

# **Analysis of Social Shaping in Solar-Powered Battery Installations for Home Use**

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

Advisor

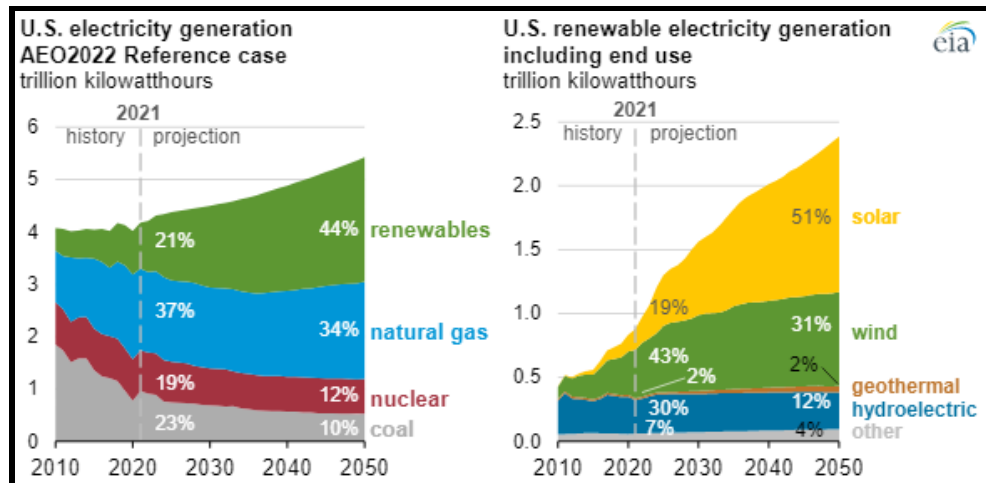
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## Introduction

“We are like tenant farmers chopping down the fence around our house for fuel when we should be using nature's inexhaustible sources of energy – sun, wind and tide. ... I'd put my money on the sun and solar energy. What a source of power! I hope we don't have to wait until oil and coal run out before we tackle that.”

-Thomas Edison (Nussey, 2018)

Looking at this quote, Thomas Edison, one of the most well-known inventors could foresee how crucial it would be to utilize technology capable of being able to harness the sun's energy and ultimately get away from fossil fuels. Edison may end up being right in his statement due to solar energy being one of the most promising sources of renewable energy that is currently on the rise. Below in Figure 1, the United States (U.S) Energy Information Administration has collected data that shows the current breakdown of energy usage in the U.S as well as predicting future numbers all the way to 2050.



**Figure 1:** Energy Generation Comparison for Electrical and Renewable Energy from 2010 to 2050 in the U.S. (Linga, 2022)

It's clear to see that solar energy has been rapidly growing over the years and will eventually be the biggest source of renewable energy.

Despite this, policies as well as high costs associated with solar battery powered installations at the home level have affected many groups, such as companies and individuals. If

the policies and costs pertaining to solar powered battery installations for home use were to be improved upon, they could shape society for the better. It's uncertain as to when in the near future these regulations, which exist at all levels of government, will be overturned as well as prices pertaining to this technology will decline ("Solar Energy Industries", 2022). The research conducted in this paper is significant to understand because it will look to address and inform on solar-powered battery installations for home use can be improved upon to further society. If this aspect is not understood, it's a fair argument to say this issue might never be resolved and society will not take advantage of this technology that could advance how we use energy.

To further support these claims evidence will be gathered which includes articles and statements from well-known sources such as Harvard Business Review and the Department of Energy. In addition, seeking various companies in this field will be used to identify any new or current problems that may exist for them. Overall, this paper will primarily focus on how this innovation was hindered in the past by various factors, such as policies and economics, to where it currently stands in society as well as speculate to where it could be in the future.

### **Problem Definition: The Gap in Knowledge and Understanding the Solution**

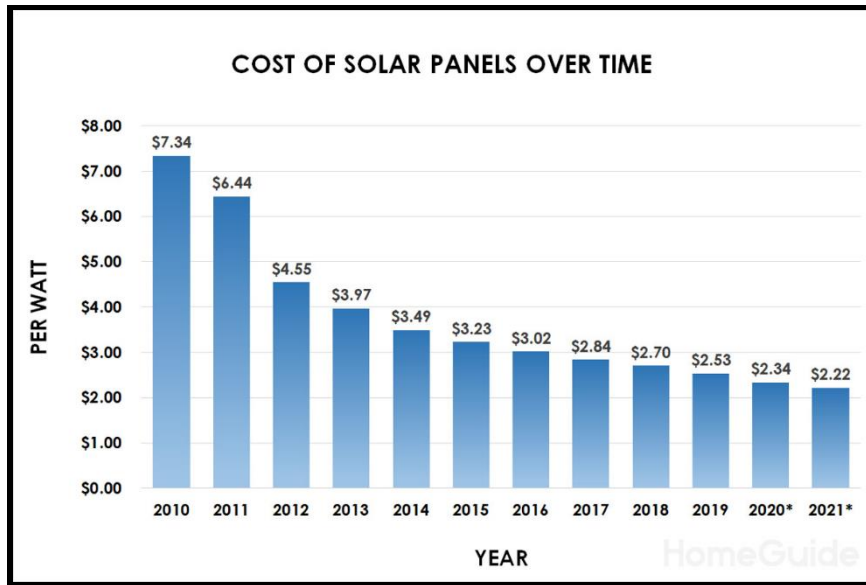
Although solar power is one of the fastest growing sources of renewable energy in society it still is being limited in several ways. In particular, the largest factors that have contributed to this is legislation that currently exists at every level of government as well as high prices associated with owning and maintaining the technology. The factors just described have affected companies and individuals utilizing various innovations and advancements in this field of energy, such as solar-powered battery installations for home usage.

Currently there are many regulations in place limiting the use of these companies' technology and if this technology is to spread, these regulations will need to be dealt with. For

example, in the U.S. there are various regulations at the federal, state, and regional levels that prevent people from installing these systems (Pearce, 2016). These installations are mostly limited in largely populated areas due to building restrictions based upon various factors, such as safety, noise, and height systems (Beck & Martinot, n.d). Soon, these regulations could change if planning departments in cities were to update their policies for the dealing and sitting for this technology. In addition, the lack of specific regulations has also contributed to the halting of this technology (Beck & Martinot, n.d). For instance, there has been a lot of confusion created for companies and individuals in several aspects. One of which being the uncertainty when it comes to code requirements for installing this technology. Companies that have employees in charge of installing this technology may not do enough or too much to be properly installed. Anything that is being contracted to a company to be constructed on or around a home requires certain health and safety codes that need to be followed. If there is not a specific set of regulations put out by localities there is always going to be a threat to safety as well as liability concern for this technology.

Not only companies but as well as individuals who are homeowners and consumers of the power grid would be affected by lowered costs pertaining to solar power. Solar-powered battery installations can be seen as a long-term investment due to having to pay upfront for this technology (“Benefits of Residential Solar Electricity”, n.d.). The cost in 2021 ranged from \$11,000 to \$15,000 for the entire system which includes solar panels along with the inverter. These systems are costly due to them containing high quality materials, such as silicon, which require a large amount of energy to create and manufacture. In addition, they also utilize high grade inverters and electrical protective materials that contribute to the high costs (Rosenberg, 2021, n.p.). However, over time one will end up paying significantly less for utility bills to use

solar energy partially or entirely to power their home (Riley, 2022). Previously, the cost was even higher making it hard for the average person to utilize this type of equipment. For example, below in Figure 2 is an average of the cost of solar panels per watt from 2010 to 2021 in the United States (U.S).

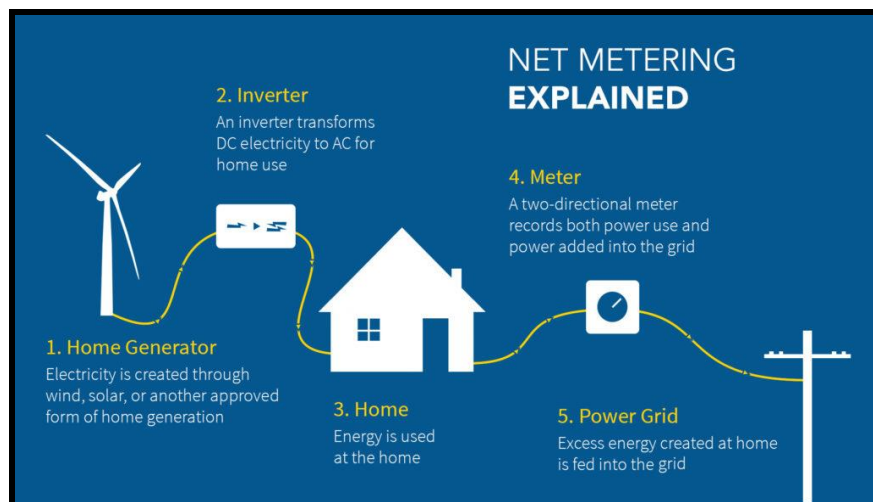


**Figure 2:** Cost of Solar Panels Per Watt from 2010-2021 (“2022 solar panel costs: Average installation cost calculator”, n.d.)

In 2010, the cost of the solar panels was \$7.34 per watt which is absurd compared to where current prices stand in today’s time. Due to this solar panels were primarily seen as a luxury technology to own. Overall, it is very evident to see that over the years there has been a trend in a reduction of cost to pay for these panels. This is largely due to researchers being able to improve upon solar technology making it more efficient and more cost-effective (“How Did Solar Become The Cheapest Energy”, n.d.).

In order to offset the expenses associated with the system and installation, the federal government as an incentive has put in place a 26% tax credit for systems installed between 2020-2022 and a 22% tax credit for systems installed in 2023 (“Homeowner’s Guide to the Federal Tax Credit for Solar Photovoltaics”, n.d.). In addition, consumers who own this system can sell

electricity that is generated by their solar panels to utilities through a net metering plan. Below in Figure 3 is a detailed description of the process for net metering.



**Figure 3:** Detailed Process for Net Metering from Generation to Power Grid (“What is net metering?”, 2021)

Essentially, this process is when residential consumers are credited for the electricity they add to the grid when the rate of generation from their solar system is greater than the rate of utility consumption (Riley, 2022). Although this is a great addition for a homeowner, utility companies may think differently about this aspect (“Net Metering”, 2017). For example, in the state of Tennessee, net metering plans aren’t offered because of contracts that exist between the Tennessee Valley Authority (TVA) and local authorities. Tennessee is viewed as a good location to harness solar energy due to getting a large amount of sun throughout the year, but there has been little to no effort from legislators to create this incentive (“Summary of Tennessee solar incentives 2022”, 2022).

Overall, researching the aspects of this topic allows for the comparison of limitations relating to this technology that have occurred in the past and currently in today’s time. Solar powered battery installations for home usage have come a long way in society, but there is still much left to do to make them readily available for anyone to own, use and even sell. By the end

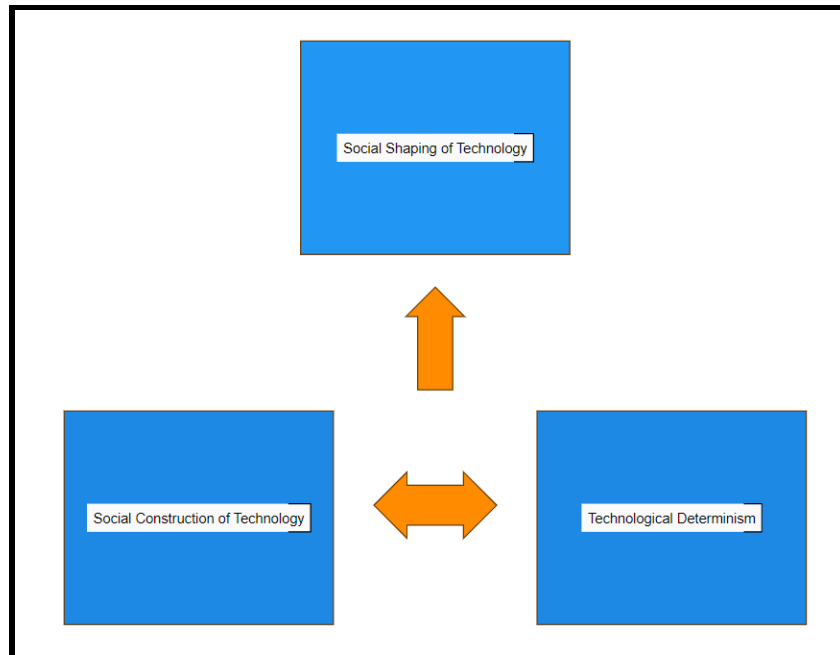
of this paper, the problems associated with solar powered battery installations for home use will be fully examined and discussed as well determine what aspects could be improved upon in the future to make this technology grow even further. Specifically, the regulatory lag as well as overall costs for this technology and how this affects companies and individuals in society.

### **Methods: Which Shapes Society, Technological or Social Factors?**

One key question that commonly arises within the field of Science, Technology, and Society (STS) is if technology shapes society or the opposite with society shaping technology. The concept that claims various aspects of society, such as culture and economics change due to advances in technology is known as technological determinism. On the other hand, the idea that the relationship between society and technology, where society is the driving force bringing forth changes and advances in technology is referred to as social construction of technology (SCOT). I argue that both concepts are correct depending on the situation and they both affect one another. When looking at the context of this specific analysis, both concepts are relevant in terms of mutual shaping

#### *Williams and Edge Analysis of Social Shaping Applied Towards Solar Powered Battery Installations*

Robin Williams and David Edge (1999) in their paper discuss the social shaping of technology (SST). Specifically, their work analyzes the content of technology as well as the various processes surrounding innovation (Williams and Edge, 1999). In Figure 4, we can see a generalization of the overall process pertaining to the social shaping of technology.



**Figure 4:** Diagram of the Social Shaping of Technology (Adapted from Osembe, 1970)

Based on this it's clear to see that SST pertains to not only the effect of technology on society, but also the society and economic impacts on technology. Overall, the main idea behind SST is to seek to understand the way cultural, social, economic, and institutional factors have played a role in the direction and rate of innovation, the form of technology, and the outcomes of technological change for various groups (Williams and Edge, 1999).

*Applying Social Shaping to Solar Powered Battery Installations for Home Use*

Williams and Edge's (1999) research were focused on analyzing the technological determinism and SCOT which both fall under the category of SST. Both parts of their framework can be applied to this paper when examining solar powered battery installations for home use.

In terms of SCOT and more specifically, the policies and economics surrounding technology, Williams and Edge (1999) make a claim based on the work by Green (1992) that the markets can be viewed as socially constructed and shaped by legal, political, cultural and knowledge processes (Williams and Edge, 1999). These aspects are relevant when looking at various legislation currently in place has hindered this technology from growing even further in



society. They later go on to discuss how although technology can be obtained by the market, it is not typically accessible as a finished product that could simply be bought off the shelf. Rather, there needs to be facilitation in developing a product that exists between the supplier and user both working together in collaboration. Essentially, when referencing the work of Newell and Clark (1992) and Fincham et al. (1995), Williams and Edge (1999) make the claim that markets are highly influenced by industrial and occupational structures, and they also are one extreme of various forms of social network that create and shape technology (Williams and Edge, 1999). Their claim can be applied to solar powered battery installations for home use when looking at the overall economics surrounding the technology. In particular, the costs relating to manufacturing the technology as well as the relationship that exists between utility companies and consumers.

When looking at social determinism, Williams and Edge (1999) reference a previous work done by Edge (1988) that states technology causes necessary and determinate “impacts” upon work, economics, and society entirely. Essentially, technology brings about change in the form of social and organizational aspects. In addition, they also go on to talk about how social, institution, economic, and cultural factors have influenced the direction and rate of innovation, the content of technological artefacts and practices, or the form of technology, and how different groups in society are affected by the outcomes of technological change (Williams and Edge, 1999). This relates to these installations due to a wide variety of impacts it can have on the environment, economics, and society.

## **Results: Overview of the Problems Surrounding these Installations and Implications**

Despite regulations and economics associated with solar powered battery installations for home use improving drastically over the years, there remains more room for improvement. If these regulations and economics are changed in a way that promotes the growth of this technology, we can expect there will be environmental, economic, and societal changes. Williams and Edge (1999) illustrate the framework pertaining to technological determinism and SCOT, which can be directly applied to these installations. When looking at this specific technology and the impacts discussed in this section, SCOT needs to occur first and then followed by technological determinism.

### *Policies and Economic Influence*

Williams and Edge (1999) state that there needs to be some form of a relationship between a supplier and a user when creating a product. However, in the case of this technology, there needs to be more of a demand from users to push suppliers to develop a product that is more affordable. Without some form of demand coming from the social network, we cannot expect these installations to improve at a rapid rate.

In addition, if there is no demand from the social network and there is pushback from groups, we can expect advances to take even longer and in some cases it may never change. One particular scenario where this has occurred is with net metering plans. Despite this being a useful innovation pertaining to solar powered battery installations, utility companies have had some pushback against them (“Net Metering”, 2017). Their claim against these plans is that it gives homeowners an unfair advantage over homeowners who don’t own the solar technology needed to have a net metering plan. Basically, ratepayers will end up paying the costs of usual power generation. Pushback such as this has caused many companies to go out of business due to the

slowing down of the market because a majority of the states are reviewing their solar energy policies (Tabuchi, 2017). This aspect furthers William and Edge's claim that there needs to be a relationship between the supplier and user. The fact that utility companies are losing money due to net metering plans doesn't give them the right to raise the rates to compensate for their loss or even lobby to prevent people from utilizing this addition to their installations.

### *Impact of Federal Initiatives and Incentives*

In 2011, the U.S. Department of Energy's Solar Energy Technologies Office (SETO) created an initiative known as SunShot which embodies the idea of SCOT. The overarching goal of SunShot was to make solar-generated electricity competitive with common sources of energy all across the country in the year 2020 by reducing the costs relating to the technology. However, this goal was achieved earlier than expected in the year 2017 for utility-scale photovoltaic installations, with these systems ultimately producing more than 3% of the U.S. electricity supply. This is a substantial increase from only producing 0.1% in 2011 when the initiative started ("2030 solar cost targets", n.d.)

Another way SCOT is relevant to these installations is through the U.S setting up incentives pertaining to this technology. The largest being in the form of a tax credit and this is crucial in order to offset the expenses associated with the system and installation, the federal government as an incentive has put in place a 26% tax credit for systems installed between 2020-2022 and a 22% tax credit for systems installed in 2023 ("Homeowner's Guide to the Federal Tax Credit for Solar Photovoltaics", n.d.). When the tax credit system was introduced in 2006, the industry grew by 10,000% with an average annual growth of 50% over the last ten years (Murphy, 2022).

These efforts by the federal government are crucial in pushing for not only solar battery installations for home use to become more readily available, but also any technology relating to solar energy in general. Both led to large increases in the growth of the U.S. solar industry and the validates the claim of SCOT pertaining to this area of technology. If these initiatives had not been put into places, we could argue that this technology would not as be aa widespread as it is today.

### *Environmental Impacts*

When discussing technological determinism, Williams and Edge (1999) state that there are various impacts that pertain to all aspects of society as a whole, which are caused by technological innovations. If these installations are allowed to expand, we can expect there to be a great deal of environmental changes to occur. There are both pros and cons to the environment surrounding the use of solar battery powered installations for home use.

Looking at the negative effects, the production of these installations is very harmful to the environment in that it can use materials that require a great deal of energy to make. It is possible that if this technology is more widespread that there could be more research conducted in an effort to develop a new method for manufacturing in order minimize the detrimental effects to the environment. In addition, overtime using these installations would end up paying back the energy debt in a brief time as well as generating even more due to the panels lasting for up to 20-25 years on average (“Solar energy and the environment”, 2022). On the other hand, solar technologies, such as this one, do not create air pollution or greenhouse gases when functioning. It is viewed as sustainable energy source that promotes energy independence and more recently has started to compete with the cost of using fossil fuels (Johnston, 2015). Overall, the positives

surround these systems outweigh the harm to the environmental they could cause in both manufacturing as well as using.

In closing, technological determinism can be applied to the environmental impacts described here that could come about if this technology is to grow. This growth could be the push society needs to get away from fossil fuels and start using a much cleaner source of energy. If not, we may never find an alternative energy source to slow down the harm effects on the environment.

### *Implications*

Overall, solar power has been growing rapidly in recent time and it is well positioned to play a monumental role in the transition to renewable energy. However, for this transition to occur there needs to be a change in the dynamic between the actors involved. Specifically, in order for this change to become a reality, there needs to be a balance between the companies and users of solar-powered battery installations for home use. This could be accomplished by a third-party group that is unbiased in order to mediate between the two actors in an effort to ensure that there is fairness on both sides. This hypothetical third-party would take on the responsibility of engaging in dialogue with the companies and users to try to find common ground and solutions that benefits everyone. This could potentially show up in the form of negotiating contracts, partnerships, or simply by finding options to promote these installations. Ultimately, the end objective is to find solutions that are fair and sustainable and help to promote the use of the installations.

## Conclusion

In order for these installations to become more common in society the issues preventing its' growth needs to be identified and addressed, which can be accomplished through the framework of SCOT. The framework of technological determinism is then used to foresee the environmental impacts that may come about with the growth of this technology brought about by SCOT.

Specifically, this paper first utilizes SCOT to identify how policies as well as high costs associated with solar battery powered installations at the home level have affected many groups, such as companies and individuals. Through this analysis, the economics and legislation surrounding this technology needs to change and this can only happen if there is a demand from the users in society. Essentially, if there was more of a push in society to make this technology more accessible, companies and electricity suppliers would be forced to adapt to the wants and needs of their consumers. Without the federal government intervening in the form of initiatives and incentives, such as SunShot and tax credits, this technology would not be anywhere even close to progression it has made over the past couple of years. This push would then bring about technological determinism in that when this technology expands, there is societal impacts which encompass economics and the environment.

Based on the work in this paper the lack of demand from society has been the cause as to why this technology has been hindered. If this technology is to change in the near future, society will need step up and take action. When the federal government can cause a large amount of growth without the push from society, we can expect an even more monumental leap when both are working together to further this technology. Overall, this research is crucial in addressing and informing on how certain aspects pertaining only solar-powered battery installations for home

use can be improved upon to shape society for the better. Which is important to understand because the overarching takeaway from this scenario could be applied to other forms of technology as well.

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