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A Parametric Study and Efficiency Analysis of Hybrid PVT System

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Abstract

The world is shifted to renewable energy resources like solar technology because of the unforeseen effects of conventional energy production system on our environment. Photovoltaic thermal (PVT) is the combination of thermal and photovoltaics coupled in a single module. A solar hybrid PVT system modeling, simulation method using MATLAB and its parameters effect is described in this paper. Electrical and thermal modeling of a PVT system is analyzed in this work. External parameter variation effect on hybrid PVT is also studied here. The presented simulation model shows the behavior and efficiency of the system. At the end, both the electrical and thermal power output with efficiency analysis is studied.

Keywords – Hybrid PVT, parameter analysis, efficiency, power output.

Hybrid PVT

A simple form of hybrid PVT system is shown in the figure below:

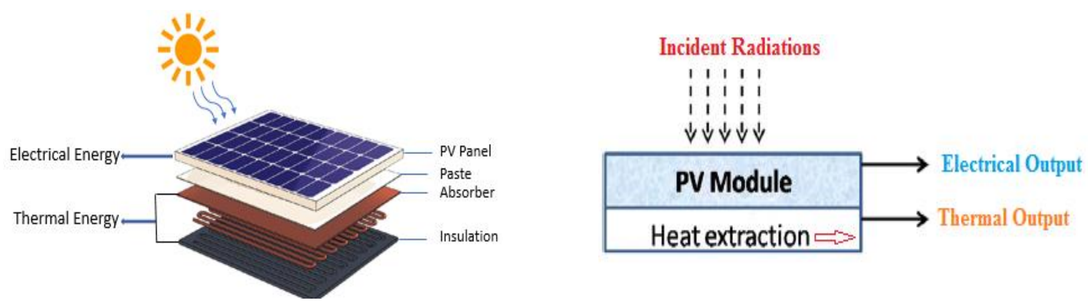

Figure 1**.** Hybrid PVT System.

- It consists of two parts are the upper and lower portion. Upper part consists of PV module which provides electricity and lower part is the heat extraction which provides thermal energy.

- Any kinds of fluid like water can be used as heat transfer fluid (HTF) to extract thermal energy from the system.

PVT System Model

The following figure shows the used hybrid PVT system modelling architecture:

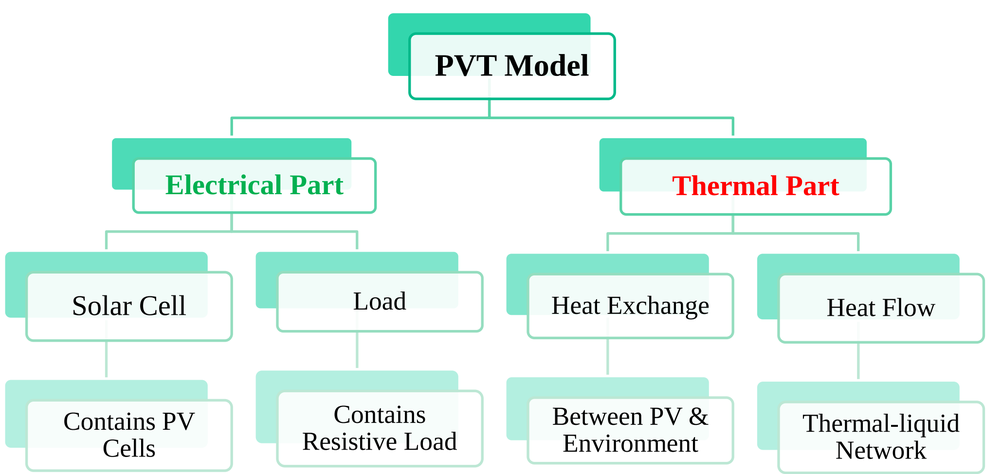

Figure 2**.** Hybrid PVT cogeneration model.

- PVT system electrical modeling is described as:

$$I = I_{ph} - I_s\left(\exp\left(\frac{qV + qR_sI}{NKT}\right) - 1\right) - \frac{V + R_sI}{R_{sh}} \quad (1)$$

- Generally, PVT system is constructed by a PV panel and a flat-plate solar thermal collector. The overall efficiency of the hybrid PVT is:

$$\eta_T = \eta_{th} + \eta_e \quad (2)$$

- The collector's total useful heat is calculated by:

$$Q_u = \dot{m} C_p \left(t_{out} - t_{in}\right) \quad (3)$$

- Overall electrical output is obtained as:

$$Q_e = A_A.G.\tau.r_c.\eta_e\left\{1 - \frac{\beta_{ref}\ \eta_{ref}}{\eta_e}\left[\tilde{F}_R(T_{ho} - T_a) + \frac{\tilde{G}}{\tau}(1 - \tilde{F}_R)\right]\right\} \quad (4)$$

Simulation Result

MATLAB/Simulink software is used for the simulation purpose. The electrical and thermal performance of a PVT panel has dependency on its external and internal parameters. Simulations results are:

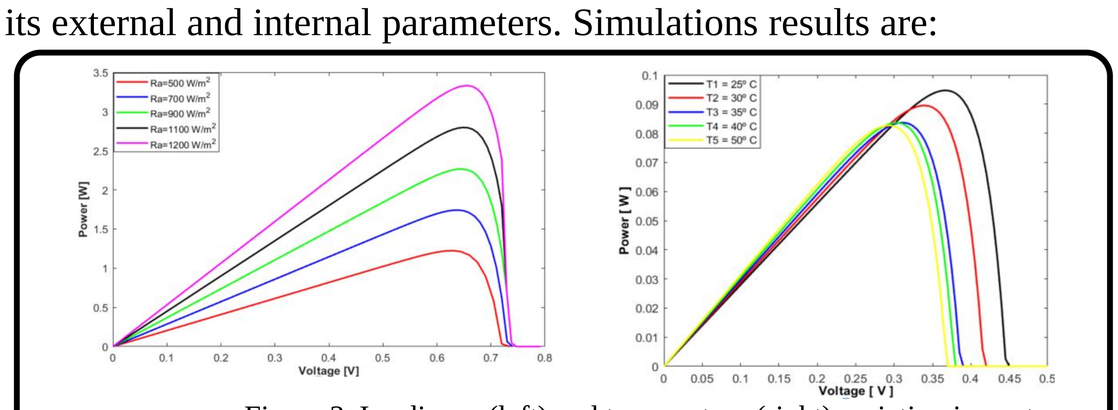

Figure 3**.** Irradiance (left) and temperature (right) variation impact.

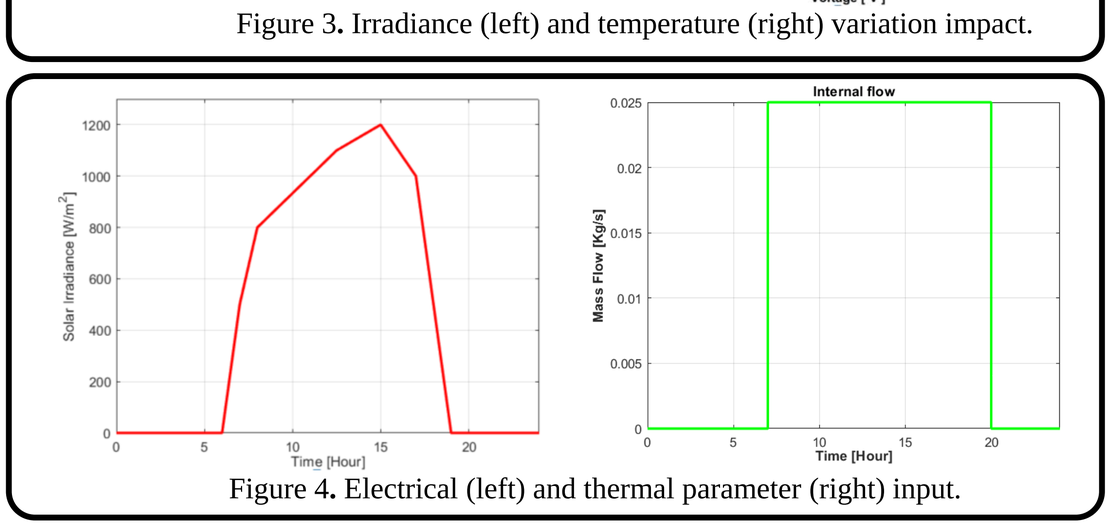

Figure 4**.** Electrical (left) and thermal parameter (right) input.

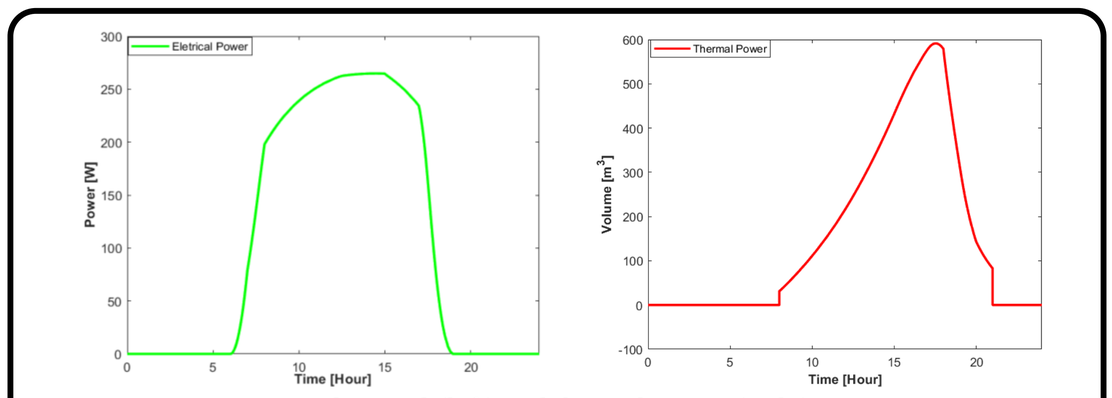

Figure 5. Electrical (left) and thermal power (right) output.

Conclusions

- ✓ A PVT simulation model is obtained to understand the behavior and efficiency of the hybrid solar system.
- ✓ In the result, overall output including electrical and thermal power indicates proposed model as efficient and robust system.
- ✓ This modeling approach by improving some other sections can be used to assess and compare other PVT system.

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