

THE USE OF SOLAR ENERGY IN THE KOREAN ECONOMY: A SOLUTION OR A PROBLEM?

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ABSTRACT

Fossil fuels power most of our society, yet they will not last forever. The search for alternative sources of energy have yielded only fleeting promises of change. Of the many types of sustainable energy, solar energy seems to be the most promising, however, solar energy is not without its flaws. This paper will explore the history and mechanics of solar energy, it will also feature a specific focus on the use of solar energy in the Korean economy. In order to ascertain whether or not solar energy may provide a sufficient alternative to fossil fuels for Korea's primary source of energy, it will be necessary to conduct a cost/benefit analysis of solar energy. After conducting thorough research on the topic and based on the evidence to be provided in this paper, it is concluded that while solar energy has the potential to serve as a replacement for fossil fuels in Korean energy production, it is not yet ready to take on that role. It will be necessary to further develop the technology involved in the capture, storage, and use of solar energy, before it serves as a significant source of power.

Keywords: Cost/Benefit Analysis, Energy Policy, Korea, Renewable Energy, Solar Energy

1. INTRODUCTION

Energy plays a pivotal role in socio-economic development by raising standard of living. It is becoming gradually accepted that current energy systems are becoming unsustainable. Development of conventional forms of energy for meeting the growing energy needs of society at a reasonable cost is the responsibility of the governments.

In recent years, public and political sensitivities to environmental issues and energy security have led to the promotion of renewable energy resources in most countries all over the world. Diversification of fuel sources is imperative to address these issues; and limited fossil resources and environmental problems associated with them have emphasized the need for new sustainable energy supply options

that use renewable energies. Development and promotion of new non-conventional, alternate, and renewable sources of energy such as solar, wind and bioenergy, etc. are now getting more attentions from all over the world than ever.

Solar power is one of the hottest areas in energy investment globally right now. With innovation, increased competition, and policy support in many countries, solar energy technologies have achieved massive technological advances and sharp cost reductions. Solar energy has come to the forefront of the global energy transition, with nearly every country adopting a renewable energy target. However, there is much debate about the future of solar technology and solar energy markets. Progress has been uneven in different countries and sectors. Technology and financial risks still hamper the expansion of solar energy into new markets. As the energy sector develops further, the increased adoption of variable energy sources needs more flexible systems.

Renewable energy has become a significant issue in Korea since the previous government adopted a new national energy policy with emphasis on radical development and use of renewal energy, particularly solar energy. The green technology policy was launched to promote the utilization of low carbon energy and technology of which solar energy has been identified as the promising green energy option. However, due to many critical geographical constraints and technological restrictions, as energy is the lifeblood for the Korean economy, overall national sustainable development efforts in this context failed to achieve its goals and brought lots of criticisms about the government energy policy.

In an effort to understand some of the current issues regarding the Korean national energy policy with radical introduction of solar energy in the Korean economy, this research was conducted on the use of solar energy in Korea. To fully understand the implications of solar energy usage in Korea, it was first necessary to learn more about solar energy. Also, it requires to investigate the progress and challenges for solar power in Korea according to the overall concept of sustainable development and identifies the technology adopted to generate solar power in Korea and its current status. Barriers are examined over the whole solar energy spectrum and policy issues and institutional roles and responsibilities are discussed.

2. ENERGY CONSUMPTION

2.1. WORLD ENERGY CONSUMPTION

The world's resources are finite. According to research published by [Enerdata. \(2019\)](#), solar energy accounted for only 2% of the world's electricity production in 2017. [Enerdata. \(2019\)](#) ranks energy consumption in million tons of oil equivalent or MTOE. In 2018, the world consumed 13,820 MTOE, not only an increase of 2.3% from 2017, but a record high [Enerdata. \(2019\)](#). In fact, world energy consumption has grown steadily every year since Enerdata began tracking these statistics in 1990, with the lone exception being 2009 during the global recession [Enerdata. \(2019\)](#). Asia leads the world in energy consumption, with China being the world's largest energy consumer. Asia also leads the world in energy consumption growth rate. Despite the overall growth in world energy consumption, some countries' energy consumption rates are declining. Energy consumption in the European Union decreased 1% in 2018, with Germany leading the way with a 3.5% decrease in energy consumption [Enerdata. \(2019\)](#). There a variety of causes for this decrease, for example, milder weather (which leads to less energy expended on heating and cooling), energy efficiency improvements, and increasing prevalence of renewable energy production [Enerdata. \(2019\)](#). Despite a few promising trends, fossil fuels still

make up most fuel sources for energy production, and overall consumption continues to increase.

2.2. ENERGY CONSUMPTION IN KOREA

In 2018, South Korea consumed 307 MTOE [Enerdata. \(2019\)](#). That is a 1.6% increase from 2017, and a 48.5% increase from 20 years ago in 1998. Of the 302 MTOE consumed in 2017, approximately 2% came from renewable energy (a complete breakdown of sources can be found below in Pie Chart 1). South Korea is the 28th largest country in the world by population. Yet according to the Energy Information Agency, they are the world's 8th largest consumer of energy [Energy Information Administration. \(2018\)](#). In other words, their amount of energy consumption does not match up with the size of their population. They are consuming more energy than other nations of similar size. The dominant theme in Korean energy is imports. South Korea imports almost all of its fuel sources. South Korea has few natural resources for energy production. While the source mix of energy production in Korea is somewhat reliant on available imports, the government has decided to reduce the reliance on coal and nuclear power, in favour of natural gas and renewables [Energy Information Administration. \(2018\)](#). According to data published by the EIA "Fossil fuels generated about 65% of South Korea's electricity in 2016, while 30% came from nuclear power, and more than 5% came from renewable sources" [Energy Information Administration. \(2018\) p. 1](#). South Korea's plan to reorganize their energy production has been mentioned several times, the specifics being that "the country's new power plan calls for shares of coal and nuclear to decrease to 36% and 24%, respectively. These shares are slated to be offset by renewable energy sources rising to a 20% share and natural gas staying at a 19% share in 2030" [Energy Information Administration. \(2018\) p. 12](#). This plan and its outcome will be discussed further in later sections.

3. HISTORY OF SOLAR ENERGY

Solar energy has been captured and used for various purposes for hundreds of years. However, it was not until 1954, at Bell Labs, that the first modern photovoltaic (PV) cell was produced [Sabas \(2016\)](#). Despite this breakthrough, solar energy remained largely too expensive for commercial or private use. Seeing its potential for use in space, the US military began funding research for improving solar energy technology for use in US satellites in the 1950's [Sabas \(2016\)](#). Since its modern-day inception, solar energy has gained in popularity due to its potential as a sustainable source of clean energy. In the last decade, the solar market in the United States has grown by an average of 50% per year [Solar Energy Industries Association \(2019\)](#).

Early PV cells converted solar radiation to electricity at an efficiency of about 4%. The technology has since been improved to convert sunlight into electricity at a rate of 20% or slightly above [Energy Sage. \(2016\)](#). In the United States, solar energy has grown primarily through government funding and incentive programs. In other countries, each has their own set of reasons for increasing solar energy production. For example, following the 2011 disaster at the Fukushima nuclear power plant, Japan committed itself to seeking alternate forms of energy production. Japan is one of the world's leaders in solar energy production even though it is a small island nation with very little excess land to be taken up by large solar arrays. Part of the reason for their large production of solar energy is their innovative use of offshore solar farms. The concept is fairly simple, floating solar arrays; however, the implementation is slightly more complicated. Offshore solar farms will be

discussed further in later sections. Another example of a country motivated to increase solar energy production is China. With the world's largest population, and largest carbon footprint, China's air quality has been suffering for years. This has given the Chinese government an incentive to increase funding and development of solar energy production.

4. MECHANICS OF SOLAR ENERGY

4.1. TYPES OF SOLAR ENERGY

The collection of solar energy is found in three main forms. The first, and most commonly known, is photovoltaic (PV) cells [Solar Energy Industries Association \(2019\)](#). In this type of solar energy collection, the PV cells are comprised of semiconductor materials, like those in computer chips. Electricity is generated when sunlight hits the cells and knocks electrons loose from their atoms [Imboden \(2017\)](#). It is important to note that PV systems are used to generate electricity. PV cells are commonly referred to as solar panels.

The second form of solar energy collection is solar heating and cooling (SHC). SHC uses the heat generated by the sun to provide space or water heating [Solar Energy Industries Association \(2019\)](#). Although SHC may seem like an unfamiliar concept, it is quite common, and more easily recognizable as a "solar oven." See the *Uses* heading for more details. The third form of solar energy collection is concentrated solar power, more commonly recognized as solar thermal power plants (STPP). STPPs use various methods of collecting solar energy for the purpose of generating enough heat to boil water, the boiled water is then used to drive a steam turbine that generates electricity, much in the same way that coal and nuclear power plants do [Imboden \(2017\)](#). In this case, the methods of generating electricity are the same, but the fuel source is different. Coal, and nuclear power, which both produce hazardous by products, are substituted for clean, and sustainable solar power.

4.2. DRAWBACKS

Each type of solar energy has many benefits; however, they also have limits and drawbacks. Beginning with the most common form of solar energy, PV systems have a variety of negatives. First, solar panels are relatively expensive. In order to install a large enough system to produce and substantial amount of power, a significant investment of over \$10,000 will most likely be needed (depending on your location and available suppliers).

Aside from the cost, PV systems largest drawback is their need for a storage medium. PV cells convert sunlight into electricity, but unless the system is tied back into the electrical grid, (which may or may not be possible given your location) a large array of batteries is needed to store enough collected energy. These batteries are often expensive on their own, and they take up a significant amount of space, especially for domestic use. Imagine having a dozen solar panels that each measure 65" by 39" (this is a common size for domestic use) on a house's roof. This system of a dozen panels would require a small closet size space to accommodate the batteries to store the energy produced by those panels. While this might not seem like much, many houses do not have additional space the residents are willing to reserve to house batteries. It is also important to note that some batteries have specific ventilation and maintenance requirements, that further complicate their use.

Both PV and STPP systems are limited by the fact that they require large amounts of land area to collect enough energy to be useful to large amounts of

people [Energy Information Administration. \(2018\)](#). Perhaps the most thought of drawback of solar energy, the necessity of sunlight. The need for a sufficient amount of sunlight negatively impacts all forms of solar energy. This can be a significant issue. The amount of sunlight received on the Earth's surface is not constant. The amount of sunlight received will vary depending on geographic region, time of year, weather conditions, and time of day [Energy Information Administration. \(2018\)](#). Certain regions of the Earth are more suitable for solar energy collections than others. Regions nearest the equator that receive the most direct sunlight have the most potential for solar energy.

Another drawback of PV panels and SHC is that they are fragile. Although new technology is being developed to make these panels stronger, many of them are still covered in glass and therefore easily broken. One last inconvenience of solar panels is that they need to be kept clean in order to be most efficient. It is for this reason that deserts are not as ideal as they may seem to host STPPs. Deserts are often very windy, and that wind blows up sand, which then covers the solar panels, drastically reducing their efficiency.

4.3. COMPARISONS

As previously discussed, the most common type of solar energy is photovoltaics. PV systems differ from SHC and STPPs in that they use an electronic process to generate electricity. Whereas SHC and STPPs use heat generated by the sun [Solar Energy Industries Association \(2019\)](#). In the case of STPPs, energy from the sun is concentrated as a heat source, and that heat is used to boil water to drive a steam turbine, which generates electricity [Imboden \(2017\)](#). SHC also uses the sun as a heat source. A common application of SHC is solar water heaters, in which, sunlight is used to heat a metal rod surrounded by water and thereby heating the water itself. Solar water heaters are found usually on rooftops, they consist of several tubes made of glass, lined with insulation with a copper rod running from end to end. In short, PV systems use sunlight to generate electricity, STPPs and SHC systems use sunlight to generate heat, which may then be used to generate electricity.

4.4. BENEFITS

Traditional energy production methods use finite resources, such as coal. The burning of coal to produce electricity emits harmful by products. An energy crisis can arise because of the lack of available resources to create energy, or because energy production damages the environment. Currently, both problems exist within traditional energy production. Perhaps the biggest benefit of solar energy is that it is an unlimited source of clean energy. Solar power emits no carbon dioxide or other dangerous pollutants [Energy Information Administration. \(2018\)](#). Solar energy is renewable, meaning that the use of solar power does not deplete the available resources [Energy Sage. \(2016\)](#). Another benefit of solar energy is that it can be used almost anywhere in the world. Any point that sunlight hits the Earth can be used to harness solar energy [Energy Sage. \(2016\)](#). Given the facts that solar energy is clean, renewable, readily available, and quite versatile, it represents a possible solution to current world energy crises.

4.5. USES

Of the three types of solar energy, PV systems are the most common, and therefore they have the most applications. PV cells can be found in any number of household items. One example that most students are familiar with is a solar powered calculator. Many scientific calculators have small solar cells powering them. Another application of PV cells that has become more common with the rise of cell phones is a solar battery pack. These devices are referred to by many names, (i.e., power banks, portable chargers, battery banks, external batteries). These are relatively small batteries that can be charged up and carried around and act as portable power stations for smartphones and other devices (see [Figure 1](#)). Some portable chargers are powered by solar cells. As solar technology improves, small applications of solar energy production are becoming more and more common. In the past, solar cells were too large and unwieldy to be used in small devices. They were also too expensive, but as the technology becomes miniaturized and cheaper, more uses are being invented.

Figure 1



Figure 1 Relatively Small Batteries

Another everyday application can be found on street signs. Many light up street signs are powered by a solar panel. An example can be seen in [Figure 2](#). Small solar panels are being installed in convenient places to provide power to portable objects as well as to provide outdoor, public charging stations. Some picnic tables in public spaces are being fitted with solar panels to allow for charging stations to be installed. These are just a few examples of small applications for PV systems, the primary application for PV systems is large scale energy production. This is the use of solar energy that concerns the state of energy production in Korea. This usually takes the form of a solar array. The larger the array, the more power produced. Solar arrays are often located in places with an abundance of available land, preferably on a flat surface, in an area with abundant sunshine.

Figure 2**Figure 2 Solar Panel**

However, this is not the case in Korea. Korea does not have large amounts of excess land to devote to solar arrays, because of this, solar arrays in Korea are typically limited in size, and located wherever space is not being used for buildings, such as the side of a mountain. Another possible location for solar arrays is offshore (pictured in [Figure 3](#)). Although still in the developmental phase, some of the more densely populated countries of Earth have already started taking advantage of the possibilities of offshore solar energy production. For example, in Japan, the “Kyocera Corporation’s Kagoshima Nanatsujima Mega Solar Power Plant is... generating enough electricity to power roughly 22,000 homes” [Gan \(2014\) p. 5](#). The biggest advantage of offshore solar farms is saving space. However, according to the *Solar Tribune* “there are many advantages to offshore solar. The panels stay cooler, and efficiency ratings go up. There are little to no costs involved with location, and because the generation can be built in modular units on land and delivered to the location ready to “plug-and-play,” installation costs can be lower” [Dana \(2018\) p. 4](#).

Figure 3**Figure 3 Solar Arrays**

SHC applications are used mostly on a small scale. Heat from the sun can be used to heat living spaces or water. Solar water heaters are fairly common, especially in areas with high utility rates and low water supply. Solar water heaters also come in many forms, ranging from the homemade system in [Figure 5](#), to a high

efficiency commercial product in [Figure 4](#). SHC can also be used for cooking. This is perhaps the oldest use of solar energy. For hundreds of years, people have been using the power of the sun to cook with. Although a simple concept, the technology has been refined in recent years to be more sanitary and efficient.

Figure 4



Figure 4 Solar Thermal Evacuated Tube Collector

Figure 5



Figure 5 Solar Water Heaters

The third and final form of solar energy production has essentially one purpose, to generate electricity using solar energy as the fuel input. STPPs are beneficial but inefficient. Solar energy seems to be trending toward smaller, individual applications using PV cells rather than the traditional power plant applications.

4.6. COSTS

The cost of solar panels varies, as according to [Energy Sage. \(2016\)](#), “solar panel costs for an average-sized installation in the U.S. usually range from \$11,214 to \$14,406 after solar tax credits” [Energy Sage. \(2016\) p. 3](#). This is just to give an idea of what a residential solar array might cost. These numbers could be quite different in other countries. Costs of solar panels and installation are part of the initial investment costs that often deter people from using solar energy. However, solar is a long-term investment. Investment costs are offset by long term energy

savings, research consistently supports the idea that “solar electricity can often pay for itself in five to ten years” [Imboden \(2017\) p. 8.](#)

4.7. OUTLOOK

The outlook of solar energy is relatively bright. The technology continues to be improved rapidly. Solar panels are becoming more efficient, which drives costs down, they are also being made more durable, and since they are becoming more popular and cost effective to produce, they are affordable for private use. One of the primary concerns of solar energy is the large amount of surface area necessary for an array large enough to capture a significant amount of energy. Offshore solar arrays were previously mentioned in the *history* section. These offshore arrays offer a potential solution to one of the primary concerns of solar energy, and therefore deserve to be mentioned when discussing the outlook of solar energy. Although this is a relatively new concept, and not available in all regions, it is a legitimate idea worth exploring on a case-by-case basis.

Another drawback of solar energy is the large battery banks required to store captured energy. With the introduction of lithium-ion batteries into mainstream commercial and private use in the last few years, entire product lines have been revolutionized. Virtually all battery powered devices have switched from using old NICD batteries to new lithium-ion batteries. Although more costly to produce, lithium-ion batteries are drastically better than traditional batteries. They have longer life spans, they are lighter, charge more quickly, hold their charge better, and because of their superior performance they are more economical in the long run. In recent years, solar energy production has begun using lithium-ion batteries for energy storage. Considering the current state of solar energy production, and the immediate outlook, the conclusion has been made that solar energy is not a sufficient substitute for fossil fuels in mainstream energy production. However, this is only temporary. Given the immense possibilities for improvement as well as the versatility and benefits of solar energy, it is believed that solar energy may serve as a viable alternative to fossil fuels soon. The conclusion has also been made that given its potential, investments should continue to be made in developing solar technology.

4.8. EFFICIENCY

Efficiency of solar energy production directly influences cost. The more efficient the technology becomes, the less expensive it is. As previously mentioned, early PV cells maintained only 4% efficiency [Energy Sage \(2016\)](#). The most efficient solar panels today operate at approximately 22% efficiency [Aggarwal \(2019\)](#). Most solar panels operate in between 15% and 20% efficiency [Aggarwal \(2019\)](#). Several factors can affect efficiency, including weather, if it is a cloudy day efficiency will be reduced. Positioning of solar panels can play a large role in their efficiency. If a solar panel is not installed to face the correct direction at the correct angle, it will not reach its maximum efficiency, it is important to note that tilt angles change throughout the year. The easiest efficiency detractor to alleviate is cleanliness, a clean solar panel will operate at higher efficiencies than a dirty solar panel. Regularly wiping off panels will help them to operate at their peak.

4.9. COST/BENEFIT ANALYSIS OF SOLAR ENERGY

This section will evaluate the fitness of solar energy as a source of energy production on a general basis. The specific practicality of solar energy differs from one case to another. The overall benefits of using solar energy do not differ much from one case to another. Solar energy produces no harmful by products or carbon emissions. After the initial investments, the cost of using solar power is relatively low. Solar cells can be used to capture energy in remote places that may be hard to access for normal utility services. Solar panels can easily be integrated into existing structures and new construction. Solar cell's ability to be used in unique places is not limited to land. It is possible to utilize solar cells in space as well, which NASA and other space organizations have been taking advantage of for years.

The costs may vary from region to region. The cost of a PV system for residential use varies based on local suppliers. The cost may be augmented by incentives offered by local governments. Initial costs for PV systems are typically high, they represent a significant investment. Energy savings, tax incentives, and rebates usually allow investment and installation costs to be made up in a few years in residential use. Commercial and utility usages usually have significantly higher costs because they also involve indirect costs. The largest of which being land space.

Whether or not it is worth it to employ solar energy depends on location. A place that receives little sunlight, with a harsher climate, such as Alaska, may not be a practical location for a solar energy production facility. The benefits of using solar energy in such places would likely not offset the costs of those systems. However, places closer to the equator with abundant and direct sunlight, such as Mexico or Morocco, are ideal locations for solar arrays. While an array would still be a significant investment, these places would get the most out of their systems.

5. DISCUSSIONS OF SOLAR ENERGY USAGE IN KOREA

5.1. CURRENT STATE OF SOLAR ENERGY IN KOREA

Current global energy consumption poses a threat to the Earth. The consumption of fossil fuels produces carbon emissions that destroy the atmosphere. This dilemma is the primary reason for the search for alternative fuel sources. The search has led to solar energy as a promising solution to the world's energy crisis. South Korea is no exception to this crisis. For years, they have produced energy and polluted the atmosphere just like the rest of the world. In recent years, many of the nations of Earth have made an increasing effort to reduce carbon emissions and safeguard the climate. South Korea has since been one of the nations on the forefront of change. In 2017, South Korean government made a commitment to increase the amount of renewable energy production to 20%, up from 6%, by the year 2030 [Chung \(2019\)](#). Nuclear power and coal currently account for 70% of South Korea's energy production [Chung \(2019\)](#). Goals like these are becoming more and more common as governments try to stem the tide of climate change.

One of the most common complaints related to energy production in South Korea is that they lack the natural resources required for energy production. South Korea imports nearly 98% of their energy [Energy Information Administration. \(2018\)](#). While this has been a reason in the past for South Korea not to produce more of their own energy, it does not have nearly the same effect on their capability to produce renewable energy. South Korea is limited by its geographical size; however, their lack of natural resources should not prohibit them from seeking to increase their production of renewable energy.

5.2. HOW THE SOLUTION BECAME A PROBLEM

It has been previously discussed that one of the problems with solar energy is the space necessary for its production. Countries such as Korea, with limited amounts of land area, find it difficult to dedicate large sections of real estate to solar arrays. Korea is a densely populated nation with a limited amount of land space per resident. To further increase the number of solar arrays would mean decreasing land area per person for a country that is already becoming claustrophobic. Unfortunately, this is exactly what has happened.

The enthusiasm for solar energy is largely due to government support. For example, starting with an announcement in 2016, the Korean Energy Ministry announced it would invest 27 billion USD in renewable energy over the course of five years [Pothecary \(2016\)](#). Additionally, "Seoul has promoted 'energy self-reliance towns' as part of its campaign to reduce nuclear power in Korea" [Kang \(2018\) p. 8](#). Another program initiated by the Korean Energy Ministry suggests, "Those who install the energy storage system at their solar power plants will be given additional points on the assessment of their renewable energy certificates" [Deign \(2016\) p. 3](#). This initiative is aimed at developing the necessary infrastructure for renewable energy production.

The result of all these government programs and incentives has been a large increase in solar arrays. Solar panels have sprung up all throughout the country. While this may sound like progress, like all progress, it has not come without its controversies. New solar arrays take up valuable real estate, and to avoid the dilemma of lack of available land, alternative locations have been used to place solar panels. These alternate locations include hillsides, and forested areas. To increase the use of renewable energy and preserve the environment, people have been cutting down trees and clearing out wooded areas. If this seems counterproductive, it is. It is sometimes easy to lose sight of the real goal, it is even easier to get lost when money is involved. Regrettably, certain economic incentives have caused people to act irrationally creating a problem from what is supposed to be the solution.

5.3. COST/BENEFIT ANALYSIS OF SOLAR ENERGY USE IN KOREA

Although a cost/benefit analysis of solar energy has already been completed, it is important to remember that the utility of solar energy depends on a case-by-case basis, and it is therefore necessary to look at this issue as it pertains to South Korea. South Korea has its own unique challenges and advantages associated with using solar power. South Korea has set a goal of relying on renewable energy to provide 20% of their power by the year 2030. Solar energy can be a great contributor to that goal. On an individual basis, solar energy could be quite economical, as the Korean government offers various incentives for using solar energy. A private citizen or business could cash in on those benefits. Lastly, the environmental benefit of renewable energy, and solar, cannot be overstated. The use of fossil fuels and their resulting carbon emissions are destroying the atmosphere. This is having a catastrophic impact on the environment, resulting in climate change.

Solar energy does not come without certain costs, however. There are direct costs associated with solar energy, such as the funding needed to develop the technology and purchase the equipment. There are also indirect costs of increasing solar energy production. Such as the cost of diverting more land to house solar

panels and converting from traditional energy production facilities to solar energy facilities. Of these costs, the greatest is the land required for large scale solar energy production. At its current efficiency, solar cells cannot collect adequate amounts of energy to supply power to a significant amount of people without massive amounts of surface. Although this cost may be reduced in the future, as the technology evolves, it is a large concern at present.

Given that solar technology has significant room for improvement, and each year the technology improves, the future of solar energy continues to be promising. Do the benefits outweigh the costs? It depends. Unfortunately, there is no straightforward answer to this complicated issue. Currently, in South Korea, the potential benefits of the continued use of solar energy do outweigh the costs associated with its use and development. There are ample possibilities for solar energy applications, and the continued research of the technology poses little risk.

6. SUGGESTIONS AND CONCLUSIONS

The use of solar energy is almost always a positive thing. It is clean, renewable energy. And yet, it is not without its flaws. The nation of South Korea nobly concentrated its efforts to increase its use of renewable energy, including solar energy. In their quest to reduce carbon emissions, Koreans turned to solar energy, but while becoming so focused on building more solar arrays, the consequences were ignored. The Korean government offers significant incentives for building solar arrays, this undoubtedly had an impact on people's enthusiasm to erect solar panels, people in fact became so enthusiastic that they defied logic and began tearing down trees to build solar farms. A paradox was created. In order to save the environment, they were destroying it. Cutting down trees and clearing forests to make space for solar arrays. Damaging the environment while trying to restore and preserve it. This brings us to the question of what an appropriate use of solar energy in Korea should be.

It would not seem appropriate to cut down trees to put up solar panels. It is important to think in advance, whether it is worth clearing out space for solar panels. Would it do more harm than good? Solar energy was supposed to be the solution to the problem, the energy crisis, and yet, it became a problem. Its peoples' haste to build more solar arrays, they lost sight of what they were really working for. They were supposed to be protecting the environment, not just earning incentives, but they were distracted, as can often be the case when money is involved. This is an important concept to consider when governments are trying to decide whether to subsidize renewable energy and to what extent. Given enough incentive, people will gladly destroy the environment in the name of renewable energy. Money can blind us from our true goals. If incentives are too powerful, they will distract people from what is really important. This is to some degree what occurred on the Korean peninsula. Money and incentives are not the only cause of this problem. The primary dilemma faced by Koreans is the lack of space. They did not have anywhere else to put the solar panels, so they cleared out the forests to make space. Ironic situations like these must be avoided if solar energy is to reach its full potential. It is critical to use the technology appropriately. Find other places to put the solar panels that will not destroy the environment in the process. Create offshore solar farms or integrate solar panels into construction materials. These are appropriate uses of solar energy.

Many solutions to the solar energy question are still theoretical. One of the major problems posed by solar energy production is the space needed to house solar panels. This problem is amplified in regions that are already tight on space, such as

South Korea. Possible solutions include offshore solar farms, and improved technology. As the technology continues to advance, solar panels will be made smaller, and more efficient. Although this would not completely eliminate the need for space, it would reduce the amount of space needed, thereby reducing the problem. Another potential solution is the integration of solar panels into existing spaces, or the use of solar panels as building materials, for example, solar panel walls. While these ideas are purely theoretical at the moment, it is plausible that they could be available in the future.

Finally, the future of solar energy is dependent upon public opinion. Much like a gladiator in ancient Rome, the future of solar energy will live and die at the will of the public. It is possible that at some point in the future, solar technology will be advanced out of necessity. However, in the near future, public opinion will determine if solar energy becomes more common. There are several reasons for this being the case. The first of which being that there is a lot of money and power wrapped up in oil and coal and other nonrenewable resources. Those large organizations do not want to see a trend away from their product. Those same organizations give large sums of money to politicians to make sure that they do not see a trend away from their product. Another reason is that several of the world's governments give significant incentives for solar energy usage. Currently, many of the governments that give these incentives are democracies, and therefore subject to change because of public opinion. If solar energy becomes more popular, and demand rises for solar energy products, then solar energy will prosper. However, at present, solar energy is not yet well established enough to advance itself without popular support.

CONFLICT OF INTERESTS

None.

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