The Negative Impacts of Solar Power

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Abstract

With the urban development, more and more environment problems are showing in people's life. The air pollution causes human health problem and the global warming impact the rise of sea level. To solve the environment problems and reduce the negative effect of environment to the future generation, people start to protect environment and one of the method is using renewable energy. Solar energy is the more popular renewable energy that people use to save energy, because it was clean and the solar resources is abundant. The electricity that transfer from solar energy can improve the energy efficiency use. However, the solar energy is zero pollution and completely clean for several reasons. The following content will discuss the negative impacts of solar power and the strategy to improve the solar energy use.

Introduction

The rise in urbanization, over-consumption of natural resources, and increased pollution bring several negative impacts to humans, animals, and the environment. Natural resources will be exhausted rapidly at the current pace. However, the use of things such as electricity is a necessary part of daily life. The electricity production produces a large number of harmful emissions. It includes Methane, Nitrous Oxide, Fluorinated gas, and Carbon dioxide. There is about 25% of 2010 global greenhouse gas emission from the process of generation of electricity and heat production. The trends of global emission reveal that CO2 emissions have increased by about 90% since 1970 (EPA, 2014). To develop sustainably, we need to increase the use of renewable energy rather than the use of non-renewable energy.

Development of renewable energy includes economic and environmental benefits. In the process of generating energy, clean energy would not produce as much greenhouse gas emissions. It can replace the use of fossil fuel in the future and reduce the dependence on imported fuel. The U.S. energy consumption by energy sources in 2017 shows that total renewable energy is 11 quadrillion Btu and in occupy about 11% of the total primary energy consumption. Additionally, 6% of the total clean energy id solar energy (EIA). Solar energy is significant to the human, economic and environmental development. It is CO2 free, and solar panels release no harmful emissions. They require no other source of coal and natural gas, which is a way to conserve natural resources and prevent mining. In the economic aspect, solar energy is free, and there are low operating costs in the photovoltaic process of transforming sunlight into electricity.

United States' total cumulative installed solar PV capacities ranks 2nd in the world behind China, which annual installed capacity was 7.3 GW in 2015 (IEA). Most of the US capacity is in the southwest in the Mojave Desert, California and Gila Bend, Arizona. The development of solar energy can be separated in several ways, which are the solar energy photovoltaics, solar heating, cooling, concentrating solar power and passive solar. There are several negative impacts on the development of solar power such as land use and habitat loss. There are two main types of solar panels, which are the PV and CSP. The PV is the photovoltaic systems which convert sunlight directly to electricity by using the solar cells with semiconductor materials. The CSP is concentrating solar power system which use reflective devices to concentrate the sun's energy and generates electricity with producing heat.

It is true that solar energy is one of the cleanest forms of energy, which can reduce some types of air pollution and bring benefits in the environment and economy. However, the use of solar energy is not completely sustainable and with no emissions. First of all, land use can be a problem. It seems that lots of solar panels are placed installed on the top of the parking garage and the rooftop of houses which are efficient use. However, in many locations, the larger utility-scale solar facilities show land degradation and habitat loss (ucsusa.org). Second, although PV solar panels are not generating electricity by water, the water use in the process of concentration of CSP is a problem. It shows in the plant location, plant design, and type of cooling system (ucsusa.org). Third, there are some hazardous materials in the process of manufacturing PV,

including the copper-indium-galium-diselenide. These materials would case the environmental public health problem if they are not disposed and recycling. Fourth, solar power may cause local heating of the ground and surrounding area. It shows in the carbon pollution in the process of materials transportation, installation, and maintenance. There are lots of ways solar panels are not green, and it is necessary for people to understand the negative impacts of solar energy. Understanding the negative aspects of solar panels could prevent people from following blindly. Also, it could help the improvement of the solar panel and improve sustainability.

This capstone will set out to research the impacts of solar development in the southwest and will analyze both positive impacts and dark sides of the solar panels. Case studies will be selected from the Ivanpah Solar Power Facility in California and Solana Generating Station in south Phoenix.

Literature Review

UN World Commission on Environment and Development defines Sustainable development that is a development that meets the need of the present without compromising the ability of future generations to meet their own needs (Brundtland Report). It corporates with three pillars which are the society, environment, and economy. The societal sustainability is the ability of a social system, includes country, family and organization(thwink.org). The environmental sustainability shows in releasing the pollution, conserving natural resources and protecting the climate for the future generation. Economic sustainability is the ability of economic support and stable development.

There are different sources of renewable energy in the world, such as wind and solar power. Scientists estimate that if the focus on renewable energy, it would reduce its emissions by almost 80% in only 15 years (clickenergy.com). To study the development of solar energy, we must understand the development trends and global markets. China is the largest solar market in the world which has the installed capacity of around 130 GW, far greater than the U.S. at around 60 GW. It accounted for about 50% of the global solar demand in 2017 (Forbes).

Photovoltaic solar panels are a common type of solar system. The construction of the PV system includes different groups of PV cells, batteries, a charger or controller for a stand-alone system, an inverter for a utility-grid-connected system with alternating current, wirings, and hardware. It can be a stand-alone system or integrated into the building design (gosolarcalifornia.gov). Solar panels get electricity from the sun by a physical process, called the photoelectric effect. It is an emission or ejection of electrons from the metal surface in response to light. The lifetime of a solar panel is around 20 years, and the basic PV module can be used for more than 30 years. In the economic aspect, the average price per watt for solar panels ranges from $2.71 to $3.57, and average-sized in the U.S. usually range from $11,380 to $14,990.

Recently, there are several problems show in the development of solar energy, and it is not exactly zero pollution. These problems are land use, water use, hazardous materials, and life-cycle global warming emissions. The build of larger utility-scale solar facilities cases the land

degradation and habitat loss. PV systems range from 3.5 to 10 acres per megawatt, and CSP facilities are between 4 and 16.5 acres per megawatt (ucsusa.org).

In the cooling system of solar energy, water plays a necessary role. There are types of cooling are mainly used, which are Once-through, Wet-recirculating, and Dry-cooling. The analysis reveals that the water was not used sustainably. This wasted water and overspent on cooling. There are two methods to reduce temperature, which are the cooling towers and concentrating solar thermal plants (CSP). They can withdraw between 600 and 650 gallons of water per megawatt-hour of electricity produced (ucsusa.org). The cooling location and use of water are depending on the plant location and design: the higher the temperature, the more effective at the cooling process.

The life-cycle of solar panels is one of the factors causing emission. The materials transportation, manufacturing, installation, and maintenance would provide global warming emissions. WWS resources show that in the process of generating solar power, it reduces the world power to 30% and required 0.41%-0.51% footprint and spacing (Jacobson, 2010).

Methodology

This capstone uses a case study methodology, which mainly focuses on the cause-and-effect relationships of the solar energy. As the goals of this study are finding the positive and negative impacts of solar energy, it is necessary to study the factors that improve the environment and society and the reasons that cause the negative environmental influences. There is also a focus on pollution across a period, by comparing the data in different years to find out the changes in CO2 emission and the benefits of solar energy. Data collected will include the basic methods of constructions, cost, and lifespan of solar panels and the news of recent development of solar energy.

Data and Results

Dark Sides of Solar Energy

Investors and solar companies should beware and understand the dark side of solar energy since it is not as bright as people thought. The construction process of the solar facilities will affect the environment. It shows in the process of generating photovoltaic cells and the uses of toxic chemicals and materials.

Land Use Problem

The land use and the choice of the location is one of the dark sides of solar energy, as larger utility-scale solar facilities can lead to land degradation and habitat. In many countries, solar facilities are built on agricultural lands, as they satisfy the needs for the generation of solar energy and farmland is often south-facing, large and well-drained (Spiegel, 2017). However, solar facilities reduce food production and livelihoods and create competition within rural

communities. This can bring many undesired results, including environmental effects and political problems.

One of the examples is Sullivan's Farms of Connecticut. The local farmers found they were competing with clean energy, because the solar developers found the agricultural lands have low costs to build solar facilities. There are about 8,812 of solar panels built around the perimeter of approximately 11 acres of Sullivan's farmland (Spiegel, 2017). Solar facilities not only reduces the use of farms but also becomes a political spark between farmers and environmental interest groups. This conflict demonstrates the fight between private property rights and state environmental policies. There was a report by the state's environmental watchdog that found the "state government spending millions of dollars to protect the agricultural lands but encouraging to build the solar facilities at the same land."

The use of agricultural lands will change food production for decades, especially showing in the more impoverished communities. India has the largest solar PV in the world. Satisfying the needs for the total land area is dependent on the different kinds of solar technology, the intensity of the solar resources and the topography of the site (UCSUSA, 2013). For the solar technology, utility-scale PV system range from 3.5 to 10 acres per megawatt and CSP facilities are between 4 to 16.5 acres per megawatt(UCSUSA, 2013). The use of wind facilities can share the land with agricultural uses. However, solar facilities have less opportunity to do so.

In the future, it is necessary to avoid land-use conflict. A lower-quality location such as brownfields and abandoned mining land can be used for the utility-scale solar systems. The reasons why these fields can be used to build solar facilities are, locating near the critical infrastructure and the large population area, costing less than other open space and including a large area of 0-2% minimum level needed for PV construction (EPA&NREL,2013). Re-Powering Renewable Energy is a project that installed the solar facilities on landfills and contaminated lands. To date (2019), the RE-Powering installed 1,561 megawatts (MW) on 289 contaminated lands, and about 72% is a large-scale system with a project capacity of 1MW or more (EPA,2019).

Water Use Problem

In the solar thermal plants, a vast quantity of water is used for cooling and cleaning. The power plant water is necessary for the turbines to spin and in the thermoelectric power plants to boil to create steam. Most of the water resource has a high temperature because it comes from geothermal heat sources underground, but colder water would create the steam in spines turbines more effectively and allow more efficient electricity generation (UCSUSA,2013).

However, the solar facilities are often located in a dry climate area, where the water resources are limited. One of the examples is the built of vast power plant heater in Morocco, North African desert. This project cost $ 9 billion and is competing with water use in local agriculture and uses 6 million cubic feet of water each year. This water resource comes from the local El Mansour Eddahbi Dam, where has the water cuts problem in recent years (Ceurstemont, 2016).

Also, different types of cooling have different water consumption. One of the cooling systems is called a Once-through system, which can take water from nearby sources like rivers and lakes, passes it through the system, and back out to the source. In the Southwest US, the wet-recirculating is the most common central cooling system. It reuses cooling liquid in the system rather than discharging the water back to the original water sources, which have lower water withdrawals than the once-through system. Dry-cooling does not use water and uses air to cool the steam. It usually has higher costs and lower efficiencies which needs more fuel and increases the air pollution problem (UCSUSA, 2013).

Material Use Problem

There are lots of harmful chemical materials used in the PV cell manufacturing process. These are the materials that include delicate recycle materials, sulfuric acid, and phosphine gas. The toxic metals material like chromium and cadmium in the solar panel also harmful to the human body and contributes to the drinking water problem.

China is the largest market of photovoltaics and solar thermal energy in the world. There are 4 million light-absorbing PV panels locates in a 27 square kilometers area in Tibetan plateau (Bibek and Nicole 2018). However, like most of the country, the Chinese solar industry could be "a ticking time bomb," since the solar panel costs a lot, wastes land, and contributed to the environment problem due to mining. The International Renewable Energy Agency predicted that the solar panels' waste would stack up around 13.5 tons in 2050. Compare to the nuclear power plants, the toxic waste that solar panels create is about 300 times more per unit of energy (Jemin and Mark, 2017)

There are several methods to solve the materials use problem in the future. Governments should create the PV panel recycling policy which can increase solar panels use. The silicon-based PV panels are the most common type in the solar panels market. It mainly composed of plastic, aluminum, and glass, including 100% reusable aluminum frame, 95% reusable conveyor belt and 85% reusable slabs (CivicSolar, 2018). The solar PV recycling system market in Europe is growing because most of the European nations installed solar PV panels in the 1990s. The first solar panel recycling company of Europe was in France. They mainly recycle all of the materials from panels to construct new solar panels. Also, Waste Electrical and Electronic Equipment Directive (WEEE) of the European Union helped PC Cycle to develop a robust recycling infrastructure (CivicSolar, 2018).

Lifecycle Problem

Although there is little pollution during the generation of electricity from solar energy, the life-cycle of solar panel will increase global warming emissions. This life-cycle continues all the way from generation to disposal or recycling of solar panels, including in parcking, manufacturing, materials transportation, installation and dismantlement. The data show that most of the solar panels' life-cycle emissions are between 0.07 and 0.18 pounds of carbon dioxide equivalent per kilowatt-hour (UCSUSA, 2013).

Conclusion

This capstone set out to explore the negative impacts of solar energy. The development of solar energy and renewable energy is one of the most important goals for sustainability. Solar power is arguably the cleanest and reliable of renewable energy we currently have available, and it has many extensive applications. Solar energy can be used on roof systems to reduce the environmental impact and electric bills, minimize future utility rate increase and decrease the electricity generated from fossil fuel. Even though it has many benefits, solar power still has several drawbacks. The land use for large solar arrays will damage the land and species and lead to land degradation and habitat loss. The water used in the cooling system of a large solar system is not sustainable. Some of the materials of manufacturing PV are hazardous. Finally, materials transportation and maintenance will cause carbon pollution.

In the future, it is necessary to focus on improving the generation process of the solar system. For the land use problem, developers can utilize an area that has less population and species. The water use problem can also be solved by designing a water circulation system. The materials that use in the generation should be improved and re-selected.

To sum up, solar energy is significant in human development. However, we need more than solar power to solve our energy issues. Other renewable energies like geothermal energy, hydropower, and bioenergy are also necessary for the move toward sustainability. These forms of energy can be based on geographic locations and natural resources, building and developing a renewable energy that can meet the different needs of humans.

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