ANALYSIS OF ECONOMIC FEASIBILITY OF PV/SOLAR THERMAL/HYBRID PVT SYSTEM IN HOSTEL APPLIANCES

[1]V. Ezhilarasi, [2]V. SharmilaDeve, [3]R. Mahalakshmi,[4]G. Priyanka

Department of EEE, Kumaraguru College of Technology, Coimbatore, Tamil Nadu, India.
[1]ezhilarasivaithi@gmail.com, [2]sharmiladeve.v.eee@kct.ac.in, [3]mahalakshmi.r.eee@kct.ac.in,
[4]priyankathean17@gmail.com

ABSTRACT

The purpose of this project is to determine the performance of hybrid systems which consists of solar thermal collectors. The study is taken out by analyzing the behavior of the designed systems and implemented in KCT hostel building. The calculations of primary energy consumption, Emissions and the inclusion of a Life Cycle Cost analysis are the major contribution. Photovoltaic panels will produce part of the electricity. Solar thermal collectors will reduce the energy required for DHW (domestic hot water) production. This project is implemented for hostel room and cooking purpose. Then analyze the hybrid system which consists of solar PV, PV thermal, solar PV thermal system. Choose the best hybrid system which suitable to hostel mess. With this system, MPPT (maximum power point tracking) is used to extract maximum power.

Keywords-*Hybrid Photovoltaic Thermal System, Carbon Dioxide Emission, Life Cycle cost, Irradiance.*

I. INTRODUCTION

In the recent years, the concept of energy efficiency has been receiving worldwide attention due to that fossil fuel resources required for energy generation are finite and that climate change is associated to carbon emissions [1]. This has encouraged a huge amount of studies with varying approaches related to the implementation of technologies capable of both producing energy in a more efficient way and avoiding its environmental impact. These studies include the innovation such as Combined Heat and Power (CHP) production [6-8], also known as cogeneration systems, which can produce thermal energy and electricity from the same source. For example, the process of power production is more efficient, polluting emissions are decreased, there are low losses in the distribution network and the reliability and quality of the supplied energy is increased. Apart from that, buildings are very essential for more efficient energy in production systems [9-11]. The need to produce more energy in buildings is the importance of CHP systems among the various technologies. The primary objective is to decrease life cycle cost and secondary objective is to decrease emissions of carbon dioxide from the system [12]. These objective functions are related to the constraints which is imposed by the power produced by the system reliability, system components and state of charge of the battery bank [13-16]. This project offers an innovative approach when it provides the energy to buildings. Hybrid systems present a new approach to the time correspondent of alternate renewable energy sources.

II. OBJECTIVE

a. The aim is to assess the efficiency of hybrid system composed of PV, Solar thermal, hybrid PV thermal system for electrical equipment located in our College Boys Hostel.
b. The study is taken out by analyzing the energy consumption of electrical appliances in our mess.
c. The parameters are primary energy consumption, CO_2 emission and life cycle cost analysis. The formula is used to calculate these parameters based on [5]. The software MATLAB is used to perform the simulation.

III. BLOCK DIAGRAM FOR HYBRID PV/T SYSTEM

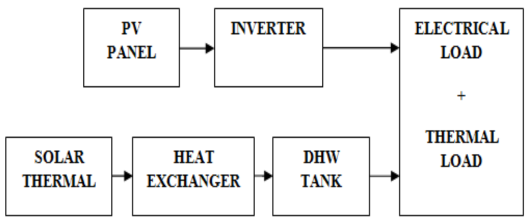

Fig. 1. Block diagram for hybrid PV/T system.

IV. METHODOLOGY

- This study was carried out in hostel building in order to analyze their impact on energy savings and the costs inferred from the necessary equipment.
- Photovoltaic panels will produce part of the electricity.
- Solar thermal collectors will reduce the energy required for DHW (domestic hot water) production.
- This project is implemented for hostel room and cooking purpose.
- Especially for electrical load- Lighting loads
- And FOR thermal load-boiler.
- Then analyze the hybrid system which consists of solar PV, PV thermal, solar PV thermal system.
- Choose the best system which suitable to hostel mess.

V. ANALYSIS OF PV, SOLAR THERMAL, HYBRID PV/T SYSTEM

Our study concentrates in KCT College based on designing the energy production system (electricity, domestic hot water (DHW), heating and cooling) for a hostel building. We have attempted an approach on a CHP hybrid system that combines solar thermal energy and photovoltaic's.

Furthermore, a emission and life cycle cost calculations will be carried out in the last section, as well as a analysis of energy costs. Taking those characteristics into considerable account, our system differs in many from those designed in previous studies.

The Life Cycle Costs of different configurations have also been calculated so as to be able to allegate between them and also the conventional case in which we get electricity from the grid. Finally, the emissions of the diverse configurations have been calculated in order to compare their emission of carbon dioxide performance.

The system has been designed with the help of the software MATLAB, which allows making easy alterations of any item included, thus making easier the task of changing parameters, connections and configuretions. The configurations which have been studied are the following:

1. Conventional case:
   In this situation, we simulate the circuit assuming that all the necessary electricity will be got from the grid. Heating and Domestic Hot Water (DHW) will be provided by boilers running on natural gas.
2. Photovoltaic panels:
   The set of 14 photovoltaic panels which will produce part of the necessary electricity.
3. Solar thermal collectors:
   An array of 12 solar thermal panels will reduce the load of the auxiliary DHW boiler.
4. Photovoltaic panels + solar thermal collectors:
   All the previously mentioned scenarios will be considered at the same time.

VI. ANALYSIS OF CO_2 EMISSION

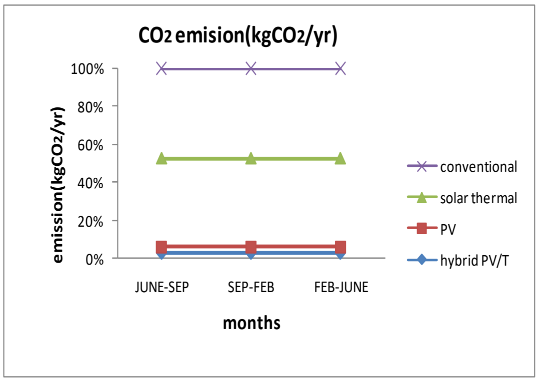

Fig. 2.CO_2 emission graph.

The emission graph is shown in Fig.2.This result forces the concept that emissions and profitability do not often go together, since improving one may penalize the other. As said before, the economy of scale might reverse this situation in the future.

VII. ANALYSIS OF LIFE CYCLE COST

One of the purposes of the study was to determine the Life Cycle Cost (LCC). A time span of 25 years was considered, which includes the capital investment, operation, maintenance, and replacement costs. The values for the life cycle costs were obtained with the following equation.

Consequently, we were able to perform all the necessary calculations in order to know the carbon dioxide emissions. In addition, we have to calculate the primary energy consumptions, total CO_2 emissions and total costs of operation. The primary energy, emission factors and the energy costs considered are the following:

- Emission($kgCO_2/yr$)=Electricity use(Kwh/yr)×Emission factor.
- Grid electricity emission factor=0.649
- Electricity usage =60.81 kwh
- Emission($kgCO_2/yr$)=1183.9707
- Reduction of CO_2emission per 1kwh = 0.7 kg of CO_2

In contrast with the previous results, it can be seen that the emissions are emitted higher in conventional design. That is mostly since the use of electricity from the grid, which entails a higher emission factor than other energy carriers. Compare with other designs, the one with all the elements (solar thermal collectors and photovoltaic) has the lower emissions in every climatic zones. The CO_2 emission is shown in table I.

TABLE I. ANALYSIS OF CO_2 EMISSION

S. No	Systems	June-Sep	Sep-Feb	Feb-June
1.	Conventional	1202.2	1198.41	1183.9
2.	PV	1158.2	1148.6	1141.4
3.	Solar thermal	1180.2	1176.3	1168.3
4.	Hybrid PV/T	1113.2	1102.1	1080

$$LCC=initial_{investment}+costs_{replacement}+(Costs_{operation}+Costs_{maintenance})+\sum_{t=1}^{30}\frac{1}{(1+r)^t}$$

TABLE II. ANALYSIS OF LIFE CYCLE COST.

S.No	SYSTEM	COST(Rs/kwh)
1.	Conventional	905678.23
2.	PV	1830244.27
3.	Solar thermal	4000243.27
4.	Hybrid PV/T	5830480.54

Analysis of life cycle cost is shown in Table II.As will become clear below, the Life Cycle Cost in conventional design is low. Conversely, it is the design with higher emissions, and its primary energy consumption is never the lowest between those examined the rest of designs. The higher LCC in every design is mostly due to the considerable influence of the initial investment, whose savings of energy do not compensate the additional costs. Furthermore, the maintenance costs are important. However, in the future a full-scale production will contribute to avoiding the investment costs, which could change the land scape of energy dramatically.

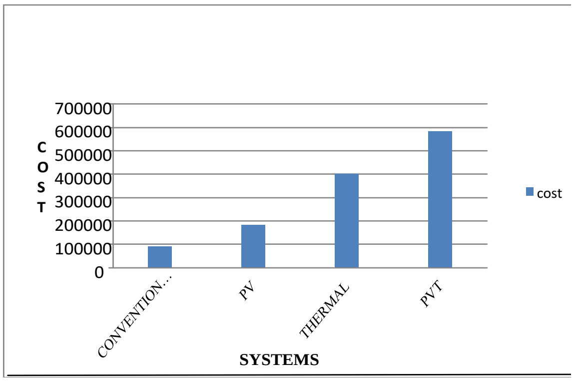

Fig. 3. Life cycle cost graph.

The life cycle cost is shown in Fig.3. From this we analyzed hybrid PV/T system is better than other system. Using MATLAB software, the hybrid PV/T system is simulated and the MPPT is obtained for tracking maximum power.

VIII. SIMULATION OF HYBRID PV/T SYSTEM

The MATLAB simulink model is used for implementing hybrid PV/T system using MPPT system is shown as fig. 4.

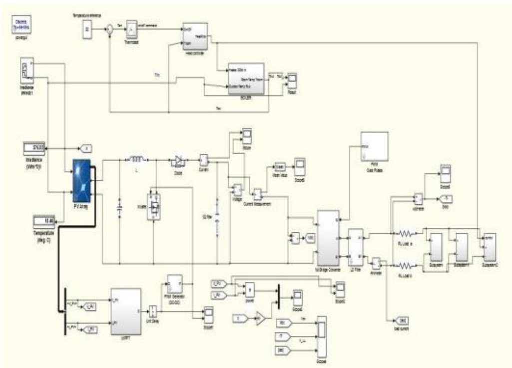

Fig. 4. Simulation of hybrid PV/T system circuit.

The irradiation graph and output of boost converter using MOSFET are shown in Fig. 5 and 6 respectively and voltage waveform of simulation result shown in Fig. 7.

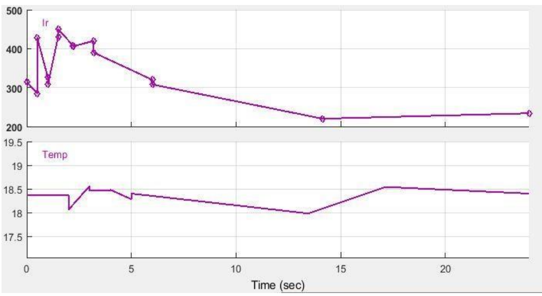

Fig. 5.Irradiation graph.

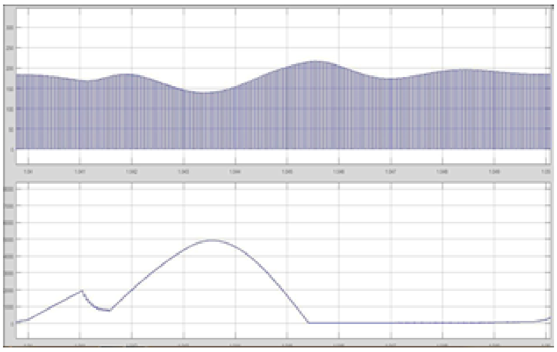

Fig. 6. Boost converter output using MOSFET

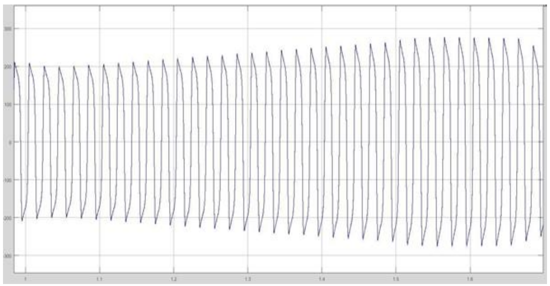

Fig. 7. Voltage waveform

IX. CONCLUSION

This project has provided an overview of the role of distributed cogeneration and generation in particular within the sector of energy. Several possibilities of design have been shown with renewable resources, supplying the energy for a very representative building.

Calculations have been developed in order to obtain a comparison based on the chosen criteria (Life Cycle Cost, emissions or energy consumption) for the considered designs and climatic zones. According to the results obtained, the LCC is best in conventional design than all cases.

This project would make more comfortable, profitable and attract the investors. If hybrid system is properly designed it tends to decrease in consumption of energy and emissions, reaffirming their usefulness and play a important role in future.

MPPT (maximum power point tracking) is used to track the maximum power.

X. REFERENCE

[1] Bilal BOuld, Sambou V, Kébé CMF, Ndiaye PA, Ndongo M., Methodology to size an optimal stand-alone PV/wind/diesel/battery system minimizing the levelized cost of energy and the CO2 emissions. Energy ProcediaPp. 14 (2012)

[2] Agarwal N., Kumar A., Varun. Optimization of grid independent hybrid PV–diesel–battery system for power generation in remote villages of Uttar Pradesh, India. Energy Sustain Dev 17: 210–9 (2013).

[3] Yamegueu D., Azoumah Y., Py X., Zongo N., Experimental study of electricity generation by solar PV/diesel hybrid systems without battery storage for off grid areas. Renewable Energy 36: 1780–7 (2011).

[4] Dekker J., Nthontho M., Chowdhury S., Chowdhury S.P., Economic analysis of PV/diesel hybrid power systems in different climatic zones of South Africa. Electr. Power Energy Syst. 40: 104–12 (2012).
[5] Boletines de Coyuntura Energética y Balances Energéticos: Factoresconversión de energía-primaria y emisiones de CO2. IDAE, MinisterioIndustria, Turismo y Comercio, Gobierno de España (2010).
[6] Barbieri E.S., Melino F., Morini M., Influence of the thermal energy storage on the profitability of micro-CHP systems for residential building applications. Appl. Energy 97: 714–22 (2012).
[7] Lee H., Bush J., Hwang Y., Radermacher R., Modeling of micro-CHP (combined heat and power) unit and evaluation of system performance in building application in United States. Energy 58: 364–75 (2013).
[8] Merkel E., McKenna R., Fichtner W., Optimization of the capacity and the dispatch of decentralized micro-CHP systems: a case study for the UK. Appl. Energy 140: 120–34 (2015).
[9] Luthander R., Widén J., Nilsson D., Palm J., Photovoltaic self-consumption in buildings: a review. Appl. Energy 142: 80–94 (2015).
[10] Project, SPAHOUSEC: Analysis of the energy consumption in the Spanish households. IDAE (2011).
[11] Project, ENCERTICUS: Energy certification, technology, information and communication for user benefit. Partially funded by European Regional Development Fund (ERDF) (2015).
[12] Nosrat A.H., Swan L.G., Pearce J.M., Improved performance of hybrid photovoltaic trigeneration systems over photovoltaic-cogen systems including effects of battery storage. Energy 49: 366–74 (2013).
[13] Ehyaei M.A., Ahmadi P., Atabi F., Heibati M.R., Khorshidvand M., Feasibility study of applying internal combustion engines in residential buildings by exergy, economic and environ-mental analysis. Energy Build. 55: 405–13 (2012).
[14] Campos Celador A., Erkoreka A., Martin Escudero K., Sala J.M., Feasibility of small scalegas engine-based residential cogeneration in Spain. Energy Policy 39: 3813–21 (2011).
[15] Obara S., Watanabe S., Rengarajan B., Operation method study based on the energy balance of an independent microgrid using solar-powered water electrolyzer and an electric heat pump. Energy 36:5200–13 (2011).
[16] Dorer V., Weber R., Weber A., Performance assessment of fuel cell microcogeneration systems for residential buildings. Energy Build. 37: 1132–46 (2005).
[17] Wang J.L., Wu J.Y., Zheng C.Y., Simulation and evaluation of a CCHP system with exhaust gas deep-recovery and thermoelectric generator. Energy Convers Manage 86: 992–1000 (2014).