision makers, which have rarely been considered simultaneously by previous research. Specifically, attributes of an institutions' energy program may include employee training, use of energy efficient technologies, and flexible investment time frames. Finally, we extend the work of Borchers et al. (2007) and Roe et al. (2001) by examining respondents' WTP for energy supplied by various production technologies. We evaluate constituents' preferences and WTP for six different energy generation technologies (i.e., fuel portfolios) together with other possible energy program characteristics for the institution.

3. Research site

The research site is a large, tier 1 university (Michigan State University) that sits on a 5200 acre campus, of which 2100 acres are developed. There are approximately 577 buildings spread throughout the campus that vary in age from new to over 100 years old. In 2009, the Michigan State University (MSU) population was comprised of approximately 47,000 students, 5000 faculty and 6300 staff. The university's governance structure parallels that of private and non-profit firms. It is overseen by a board of trustees, and administrators control the university's day-to-day operations. The university also has the ability to charge various fees to its constituents, which provides a plausible mechanism for designing a study that can quantify respondent's preferences monetarily. In fact, the university's environmental stewardship initiatives and carbon reduction targets resulted in the levying a $57 energy fee per semester on all students in 2008 and included energy fees as part of enrollment fees in 2009, the year in which we conducted our survey.

The co-generation power plant produces all of the electricity and steam for the campus. For fiscal year 2006–2007, peak levels of electricity demand were 58.4 MW, while steam demand for heating and cooling reached 537,000 lbs/h. In total, the university's emissions level for 2007 amounted to 601,579 tons of carbon equivalent emissions, and it is estimated that the power plant accounts for 96% of the university's carbon emissions (Boomer, 2008). The power plant gives the university direct control over its energy supply, and an ability to manage its carbon footprint through altering its sources of energy production. The co-generation power plant currently uses approximately 90% coal, 10% natural gas, and less than 1% biomass. The university uses