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Solar Energy Systems affecting the Environment

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ABSTRACT: In the vast sustainable and green global transmission of electricity, the annual rise in global energy demand, along with its environmental challenges and issues, plays an important role. Of all the other green energy technologies, solar energy systems have gained the most interest over the past years. Even renewable energy, though, may have some harmful environmental effects; more consideration and adequate precautionary procedures should therefore be given.This paper explores in depth the environmental implications of many small-scale and utility-scale industrial and evolving solar power generation. The research applies to some of the corresponding developments, along with some of the primary components in their structures. The method follows all processes, beginning with the plans, then during the phases of assembly, products, fabrication or implementation, and throughout the lifespan of service and decommissioning. In addition to some scientifically and ecologically beneficial guidelines for minimising the impacts, concrete strategies for most processes like reducing waste and recycling are addressed.

Keywords: Environment, Photo Voltaic, Solar Energy, Technologies, Renewable energy, Sunlight.

INTRODUCTION

Through industry revolution, energy production is considered a significant problem, particularly as the global population is growing increasingly. Communities are spreading and moving to previously uninhabited areas and emerging technology, thereby growing the need for electricity in general and, in particular, for electrical energy. Thus, for a sustainable and stable world, a clean, environmentally friendly and effective energy supply is needed more than ever. The energy consumption of coal, shale oil, and natural gas, covering more than 80% of the primary energy supply in 2018, has been controlled by fossil fuels and traditional energy production methods.Little did we realise that a double-edged sword was the heavy use of those fossil fuels, which sadly has a negative impact on the climate. A variety of dangerous environmental issues have been created by the immense reliance on and widespread misuse of fossil fuels in virtually all fields of life, one contributing to another, like land drought, heatwaves, wildfires, sea level rise, flooding, and other extreme climate phenomena[1].

Related study articles on various solar systems and various environmental impacts have been conducted by several academic organisations. In relation to certain metrics, such as CED, EPBT and multiple GHG emissions, studies have addressed the environmental impacts of OPVs. The study, nevertheless, was restricted to OPVs only, without other innovations, and progress on environmental protection was lacking. Then, the study of some other report primarily investigated PV technology's EPBT and CO_2 emissions.The work, however, neglected to determine the technical characteristics of the panel and the BOS modules, and was limited only to the PV panel, excluding other components of the system, and did not take

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into account new PV technologies, in comparison to being limited only to CO_2 emissions and ignoring other climatic factors. Studies have extensively examined several solar energy innovations, concluding that over the life cycle, CdTe PVs and solar pond CSP have minimum emissions of GHGs. The study did not, however, recognise the input of other elements of the project and did not take into account new PV technologies; however, the analysis was restricted to emissions of GHGs[2].

ENVIRONMENTAL IMPACTS OF A PV SYSTEM'S COMPONENTS

A study was conducted to analyse the LCA of a PV system and discuss the environmental effects of multiple system elements, including a Li-ion battery and a Mono-Si PV panel, in a very unique and efficient manner [4].They evaluated the life cycle outputs and inputs of the components using the Raw Materials Flow technique, concluding that the water outputs were considerably high out of the converter, battery, wire, and power metre without any solid waste outputs, whereas the breaker, inverter, and PV panel did not have any water outputs but had a comparatively higher output in other types. In addition, they have made a thorough comparison of the environmental profiles of the elements, including natural resources, carbon resources, renewable resources, water resources, and ozone depletion, as well as land use, acidification, climate change, human toxicity, etc., using the International Reference Life Cycle Data (ILCD) process. Although these comparisons are not valid for any other PV device or feature and can vary according to various configurations, they offer a clear indicator of each component's environmental effects[3].

Mitigation of PV's environmental impacts

In general, much of the materials used in the processing of TFPV and PV are potentially harmful, highly expensive, and sometimes uncommon, and may likely be released into the atmosphere by air and water, creating some severe problems. They can then be dealt with during the lifetime of the system, beginning from the production stages to the removal stage at the end of the lifetime of a product. Proper waste management strategies have been developed and addressed for the waste produced by PV industries, in particular since their industry is very close to the semiconductor industry.Some of the best ways to mitigate the environmental issues associated with PV devices, as well as at the end of their life, waste minimization throughout processing and recycling[4].

Solar thermal systems

The same desires that drew the world into the solar PV sector, which is the overwhelming amount of available energy originating from the sun, are shared by solar thermal devices, also recognized as Concentrated Solar Power (CSP) schemes. For the last ten years, CSP systems have been rising steadily in several places worldwide, with a large rise in interest over the last two years. Solar thermal technologies are comparatively older, more advanced, more space-efficient, and less complex as compared to solar PV technologies.While they have common general environmental standards, such as low carbon and GHG emissions and low fossil fuel requirements, initial configuration and lifecycle costs are comparatively more costly for CSPs. Any of the environmental effects such as water usage, potentially radioactive waste, land use, habitat fragmentation, potential urban species destruction, and some adjustments in microclimate are shared by all technology. Solar thermal systems, being a powerful, reliable, easy technologies to be used in households and relying mainly on well-known methods and tools, have a considerable capacity to reduce energy loads for DHW domestic hot water uses, particularly for locations with high radiation.

While most designs of solar thermal systems, such as solar power plants, will operate at maximum power, they are often backed up by a fossil fuel system, this applies in particular and more often to parabolic trough systems. We can assume that most if not all of the CSP systems would have the same environmental effects due to their maturity and non-electrical or thermal-based generation, with thorough analysis of the general environmental effects of CSP. On the other side, comprehensive LCAs have been carried out on many CSP technologies on both large-scale laboratory and real-life applications, with a further emphasis on thermal systems.Across the lifespan of utility-scale CSP systems, many direct environmental effects and threats are likely, like air emissions, biodiversity effects, water use, necessary land use from humanly uninhabited wildlife, visual and possibly audio effects, energy and material utilise, and the potential of fire hazards, especially with the use of synthetic oil as heat transfer The key and subcomponents of the environmental effects as well as the habitats were identified and outlined by a few researchers[5]. Centered on the various environmental elements, these results can be summarised as follows:

1. Land: degradation of soil due to land use and coverage changes, and also the spill of high-temperature liquids.
2. Water: Surface and ground water pollution.
3. Air: concentrations of GHGs, albedo adjustment, contamination of light and noise, and dust. Moreover, biodiversity is influenced by it.
4. Land use is not a concern because of space-efficient models.
5. Unless basic general steps are not taken, human health and safety will not be impacted by CSP power plants.
6. The influence of CSP power plants on biodiversity and ecosystems is transient and almost negligible.
7. Huge disruptions during the construction phase of the power plant would affect local atmosphere and particularly the soil.
8. The volume of water used is largely dependent on cooling systems and the temperature of the steam.

Environmental impacts of a CSP system's components

Much as for the elements of the PV system. An LCA study was conducted by a researcher on a CSP system and discussed the environmental effects of multiple system components in a commercial CSP system.They contrasted the life cycle outputs and inputs of the elements of the CSP system, close to the PV system and using Raw Materials Flow RMF methodology, suggesting that the HTF tank and flow metre had 100% of their outputs to water without any inputs from nature; even the value had an immense percentage of its outputs influencing water, all of which makes sense as they deal with almost only water.In addition, they evaluated the environmental profiles of the elements using the ILCD approach and found that the solar collector and heat storage had the highest influence on almost all the variables [8]. Although these contrasts are not valid for any other CSP device or any particular component and can vary according to various parameters, similar to the PV example, it provides a clear indicator of each component's environmental effects.

ENVIRONMENTAL IMPACTS OF UTILITY-SCALE SOLAR SYSTEMS

Impacts regarding the availability of land resources and erosion

In addition, installation of photovoltaic panels is much more technically invested than other building projects of power stations, due to the impact on the quality, productivity, and output of the device over its lifetime of any unpredicted or ignored soil/land element. Major landscape changes, such as removal of trees, land levelling, soil compaction, removal of unwanted roads, and construction of main access roads, are often typically expected.This will contribute to increased topsoil degradation or even lower depths, elevated turbidity or sediment content in local waterways, reduced filtration of rainwater and air pollution, decreased regeneration of groundwater and the risk of floods. For example, in the event of a solar power plant being on a slope or an inclined location, access roads between solar panels and arrays have a strong probability of producing erosion[6].

Impacts regarding water resources

Water requirements vary from phase to phase during the life cycle of the solar power plant, but they are needed from the first phase of the development period until the final phase of the decommissioning phase, not to mention their demands throughout the manufacture of components and other processes. In their analysis, for example, some researchers concluded that during the land levelling process in the construction phase, dust suppression demands the highest water consumption rate. In comparison, depending on the technology, whether its CSP or PV, the water usage rate can vary, as well as the used cooling system, whether it is wet, dry or hybrid and the location of the site.However, when comparing cooling systems, the wet cooling technology of CSP, though being the most common among other cooling techniques, is comparable to the conventional cooling technologies of thermoelectric power plants with the highest performance at the lowest cost. Amongst those two cooling techniques of 3100-3800 L/MWh, other tests have shown that it absorbs the most water. Hybrid technology, on the other hand, needs 65-80% lower water usage of 600-1300 L/MWh). In the other hand, while it has a considerably lower water usage of 100-400 L/MWh, the dry cooling system is much less powerful and expensive[7].

CONCLUSION

The environmental effects of solar energy systems have been addressed in depth in this study, including some industrial and evolving solar PV and CSP projects with many advanced technology and facilities, along with several of the core elements in their projects. The topic covered the key phases of both small-scale and utility-scale structures, beginning from the early design stages, during their development, material use, building, or implementation phase, during their lifespan and at the end of their decommissioning. There was debate and summarization of a handful of analysis and LCA works.Relevant solutions have been provided for most schemes, such as waste minimization and recycling, and even some theoretically and environmentally beneficial guidelines for their effects on natural resources.

It can be inferred that with regard to their environmental effects, like crystalline Si-based PV systems, certain well-established mechanisms have been well examined.Further environmental and technological focus is needed, moreover, for a few of the evolving wafer-based and thin-film technologies like GaAs, CZTS, OPVs, DSSCs and QDPVs. In specific, CSP systems and, in addition, flat plate collectors and thermal storage systems have been well established. Further study on the evaluation of the related environmental effects of certain structures is required.

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