

Efficient Solar Panels with Phase Change Materials And Their Applications

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Abstract - In today's world most of the work are automatic, means they are running with help of some energy may electrical energy or with some fuel. And furthermore, human is moving towards sophistication. For all this some source of energy is required. From long time we are continuously dependent on mainly on our fossil fuels. And as per explored knowledge the fossil fuel with in limited and calculated period, if we are continuously using at the same rate. So, we need alternate source of energy, which are renewable and does not cause any adverse effect to our environment, as fossil fuels have affected a lot to our environment. In the present work use of solar energy will be discussed. So, here the focus will be on solar panels which convert light energy coming from sun directly to electrical energy. The present study explores the efficient solar panels with phase change materials and their applications. The study first explores about existing global scenario and then benefit of integrating phase change materials with solar panels and non-conventional applications.

Keywords: Renewable Energy, Solar Skins, Solar Fabric, Solar Energy, Phase Change Materials, Floatovoltaics

I. INTRODUCTION

The journey of humans started with stone weapons, which humans have used to protect themselves as well as to kill animals for food, after discovery of fire humans used it for safety, cooking food and light source. At the initial time there was no use of fossil fuels. Then human learnt to use coal for fire and then sunning steam engines. Then started extraction of liquid fuel and gaseous and started to use in internal combustion engines. Due to excessive use of fossil fuels the CO₂ level has reached to 412 ppm at present from 300 ppm in the year of 1950. This increase in CO₂ level has increased the greenhouse effect, which resulted in trapping of more heat which is received from sun. Due to this enhance greenhouse effect, the temperature has increased around 1°C. The effect of which is visible in the form of increase in sea level, shrinking ice sheets, decrease in snow cover. The effect till date is not so much pronounced, but if this problem is not considered properly, then the future effects will be devastating. The one reason for shifting towards alternate energy sources is the increasing level of CO₂, the other reason is fossil fuel reserves known till now will end up soon within 50 years. So, after some year, the human being who has made its life style such that, in every step of life he requires energy, whether its water in the bathroom in the morning, vehicle to reach office, entertainment, communication etc. will be stopped. So, looking for alternate energy sources has become necessity.

II. WORLD SCENARIO OF FOSSIL FUELS

The expected lifetime of different fuel can be seen in Table 1.1,[BP. 2017]. From Table 1.1, it can be observed that as per the proven reserved and considering the rate of expenditure of different types of fuels, the natural gas can be extracted for around 53 years only by the whole world taken together. Iran is having major share of reserve around 18%. But due higher rate of expenditure of natural gas it can survive with its natural gas reserve for around 165 years. Turkmenistan has 9% share as reserves, but due to low rate of expenditure of natural gas, its natural gas reserve will last up to 262 years, which is highest of all other countries. The crude oil will last up to 51 years in a global scenario. Venezuela having highest share of reserves, which is 18% can survive on its crude oil reserves for 342 years if only Venezuela is using the reserves for its own country. Saudi Arabia having 16% share of total crude oil reserves can only survive for 59 years, as per current extraction rate. Libya holding only 3% of reserves of crude oil can survive for 311 years. So, the above scenario is about the fuel which is mostly used for transportation. The Coal which early vehicles, but now nowhere used for transportation purpose, however large quantity of coal still used for production of electricity in thermal power plants. As per global scenario coal can be used for about 153 years. Unite States having highest share, 22% can use its coal reserve for next 381 years, while china having 21% share of total reserve can extract up to 71 years only. Ukraine having 3% of share can extract coal up to 822 years which is highest. India has 8% share of total global reserves and can extract up to 137 years. In India only coal reserves are in enough quantity, crude oil and Natural gas reserved availability is very less, so it is imported from other oil rich countries. This import cost is very high,

and the oil prices are not in hands of our country. So, most of our energy needs are fulfilled by other countries. So, if buy some reason the country on which we dependent for our energy needs denies providing the crude oil, our country will stop, there will be no transportation, huge inflation may occur due to stopped transportation. This is just starting speculation; the result may be more devastating, and condition will become even worst with time. So, every country must think of alternate energy sources in which no specific country has ownership. Which is available to all in one or the other form[1]-[4].

Table 1.Expected lifetime of Natural Gas, Crude Oil and Coal (BP 2017)

Natural Gas				Crude Oil				Coal			
	2016				2016				2016		
	Proved reserves, trillion cubic metres	% of world reserves	years of extraction remaining		Proved reserves, thousand mln. barrels	% of world reserves	years of extraction remaining		Proved Reserves, mln. tonnes	% of world reserves	years of extraction remaining
World	187	100	53	World	1,707	100	51	World	1,139,331	100	153
Iran	34	18	165	Venezuela	301	18	342	US	251,582	22	381
Russian Federation	32	17	56	Saudi Arabia	266	16	59	China	244,010	21	72
Qatar	24	13	134	Canada	172	10	105	Russian Federation	160,364	14	416
Turkmenistan	17	9	262	Iran	158	9	94	Australia	144,818	13	294
US	9	5	12	Iraq	153	9	94	India	94,769	8	137
Saudi Arabia	8	5	77	Russian Federation	110	6	27	Germany	36,212	3	206
UAE	6	3	98	Kuwait	102	6	88	Ukraine	34,375	3	822
Venezuela	6	3	166	UAE	98	6	66	Kazakhstan	25,605	2	250
China	5	3	39	Libya	48	3	311	Indonesia	25,573	2	59
								Poland	24,161	2	184

III. RECENT DEVELOPMENTS

3.1 Solar Energy

The solar energy importance can be accessed with the fact that amount of sunlight in one day in one hour which is reaching the earth is more than the requirement of one year at present. In one year, earth receives about 178,000 terawatt (TW) of solar energy which is around 15000 times what world consumes today. 30% of solar energy is reflected by atmosphere back into the space, 50% of solar energy is absorbed by earth, 20% is used in hydrological cycle and 0.6% of solar energy is used in photosynthesis [5].

In earth human has learn to harness all types of renewable energy, here the discussion will be focused to harnessing solar energy by solar cell, which convert solar energy directly to electrical energy. Solar cell has good efficiency in lower temperature, but direct beam and diffuse radiation are continuously heating the solar cells which diminish the efficiency of solar cells. So, to restrict the solar cells from excessive heating, phase change materials are used [6]-[11].

3.2 Phase-change materials for solar panels

High operating temperatures in solar panels induce a loss of efficiency. Now to maintain the temperature of solar panels the phase-change materials (PCM) is used, so that the temperature is close to ambient. In the study performed by Sophia Antipolis et. al., show that by adding a PCM on the solar panel at its back under a constant solar radiation of 1000W/m can maintain the solar panel's operating temperature under 40°C for 80 minutes [12].

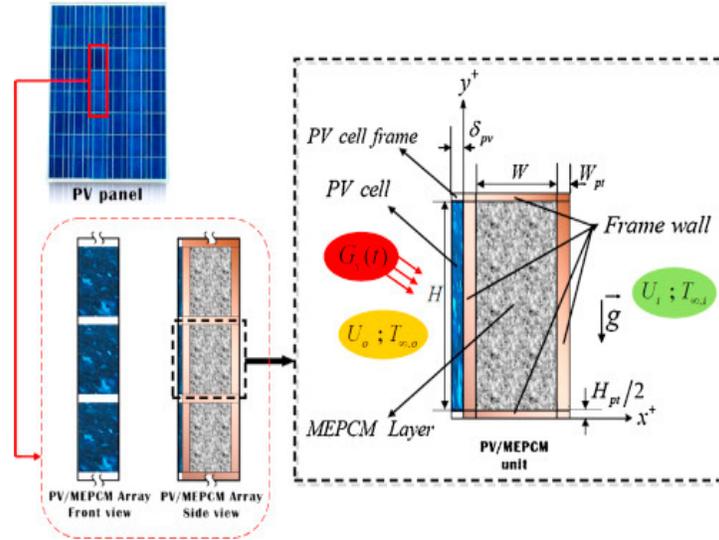


Figure 1. Phase Change Material stacking in solar cells [13]

The solar cells nowadays not only mounted in roof but water bodies such as canal, sea surface referred as Floatovoltaics as shown in Figure 2. So, using the water surface save land cost and installation cost also less than land-based installations. And it has been observed that power production is 10% more due to cooling effect of water. This type of arrangement is helpful in reducing evaporation of water.



Figure 2. Floating solar farm layout[22]

Building-integrated photovoltaics as shown in Figure 3, is blended seamlessly into building architecture in the form of curtain walls, roofs, canopies, facades, and skylight systems. Building-integrated photovoltaics can be aesthetically appealing and made to fit with the building design.



Figure 3. Building Integrated Photovoltaics [14]

Solar skins as shown in Figure 4, are also in development for integrating the designs into solar panel systems. High efficiency in solar thin-film skins is maintained due to selective light filtration. Solar skins provide solar energy and simultaneously displays the custom image.



Figure 4. Solar skins used in roof-top solar panels [23]

Apart from the renewable energy sources (Solar energy) discussed above other renewable energy sources such as wind energy in which energy of wind is harnessed with the help of wind turbines, here off shore wind energy is having lot of potential as the wind is having no obstructions for many kilometers so it gains high velocity and the cost of land also is not issue [15]. Other renewable energy is the Biomass from which biogas, ethanol and biodiesel can be produced for fuel [16]. Our water bodies like oceans also playing important role in providing renewable energy such as electricity production from Ocean Thermal Energy Conversion (OTEC), where temperature difference is utilized to generate electricity either by converting water to steam with the help of vacuum and then feeding steam to turbine, or using secondary fluid which boils at low temperature of 25 degree Celsius such as Ammonia, to drive the turbine [17]. Other ocean energy is Tidal energy in which the tides caused due to gravitational attraction of earth moon and sun courses ocean water to rise and fall 2-2 times, means 2 high tides and two low tides every day, due to which it becomes very good reliable source of renewable energy as like wind and solar energy it is available every time, its availability will not depend on day and night. Tidal energy is produced by making small dam with turbine in which higher water level on either side is and lower water level on the other side is utilized to run turbine and generate electricity [20].

The other form of renewable energy available from ocean is wave energy in which the wave motion is trapped and converted to rotatory motion to generate electricity, and other arrangements include filling water in high rise reservoir to run turbine and generate electricity. Or utilizing air column system to generate electricity [18], [19]. The other form of renewable energy having high potential is Geothermal Energy where heat inside the earth is being utilized for production of electricity, in which steam coming out from earth may be directly utilized to run turbine and generate electricity or if low temperature water is available then secondary fluids with low boiling point can be utilized to turn the turbine and get electricity. Sometimes water is not available, but heat is available in Hot Dry Rocks in that case cold water is pumped through one hole and hot water is taken from other hole which is used to generate electricity or it can be utilized for space heating purpose [20]. Similarly, by using big dams potential energy of water is converted to kinetic energy which in turn used to run turbine and generator connected to it generates electricity [21].

IV. CONCLUSIONS

Solar Energy is a renewable energy which is the ultimate source of energy for other renewable energy, such as ocean thermal energy, wind energy, biomass energy, wave energy, hydel energy. Only geothermal, tidal are the renewable energy where the role of solar energy is not there. So, these forms of energy are clean energy, and these energies will not cause any pollution and global warming. Phase Change Materials integration in Solar Panels increases the efficiency or other words we can say that it helps in keeping the temperature stable and keeping helps in maintaining efficiency. As solar cells energy conversion efficiency is very less so the phase change materials are helpful in maintaining the efficiency by maintaining the temperature of the solar panels.

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