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# Developments in Solar Energy and their Effects on the Environment

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**ABSTRACT:** Solar power facilities reduce the environmental impacts of combustion used in fossil fuel power generation, such as impacts from green house gases and other air pollution emissions. Unlike fossil fuel power generating facilities, solar facilities have very low air emissions of air pollutants such as sulfur dioxide, nitrogen oxides, carbon monoxide, volatile organic compounds, and the greenhouse gas carbon dioxide during operations. In addition to these benefits of solar development, construction and operation of solar facilities creates both direct and indirect employment and additional income in the regions where the development occurs. However, there are also some adverse impacts associated with solar power facilities that must be considered in BLM's process of granting solar right-of-way authorizations and DOE's process of developing environmental guidance for solar facilities. Potential adverse impacts to various resources associated with the construction, operation, and decommissioning of solar power plants are briefly outlined below. These impacts and mitigation measures for solar facilities are addressed in detail in the Solar Energy Development Programmatic EIS.

**KEYWORDS:** solar energy, development, effects, environment

## I. INTRODUCTION

All utility-scale solar energy facilities require relatively large areas for solar radiation collection when used to generate electricity at utility-scale (defined for the Solar PEIS as facilities with a generation capacity of 20 MW or greater). Solar facilities may interfere with existing land uses, such as grazing, wild horse and burro management, military uses, and minerals production. Solar facilities could impact the use of nearby specially designated areas such as wilderness areas, areas of critical environmental concern, or special recreation management areas. Proper siting decisions can help to avoid land disturbance and land use impacts.

Construction of solar facilities on large areas of land requires clearing and grading, and results in soil compaction, potential alteration of drainage channels, and increased runoff and erosion. Engineering methods can be used to mitigate these impacts.

Parabolic trough and central tower systems typically use conventional steam plants to generate electricity, which commonly consume water for cooling. In arid settings, any increase in water demand can strain available water resources. Use of or spills of chemicals at solar facilities (for example, dust suppressants, dielectric fluids, herbicides) could result in contamination of surface or groundwater.[1,2,3]

The construction and operation of solar facilities generates particulate matter, which can be a significant pollutant particularly in any nearby areas classified as Class I under Prevention of Significant Deterioration regulations (such as national parks and wilderness areas).

The clearing and use of large areas of land for solar power facilities can adversely affect native vegetation and wildlife in many ways, including loss of habitat; interference with rainfall and drainage; or direct contact causing injury or death. The impacts are exacerbated when the species affected are classified as sensitive, rare, or threatened and endangered.

Because they are generally large facilities with numerous highly geometric and sometimes highly reflective surfaces, solar energy facilities may create visual impacts; however, being visible is not necessarily the same as being intrusive. Aesthetic issues are by their nature highly subjective. Proper siting decisions can help to avoid aesthetic impacts to the landscape.

Cultural and paleontological artifacts and cultural landscapes may be disturbed by solar facilities. Additionally, socioeconomic impacts (both positive and negative) may be associated with solar facilities. For example, solar energy development could provide new employment opportunities, but an influx of workers could disrupt public services. These impacts may be disproportionately experienced by minority or low-income populations, thus resulting in environmental justice issues.

Photovoltaic panels may contain hazardous materials, and although they are sealed under normal operating conditions, there is the potential for environmental contamination if they were damaged or improperly disposed upon decommissioning. Concentrating solar power systems may employ materials such as oils or molten salts, hydraulic fluids, coolants, and lubricants, that may be hazardous and present spill risks. Proper planning and good maintenance practices can be used to minimize impacts from hazardous materials.

Concentrating Solar Power (CSP) systems could potentially cause interference with aircraft operations if reflected light beams become misdirected into aircraft pathways. Operation of solar facilities, and especially concentrating solar power facilities, involves high temperatures that may pose an environmental or safety risk. Like all electrical generating facilities, solar facilities produce electric and magnetic fields. Construction and decommissioning of utility-scale solar energy facilities would involve a variety of possible impacts normally encountered in construction/decommissioning of large-scale industrial facilities. If new electric transmission lines or related facilities were needed to service a new solar energy development, construction, operation, and decommissioning of the transmission facilities could also cause a variety of environmental impacts.

## II. DISCUSSION

Solar energy technologies and power plants do not produce air pollution or greenhouse gases when operating. Using solar energy can have a positive, indirect effect on the environment when solar energy replaces or reduces the use of other energy sources that have larger effects on the environment. However, producing and using solar energy technologies may have some environmental affects.[4,5,6]

Solar energy technologies require materials, such as metals and glass, that are energy intensive to make. The environmental issues related to producing these materials could be associated with solar energy systems. A number of organizations and researchers have conducted PV energy payback analysis and concluded that a PV system can produce energy equivalent to the energy used for its manufacture within 1 to 4 years. Most PV systems have operating lives of up to 30 years or more.

The hazardous chemicals used for manufacturing photovoltaic (PV) cells and panels must be carefully handled to avoid releasing them into the environment. Some types of PV cell technologies use heavy metals, and these types of cells and PV panels may require special handling when they reach the end of their useful life. Some solar thermal systems use potentially hazardous fluids to transfer heat, and leaks of these materials could be harmful to the environment. U.S. environmental laws regulate the use and disposal of hazardous materials. The U.S. Department of Energy is supporting various efforts to address end-of-life issues related to solar energy technologies, including recovering and recycling materials used to manufacture PV cells and panels. Several states have enacted laws that encourage recycling PV panels.

As with any type of power plant, large solar power plants can affect the environment at or near their locations. Clearing land for a power plant may have long-term effects on the habitats of native plants and animals. However, installing solar energy systems on land that has marginal agricultural value or integrating solar energy systems on farms may provide a variety of economic and environmental benefits to farmers.

Some solar power plants may require water for cleaning solar collectors and concentrators or for cooling turbine generators. Using large volumes of ground water or surface water for cleaning collectors in some arid locations may affect the ecosystems that depend on these water resources. In addition, the beam of concentrated sunlight a solar power tower creates can kill birds and insects that fly into the beam.[7,8,9]

### III. RESULTS

#### Solar Lowers Your Utility Bill

Investing in solar energy can significantly reduce the amount you pay each month for your utility bills. This form of energy relies on ultraviolet (UV) rays, and the clean energy created can offset the costs associated with your electricity usage at home. As a result, you'll likely end up paying less over time, allowing you to recuperate your costs for your investment.

Some utility companies allow you to sell any excess energy your panels produce through a process called net metering. Others in your community can benefit from the clean energy you've created while you enjoy a lower monthly electricity bill.

#### Solar Creates Jobs

As more people become interested in installing solar panels, more energy employees are needed to meet demand. This sector requires jobs for manufacturing, installation and maintenance. By investing in solar, you're also investing in a new job market, bolstering your local economy.

#### Solar Assists During Emergencies

Numerous natural disasters can disrupt the power supply from the grid, including earthquakes, hurricanes and floods. Fortunately, solar panels provide a powerful alternative when traditional electricity fails during emergencies. Even during a natural disaster, the sun can still provide the energy needed to power solar panels when energy sources, such as fossil fuels, are unavailable.

Using solar power will also help reduce your carbon emissions, which have an impact on climate change and contribute to worsening natural disasters.

#### Solar Incentives for Installation

Installing solar panels makes you eligible for federal incentives, such as the solar investment tax credit. Many states also offer their own incentives, including North Carolina. These incentives can help reduce the cost of what you initially spent on the purchase and residential or commercial installation of your solar panels, which contributes to the economy.

#### Solar Energy Is Better for the Environment

Collecting fossil fuels for electricity is responsible for damage to certain local ecosystems. Many plants and animals suffer, as habitats are destroyed and flora is removed to create space for energy operations such as drilling infrastructure.

Alternatively, clean energy sources like solar can help ecosystems flourish once again. The installation of solar plants requires much less space and can be installed on top of buildings. Further, people and wildlife don't experience air or water pollution from solar panels.

The production of fossil fuels requires mining, burning and drilling, which release greenhouse gas emissions (GHG) into the atmosphere. These GHG emissions, such as carbon dioxide, have detrimental impacts on the environment. By opting for solar energy and other clean energy sources, we can limit GHG emissions and help protect the planet from further damage.

Overall, solar energy can help your community restore ecosystems, reduce pollution and reduce green house gas emissions, all of which is vital to protecting humans, wildlife, and entire ecosystems. This in turn makes air more breathable and decreases the amount of water necessary to generate power.[10,11,12]

#### Solar Helps With Land Use

Many traditional forms of electricity require a significant amount of space for energy plants, including a lot of valuable land. Fortunately, solar systems don't have the same land use requirements. The benefit of solar systems is they can be mounted on your roof or placed in a remote area with barren land. As new technology comes out, solar systems will be better equipped to assist with land usage. Overall, your local environment can benefit from the minimal land use solar systems require.



#### Solar Reduces Carbon Emissions

Unlike fossil fuels, which require mining, drilling, transporting and burning to produce electricity, solar panels are renewable energy sources that don't release the harmful carbon emissions that damage waterways and the atmosphere. These pollutants are also damaging to the health of wildlife and ourselves, and reducing them could save 25,000 lives. Using renewable solar power will help reduce our dependence on finite resources that damage the environment, helping keep the Earth healthy and protecting our infrastructure.

Overall, the environmental impact of solar energy is generally favorable. However, it's important to note that harvesting the materials for solar panels, such as specific metals and glass, can impact the environment, as can the construction of the panels themselves. Still, experts say solar panels can make up for the energy required to produce them in one to four years. These systems can also work for 30 years, meaning solar panels can make up for their environmental production costs multiple times throughout their useful life.

There are also some concerns about land use regarding solar energy. Some worry that solar panel installation for large-scale projects can damage or degrade the land and contribute to habitat loss. However, the potential damage to land and habitats can be minimized or even eliminated by installing large solar panel projects in low-quality locations, such as abandoned mining facilities to avoid causing land degradation in existing habitats, installing panels on top of existing buildings can also reduce land use.

Naturally, some concerns about solar panels exist. Fortunately, the potential problems can be remedied by careful planning and attention to proper disposal methods.

#### Recycling Solar Panels

If you're considering solar panels, you should be aware of how you can further reduce your environmental impact.

One of the main concerns with solar panels and the environment is the hazardous materials that certain solar panels require during manufacturing.[13,14,15] A solution is to recycle solar panels, which is more than possible but isn't as common as it should be among solar panel owners.[16,17,18]

### IV. CONCLUSION

Additionally, solar panels can use precious metals, such as silver or indium, which could become scarce if solar panels aren't properly recycled. One of the problems with solar panel recycling is a lack of awareness about the materials required during the manufacturing process and how they can be recovered for future production. If you're trying to do your part for the environment and are considering solar panels, you should consider what you're going to do when you need to replace parts or the panels reach the end of their life cycles.[19,20,21]

Talk with your solar panel provider about the proper way to recycle solar panels and where you can find a recycling location that will take them. Some providers will even handle the recycling process for you, ensuring it's done correctly. Improper disposal could waste precious materials and cause potentially hazardous substances to harm the environment.

As we rely on crude oil and other fuel that has high carbon emissions, the pollutants contribute to climate change, which is responsible for rising sea levels, changing weather patterns, melting glaciers and other concerning issues. Using clean energy like solar should be part of a global effort to eliminate carbon emissions, and it's essential for homeowners and businesses to do their part by making the switch to protect the environment and our health.

Currently the recycling of solar panels faces a big issue, specifically, there aren't enough locations to recycle old solar panels, and there aren't enough non-operational solar panels to make recycling them economically attractive. Recycling of solar panels is particularly important because the materials used to make the panels are rare or precious metals, all of them being composed of silver, tellurium, or indium. Due to the limitability of recycling the panels, those recoverable metals may be going to waste which may result in resource scarcity issues in the future.

Looking at silicon for example, one resource that is needed to make the majority of present day photovoltaic cells and which there is currently an abundance of, however a silicon-based solar cell requires a lot of energy input in its

manufacturing process, the source of that energy, which is often coal, determining how large the cell's carbon footprint is.

The lack of awareness regarding the manufacturing process of solar panels and to the issue of recycling these, as well as the absence of much external pressure are the causes of the insufficiency in driving significant change in the recycling of the materials used in solar panel manufacturing, a business that, from a power-generation standpoint, already has great environmental credibility.[21]

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