

# Solar Energy Adoption: Where Economics and Psychology Meet

Lance Rachlin  
Senior Capstone  
Professor Horowitz  
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## Abstract

We have a problem. We have polluted and destroyed our earth to a dangerous degree and are continuing to do so despite our knowledge of the potential fallout if we continue on this path. Lucky for us, we also have a solution in the form of renewable and clean energy sources such as solar energy. Alas, we as a society are unable to agree on and use this amazing solution to the problem for a multitude of reasons which leads to the question proposed by this project. This project aims to answer the question of 'how has America used incentives to encourage or discourage solar panel installation on private homes.' The results of this project indicate that although we provide a multitude of incentives for the consumer to switch over to this cleaner energy type, not all of them work well, if at all. The research conclusively shows over and over that we need to look into making the incentives more appealing psychologically. A great thing about the results this project produced is that they also show that there is strong interest and desire to make this beneficial change if only it could be made more affordable and feasible for the general consumer.

## Chapter 1: Introduction

The world we live in today is filled with all sorts of innovative and exciting technology which is both a great thing and bad thing. As with everything in life there are pros and cons to everything, and technology is no exception in that it requires a huge amount of energy. As human society has expanded and grown in technology, so too has our pollution and destruction of the world in which we live. As we became more and more cognizant of our effect on our world, our society has tried to change its ways to preserve rather than destroy. In this project, I will answer the question of how has America used incentives to encourage or discourage Solar Panel Installation on private homes. I will do this through the qualitative analysis of studies and data from a wide variety of sources.

The results of this project show that although we currently have a number of different types of incentives available, only a few of them truly work. This does not mean that the other incentives are complete failures or even that the ones currently showing success are truly working as they stand now but rather that all of them could benefit from improvement. The results from this project shall hopefully aid in the revamping and improving of all the current incentives available. From the results we can clearly see that the cash incentives are the most successful ones around followed by the tax incentives and active or passive peer effects.

Like anything else in life, change is never easy nor simple and this topic is no different. Climate change is a real thing and our society has negatively impacted our climate through our various technological advances and industrial revolutions. However, all is not lost because just as we developed technology that hurt our environment and world, we have come up with multiple

technological advances that can save our planet and help the climate. One of the newer technologies developed is the idea of solar power. Solar power uses the sun, yes just as it sounds, to power things and is a much cleaner and more efficient method of electricity or energy than using fossil fuels as we currently do. The problem is that the switch to solar power is not so simple or cheap and thus we have many issues around everyone adopting this new change.

## Background

In order to understand the problems of the present we must first understand our past and how it led us to this point. Way back in time, around the late 1860's, our country was predominantly focused around agriculture and not business as we know it now. However, time affects us and our society the same way as it does anything else which is to say that change is always around the corner and in this situation that change came in the form of the Industrial Revolution. The American Industrial Revolution began in the late 1870's and continued through the early 1900's (Encyclopedia.com accessed 12/18/22). During this busy time period our country went through a major change in that our economy became based on industry rather than agriculture which unbeknownst to us is the beginning of when we started to hurt the Earth, we inhabit via carbon pollution.

What does that mean you might enquire? Well, what I mean is that when we were agriculturally based, we actually helped the environment and the earth as plants help to produce oxygen and remove carbon dioxide to name just one beneficial task, they performed whereas industrialization had us move away from that and into manufacturing. As we moved more and more into an economy based on profitable businesses and manufacturing, we had to of course create industrial plants, some to do the manufacturing and others to provide power or electricity.

This is where our growth and expansion in this industrial and technological age began to have negative impacts on our planet via the way in which these plants were powered. They all used some form of fossil fuel to run and generally that fuel was coal. Coal has been used as a source of heat and fuel since the time of cavemen and became the predominate form of fuel in the United States starting when James Watt invented the steam engine (Energy.gov accessed on 12/18/22). In fact nearly half of the electricity we produce in this country is coal-generated electricity and all the time it is polluting our earth as its burned. Although there are ways to eliminate the negative products of using coal as a fuel source, it doesn't reverse the damage already done and we still need to look for cleaner and better solutions as coal is a finite source. Thus we come to the invention of Solar Energy, something that is clean to use and is going to be around as long as the sun exists.

The first Solar Energy and Solar Cells discovery actually goes all the way back to France in 1839 where a young physicist by the name of Alexandre-Edmond Becquerel was working with metal electrodes in an electrolyte solution that when exposed to light, produced electric currents (aps.org, accessed on 12/18/22). Willoughby Smith was an English engineer in 1873 who discovered the photoconductivity of selenium and then in 1883 Charles Fritts created the first solar cell by coating selenium with a thin layer of gold (smithsonianmag.com, accessed on 12/18/22). In 1940 Russell Shoemaker Ohl created the next major advance in solar cell technology when he inadvertently created the first solar cell which he proceeded to patent even though it was not very efficient (aps.org, accessed on 12/18/22).

The first useful solar cell was created in 1953 by Daryl Chapin who ended up working with Calvin Fuller and Gerald Pearson to create a solar cell which was 6% effective at converting solar energy into electricity, which was a big deal back then. On April 25, 1954 Bell Labs

announced the invention they called a “Solar Battery” which consisted of multiple solar cells linked together and they used it to power a small toy Ferris wheel and radio transmitter in Murray Hill, New Jersey (aps.org, accessed on 12/18/22). The University of Delaware is credited with creating one of the first solar buildings, “Solar One”, in 1973 and it ran on a combination of solar thermal and solar photovoltaic power although the solar panels weren’t on the roof but rather integrated into its rooftop (smithsonianmag.com, accessed on 12/18/22).

Now the 1970s was a busy time for the United States as we had a lot going on including the energy crisis, which I’m sure played a part in the many different laws and bills that got passed over the next few decades having to do with energy and renewable energy sources. An example of one being the Solar Energy Research, Development and Demonstration Act of 1974 in which the federal government was committed to making solar energy viable and affordable to the public (congress.gov accessed 12/19/22). Fast forward to current times and we see that solar energy and solar power are still an important goal to our government and society an example of which can be seen from President Obama’s efforts to increase solar energy use through a variety of means, his ‘Clean Energy Savings for All Initiative’ being one such example (obamawhitehouse.archives.gov accessed on 12/19/22). The Clean Energy Savings for All Initiative is a cross government partnership through which the administration aims to continue promoting and enabling solar energy transitions to consumers through a multitude of sources focusing on making the change affordable and desirable.

## Chapter 2: Literature Review

Finding reliable and relevant information on the topic of solar power was actually harder than I anticipated. I believe this to be caused by a variety of factors, but three of the big ones would be possible interference by negatively impacted parties, the simple vastness of the topic, and lastly the simple fact that this is a very politicized and controversial issue. Now I know what you're thinking, what does interference from negatively impacted parties even mean? Well, what I mean is that there are a lot of companies who do not want to lose business to the development of solar panels and therefore these companies might be providing incentives for researchers to look into other topics or needs in society as opposed to looking into this critical issue. The topic of Solar Power is a very large one which means that the research being done could be on any number of smaller aspects irrespective of the one relevant to this project and my research. Finally, as I believe we can all agree, any subject that is controversial or politicized like solar powered energy is will be hard to do research on simply due to the various groups who are interested in the subject. However, despite all of these challenges I was able to find relevant and reliable information to use in this project and below is what I found.

Adoption of residential solar power under uncertainty: Implications for renewable energy incentives written by Christoph Bauner and Christine L. Crago is an article directly related to this essay as it aims to answer the question of what it takes to motivate individuals to install solar panels. Both authors are highly qualified individuals. Christoph Bauner is now an assistant professor at Amherst, received his education at Duke and has received numerous grants for

research and Christine L. Crago is no lay-about being an associate professor of energy and environmental economics at the university of Massachusetts Amherst where she appears to specialize in solar panels and the related field of solar energy. Using a simulation model based off of data obtain in Massachusetts Bauner and Crago hope to explain how policy uncertainty has affected the adoption of Solar Panels.

Using the Option Value Model, a concept that describes how a private individual when looking at an investment with uncertain benefits both now and in the future shall generally holdoff on making the decision to invest until such a time that the current uncertainty is resolved (dixit and pindyck, 1994) and the Net Present Value (NPV) decision rule which equates discounted benefits to the initial investment cost, Bauner and Crago find that the median adoption time under the OV rule is 6-21 years longer than that of the NPV rule. It was found that private investors need to see that they will have an immediate return or benefit from their investment that is at least 60% more than the installation cost of this solar panel investment. Essentially after all tax and financial incentives are taken into account the private person must be getting a 60% benefit over what they laid out to make this investment worthwhile, this is no small expectation and shows that there is significant work that can be done to improve solar panel investment starting with policies that reduce the uncertainty around this large investment.

Along similar lines a person should read, The Comparative Effectiveness of Residential Solar Incentives by Daniel C. Matisoff and Erik P. Johnson is another great article written on solar panel technology and its adoption by the general public. Daniel C. Matisoff is senior associate professor at Georgia Institute of Technology and received his education from the university of Pennsylvania and the Indiana university of Bloomington which he uses to focus his research on the energy and environment, specifically how policy's affect changes in this field by



the consumer. Professor Erik Johnson is an empirical economist who studies the intersection of environmental quality, policy and economic outcomes (Carthage.edu accessed 12/18/22). He received his education from the university of Michigan and worked at the Georgia institute of technology as a professor prior to coming to Carthage college where he is a professor and chair of the economics department.

Together they tried to answer the question of what type of incentive or incentives will get consumers to invest more in the solar panel technology. They found that many of the incentives in existence at this point in time don't actually help consumers choose to go the solar route. This is due to the incentives not being researched well enough insofar as how to best target the consumer. 73% of the data they found comes from places that use Net Metering and so they propose that if more states use Net Metering in conjunction with better incentives, solar panel use will increase. Net Metering is a system in which a home is billed only for the amount of energy used each month and tracks the amount if any over what is used that's contributed to the power grid and therefore credited to your account for future use (Sunpower.com accessed 12/18/22). Specifically, they found that cash incentives greatly outperform other methods of incentivizing the public to invest in solar panels thus they propose that current policies and incentives should be looked over to ensure they are actually geared towards the targeted demographic.

Furthermore, Consumer Responses toward home energy financial incentives: a survey-based study is an article written by Tingting Zhao, Lindsey Bell, Mark W. Horner, John Sulik and Jinfeng Zhang. Tingting Zhao, Mark W. Horner and John Sulik all work at the department of geography for the Florida state university. Lindsey Bell works for the coastal Carolina university in their department of mathematics and statistics whilst Jinfeng Zhang works out of the Florida

state university's department of statistics. All of whom are well educated and interested in the field of renewable energy, specifically the ways in which we can incentivize private individuals to invest in solar panels as well as other forms of energy efficient and renewable energy(EERE), using a survey that they sent out to a county in the state of Florida they aimed to find out information on how people felt towards 6 different types of renewable energy products as well as the available tax credits and/or interest free loans for said products.

What they found was that while society is becoming more aware of these products and may even begin wanting to use them, their needs to be a significant change in current incentives to address the high cost of these options. From this limited survey it is evident that not enough financial incentives exist to make people invest in these new energy products such as solar panels. Higher tax credits are especially needed for the more expensive ones such as solar panels and are even more needed in regard to those of lower financial status or living in older domiciles. They conclude that this study highlights how further research must be done and the incentives tailored more towards the different demographics of the area being targeted. Another good article on this subject comes all the way from Australia.

Modelling Future uptake of solar photo-voltaics and water heaters under different government incentives written by Andrew Higgins, Cheryl McNamara and Greg Foliente is an interesting article from Australia in which they aim to help develop and adjust a good forecasting model regarding the changeover to solar powered products. All three authors work for CSIRO Ecosystem Sciences as research scientists and have gotten their educations at reputable schools. They chose an integrated diffusion-choice model to forecast the adoption of solar powered products, specifically panels and water heaters, and what different outside influencers such as tax incentives worked best. The survey was also able to show how different factors in the surveyed

area affected the choice of products. They concluded that this survey model type was a good forecaster of how likely people were to adopt new solar powered products as well as what incentives worked or could be changed so as to make people adopt this technology. This article is very interesting in how perhaps we can use this type of a survey to get solar powered technology to be more prominent in our country.

Once discussing the idea of becoming more prominent within our country we also must look to see what types of incentives we have such as discussed in: Are Policy incentives for solar power effective? Evidence from residential installations in the northeast written by Christine Lasco Crago and Ilya Chernyakhovskiy is an article which centers on the incentives offered by states for solar power adoption or investment by consumers. Christine Crago works at the university of Massachusetts Amherst and is very involved in the solar power field whilst Ilya Chernyakhovskiy is employed by the national renewable energy laboratory thus ensuring that this article is written by well-educated and knowledgeable people. They used an empirical strategy in which they examined county level data spanning eight years from 2005-2012 for 13 states in the northeast united states so as to examine the impact of policy incentives for residential solar panel adoption. What they found was that amongst the many financial incentives that exist, the ones with cash rebates had the most and largest effect. Additionally, they found that solar panel installation and use shows evidence of being limited to or more predominant in situations of high financial income being available or in other words wealthier people tend to be making the change rather than those in the middle- or lower-income brackets. Research suggests further inquiry into this may be needed to obtain good incentives for all income levels.

Using electrical energy storage in residential buildings- sizing of battery and photovoltaic panels based on electricity cost optimization written by Juha Koskela, Antti Rautiainen and Pertti

Jarventausta is a good article on this subject. The authors are employed by Tampere University out of Finland and all appear to be educated and without any large bias. This article is very interesting as they study the concept of Electrical Energy Storage Systems (EESS) and how when used in conjunction with solar panels could become very efficient and profitable to the consumer. In this study they analyzed the different factors involved in both installing a solar panel system and an EESS to go with it so as to maximize the benefits for the consumer. What they found was that this system of using solar panels (PV) in conjunction with EESS could help eliminate issues that exist when connecting multiple systems to the overall power grid as well as make it more affordable and palatable to the average consumer. They concluded that if the consumer was to get an EESS set or configured for them first and then the solar panels were installed so as to know how large an array is needed for the system, the cost would go down as the PV system is built to work with the EESS which was made specific for the home and its usual use. Not being connected to the overall grid helps reduce issues related to that and also lowers installation cost as you are building the system for your needs not an estimated usage amount wherein you expect to get a surplus of energy that would have to go somewhere.

In a similar vein of thought, Electricity bill savings and the role of energy efficiency improvements: a case study of residential solar adopters in the USA is written by Mahelet G. Fikru. Mahelet G. Fikru is a Professor at the Missouri university of science and technology where she works in the department of economics. Ms. Fikru obtained her education from the southern Illinois university and seems to be highly educated and involved in the renewable energy field. This article is different from many others in that she studies the actual value of electricity savings for a residential solar adopter. The study aims to measure the actual value of electricity bill savings for solar adopters in the United States and to quantify the effect that household

choices and actions can have on the savings. The study found some interesting results and suggests a number of different things.

First it brings into context the idea of lease versus ownership in regards to solar panel setups and indicates that although leasing appears cheaper a consumer should do all research as it may in actuality be more costly. The findings further suggest that additional improvements to the home at the time of or around the time of solar panel adoption can significantly increase the savings to a consumer. Fikru concludes with the suggestion that further studies are needed to determine the true electrical savings obtained by switching to solar power and what further could be done to get the full benefits of it. she additionally mentions that the interaction between markets and technology such as solar power make it difficult for policy makers to create effective incentives or policies thus, they need to do more research so as to obtain a deeper understanding of how to create proper policy and incentives.

The Heterogeneous preferences for solar energy policies among us households written by Yan Heng, Chao-Lin Lu, Luqing Yu and Zhifeng Gao attempts to figure out the preferences of solar energy consumers and to further identify what if any impact policies have on consumers support of solar energy. To accomplish this a survey was used consisting of three sections. The first section includes basic respondent demographic information, the second includes respondents' attitudes towards climate change and solar energy whilst the third and final section is where respondents choose their favorite from three options of solar energy policy profiles. It was designed to elicit the preferences of consumers living in the United States regarding solar energy. What they found was that at the time of this article consumers show an interest and preference for solar energy use policies however they need the financial incentives to make it

possible in anyway. They suggest that further research could and should be done as well as finding ways to make it more affordable.

Besides affordability it would appear that humans still care about appearances over functionality which leads to the interesting article: Understanding the role of visual appeal in consumer preference for residential solar panels written by Qifang Bao, Tomonori Honda, Sami El Ferik, Mian Mobeen Shaukat and Maria C. Yang approaches the concept of solar panel adoption through the lens of visual appeal. The goal of this study was to identify if visual appearance had any effect on consumer adoption of residential solar panels. To accomplish this they conducted two surveys, Survey 1 investigated the consumers preference regarding the appearance of solar panels whilst the second survey examined a consumer's preference for a solar panel's functional performance, price and the interaction between the preference for a functional panel and visually appealing panel. The results from this study show that unsurprisingly the aesthetic appeal plays a significant role in a consumer's interest and investment in solar energy. Furthermore, the study indicates that people may be willing to adopt solar panel technology more if the panels and set up were more aesthetically pleasing. The authors further suggest that future research may want to be done in this lane of thought so as to increase the overall adoption of this technology.

Finally, we come to the point where we must ask ourselves what influences us in regards to decision-making and this next article does just that. Passive and Active peer effects in the spatial diffusion of residential solar panels: a case study of the Las Vegas valley by Jesse L. Barnes, Anjala S. Krishen and Alexander Chan is an article where they aim to answer the research question of what influences consumers more, passive or active peer effects? Active peer effects consist of things like word of mouth and other peer to peer information exchanges whilst

passive peer effects consist of the idea of seeing visible examples of the product in use or similar situations. The results of this study were similar to what I would have expected which is that Active Peer Effects influence the most consumers and that Passive Peer Effects influence consumers also albeit in a lesser degree and more towards the later end of the diffusion process of technology adoption. This study is useful and contributable to the current data on this subject as it helps show what is influencing consumers to adopt the new solar technology as well as at what stage of diffusion it generally occurs.

## Chapter 3: Methods

### Introduction

This project was designed to use existing data and scholarly publications as well as other research sources to enable me to perform a qualitative analysis of the state of solar panel industry in the United States. I compared and contrasted multiple scholarly works in an attempt to deduce the current status of our solar panel industry. I analyzed the various studies I found from a quantitative standpoint so I could best understand what they concluded and how it truly relates to the issue at hand now as opposed to how it was when the original study was conducted.

### Selection criteria

In order to ensure this project was done in a valid and reliable method I chose to use sources that were peer-reviewed in addition to coming from reliable sources. I looked for information pertaining to the economics of home solar technology in addition to the technological aspects. Furthermore, I also analyzed how human psychology is related to and involved in the growth and development of the home solar technology field.

### Search terms

It took some experimenting with search terms to get the right results but eventually I was able to locate what I was looking for. The terms that ultimately proved the most useful were Solar Energy, Solar Power, Solar Energy Incentives, Solar Energy United States and Solar Power Incentives. It was very surprising to me that when I starting researching this topic, I kept getting



results that had nothing to do with this project or topic. It would appear that since Solar Power is such a large and controversial field that there is a lot of research available. However, it all seems to be on different minor aspects of the larger topic. Although I used the SUNY Purchase General database to find scholarly research sources, I believe that the struggle to find relevant and precise sources highlights the need for a larger organizational method for this topic which would centralize all the true and relevant research in one place thus preventing duplicative work or struggles to find answers that exist already.

#### Data collection and analysis methods

The data I collected is all secondary (from publications) and the method in which I analyzed it was qualitative. I chose to obtain my research sources from scholarly works that were not just from reliable scholars but also were peer-reviewed thus lending another edge of reliability to the information within the study. Once I collected my sources, I proceeded to analyze each one so as to see exactly how they relate to this project and if their study methods were sound enough to support this project's goal. Finally, I took the sources I found most relevant and reliable and proceeded to analyze them in the lens of this projects research question so that I may come to a conclusion based on educated research.

#### Study quality and risk of bias

This study is high quality because of my exacting parameters insofar as my research sources go and my analytical process. I used only peer-reviewed scholarly sources to ensure that the information I analyzed was not just reliable, current or related to the question at hand but most importantly would be accepted by my peers in order to ensure this project was meaningful

and substantive. I do not believe I have any bias risk in this project as this topic is a neutral one for me and I strove to ensure that any resources I used did not include any bias and if present I would ensure to take that into consideration.

## Conclusion

Using these methods, it was possible to generate this project with a high degree of reliability and accuracy which was of the utmost importance. The reason this was so important is that in order for a project to be truly helpful, educational and influential it must be done in a method that is not just transparent but also reliable, accurate and replicable. To this end I have endeavored to conduct this project to the highest standards possible and in such a way as to be replicable in the future if needed.

## Chapter 4: Findings

Having conducted all of this research, I have concluded that although a multitude of incentives and encouragements have been used to promote the adoption of Solar Energy and Solar Panel use by private residential consumers, only three types were truly successful, and I will review each. The three types of incentives that were most effective in promoting solar energy adoption were cash incentives, tax incentives and passive/active peer effects.

Tax incentives was the method that I found to work the least at encouraging solar energy adoption with private residential consumers. The reason that this incentive does not promote the adoption of this new technology as planned is that the tax benefits are not significant enough. The current tax incentives are not large enough to make the change to solar energy affordable or desirable by most consumers even though many consumers expressed an interest in the changeover. For example, in Fig 1. It is clear that consumers have an interest in adopting energy efficient and renewable energy products, solar panels being one of them.

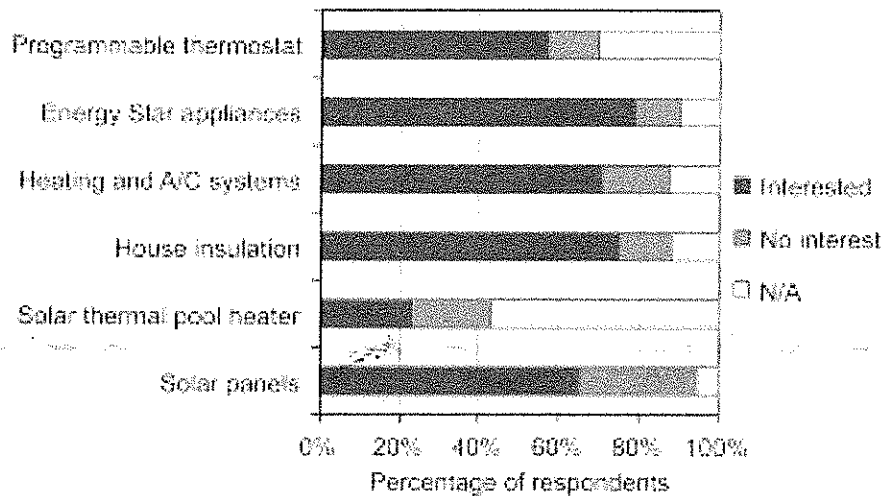


Fig 1. (Zhao et al. 2012, Fig 1)

However, it is also clear from Fig 2. that savings and available tax credits are big influencers on whether or not a consumer will make the big purchase.

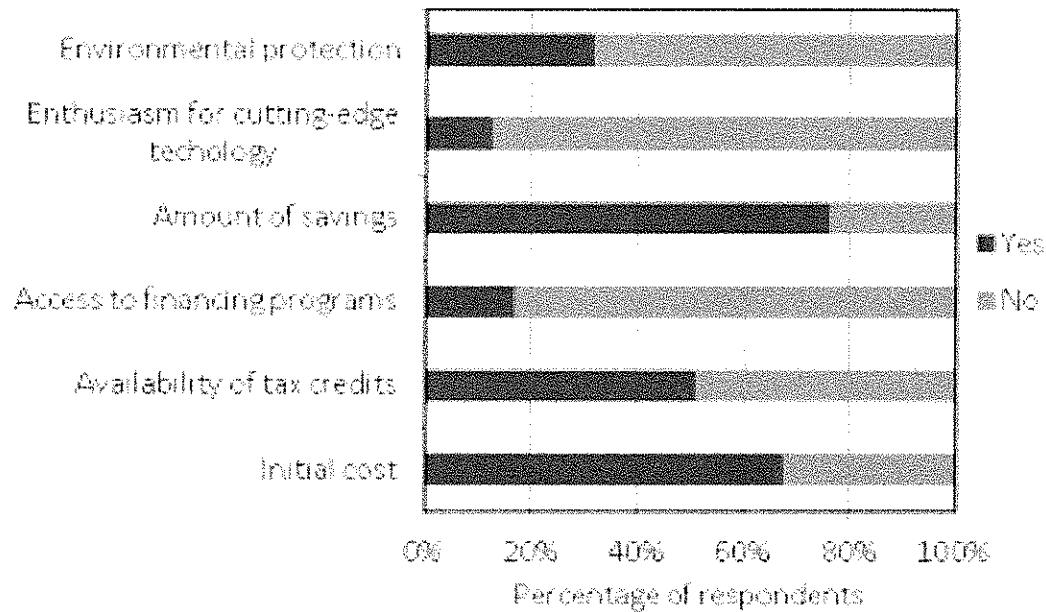


Fig 2. Factors that influence respondents' decisions to install energy-efficient and renewable energy products (Zhao et al. 2012, Fig. 2)

Unfortunately, all the research has shown that the current tax incentives just don't outweigh the costs and other big factors that influence the consumer. What is evident to me is that we need to take all of this existing research and use it to fine tune our current incentives so as to make it worthwhile for the consumer. In fact, Fig 3 clearly shows that if the tax incentives were to be increased, more consumers would make the big choice to invest in solar energy as well as other forms of EERE.

Cash incentives, on the other hand, have proven to be the leading way in helping consumers make the choice and switch to solar energy. Why might this work better than tax incentives you may ask? Well, the reason is that cash incentives have shown to be more immediate and apparent to the consumer, thus helping to outweigh the other negative factors influencing the consumer. What must be kept in our mind as we conduct this project is that solar

panel adoption has a very large upfront cost as well as a long-term cost too. The idea behind it is that not only is it a cleaner and better energy source for the environment and us but it is also cheaper for the consumer than what they currently utilize for energy.

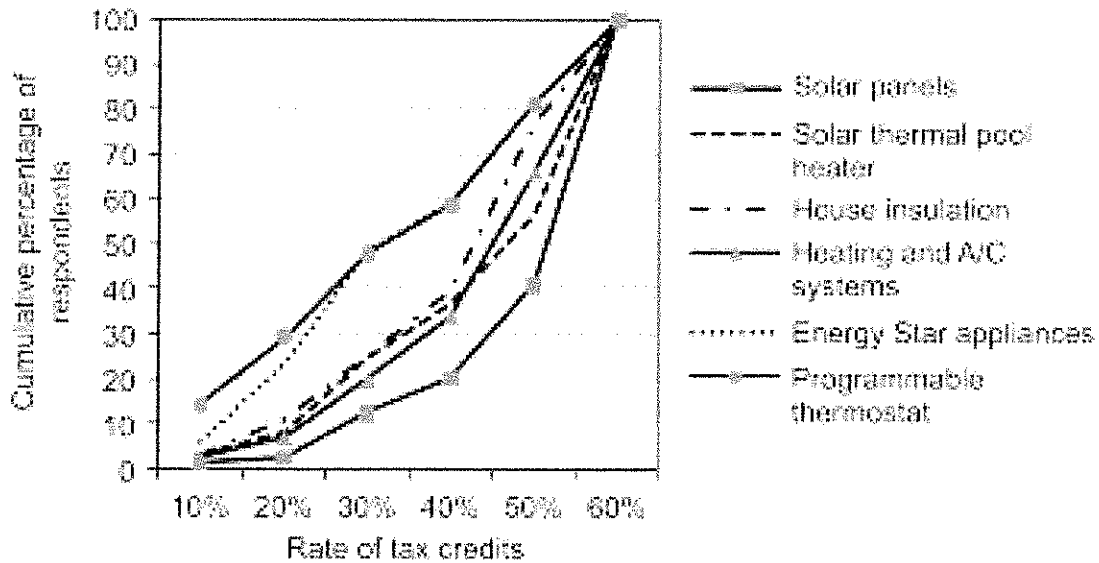


Fig 3. Tax credit rate needed to induce consumer purchase (Zhao et al. 2012, Fig. 3)

These cash rebates are more influential for a consumer as they are usually upfront or semi-immediate thus assisting with the many costs of adopting this energy source. All the research has shown that cash incentives work best however they also indicate that we need to improve upon our current cash incentives or rebates. It can be seen that if the rebates were increased even marginally, it would greatly increase the adoption of solar panels. Table 1 helps highlight the average costs of the consumer for making this change in a number of different states.

Additionally, the research supports that increasing the average rebate by just \$1 more per watt of energy would significantly increase the consumer adoption of this technology.

Finally, we come to the final type of incentive that is highly successful in promoting consumer adoption of solar energy however, it is not an actual incentive in the same way as the

others discussed in this project are. This significant incentive is called Passive and Active peer effect. Although it sounds all scientific and therefore complicated, it actual is really the concept of how we as humans are influenced by our environment and all that It contains. Thus, we are influenced to make the desired change to solar energy or not influenced to do so by the environment we are in along with the people we surround ourselves with. Which we can all agree is a simple concept to understand.

State	Average rebate 2005–2012	Policy cost	Implied cost of CO <sub>2</sub>
Empty Cell	\$/watt	\$/watt	\$/ton CO <sub>2</sub>
<b>CT</b>	0.22	0.10	145
<b>DC</b>	1.14	0.16	221
<b>DE</b>	3.61	0.19	269
<b>MA</b>	0.29	0.11	152
<b>MD</b>	1.19	0.13	175
<b>ME</b>	0.90	0.11	152
<b>NH</b>	1.03	0.14	192
<b>NJ</b>	0.66	0.13	177
<b>NY</b>	3.31	0.18	253
<b>PA</b>	0.82	0.15	206
<b>RI</b>	0.00	0.10	134
<b>VT</b>	1.49	0.13	176
<b>WV</b>	0.00	0.10	134
<b>Average</b>	1.13	0.13	184

Table 1. Policy cost of rebate programs (Crago and Chernyakhovskiy 2017, Table 9)

Passive Peer Effect is the idea that if we see things in our environment often enough; know about it being used and possibly hear about it in other passive manners then we will be influenced to make that decision. It is essentially the idea that nobody wants to be the odd one

out and therefore the more predominant solar panel adoption is in a given area so too does the likelihood of other consumers making the change increase. Now active peer effect is exactly what it sounds like, the effect that happens from your peers actively doing something to or with you. active peer effect consists of things like having conversations with people who have made the change to solar panels, word of mouth, advertisements or salespeople and any other situation in which something is actively influencing or interacting with you.

The research shows that amongst all the many forms of incentives to try and get consumers to adopt this new energy technology, this is the second if not most effective method. Why is this the second most effective influencer if not the first when it doesn't actually give the consumer anything tangible to make the change? well its simple psychology at work here, nobody wants to be the odd man out thus the more people who switch over to solar energy the easier it will be for others to do so. Fig 4. Depicts the various stages of adoption diffusion that occurs overtime in a given area, passive and active peer effect are highly influential the further on the curve of diffusion we get. Essentially Fig 4. helps show the stages of technology adoption in an area and the research done through this project indicates which incentives work best at the various stages.

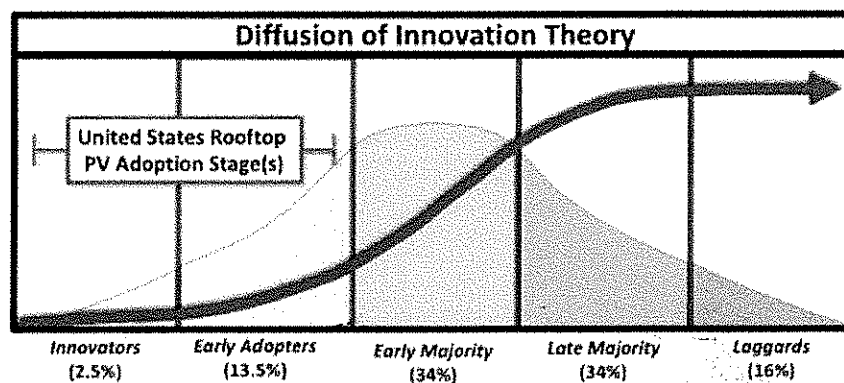


Fig 4. Curve of Technology Adoption (Barnes, et al. 2022, Fig 1.)

## Chapter 5: Conclusions

Human beings from the beginning of time have always sought to grow, expand and improve upon not just our surroundings or society but the world as well. throughout this endless endeavor we have developed and crafted a myriad of different technologies all of which are new and exciting as they come about however, do we ever consider the consequences of these developments? Sadly, we don't often consider it, in fact oftentimes people forget that there is a pro and con to all things that we do and that has resulted in serious pollution and destruction to our environment. Now I know what you're thinking, if this is all true why am I reading this essay? Isn't it already fixed since we developed the better technology and options? Alas, this is not the case because we are human and therefore complicate things because we don't just think altruistically but also selfishly. Humans think about their current lifestyle and how this new technology might affect it, thus leading to the reason I am writing this paper. The reason I am writing this paper and enacting this project is so I can answer the question of how America has used incentives to either encourage or discourage Solar Panel installation on private homes. Surprisingly this answer is quite simple and yet simultaneously it's not so simple because we are human.

America has an abundance of incentives in existence to help consumers make the choice to change into solar energy however, they all need some tweaking to make them work as well as they should and were designed to do. We have figured out the problem as well as the solution but once we created these incentives to try and get society to start changing, we seem to have



stopped. What do you mean by stopped? Well unfortunately it seems that once the incentives were created, we just stopped and said Well its done, here you go when what we should be doing is research on how they actually work in the field. What should be done is research into how well or unwell the incentives and programs are working so that they could be improved. This project is an example of said research that should and hopefully will be evaluated and used to improve the incentives we have in existence.

The research I've conducted shows that the cash incentives, tax incentives and active/passive peer effect are the three most successful incentives we have to getting consumers to switch over. However, the research also showed that they all need some work done, tweaking done so as to make them work better. I believe that further research can and should be done into the various programs we have now so as to improve them. I believe that we have a good amount of current research in existence which should help people narrow down their search parameters. For example, further research should be done into finding a way to tailor incentive programs to a person's individual situation as opposed to being a general rule, this I believe might be much more effective in convincing people to change over to solar energy. So, to conclude this paper I will just suggest that further research be done to improve our current solar program incentives and il also ask you to ponder this one question: should we ever stop trying to improve?

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