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Research Article

Environmental Impact Assessment of Solar Power

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Abstract

Once the use of environmentally sustainable practices is followed during the manufacture of solar cells, the unknown threat that the raw materials pose can be overruled. The toxic materials like Cadmium, Arsenic etc. are being used which although for the present seem to be good but are expected to have potential harmful effects in the future. Hence, it is the need of the hour to study these harmful effects and make an attempt to minimize and ultimately stop the use of such raw materials during the manufacture of the solar cells, by finding out an alternative better option. Apart from the raw materials used, there are many more other threats which are on the fence. So, it is wise to analyze each of those threats and finally act in a suitable way such that energy conversion and environmental sustainability go hand in hand. In order to achieve sustainability, some measures are to be taken up strictly. The prime focus towards achieving a sustainable future is by nullifying these harmful effects created by the solar panels, which efficiently convert solar energy into electricity. The individual type of solar panel is associated with its own merits and demerits, whether it is a mono-crystalline, polycrystalline, an amorphous or thin film solar panel. Although the solar panel possesses many advantages, still its loopholes cannot be neglected. Hence, some of the important measures have been noted down in this piece of research work to the best of our knowledge.

Keywords: *Solar panel, toxicity, pollution, carbon footprint.*

1. Introduction

Known to have little impact on the environment, the solar energy is better referred to as the Clean Energy since it does not emit gases like other energy sources e.g. fossil fuels. The only drawback of solar energy is its unreliability, as compared to manifold advantages like abundance, use in the remote areas, non-polluting, clean, efficient, no noise pollution, low maintenance and others. It also reduces the carbon footprint (Kocjancic. K et al, 2013), which is well cited in the Journal Carbon Management as, "A measure of the total amount of carbon dioxide and methane emissions of a defined population, system or activity, considering all relevant sources, sinks, and storage within the spatial and temporal boundary of the population system or activity of interest. Calculated as carbon dioxide equivalent using the relevant 100 year Global Warming Potential." In order to utilize this energy source to meet our daily needs, we need to convert it into electricity, which is done efficiently by the solar panels. The sunlight is directly converted into electricity by the solar panels with all the advantages of the solar energy intact. The individual type of solar panel is associated with its own merits and demerits, whether it is a mono-crystalline, polycrystalline or an amorphous solar panel. Although the solar panel possesses many advantages, still its loopholes cannot be neglected, which are discussed in detail in the individual sections and their solutions are provided to a great extent.

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2. Effects by the panels and on the panels

The individual type of solar panel is associated with its own merits and demerits, whether it is a mono-crystalline, polycrystalline or an amorphous solar panel. Although the solar panel possesses many advantages, still its loopholes cannot be neglected, which are discussed in detail in the individual sections and their solutions are provided to a great extent. Briefing them, they are:

2.1 land requirement

The land is a major requirement for the production of electricity. In case of the already existing areas (Non-hydroelectric renewable energy, 2012) e.g. roof tops, the land requirement is not a matter of concern but when electricity is to be produced for commercial purposes, the area occupied by the system gets unavailable for any other purposes. According to the Union of Concerned Scientists, an area of 1 km^2 is required to produce an electricity of 20-60 megawatts (JacobS, 2010). Hence, the land requirement

by the establishment of the solar panel in an area drives the attention of the people and this issue needs to be taken care of at the soonest, as this issue can prove to be a threat to the environmental preservation and wildlife protection.

Figure 1: Solar Updraft Tower

The above figure shows a solar updraft chimney and the collector area at the base. This collector may extend occupying an area of as more as 10km diameter (Mishra. S et al, 2013). Many a times, the local people do not get agreed to leave their place for this type of projects. This creates trouble. Hence, the best way to fight this problem is to set up these projects in the desert areas. The huge amount of land in the desert areas often go neglected as if it cannot help in any way. These lands, for sure, cannot be used for cultivation or building houses, but may behave as blessing in disguise by helping the large solar projects to be set up upon them. This is the best way because with the use of this way, two issues can be solved: it would not disturb the human population in that place and secondly, the purpose of producing and supplying solar power can be effectively met.

2.2.Production

Before moving forward to abandon the conventional sources of energies and hence, replacing the conventional sources of energies with the solar panels, two major issues (Ingienous designs, 2013) which needs to be focused are the (a) the emission of toxic gases at the time of production panels and (b) the toxicity emission at the time of disposal of the solar panels.

A huge amount of money was and is being spent by many government and private organizations towards getting a specific idea of whether or not, the solar PV panels be fully relied upon. One such step was taken by Silicon Valley Toxic Coalition in 2009, which studied and produced a white paper named 'Toward a Just and Sustainable Solar Energy Industry', highlighting a range of actions that the policy makers, solar panel manufacturers, and consumers can take to help ensure that the solar photovoltaic industry becomes truly sustainable (Ingienous designs, 2013).

It is believed by most of us that the generation of solar power does not create any pollution, whereas the truth lies somewhere a little far from this assumption. The substances used for the production of the solar panels include some of the harmful heavy metals, some carcinogens and hazardous materials. When compared to the traditional fossil fuels, the effect of solar panel may seem to be less; but on a whole, it can be found out that the production of solar panels affect the environment adversely.

Figure 2: Solar panel production (R.M. Schneidermen, 2009)

The Union of Concerned Scientists says that for the manufacture of solar panel, the major required materials are Arsenic, Cadmium and the polysilicon, which are considered among fifty different cancer causing chemicals (Renewable energy geek.ca , 2009). Each ton of polysilicon being manufactured produces four tons of liquid wastes which if exposed to the atmosphere can get transformed into various harmful acids and gases. This is reported well in The Washington Post. Moreover, the Cadmium is a toxic heavy metal and the Arsenic is known to have adverse effects. According to the Union of Concerned Scientists, it is known that the impact of the solar panels depend primarily on how the panels are manufactured, installed and ultimately disposed of. Although no particular solution seems to set fit to this problem, but some difference could be put by allowing the use of less toxic substances and in less quantity, while the required ratio is still to be kept in view.

2.3 hazardous wastes and health hazards

Although installing solar panels at the roof-top or nearby would not kill us, but it will expose us to a variety of hazardous chemicals, those may result in undesirable health problems (Renewable energy geek.ca, 2009). The people at the highest risk are the workers at the solar panel manufacturing units. They get exposed to the chemicals at a high and frequent rate, most of which are major

carcinogens. On the other hand, as the end of solar panels occurs, the users generally dispose the panels at their local garbage dump. Hence, there are chances that the users may suffer to a great extent if the panels are not properly disposed of, as many of the toxins (Renewable energy geek.ca, 2009) leaking from the disposed panels are unknowingly inhaled by the people and consequently result in harmful effects on the body. And even the World Health Organization reported in June 2006 that almost one quarter of all diseases is a direct result of exposure to toxins.

Effects of e-waste on human body (Ingienous designs, 2013)

1) Selenium

Exposure to high concentration causes Selenosis which can cause hair loss, nail brittleness, neurological abnormalities (i.e. numbness and other odd sensations in the extremities).

2) Lead

Lead exposure can cause brain damage, nervous system damage, blood disorders, kidney damage and damage to fetal development. Children are especially vulnerable.

3) Beryllium

Exposure can cause lung cancer and chronic Beryllium disease, whose symptoms include breathing difficulties, coughing, chest pain and general weakness.

4) Polyvinyl Chloride

PVC is the most used plastic found in everyday electronics. When burned it produces large quantities of hydrogen chloride gas, which combines with water to form hydrochloric acid (HCl). Inhaling HCl can cause respiratory problems.

5) Mercury

Exposure through ingestion or inhalation can cause central nervous system damage and kidney damage.

6) Arsenic

Long term exposure may cause lung cancer, brain damage and various skin diseases. Arsine gas (AsH3), used in tech manufacturing, is the most toxic form of Arsenic.

7) Trichloroethylene

Exposure to TCE (depending on amount and route) can cause liver and kidney damage, impaired immune system function, impaired fetal development, and death.

8) Cadmium

Long term exposure to Cadmium can cause kidney damage and damage to bone density. Cadmium is also a known carcinogen.

9) Barium

Exposure may lead to brain swelling, muscle weakness, damage to heart, liver and spleen, or increased blood pressure.

10) Brominated flame retardants (BFRs)

Suspected to hormonal interference (damage to growth and sexual development), and reproductive harm. BFRs are used to make materials more flame resistant. Exposure studies reveal BFRs in breast milk and blood of electronics workers, among others.

11) Polychlorinated biphenyls (PCBs)

Toxic effects of PCBs include immune suppression, liver damage, cancer promotion, nervous damage, reproductive damage (both male and female), and behavioral changes. PCBs were widely used (prior to 1980) in transformers and capacitors. Though banned in many countries, they are still present in e-waste.

12) Dioxins and Furans

Skin disorders; liver problems; impairment of the immune system, the endocrine system and reproductive functions; effects on the developing nervous system and some types of cancers.

13) Chromium (IV) - Hexavalent Chromium

Exposure can cause strong allergic reaction (linked to Asthmatic Bronchitis) and DNA damage to cells. Workers are exposed at disposal stage and Chromium IV can also be released into the environment from landfills and incineration.

Nitrogen Trifluoride is a compound which is 17,000 times (JacobS, 2010) more potent as a global warming agent as compared to the carbon dioxide. It is used to etch surfaces on solar cells, 2 percent of which escapes into the atmosphere and may cause very uninviting conditions in the atmosphere. The hazardous wastes those are created at time of the production of the solar panels and from the disposal of the broken panels and batteries of the solar panel system must be taken care of in a wise manner in order to nullify the harmful effect of these wastes to the living population and the environment. The panels contain sulphuric acid and lead, which cannot be disposed of along with the garbage due to their adverse effect to the environment.

Also, as we know that in order to make the supply of solar power at night and cloudy weather, we need to store electricity produced by the solar panels in presence of sufficient amount of sunlight, in the batteries. Hence, they are considered to be an important component of passive solar installation (Nolan. A, eHow contributor). These

batteries, if disposed of improperly, are a threat to the environment owing to the presence of lead acid in the batteries which is quite difficult to be recycled. And even if it is possible to recycle the lead acid batteries, according to the Renewable Energy Policy Project, the developing countries do not have sufficient means to recycle these batteries (Nolan. A, eHow contributor). Hence, the closest possible solution to this problem can be possible only when the solar panels can be made fully recyclable (Ingienous designs, 2013) and proper disposal measures should be owned (Underwood. K., 2009). This will result in diminishing or nullifying the fatal consequences of inhaling the harmful gases of the used and disposed solar panels.

2.4life span of solar panels

It is another major demerit being faced by solar panels specifically in India. The usual lifespan of solar panels is 30 years (Mcarling, 2013) (Smith. E, Green living) whereas in India the practical lifespan of the panels is found to be only around 7 years. Even good Companies like Superlite Luminaires (Solar lighting, Superlite) guarantee a life of only 25 years. This creates the downfall in the marketing of the panels creating lack of interest in this field. There is always the need of experts before and during the installation of the solar panel system, mainly if the customer is a first time user of the solar panels and experts are also needed during the maintenance of the panels. Moreover, the durability of solar panels depends on many delicate manners like location and placement of solar panels, extreme weather and environmental conditions, and also on the type and frequency of maintenance (Smith. E, Green living).

Although focus should shift to enhancing the life span of solar panels, but still, the solar panels now have a healthy life span i.e. the power output of the panels decrease by only around 0.7% each year as experimented by the Center for Alternative Technology (CAT Information Service).

2.5weather and surroundings

Only solar panels are not always the ones creating problems, sometimes they become the sufferers also. Efficiency of the solar panel system gets easily affected by the trees and shadow of the houses and other buildings of the surroundings, and even by the bird droppings and other debris like the tree leaves and dust.

Figure 3: Before and after panel cleaning (North coast Solar clean)

Along with the cloudy weather, the efficiency also decreases with any shadow on the panels. The efficiency may drop from 25% to 50%, if not cleaned properly and at regular intervals (North coast Solar clean) (Anaheim, 2011). Hence, a quite good maintenance is required at a frequent rate in case of the cleaning of the solar panels, which signifies that it cannot be assured to the users that a solar panel requires no or little maintenance. Moreover, the unfiltered municipal or well water leaves water spots owing to the naturally occurring minerals those are present in the water, removing which becomes difficult. Therefore, a multi-level water purification system is often needed in order to prevent the aluminum frames of the solar panels (North coast Solar clean) from corrosion, which results from the varying pH and mineral content of the water. Also, when cloudy weather comes into the picture, it may be concluded that the solar panels can prove to be a doubtful choice in less sunny weather, owing to the drop in their efficiency (Ingienous designs, 2013). As it is known to us, the cells in the solar panels are interconnected, as a result of which, even if some cells are shaded, the consequence will either be poor power output or stopping of the panel (Davis. J, Green living) (NREL, 2012).

The most appropriate solution for this issue can be possible by using water sprayers, which can be able to remove the dust, tree leaves, bird droppings etc. or by installing the panels in those areas which do not have trees or building shading it. The solar panels should be placed so that they do not show inter-row shading phenomenon, that is, the solar panels should be placed so as to avoid shading from other panels (Davis. J, Green living) (NREL, 2012).

2.6water

Although a good amount of water is needed in the production process of energy, but there lies an exception in case of the solar panels because the amount of water needed by the solar panels to produce energy is nil (Anderson. D., Demand media, Green living) (U.S. EPA, 2012) or really less in some exceptional cases.

But when it comes to consider the effect on the solar panels then the frost is the one which instantly comes to picture (Marshall. P, 2010). Although normal water does not influence the parameters of a panel; the frost of colder climates does have some effect. Being a combination of cold temperature and moisture, frost tends to drop the efficiency of the solar panels.

3. Conclusion

Our main motto is not to end up the way we are now reacting with the conventional sources of energy. Simplifying my statement, I can say that while starting to use conventional sources, we didn't care much to focus on the harmful effects these may result in, in the future; rather we just started using the conventional sources of energy to the best limit we can. The consequence is what we see today – huge amount of pollution, depleting resources,

many diseases, available at specific areas (many a times remote inaccessible areas), transportation problems and much more. Now when it is in the high plan to rely upon the renewable energy sources and moreover, when there is time in our hands to go into the details of the side-effects of the renewable energy sources, we should not delay in determining the side-effects and hence, nullifying those harmful effects. This will not only make the solar power more practical, but also truly green.

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