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An Overview on Hybrid Photovoltaic Solar Energy

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ABSTRACT: Worldwide environmental concerns or rising energy demand, along with continuous advancements in renewable energy technology, are creating new possibilities for renewable energy usage. Solar energy is the most plentiful, unlimited, and clean renewable energy supply currently available. The amount of energy intercepted by the planet from the sun is about 1.9 1011 MW, which is several times more than the current pace of total energy use. Photovoltaic technology is one of the most effective methods for harnessing solar energy. This article examines photovoltaic technology, its capacity to generate electricity, the many light-absorbing materials now in use, as well as its environmental impact and a range of uses. The many current performance and reliability assessment methods, size and control, grid connection and distribution, and grid connection and distribution have all been addressed.

KEYWORDS: Hybrid, Light, Photovoltaic, Power Generation, Solar Energy.

1. INTRODUCTION

The conversion of sun lights directly into electricity without the need of a heat engine is known as photovoltaic conversion. Photovoltaic devices are rugged and simple in construction, requiring little maintenance, and their primary advantage is their capacity to provide outputs ranging from microwatts to megawatts as stand-alone systems. They're used in power plants, water pumps, distant buildings, solar home systems, communications, satellites & spacecraft, reverse osmosis facilities, and even megawatt-scale power plants as a consequence of this. The broad variety of uses for photovoltaics drives up demand year after year[1].

1.1.Photovoltaic power generation:

A photovoltaic power producing system is made up of many components, such as cells, mechanical and electrical connections and mountings, and methods to regulate and/or change the electrical output. The amount of electrical power that a system should produce on a clear day with the sun directly above is measured in peak kilowatts (kWp). A grid-connected system is one that is linked to and feeds electricity into a large independent grid, typically the public energy grid. They come in a variety of sizes, from a few kWp for household usage to solar power plants with tens of gigawatts of capacity. This is a kind of distributed energy generation. Poponi assessed the prospects for photovoltaic (PV) technology for electricity generation in grid-connected systems using experience curves methodology, which is used to predict the different levels of cumulative world PV shipments required to reach the calculated break-even prices of PV systems, assuming different trends in the relationship between price and cumulative world PV shipments. Solar radiation and sunlight duration distribution across Saudi Arabia utilizing monthly average daily global solar radiation and sunshine duration data, as well as renewable electricity and economic

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assessment of a 5 MW photovoltaic oriented grid connected power plant for electricity generation Because the electric load demand can be supplied by both the solar array as well as the utility grid in Kuwait, grid-connected PV systems are used. They found that the peak load matched the highest incoming solar radiation in Kuwait during the performance assessment, highlighting the significance of utilizing the PV station to decrease the electric demand[2].

Hybrid solar system generate electricity in the same manner as a traditional grid-tie solar system does, but they store it in special hybrid inverters and batteries for later use. Because of their capacity to store energy, most hybrid systems may function as a backup power source during a blackout, much like a UPS system. In the solar industry, the word "hybrid" refers to a systems that utilizes a combine of solar & batteries that may interact with the energy grid. Figure 1 shows the hybrid Inverter.

Figure 1:Basic lay out diagram of common solar hybrid system[3]**.**

The economic and environmental potential of a 100 MW very large-scale photovoltaic power generating (VLS-PV) system that will be built in the Gobi desert, based on the system's energy payback time (EPT), life-cycle CO2 emission rate, and generation cost. Investigated the economics of power generation from a floating solar chimney power plant (FSCPP) by assessing cash flows over the course of a 100 MW plant's operational life. Muneer et al. investigated the long-term prospects of large-scale PV generation in arid/semi-arid locations around the world, as well as its transmission using hydrogen as the energy vector. The megawatt plant at the new Munich Trade

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Fair Centre, which represents a significant advance in large-scale PV plant technology, both in terms of system technology and the components used, as well as operational control and costs.

1.2.Hybrid photovoltaic power generation:

A hybrid power generating system combines a renewable energy source (in this example, PV) with other types of generation, such as a diesel-powered generator or another renewable energy source such as wind. These hybrid systems help to decrease nonrenewable fuel usage. Barton et al. described a novel method of modeling an energy store that was used to match the power output from a wind turbine and a solar PV array to a varying electrical load.

The method was validated against time-stepping methods and showed good agreement over a wide range of store power ratings, store efficiencies, wind turbine capacities, and solar PV capacities. The use of wind-alone, solar-alone, and combined wind PV production for use as stand-alone producing systems in distant regions, based on site matching and an energy flow strategy that fulfills the demand with optimal unit sizing, was explored. Deshmukh et al. described methodologies to model hybrid renewable energy system (HRES) components, HRES designs, and their evaluation, demonstrating that hybrid PV/wind energy systems are becoming increasingly popular and highlighting the issues related to penetration of these energy systems in the current distribution network as it provides prospects of incorporating in power generation capacity to imitate the current distribution network. Bitterling tried to investigate the present feasibility of a cellular phone base station power generating solution combining wind and PV power generation with an energy storage system. Prasad et al. proposed a method for determining the optimal size of an integrated wind, photovoltaic, and battery backup system, based on calculated values of life cycle unit cost (LUC) of power generation, relative excess power generated (REPG), or unutilized energy probability (UEP) for a given power supply probability deficiency (DPSP)[4].

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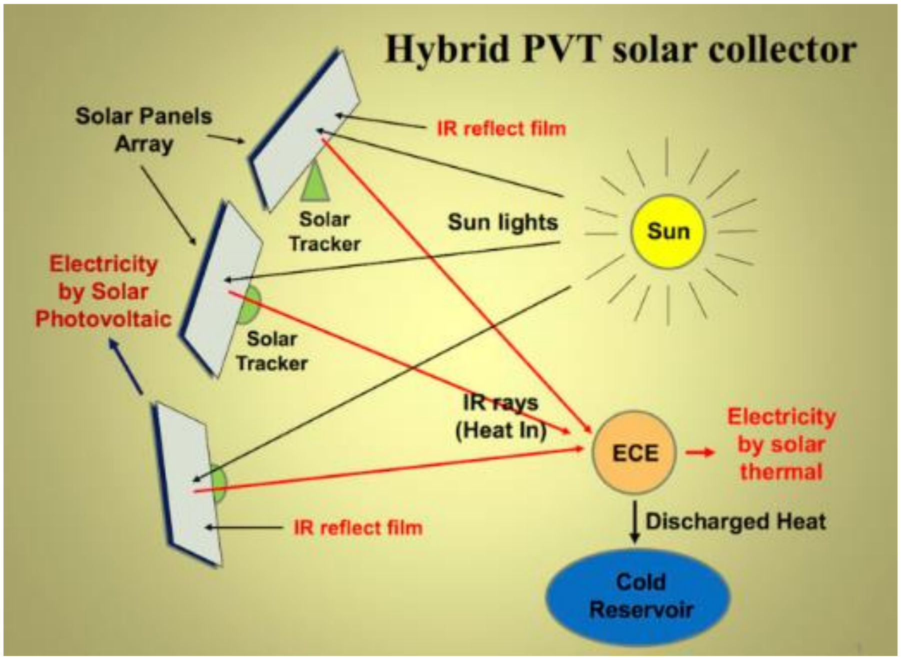

Figure 2: The Hybrid Photovoltaic Thermal systems collects both photovoltaic and thermal energy from incoming sun light[5]**.**

From sun's rays, a hybrid photovoltaic thermal (HPVT) system gathers both photovoltaic and thermal energy. Solar panels that gather photovoltaic energy squander solar thermal energy when exposed to sunlight, show in Figure 2. The proposed HPVT system gathers photovoltaic energy with a standard solar panel and reflects infrared rays from the panel toward that Electronic Carnot Engine (ECE), which transforms solar thermal energy directly into electricity without the use of a generator.

1.3.Light absorbing materials:

To absorb photons as well as create free electrons via the photovoltaic effect, all solar cells require a light absorbing substance that is present inside the cell structure. The photovoltaic (PV) effect is what allows photovoltaic (or solar) cells to convert light into energy. When sunlight strikes a PV cell, it gives certain electrons (negatively charged atomic particles) enough energy to boost their energy level and so liberate them. The cell's built-in potential barrier works on these electrons to generate a voltage, which is then utilized to drive a current via a circuit.

1.4.Silicon:

According to Bruton, silicon technology has dominated the supply of power modules for photovoltaic applications, with an increasing proportion of multi-crystalline and monocrystalline silicon being used for high-efficiency solar cells, while thinner wafers and ribbon silicon technology continue to advance. The recent advances in chemical and metallurgical routes for photovoltaic (PV) silicon production and discovered that (solar-grade silicon) So GSi (expand the acronym) production can be five times more energy efficient than the conventional Siemens

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process, which uses more than 200 kWh/kg. The history of photovoltaic materials was studied, and future possibilities were considered, with silicon as the primary focus. The current PV production cost ranges for single crystalline silicon, multi- amorphous silicon, crystalline silicon, and other thin film technologies, both in terms of capacity installation and electricity generation, assessing possible cost reductions as predicted by the learning-curve methodology. optical stability of porous silicon layers (PSLs) intended for application in silicon solar cells technology, using UV irradiation to improve the PV properties of PS-treated solar cells[6].

1.5.Amorphous :

Amorphous (uncrystallized) silicon is the most common thin film technology with cell efficiencies of 5–7 percent with double- and triple-junction designs increasing it to 8–10 percent. But it is prone to deterioration. Some of the varieties of amorphous silicon are amorphous silicon carbide (amorphous silicon germanium microcrystalline silicon (c-Si), and amorphous silicon-nitride (SiN) the advances made in amorphous-Si PV technology that led to the achievement of an AM 1.5, 13 percent stable cell efficiency and set the foundation for the spectrum splitting triple-junction structure being manufactured by the roll-to-roll continuous deposition process.

1.6.Crystalline silicon:

Crystalline silicon provides an increased efficiency when compared to amorphous silicon while still utilizing just a minimal quantity of material. The commercially available multi-crystalline silicon solar cells have an efficiency of 14–19 percent. Green et al. developed crystalline silicon on glass (CSG) solar cell technology aiming to combine the advantages of standard silicon wafer-based technology with that of thin-films, with the lowest likely manufacturing cost of these contenders and confirmed efficiency for small pilot line modules already in the 8–9 percent energy conversion efficiency range, on the path to 12–13 percent. Aberle examined the current state of high-throughput plasma enhanced chemical vapor deposition (PECVD) equipment for the deposition of SiN onto c-Si wafers, and the basic characteristics of Si-SiN surfaces produced by PECVD. Optimization of cell architectures and their light-induced deterioration. Macdonald et al. described an alternative approach to implementation of the impurity-photovoltaic (IPV) effect in crystalline silicon, referred to as electronically coupled up-conversion that avoids two of the major problems associated with the conventional IPV approach—namely, recombination of minority carriers generated in the base by a single photon, and parasitic absorption. Franklin et al. described the novel sliver cells made of single crystal silicon solar cells that offer the potential for a 10–20 times reduction in silicon consumption for the same sized solar module, while also having the added benefit, in an industrial production environment, of requiring 20–40 times fewer wafer starts per MW than for conventional wafer-based technologies.

1.7.Environmental Aspect :

a novel process for overestimate the number of CO2-emission reduction in the case where carbon-tax revenue is used as a subsidization to promote PV-system installations, and found that marketing the PV system with subsidy policy increases the amount of CO2-emission reduction even at the same tax rate, and the CO2-payback time of the PV system is cut in half if the GDP is assumed to

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remain constant. Krauter et al. looked at a CO2 thorough balance over the life cycle of a photovoltaic power system and discovered that the actual effect of the PV system in terms of net carbon dioxide reduction is the difference between the sum of electrical yield related to the local grid and the value for recycling, as well as the sum of production orders and transport emission levels solar- and nuclear-emitting vehicles.

1.8.Applications :

1.8.1. Desalination Plant :

Lamei et al. described the price at which solar energy can be considered cost-effective for RO (Reverse Osmosis) desalinated water that is self-sufficient of RO plant capacity, as well as proposed an equation to estimate the unit production costs of RO desalination plants that can be used to calculate cost of production for desalinated water using photovoltaic (PV) solar energy based on current[7]. Kershrnan et al. investigated a seawater reverse osmosis (SWRO) desalination plants powered by renewable resources (RES) on Libya's Coast, with both wind energy conversion (WEC) as well as photovoltaic power generation (PV) being incorporated into a grid-connected power source for a reverse osmosis (RO) desalination plant with power recovery. To demonstrate the economic possibilities of the combination, El-Sayed modelled desalination using spiral-wound RO membrane modules powered by sunlight to power photovoltaic converter panels[8].

1.8.2. Building integrated systems:

Building-integrated photovoltaic system combine photovoltaic characteristics into building materials such as roofing, siding, and glass, providing economic and aesthetic benefits when used as a replacement for traditional materials in new construction. Furthermore, BIPV installations are more aesthetically pleasing than roof-mounted PV systems. Yoo et al. proposed a building design in which the PV modules shade the building in the summer to reduce cooling loads while allowing solar energy to enter the building during the heating season to provide daylight, and they conducted a system performance analysis, performance parameters evaluation, as well as power output analysis. A computerized renewable power technologies assessment tool was used to look at the installation, technical features, operation, and economic evaluation of a grid-connected building integrated photovoltaic system (BIPV), as well as the technical or economic aspects.

1.8.3. *Home solar system*:

The existing experience or trials utilizing solar photovoltaic technology in East Timor, which included the deployment of solar household systems. Commercially available Solar Home Systems (SHS) that are cost-effectively utilised to replace kerosene and dry cell batteries to minimise GHG emissions and so make a substantial contribution to weather protection.

1.8.4. Pump:

The researchers created a solar photovoltaic pump drip irrigation system for growing orchards in arid regions, taking into account various design parameters such as pump size, water requirements, diurnal variation in pump pressure due to irradiance changes, and pressure compensation in the drippers. Some policies to make solar photovoltaic water pumping systems a suitable technology for the particular application area, since they have shown their technical, economic, and

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environmental benefits in developed nations. engaged in solar water pumping projects, detailed the good and negative impacts on the community, as well as suggested a completely new kind of pump, taking into account the measures that might be done to guarantee future sustainability[9].

1.8.5. Photovoltaic and thermal technology :

photovoltaic as well as hot water collector wall system that can serve as a water pre-heating system using collectors installed at vertical facades, people who prefer natural water circulation over forced circulation, and the thermal efficiency was found to be 38.9% at zero reduced temperature, and the corresponding electricity conversion efficiency was found to be 38.9% at zero reduced temperature. He et al. suggested utilizing water as the coolant in a hybrid photovoltaic and thermal (PVT) collector system to improve energy performance. Vokas et al. investigated a photovoltaic–thermal system for home heating and cooling, finding that it can provide a significant portion of domestic heating and cooling needs. Chow et al. proposed a photovoltaic-thermosyphon collector with rectangular flow channels for residential applications and evaluated its energy efficiency[10].

2. DISCUSSION

Photovoltaic conversions is the solar energy can be converted directly into electricity without the need of a heat engine. Photovoltaic devices are tough and simple in design, needing minimal maintenance, as well as their greatest benefit is their ability to provide outputs ranging from microwatts through megawatts as stand-alone systems. Global environmental concerns and rising energy demand, along with continuous advancements in renewable energy technology, are creating new possibilities for renewable energy usage. Solar energy is the most plentiful, unlimited, and clean renewable energy supply currently available. The many uses of solar PV systems are also discussed, including building integrated systems, desalination plants, space, solar household systems, and pumps. Manufacturers of solar PV systems, academics, researchers, generation members, and decision makers may find this article helpful.

3. CONCLUSION

Photovoltaic conversions is the conversion of sunlight directly into electricity without the use of a heat engine. Photovoltaic devices are tough and simple in design, needing minimal maintenance, and their major benefit is their ability to provide outputs ranging from microwatts to megawatts as stand-alone systems. Global environmental concerns and rising energy demand, along with continuous advancements in renewable energy technology, are creating new possibilities for renewable energy usage. Solar energy is the most plentiful, unlimited, and clean renewable energy supply currently available. A summary of key solar photovoltaic technologies is given, including PV power production, hybrid PV generation, different light absorption materials, PV system performance and dependability, size, distribution, and control. The many uses of solar PV systems are also discussed, including building integrated systems, desalination plants, space, solar household systems, and pumps. Manufacturers of solar PV systems, academics, researchers, generation members, and decision makers may find this article helpful.

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