Willingness to Pay for Renewable Energy – A Longitudinal Study

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Introduction

Renewable Energy (RE) is widely accepted as the key path to arrest CO_2 emissions from electricity generation, which in turn will help slow global warming and climate change. In the long term, fuel free electricity will be cheaper than current fossil fuel generation; however, in the short and perhaps medium term, there are additional costs in ramping up RE sources, costs that need to be paid somehow. In the current regulatory environment, most of those expenses would be passed on to the consumer, the power company customers. Consumer's willingness to pay (WTP) depends upon numerous factors, and many customers are not willing to pay any additional amount. WTP for RE could also change over time, and the socio-economic factors influencing that change are the focus of this research.

Who should care about the level of WTP for RE? First national, state and local officials are entrusted with balancing competing societal needs and fashioning policies which are equitable across the population which they serve. In this case, understanding society's WTP for more RE in the generation mix helps craft policies that can balance higher utility bills with action on climate change. Regulators, who are charged with overseeing monopoly utilities, their generation plans, investments and pricing, would benefit from understanding the propensity to pay for more RE energy. Utility companies, be they vertically integrated or generators only, must make long term plans for facilities that will provide electricity for decades to come. Making these investments with RE in the mix, either with or without a legislative mandate, requires an understanding of consumer WTP sentiment. Understanding the underlying factors that drive WTP can help all parties anticipate acceptance of any additional costs for RE.

Literature Review

There have been numerous previous studies into WTP for RE. Some have been very narrow, based upon specific geography or RE programs. Other have been broader in scope and have proposed certain factors that influence their respondent's WTP, mostly age and political party affiliation based. Pew Research (2017) found that younger adults and Democrats tend to believe in government regulations to increase RE provision, but the question of how to pay was not raised. This was a single point in time survey in May 2017 sampling US adults (n=1,012) via cell or landline telephones.

In December 2018 Leiserwitz et. al. published Energy in the American Mind, a joint report issued by the Yale Program on Climate Change Communication and the George Mason University Center for Climate Change Communication. This study represents the most recent and comprehensive snapshot of public attitudes towards many issues in energy policy. Research was conducted on a nationally representative sample of adults (N=1,114) querying attitudes on clean or renewable energy sources, health impacts of burning fossil fuels, availability of 100% clean energy and the relative costs of different energy sources. There were also questions pertaining to WTP for RE where around half of Americans would pay more for 100% renewable power, although party affiliation comes into play here with Republicans much less likely to pay more than Democrats. The median amount of those that would pay additional was $15 per month. Of course, this also means that about half of Americans would not pay additional for electricity generated from RE sources.

More recently still, Gustafson et. al. (2019), the authors of the Yale/GMU study, issued an update on WTP for RE. In this update (N=1,291), it is noted that while 85% of

Americans favored requiring electric utilities to switch over to RE, only 38% believed that wind or solar are cheaper. This led to the conclusion that many people would be willing to pay for RE, which may or may not be true. This update calculated the average amount all customers would be willing to pay for RE at $16.25 per month, this number included about half of the respondents indicating no WTP. The average for those who would pay an additional amount was $33.72 per month. The study showed that propensity to pay for RE, and the amount people are willing to pay, does not appear to be a function of income (i.e. the ability to pay) but depends more on political affiliation, age and education. Younger adults, Democrats, and those with a college degree show more inclination to pay for RE. Those earning below $50,000 had a similar WTP for RE as participants with incomes above $150,000, and both groups were very close to the average WTP of $16.25 per month. Race was also considered but did not prove to be a strong indicator, with black, Hispanic, white and other races showing similar WTP.

One obvious factor behind a person's WTP for RE is belief and views on global warming and climate change. Borick and Rabe (2014) cite studies which indicate that "partisan affiliations and ideological leanings" might be the strongest factor behind an individual's belief that global warming is occurring. The same study suggested that certain demographic aspects exhibit mixed results when attempting to predict belief in global warming. Higher educational achievement, age and gender are often cited, with those having college degrees or above, younger people and females usually expected to show more belief in climate change. However, Borick and Rabe point out that some studies, from various years, show somewhat contradictory results.

The data used in this study starts in 2008, deep in the Great Recession that started in 2007 and lasted until well into 2009. No studies exist which examine the direct impact on WTP for RE from recessionary times, however Cho et. al. (2011) studied inclination to pay for environmental landscape amenities such as water views and forest space. In normal times these features would seem desirable and valuable, and indeed the study found that to be the case, and that once the recession hit people's propensity to pay for such amenities diminished. The Cho study did not measure a rebound in the inclination to pay for these features once the recession ended but expected a rebound once the economy recovered.

Does the WTP for RE change over time? What drives this change, if indeed one exists? Does the influence of a person being female, college educated, wealthy, Democratic or young trend over time, or is the impact the same regardless of survey date? Do societal or economic events have more influence over WTP for RE?

Data and Methodology

The main dataset is entitled the National Surveys on Energy and Environment (NSEE) and is produced in a partnership between the Muhlenberg Institute of Public Opinion at Muhlenberg College and the Center for Local, State, and Urban Policy at the University of Michigan's Gerald R. Ford School of Public Policy. The NSEE consistently surveys national opinion on issues directly related to climate change, along with other ecological topics such as hydraulic fracturing ("fracking") and views on environmental public policy. Funding is provided by the general revenues of both the Muhlenberg College and the University of Michigan. The NSEE annually surveys a randomly selected sample of adult (aged 18 or above) US resident participants using either land

line or cell phones, the sampling frame of US telephone numbers provided by Marketing Systems Group in Pennsylvania. The sample data includes, and is weighted by age, race, educational attainment, income, and gender to reflect population parameters for these factors provided by the United States Census Bureau. The survey also parses participants and responses into four regions based upon the state of residence, the regions being the Northeast, South, Midwest and West which facilitates a more granular view of WTP by region. The respondent's political affiliation is also captured. Respondents are given the option to refuse a question, or to respond with "not sure", and in these instances the response was dropped for the analysis. The survey started in 2008 with the latest dataset from 2018, and the N has varied from a low of 358 (Fall 2008) to a high of 823 (Fall 2009) with a mean N of 579. Given the variance in N there is no single margin of error, however an N of 579 would have a margin of error of +/- 4.1% at a 95% confidence level.

NSEE runs the survey in the fall, however there have been three years (2013, 2017 and 2018) where a spring edition has been conducted. For consistency, only the fall editions have been included in this study. It may be that respondents could have different views on energy in contrasting seasons of the year.

Independent Variables of Interest

The NSEE has asked many questions in the same manner over the life of the survey which facilitates the longitudinal approach. The following data points have been selected as IVs in this study:

Education (>HS, HS graduate, some college, college graduate, graduate degree)

Gender (Male, Female)

Family Income (<$20k, $20k-$40k, $40k-$60k, $60k-$80k, $80k-$100k, >$100k)

Age (18-29, 30-44, 45-64, 65+)

Political Affiliation (Democrat, Republican, Independent, Other)

For the purposes of the analysis, education was recoded into two categories, college graduate or not. Independents and those selecting other in political affiliation were combined into one category. Proportions of respondents in each category, by survey year, are shown in Tables One and Two:

Table One – IV Categorical Proportions by Survey Year

	College	Gender	Family Income					
Survey	Graduate	Males	<$20k	$20k-$40k	$40k-$60k	$60k-$80k	$80k-$100k	>$100k
F_2008	53.6%	42.2%	10.9%	17.6%	19.6%	14.0%	13.4%	24.6%
F_2009	53.0%	31.5%	7.9%	20.9%	23.1%	19.7%	13.0%	15.4%
F_2010	47.1%	46.2%	12.4%	22.3%	20.3%	15.1%	9.2%	20.6%
F_2011	46.6%	53.4%	13.0%	22.1%	23.2%	17.0%	12.0%	12.7%
F_2012	48.2%	52.6%	13.0%	23.3%	19.1%	15.7%	8.2%	20.7%
F_2013	39.1%	52.3%	17.6%	31.7%	21.5%	12.7%	5.0%	11.5%
F_2014	47.9%	50.8%	13.8%	20.6%	24.4%	16.8%	7.8%	16.6%
F_2015	49.5%	55.6%	9.1%	18.4%	19.3%	22.5%	12.3%	18.4%
F_2016	45.5%	60.7%	11.3%	21.5%	18.1%	16.2%	12.4%	20.5%
F_2017	52.5%	56.8%	10.2%	15.6%	15.4%	18.4%	11.7%	28.8%
F_2018	51.6%	54.3%	9.2%	17.4%	16.1%	18.9%	12.5%	25.9%
All Years	**48.5%**	**50.1%**	**11.6%**	**21.2%**	**20.2%**	**17.2%**	**10.7%**	**19.2%**

Table Two – IV Categorical Proportions by Survey Year

	Age Group				Political Affiliation		
Survey	Age 18-29	Age 30-44	Age 45-64	Age 65+	Democrats	Republican	Ind/Other
F_2008	9.2%	23.5%	45.5%	21.8%	36.9%	27.7%	35.5%
F_2009	22.0%	34.3%	37.5%	6.2%	36.9%	27.7%	35.4%
F_2010	6.3%	15.4%	46.8%	31.5%	36.5%	30.7%	32.7%
F_2011	9.3%	22.0%	41.1%	27.6%	37.4%	27.1%	35.5%
F_2012	9.9%	20.1%	39.6%	30.4%	38.4%	25.6%	35.9%
F_2013	8.8%	21.0%	42.0%	28.2%	37.3%	27.2%	35.5%
F_2014	11.3%	17.9%	36.2%	34.6%	38.8%	26.4%	34.8%
F_2015	17.7%	15.6%	35.3%	31.4%	35.3%	27.5%	37.2%
F_2016	24.6%	21.8%	29.0%	24.6%	33.7%	28.5%	37.8%
F_2017	14.8%	22.1%	37.7%	25.4%	31.5%	28.2%	40.3%
F_2018	20.4%	18.7%	31.0%	29.9%	29.5%	29.4%	41.1%
All Years	**14.6%**	**21.5%**	**38.1%**	**25.8%**	**35.7%**	**27.9%**	**36.4%**

Dependent Variable

The NSEE has consistently asked the following question in its research:

QUESTIONNAIRE TEXT: If it required you to pay extra money each year in order for more renewable energy to be produced, how much would you be willing to pay? Would you be willing to pay...

1	Nothing
2	$1-$50 per year
3	$50-$100 per year
4	$100-$250 per year
5	$250-$500 per year
6	Over $500 per year
98	Not sure
99	Refused

Responses to this question can be viewed in two ways, either that participants are willing to pay nothing or something, then also the specific amounts. WTP for RE is posited as a function of the five independent variables listed above. Over time both views of this measure shift and examining the relationship between this variance in WTP over time with changes in the independent variables will provide insight into the relationship. Table Three shows the proportion of responses in the six categories by year of survey:

Table Three – Distribution of DV Responses by Survey Year

	Amount Respondents Were Willing to Pay Per Year					
Survey	$0	$1-$50	$50-$100	$100-$250	$250-$500	>$500
F_2008	21.5%	17.3%	21.2%	15.9%	12.8%	11.2%
F_2009	30.5%	33.3%	16.0%	14.1%	3.5%	2.6%
F_2010	36.4%	27.4%	17.9%	8.3%	6.4%	3.7%
F_2011	42.2%	23.2%	16.7%	9.8%	4.7%	3.3%
F_2012	32.7%	26.0%	18.7%	11.9%	4.4%	6.3%
F_2013	48.0%	18.9%	17.4%	8.6%	5.5%	1.5%
F_2014	46.1%	19.1%	18.9%	8.0%	4.4%	3.5%
F_2015	35.6%	23.3%	24.4%	10.2%	3.5%	3.0%
F_2016	37.9%	24.5%	16.6%	10.3%	6.0%	4.7%
F_2017	33.4%	18.2%	15.8%	12.1%	10.8%	9.8%
F_2018	35.0%	19.8%	18.9%	13.9%	7.5%	4.8%
All Years	**36.6%**	**23.5%**	**18.2%**	**11.1%**	**6.0%**	**4.6%**

In 2013 the NSEE slightly changed the way this question was asked. Half of the participants heard the normal query, with the response choices segmented as above. The other half of the participants were asked for a dollar amount without any guidance, although the NSEE subsequently recoded the responses into the usual categories.

Data is available for 11 individual surveys beginning in 2008 and running until 2018. Each individual year is a cross sectional dataset with individual respondent being the unit of observation. However, the consistency over the study period allows for longitudinal analysis.

The IVs are all ordinal variables, as is the DV, so to facilitate an ordered logistic regression, each IV was recoded as a set of dummy variables, with a one indicating a positive response for that category. That resulted in a total of 15 separate variables, which produced this stochastic equation for the model:

$$WTP = \beta_0 + \beta_1 * college\ graduate + \beta_2 * gender + \beta_3 * income <\$20k + \beta_4 * income\ \$20k\text{-}\$40k + \beta_5 * income\ \$40k\text{-}\$60k + \beta_6 * income\ \$60k\text{-}\$80k + \beta_7 * income\ \$80k\text{-}\$100k + \beta_8 * income >\$100k + \beta_9 * age\ 18\text{-}29 + \beta_{10} * age\ 30\text{-}44 + \beta_{11} * age\ 45\text{-}64 + \beta_{12} * age\ 65\ over + \beta_{13} * Democrat + \beta_{14} * Republican + \beta_{15} * Ind/Other + u$$

Each individual survey iteration was analyzed using the STATA Ordered Logistic Regression (ologit) function, with the DV as the willingness to pay variable, which has outcomes 1 to 6. College Graduate and Gender IVs were already classified as binary (college graduate = 1, non = 0 and female = 0, male =1) and in order to place one option from age, income and political affiliation at the intercept age 18-29, income <$20k, and political affiliation of Republican were omitted in the model. Once the ologit

function completed each DV outcome was run through the marginal effects analysis (mfx) to ascertain the marginal effect of each variable on the particular DV outcome, relative to the appropriate omitted variable.

Results

The first test of the model was to look at the predicted outcome of proportions by year and by DV outcome based upon the included IVs based upon the overall marginal effects predictions. Those results are shown in Table Four. The marginal effects model tended to overestimate the responses in DV outcomes two and three ($1 - $50 and $50 - $100 respectively) and underestimate the responses in the other four categories. Each specific IV also has a marginal effects predictor from the model that can be compared to the omitted category and to itself over time. Those results are summarized in Table Five.

Table Four – Model Estimates for DV Outcomes by Year

	Amount Respondents Were Willing to Pay Per Year					
Year	$0	$1-$50	$50-$100	$100-$250	$250-$500	>$500
2008	17.6%	18.7%	25.1%	17.5%	12.2%	8.9%
2009	28.9%	36.1%	16.7%	13.2%	3.0%	2.1%
2010	33.6%	31.4%	19.5%	7.6%	5.3%	2.7%
2011	40.8%	26.0%	17.7%	9.0%	3.9%	2.6%
2012	29.6%	30.1%	21.1%	11.1%	3.5%	4.6%
2013	47.4%	21.4%	18.0%	7.7%	4.4%	1.2%
2014	44.7%	21.2%	20.1%	7.6%	3.7%	2.7%
2015	34.3%	27.4%	24.7%	8.6%	2.8%	2.2%
2016	36.5%	26.0%	17.6%	10.2%	5.6%	4.1%
2017	30.0%	21.1%	18.6%	13.0%	10.0%	7.4%
2018	32.9%	22.9%	21.0%	13.2%	6.3%	3.6%

The results show the first year, 2008, the last year available, 2018 and 2010 which is included as it is the first year after the Great Recession ended. The dy/dx value

included is the marginal effect of changing the variable from zero to one. So, for instance the 2008 marginal effect of being a college graduate on responding to the WTP question with a one (i.e. not willing to pay additional for RE) is -0.085851 indicating that a college graduate is less likely than a non college graduate to make that response. For a WTP response of six (i.e. willing to pay $500 or more per year) a college graduate shows a marginal effect of 0.046612 suggesting that a graduate would be more likely to select this response than a non graduate. The marginal effects for other IVs are relative to the omitted variables, except for gender, which measures the effect of being male rather than female. Of particular note is that every IV is less likely to chose zero (WTP = 1) when comparing 2010 to the 2008 results. This would indicate that the end of the recession, late in 2009, had the expected impact on peoples WTP or RE, i.e. that willingness would increase, suggesting that WTP is correlated with economic well-being. The outcomes that saw an increase from the reduction in WTP = 1 appeared to be mostly WTP = 3 ($50 - $100) and WTP = 4 ($100 - $250). Since 2010 however there has been a slight trend back toward the lower levels of WTP looking at all the IVs together. Full results for all years and IVs are included in appendix one.

College Graduate IV

College graduates show a pronounced tendency to support higher WTP for RE across all years, with negative marginal effects relative to non graduates in the lower WTP outcomes of the DV. That tendency has certainly moderated over the last few years but is still evident in the marginal effects (see appendix one for complete results). Consistent with results shown by Gustafson et. al. (2019) higher education is correlated with a higher propensity to pay for RE.

Table Five – Marginal Effects by IV for Selected Years

Marginal effects after ologit

	WTP = 1 ($0)				WTP = 2 ($1 - $50)				WTP = 3 ($50 - $100)			
	Fall 2008	Fall 2010	Fall 2018		Fall 2008	Fall 2010	Fall 2018		Fall 2008	Fall 2010	Fall 2018	
IV:	dy/dx	dy/dx	dy/dx		dy/dx	dy/dx	dy/dx		dy/dx	dy/dx	dy/dx	
college graduate	-0.085851 *	-0.119819 *	-0.038809		-0.048915 *	-0.003646	-0.004471		-0.001738	0.051201 *	0.012081	
gender	-0.026606	-0.040990	0.052135		-0.015994	-0.001036	0.006341		-0.001337	0.017663	-0.016075	
age 30-44	0.043076	0.004964	0.029241		0.023530	0.000079	0.002806		-0.000923	-0.002139	-0.009316	
age 45-64	0.079423	0.016236	0.105418 *		0.045248	0.000314	0.007522		0.001432	-0.006997	-0.034093	
age 65 over	0.142769 *	0.091949	0.132247 *		0.061494 *	-0.002361	0.007570		-0.018069	-0.039096	-0.043092 *	
income $20k - $40k	-0.104931 *	-0.146613 *	-0.014244		-0.076510 *	-0.021938	-0.001818		-0.030862	0.061863 *	0.004372	
income $40k - $60k	-0.131236 *	-0.165670 *	-0.162626 *		-0.097615 *	-0.029896	-0.041528		-0.045386	0.068864 *	0.036354 *	
income $60k - $80k	-0.166895 *	-0.247978 *	-0.164088 *		-0.137684 *	-0.081926	-0.039902		-0.097234 *	0.087650 *	0.038013 *	
income $80k - $100k	-0.160518 *	-0.269098 *	-0.210742 *		-0.132369 *	-0.121661 *	-0.068480 *		-0.091729 *	0.074824 *	0.032342 *	
income > $100k	-0.222105 *	-0.301917 *	-0.307529 *		-0.162434 *	-0.097911 *	-0.087202 *		-0.097365 *	0.099341 *	0.046336 *	
democrat	-0.080809 *	-0.182290 *	-0.255649 *		-0.050676 *	-0.017005	-0.059656 *		-0.008266	0.076674 *	0.054784 *	
ind/other	-0.036072	-0.122247 *	-0.197548 *		-0.022129	-0.010279	-0.029927 *		-0.002503	0.052306 *	0.055233 *	

	WTP = 4 ($100 - $250)				WTP = 5 ($250 - $500)				WTP = 6 (over $500)			
	Fall 2008	Fall 2010	Fall 2018		Fall 2008	Fall 2010	Fall 2018		Fall 2008	Fall 2010	Fall 2018	
IV:	dy/dx	dy/dx	dy/dx		dy/dx	dy/dx	dy/dx		dy/dx	dy/dx	dy/dx	
college graduate	0.040795 *	0.031587 *	0.015544		0.049097 *	0.025878 *	0.009529		0.046612 *	0.014799 *	0.006125	
gender	0.012914	0.010720	-0.021041		0.015881	0.008700	-0.012986		0.015143	0.004944	-0.008374	
age 30-44	-0.020677	-0.001282	-0.011442		-0.023483	-0.001036	-0.006894		-0.021523	-0.000587	-0.004395	
age 45-64	-0.037852	-0.004213	-0.039992 *		-0.045347	-0.003407	-0.023775 *		-0.042905	-0.001932	-0.015081 *	
age 65 over	-0.063788 *	-0.022506	-0.049271 *		-0.065237 *	-0.017916	-0.029069 *		-0.057169 *	-0.010071	-0.018386 *	
income $20k - $40k	0.045280 *	0.044593 *	0.005791		0.077945 *	0.038949 *	0.003585		0.089079	0.023147 *	0.002314	
income $40k - $60k	0.052041 *	0.052134 *	0.075013 *		0.100032 *	0.046533 *	0.054582 *		0.122164 *	0.028035 *	0.038205	
income $60k - $80k	0.037432	0.089688 *	0.074867 *		0.137478 *	0.091889 *	0.053740 *		0.226904 *	0.060677 *	0.037371 *	
income $80k - $100k	0.038989 *	0.105060 *	0.101143 *		0.133167 *	0.122453 *	0.083338 *		0.212459 *	0.088422 *	0.062399 *	
income > $100k	0.053046 *	0.107413 *	0.138232 *		0.161304 *	0.114726 *	0.118306 *		0.267553 *	0.078348 *	0.091857 *	
democrat	0.038353 *	0.052003 *	0.113785 *		0.050784 *	0.044483 *	0.085438 *		0.050613 *	0.026135 *	0.061298 *	
ind/other	0.017477	0.034441 *	0.082115 *		0.021995	0.028961 *	0.054034 *		0.021231	0.016818 *	0.036093 *	

dy/dx is for discrete change of dummy variable from 0 to 1

* significant at 0.05 level

Age IV

Younger respondents show a greater willingness to pay for RE based upon the evidence in this data. With very few exceptions older age groups are more likely to opt for WTP outcome indicating no propensity to pay additional for RE. Additionally, very few older age groups show a positive marginal effect over their younger cohorts when considering the higher levels of WTP. This runs somewhat counter to the results from Gustafson (2019) who saw the 30 to 44-year age group having the highest WTP for RE, although the same study did show the 18 to 29-year age group having a higher than average WTP. Those 65 and above appear strongly opposed to paying for RE.

Political Affiliation IV

Consistent with Gustafson (2019), those with Democrat affiliations have a higher propensity to pay for RE than Republicans. This is consistent throughout the study period. Respondents identifying as Independent or Other are also more willing to pay for RE than Republicans. With this IV, the differences are starker at the extremes; Democrats and Independent/Other are highly unlikely to appear in WTP outcome one ($0) and more likely than Republicans to appear in WTP outcome six ($500 or more). Over time this relationship was consistent, with two exceptions. In 2013 the gap narrowed significantly for all DV outcomes for both Democrats and Independent/Other perhaps caused by Republicans temporarily becoming environmentally aware since 2013 saw the publication of the IPCC's seminal report on climate change which garnered considerable press coverage on global warming. In 2017 the gap widened again considerably, perhaps as a reaction to the 2016 election.

Income IV

Unsurprisingly those with higher incomes are more likely to agree to paying more for RE. In all years, especially at the higher levels of WTP, those with greater incomes showed positive marginal effects relative to respondents in the lowest income category.

Gender IV

Borick and Rabe (2014) suggested that gender might be a contributing factor to WTP, although they did cite contradictory studies. This analysis finds no evidence that gender has any impact on willingness to pay for RE. The marginal effects of changing male to female moved from positive to negative randomly and none of the results were statistically significant. Female respondents tended to be slightly more Democrat affiliated, a little older than male respondents, more likely to have lower income, and equally likely to be college educated. The total dataset of all years (N = 6,373) had an almost exactly 50:50 gender split.

Caveats

There are a few potential problems with the analysis. First, there might be a heteroskedasticity issue given the wide range of the DV. At very high levels (i.e. when respondents are willing to pay over $500 per year) other variables not included in the model, for instance wealth, might have an impact. There is also no demographic data on marriage or family make-up, potentially respondents with children might display a more environmentally amenable response.

Conclusion

This research set out to examine the variables that influence a respondent's willingness to pay additional in order that additional renewable energy may be produced, presumably to help combat climate change and global warming. The data points to college education and youth being indicators of that willingness, with a Democrat affiliation also having an effect. Unsurprisingly, respondents with higher incomes also have a greater propensity to pay for RE. Gender does not seem, based on this analysis, to have an impact. Thus non college graduates, older citizens, those of limited incomes, and Republican affiliates have a lower propensity to pay for renewable energy provision. However, other than the shift coming out of the Great Recession in 2010 when all respondents showed an increased willingness to at least pay some amount towards greater RE, and the above mentioned political affiliation variances, the longitudinal aspect of the research has not revealed any discernable trends over time, indicating that the factors influencing the willingness to pay for renewable energy are not changing over time, despite changing societal and political climates. This apparent lack of change over time seems counter-intuitive given the increased attention to the issue of global warming in recent years. However, belief or skepticism in climate change over the last decade or so also does not seem to have an impact, so it may be good news for policy makers, regulators and utility companies that those with a propensity to pay more for renewable energy retain that willingness over time. The focus of persuasion clearly needs to be on the unwilling, older people without college degrees, who also might be Republican. Hopefully the NSEE will continue to make this data available for further longitudinal study.

References

Borick, C., & Rabe, B. (2010). A Reason to Believe: Examining the Factors that Determine Individual Views on Global Warming *. *Social Science Quarterly, 91(3),* 777-800.

Borick, C., & Rabe, B. (2014). Weather or Not? Examining the Impact of Meteorological Conditions on Public Opinion regarding Global Warming. *Weather, Climate, and Society, 6*(3), 413-424.

Cho, S., Kim, S., & Roberts, R. (2011). Values of environmental landscape amenities during the 2000-2006 real estate boom and subsequent 2008 recession. *Journal of Environmental Planning and Management: Landscape Valuation and Planning, 54*(1), 71-91.

Dunlap, R., & Mccright, A. (2008). A Widening Gap: Republican and Democratic Views on Climate Change. *Environment: Science and Policy for Sustainable Development, 50*(5), 26-35.

Gustafson, A., Goldberg, M., Rosenthal, S., Kotcher, J., Maibach, E., & Leiserowitz, A. (2019). *Who is willing to pay more for renewable energy?* Yale University and George Mason University. New Haven, CT: Yale Program on Climate Change Communication. URL https://climatecommunication.yale.edu/publications/who-is-willing-to-pay-more-for-renewable-energy/

Hamilton, L. (2011). Education, politics and opinions about climate change evidence for interaction effects. *Climatic Change, 104*(2), 231-242.

IPCC, 2013: Summary for Policymakers. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Lachapelle, E., Borick, C., & Rabe, B. (2012). Public Attitudes toward Climate Science and Climate Policy in Federal Systems: Canada and the United States Compared. *Review of Policy Research, 29*(3), 334-357.

Leiserowitz, A., Maibach, E., Rosenthal, S., Kotcher, J., Gustafson, A., Bergquist, P., Ballew, M., & Goldberg, M. (2018). *Energy in the American Mind, December 2018*. Yale University and George Mason University. New Haven, CT: Yale Program on Climate Change Communication.

Mccright, A. (2010). The effects of gender on climate change knowledge and concern in the American public. *Population and Environment, 32*(1), 66-87.

Mccright, A., & Dunlap, R. (2011). The Politicization of Climate Change and Polarization in the American Public's Views of Global Warming, 2001-2010. *The Sociological Quarterly, 52*(2), 155-194.

Pew Research Center, May 2017, “Public Divides Over Environmental Regulation and Energy Policy”

Zia, A., & Todd, A. (2010). Evaluating the effects of ideology on public understanding of climate change science: How to improve communication across ideological divides? *Public Understanding of Science, 19*(6), 743-761.

Appendix One – Full Marginal Effects Results, All Years, All IVs

Marginal effects after ologit

WTP = 1

IV:	F_2008 dy/dx		F_2009 dy/dx		F_2010 dy/dx		F_2011 dy/dx		F_2012 dy/dx		F_2013 dy/dx		F_2014 dy/dx		F_2015 dy/dx		F_2016 dy/dx		F_2017 dy/dx		F_2018 dy/dx	
college graduate	-0.085851	*	-0.102693	*	-0.119819	*	-0.075713		-0.101257	*	-0.173429	*	-0.219443	*	-0.122963	*	-0.106749	*	-0.073394	*	-0.038809	
gender	-0.026606		0.034236		-0.040990		0.018011		-0.011090		0.072522		0.008346		0.040232		0.004691		0.027280		0.052135	
age 30-44	0.043076		0.081943	*	0.004964		0.151005		0.066842		0.136565		-0.011508		0.103073		0.105149	*	-0.073843		0.029241	
age 45-64	0.079423		0.120596	*	0.016236		0.139844	*	0.040389		0.193407	*	0.062420		0.200620	*	0.164304	*	0.054933		0.105418	*
age 65 over	0.142769	*	0.147702	*	0.091949		0.193546	*	0.075450		0.256277	*	-0.003847		0.158644	*	0.112540	*	0.069185		0.132247	*
income $20k - $40k	-0.104931	*	0.003478		-0.146613	*	-0.107175		-0.059092		-0.199866	*	-0.149901	*	-0.061038		-0.079366		-0.154842	*	-0.014244	
income $40k - $60k	-0.131236	*	-0.047726		-0.165670	*	-0.286935	*	-0.186150	*	-0.301643	*	-0.201758	*	-0.257243	*	-0.166438	*	-0.199821	*	-0.162626	*
income $60k - $80k	-0.166895	*	-0.052535		-0.247978	*	-0.312071	*	-0.228767	*	-0.322167	*	-0.197915	*	-0.271659	*	-0.094939		-0.238137	*	-0.164088	*
income $80k - $100k	-0.160518	*	-0.121597	*	-0.269098	*	-0.186808	*	-0.218098	*	-0.216997	*	-0.186313	*	-0.284737	*	-0.134266	*	-0.292579	*	-0.210742	*
income > $100k	-0.222105	*	-0.107356	*	-0.301917	*	-0.320228	*	-0.276541	*	-0.349073	*	-0.332058	*	-0.291477	*	-0.215243	*	-0.345973	*	-0.307529	*
democrat	-0.080809	*	-0.219793	*	-0.182290	*	-0.266211	*	-0.277955	*	-0.103967	*	-0.175160	*	-0.184761	*	-0.129258	*	-0.243516	*	-0.255649	*
ind/other	-0.036072		-0.135260	*	-0.122247	*	-0.174668	*	-0.192959	*	0.010126		-0.062171		-0.114692	*	-0.068875		-0.215420	*	-0.197548	*

dy/dx is for discrete change of dummy variable from 0 to 1 * significant at 0.05 level

Marginal effects after ologit

WTP = 2

IV:	F_2008 dy/dx		F_2009 dy/dx		F_2010 dy/dx		F_2011 dy/dx		F_2012 dy/dx		F_2013 dy/dx		F_2014 dy/dx		F_2015 dy/dx		F_2016 dy/dx		F_2017 dy/dx		F_2018 dy/dx	
college graduate	-0.048915	*	-0.009829		-0.003646		0.005845		-0.016138		0.018517	*	0.017511	*	-0.006103		-0.002384		-0.013538		-0.004471	
gender	-0.015994		0.002895		-0.001036		-0.001469		-0.001714		-0.009842		-0.000758		0.002195		0.000059		0.005306		0.006341	
age 30-44	0.023530		0.004936		0.000079		-0.023806		0.006147		-0.026205		0.000979		-0.003523		-0.005404		-0.017748		0.002806	
age 45-64	0.045248		0.006289		0.000314		-0.014677		0.005707		-0.030251	*	-0.006476		-0.004272		-0.009899		0.009534		0.007522	
age 65 over	0.061494	*	-0.014250		-0.002361		-0.030528		0.008104		-0.052830	*	0.000346		-0.003363		-0.005522		0.010388		0.007570	
income $20k - $40k	-0.076510	*	0.000365		-0.021938		0.002082		-0.012402		0.015540	*	0.002382		-0.006111		-0.005186		-0.050439	*	-0.001818	
income $40k - $60k	-0.097615	*	-0.007684		-0.029896		-0.027393		-0.068992	*	-0.003823		0.000318		-0.071890	*	-0.024193		-0.073368	*	-0.041528	
income $60k - $80k	-0.137684	*	-0.009156		-0.081926		-0.052653	*	-0.106324	*	-0.026904		-0.004951		-0.070897	*	-0.008500		-0.089467	*	-0.039902	
income $80k - $100k	-0.132369	*	-0.038158		-0.121661	*	-0.015378		-0.119418	*	-0.007535		-0.009425		-0.111237	*	-0.018719		-0.141447	*	-0.068480	*
income > $100k	-0.162434	*	-0.029284		-0.097911	*	-0.071404	*	-0.125655	*	-0.040440		-0.039040		-0.093670	*	-0.037206		-0.112955	*	-0.087202	*
democrat	-0.050676	*	-0.047939	*	-0.017005		0.002460		-0.067851	*	0.012249	*	0.010029		-0.021950		-0.007860		-0.068947	*	-0.059656	*
ind/other	-0.022129		-0.025347	*	-0.010279		0.004984		-0.046468	*	-0.001428		0.004702		-0.009917		-0.002123		-0.048862	*	-0.029927	*

dy/dx is for discrete change of dummy variable from 0 to 1 * significant at 0.05 level

Marginal effects after ologit

WTP = 3

	F_2008	F_2009	F_2010	F_2011	F_2012	F_2013	F_2014	F_2015	F_2016	F_2017	F_2018
IV:	dy/dx	dy/dx	dy/dx	dy/dx	dy/dx	dy/dx	dy/dx	dy/dx	dy/dx	dy/dx	dy/dx
college graduate	-0.001738	0.038541 *	0.051201 *	0.028334	0.040887 *	0.068623 *	0.090371 *	0.064176 *	0.033922 *	0.013528	0.012081
gender	-0.001337	-0.012949	0.017663	-0.006758	0.004537	-0.029003	-0.003513	-0.021189	-0.001511	-0.004919	-0.016075
age 30-44	-0.000923	-0.030727 *	-0.002139	-0.055669 *	-0.027515	-0.054064	0.004840	-0.053183	-0.034373	0.010972	-0.009316
age 45-64	0.001432	-0.044856 *	-0.006997	-0.051966 *	-0.016544	-0.076501 *	-0.026266	-0.102355 *	-0.053331 *	-0.010524	-0.034093
age 65 over	-0.018069	-0.052483 *	-0.039096	-0.070980 *	-0.030963	-0.099981 *	0.001619	-0.081548 *	-0.036732 *	-0.014092	-0.043092 *
income $20k - $40k	-0.030862	-0.001320	0.061863 *	0.039745	0.023651	0.078283 *	0.061075 *	0.032135	0.024688	0.010822	0.004372
income $40k - $60k	-0.045386	0.018130	0.068864 *	0.093935 *	0.061544 *	0.108687 *	0.080637 *	0.114787 *	0.046835 *	0.003571	0.036354 *
income $60k - $80k	-0.097234 *	0.019945	0.087650 *	0.090888 *	0.059458 *	0.104833 *	0.077728 *	0.121806 *	0.028925	-0.001212	0.038013 *
income $80k - $100k	-0.091729 *	0.044294 *	0.074824 *	0.065121 *	0.045377 *	0.079367 *	0.071861 *	0.100747 *	0.038571 *	-0.051506 *	0.032342 *
income > $100k	-0.097365 *	0.039782 *	0.099341 *	0.082860 *	0.064856 *	0.104202 *	0.106863 *	0.117365 *	0.056599 *	0.000028	0.046336 *
democrat	-0.008266	0.077847 *	0.076674 *	0.094580 *	0.096170 *	0.041484 *	0.072247 *	0.094644 *	0.039930 *	0.020717 *	0.054784 *
ind/other	-0.002503	0.050309 *	0.052306 *	0.064131 *	0.072073 *	-0.004056	0.026073	0.059976 *	0.021908	0.029678 *	0.055233 *

dy/dx is for discrete change of dummy variable from 0 to 1 * significant at 0.05 level

Marginal effects after ologit

WTP = 4

	F_2008	F_2009	F_2010	F_2011	F_2012	F_2013	F_2014	F_2015	F_2016	F_2017	F_2018
IV:	dy/dx	dy/dx	dy/dx	dy/dx	dy/dx	dy/dx	dy/dx	dy/dx	dy/dx	dy/dx	dy/dx
college graduate	0.040795 *	0.050035 *	0.031587 *	0.022277	0.039605 *	0.045951 *	0.054989 *	0.038518 *	0.033357 *	0.023565 *	0.015544
gender	0.012914	-0.016431	0.010720	-0.005262	0.004308	-0.018215	-0.002040	-0.012636	-0.001451	-0.008829	-0.021041
age 30-44	-0.020677	-0.038239 *	-0.001282	-0.039240 *	-0.024081	-0.030986	0.002841	-0.028028	-0.030041 *	0.024225	-0.011442
age 45-64	-0.037852	-0.055815 *	-0.004213	-0.039500 *	-0.015448	-0.046969 *	-0.014921	-0.056343 *	-0.046395 *	-0.017569	-0.039992 *
age 65 over	-0.063788 *	-0.056312 *	-0.022506	-0.050360 *	-0.027712	-0.056875 *	0.000942	-0.044331 *	-0.032247 *	-0.021817	-0.049271 *
income $20k - $40k	0.045280 *	-0.001709	0.044593 *	0.034300	0.024467	0.055684 *	0.041661	0.020620	0.026035	0.049689 *	0.005791
income $40k - $60k	0.052041 *	0.025012	0.052134 *	0.106657 *	0.090611 *	0.097238 *	0.057469 *	0.116092 *	0.058912 *	0.060557 *	0.075013 *
income $60k - $80k	0.037432	0.027941	0.089688 *	0.125171 *	0.119172 *	0.114432 *	0.058738 *	0.119862 *	0.031942	0.068109 *	0.074867 *
income $80k - $100k	0.038989 *	0.074901 *	0.105060 *	0.068424 *	0.120023 *	0.072084 *	0.057441	0.148596 *	0.047380	0.048681 *	0.101143 *
income > $100k	0.053046 *	0.063454	0.107413 *	0.134586 *	0.140545 *	0.128684 *	0.112020 *	0.139897 *	0.077563 *	0.086946 *	0.138232 *
democrat	0.038353 *	0.123566 *	0.052003 *	0.086738 *	0.119470 *	0.026966 *	0.045518 *	0.065068 *	0.042141 *	0.074533 *	0.113785 *
ind/other	0.017477	0.073208 *	0.034441 *	0.055272 *	0.082782 *	-0.002518	0.015609	0.038074 *	0.021745	0.067609 *	0.082115 *

dy/dx is for discrete change of dummy variable from 0 to 1 * significant at 0.05 level

Marginal effects after ologit

WTP = 5

IV:	F_2008 dy/dx	F_2009 dy/dx	F_2010 dy/dx	F_2011 dy/dx	F_2012 dy/dx	F_2013 dy/dx	F_2014 dy/dx	F_2015 dy/dx	F_2016 dy/dx	F_2017 dy/dx	F_2018 dy/dx
college graduate	0.049097 *	0.013806 *	0.025878 *	0.011239	0.015259 *	0.031368 *	0.031776 *	0.014186 *	0.022938 *	0.026087 *	0.009529
gender	0.015881	-0.004478	0.008700	-0.002642	0.001643	-0.012062	-0.001151	-0.004632	-0.000984	-0.009846	-0.012986
age 30-44	-0.023483	-0.010355 *	-0.001036	-0.018995 *	-0.008948	-0.019809	0.001608	-0.009939	-0.019620 *	0.028880	-0.006894
age 45-64	-0.045347	-0.015147 *	-0.003407	-0.019708 *	-0.005862	-0.030966 *	-0.008358	-0.020328 *	-0.030340 *	-0.019137	-0.023775 *
age 65 over	-0.065237 *	-0.014358 *	-0.017916	-0.024491 *	-0.010379	-0.036448 *	0.000531	-0.015897 *	-0.021110 *	-0.023143	-0.029069 *
income $20k - $40k	0.077945 *	-0.000470	0.038949 *	0.017979	0.009612	0.039052 *	0.024950	0.007719	0.018411	0.070089 *	0.003585
income $40k - $60k	0.100032 *	0.007055	0.046533 *	0.063834 *	0.040473 *	0.076235 *	0.035097 *	0.050838 *	0.045146 *	0.096654 *	0.054582 *
income $60k - $80k	0.137478 *	0.007932	0.091889 *	0.081638 *	0.059014 *	0.098339 *	0.036609 *	0.052243 *	0.023044	0.116717 *	0.053740 *
income $80k - $100k	0.133167 *	0.023046	0.122453 *	0.039022	0.063350 *	0.056059	0.036463	0.073517 *	0.035814	0.153806 *	0.083338 *
income > $100k	0.161304 *	0.019047	0.114726 *	0.093934 *	0.072621 *	0.117694 *	0.080467 *	0.065128 *	0.062051 *	0.157884 *	0.118306 *
democrat	0.050784 *	0.037681 *	0.044483 *	0.047275 *	0.051572 *	0.018125	0.026553 *	0.025046 *	0.029912 *	0.104305 *	0.085438 *
ind/other	0.021995	0.021241 *	0.028961 *	0.029082 *	0.034150 *	-0.001658	0.008903	0.014242 *	0.014983	0.083802 *	0.054034 *

dy/dx is for discrete change of dummy variable from 0 to 1   * significant at 0.05 level

Marginal effects after ologit

WTP = 6

IV:	F_2008 dy/dx	F_2009 dy/dx	F_2010 dy/dx	F_2011 dy/dx	F_2012 dy/dx	F_2013 dy/dx	F_2014 dy/dx	F_2015 dy/dx	F_2016 dy/dx	F_2017 dy/dx	F_2018 dy/dx
college graduate	0.046612 *	0.010139 *	0.014799 *	0.008019	0.021643 *	0.008970 *	0.024795 *	0.012187	0.018915 *	0.023752 *	0.006125
gender	0.015143	-0.003274	0.004944	-0.001880	0.002316	-0.003401	-0.000884	-0.003970	-0.000804	-0.008991	-0.008374
age 30-44	-0.021523	-0.007559 *	-0.000587	-0.013295 *	-0.012446	-0.005501	0.001239	-0.008400	-0.015711 *	0.027513	-0.004395
age 45-64	-0.042905	-0.011069 *	-0.001932	-0.013994	-0.008242	-0.008721 *	-0.006400	-0.017322	-0.024339 *	-0.017238	-0.015081 *
age 65 over	-0.057169 *	-0.010299 *	-0.010071	-0.017188 *	-0.014499	-0.010142 *	0.000409	-0.013505	-0.016928 *	-0.020520	-0.018386 *
income $20k - $40k	0.089079	-0.000344	0.023147 *	0.013068	0.013764	0.011307 *	0.019835	0.006675	0.015419	0.074680 *	0.002314
income $40k - $60k	0.122164 *	0.005213	0.028035 *	0.049902 *	0.062514 *	0.023306 *	0.028238 *	0.047415	0.039738 *	0.112407 *	0.038205
income $60k - $80k	0.226904 *	0.005873	0.060677 *	0.067026 *	0.097447 *	0.031467 *	0.029792	0.048645	0.019528	0.143991 *	0.037371 *
income $80k - $100k	0.212459 *	0.017515	0.088422 *	0.029619	0.108766 *	0.017022	0.029973	0.073114	0.031221	0.283044 *	0.062399 *
income > $100k	0.267553 *	0.014357	0.078348 *	0.080252 *	0.124174 *	0.038933 *	0.071748 *	0.062757	0.056237 *	0.214070 *	0.091857 *
democrat	0.050613 *	0.028638 *	0.026135 *	0.035159 *	0.078595 *	0.005144	0.020812 *	0.021953	0.025135 *	0.112908 *	0.061298 *
ind/other	0.021231	0.015850 *	0.016818 *	0.021201 *	0.050422 *	-0.000466	0.006885	0.012317	0.012362	0.083194 *	0.036093 *

dy/dx is for discrete change of dummy variable from 0 to 1   * significant at 0.05 level