Cape Peninsula University of Technology

LeNSeS Conference 28 - 30 September 2016

INTEGRATED SOLAR PHOTOVOLTAIC AND THERMAL SYSTEM FOR ENHANCED ENERGY EFFICIENCY

Presented by Mr. Cedric Obiang Assembe

OUTLINE

1. Introduction
2. Aims & Objectives
3. What is PV/T?
4. Materials & Methods
5. Results
6. Conclusion
7. Questions, Remarks & Suggestion

INTRODUCTION

- Concern regarding Renewable Energy (RE)
- Socio-environmental impact of fossil fuels
- Explore clean and environmental friendly Energy
- Investigate on Combined Photovoltaic & Thermal system (PV/T)

Aims & Objectives

- Build a combined PV/T to Improve electricity efficiency.

1[rst]

- To enhance low energy efficiency.

2[nd]

- To perform analytical or experimental work on the constructed PV/T.

- Evaluate heat and electricity efficiency of PV/T.

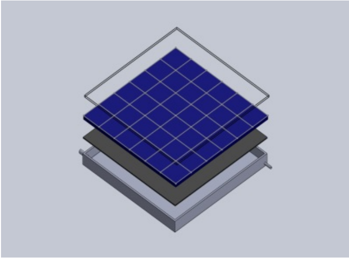
What is PV/T?

- PV/T
  - Electricity
  - Heat
- What kind of PV/T will be suitable for this idea?
- Which principles need to be used to develop this idea?

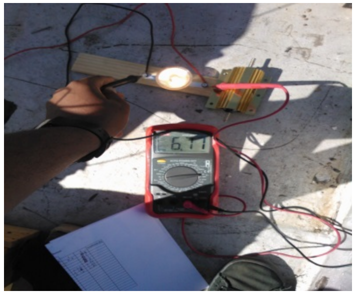
Materials & Methods

- Researches

- Design



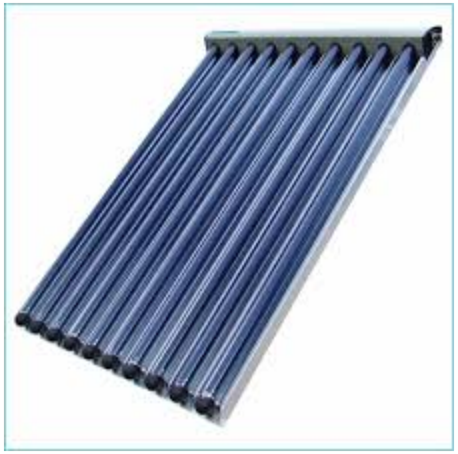
- Experiments



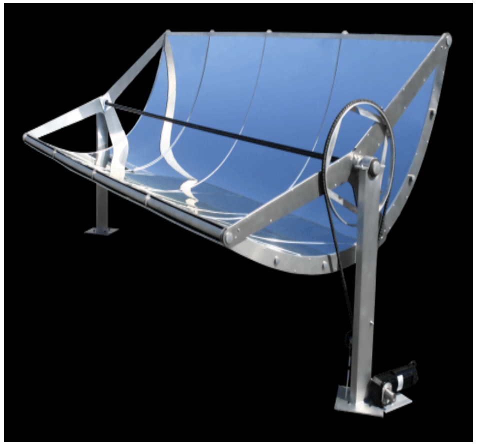
MATERIALS & METHODS

Design types

- Flat plate collector



- Evacuated tube collector



- Concentrating collectors

MATERIALS & METHODS

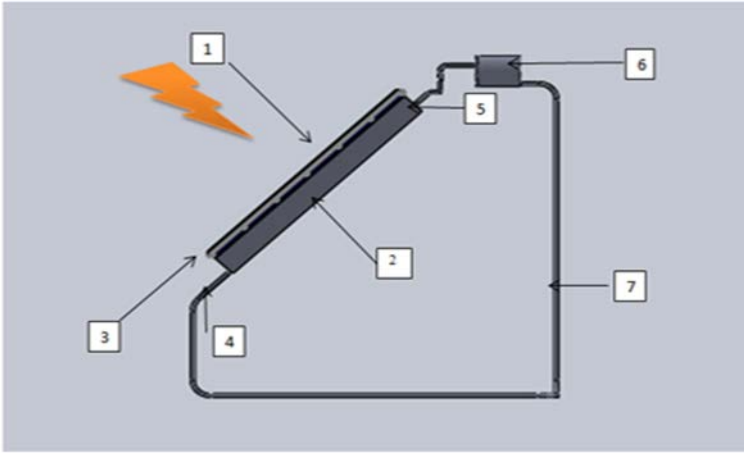


Figure 1: *Final model of the PV/T water based collector*

1 Cover plate
2 Thermal collector (water flow)
3 Photovoltaic cell (PV module)
4 Inlet water flow
5 Outlet water flow
6 Tank
7 Flexible or water conduct

Figure 2: Constructed PV/T model for experimentation

Materials & Methods

Main Calculation for data

- $Q_u = A[E\alpha\tau - U_L(T_m - T_a)]$ (1)
- $\dot{m} = {Q_u}/{C_p(T_{fo} - T_{fi})}$ (2)
- $Q_u = F_R A[E\alpha\tau - U_L(T_{fi} - T_a)] = \dot{m} C_p (T_{fo} - T_{fi})$
- $F_R = \frac{Q_u}{A[E\alpha\tau - U_L(T_{fi} - T_a)]}$ (3)

Efficiencies equations

- $\eta_{th} = \frac{F_R A[E\alpha\tau - U_L(T_i - T_a)]}{AE}$ (4)
- $\eta_{ee} = \frac{I_{sc} * V_{oc}}{AE}$ (5)
- $\eta_{pvt} = \frac{F_R A[E\alpha\tau - U_L(T_i - T_a)]}{AE} + \frac{I_{sc} * V_{oc}}{AE}$ (6)

RESULTS

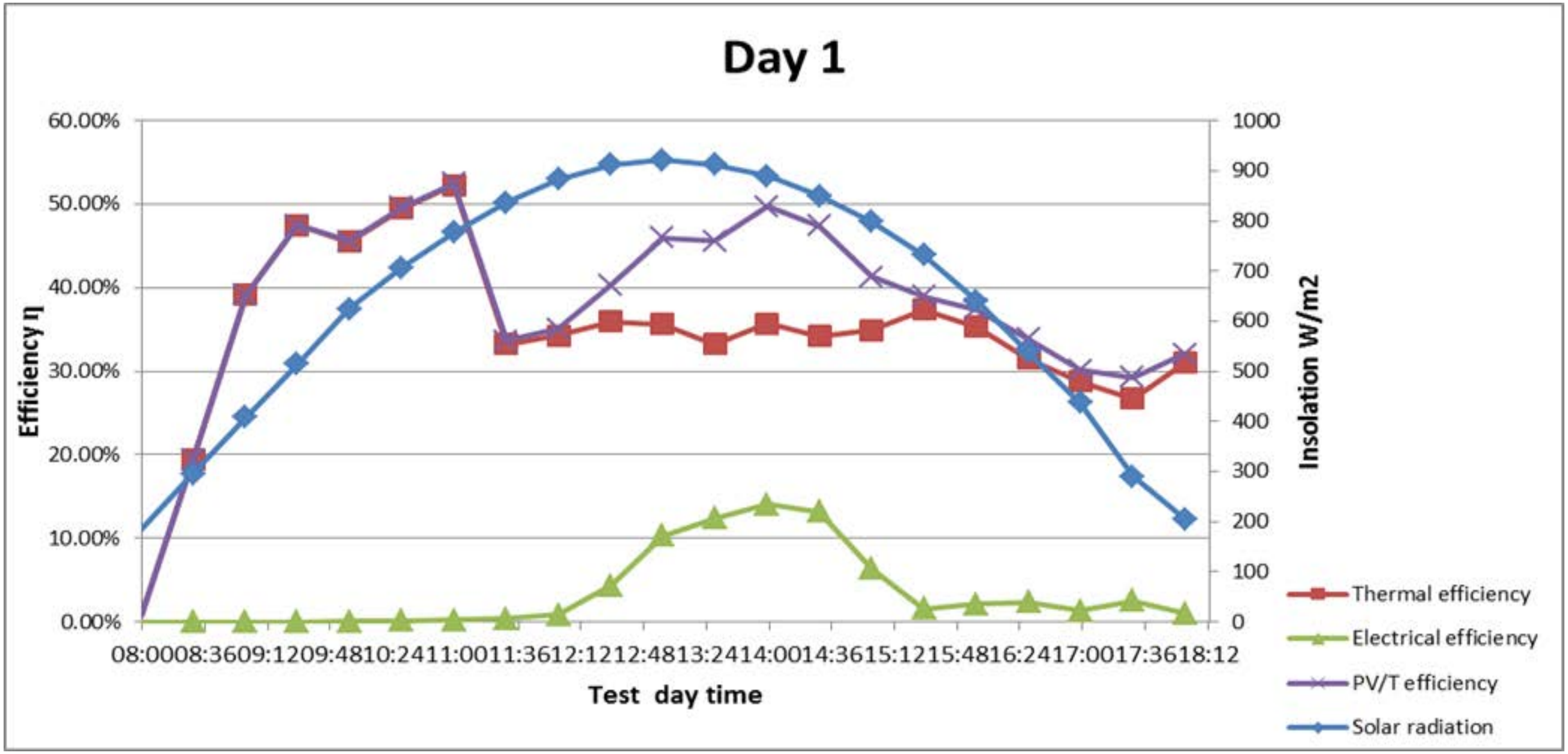


Figure 3: *Graphical plot of test result of efficiencies (thermal, electrical and PV/T) as function of time during day 1.*

1. Solar radiation shows a parabolic tendency.

2.when the thermal efficiency drop the electrical efficiency started to rise.

RESULTS

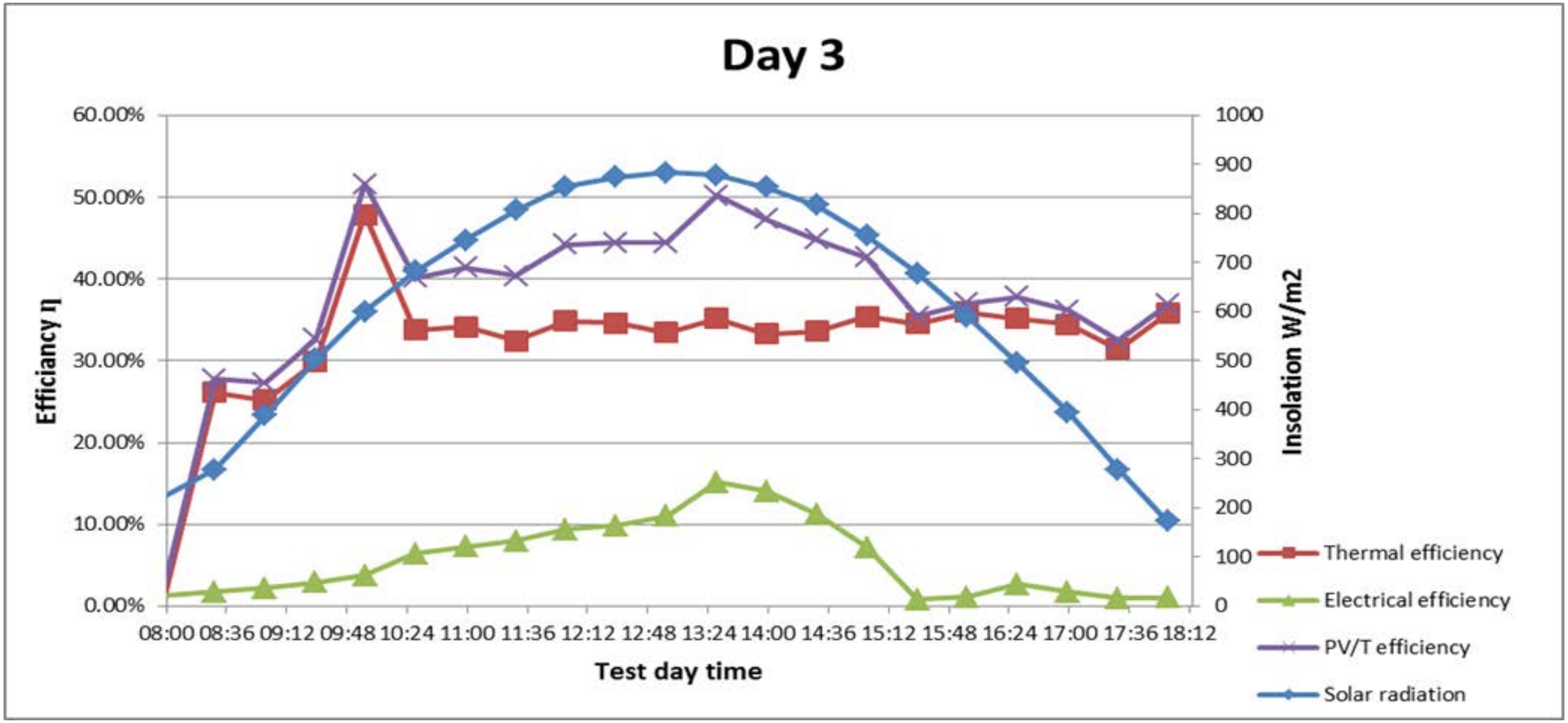


Figure 4: *Graphical plot of test result of efficiencies (thermal, electrical and PV/T) as function of time during day 3.*

1. The thermal efficiency of the PV/T was influenced by thermal condition of heat exchange
2. The electrical efficiency became quickly efficient

RESULTS

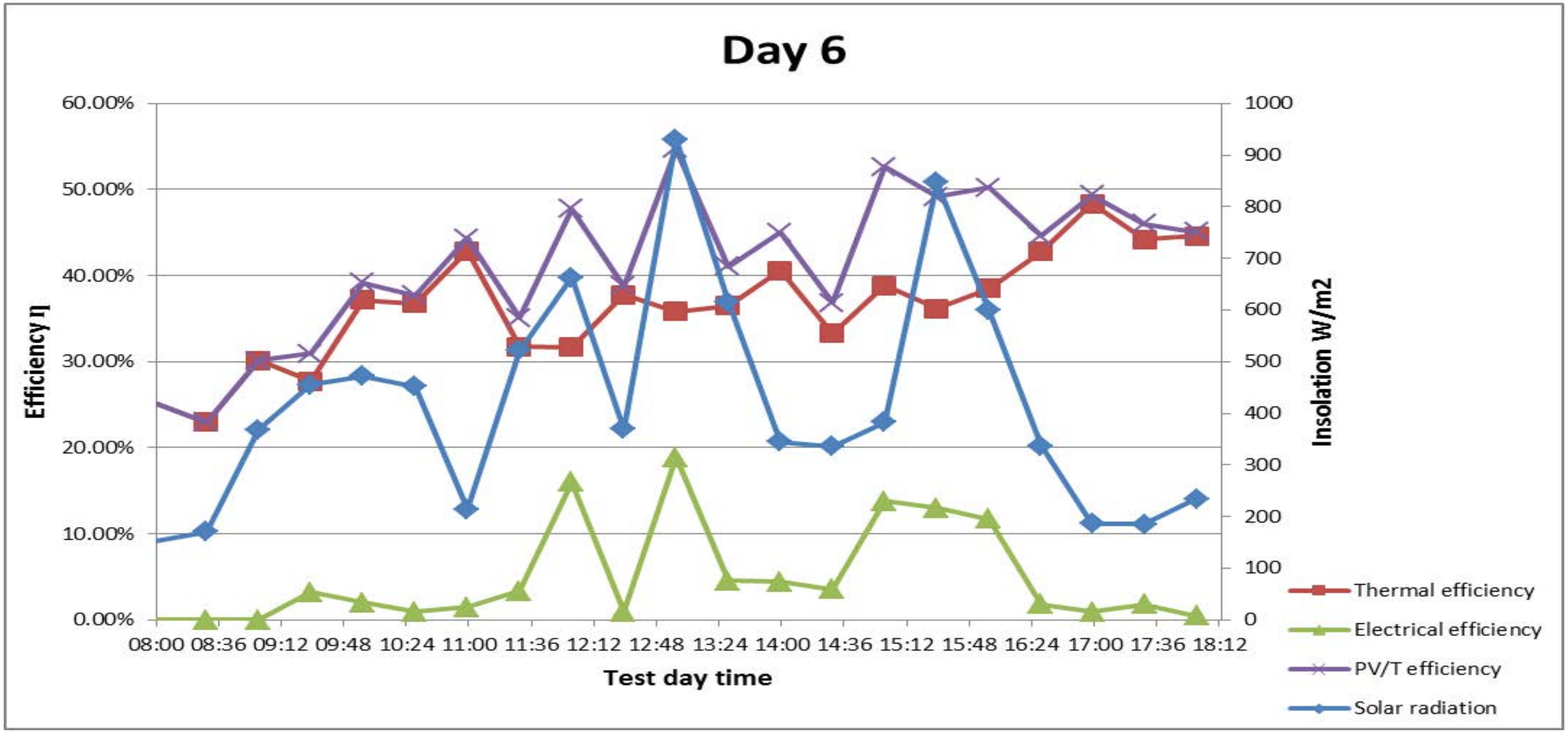


Figure 5: *Graphical plot of test result of efficiencies (thermal, electrical and PV/T) as function of time during day 6.*

1. The Electrical efficiency depends on solar radiation.

2. Two peaks occurred for the electrical efficiency with the best efficiency

Analysis Results

Thermal Efficiency	Electrical Efficiency
The effect could not be neglected in the calculation of the global PV/T efficiency.	The effect could help increase PV/T efficiency performance if solar radiations on the PV module decrease.
The results of thermal efficiencies was more favorable to be used.	The results of electrical efficiencies was only presented a slightly improvement.

Conclusion

- Could help increase the electrical efficiency to a better performance.
- Presented a considerable yield on the overall PV/T efficiency.
- Will increase the competitiveness of PV/T collectors and utilization of renewable energy devices

References

- Andrews, J. W. (1981). Evaluation of flat-plate photovoltaic/thermal hybrid systems for solar energy utilization. Department of Energy and Environment, Solar Technology Group, Brookhaven National Laboratory. Retrieved from https://www.bnl.gov/isd/documents/22828.pdf
- Baljit Singh, M. Y. O. (2009). A review on photovoltaic thermal collectors. Journal of Renewable and Sustainable Energy, 1(6). http://doi.org/10.1063/1.3266963
- Huizinga, F. S. (2013, December 4). Combined Photovoltaic and Solar Thermal (PV-T) systems; Design optimization and thermal annealing [Master thesis]. Retrieved May 22, 2016, from http://dspace.library.uu.nl/handle/1874/287438
- Kalogirou, S. A. (2004). Solar thermal collectors and applications. Progress in Energy and Combustion Science, 30(3), 231–295. http://doi.org/10.1016/j.pecs.2004.02.001

THANK YOU

REMARKS AND QUESTIONS