



In 2012, Enel Green Power developed a commercial scale hybrid geothermal-solar plant in Nevada and recently expanded it with a concentrated solar thermal system (Dimarzio et al., 2015). 26 MW of solar PV power was added to the 33 MW geothermal binary plant in order to complement the geothermal plant output degradation during hot summer with



Hybrid solar???waste heat power systems can increase plant conversion efficiency and power generation while reducing intermittence. This study focused on the development of software (AERES) to economically optimize hybrid solar???waste heat power systems in terms of technology selection, sizing, operating conditions and power block characteristics.



Over the most recent couple of decades, tremendous consideration is drawn towards photovoltaic???thermal systems because of their advantages over the solar thermal and PV applications. This paper intends to show different electrical and thermal aspects of photovoltaic???thermal systems and the researches in absorber design modification, ???

# SOLAR PHOTOVOLTAIC THERMAL HYBRID POWER SYSTEM IN ERNAKULAM



This paper presents a detailed review of the current state of art in solar photovoltaic-thermoelectric hybrid system for electricity generation. It begins with the analysis of the ???



this, hybrid photovoltaic and thermal (PV/T) collectors are introduced to simultaneously generate electricity and thermal power. The hybrid photovoltaic/thermal (PV/T) collector is an integration of single-crystalline silicon cell into a solar thermal collector. The PVT system is able to generate electricity and hot water simultaneously. II.

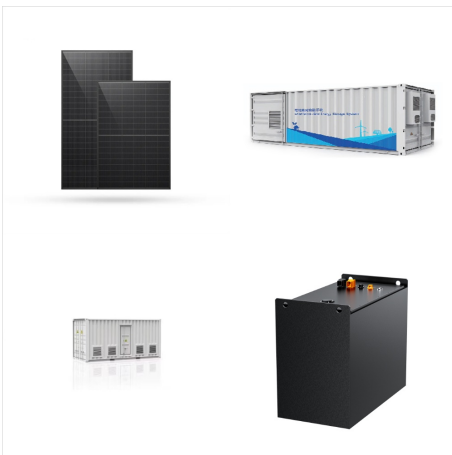


The use of thermoelements with shorter length can result in improved power outputs when the hybrid PV-TE system is operated under sufficient illumination [75]. Thermal-photovoltaic solar hybrid system for efficient solar energy conversion. Sol ???

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Furthermore, a combined hybrid PV and solar-thermal system (PVT) is an alternative solar energy solution, which offers the distinct advantage of providing from a single unit both a thermal output (e.g. for water heating), as well as an electrical output with an improved efficiency compared to stand-alone PV modules if designed correctly [6], [7]



Renewable energy has surpassed fossil fuels as the main driver of global power capacity growth since 2015, currently accounting for more than 50% of new installations [1], with distributed solar-energy systems [2] and in particular photovoltaic (PV) technology expected to continue to dominate the growth of this market in the short term. Apart from power generation ???

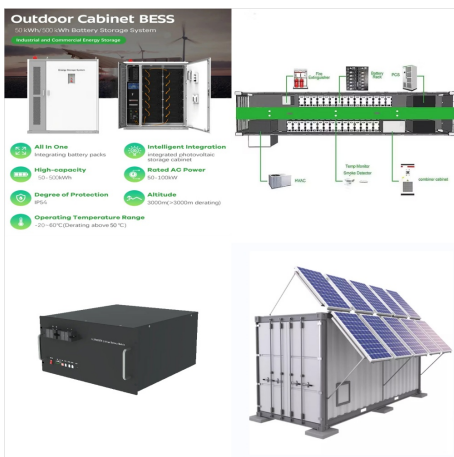


The potential of nanofluids (NF) to enhance the performance of solar energy systems and heat exchanging devices paves the way for increased research attention on solar photovoltaic???thermal (PV/T) systems for producing heat and electricity since few decades. In addition to the mononanofluids, the development of hybrid and ternary nanofluids has led to ???

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It consists of a MATLAB Function block, with the 2 solar inputs, and 3 outputs: the transmitted irradiance on the PV cells, the heat absorbed by the glass, and the radiative power absorbed by the PV cells. Part of it will be transformed into electrical power ( $V \cdot I$ ) and the rest will be heat absorbed by the PV cells.



1.4 The use of phase-change materials (PCMs) in PV/T. Thermal energy can be stored and released from solar PV/T systems with PCMs, thereby increasing energy efficiency (Cui et al., 2022). When a material phase changed from solid to liquid or from liquids into gases, this material absorb or release thermal energy (Maghrabie et al., 2023). A hybrid PV/T system, ???



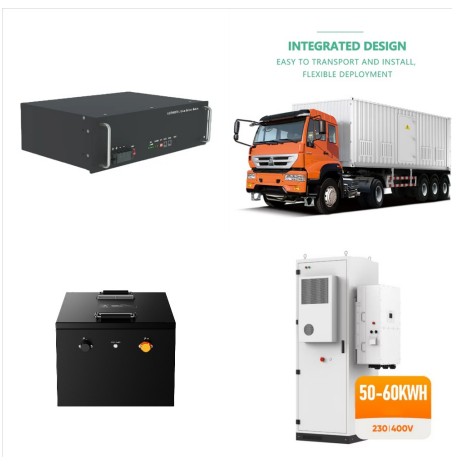
Photovoltaic thermal collectors, typically abbreviated as PVT collectors and also known as hybrid solar collectors, photovoltaic thermal solar collectors, Under ideal conditions, about 75% of the Sun's power directly incident upon such systems can be gathered as electricity and heat at temperatures up to 160 °C. [16]



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Fig. 1: Components of Photovoltaic/Thermal (PV/T) systems. Solar Photovoltaic (PV) unit produces electricity and solar thermal (T) unit produces useful heat, simultaneously (Riffat and Cuce, 2011) HPV/T Collectors: Flat-Plate Types In late 1970s, the fundamentals of flat-plate type HPV/T collectors are initially explained by Russell and Kern

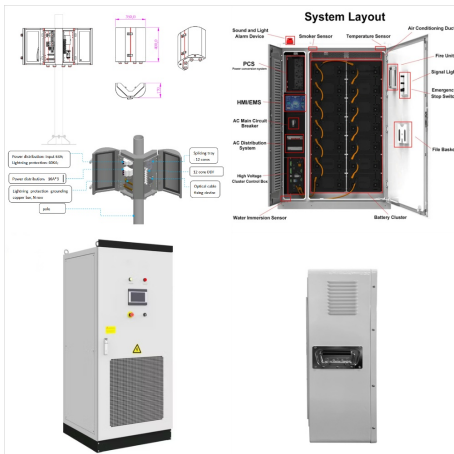


A Hybrid Solar PV power plant system comprises of C-Si (Crystalline Silicon)/ Thin Film Solar PV modules with intelligent Inverter having MPPT technology and Intentional-Islanding feature and associated power electronics, which feeds generated AC power to the Grid and islands when the Grid is not available.



Kern and Russell (1978) first proposed the PVT system in the mid-1970s to address the issue of solar efficiency decline with increasing solar cell temperature. Because more than 80% of renewable power energy is converted to heat, that can harm PV cells if not stored in a thermal collector (Diwania et al., 2020). The concept of PVT system is depicted in Fig. 2.

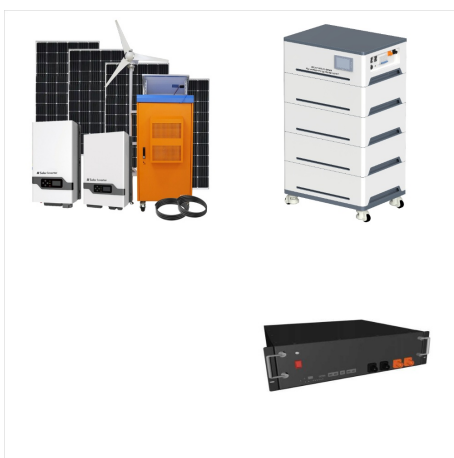
# SOLAR PHOTOVOLTAIC THERMAL HYBRID POWER SYSTEM IN ERNAKULAM



The system was monitored over one-hour operating times for a range of solar irradiances [250???650 W/m<sup>2</sup>], water flow rates through the photovoltaic-thermal module [7.3 l/min???17.3 l/min] and



Oyieke AY, Inambao FL. Performance characterisation of a hybrid flat-plate vacuum insulated photovoltaic/thermal solar power module in subtropical climate. Hybrid PV and solar-thermal systems for domestic heat and power provision in the UK: techno-economic considerations. Appl Energy 2016 Jan 1; 161: 512???532. Crossref. Google Scholar.



A comprehensive 2-D model of the proposed PV thermal management system (PV + PCM + HS + RC), consisting of all the PV module layers, a radiative cooling layer at the top surface, PCM, and heat sink, as shown in Fig. 1, is developed and analyzed numerically using COMSOL Multiphysics software. The model includes a radiative cooling layer on top of the PV ???

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Remote areas that are not within the maximum breakeven grid extension distance limit will not be economical or feasible for grid connections to provide electrical power to the community (remote area). An integrated autonomous sustainable energy system is a feasible option. We worked on a novel multi optimization electrical energy assessment/power ???



Hybrid photovoltaic-thermal (PV-T) systems can reach overall efficiencies in excess of 70%, with electrical efficiencies in the range of 15-20% and thermal efficiencies of 50% or higher.



PV-Thermal (PVT) Collectors: PVT collectors combine PV cells and thermal absorbers into a single unit, generating both electricity and heat simultaneously. This technology offers a more compact and efficient way to utilize solar energy. Concentrated Solar Power (CSP)-PV Hybrid Systems: Combining CSP with PV technologies can create hybrid systems that offer increased ???

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The following features make PV/T hybrid systems in building integration than the separate installation of PV and solar thermal systems: The discounted payback period of the PV/T system is about 14.7 years, which is much lower than the life of separate solar systems PV/T systems enhance energy saving per unit area The integration of the PV/T



The solar photovoltaic/thermal (PV/T) system is one of the key research focuses of the solar energy utilization field due to its high thermal energy output and comprehensive utilization compared