ISSN No: - 2456- 2165

A Review of Various Aspects of Solar Energy Utilization

Manoj Kumar Sharma
M.tech Scholar
Power System
NIMS university
Sharmamanoj300@gmail.com

Arvind Kumar Pandey
Assistant Professor
EE department, NIMS University
(M.Tech, NIT warangal)
Arvindpandey10@gmail.com

Rajendra Prasad Jeenjwria
M.tech Scholar
Power System
AIET, Jaipur
Rajendrachoudharyyy123@gmail.com

Abstract: **- Solar Energy (SE) is considered as a major response for future world in terms of energy. The consumption of SE can take a major account for further energy needs. The SE is becoming a fascinating field for various researchers. A brief view of various designs, details of the construction is majorly applied for diversified designs of SE systems reported previously are demonstrated. Hence, in this paper, we have made an attempt for summation of earlier & current research in the area of SE technology. The main aim of this research is to demonstrate present & future aspects of SE in the world by evaluating the several SE related studies conducted up to date & present associated provided sustainable energy techniques for establishing energy policies.**

Keywords*: Solar Energy, Renewable Energy, Application of Solar Energy.*

I. INTRODUCTION

The solar energy is considered to be ubiquitous in nature, accessible & environmental friendly. As per the economy viewpoint of this renewable source of energy, this is practically used for generating power in the developing countries [1]. For coming over the negative aspects of the atmosphere & various other issues emerged by burning of fossil fuels has gained attention of countries to opt some alternatives to meet the energy requirement [2]. Solar energy is considered a some of the most prominent renewable source of energy possessing minimal adverse effects over environment. Most of the countries has framed SE policies in order to minimize their dependency over fossil fuels & domestic energy generation.

Researches & progressing efforts in solar & other RE techniques are required for improvising the efficiency, producing some additional methodologies & predicting heir outcome and reliable integration for determining the outcome in accurate form through other conventional resources. In this paper, some developments are been made in the field of solar thermal applications are also discussed. Even, the present & future status of SE applications is also examined.

The amount of power generated by sun's energy is calculated as 1.8×1011 MW that is much times bigger than the current rate of consumption of energy. PV technology is considered to be one of the most prominent techniques for useful consumption of solar energy. PV conversion directly converts the solar energy to electricity without using any intermediate interface [3].

Barton et al., resented a novel technique for modeling of an energy storage for matching of power output generated by a wind turbine & solar PV array over a variable electrical load & validating the technique in confront to time-stepping techniques that presents a fine agreement of store power ratings, efficiency of storage, wind turbine capacity & solar PV capacities [4].

This paper concentrates over presetting advancements in solar thermal usage while giving a view about solar collectors & thermal energy storage systems. Several solar collectors are examined & evaluated comprising non-concentrating collectors (operational at low temperature applications) and concentrating collectors (operational at high temperature applications). Several forms of thermal energy storage systems are also examined & presented along with heat storage.

In the [5] a review is provided demonstrating the main techniques for obtaining seasonal storage of Solar Thermal Energy (STE). It is mainly concentrated over scale systems & specially the ones that are presently implemented practically that stores energy as heat energy.

II. BACKGROUND

Energy requirement will be increased with degradation in supply because of traditions of world population & economic growth of 21st centaury. For saving the traditional supply of energy with a support to growth of economic activity, some latest sources of energy are required [6, 7].

The potential amount of world solar energy that can be harnessed is sufficient for global population needs during the 21st century. It has been forecast that photovoltaic technology shows promise as a major energy resource for the future. Much potential exists in the world's desert areas. If appropriate approaches are found, they will provide solutions to the energy problem of those countries that are surrounded by deserts [8]. Technologies that are developed by harvesting solar energy has a long history. From the year of 1860 & Fist World War, various techniques were produced for generation of steam with help of sun's heat in order to operate engines & [9].Solar PV cells were produced by Bell Labs in the United States in year 1954, and they were implemented in space satellites for producing electricity till late 1950s [10].

With the passage of years while following the oil-shock in seventies gained much development & commercialization of solar energy techniques. As so, incipient solar energy industry in 1970s & early 80s years came down because of straight declination in prices of oil &

ISSN No: - 2456- 2165

lacking the sustained policy support [11]. Solar energy markets have got a hike from the 2000 years, presenting a consistent growth. The total storage of electricity generation based over solar energy has raised to around 40 GW by the year of 2010 from negligible capacity in the early 90s [12]. The raised efficiency, that will minimize the cost & minimal pollution are the boons of PV systems which had got a broad range of applications.

Data of solar radiation gives information about the energy of sun falling over surface at a given location on the earth in a definite time. This information can be needed for implementing efficient researched techniques for solar energy utilization. Because of the pricing and complications in computing solar radiations & the data is not available publically, researchers are seeking for alternatives to produce this data. a review s presented in this paper that is constituted over solar energy modeling techniques which are presented as per their nature [13].

Solar energy is the part of the energy of sun that falls over the surface f earth for some useful applications. This computed values of solar energy can be applied for performing development of solar energy models that defines mathematical equations in metrological variables like humidity, temperature, sunshine ratio & solar energy. Such models can be further used for making assumptions over direct & diffuse solar energy through historical metrological data on the portions where no device for calculating solar energy is implemented [14].

While examining the solar energy, information provided for solar radiation & its factors over a précised location is highly required. Data about solar radiations is required by architects, solar engineers & agriculturists for several applications like cooking, heating, illumination & drying. For this cause, few mathematical modeling presuming perfect & secular reflectance can be observed in this theory [15],

At the initial stage of calculations, the standard spatial geometrical characteristics for every pixel are computed. Then it is determined if the sunshine will get onto grid plot theoretically & there is no hindrance in between surface & sun. the plot can be provided over shaded portion on the hill or else a slope can hide it that will lie in front of the surface (termed as shadowing effect of terrain). This algorithm is implemented for every grid plot. This calculation will be performed again and again for determining actual position of sun (declination & angle) that is determined by local time. Outcome from this routine is termed as duration of sunshine throughout optional time domain such as hours or days [16, 17].

III. APPLICATIONS

A . Photovoltaic's

Photovoltaic cells are the types of solar cells which generates electricity straightly from the sunlight. These solar cells are comprised of thin layers of silicon. These layers are treated with a special type of compound and further left with either too high or minimal number of electrons. As soon light hits the multiple layers of material, electron will begin to flow which will lead to generation of electric current [18].

Photovoltaic are implemented everywhere for operating appliances, power navigation system, lightning & communication. Photovoltaic cells are also implemented in satellites & space ships for giving over. PV cells are able to generate required power or operating various consumer appliances like watches & calculators. PV systems are also used for supplying electricity to remote areas, medical centers, residences etc where pricing of PV systems is calculated to be less them establishing power lines or generating electricity through diesel generators [19].

Bhuiyan et al., examined the economic structure of stand-alone PV power system for testing the feasibility in rural & remote locations of Bangladesh & contrasted the renewable generators to non-renewable generators by exempting their price throughout the life cycle through the technique of net present value analysis & also demonstrated that cost of life cycle by PV energy is less that energy cost through petrol or diesel generators in Bangladesh & hence it is economically feasible in rural locations of Bangladesh [20].

Feltrin et al., analyzed several photovoltaic technologies, ranging from silicon to thin films, multi-junction and solar concentrator systems for terawatt level deployment of the existing solar cells, and for each technology, identified improvements and innovations needed for further scale-up [21].

B. Solar Thermal

The solar thermal power is the heat that is generated through exposure of a collective device to the sun radiations. This solar thermal system requires warmth that is collected by collector for purpose of heating the water or another fluid. This hot water can be used in commercial & domestic buildings or industries. Steam can be used for producing the heat that will rotate a turbine to generate electricity or industrial power [22].

There are various solar thermal power systems comprised of a 'flat plate' solar water heaters; concentrating collectors like central tower receivers & parabolic trough and also dish collectors [22, 23].

C. Flat Plate Solar Water Heaters

Water flowing through the tubes are linked to black metal absorber plate. This place is confined to an insulated box having a transparent window providing a passage for sunlight. The available warm water will be moved to tank that is provided for domestic, institutional or commercial usage.

D. Central Tower Receivers

For generation of steam & electricity through solar thermal energy, central receivers are comprised of a section of tracking mirrors which s termed as heliostats in order to focus the sunlight over a receiver placed on a tower. Water or various other heat transfer fluid in tower get heated up & can be used straightly or transformed to steam for generating electricity.

E. Parabolic Dishes or Troughs

Curved panels that go along with the sun ray direction & concentrate the sunlight over receivers. A liquid that is filled in the pipes on the receiver focal point consumes thermal energy. This received thermal energy will be transformed to electricity on every unit or transferred to a central point to transform it to electrical energy.

F. Solar Stills

Solar stills are the systems formed for filtration or purification of water. There are variegated systems are developed for filtration of water. The increase in supply of water has also raised level of salinity, contamination and people are refusing to drink such water. These water filtration systems can may have a basic design for taste & odor for complicated systems for elimination of toxins & impurities.

Solar water distillation is one of the simplest and most effective methods of purifying water. Solar water distillation replicates the way

ISSN No: - 2456- 2165

nature purifies water. The sun's energy heats water to the point of evaporation. As the water evaporates, purified water vapor rises, condensing on the glass surface for collection [24].

This process will be helpful in elimination of impurities like heavy metals & salts and also cause destruction to micro organisms like bacteria. The outcome is a clean water that is even much pure than rain water. Solar energy is passed to collector for heating the water. The evaporated water will condense on the inside walls of glass. As the evaporation takes place, the water vapor will rise & leave the contaminations behind. A slope of the glass will push the condensed water to collection trough that will deliver the water to collection bottle.

G. Solar Dryers

The sun energy is used for during the crops & grains and this technique is considered as one of the most convention method using solar energy. The basic & non- expensive technique is drying the crops by their natural tendency in an open field or spreading the grains in sunlight. A drawback of this technique is that grains & fruits can be harmed by birds and animals, wind, dust & dirt. Some sophisticated solar dryers can be used for protecting the grains & fruits, minimize loss, dry at a faster rate and produce better product quality than the open air technique [25].

The general elements of a solar dryer are a shed, screened trays & solar collector. In hot & arid temperature, collectors may not be required. The southern portion of enclosure can be concentrated to permit the sunlight in order to dry the material. The collector can have a basic design like a glazed box having dark colored interior that will consume the solar energy for heating the air. The hair get heated up and moves in sola collector through either by natural tendency or push of a fan and hence drying the material inside. The collector size & rate of airflow is dependent over quantity of material that is to be dries, moisture in the material, humidity of air & average amount of solar radiations in drying season [26].

There is generally small number of soar crops dryers in United States. It happens because the solar collector can be high & rate of drying cannot be controlled as they are indulged with propane or natural gas. The collector can be also used for heating the farm buildings & so making it more efficient. It is also possible to produce low cost & small dryer from basic materials. This system can be used for drying fruits & vegetables for domestic use.

Producing a cost efficient & effective provided with a thermal energy storage system for purpose of consistent drying the agricultural food products over a stable level & medium temperature (40–75 C) has become potentially a viable substitute for fossil fuel in much of the developing world.

There is a possibility for minimize solar energy storage & energy requirement, hence having a cardinal role in the energy conservation. The urban & rural structures rely over non-commercial fuels to deal with energy requirements. Solar drying is considered to be one solution that but it is limitedly used because of some restrictions. A good deal of experimental work from past few decrease has presented that agricultural materials can be dehydrated through making use of solar energy. Several designs based over small scale solar dryers compressed thermal energy storage that is mainly applied for drying the agricultural materials [27].

The process of drying has to be executed or preserving agricultural products. For food products, particularly vegetables & fruits hot air on the temperature of 45-60 C is safe for drying. Performing drying in safe & controlled humidity & temperature helps in efficient drying of products that will also improve product quality [4]. Controlled drying is mainly implemented in industries. The hot air for controlled drying is produced through using fossil fuels & too much amount of fuels are being burnt across the world. The high costing & its impacts over environment has put a limitation over using such fuels [29].

The above description focuses over merits & demerits of several designs of solar dryer comprising heat storage systems for purpose of drying the agricultural products [29].

A transient analytical model is presented by Jain [30] for demonstration of research about a latest concept of solar crop dryer comprising reverse absorber plate type collector & thermal storage having a neutral flow of air. This crop dryer linked to backed bed was used for drying opinions by placing them in trays. The temperature of crops is dependent over width of air flowing channel & height of packed bed. The thermal energy storage will put an impact over drying process when there is no sunshine & also is pertinent for minimizing the fluctuation in temperature for drying. The proposed mathematical model can be used for assessment of performance for reversed absorber type collector & thermal storage comprising natural convective solar crop dryer. It can also be used for prediction of crop temperature, moisture content & rate of drying for the crop.

Madhlopa and Ngwalo [31] designed, constructed & assessed an indirect type natural convection solar dryer provided with integrated collector-storage solar & biomass-backup heaters for drying of fresh pineapple. The main elements of the dryer are biomass burner (having a rectangular duct and flue gas chimney), collector-storage thermal mass & drying chamber.

Shanmugam & Natarajan [22] examined the performance of an indirect forced convection & desiccant integrated solar dryer for drying the green peas & pineapple slices with or without the reflective mirror. This system will function in two states, sunshine hours & off-sunshine hours. In the sunshine hours, hot air coming from flat plate collector is pushed towards drying chamber for drying the product & adjacently the desiccant bed accumulates solar radiation straightly & through the reflected mirror. During the period of off-sunshine hours, the dryer works by circulation of air in the drying chamber through the desiccant bed by a reversible fan.

H. Solar Cooling

So, cooling phenomenon works by making use of thermal energy gathered from sun considered as principal energy input for the system to dehumidify & cool down the portion [23]. This will replace the presently used electrical power input which is needed in vapor compression refrigeration cycle. An advantage of this system is that it is capable of potentially minimizing the consumption of electricity & carbon dioxide generated from electricity in the summer months of Canada when need over power grids id at peak level. These systems are efficient when energy requirements at fulfilled by the solar radiations that is implemented buildings by the cooling loads, hence helping to generate more cooling [24].

I. Solar Collector

A solar collector, particularly energy exchanger transforms solar irritation energy either for thermal energy to obtain working felid in thermal applications or electric energy straightly to the PV applications. Solar collectors are majorly described in two classes as per their concentration ratios [25]: non-concentrating collectors & concentrating collectors.

A non-concentrating collector possess same intercepting area as its absorbing area, whilst a sun-tracking concentrating solar collector is comprised of a concave reflecting surfaces to intercept & concentrate solar irradiation to a much smaller receiving area.

As the solar collectors collects thermal energy, it should be sufficiently stores when has to be released further. Hence, it is highly required in an efficient design. Section 3 of the present paper concentrates over solar thermal energy storage, explain its designing criteria, required materials & developing methods for heat transfer enhancement.

There are three major considerations for taking into account while designing solar thermal energy storage system:

- Cost effective
- Technical characteristics
- Environmental effect.

Cost effectiveness obliges the payoff period for investment & hence it is highly required. The pricing of solar energy storage systems is majorly comprised of three portions [5]: heat exchanges, storage material & land cost.

This paper presents state of art over applications of solar thermal energy while concentrating two main subsystems: thermal energy storage subsystems & solar collectors.

Variegated solar collectors are presented comprised of non-concentrated forms. Through, out of various non-concentrating collectors, PVT solar collectors' present best aggregated level of performance. Sun-tracking concentrated solar collectors are also been enhanced along with various sun-tracking systems.

Three distinctive concentrated solar collectors are presented & contrasted: parabolic dish collectors, heliostat field collectors & parabolic trough collectors. The components applied for high temperature storage systems of thermal energy are been contrasted in several categories of thermal storage systems are proposed

Heat transfer enhancement is highly required for conquering the poor transfer of heat in such applications. For such purposes, metal foams & graphite composites are taken as ideal materials. At last, the status of present solar power stations is examined and potential future research developments are also proposed.

Solar cooking can be considered as a solution but it couldn't be accepted for all practical uses because of some limitations. Solar cooker are not capable of cooking at night. This imitation can be overtaken by applying a storage unit to solar cooker.

IV. CONCLUSION

Solar energy is considered to be most reliable energy source with renewable nature. It is increasing over a rapid rate while for maintaining the growth rate required for developing in terms of materials, usage, design of device, production & reliability along with new interpretations for enhancing the aggregated efficiency.

Solar energy can be used in solar PV routes & thermal applications. The power produced by solar energy is not convenient but also environmental friendly while contrasting the production of power through coals & other fossil fuels. While taking the fact about consumption of power worldwide into consideration it is viable to use the solar energy. A review about main applications about energy is demonstrated here. This paper will be more useful for solar PV systems manufacturers, researchers, academicians, generation of members & decision makers.

References

[1] J. Kreider and F. Kreith, "Solar energy handbook", New York, McGraw-Hill, **(1981)**.
[2] T. Khatiba, A. Mohameda and K. Sopianb, "A review of solar energy modeling techniques", Renewable and Sustainable Energy Reviews, vol. 16, **(2012)**, pp. 2864-2869.
[3] Z. Sen, "Solar energy fundamentals and modeling techniques", Germany, Springer, **(2008)**.
[4] J. PB and D. GI, "A probabilistic method for calculating the usefulness of a store with finite energy capacity for smoothing electricity generation from wind and solar power", Journal of Power Sources, vol. 162, **(2006)**, pp. 943-8.
[5] P. Pinel, C. A. Cruickshank, I. Beausoleil-Morrison and A. Wills, "A review of available methods for seasonal storage of solar thermal energy in residential applications", Renewable and Sustainable Energy Reviews, vol. 15, **(2011)**, pp. 3341-3359.
[6] H. Ghosh, N. C. Bhowmik and M. Hussain, "Determining seasonal optimum tilt angles, solar radiations on variously oriented, single and double axis tracking surfaces at Dhaka", Renew Energy, vol. 35, **(2010)**, pp. 1292-7.
[7] R. Kuwahata and C. R. Monroy, "Market stimulation of renewable-based power generation in Australia", Renewable and Sustainable Energy Reviews, vol. 15, **(2011)**, pp. 534-43.
[8] Clean Energy Council. Clean energy fact sheets all about solar photovoltaic. Melbourne, Clean Energy Council, **(2008)**.
[9] C. Smith, "Revisiting solar power's past", Technology Review, **(1995)**, pp. 38-47.
[10] M. Hoogwijk, "On the global and regional potential of renewable energy sources", Faculteit Scheikunde, Universiteit Utrecht, **(2004)**.
[11] T. Bradford, "Solar revolution", The economic transformation of the global energy industry, Cambridge, MA: The MIT Press, **(2006)**.
[12] REN21. Global status report. Paris: REN21 Secretariat, **(2005)** to **(2011)** Issues.
[13] M. Ahmad and G. Tiwari, "Solar radiation models-review", Int Journal Energy Environ, vol. 1, pp. 513-32, **(2010)**.
[14] S. Jebaraj and S. Iniyan, "A review of energy models. Renewable and Sustainable Energy Reviews", vol. 10, **(2006)**, pp. 281-311.
[15] K. Bakirci, "Models of solar radiation with hours of bright sunshine: A review", Renewable and Sustainable Energy Reviews, 13, **(2009)**, pp. 2580-2588.
[16] M. M. H. Bhuiyan, M. Ali Asgar, R. K. Mazumder and M. Hussain, "Economic evaluation of a stand-alone residential photovoltaic power system in Bangladesh", Renewable Energy, vol. 21, **(2000)**, pp. 403-10.
[17] A. Feltrin and A. Freundlich, "Material considerations for terawatt level deployment of photovoltaics", Renewable Energy, vol. 33, **(2008)**, pp. 180-5.
[18] J. A. Duffie and W. A. Beckman, "Solar engineering of thermal processes", 3rd ed. Madison, US, John Wiley & Son, **(2006)**.
[19] T. Schmidt, D. Mangold and H. Muller-Steinhagen, "Seasonal thermal energy storage in Germany", ISES solar world congress, **(2003)**.

[20] B. B. Sahoo, N. Sahoo, P. Mahanta, L. Borbora and P. kalita, "Performance assessment of solar still using blackened surface and thermocole insulation", Renewable Energy, no. 33, no. 7, pp. 1703-1708, **(2008)**.

[21] A. Sharma, C. R. Chen and N. Vu Lan, "Solar-energy drying systems: A review. Renewable and Sustainable Energy", vol. 13, **(2009)**, pp. 1185-1210.

[22] R. Smitabhindu, S. Janjai and V. Chankong, "Optimization of a solar-assisted drying system for drying bananas", Renew Energy, vol. 33, **(2008)**, pp. 1523-31.

[23] A. Madhlopa and G. Ngwalo, "Solar dryer with thermal storage and biomass-backup heater", Solar Energy, vol. 81, **(2007)**, pp. 449-62.

[24] P. P. Singh, S. Singh and S. S. Dhaliwal, "Multi-shelf domestic solar dryer", Energy Conversion Management, vol. 47, **(2006)**, pp. 1799-815.

[25] L. M. Bal, S. Satya and S. N. Naik, "Solar dryer with thermal energy storage systems for drying agricultural food products: A review", Renewable and Sustainable Energy Reviews, vol. 14, **(2010)**, pp. 2298-2314.

[26] D. Jain, "Modeling the performance of the reversed absorber with packed bed thermal storage natural convection solar crop dryer", Journal of Food Engineering, vol. 78, **(2007)**, pp. 637-47.

[27] A. Madhlopa and G. Ngwalo, "Solar dryer with thermal storage and biomass-backup heater", Solar Energy, vol. 81, **(2007)**, pp. 449-62.

[28] V. Shanmugam and E. Natarajan, "Experimental study of regenerative desiccant integrated solar dryer with and without reflective mirror", Applied Thermal Engineering, vol. 27, **(2007)**, pp. 1543-51.

[29] H. Henning, "Solar assisted air conditioning of buildings-an overview", Applied Thermal Engineering, **(2006)**.

[30] J. Duffie and W. Beckman, "Solar Engineering of Thermal Processes", Third Edition, Hoboken, New Jersey, John Wiley & Sons, Inc., **(2006)**.

[31] F. De Winter, "Solar collectors, energy storage, and materials, Massachusetts, The MIT press, **(1991)**.