

Lifespan and Decomposition Effects of 1st and 3rd Generation Silicon Solar Cell with respect to Environment and Health

Sadaf Faryal¹, Amjad Ali², Abdul Hameed Memon³

(Received November 27, 2018; Revised December 10, 2018; Accepted December 11, 2018)

DOI: 10.33317/SSURJ.V9I1.110

Abstract— Utilization of solar photovoltaic is increasing day by day to reduce dependence on the power grid. Decomposition of 1st and 3rd generation silicon solar cells not only depends upon the plastic and other materials but also the hazardous element mainly used as their character on the bases of which they are categorized as 1st, 2nd and 3rd contemporaries solar cells. These ingredient are mostly carcinogenic and some of them having life span of more than 100 years. After abjection of solar cells, they remain in the soil for many years and cause serious problem to land environment and also responsible for causing carcinogenic disease in human and other living beings. This paper explores decomposition rates of the chemical element mainly used in 1st and 3rd generation solar cells throughout the past years, possible environmental and health effects by the hazardous elements used in them typically silicon (atomic number 14) and focusing on possible suggested solutions or alternatives.

Index Terms— Photovoltaic, Decomposition, Carcinogenic, Hazardous Elements, Silicon Cells.

I. INTRODUCTION

Solar energy is considering green, yet while creating power through photovoltaic is totally preferable for the earthly concern over consuming petroleum derivatives. Decomposition of 1st and 3rd generation silicon solar cells depends upon materials/hazardous element mainly used as their character on the basis of which they are categorized as 1st, 2nd and 3rd contemporaries solar cells, these ingredient are having life of more than 100 years, and can cause serious problem to land environment and also responsible for causing carcinogenic disease in living beings as shown in Table I [1] [2]. Problems have connected with these panels that they cause contamination, and incidentally the time solar cells yield it needs more energy than it payback and the ozone depleting substances radiated in photovoltaic panels cause problem basically for environment and health [3]. The degradation of solar cell on the solid ground that the components having long dotage for example silicon. Infiltration of silica is known to cause a provocative response and endless exposure prompt lung fibrosis and can advance into the infection, silicosis, refined crystalline silica particles quickly experience apoptotic and threatening expiration [4]. The classic work by which speck is leap and epitomize and the reason particles are harmful is questionable. Amorphous silica has been a sense of

think to be a less toxic frame, however this view is hostile, corresponded the take-up and lethality of formless silica to crystalline silica [5], [6]. Crystalline-silicon module represented 87% of the overall PV module shipments in 1997 and 93% of those module sent for open airwave [7]. In spite of these points of interest, the perceptual experience of the accompanying outline recommends that even after numerous long periods of ontogeny of photovoltaic impact, its exercise to deliver force has been extremely constrained.

Table I: Hazardous Elements used in 3rd Generation Solar Cells, Their Half-Life and Life-Time

S. No.	Generation of Solar Cell	Element	Form Used In Solar Cell	Elements Lives	
				Half Life	Life Time
1	1 st and 3 rd Generation Solar Cell	Silicon	Mono Crystalline Silicon Cells	Stable	Stable
			Poly Crystalline Silicon Cells		
			Amorphous Silicon Cells		
			Hybrid Silicon Cells		
			Silicon Wires		
2	2 nd Generation Solar Cell	Cadmium	Cadmium Telluride (CdTe)	Stable	Stable
		Tellurium			
3	2 nd Generation Solar Cell	Indium	Copper Indium Gallium Diselenide (CIGS)	Stable	Stable
		Gallium			
4	3 rd Generation Solar Cell	Carbon	Nano Tubes	Stable	Stable

An investigation by Universal Elan vital Organization (IEA) demonstrated that from 2016 to 2040, the utilization of all sustainable power root assets including solar power, wind and thermal power would increase Global Warming [8].

Amid the last quarter of the century, sunlight based age of power has been demonstrated in fact achievable and solid. In any case, the utilization of these sustainable assets still less than 1% of superior general energy utilizes. Indeed, even

¹MS (Energy & Environment), Department of Post Graduate Studies, Graduate School of Engineering Sciences & Information Technology (GSEIT), Faculty of Engineering Sciences and Technology (FEST), Hamdard University, Karachi, Pakistan. sadaf.faryal29@gmail.com

²Research Engineer, Center of Research Excellence in Renewable Energy (CoRE-RE), King Fahad University of Petroleum and Minerals, Dhahran, Saudi Arabia. amjad.ali@kfupm.edu.sa

³Professor Mechanical Engineering, Department of Mechanical Engineering, Faculty of Engineering Sciences and Technology (FEST), Hamdard University, Karachi, Pakistan. ahameed_memon@hotmail.com

today, crude oil, coal and gaseous petrol, which still mean value more than 60% alongside atomic vitality, have been the most utilized energy assets as shown in Fig. 1, a and b as well as in Table II of energy mix 2016-2040 [9].

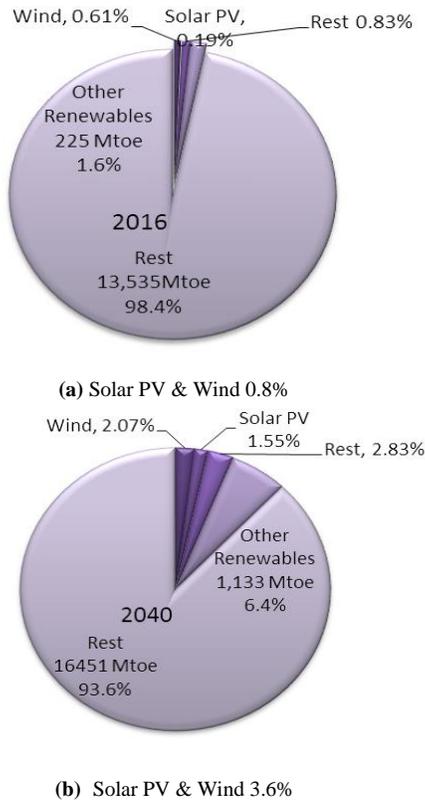


Fig. 1: Energy Mix 2016-2040

Table II: International Energy Agency 2018 World, New Policies Scenario

Years	Energy Demand (Mtoe)						
	2000	2015	2016e	2025	2030	2035	2040
TPED	10 035	13 633	13 760	15 182	16 806	16 806	17 584
Coal	2 0311	3 837	3 755	3 842	3 896	3 909	3 929
Oil	3 670	4 327	4 388	4 633	4 715	4 764	4 830
Gas	2 071	2 938	3 007	3 436	3 737	4 068	4 356
Nuclear	676	671	681	839	897	949	1 002
Hydro	225	334	350	413	459	499	533
Bio Energy	1 023	1 326	1 354	1 530	1 630	1 721	1 801
Other Renewable	60	200	225	490	676	896	1133

II. HISTORY AND BACKGROUND OF SILICON BASED SOLAR PHOTOVOLTAIC

Among the majority of the materials recorded above, silicon is the most normally utilized material in the photovoltaic cells. It is likewise present in plenitude in nature as silicon dioxide in sand and quartz, from which it is extricated by decrease with carbon. Indeed, silicon represents about 26% of the world's hull. In the photovoltaic cells, two distinct types of silicon are being utilized, for example, unadulterated crystalline silicon and the undefined silicon. Because of the adjustment in the

structure, there are a great deal of contrast as far as physical properties of unadulterated crystalline silicon and shapeless silicon. In many rooftop incorporated applications, strings are typified (for the most part behind glass) to shape a module (ordinarily alluded to as a 'panel'). The PV panel is the energy building square of a PV framework and any number of panels can be associated together to give the ideal electrical yield. Notwithstanding, two sorts of PV are best kept as a thin film, and typically sold typified in a polymer attached to a substrate that can be utilized as a component of the roofing material. Silicon cells having poisonous quality and potential cancer-causing properties, these are just utilized in uncommon applications, for example, satellites or exhibit sunlight based fueled vehicles. Natural based PV arrangements that are still under research.

No appropriate interpretation explaining the discrepancy may well be given, however the purity of TEOS (Tetraethyl Orthosilicate) or creature conditions is also a bit of the explanation [10]. Ecological exposures to Silicon transmitted into the air as a component of particulate emanations made by normal, mechanical, and cultivating movement [11]. A basic audit of workplace studies and reports on the unfriendly wellbeing impacts of quartz presentation [12], [13]. An audit of the cancer-causing nature contemplates led by the International Agency for examination on malignant neoplastic sickness [14]. An audit of the non-malignant growth wellbeing impacts of close quartz concerning the hazardous impacts of semiconducting texture upon wellbeing [15].

III. SILICON IN PHOTOVOLTAIC CELL

Silicon has some exceptional compound properties, particularly in its crystalline shape. An iota of silicon has 14 electrons, organized in three distinct shells. Mono crystalline Si is a constant crystalline material with no grain limits. The entire real structure is one intensifier crystalline structure. This mass of silicon, that contains only mono crystalline manufactured part with dopants all through, is then evacuate cuts and these cuts foursquare bill progressively dealt with into awfully thin wafer, plan thickness from 200-300 micrometer [16].

The Polycrystalline silicon is made of a couple of tiny grains of mono crystalline silicon, with a couple of grain confines between the individual valuable stones. Polycrystalline cell, about 17% capable, is most frequently organized by using fluid liquid silicon mixed with dopants. Variation on multi crystalline innovation where the silicon is saved in a persistent procedure onto a base material giving a fine grained, shimmering appearance.

Like all crystalline PV, it is ordinarily exemplified in a straightforward protecting polymer with a safety glass cover and after that bound into a metal encircled module. Thin film sun oriented cells are built from hydrogenated indistinct silicon (a-Si: H), comprising of an un-doped protecting area between doped p-type and n-type end locales. Other thin film PV panels consist upon various different materials, for example, Cadmium Telluride (CdTe) and Copper Indium Diselenide (CIS) are presently being utilized for PV modules.

IV. COMPONENTS OF A PV MODULE

Solar panels are implanted in the bilayers covering; Mono-or poly-crystalline sun oriented cells which are associated with pig strips; weatherproof plastic sponsorship produced using polyvinyl fluoride (PVF) and Polyethylene (PET); Junction box for interfacing the PV modules to one another.

All these components are fabricated in various routes by different maker and. are then collected by the suppliers of PV modules. Besides, data about the series of parts of the c-SI framework segments is vital for knowing assembling and reusing psychological procedure of PV modules. Drinking glass return 75% of arrangement, which is most noteworthy. The aluminum outline amount to decade percentage though all polymers add to around 6.5 %. In division, the mass of sun based cells is 3% as it were. Every other material (like Zn, Pb) contributes less than 1% as shown in Table III [17].

Table III: Components of Silicon PV Module

Important Materials		Remaining Materials	
Material	% (wt)	Material	% (wt)
Glass	91.4%	Zinc	0.1
Polymer(laminating & Plastic Backing)	≈6.5	Lead	<0.1
Solar Cells	≈3	Copper (ribbons)	0.6
Aluminum Frame	10	Silver	<0.006

A large portion of the PV maker does not deliver all segments: materials like aluminum and copper are created in regular oblivious process by conventional producer. These processes are extremely all around created – effectiveness; advancement in assembling is difficult to accomplish. Conversely, silicon creation is a fairly new addition. Thus prospects for lessening of important requirement for assembling solar cells are clear.

V. LIFE CYCLE OF PV SYSTEM

The life-cycle of photovoltaic begins from the extraction of crude materials and finishes with the transfer or reusing and recuperation of the PV parts.

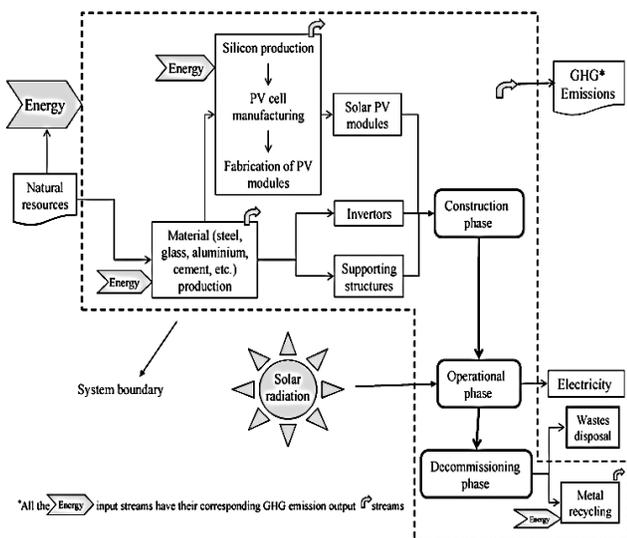


Fig. 2: Life Cycle of PV System

Besides, while building the worthy solar cell, it is extremely critical to remember the length of working life, which is typically set at around twenty years. The mining of crude materials, for instance, quartz sand for silicon PVs, is trailed by further handling what's more, cleaning stages, to accomplish the required high purities, which ordinarily involves a lot of vitality utilization. See Fig. 2.

VI. LIFE SPANS OF 1ST AND 3RD GENERATION SILICON SOLAR CELLS

Solar cell producers need to put significant effort into making their solar panels solid so that their lifespan could increase. They must be prepared to nerve up to weather cycles and noteworthy climate. In any case, solar panels aren't great and that they can unavoidably age [18].

A. How Quick Do Sunlight Based Boards Debase/Lose Their Effectiveness?

The appraised power generation of solar panels by large debases at concerning 0.5%/year. In any case, thin-film solar panels (a-SI framework, CdTe and CIGS) debases faster than panels that zone unit upheld mono-and crystalline star boards. Pre and Post take a seat with establishments previously and post year 2000.

Data is taken from Degradation Rates — confidant organize audit NREL. Star control board more often than not debase faster inside the underlying number of end of their movement as shown in table IV.

Table IV: Output Loss of Different Solar Cells

Kinds of Solar Cell	Output Loss (% Per Year) [15]	
	Pre	Post
Amorphous silicon	0.96	0.87
Cadmium telluride	3.33	0.4
Copper indium gallium selenide	1.44	0.96
Mono crystalline silicon	0.47	0.36
Polycrystalline silicon	0.61	0.64

B. What Will Happen to Solar Panels Following 25 Years?

The Truth is, there is not by any stretch of the imagination and a lot of information to take a gander at since photovoltaic is a generally new innovation (the immense legitimate age of all solar panels are under ten years of age). Here are some of fascinating reports:

- A 33W solar panel (Arco Solar 16-2000) really outflanked its unique production line particulars 30 years after it was made.
- World's first present day sun powered board still works following 60 years.
- Kyocera has announced a few sunlight based power portion that keep on working dependably and produce electrical power despite the fact that they are almost 30 years of age.

The building science has enhanced, the sunlight based jury on today's showcase are more powerful and tough.

C. Different Components Which Can Debase Solar Cells Quicker

In general the more the physical harm (e.g. trees and shrubberies blowing in the insight and scratching), the more control surface scrawl, the more execution debasement. In the most noticeably bad grandstand, water can leak through the surface, which can hamper sun oriented boards. The more climate and wind the sun oriented sheets are presented to, the quicker they will debase.

VII. ISSUES AND PROBLEMS WITH PV PANELS

In 15 to 20 year, if the advancement in productivity carries in transit it does now, a solar panel with a proficiency of 10% created today should rival less expensive solar panels that have efficiencies of around 20%. Also, and that is a reality that the scientists are not considering, sun based solar panel debase in time. Commonly, the guarantee given by solar power cell producer covers only 80 percent of intensity yield. This implies it might predict well to substitute more established control board with more up to date boards before they are 30 years of age. Once more, even in that sheath the environmental score will presumably still be superior to anything the one of fogy fuel, yet the fact of the matter is that the disturbance can turn out to be little. For housetop and interwork - base portion, the eco-cordiality can be exchange great or farfetched, contingent upon the solar power protection and the existence expectation. Be that as it may, on the off chance that we consider solar panels mounted on like PCs or cell phones, solar panels turns into an obviously awful thought.

In the event that take a liveliness anticipation of 3 years (as of now very hopeful for most devices) and a sunlight based separation of 900 kWh/m² (very idealistic as well, since these thing are not lying on a rooftop), the outcome is one, 038 gram CO₂ for each kWh in the most noticeably bad pillowcase situation (statures - proficient mono - crystalline cells delivered in the US). That implies that it is better for the earth to control a contraction with power produced by coal, instead of by a sun oriented board.

VIII. DANGEROUS MATERIALS

Decontamination of silicon unsafe material, for example, Silane may be required. Moreover, other lethal synthetic compounds, e.g. Diborane and Phosphine, are vital for doping the silicon. Just little measure which is weakened in dormant of thing Ga is utilized for this procedure. As this stuff is ordinarily utilized in the microelectronic enterprising nature, an entrenched control and observing exists. Amid normal activity of the produce technique these gases are not risky, but rather in the event of any mishap or release hazardous emanations of the previously mentioned gases could occur. Utilizing zinc ought to be maintained a strategic distance from as this adds to the weariness of crude materials and in addition to the strong driftlessness. Fan stuff like aluminum and copper are related with the ultimate modern hazard. In spite of the fact that PV intellectual capacity may be transported crosswise over long separations, just 0.1% to 1% of the outflows emerge from extradition. To aggregate up, amid yield the

accompanying dangerous materials are transmitted, Silicon oxide dust, Silanes, Diborane, Phosphine, and Solution [19].

IX. DISCHARGES SHAPE PHOTOVOLTAIC MODULE AND FRAMEWORK

Table V demonstrates the outflows from Photovoltaic Module manufacture and a whole photovoltaic process. The information is around fifteen years of age; in this manner there probably been enhancement in the assembling member. Rather than the information in Table V, ongoing examinations demonstrate the natural weight in the outflows of grams of carbon dioxide comparable per kWh delivered electrical energy amid the existence cycle every second of a PV intellectual capacity. The Major examinations give the CO₂ proportionate as opposed to recognizing diverse sorts of emanations. Rooftop photovoltaic panels with poly Si created with hydropower and wafer, cell phone and module produced with UCTE power has a carbon impression of 34 g CO₂ eq/kWh. This was ascertained accepting a PV panels introduced in Southern EC, with a sun powered radiotherapy of seventeen hundred kWh/m², every year. Specialists foresee more enhancement of the assembling activity which will cut of impression by 40 half. The neighborhood sedative power blend, i.e. the power sources utilized for assembling the modules, impact the essential vitality required and additionally the CO₂ equally transmitted per kWh created. Contrasts happen particularly in the creation of nuclear number 14.

Table V: Output Loss of Different Solar Cells

SO ₂	NO _x	Particles	CO ₂	CH ₄	N ₂ O
PV Module 5-5.5	4.5 - 5.3	No Info	2.7 -3.8	No Info	No Info
Entire PV System 1.9	1.8	0.11	971,000	1.6	0.0031

The ecological aftereffect of multi crystalline solar cell is lower as less power is needed for the assembling procedure. Fundamentally, just the abiotic consumption, the Global Warming Potential (GWP) and the fermentation impact the earth. Because of the consuming of petroleum product s for power age amid assembling, the non-renewable energy source stores are exhausted. This reasons the abiotic exhaustion. The GWP to the fermentation potential is caused by emanation from fuel burning as shown in Fig. 3.

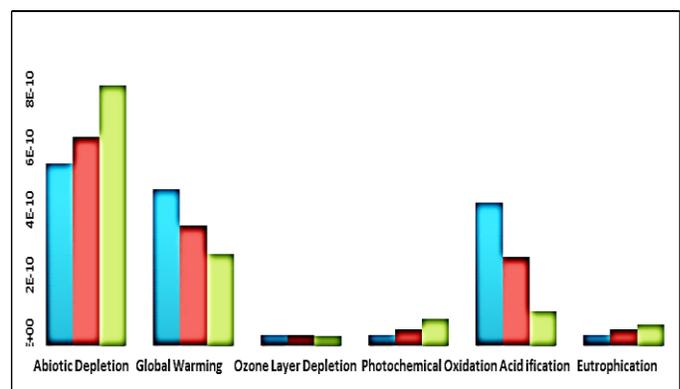


Fig. 3: Discharges Effects of Photovoltaic

X. DECOMPOSITION IMPACTS OF 1ST AND 3RD GENERATIONS SILICON SOLAR CELL UPON HEALTH AND ENVIRONMENT

Silicon is leap forward in numerous dioxide frames and in uncountable varieties from the characteristic silicates. The Si is considerably more plenteous than some other segment, aside from the O. It establishes 27-.72% of the strong express Earth's outside, while the oxygen comprises 46.6%, and the following component after silicon, aluminum, is revelation in a 8-13%. A couple of silicate minerals are mined, e.g., powder and mica. Other mined silicates are Felspar, Nephenile, Olivine, Vermiculite, Perlite, Kaolinite, and so forth, other are types of silica so uncommon that they are attractive thus alone: jewel Opal, Agate and Rhinestone.

Silicon is poisonous as the component and in the entirety of its characteristic mannequin, specifically silica and silicates, which are the most inexhaustible.

Silicon is a dormant material, causing fibrosis in lung tissue. Be that as it may, slight aspiratory injuries have been accounted for in research center energize being from intratracheal infusions of silicon garbage. Silicon dust has minimal unfavorable effect on lungs and does not seem to create huge natural manure sickness or dangerous impression when photons are kept underneath presentation division line. Silicon may cause ceaseless respiratory outcome. Crystalline silicon dioxide (silicon dioxide) is a strongly dangerous for respiratory track. In any case, the probability of crystalline silicon oxide peers amid typical handling is exceptionally remote. LDL (oral)- 3160 mg/kg . (LD50: Lethal portion 50. portion of a substance that causes the passing of half of a creature populace from introduction to the substance by any course other than inward breath. Normally, communicated as milligrams or grams of material per kg of creature weighting) [20].

Silicon crystalline bothers the eyelids and eyes. Inward breath will make aggravation the lungs and bodily fluid layer. Disturbance to the eyes will cause watering and redness. Blushing, scaling, and tingling are according for skin intensity. Lung malignant growth is related with exposures to crystalline silicon dioxide particularly quartz and cristobalite. A presentation reaction human relationship has been accounted for in report of excavators, diatomaceous earth specialists, rock laborers, earthenware specialists, hard-headed block specialists, and different specialists and epidemiological overview have detailed factually critical numeral of overabundance passing or instances of immunologic jumbling and immune system maladies in silica-uncovered specialists. These infections and confusion incorporate scleroderma, rheumatoid joint pain, foundational Lupus erythematosus, and sarcoidosis.

Later epidemiological examinations have detailed measurably noteworthy relationship of word related photograph to crystalline silicon dioxide with renal infections and subclinical renal changes. Crystalline silica may influence the resistant framework, prompting mycobacterial contaminations (tuberculous and nontuberculous) or parasitic, particularly in specialists with silicosis.

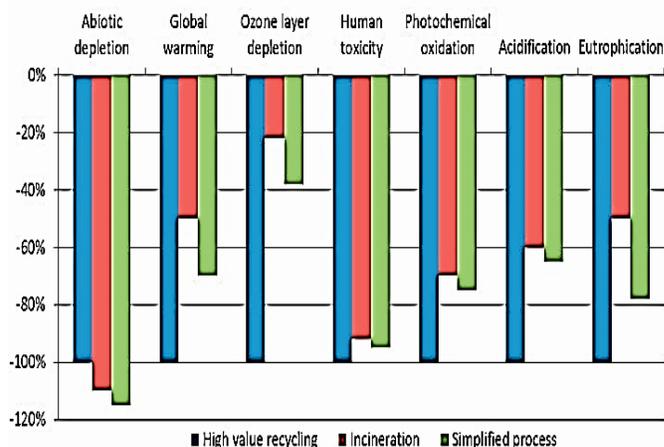


Fig. 4: Impacts of Decomposition 1st and 3rd Generations Silicon Solar Cell upon Health and Environment

Word related helplessness to breathable crystalline silica is related with bronchitis, Chronic Obstructive Pulmonary Disease (COPD) and pneumonic emphysema. Some epidemiologic examinations propose that these wellbeing impacts might be less successive or missing in nonsmokers.

The cruel natural stun identified with the synthetic concoction component because of monoxide might be a turn off of the imperative technique acting compound. Component is prepared from silicon oxide; anyway this can be an immaterial supply of standard air carbon, contrasted with the number produced by ignition of petroleum product as shown in Fig. 4.

XI. SOCIAL AND ECONOMIC IMPACT OF 1ST AND 3RD GENERATIONS SILICON SOLAR CELL

The greater part of the exploration has been managing the specialized and monetary parts of the assessment. It is still minimal thought about the infringement all in all on the grounds that the solar panel building science is amazing and its life-time wheel is long. New advancements and segment are yet to be created. Henceforth explore depends on express boldness which is made after examination the sun based with the effects from electrical gadgets. Besides examination depends on proving ground mental testing - they can vary from the consequence in the genuine universe. Typically researchers will in general disparage effects, for example, a past model on ozone gap. Still in the event that we can evaluate dangers and perils we can create elective materials and parts expecting to accomplish 100% reuse capacity.

Principle amiable and related financial stuns which are divided in positive and negative angles. In spite of the fact that the welfare is clear, the securities business - and not strategies - for the most part chooses about embracing sunlight based PV effectively. From an ordeal on quality in the EU housetop showcase one can discover that this sort of market can't continue in the long haul. Not just that solar panel has achieved fight with the coal, raw petroleum, gas and other carbon producing creativity yet in addition it needs no water for energy age. At long last by executing sun based vitality numerous worldwide clashes for oil and water can vanish and spare the gigantic military expenses.

One outstanding point is to talk about wellbeing infringement from the whole life-time round of the PV cells: (a) generation/fabricating, (b) activity and (c) reusing of tolerant waste. One specific reward of PV materials is that they are 99% recyclable; require low support and little material mass. The fundamental variable stars influencing human wellbeing are:

- Toxicological property of materials (unsafe, malignancy causing or inflammable).
- Degree of diminutiveness.
- Recurrence and length of photograph.
- Potential of receptor to absorb the compound, and mortal ability to sense of man bodies.

XII. CONCLUSIONS AND RECOMMENDATIONS

It must be understood that no artificial projection particle can totally maintain a strategic distance from some impingement to nature, so neither can photovoltaic. Strength ecological disadvantage relies upon its measure and nature of the task and its particular area. The vast majority of these weights are related with loss of pleasantry (e.g., seeing effect/ commotion in the textual style of focal frameworks). In any case, unfriendly impacts are for the most part little and can be limited by suitable alleviation meter, including the utilization of the best accessible advances.

In the module creation process gas and petrol are utilized. The treatment of perilous gases in the module creation ought to be a point of consideration, particularly where substantial graduated table generation is concerned. Research ought to be do regarding how reusing of 80% to 95% of the modules can be accomplished. Since accessibility, fulfillment and character of the information on material and procedures is a long way from such, future research for LCA-review ought to incorporate the improvement of a database with information from both national and universal forms.

A superior procedure is utilizing officially accessible solar panel to green products more solar panel. The researcher figured that the biological weight of solar panel can be divided if 100 percent of get-up-and-go in the industrial facilities would be conveyed by sun based energy.

It is up to designers to make the proper assurance by bringing ecological issues into genuine thought. With that in mind, an environment impingement assessment for focal frameworks, which should appraise the request of extent of potential natural friendly and propose suitable alleviation model, can play a critical use to legitimate undertaking structure and to a consequent task masses acknowledgment.

This does not imply that PV sun based vitality ought not be advanced. For one issue, it's greatly improved utilizing nuclear number 14 wafers to make vitality creating hardware rather than vitality swallowing gear (like registering gadget, portable sound and railroad vehicle gadgets). Yet, some reality must be confronted.

To begin with, solar cells are a long way from a zero discharge innovation. Solar panels can be a suspicious decision in less bright districts. Solar panels mounted on creation are totally unbelievable. Solar cells ought to be reused. Some law or reward ought to be acquainted with assurance an actual existence time anticipation of 30 years. What more, if

conceivable, sun oriented warm power ought to have need over sun oriented PV control.

The pleasant expectation picked by the examiner is, well, only a math mean. The facts demonstrate that most producer spring guarantees of 20 to 25 years, so innovatively delivering a lifelong incarceration story expectation of thirty years isn't impossible. Notwithstanding, there are other than innovative insightfulness that may guide to a fundamentally lower future. The researchers' monetary order that the ecological score of solar panel will enhance, since they are winding up more effective every year. (They additionally turned out to be more slender, so less power is expected to make them). The facts demonstrate that most producers' springiness guarantees of 20 to 25 years, so mechanically a future of thirty years isn't farfetched. Be that as it may, there are other than innovative reason that may prompt a fundamentally lower future. The researchers take note of that the natural score of sun powered boards will enhance, since they are winding up more productive every year. (They likewise turned out to be more slender, so less vitality is expected to make them). In all likelihood they will likewise end up less expensive.

A best system is utilizing in advance open sunlight based panels to make more sun oriented panels and to use synthetic material instead of carcinogenic materials.

XIII. DISCUSSION AND FUTURE SCOPE

This research based upon online survey, readings of different research papers, reports and reviews. By the study of different reports and review one can say that the photovoltaic panels making take as much energy as one cannot obtain after their installation and 1st and 3rd generation silicon solar cells mainly depends upon silicon which is highly toxic and carcinogenic material which can cause different problems within the environment and health so instead of making more new panels the use of prior degraded old panels would be or we can say making of new panels from old ones would be much batter so that the silicon can be reuse although this method cannot be good for environment and health but by the reuse of solar cells the amount of threat can be decreased.

ACKNOWLEDGMENT

As this research paper is on some extent bases upon online reading of different research papers, articles and reports published by NIOSH (National Institute of Occupational Safety and Health), NREL (National Renewable Energy Laboratory), OSHA (Occupational Safety and Health Authority and Agency), US EPA (Environmental Protection Agency), IARC (International Agency for Research on Cancer) in different years and some are other internet sources. Giving high respect and paying my thanks to them all. Thankful to the supervisor, my teachers, family and friends who made their belief in me that I can do this, regards to them to give me moral support as well.

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