

# Policies to Encourage Solar Energy Usage

William Cochran and Anoop Sattineni  
Auburn University, Auburn, AL, USA

## Abstract

The economic reality of fossil fuels is that these resources are found in a limited number of locations around the world, yet are consumed everywhere. Conversely, solar energy is available almost everywhere in world and is not being fully used. Fossil fuels and solar energy are complete opposites in not only their environmental effects, but also their economic effect. This study investigates global policies that encourage the development and deployment of solar energy. Solar energy is green, non-polluting, everlasting, and free of charge depending on how you look at it. Countries around the world have taken action and implemented solar energy with both progressive policies and incentives for those who use renewable energy. Governmental agencies and their affiliates have responded to this environmental movement and have spent a lot of time and money researching alternate energy sources, including solar energy. There are many different types of renewable energy, but the focus of this research will be solar energy.

## Keywords

Photovoltaic, Solar Energy, Governmental Policy, Global Perspective

## I. Introduction

Renewable energy is generally defined as energy that comes from resources, which are continually replenished, on a human timescale such as sunlight, wind, rain, tides, waves, and geothermal heat [1]. There are a number of reasons why solar energy should become a main source of power. The first is personal and national security. The more one uses solar energy, the less dependent that person is on non-renewable fossil fuels. Also, using solar energy will reduce pollution and decrease the need for foreign oil. A second reason why one should turn to using solar energy is protection against energy price increases. In many countries and regions, electricity prices are increasing. In California, for example, a combination of population growth, deregulation, increased demand for power, and decrease in construction of power plants has made electricity costs skyrocket. Other states and countries forecast energy prices increasing due to hydroelectric sources already being tapped and the decommissioning of nuclear power plants due to high costs and risks associated with nuclear waste disposal. It is for these reasons why new sources of electricity are needed. A third reason to use solar energy is because it is becoming a viable option financially. One way this occurs is through government rebates, tax credits, and grants. These help decrease the costs of solar energy installations and create a faster return on investment. Another way solar energy is a viable option financially is through net-metering. Typically, when a home consumes power from the grid, the meter runs forward and the homeowner is charged a certain amount of money per kilowatt hour. When one installs solar panels and connect their

panels to the grid, they are able to make the meter run backwards. This is accomplished by taking unused power generated from solar panels and feeding that power back into the grid. Finally, a fourth reason why using solar energy is beneficial is its impact on global warming reductions. In 2013, the U.S. increased energy usage by 2.3 quadrillion thermal units from the previous year. This increase in energy usage was supplemented with an increase to 5,390 million metric tons of carbon emissions. This steady increase in CO<sub>2</sub> emissions alone warrant the need for a more sustainable form of energy production and this is why solar energy is the answer to preserving the environment for future generations.

Different countries and cities around the world are on the brink of exploring and initiating new ways to preserve the earth, reduce reliance on fossil fuels, meet consumer demand, and reduce energy costs. This is being done through governments that are creating a market for solar energy through policies that help develop and deploy solar technology.

## II. Methodology

Literature review is an essential part of an academic research project. In the literature review, there are a few different sections which helped to understand different aspects of the topic. The first section of literature review analyses photovoltaic technology and its history. The second section of literature review is about global policy, current usage, and the evolution of solar energy. Finally the methodology consisted of primary data gathering from semi-structured interviews with subject matter experts.

A government's policies or lack of policy can greatly affect the success and/or failure of solar energy in a country. Information gathered about each country includes information about past policies, current policies, and future policies which promote solar energy in a positive way. Of these policies, secondary data showed what types of policies worked and what did not work. Many cities and countries across the world have set goals for themselves to use a certain amount of solar energy by a specific period in time. Additional information in the literature review includes case studies which show the success of different solar energy projects. Additionally, other governmental initiatives, statistics, and views were researched to fully satisfy the research aim.

The purpose of constructing semi-structured interviews is to talk to subject matter experts who have studied this issue for a long period of time. Interview candidates were carefully selected in order to gather valid data from knowledgeable sources about this topic. Each candidate interviewed either is involved in the solar industry or has conducted vast research related to solar energy. A list of questions was asked in each interview. As interviews evolved they turned into

conversations and answers to futures questions may have been answered. Therefore, some questions were not asked in some interviews. Also, some questions had to be reframed to apply to certain interviewee's positions and country or city of residence. Upon completion of each interview, the interviews were transcribed for textual analysis. All information obtained in each interview is used to supplement and compare to secondary data gathered in the literature review.

Thematic analysis is a method for analyzing and identifying patterns or themes within textual data. Thematic analysis can organize and describe data to an extent and can even interpret various aspects of the research topic. Thematic analysis is widely used, but sometimes there is uncertainty and disagreement to what thematic analysis actually is and how to go about doing it [2]. Thematic analysis was used in this paper to identify themes within data collected from interviews. Five candidates, educated on the subject matter, were interviewed and asked questions to help understand and complete the research aim. Answers to each question were coded. Codes were gathered and grouped together with comparable codes making up a theme. The themes gathered from interview data supplemented related themes found within the literature review which helped validate all data collected.

### iii. Background

There is an abundance of information regarding the use of solar energy all around the world. Some countries and governments have fully adopted the use of solar energy and have set goals on making renewable energy sources their main source of power. The installation and initial push to begin using solar power is an expensive venture and has kept many countries and governments away from using renewable energy [3]. Solar energy producing technology has improved and using solar power is becoming more affordable and heavily considered by countries around the world [4].

Solar power technology can be traced back to the 1800's. In 1839, French physicist, Alexander Edmond Becquerel discovered the photovoltaic effect. He was able to determine that shining light on a conductive solution could create electrical current. The rebirth and further discovery of this technology did not take place until 1941. In 1941, Russell Ohl invented the solar cell and the technology has only improved since that time [5]. Today, this technology continues to evolve and improve. Solar panels can generate power without any natural resources, waste, or pollution. It can be installed and used on any scale unlike conventional forms of power generation, which can have large-scale plants that require maintenance and the issue of transporting that power over long distances. Although there are solar plants that have to do this, solar panels can be installed and generate power at the location of the panel thus eliminating the need to transport power. As this technology improves it has gradually become more affordable and is being used around the world [6].

#### A. *Solar vs Other Renewable Energy Sources*

Solar power is a leading renewable energy source and from an environmental perspective, is very sustainable source of energy. In almost every part of the world, energy from fossil fuels is most common. Fossil fuels include coal, oil, and natural gas. These resources are non-renewable. Solar, wind, hydroelectric, bioenergy, hydrogen, geothermal, and ocean energy are all ways of creating power from renewable sources. Many of these types of renewable resources do not compare to the efficiency of others because some resources are suitable in more diverse types of geographical locations. Of the resources listed, the most popular forms are solar, wind, hydropower, and biomass. It is obvious that solar power has environmental and sustainable advantages over traditional fossil-fuel based energy sources. Solar energy also has advantages over other popular forms of renewable energy.

There are many advantages to using solar power over wind generated power. Wind turbines generate a lot of noise making wind turbines better suited for rural areas. Wind turbines also require maintenance while solar panels are virtually maintenance free and wind turbines do well in only windy places. Germany is not known to be a sunny place and they are the world leader in solar energy use. This shows that solar panels are suited for almost any location as opposed to wind turbines which can only be used in limited geographical locations. The good thing about wind power as opposed to solar power is that the initial costs for wind can be less expensive [7].

When comparing solar energy to hydropower, the cons of solar power are enough to prove how much more beneficial solar energy can be. Hydropower is possible with large dams which are extremely expensive to construct (Adele, 2010). These dams flood large areas of land, destroy natural habitats, and cause human relocation. Solar panels can be installed on rooftops and open space making solar energy a less destructive form of renewable energy (Adele, 2010).

Biomass comes from wood and plants and is typically used for fuels, but can be used for electricity production. Crops that are used as sources for biomass require land that could be used for food crops. Even though there are solar farms which take up space, solar panels can be installed on roof tops. Just because a source is renewable does not mean it is environmentally friendly. Burning biomass creates CO2 emissions while solar emits no pollutants. Solar panel technology is becoming more efficient and at this point in time, efficiencies are as high as 19% which means that a good bit of the suns energy is converted to electricity. The efficiency of biomass is less than 1% [7].

There are many positive aspects of using solar technology, but there are also many negative aspects which can be enough to sway someone from using solar technology. Perhaps the biggest con of solar energy is the initial cost of solar cells. Currently, prices of efficient solar cells can range to over \$1000. Most installations need more than one cell which makes solar very expensive. Depending on the size and location of the installation, the payback period could be too

long and in some situations the solar installation may never pay for itself [8]. Solar energy is more expensive than some of the other forms of energy production including coal, natural gas, nuclear, geothermal, and some wind installations, but is not the most expensive [9].

#### IV. Solar Policies

In this section a review of solar policies from select locations around the globe are presented.

##### A. United States

In the United States, there are many governmental incentives and programs designed to promote the development and deployment of renewable resources such as solar power. With that said, the United States has not implemented a renewable energy policy on the federal level. This is due to a multitude of hurdles caused by the United States political structure and culture. Divided government, incompatible political parties, and the elimination of previous policies, are just a few of the many areas that make it hard to come up with a long lasting policy. The fact that there is no policy does not mean the U.S. hasn't tried to move towards the use of renewable resources [10].

Plans have consistently been in place to promote renewable energy. However, policies have not been created using these plans. In 1977, the federal U.S. Department of Energy (DOE) was created and by law, every two years, the president and DOE are to meet and put together a "national energy policy plan." The only issue with this meeting between the president and DOE is that the plans created come and go, as presidents and their policies/plans come and go from office, thus making the last presidents policy or plan pointless as it was never carried out to satisfy its intended purpose or goal. These plans don't compare to a policy. A policy is more closely related to the Renewable Energy Directive in Europe. This policy created binding obligations on European countries and make it easier to set goals for the use of solar power. The latest plan by a president was Barrack Obama's plan to spend \$90 billion on the development of new green technologies, instead of deploying existing technologies, which would decrease reliance on energy produced by fossil fuels [10]. Another issue standing in the way of a permanent policy being created is the fact that the United States has a divided government. Unlike European parliamentary situations where the executive and majority of members of legislature are of the same political party, the U.S. government's different branches and houses of congress are all run by different parties, which are always clashing. And when it comes to deciding on a policy for the use of solar energy, the parties may agree on the fact that there should be a policy in place, but will disagree on how the policy is formed, the content of the policy, and the method of funding such a policy.

Even in the absence of a federal policy, there is a consensus between different parties and groups that the use of solar power as well as other renewable resources needs to begin. This consensus is formed because solar energy is the answer to a range of issues including, but not limited to

combating global warming, using a renewable source of energy, and creating energy independence and security for the future. The National Energy Policy of the United States stresses the importance of producing reliable, affordable, and environmentally sound energy that will ultimately benefit Americans for years to come. Although there is no policy in place, there are plenty of well-developed legal instruments that help in the push towards mass use of solar energy. There are many governmental incentives and regulations currently in place which include tax incentives, loan incentives, grant incentives, rebates, industry recruitment incentives, leasing/purchase incentives, production incentives, public benefit funds, green power purchasing policies, net metering rules, generation disclosure rules, and green power purchasing policies [10].

##### B. Australia

There are a number of governmental policies in Australia, which have helped influence both the development and use of solar energy. In 2001, the Mandatory Renewable Energy Target (MRET) was created in Australia. The Howard government introduced the policy and had goals set up through 2010. In 2011, the Gillard government revised the policy setting new goals for Australia to produce even more energy from renewable resources by 2020. Unlike the United States, the Australian government was able to take a policy created by a previous office and expand upon the existing policy instead of eliminating it all together [11].

The current target requires that 20% of Australia's energy come from renewables by the year 2020. To fulfil this goal, the Australian government has set annual targets for each year the policy is in place. These targets are achieved by requiring electrical retailers and wholesale purchasers of electricity to meet specifications of the policy. To police these retailers, Renewable energy certificates (RECs) were created. An REC is the equivalent to one additional megawatt-hour (MWh) of electricity produced by renewables. The key reason for the REC is to make sure these different companies are contributing to creating energy from solar power and helping meet the government's goals. RECs are the best way to enforce the MRET policy. There are two separate categories for RECs, the Large Scale Renewable Energy Target (LRET) and the Small Scale Renewable Energy Scheme (SRES). The LRET category is designated for large-scale renewable energy projects and the SRES is for small-scale installations such as installing solar panels on a residential building or household. Both categories have separate goals. The LRET hopes to generate 41,000 gigawatt hours (GWh) by 2020 and the SRES hopes to generate 4000 GWh annually. Electricity retailers and wholesale buyers now have to report RECs to the government to show they are doing their part to help meet goals. By introducing RECs, the retailers and wholesale buyers have to either generate their electricity from photovoltaics and other renewable sources, or they can choose to purchase RECs from other entities that have generated electricity from solar and other renewable sources. If these companies do not report proper RECs, they are charged \$65 per MWh [11].

In the United States, as discussed previously, the federal government has struggled in creating a national policy, but state policies have been quite successful. In Australia, federal policies are in place as well as state and city policies. This level of government influence is key in pushing towards the widespread use of solar energy. Sydney and Melbourne are two of the largest cities in Australia and are greatly contributing to Australia's overall goals and have even implemented goals for their cities alone. Sydney is in the midst of a massive energy infrastructure expansion. This expansion is expensive and to help with the cost of this expansion, energy distributors and retailers in New South Wales have been given the go ahead to increase energy prices to help recover the investment needed to deliver their modern energy system. Prices have also been increased due to a higher demand for electricity especially during peak demand, which occurs from 10am to 4pm. This high demand has sparked the need for alternate energy sources and has introduced the mass use of solar panels throughout Sydney's business districts and residential areas. To help meet the cities goals, a \$4.3 million dollar project has begun which involves the installation of solar panels on over 30 sites throughout Sydney. A few sites already in use include the Sydney Park Pavilion, Glebe Town Hall, and the Town Hall House. Other locations and future locations include various libraries, community centres, depots, and other public facilities. This will be the largest building-mounted solar panel program in Australia and will have a total peak capacity of 1.25 megawatts, greatly reducing the high demand of electricity during peak hours. By the end of this program, over 5,500 solar panels will have been installed on city buildings and will provide 12.5% of the cities energy requirements [12]. The blueprints of Sydney's master plan show how the city will be able to meet its goal of reducing greenhouse gas emissions across Sydney 70% below its levels in 2006 and generate 30% of the cities electricity from renewable sources by 2030. The master plan ultimately sees Sydney operating 100% from renewable energy [12].

Government influence is key for cities, states, and countries to adopt solar energy. There are different policies, plans, incentives, and methods to go about adopting solar energy. Melbourne's way of influencing this action is not by forming an ultimatum to install solar panels, but to advertise the need for solar energy and offer ideas on how the city can become more sustainable with its city planning, case studies, and incentives [13]. Melbourne's city government has explored and initiated alternate ways of promoting solar energy. A large impact has come from city planners encouraging all new construction to include the use of solar panels in their design. If owners do not want solar panels, they are encouraged to design a designated space for the future use of solar panels. On December 18, 2012, "Planning Scheme Amendment C187" was submitted and approved to the Minister of Planning for the city of Melbourne. The amendments mission statement declares, "Through good design, construction and operation, new buildings can have a significant impact in reducing our greenhouse gas emissions, water use and waste production." This policy will ensure that all new buildings in Melbourne will be eco-friendly. Although it is a broad policy involving aspects other than solar energy, the city is still heavily focused on the installation and use of

solar panels on all future buildings [13]. Melbourne plans to explore the opportunity to promote solar installations in many different ways. The city is identifying changes in solar energy technology to insure building owners with greater certainty toward solar installations. Also, future planning requirements are being reviewed to see if there is a better way to facilitate solar installations. Planning applications for new developments in the city of Melbourne are now required to show how using renewable energy will achieve high environmental performance and efficiency [13].

With the trend of increasing electricity prices expected to continue over the next few years, households in Brisbane, Cairns, and the rest of Queensland are looking to reduce their electric bills and even eliminate them altogether. In Brisbane, electricity prices have skyrocketed by 68% between 2007 and 2012. From 2012 to 2013, there was a 16% increase and now Queenslanders face prices increasing another 22%. With these increasing costs, switching to solar energy is becoming more of a necessity for homeowners throughout Queensland and to make the switch to solar easier, the federal government has implemented rebates, incentives, and feed in tariffs as a part of the Renewable Energy Target program. The feed in tariff is a way of paying homeowners for the solar energy they produce and do not use. There is no effective way to store energy, so pouring unused energy back into the grid is an effective way of using that energy and the power company will pay customers and consumers for that unused energy. In Queensland, homeowners will be paid \$0.16 per kilowatt hour for the excess solar energy produced that has the capability of being fed back into the grid. \$0.08 per kW hour will be paid to homeowners by the government and the other 6-8 cents is paid by electricity retailers. With the correct solar panel solution, homeowners can now not only meet their own electricity needs, but get paid 16 cents per kW hour for surplus electricity. This will greatly reduce energy prices for homeowners saving them hundreds of dollars a year on a 1.5kW system and thousands a year on a 5kW system. Power bills can even be eliminated thanks to solar energy [14].

### **C. Africa**

Sub-Saharan Africa has experienced remarkable economic growth over the past decade. In fact, they are number six of the ten fastest growing economies in the world. Despite this economic growth, the continent, as a whole, continues to face energy sector problems that will inevitably inhibit their rapid growth. Africa is a poverty stricken continent with a population expected to double to two billion by 2050 [15]. The need and consumption of energy will continue to grow with population growth and will become a much larger problem than it is now. For the continued economic growth of this continent, an alternative to the dependence on fossil fuels and hydropower is badly needed. These problems will ease and may even be eliminated with the implementation and use of solar power [15]. The World Bank shows that power tariffs in most parts of the developed world range from \$0.04 to \$0.08/kWh. In sub-Saharan Africa the average is \$0.13/kWh. On average, African economies lose 2.1% of GDP annually due to power shortages. With the reduction of technology costs, the increased supply of technology, and a rapidly

growing population, the investment in solar energy projects in sub-Saharan Africa is beginning to unfold.

Although there are no governmental incentives or legislation for the use of solar energy, there are encouraging signs of foreign investment. Some impoverished African countries are implementing solar feed-in tariffs (FITs). FITs are policy mechanisms designed to accelerate investment in renewable energy technologies. It achieves this by offering long-term contracts to renewable energy producers, typically based on the cost of generation of each technology. Rather than pay an equal amount for energy. According to Dr. Xavier Lemaire, coordinator of the Sustainable Energy Regulation Network at the University College London Energy Institute, the cost of solar technology is one of the most expensive of all renewable resource technologies. This makes it difficult to implement these tariffs. Kenya, Uganda, Tanzania, Mauritius and Ghana have adopted these tariffs while Ethiopia, Botswana, Namibia, Nigeria, Senegal, Zambia, and Zimbabwe are only considering them [15].

Of these countries, Ghana has been led the way in their pursuit to using solar energy as their main form of renewable energy. In 2011 Ghana's government established their vision with its Renewable Energy Act. In this legislation, the government has vowed to provide electricity to the entire population by 2016. In November of 2012, Ghana sought out \$1 billion in private investments to help meet their renewable goals. By December of 2012, a UK-based company, Blue Energy, agreed to construct a \$400 million PV plant in Western Ghana. The plant is the fourth largest of its kind globally and is expected to begin producing energy this calendar year. The plant is expected to increase the countries generating capacity by 6% by 2020. South Africa, which happens to be the continent's largest economy receives 90% of its electricity from coal. South Africa seeks greater capacity and has developed its "Integrated Resource Plan" which calls for 42% of the nation's electricity supply to come from renewable resources by 2030 [15].

#### D. China

The solar industry, in all countries, is heavily influenced by governmental policy. This of course can be in the form of feed in tariffs and subsidies for research and development. A good policy can support PV manufacturing, contribute to research, and strengthen the market for solar panel manufacturers and installers. There are four elements needed for the success of any renewable energy policy and those elements include a clear guaranteed pricing system, strong planning and administration procedures, priority access to the grid, including the identification of grid connection responsibility, and public acceptance. China's policies contain a few of these elements including a pricing system a feed in tariff, and procedures for planning and administration. These policies also include required quality certification of technology and incorporation requirements [16].

Two of China's primary policies that have influenced their solar involvements include the Renewable Energy Law (REL) established in 2005, and the 12th Five-Year Plan (FYP). The REL acts as the legal basis for the development and

improvement of renewable energy in China[17]. The REL also requires grid enterprises to purchase renewable energy power that is generated within their grid, and they must provide connections to those who contribute to the grid (JRC, 2011). China's FYP was released in March of 2011. Its goal is to encourage domestic consumption, clean up the environment, develop the service sector, and increase manufacturing while increasing the value of renewable products [17]. China's solar policies have helped it in its success in the solar industry and has helped them claim a dominant position as the leader in solar panel manufacturing. In the past five years, photovoltaic module shipments produced and distributed in the U.S. has decreased from 9% to 6%, while China has grown from 6% to 54% global market share [18]. Chinese PV companies are now the dominant factor in the solar game and it is all thanks to the Chinese government's strong support for solar panel manufacturing.

#### E. Europe

Europe contains nine of the largest fifteen solar energy markets worldwide. As of 2011, PV installations amounted to 20.9 GW making up 75% of the world's total installed PV[19]. Today, Europe's total solar PV system capacity is 69 GW which is enough to meet 2.4% of Europe's electricity needs and is enough to power every Italian household [20].

Germany is the world leader in total installed solar power with a capacity of 32.6 GW. As soon as this capacity reaches 52 GW, the Federal Government plans to phase out support for solar power. Germany's Renewable Energy Act, created in 2000, is the first legislation of its kind. The policy introduced guaranteed feed-in tariffs that would last for 20 years at a fixed price [19]. Rates gradually decrease for new installations which creates a downward pressure on manufacturers to drive innovation. This is a stable scheme that has gained popularity making solar energy a confident investment and causing exponential growth in solar installations throughout Germany over the last twenty years. There have been a couple of revisions to the Renewable Energy Act in 2004, 2009, and 2012. The latest revision set goals stating that at least 35% of electricity should come from renewables by 2020, no less than 50% by 2030, no less than 65% by 2040, and finally no less than 80% by 2050. The law and its targets were introduced by the Ministry of Environment in 2010 [21].

Germany is not the only country within Europe that is experiencing this exponential growth in solar capacity on a yearly basis. Italy experiences some of the best weather conditions in Europe that are favorable for solar, a small factor which helps Italy rank as the world's second largest installer of PV. Studies conducted by Gestore Servizi Energetici found that Italian installations tripled in capacity from 2009 to 2010 bringing them from 1 GW to over 3 GWs. This number tripled again in 2011 bringing them to 9 GWs of solar installed [21]. This growth is shown in the figure below. This rapid surge would not have been possible without the intervention of government policy. In 2010, the Italian government implemented a feed-in tariff on top of a generous grant system [21]. The feed in tariff was meant to be in place until 2013 or

until the government reached a U.S. \$9.3 Billion cap of payments. This cap was met on July 5, 2013 [22].

Recently in the UK, the solar industry has been frowned upon. In April of 2010, a feed-in tariff was introduced to the UK and caused a major boom in the number of solar installations installed. This major boom is illustrated in the table below. A rapid increase in the demand for residential solar installations caused an increase in competition amongst solar companies resulting in a price drop of 30% for installing complete photovoltaic systems which includes panels and connections to the grid [19]. The government underestimated how successful the scheme would be and began to panic. Although the rate of adoptions was impressive, the Department of Energy and Climate Change (DECC) had to correct their mistake by eliminating the tariff. The DECC attempted to cut the FIT rates by 50% without consultation and this action led to an extended court case with several solar companies. The action was eventually ruled illegal. Regardless of the decision, original rates will decrease because the number of installations is at an all-time high [19]. This situation shows just how important government policy is in the solar energy market. The difference between a good and bad policy could mean the difference in the existence of the solar industry in a particular country.

## v. Solar Energy Policy

In this section, the results of the interview data are presented. The results were analyzed using thematic analysis.

### A. Importance of Policies

Each interviewee was asked about the role of government policy in influencing solar panel adoption and promotional landscape. This was asked so the researchers could compare multiple opinions on solar policies and confirm that policies are needed for solar energy to be used on a large scale. What the researchers found out was that all interview participants suggested that governmental policy is crucial for the use of solar energy to occur. It is for that reason why the researchers determined that creating policies is a government action and theme necessary for solar energy to be used. Figure 3.1 shows that policy is a theme necessary based on data collected in interviews. However, the data also reveals that there are a few negative aspects of policies. In spite of the negative aspects of policy, it is still necessary. While discussing the role of government policy regarding the issue of solar energy, one interviewee mentioned, “We can do everything we can as individuals, but that is not enough.” The interviewee went on to say, “We need individual actions, actions by communities, and most importantly, policy changes.” This response highlights the importance of policy. In another interview, a question was asked, “How important is the government’s role in seeing that solar becomes a main source of energy?” This interviewee replied, “Some people probably don’t agree and some people think that if many individuals start doing the right thing, it (solar becoming a main source of power) will happen, but I think it will never happen unless the government gets involved. I think it’s absolutely the single most important thing.” The response was similar to the previous statement by

the last interviewee in that government intervention and policy is most important. The interviewee went on to talk about how there are enormous subsidies and policies that benefit fossil fuel industries. If there was a level playing field and the same subsidies and policies were offered for solar energy and if the government was honest about how much it really costs to produce power from coal, then solar energy would be competitive. The United States is a great example of a country that does not have a good and lasting policy and because of that, it’s obvious to why the U.S. is lagging in its efforts towards a solar energy movement. Another interviewee made it clear that the only way to avoid climate catastrophe is to turn towards renewables. That means large companies like Exxon Mobil, who has a lot of money invested in fossil fuels, need to get out of the way of thoughtful and progressive government policy. Politics are in the way of these progressive policies and one thing that trumps politics and money is votes. Therefore, public interest is extremely important in seeing that officials, who will create better policies, are elected. After discussing these issues, the interviewee said, “This is the only way we can turn to renewables.”

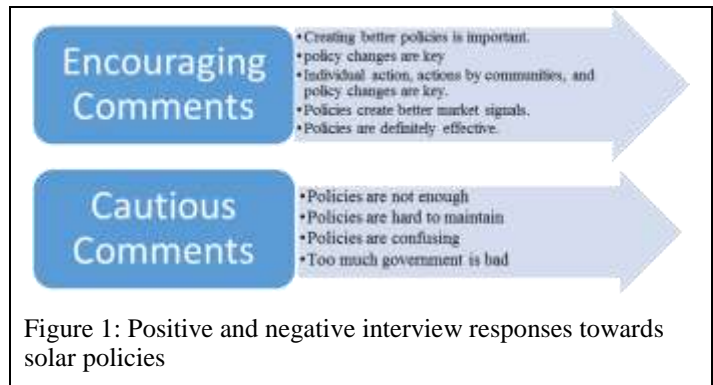
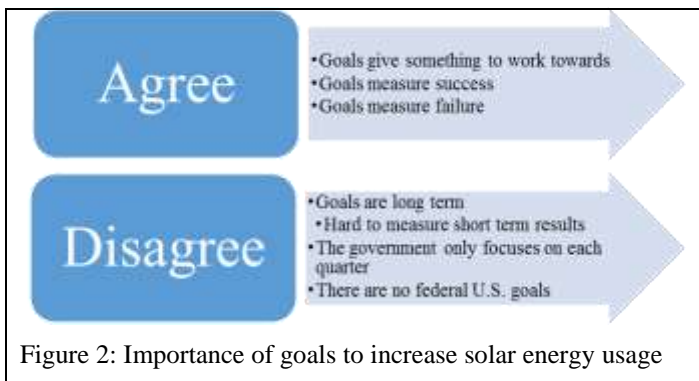


Figure 1: Positive and negative interview responses towards solar policies

### B. Importance of Goals

It is extremely important to set goals because goals will give a scale of how successful or unsuccessful efforts are. Each interviewee was asked if there were any benchmark goals in place, by the government, for solar energy technologies. The researchers asked this question to find out if the interview candidates were aware of any goals and to find out if there were any goals that weren’t discovered while conducting research. For the interviewees that live in the U.S, when asked if there were any goals each responded by saying there were no goals in place. One interviewee responded by saying, “On the federal level, there are currently no meaningful goals, however there have been goals implemented on the state level.” One interviewee discussed how Hawaii is one of several states with plans to use specific amounts of renewables by the year 2030. To strengthen the argument that “goals” are an important theme, meaningful goals mentioned in the literature review validate a goals importance. Two goals include the “master plan” for renewable energy in Sydney, Australia and the 45% target by 2030 in Germany. Sydney has set a target to reduce greenhouse gas emissions across the entire local area to 70% below levels in 2006, and to obtain 30% of electricity from renewable sources by 2030 [12]. The 45% target in Germany is a goal to obtain 45% of the energy

from renewable sources by 2030 [23]. Germany's Renewable Energy Act reveals goals in place and since its creation, there has been three different revisions that set new goals due to the success and completion of previous goals. The latest revision was in 2012 which calls for at least 35% of electricity to come from renewables by 2020, no less than 50% by 2030, no less than 65% by 2040, and finally no less than 80% by 2050 [21]. These aggressive goals have showed how successful Germany is in this movement and is one of the reasons why they are the world leader in photovoltaic installations. After analysing data from the literature review and interviews, the researchers determined that goals are an important government action and theme. Of all the governmental actions involved in making solar energy prosper, goals are one of the more important tools for the successful implementation of solar energy because goals measure success. Figure 2 highlights goals as a theme and asks if goals are necessary for an increase in solar energy usage. Codes reflect responses that either agreed or disagreed with the question. After breaking down and analysing this data, the researchers was able to understand the importance of goals, and also understand that the absence of goals can become a hurdle when trying to use solar energy.



### C. Educating the Public about Solar Energy

The majority of the public has not conducted research on the subject matter giving them a lack of knowledge about solar energy. This lack of knowledge could prevent the public from adopting solar energy, and therefore a means of educating the public is necessary. After asking a question regarding public reaction towards government incentives and policies, one interviewee believed a common reaction to those incentives and policies was confusion. Specifically, the interviewee said, "I think confusion a lot of times. How does this really work and is it really better? Understanding the benefits is important. Incentives need to be very clearly identified for the consumer. You are going to pay this amount and this is how much you are going to get back and this is the amount of time it will take for you to start making money." This answer revealed to the researchers that confusion is exactly why a government interested in a prosperous solar industry must focus on educating the public. In each interview, there researchers asked the interviewees what they believed was the most effective means to educate citizens about solar energy. The researchers asked this question because there are many

different ways to educate, inform, and motivate people. One method isn't necessarily better than another, so the question was asked to get multiple opinions. One of the interview candidates is an assistant professor at a University and one of their classes focusses on sustainability. The interviewee and any other teacher must find ways to motivate students. After being asked how to motivate people, the professor responded saying, "I don't know, I contemplate this question a lot on how to get people to care about sustainability. If people can see that it (solar energy) saves them money or they are able to draw a connection between what they do every day and what that value adds to them, then they may adopt. Trying to appeal to people and make a personal connection and show how it saves money can be effective."

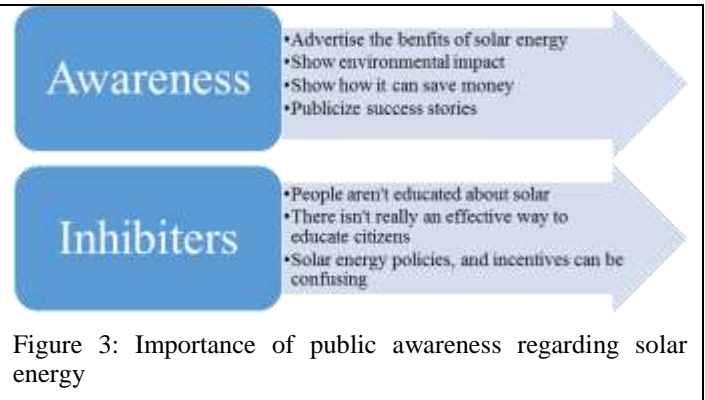


Figure 3 is the result of thematic analysis. By understanding that the public needs to understand solar energy and solar energy policies, in order to adopt, the researchers wanted to know what methods were best for educating the public. The researchers also wanted to know if educating the public was in fact an issue. By asking questions regarding the education of solar energy, it was revealed to the researchers that there are inhibitions in the adoption of solar energy due to the public's lack of knowledge about solar energy. Based on responses to the questions asked, the researchers was able to understand that education is a big deal and there many different solutions that can help with the issue of educating the public about solar energy. The responses to these questions led the researchers to believe that there isn't really a good way to educate the public, but the interviewees did provide excellent ideas on how to influence people to use solar energy. Advertising the benefits of solar, showing the positive effect on the environment, showing a plan of how it will save money, and advertising success stories are all excellent means to educate the public according to the interviewees. After analysing interview data, the researchers was able to determine that public education is extremely important, but is pointless unless solar energy becomes a viable and affordable option and this is only done through incentives.

### D. Importance of Incentives

Of the ten baseline questions asked in each interview, eight of the ten questions led to responses that ultimately showed the importance of incentives. After data collected in both the interviews and literature review, the researchers was able to

determine that incentives are without a doubt the most important tool in solar energy promotion because incentives make solar energy affordable. When asking a question about how the government is influencing solar panel adoption and promotional landscape and wondering if legislation used is effective, 100% of the people interviewed said incentives and subsidies were necessary for solar energy to take off and will produce positive results. Based on all data, the bottom line is that if solar energy doesn't save or make a person money, there is no educating method, policy, goal, or any other governmental action that can alone make the solar industry prosper.

After asking questions about incentives, the researchers found out that incentives are for the most part beneficial. There are however a few issues when it comes to these incentives that were revealed to in the interviews. The first issue was previously discussed. Sometimes when there are new policies and incentives, and there can be confusion due to ineffective communication between policy makers and the general public. This confusion can also come from a lack of knowledge regarding the technology. The next issues is that even with incentives, there are times when the market isn't ready for investment. When asking what has been the reaction by the public towards governmental incentives, one interviewee responded by saying, "I think when there has been renewable tax credits, there has been a great boom to the solar industry. There's a lot of money sitting on the sidelines waiting to be invested in renewables, but it is waiting on a good market signal. A carbon tax would be a great signal that would make the market right for renewable investments. If there is a tax on say each ton of CO2 emissions, then that will create more reason to turn to renewables and solar energy. If the incentives are there, then people will open up their wallets and invest. In terms of what has happened so far, the tax incentives and tax credits have been a real help whether it be buying a Chevy Bolt or installing solar panels on the roof. But to answer the question, the public will react by investing if there are the right market signals." The interviewee first reveals that when there are incentives, such as tax credits, there has been increased adoption in the solar industry. The interviewee is also saying is that the U.S. government isn't doing anything right now to stimulate a solar market. The interviewee gave an example saying that a carbon tax would be a great market signal that determines if one will adopt solar energy. This is because a carbon tax would make large companies invest in cleaner energy to reduce the amount of taxation on their carbon footprint. Once signals such as this occur, the market will be ready and people will invest. One last issue with incentives is that they can be downgraded. In one interview, the researchers was told of an incentive offered in Queensland, Australia. The incentive was a feed-in tariff. The government would buy unused solar power for 44 cents per kilowatt-hour. This, and increased energy costs, was enough of an incentive to start using solar energy. Unfortunately, the incentive was downgraded because the government was losing money due to the incentive. Today, the government will only purchase peoples unused power for 8 cents per kilowatt-hour. This greatly increases the time it takes for a payback on investment and is discouraging for those who invested due to the initial incentive.

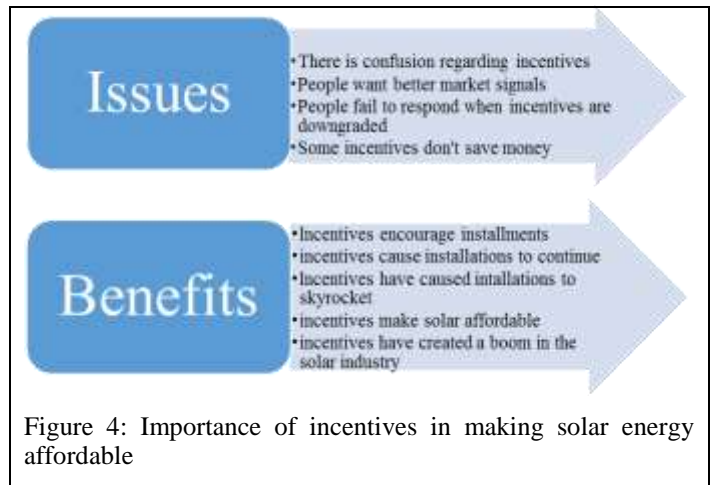


Figure 4 shows the results from a thematic analysis. Various codes were created based on responses to many different questions. Comparable codes revealed that incentives are an important theme and action that needs to be addressed. The codes were separated into two sections. Some codes revealed the issues that can occur with incentives and were placed in the "issues" section. The other codes revealed ways incentives are beneficial and were placed in the "benefits" section. After analysing all codes and data, the researchers found out that incentives are needed for creating market signals, influencing solar panel adoption, gaining the interest of the public and investors, increasing adoption, and achieving goals.

## VI. Conclusions

Deciding which alternate renewable energy resource to use is an important first step and a government must consider every option. Some reasons for using a particular renewable energy resource can be location dependent. Although there may be more efficient forms of renewable energy, solar is the only renewable technology that can be used anywhere. Wind is a renewable resource that rivals solar [24]. It is understandable to install wind turbines along the coast or desert, but that form of renewable energy is only available in windy places. The sun is shining on every inch of the earth and is a resource that will never go away. Some believe you must live in a sunny place to install photovoltaics and that is not the case. Germany is the world leader in solar energy capacity and is not considered a sunny place.

Once a country decides they want to use solar as an alternate energy source, they must create a market for solar energy. This is done by creating policies and doing things like issuing limitations on power companies and making them abide by certain sustainable standards. Many cities and countries around the world require power companies to produce certain amounts of power from renewable resources. Another great way to create a market for solar energy is to find a way to make solar energy a necessity. This could be done by creating a carbon tax. If this were to take place then coal, fuel, power, and other large companies, that emit large amounts of



carbon dioxide, will have to use solar energy because it will be the only way to maintain their business financially.

A necessity for a successful solar energy landscape is government involvement that produces progressive policies and incentives. These policies are created because there is a need for an alternative source of energy. The reason for that need varies per country. If a country is looking to make a policy, it is a good idea to find a comparable country and see what types of policies work for them. Many countries experience a lot of trial and error when it comes to creating successful policies. In Brisbane and the UK, the government created policies which brought forth incentives to install solar energy. The incentives were too aggressive economically to the point where the government began losing money. This led to the immediate downgrade of incentives which almost crippled the solar energy industry in those regions [15]. Germany has experienced great success in creating lasting policies that have created a prosperous solar energy market [21]. This is a great country to try to imitate when trying to develop a solar energy market. Unfortunately, not every country has a government like Germany that can maintain a policy for an extended period of time. If the United States, for example, was able to maintain a policy for an extended period of time, a solar energy market would be created, people would invest, and solar energy would become a viable option as compared to power generated from fossil fuels.

Solar energy is important because it uses an everlasting resource to help reduce utility costs and help eliminate carbon emissions. Individuals can join in and do their part to reduce their carbon footprint, consume clean energy, and try to preserve the earth for future generations by investing in solar energy and other renewables. Unfortunately individual actions are not enough to do this. For the mass use of a renewable energy resources like solar energy to occur, a progressive policy must be in place that educates the public, creates incentives, and creates goals for the development and deployment of solar energy.

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