Measuring the Economic Value of Appalachian's Sustainability Mission

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Executive Summary

Sustainability at Appalachian is a critical component of its central mission. As part of this mission, Appalachian developed the Renewable Energy Initiative (REI), funded through student fees, to develop and construct energy efficient projects on campus. Appalachian's commitment to sustainable practices has enabled it to position itself as a leader in suitability among U.S. institutions. While the costs of the REI projects are known, the benefit, or economic value, to Appalachian is not. This report examines the benefit of REI projects to Appalachian's student body. Using the contingent valuation method, we capture the value of the REI projects to students by surveying and eliciting their willingness to pay for REI projects. After adjusting for potential hypothetical bias in the survey instrument, we find student **average willingness to pay for REI projects to be $108.** In aggregate, with 18,000 students attending Appalachian, findings indicate a **one-time snapshot economic value of Appalachian's sustainability mission to be $1.22 million**. In terms of a rolling annual value, with approximately 4,500 new students each year, the **annual economic value of Appalachian's sustainability mission is estimated as $441,000**.

Project Description

Sustainability at Appalachian is a critical component of its central mission, vision and values. Appalachian's Mission Statement explicitly identifies Appalachian as a leader in "creating a world where environmental, societal, and economic qualities exist in balance to meet the resource needs of today and of future generations." As part of the sustainability mission, Appalachian developed the Renewable Energy Initiative (REI). REI at Appalachian consists of a student committee and faculty/staff advisors responsible for allocating money towards the implementation of renewable energy on campus. The committee's annual operating budget comes from a self-imposed student fee of $10 per student per academic year. This began in 2004 when the student body voted to tax themselves with an 83% approval rate. In 2007, the students voted again in favor of a self-imposed annual fee, this time with a 92% approval rate. The principle component of REI is the development and construction of energy efficient projects on campus. Some examples of recent projects include a commercial scale solar thermal system that was installed in Summit Hall to heat water for the 330 students housed there. Also, the Broyhill Wind Turbine, situated at the top of Bodenheimer Drive, that is clearly visible across campus, produces 147,000 kWh annually. All current projects are listed at
< https://rei.appstate.edu/proj>.

Assessing the validity and importance of Appalachian's sustainability mission and REI requires an understanding of the benefits of these renewable energy projects, as well as their costs. From an economic perspective, this is achieved through a benefit-cost analysis. As is typical in most benefit-cost analyses, project costs are relatively easy to quantify, but measurement of potential benefits can be more complicated. The principle costs of the REI projects involve the additional expense in designing, modifying and constructing more energy efficient buildings and facilities. For example, the Summit Hall system cost $131,000 to install, while the Broyhill Wind Turbine cost $533,000.

On the benefit side, the value derived from these projects may be widespread. Students, alumni, faculty, local residents (and even non-local residents) may derive a level of satisfaction, or economic value, from their construction and use. The problem faced by researchers, however, is how to capture the value of such goods, resources, or services that are not explicitly traded in real markets. These are called non-market goods or services, and to overcome the problem, economists have developed a variety of methodologies to estimate their economic values. These methodologies are based on individuals' actual (observed) and/or anticipated (stated) behavior with regard to these goods or services in order to model and quantify their economic values.

The purpose of this analysis in to use one such method, termed the contingent valuation method (CVM), to derive an estimate of students' valuations of Appalachian's sustainability mission. The idea behind CVM research is straightforward. One way of measuring economic value is by the amount that an individual is willing to pay for the good or service. With a CVM, in a survey setting research participants are presented with a hypothetical market in which they can pay for a specified increase in a public good or pay to avoid a specified loss of a public good. Their willingness to pay (WTP) is contingent upon the hypothetical scenarios and markets described to them in the survey, hence the name "contingent valuation method" (Mitchell and Carson, 1989).

There are different potential methods to elicit individuals' WTP using the CVM. However, following the Exxon Valdez oil spill, a blue-ribbon-assembled panel of economists assessed the reliability of CVM and endorsed the referendum method as the preferred procedure for CVM analyses (Arrow et al., 1993). We will use the referendum method. In this method, each individual (student) that we sample is asked whether they would vote for a new one-time fee to fund further REI projects. The dollar amount of the fee is varied across student respondents. From this, statistical methods are then used to estimate the average student WTP. Beyond providing an estimate of the value of Appalachian's sustainability mission, the CVM will also provide feedback on the individual-level preferences and attitudes that are likely to lead to an increased acceptance of Appalachian's sustainability effort.

In any stated preference framework such as CVM, the threat of potential hypothetical bias in survey responses is apparent. Results from early CVM applications designed to elicit WTP were met with skepticism as CVM and WTP valuation critics disputed whether respondents' stated WTP estimates approximate their true WTP. For example, Diamond and Hausman (1994) argued that stated preference responses to hypothetic scenarios do not necessarily correspond to what the individual would pay in real life, and suggested that payment responses would be less if the respondent had to actually pay for the provision at that point in time. The notion of hypothetical bias was supported by Little and Berrens (2004), Harrison (2006), and Harrison and Rutström (2008), who all suggested that WTP estimates from CVM techniques tended to overstate actual vales. To counter criticism of CVM methods and to elicit WTP values with confidence, a number of *ex ante* and/or *ex post* methods were suggested as a means to address hypothetical bias and estimate WTP values more in line with actual values (Arrow et al., 1993). As a means to control for potential hypothetical bias in our framework, we include an *ex post* calibration technique (certainty statements) (Loomis 2011).

Survey Description

The first component in the analysis is to develop a survey to be administered to a randomly chosen set of Appalachian students. The survey consists of three sections. First, students are asked a series of attitudinal questions regarding their perceptions towards sustainability in general, Appalachian's sustainability mission in particular, and REI projects. Second, they are asked questions with reference to their academic status at Appalachian and sociodemographic details. Finally, students are presented with the proposed hypothetical policy and CVM questions. Three thousand student emails were randomly drawn and provided to us by the Office of Institutional Research, Assessment, and Planning. The survey was developed in the Qualtrics, Inc, survey software package and emailed to students in April, 2016. As is standard, a survey incentive as offered to participants. Specifically, 2 iPad Minis were offered from a random drawing to students that competed the survey. From this, 599 students took the survey (a 20 percent response rate). After deleting some incomplete responses, there were 539 usable observations.

Definitions and detailed statistics for all variables used are shown in Tables 1 and 2.

Table 1. Variable Definitions

Variable	Definition
Bid	One-time dollar amount to be paid by respondent if referendum passes.
For	Equal to 1 if respondent would vote in favor of referendum for a one-time payment, 0 otherwise
Age	Age of respondent in years
Gender	Equal to 1 if respondent is male
Traditional	Equal to 1 if respondent is self-identified as dependent on financial support from family
Trad Income	Household income (thousands) if traditional student
Non-Trad Income	Household income (thousands) if non-traditional student
Trad Debt	Anticipated debt upon graduation if traditional student
Non-Trad Debt	Anticipated debt upon graduation if non-traditional student
Import Mission	Rated importance of sustainability Mission to respondent scaled from "1=Not Important At All" to "4=Very Important"
Import Watauga	Rated importance of sustainability Mission to residents of Watauga County scaled from "1=Not Important At All" to "4=Very Important"
REI	Rated importance of REI initiative to respondent scaled from "1=Not Important At All" to "4=Very Important"
Projects	Rated importance of REI Projects to respondent scaled from "1=Not Important At All" to "4=Very Important"
Labels	Rated importance to respondent of purchasing goods labeled as sustainable scaled from "1=Not Important At All" to "4=Very Important"
Recycle	Rated importance to respondent of recycling products scaled from "1=Not Important At All" to "4=Very Important"
Freshman	Equal to 1 if respondent is a freshman
Sophmore	Equal to 1 if respondent is a sophmore
Junior	Equal to 1 if respondent is a junior
Senior	Equal to 1 if respondent is a senior
Grad	Equal to 1 if respondent is a graduate student
Arts	Equal to 1 if respondent is in College of Arts and Sciences
Health	Equal to 1 if respondent is in College of Health Sciences
COB	Equal to 1 if respondent is in College of Business
Fine	Equal to 1 if respondent is in College of Fine and Applied Arts
Music	Equal to 1 if respondent is in College of Music
Ed	Equal to 1 if respondent is in College of Education

Table 2. Descriptive Statistics

Variable	Mean	Std. Dev.	Min	Max
Fee	39.84	21.29	10.00	70.00
Yes	0.71	0.45	0.00	1.00
Age	21.60	3.44	19.00	52.00
Gender	0.32	0.47	0.00	1.00
Traditional	0.78	0.41	0.00	1.00
Trad Income	83.24	43.64	5.00	150.00
Non-Trad Income	31.09	36.37	5.00	150.00
Trad Debt	14.58	14.13	0.00	40.00
Non-Trad Debt	22.39	14.13	0.00	40.00
Imp. Mission	2.98	0.80	1.00	4.00
Imp. Watauga	2.94	0.81	1.00	4.00
Imp. Projects	3.19	0.79	1.00	4.00
Labels	2.95	0.80	1.00	4.00
Recycle	3.16	0.74	1.00	4.00
Freshman	0.22	0.41	0.00	1.00
Sophmore	0.23	0.42	0.00	1.00
Junior	0.25	0.43	0.00	1.00
Senior	0.21	0.41	0.00	1.00
Grad	0.08	0.27	0.00	1.00
Arts	0.33	0.47	0.00	1.00
Health	0.21	0.40	0.00	1.00
COB	0.18	0.38	0.00	1.00
Fine	0.13	0.33	0.00	1.00
Music	0.03	0.16	0.00	1.00
Ed	0.07	0.25	0.00	1.00

The majority of students are female with an average age of 22. Most student respondents (78 percent) self-identify themselves as traditional students, which we define as being dependent on financial support from their family (as opposed to non-traditional students, which we define as self-funded individuals). The average annual household income of traditional students in our sample is $83,000, compared to $31,000 for the annual income of non-traditional students. In terms of expected debt upon graduation, traditional students anticipate an average debt of $14,500 compared to $31,000 for non-traditional students. A breakdown of respondent university status and college are also shown. The status breakdown shows that a fairly even percentage of respondents from each class were sampled. The largest percentage of sampled students (25 percent) are juniors. A further 8 percent of respondents are graduate students. Most students are in the College of Arts and Sciences (33 percent), followed by the College of Health Sciences (21 percent), and the College of Business (18 percent).

We asked respondents a series of questions regarding their attitudes toward sustainability. All attitudinal questions were on a four-point scale of importance, where 1=”Not Important At All”; 2=Somewhat Important”; 3=”Important”; and 4=”Very Important”.

The average sampled respondent rated a level of importance for Appalachian's sustainability mission to themselves and Watauga residents as "important". Similarly, they rated the importance of REI's projects as also "important", on average. A percentage breakdown of responses of is shown in Table 3.

Table 3. Importance of Appalachian's Sustainability Mission

Question	Not Important At All (%)	Somewhat Important (%)	Important (%)	Very Important (%)
Importance of Sustainability Mission to Respondent	3.2	23.2	45.8	27.9
Importance of sustainability Mission to residents of Watauga County	3.8	24.6	46.0	25.7
Rated importance of REI Projects to respondent	2.2	18.2	41.3	38.3

In the survey, the critical component is the eliciting students' willingness to pay. Within the CVM literature, different methods can be used for this purpose. For example, an open-ended method can be used where respondents are directly asked to state their willingness to pay for a non-market good. However, this elicitation method suffers from a number of shortcomings, such as incentive incompatibility. Following the Exxon Valdez oil spill, a blue-ribbon-assembled panel of economists assessed the reliability of CVM and endorsed the referendum method as the preferred procedure for CVM analyses (Arrow et al., 1993). We use the referendum method. The referendum method provides students with a hypothetical scenario of whether they would vote for a new proposal to further support REI funding. They are told that if more than 50% of students vote for the policy, then it will be put into practice.

First, respondents were told to imagine that there is a proposal for a one-time increase in their student fees of (either $10, $25, $40, $55, or $70) to further support projects under Appalachian's Renewable Energy Initiative. Then, they were informed that if the proposal were put to a vote and more than one-half of all students vote for it, Appalachian would put it into practice. In our case, the WTP question for REI funding follows a dichotomous choice framework. The variable "yes" is a qualitative variable equal to one if the students answered "for" to the question:

"*The additional funding would be used to install 100 KW PV solar panels by the physical plant on State Farm Road that would generate enough electricity to power 10 U.S. households for a year. If there was a vote today and you knew that there would be a one-time increase in your student fees of $x, would you vote for or against they proposal?"*

This project is a current proposed project at REI so we include it in the description to provide respondents with a realistic project. They were given one of four options; either to vote "For", "Against", "I Would Not Vote", or "I Don't Know". $*x* is the randomly assigned bid variable of either $10, $25, $40, $55, or $70. One problem that arises when coding dichotomous choice CVM questions is what to do with "I Would Not Vote" and "I Don't Know" responses. In the model, to be conservative, both "I Would Not Vote", or "I Don't Know" votes are re-coded as "Against" votes.

Another problem that arises with CVM surveys is the potential for hypothetical bias. Hypothetical bas exists if respondents are more likely to say that they would pay a hypothetical sum of money than they would actually pay in a real market setting. As economic values are based on actual behavior, hypothetical bias may lead to economic values that are too high. In the CVM literature, different methods have been proposed for controlling for hypothetical bias in survey responses. We decided to use an *ex post* calibration technique called certainty statements. Immediately following the referendum question, respondents were asked to indicate on a Likert scale of 1 to 10, how certain they are of their response. Research has indicated that including responses from individuals that are uncertain about the likelihood of actually paying the fee in a real situation can result in overestimating true WTP. As such, only responses from individuals who are certain that they would do what they have stated should be included in the model. Poe et al. (2002) and Vossler et al. (2003) both found that respondents who indicated that they are certain of their WTP at a level of 7 or more out of 10 had similar stated preference payment probabilities as a real WTP sample. We calculate WTP estimates for (1) the entire sample (uncorrected model); and (2) as a means for controlling for potential hypothetical bias, for only respondents who indicate a level of certainty of 7 or above to the referendum question (corrected model).

Results

Using standard CVM methodology, the survey results can be used to determine students' willingness to pay for REI funding. Shown in Table 4, as expected and consistent with economic theory, the percentage of respondents saying yes to the one-time student fee decreases as the fee rises. Even at the highest bid of $70, 59% of respondents would be willing to pay the fee.

Table 4. Bid Function

Bid	**Yes (%)**	**No (%)**
$10	76.2	23.8
$25	81.8	18.1
$40	72.6	27.4
$55	64.2	35.8
$70	59.3	40.7

As the outcome variable to the referendum question (yes/no)is binary, we use a linear probit model to examine the determinants of WTP. We estimate a probit model specification for our yes variable:

$$\Pr(Yes) = \beta_0 + \beta_1 \boldsymbol{F} + \beta_2 \boldsymbol{X}_1 + \beta_3 \boldsymbol{X}_2 + \beta_4 \boldsymbol{X}_3 + \epsilon$$

where $\boldsymbol{F}$ is the fee amount, $\boldsymbol{X}_1$ is a vector of sociodemographic variables, $\boldsymbol{X}_2$ is a vector of individual sustainability attitudes, and $\boldsymbol{X}_3$ is a vector of student status variables, and ϵ is the error term.

The model allows for an analysis of the factors that can influence student responses to the referendum vote and increase or decrease their likelihood of saying yes to the policy. Table 5 presents the results from the probit model.

Table 5. Probit Model Regression

Variable	Coefficient	Standard Error	P-Value
Constant	-0.206	0.274	0.453
Fee	-0.010	0.003	0.001
Income	0.002	0.002	0.218
Mission	0.014	0.192	0.941
Sustain	0.098	0.203	0.628
Watauga	0.019	0.144	0.897
Labels	0.174	0.165	0.292
Recycle	0.346	0.166	0.037
REI	0.715	0.199	0.000
Projects	0.335	0.201	0.095
Traditional	-0.008	0.170	0.964
Freshman	-0.261	0.149	0.080
COB	-0.295	0.159	0.063
CVM Dummy	-0.301	0.127	0.017
Log Lik	-265.7		

We interpret coefficients from a probit model as the impact on the probability of saying yes to the referendum question. For example, a negative and statistically significant coefficient means that an increase in that variable amount leads to a decrease in the

likelihood of a yes answer. Importantly, the coefficient on the fee variable is negative and statistically significant. As such, as the fee increases, the probabilities of students saying yes decreases. This is an important result as it is in line with economic thinking. We find that student status can influence response to the vote. For example, Freshmen students are less likely than the rest of the student body to vote yes to the new funding policy. This may be because the new student intake has yet to experience Appalachian's sustainability mission and so doesn't value its importance as much as more senior students. College of Business students are also less likely to say yes to the referendum vote, relative to other students.

A positive coefficient indicates that an increase in the predictor leads to an increase in the predicted probability. For example, respondents that self report that they often or always recycle are more likely to vote yes. This is also the case for students that believe the REI initiative and projects to be important.

All other variables analyzed in the model do not seem to influence the likelihood of students saying yes to the referendum vote. For example, whether an individual is considered a traditional or non-traditional student does not influence response to the referendum; nor do income levels or individual perceptions on sustainability and Appalachian's sustainability mission in particular.

Finally, the coefficient on the CVM_dummy is negative and statistically significant. Some students in the survey were informed that the proposed policy included more projects. This was included for the purposes of a scope test to examine whether students would be willing to pay more toward REI funding for additional projects. Based on these results, our scope test failed and it seems that the number of proposed projects does not increase the likelihood of students saying yes to the policy.

Mean willingness to pay estimates can be derived from the coefficients of the probit model. Here, we estimate mean student willingness to pay (and a 95% confidence interval) for both an uncorrected and corrected model.

Table 6. Mean Willingness to Pay Estimates

Model	Mean WTP	95% Lower Bound	95% Upper Bound
Uncorrected Model	$103.45	$77.69	$201.88
Corrected Model	$58.45	$42.24	$113.99

Table 6 shows that in a standard uncorrected model, mean student willingness to pay for additional REI funding is approximately $103. However, once we account for potential hypothetical bias (corrected model), mean student willingness to pay declines to about $58. Recall that the one-time student fee is on top of the existing annual $10 fee ($40 in total). This implies that a conservative estimate of the economic value derived by students from REI's sustainable energy efficient projects is $98. So, every student that comes through Appalachian values the sustainability mission, on average, at $98. With a

freshman enrollment count of approximately 3,000 students, this implies an annual value to Appalachian's sustainability mission of $294,000.

Conclusion

Appalachian's commitment to sustainable practices has enabled it to position itself as a leader in suitability among U.S. institutions. Central to its sustainability mission is the development and construction of on-campus energy efficient projects. While the costs of the REI projects are known, the benefit, or economic value, to Appalachian is not. This report examines the benefit of REI projects to Appalachian's student body.

Using responses from 599 completed surveys of current students, we capture the value of the REI projects to students though the contingent valuation method. Students are asked to vote for or against a new policy for a one-time increase in student fees beyond the existing annual $10 payment that supports REI. Results from a linear probit model suggest students that believe the REI initiative and projects are important are more likely to vote in favor of the policy. However, freshman and COB students are more likely to vote against the policy.

The economic value that Appalachian students derive from the sustainability mission is estimated through their willingness to pay for REI projects. After controlling for potential hypothetical bias in survey responses, students' average willingness to pay for the one-time payment is estimated at $58. Recall, this one-time value is in addition to the existing annual $10 fee paid by students to support current REI projects.

There are different ways to think about aggregate values:

1) In terms of a one-time snapshot aggregate value, then each year students pay $10 in fees toward existing projects. Our results indicate that they will pay $58 in fees in addition to this for new projects. As such a one-time snapshot aggregate value of Appalachian's sustainability mission to students is approximately $1.22 million.
2) For a rolling annual valuation, with approximately 4,500 new students every year (consisting of 3,049 freshmen and 1,489 transfer students), an annual rolling economic value would be $441,000.[1]

Finally, the focus of this research is to estimate and report the economic value of Appalachian's sustainability mission to Appalachian State students. There are other subgroups connected to Appalachian that may also derive benefit from REI projects. For example, faculty employed by the university as well as local residents and alumni. We do not include these groups in this analysis. Including the economic value to these groups would increase the overall estimate.

[1] Freshmen and transfer student the counts are based on 2015 data.

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