

The Effect of Renewable Energy Marketing Techniques on Different Age Brackets

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ABSTRACT

Renewable energy technologies are often seen as one of the most useful solution to the issue of climate change. Hamilton, Hartter, and Bell (2019) conducted a study where participants of various ages were surveyed about their opinions and attitudes towards renewable energy. They found that there was a difference between how younger and older people perceived renewable energy and other related technologies. There is also extensive research into how different appeals people's perception of a product in advertising. This study combines the two to investigate how age impacted the effectiveness of various commercial types regarding renewable energy. A Posttest-only control group, experimental design was used to conduct this study. A survey was modeled from various related experiments and given to participants from five different age groups. A one-way ANOVA test was run for the numerical results of each of the age groups in the survey. The p-Value for age group one was determined to be statistically significant at $p < 0.05$ and a null hypothesis was rejected. This, along with anecdotal responses from participants, was used to draw three conclusions. People in the first age group are concerned with the environmental benefits of renewable energy technologies, but are more concerned with their implementation into society. Participants across most of the age groups are concerned with the cost of renewable energy technologies. Finally, the participants believed that the individual situation of the installer should determine if they should invest in renewable energy technologies.

Introduction

Climate change has prompted numerous multinational litigations. Agreements such as the Paris Accords have addressed the increasing concern that climate change will continue to have an adverse effect on the globe without immediate governmental intervention (UNFCCC, 2016). One commonly proposed solution for this issue is the implementation of renewable energy (RE) sources in favor of phasing out traditional methods of energy generation such as natural gas and other carbon-based technologies. Of these RE types, photovoltaic (PV), or solar panels, are shown to be one of the most beneficial to humanity because they offer the potential to provide adequate electrical power for the world at a higher power density. These originally silicon-based panels are now beginning to be made with organic materials such as cadmium telluride. This recent advancement in PV technology has lowered the production price of solar energy, with much more room for improvement by means of elevated optic technology (Battersby, 2019). Some researchers even maintain that "the adoption of solar technologies would significantly mitigate and alleviate issues associated with energy security, climate change, unemployment, etc." (Kabir, Kumar, Kumar, Adelodun, & Kim,

2018). With the level of research and development (R&D) that has been invested into PV and RE technologies, they are appearing to become a more viable source of clean energy.

To fully utilize the energy generated from PV panels, a suitable infrastructure system is needed to support them. Many governments and private investors are studying policies and procedures that will help deploy PV panels and any related systems needed for them to function. Jones (2015) has analyzed potential “barriers” that private market investors consider when they try to get involved in “clean energy infrastructure” and has devised a solution that could help to mitigate these barriers to increase private participation in the RE markets. He claims that a change in management is required to take advantage of new infrastructure and that large upfront investments are needed to support any infrastructure created. In terms of investments in transmission infrastructure (the electrical grid, or “grid”), the US Energy Information Administration (EIA) has reported an increase over the past ten years including \$21 billion spent in 2016 (EIA, 2018a). This demonstrates a need to increase the revenue of electricity utility providers to aid this trend towards more transmission infrastructure.

This revenue can come in many forms, market investors, new introductory consumers, and increasing the utility bills of existing customers. The EIA (2019) reports that from 2017 to 2018, the total revenue of the electric industry increased from \$390 billion to \$406 billion, with around three million new consumers entering the market (EIA, 2019), explaining the vast increase of revenue. Naturally then, an increase in the number of consumers correlates with an increase in revenue. One possible way to target possible entrants into the market is to focus advertising on a younger audience who are first-time independent consumers. Encouraging other consumers that have been in the market longer also need to be targeted to encourage them to invest into the RE market. These two groups may have slightly different attitudes and opinions on RE and related factors as per Hamilton, Hartter, and Bell (2019). Quantifying and applying these attitudes to unique marketing campaigns could increase the number of consumers entering the market and in turn, increase the funding towards RE infrastructure. A high caliber, more well-funded grid will be able to take full advantage of the developing PV technologies. In order to investigate these attitudes on RE, this study aims to rank the effectiveness of different types of advertisements to various age ranges.

Literature Review

Marketing Types

Electric utilities, like other companies, depend on revenue to make a profit. Advertisements such as television commercials or social media campaigns are useful to send out information about certain aspects of a company, as well as different promotions that they may be running. Appeals such as environmental, monetary, or self-empowerment may be used by companies to convince the consumer to feel a certain way about their service and encourage them to purchase their electricity from one company.

Environmental

An appeal to the environment has often been effective in marketing. Advertisements including “visual representations of nature” often perform well in the market and are well received by consumers (Hartmann, Apaolaza, & Alija, 2013, p. 185). In an experimental field study conducted by Hartmann et al. (2013), it was found that images detailing idealized scenes of nature were more compelling and increased the impact the advertisement had to its viewers. This suggests that a commercial involving the environment should show how a product improves nature, rather than simply implying that the product and environment can coexist together. Marketing for electric utilities may then attempt to depict scenarios where their product betters the world the consumers live in (compared to other electric utilities) and consumers should purchase it to support this act.

Investment & WTP

Another factor that an advertisement may attempt to market towards is the monetary aspect of investing into the RE market. According to Jones (2015), investors view policy longevity and complexity, as well as country governance, as the biggest determinants of a safe investment. Without these, investors will not fund the R&D of transmission infrastructure. Policies on grid infrastructure and the integration of RE sources into the grid must be put into effect and maintained in order to gain revenue. Jones (2015) also coins a “lack of human capital,” or individuals educated enough to construct and operate this infrastructure, as a deterrent to investment. As per the EIA (2018), federal subsidies of coal energy (in million 2016 dollars) have decreased from 20,223 to 14,807, while PV subsidies have increased from 205 to 533. However, there has been increased subsidization of natural gas and crude oil, both of which have increased from the fiscal year 2013 to the fiscal year 2016. The subsidies that solar and other RE forms get are substantially lower than those received by fossil fuel energy types. The EIA (2018b) does concede that coal annual growth from 2000 to 2016 was only 2.9 percent with solar energy being 31.8 percent (EIA, 2018b), hinting at an expected increase in RE subsidies. Even with a growth rate ten times larger, the existing value of fossil fuel subsidies are orders of magnitude higher than what has been invested into RE.

From a consumer perspective, the consumer wants the end-user price to be as low as possible. Their willingness to pay (WTP) will determine how they feel about a product and whether they would consider purchasing it. Kim and Kim (2015) studied Koreans’ perceptions of the supply security of their main form of energy, fossil fuels. It was concluded that through government subsidies, the consumers would have a higher WTP because they would perceive higher energy security. Though this study applies this result to the fossil fuel industry in Korea, the same principle explains attitudes towards renewable energy. People are more willing to pay when they feel there is some security that they get from this increase in cost.

Empowerment

Consumers benefit from feeling a sense of empowerment or control in the decisions they make. Vecchiato and Tempesa (2015) concluded that customers were more willing to enter a contract that provided them with electricity from

RE sources when they were able to choose from what generation method it was produced. They found that participants were more willing to pay when they were given the option to choose energy generated from PV panels (Vecchiato & Tempesta, 2015). The option to choose to participate in the RE market was more valuable than the potential monetary influences the contract might have. Consequently, it can be inferred that combining the two would result in a strong appeal. This is consistent with results found by Abdmouleh, Gastli, and Ben-Brahim (2018), who found that people are willing to accept advancements in RE technologies, but only after they are educated on the subject. A clear distinction between technical and non-technical background knowledge of RE is thus to be expected and to be a determining factor in decisions made by the participants of this study.

Age & Political Inclination

Perception is often affected by individual experiences and opinions on varying topics. Hamilton, Hartter, and Bell (2019) elaborated on earlier studies concerning the public's view on RE and related issues. Some of the main questions they investigated were whether or not people believed that humans were a fundamental cause of climate change and whether or not they thought RE technologies would have a positive impact on mitigating this delta. They found that people ranging from 18-29 years old favored RE solutions, with 90% of their New Hampshire study and 77% in their Oregon study supporting RE technologies (Hamilton et al., 2019). These percentages are 10 percentage points less in their respective categories for those ages 65 and up. This "generation gap" is larger by 16-21 percentage points concerning the causes of climate change (Hamilton et al., 2019). They discuss how "age has significant positive effects on both climate and energy views even after controlling for sex, education, political identification and year of survey" (Hamilton et al., 2019). These differences between younger participants being more favorable towards RE and older participants being more reserved hint at ulterior motives on either end.

Perhaps, as suggested by O'Brien, Selboe, and Hayward (2018), younger participants are more aware towards current socio-political (e.g. social injustice or poverty) and environmental (e.g. pollution) situations. They could be forced to think critically about policies on climate change and how they are being addressed by public, private, and governmental organizations alike (O'Brien et al., 2018). Or perhaps older participants are behaving similarly to those studied by Cann and Raymond (2018) and focusing on "more immediate and tangible" (p. 18) impacts that climate change policies have. Their discussion of anti-science arguments, which are currently found in those who are more socially conservative, presents a level of partisanship in direct contrast to that proposed by O'Brien et al. (2018). Hamilton et al. (2019) add that this age gap in attitudes may be a result of this two-sided political spectrum. This political spectrum, combined with the age differences is well researched and proposes an explanation for the gap in perspectives on RE.

Gap in Literature

It is clear from the Literature Review that there has been extensive research into how advertising styles persuade consumers into entering the RE market. Likewise, RE has been demonstrated to have different appeals to those of diverse age ranges, mostly due to policy and perception of how RE technologies will impact other policies or markets. Past studies have focused on these factors independently of each other, controlling them as constants, but have not

discussed how the two may influence each other. The focus of this study is to investigate how people in varying age ranges are impacted by different RE marketing techniques.

Hypothesis

The hypothesis for this study is that participants in younger age brackets will be more impacted by advertisements with a purely environmental appeal, as their more progressive thinking will limit them to only be concerned with the natural impacts of RE systems. Participants in older age brackets will be more impacted by an advertisement appealing to more diverse topics such as cost or installability, and they would feel a sense of empowerment for doing something “good” for their community and society. As discussed in the Literature Review, there is substantial research on how both age and marketing appeals impact attitudes on RE, but this study combines them to highlight potential differences in reasoning or lines of thinking and conclude which advertising appeal is most effective for which age group.

Methods

This study uses an experimental framework with a Posttest-only Control Group Design. In this design, subjects are randomly selected and assigned to the two groups (control and experimental), and only the experimental group is treated. The treatment included exposure to a video advertisement aimed at convincing consumers to invest into the RE market. After close observation, both groups are post-tested by reacting to a series of statements about their attitude towards RE technologies, and a conclusion is drawn from the difference between the control and experimental groups.

Advertisement Curation

As concluded in the Literature Review, there are many different types of advertisements that all have unique impacts on people. It was decided to address the environmental appeal of investing in RE technologies, as well as an empowerment appeal that involved factors such as price and social impact on society. This experiment used two video advertisements (one for the Environmental group and one for the Empowerment group) that fit a strict criteria of guidelines. First, the two videos would need to be of similar length and timing. They were both approximately one minute in length so that the participants were exposed to similar amounts of information. Another criterion that the advertisements needed to fit was having similar styles in how they presented information. The two that were chosen involved on-screen text at the bottom of the screen making the major claims of the commercial. They also depicted background images that were visual representations of what the text was talking about.

In terms of the content that the videos included, they were both going to be shown to the experimental group. Those in the Environmental group would be shown a video that detailed how RE technologies were worth buying because of the positive impacts they had on the environment. It claimed that solar panels reduce pollution and carbon footprint by not relying on fossil fuels and other carbon-based energy generation methods. It continued to explain how solar panels combat climate change by not producing any direct form of greenhouse gases.

The participants in the Empowerment group would be shown a video that discussed other reasons that consumers should invest in RE, other than potential environmental impacts. It mainly focused on financial reasons as to why RE technologies are more impactful. The consumer pays less in the long run due to technologies like solar panels generating electricity for the user, it may even make them some money after that. It also addressed that solar panels need to be installed by a human, thus creating jobs and stimulating the economy. Finally, the video ends on an emotional appeal by claiming RE technologies will better the world for future generations.

Survey Development

The groups were determined using the first letter of the participant's last name. Three letter ranges (A-F, G-N, and O-Z) were used from a random sample of last names to divide a test population into even groups. The survey was developed using Google Forms, a common online-based survey creation tool. Vecchiato and Tempesta (2015) used a section of their questionnaire to evaluate the participants' understanding of RE, another section to question the participants' utility contracts that focused on green energy, a third to make sure that participants had an understanding of PV and biomass installation and related issues. Using these themes, various statements were developed to examine the participants' attitudes towards these subjects. In the same journal, Abdmouleh et al. (2018) used a Likert scale to have their participants rank their perceptions on smart grid technologies, which are often used in conjunction with RE generation sources. From this, the researcher modeled a Likert scale. The following statements were developed using Vecchiato and Tempesta's section topics, along with suggestions by the Pew Research Center (n.d.) such as considering reverse scoring some of the statements so participants will not simply agree with a statement:

- S1: Renewable energy is beneficial for the environment.
- S2: Renewable energy technologies do not help combat climate change.
- S3: A person would be just to not use renewable energy.
- S4: I would be a better person if I used renewable energy.
- S5: I think people should install solar panels on their homes.
- S6: I am willing to pay to install solar panels at my house.
- S7: Renewable energy technologies are a waste of money.

These statements were designed specifically to address different appeals that the advertisements used. People with the environmental video may respond stronger to S1 and S2 while people who watched the empowerment advertisement may answer stronger to S4 and S5. S3 would end up being discarded due to varying interpretations of the question.

Qualitative data was also generated from the survey, as participants were also given a section at the end of the survey to give feedback on the statements, to explain their reasoning behind certain answers, or to further explain their views on renewable energy.

Participants

In order to have variance, participants of all ages were needed to take the survey to ensure enough participants in each stratum. They are broken up into groups as defined by Hamilton, Hartter, and Bell (2019): 18 to 29 years old, 30 to 39, 40 to 49, 50 to 64 and 65 and above. A grouping of participants 17 years old and younger was also used in this experiment to have a distinctly younger population. The final two groupings that Hamilton et al. used were also combined into one for this experiment to have a more defined older population to contrast with the other age groups (AGs). After having approval from the IRB committee (see Appendix A), the survey was sent out to the general public using various methods. Students and staff of all ages at a local high school were reached through a school-wide email and asked to complete the survey. Additionally, the survey was uploaded to numerous online-forums, asking for volunteers to complete the survey.

Surveying Period & Testing

The survey (see Appendix B) was sent to a local high school to be entered into the weekly, school-wide email. This returned younger aged participants, along with responses from faculty and staff at the school.

Results

Once data collection had been completed for 140 participants, the data was compiled and organized into spreadsheet software to analyze. The Likert scale needed to be amended for some of the questions as they were to be reverse scored (e.g. S2). The responses of each participant were then converted into a numerical score (1-Strongly Disagree, 2-Disagree, 3-Neutral, 4-Agree, and 5-Strongly Agree) and summed to a total score. If a participant reported a higher total score, they had a more positive attitude towards RE (see Fig. 1). Averaging these total scores indicates that the videos had an effect on participants' attitude of RE to some degree.

Figure 1: Figure depicts the mean score for each age group (AG) in the three treatment groups.

Total Score Averages						
	Age Groups (AG)					
	AG 1 (0-17)	AG 2 (18-29)	AG 3 (30-39)	AG 4 (40- 49)	AG 5 (50+)	OVERALL
Control Group	24.136	25.286	25.800	24.846	25.000	25.086
Environmental Video	24.250	24.571	27.600	24.500	22.375	23.848
Empowerment Video	26.647	24.200	26.600	24.000	24.857	21.650

To determine whether or not these changes in the data were statistically significant, a one-way ANOVA test was run using the sums from each participant in each group (control, environmental, and empowerment), not yet taking into account the effect age had on the responses. The resulting p-value was $p=0.3525$, meaning that the overall result of

the survey is not statistically significant at $p < 0.05$. Thus, a null hypothesis is accepted for the impact that the advertisements have on the treatment groups overall.

There is more to look at, however. This study also questions the effectiveness of the video advertisements in each age group. The averages in Figure 1 seem to suggest that the empowerment video is more convincing versus the environmental video when compared to the control group for AG 1. The averages for AG 3 also seem to hint that the environmental advertisement is more convincing than the empowerment video. The differences prompted One-Way ANOVA tests (Fig. 2) to be run for each AG.

Figure 2. Figure 2 lists the p-values for ANOVA tests for the experimental groups vs. the control group.

p-Values for One-Way ANOVA Tests Across Control, Environmental, and Empowerment Groups						
	Age Groups (AG)					
	AG 1 (0-17)	AG 2 (18-29)	AG 3 (30-39)	AG 4 (40-49)	AG 5 (50+)	OVERALL
p-Value	0.044602	0.79121	0.677256	0.834667	0.560172	0.352548

These tests yielded that only AG 1 was statistically significant to $p < 0.05$ with a p-Value of 0.045. This means that the attitudes of the participants that had watched a video were different than those in the control. Figure 3 shows the ANOVA table for the test done with AG 1. The F-statistic in the table is 3.32048 and because it is relatively close to the Standard Deviations also provided in the table, this also indicates that the data used to run the ANOVA test is significant. The null hypothesis has failed to be rejected and an alternative hypothesis can be drawn.

Figure 3. Figure 3 shows the ANOVA test results for the One-Way ANOVA test done to AG 1.

One-Way ANOVA Test for AG 1 (0-17)				
	Treatments			
	Control	Environmental	Empowerment	Total
N	22	12	17	51
ΣX	531	291	453	1275
Mean	24.1364	24.25	26.6471	25
ΣX²	13065	7173	12207	32445
Std.Dev.	3.4406	3.2509	2.9142	3.3764
Result Details				
Source	SS	df	MS	
Between-treatments	69.2767	2	34.6384	F = 3.32048
Within-treatments	500.7233	48	10.4317	
Total	570	50		

Discussion

From this discussion of the statistically significant numerical data and anecdotal data provided to this study, a few conclusions can be made. These tests show that the mean score from AG 1 is statistically significant and can thus be interpreted. The mean score for the AG 1 Control was 24.136, 24.250 for the Environmental advertisement, and 26.647 for the Empowerment commercial. The higher mean score for the Empowerment group signifies that the commercial was more impactful on the participants versus the Environmental one when compared to the Control group who saw neither commercial. The mean Environmental score was higher than the Control, but only by just over a tenth of a point, whereas the Empowerment was over 2.5 points higher. These positive, although miniscule, changes suggest that the video advertisements were effective at improving the opinions about RE for those in AG 1 (0-17). The hypothesis was not supported by this data. This is, however, reasonable because younger people are used to video-format content in their daily lives.

As addressed in the Literature Review, O'Brien et al. (2018) have found that young people are more involved with socio-political and environmental issues in the world. A possible explanation for why the Empowerment advertisement was more effective is that the participants in AG 1 may view the implementation of PV panels and other forms of RE sources as more of a social status than a technology used to better the environment. At least one participant from each of the three groups explained that their answers were heavily impacted by cost. One participant claimed that "For those who do not have disposable income or do not own their roof (as renters do not), solar panels are not an option..." Another said,

"... I also think that it would be in [people's] best interest to use renewable energy (for environmental purposes). But if they chose not to use renewable energy, (because sometimes it can be expensive) that is their choice, and I respect that" [sic].

It was hypothesized that these aspects of RE would be more important to those in older AGs, but without statistically significant data for those brackets, no conclusion can be made for that. O'Brien et al.'s (2018) understanding of youth involvement may extend further into the socio-political concerns than the environmental concerns. Youth seem to address social inequalities more than ever (O'Brien et al., 2018) and as a result social issues merge into other issues e.g. environmental. It is clearly shown and concluded by these statements that cost and availability is far more important to those in AG 1 than previously thought.

C1: Participants in AG 1 care that the environment is bettered through RE, but are more concerned with cost and availability than originally hypothesized.

Other AGs also display more care about these facets as well. One member of the Control group (AG 4) specified concern about the current return on investment (ROI) that REs like PV panels have. These concerns are echoed by a participant from the Empowerment group (AG 4), who says that "The initial cost of hardware and installation of renewable energy products like solar panels hasn't yet become affordable for the average family." and one from the Environmental group (AG 3) who claims that they are "afraid that it will initially be too expensive." A participant

from AG 2 also adds that PV panels are the cheapest form of RE that is widely available when compared to other RE forms, but still has too high of an investment price. Although the numerical data from these other AGs is not significant, these anecdotal responses indicate a common fear and concern about the current cost of RE technologies and sources.

C2: The fear and barrier about the cost of RE technologies extends across most of the AGs.

Members of the two experimental groups also cited a lack of sun as explanations for their responses. One participant (AG 2) said that they would “love to install solar panels, but [they] live in” an area that only “receive[s] sunlight approximately 60% of the year.” They go on to say how it would make more sense in an area such as the Southwest US, where there is more direct access to sunlight. A member from AG 5 also claimed that their area is “lacking in sun” and thus they could not see themselves installing PV systems or other similar RE systems. Many other participants from all three groups and various AGs also made comments on the viability of PV or solar panels for their or other people’s specific scenarios. One in particular discusses how PV energy is the cleanest form of RE, especially when compared to nuclear or natural gas, but it is “not nearly as efficient as burning natural gas or using nuclear energy.” These numerous comments show an established concern for different people’s scenarios and the efficiency of current RE methods. Solar energy may not be the best choice for RE, or a person’s individual livelihood may not allow for the installation of RE technologies. This can refer back to potential financial limitations, or it can extend into simple geography and what is the most efficient energy source.

C3: People believe that the individual scenario of the installer is what dictates investment in RE technologies.

The three test groups all provided some level of anecdotal data from personal beliefs. These beliefs appear to be widespread among those surveyed as many of the comments address similar themes.

Limitations

Although the above three conclusions were able to be drawn from qualitative and quantitative data acquired by this study, there are a few limitations to these conclusions, as well as what they imply.

Overall Limitations

The most detrimental limitation to the study were unequal participants in the AGs. Each AG in all of the test groups was composed of different quantities of people. This could have impacted the ANOVA tests that were run and resulted in a higher p-value than desired. The study was also conducted online and only promoted in person at a local high school. Ideally, the participants should have been controlled to be from more diverse social and political backgrounds.

Survey Limitations

The physical qualities of the survey also could have been improved. The statements were modeled from a similar study with questions on PV panels. Many of the participants addressed the specificity towards PV panels as a general assumption about RE technologies. The statements could have been more generalized about RE technologies and used PV panels as an example, to account for this. Or an initial run of the study could have been organized so that a better understanding of how the questions would be interpreted could be gained. Finally, the video advertisements were from two different companies and might have had different motives for creating them. In the future, advertisements from the same company should be used to control how the commercials were designed and produced.

Implications & Future Directions

This study investigated how advertisements and appeals to different aspects of renewable energy are viewed by different age groups. It determined that younger people are concerned with the environmental impact of renewable energy but are more concerned with the financial limitations of renewable energy than originally thought. This implies that the cost of renewable energy technologies will need to come down for them to become more appealing to the masses. With this conclusion coming from AG 1, this cost drop would need to happen in the next one or two decades for renewable energy technologies to be a serious consideration for many in this age range. Unfortunately, as discussed in the Literature Review, electric utilities are companies and need profit to update grid infrastructure as well as R&D for new or more efficient renewable energy technologies. This money must come from somewhere to continue these processes. It is the R&D into the technology that will result in a lower initial cost of technologies such as PV panels. Perhaps the recent use of non-silicone panels will start this development cycle.

This study displays a future direction of innovating current renewable energy technologies to be more cost-effective. Research should be directed at how to obtain raw materials faster, assemble them stronger, and sell them cheaper. Once this begins, some efforts should be spent understanding what differences make the end-user price cheaper. The adoption of technology is driven by the consumer sector. When the average family or consumer has access to and wants to use renewable energy technology, governments and industry will follow this adaptation.

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