STUDY OF SOLAR/BIOGAS HYBRID POWER GENERATION

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In

POWER SYSTEM AND ELECTRIC DRIVES

(P.S.E.D)

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CERTIFICATE

I hereby certify that the work which is being presented in this thesis entitled, **"Study of Solar/Biogas Hybrid Power Generation"** in partial fulfillment of the requirements for the award of degree of **Master of Engineering (Power System and Electric Drives)** in the **Department of Electrical And Instrumentation Engineering,** at **Thapar University, Patiala**, is an authentic record of my own work carried out under the supervision of **Ms.Gagandeep kaur (Asst. Professor), Mr.Souvik Ganguli (Asst. Professor),** and refers other researcher's work which are duly listed in the reference section.

The matter embodied in this thesis has not been submitted for the award of any other degree to any other university.

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ABSTRACT

This thesis is study of proposes a solar photovoltaic and biogas hybrid system for generation of electricity. To overcome form global warming effect, economic and statistical impact on prosperity and dependency. In the hybrid system energy has a higher reliability, can be cost effective and improve the quality of live in small town .we will redesign the power system with environment friendly .we will show that India can be great market for its production .At large scale and hybrid system will independently provide a stable power source and daily gas for small towns. Hybrid power system that aims to increase the system efficiency and increase use of renewable energy based hybrid power system. In order to meet sustained load demands during varying natural conditions, different renewable energy sources need to be integrated with each other like solar ,wind ,ocean, geothermal ,biomass/biogas ,Bio diesel ,wave energy , fuelcell technologies ,waste of energy municipal waste/ liquid waste/Industrial waste ,small hydro. Thus we have seen that biogas is a promising tool for employment generation energy .self sufficiency and reduction of green house gases and recover global warming effect. Energy, Economy & Environment is the three inter-related areas having direct correlation for development of any nation. Per capita energy consumption is an index for development of any nation so we are tries to increase pre capita energy consumption in India with use of renewable energy source.

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LIST OF ABBREVIATIONS

PV	Photovoltaic
D.C	Direct Current
A.C	Alternating Current
W	Watt
MNES	Ministry of Non-Conventional Energy Sources
HPS	Hybrid power system
I.C	internal combustion engine
PWM	Pulse-Width Modulation
PCS	Power Conditioning System
CSI	Current Source Inverter
VSI	Voltage Source Inverter
OCC	One Cycle Control
SPV	solar photo voltaic

Chapter 1

Introduction

1.1 Hybrid System

Hybrid systems are usually a combination of photovoltaic with wind turbines and/or generators running on diesel or bio fuels/biogas is also used. Power generated by the PV array during the day is stored in the battery bank through an energy manager, which controls the complete system. Diesel generators are expensive to run, and may also require frequent maintenance support. A judicious mix of solar and other renewable technologies, coupled with a diesel generator / grid, can offer a techno-commercially viable solution that will power the backbone of rural connectivity. The resultant hybrid system thus offers an optimal solution at a substantially lower cost. It is ideal for electrification of remote villages in India. Cutting edge technologies based on latest research to integrate dual power sources in the most ideal way.

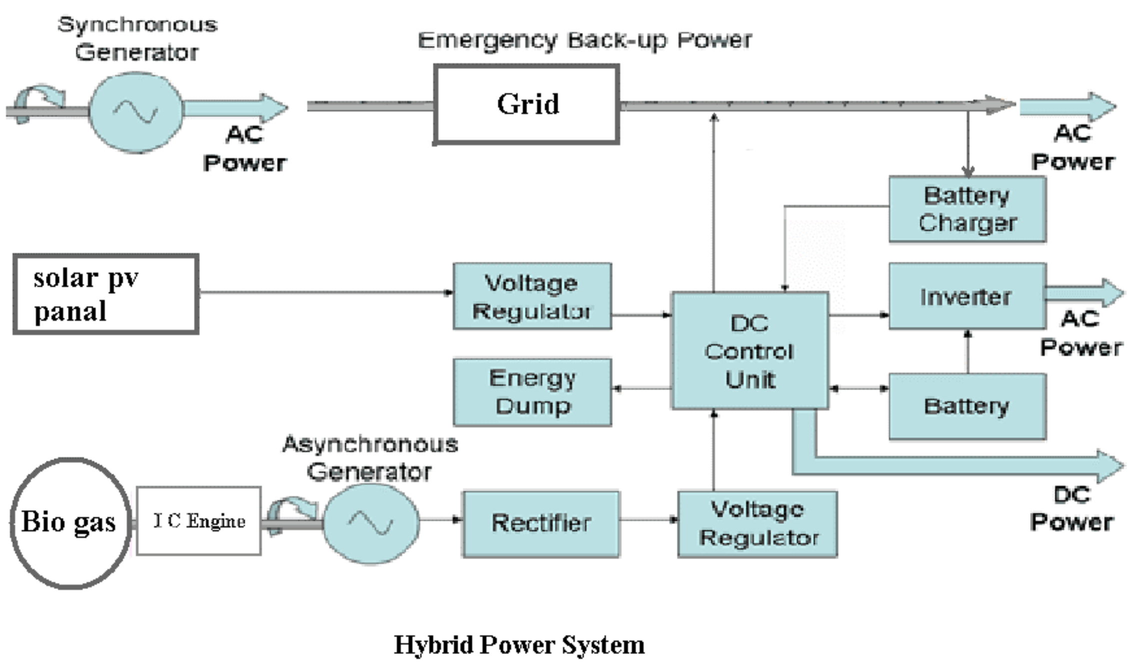


Fig.1.1 A hybrid PV system

The other form of power generation is usually a type which is able to modulate power output as a function of demand. India is equipped to offer reliable off-grid and hybrid solutions for all energy needs for small area/ especially rural area, where powering critical loads are often a challenge. However more than one form of renewable energy to be used, e.g. wind/geo-thermal and solar/biomass/biogas. The photovoltaic power generation serves to reduce the consumption of non renewable fuel.

1.1.1How does it work?

The solar generation is combining with biogas generation. The output is stored in the battery bank. This energy is drawn by the electrical loads through the inverter, which converts DC power into AC power. The inverter has in-built protection against short-circuit, overheating, low battery voltage and overload. The battery bank is designed to feed the loads up to a certain number of days with no sun or wind/biogas, depending upon the system requirement.

The solar panel is the power source of all photovoltaic installation. Photovoltaic (PV) are solid-state, semi-conductor type devices that produce electricity when exposed to light. The word photovoltaic actually means "electricity from light." Many hand-held calculators run off power from room light, which would be one example of this phenomenon. Larger power applications for this technology are also possible.

Prime over system is running by I.C. Engines use of biogas in diesel engines. Existing diesel engines can be modified to run on dual fuel while still retaining the ability to use diesel fuel only, Petrol engines: These engines can run on 100% biogas

Biogas is a type of gas that is formed by the biological breakdown of organic matter in an oxygen deficient environment. It is counted as an eco-friendly bio-fuel. Biogas contains 60% methane and carbon dioxide. It can be employed for generating electricity and also as automotive fuel. Biogas can be used as a substitute for compressed natural gas (CNG) or liquid petroleum gas (LPG).

1.1.2 Other hybrid combination

The system wind generator starts generating power when wind reaches the cut-in speed of 3m/s and the wind turbine is self-regulated with a patented pitch control mechanism which guarantees a stable energy output during strong winds. It also ensures storm protection and is much lighter than conventional small wind turbines. During very windy periods, the excess energy is dissipated through a dump load, which can be used for heating purposes.

Solar complementary system makes use of solar and wind power to generate electricity simultaneously, therefore it can utilize weather resources more effectively. Generating electricity day and night can be realized. In appropriate weather conditions, Wind and Solar complementary system can improve the continuity and stability of generation. As there is always strong wind at night, the product can complement well, it would reduce the system's solar panel deployment and greatly cut the cost. The initial investment and generation cost of system's unit capacity are lower than independent photovoltaic system.[31]

1.2Introduction of biogas

The technology for the production of biogas, by anaerobic fermentation of organic materials which are abundant, low-cost and renewable in nature, is readily available. In fact, several thousand biogas plants are already in operation in many developing countries such as India, China, Thailand, Asian countries and others.

However, further widespread generation and use of biogas depend largely on the availability of inexpensive and appropriate plant designs, which could be constructed with locally available materials and skills. Also, it is important that financial institutions and national governments consider liberal fiscal incentives to make this technology attractive at the level of individual families as well as communities.

The thesis explains the theory of biogas productions, factors affecting plant designs, and operation of plants. Details of several popular biogas plant designs, their construction, installation, operation and maintenance have been covered with appropriate illustrations. Designs of biogas utilization devices and their operational requirements for used in lighting and cooking and as fuel for prime movers have also been included. Further, the use of digested slurry as a source of organic fertilizer is discussed Technical problems faced in the construction and operation of biogas plants and appliances have been identified along with the causes and known solutions.

1.2.1 What is Bio Gas?

Biogas is gaseous mixture of methane, carbon dioxide, hydrogen sulphids and several other gases, produced by anaerobic fermentation of organic material such as animal and human manure, leaves, twigs grasses, industrial waste, etc.

The presence of methane in biogas lends it the property of combustion which makes it suitable for cooking, lighting, and powering prime movers.

Mechanism of extraction

The fermentation process for formation of methane from cellulosic material through the agency of a group of organisms belonging to the family 'Methanol bacteriaceae' is a complex biological and chemical process involving two main stages.

1.2.2 Stage first: bacteria break down complex organic materials, such as carbohydrates and chain molecules, fruit acid material, protein and fats. The disintegration produces acetic acid, lactic acid, propaonic acid, butanoic acid, methanol, ethanol and butanol, as well as carbon dioxide hydrogen H2S and other non organic materials, in this stage the chief micro-organisms are ones that break down polymers, fats, proteins and fruit acids, and the main action is the butanoic fermentation of polymers.

1.2.3 Stage second: the simple organic materials and carbon dioxides that have been produced are either oxidized or reduced to methane by micro-organisms of which there are many varieties.

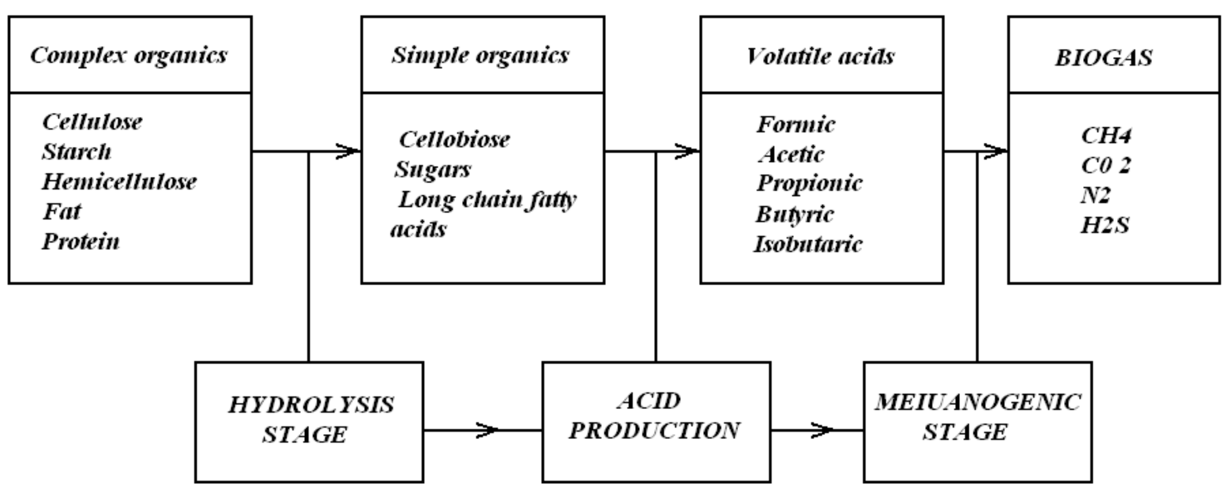
1.2.4 Methane production:

Airtightnees : breakdown of organic materials in the presence of oxygen produces co2 and in the absence of it produces methane.

Temperature: Temperature for fermentation will greatly affect biogas production. Depending upon prevailing conditions methane can be provide within a fairly organisms which take part in methane fermentation have the optimum activity at 35^{o}C-40^{o}C

This stage may be represented by the following overall reaction:

$$(C_6H_{10}O_5)n + H_2O \xrightarrow{through the action of methane bacteria} \begin{matrix} 3nCH_{4+} \\ 3nCO_2 \end{matrix}$$



Patyway for anaerobic decomposition

Individual reaction include:

1. Acid breakdown into methane

   $$2C_3H_7COOH + H_2O \longrightarrow 5CH_4 + 3CO_2$$

2. Oxidation of ethanol by CO_2 to produce methane and acetic acid.

   $$2C_3CH_2OH + CO_2 \longrightarrow 2CH_3COOH + CH_4$$

3. Reduction with hydrogen of carbon dioxide to produce methane

   $CO_2 + 4H_2 \rightarrow CH_4 + 2H_2O$

A careful balance should be maintained between the two stages. If the first stage proceeds at a much higher rate than the second, acid will accumulate and inhibit the fermentation in the second stage, slow it down and actually stop it.

1.3 Methane Production :

Airtightness: Breakdown of organic materials in the presence of oxygen produces CO_2 and in the absence of it produces methane. Thus it is crucial to have the biogas pit airtight and watertight.

1.3.1 Temperature: Temperature for fermentation will greatly affect biogas production. Depending on prevailing conditions methane can be produced within a fairly wide range of temperature. However, the micro-organisms which take part in methane fermentation have the optimum activity at 35^oC – 40^oC. The production of biogas is fastest during summer and it decreases at lower temperature during winter. Also methanogenic micro-organism are very sensitive to temperature changes, a sudden change exceeding 30C will affect production, therefore one must ensure relative stability of temperature.

1.3.2 pH factor: The micro-organisms require a neutral or mildly alkaline environment – a too acidic or too alkaline environment will be detrimental. Ideal pH value is between 7.0 – 8.0 but can go up or down by a further 0.5. The pH value depends on the ratio of acidity and alkalinity and the carbon dioxide content in the biogas digester, the determining factor being the density of the acids. For the normal process of fermentation, the concentration of volatile acid measured by acetic acid should be below 2000 parts per million too high a concentration will greatly inhibit the action of the methane – genie micro-organisms

Solid contents: Suitable solid contents of raw materials in 7-9%. Dilution should be in the ratio of 4:5 or in equal proportion.

C/N ration: A specific ration of carbon to nitrogen must be maintained between 25:1 and 30:1. The ratio varies for different raw materials.

1.3.3 Water content: This should be about 90% of the weight of the total contents. With too much water the rate of production per unit volume in the pit will fall, preventing optimum use of the digester. If the water content is too low, acetic acid will accumulate, inhibiting the fermentation process and hence production and also thick scum will be formed on the surface. The water content differs according to the raw material used for fermentation.

Nature of organic materials: materials rich in cellulose and hemi-cellulose with sufficient protenaceous substance produce more gas. Complex polysaccharides are more favorable for methane formation while only protenacous materials produce little quantity of gas. Lignin as such does not contribute to the gas production.

1.3.4 Supplementary nutrients: In case of cow dung, as it contains all the nutrients needed by organisms for the production of methane there is no necessity for addition of nutrients to it.

Reaction period: Under optimum condition 80-90% of total gas production is obtained within a period of 3-4 weeks. Size of the fermentation tank also decides the reaction period.

Harmful materials: The micro-organism that help to produce biogas are easily affected by many harmful materials. Maximum allowable concentration of such harmful materials is as follows:

Sulphate (SO_4^-)	5000 parts per million
Sodium chloride (NaCl)	40,000 parts per million
Copper (Cu)	100 mg per liter
Chromium (Cr)	200 mg per liter
Nickel (Ni)	200-500 mg per liter
Cyanide (CN^-)	below 25 mg per liter
ABS (detergent compound)	20-40 parts per million
Ammonia (NH_3)	1,500-3,000 mg per liter
Sodium (Na)	3,500-5,500 mg per liter
Potassium (K)	2,500-4,500 mg per liter

Calcium (Ca)	2,500 – 4,500 mg per liter
Magnesium (Mg)	1,000 – 1,500 mg per liter

These toxic material should either not be present or their concentration should be diluted, for example by addition of water.

1.3.5 Gas output:

The exact amount of gas produced depends on various factors. In the first instance the amount of an animal droppings vary from animal to animal, feed gives to the animal, feed given to the anima, season of the year, whether the animal is stable-bound or a free-grazing type etc. The following table gives an idea of the amount of gas available from different type of raw material. The figures however are likely to vary widely.

1.3.6 Harmful Effects of Chemical Fertilizers:

The leftover of a biogas plant is an excellent fertilizer for the plants and can be used instead of chemical fertilizers. Chemical fertilizers contain a nutrient that a plant can use but it also contains some elements that are not taken by plants in significant amount, the result is that these elements remain in soil and create problem .For example nitrate of soda, the plant take much of nitrate but not soda which when combines with carbon forms carbonate of soda and soil becomes hard because of this. The leftover of a biogas plant is an excellent fertilizers for the plants and can be used instead of chemical fertilizers.

1.3.7 Deforestation and Species Extinction:

Each day at least 80,000 acres (32,300 ha) of forest disappear from Earth. At least another 80,000 acres (32,300 ha) of forest are degraded. Along with them, the planet loses as many as several hundred species to extinction, the vast majority of which have never been documented by science. As these forests fall, more carbon is added to the atmosphere, climactic conditions are further altered, and more topsoil is lost to erosion. The above mentioned problem of destruction of forests mostly for energy need mostly for cooking purposes can be solved to great extent by using biogas for cooking it hardly releases smoke and is almost as efficient as LPG, moreover it saves oil import bill of country like India that has huge oil import bill. The money thus saved on oil import can be used by government for other constructive developmental works, thus saving money as well as environment. Biogas burners are available in a wide range of capacity ranging from 8-cft to 100-cft biogas consumption per hour.

1.4 What is Photovoltaic?

Photovoltaic (PV) are solid-state, semi-conductor type devices that produce electricity when exposed to light. The word photovoltaic's actually mean "electricity from light." Many hand-held calculators run off power from room light, which would be one example of this phenomenon. Larger power applications for this technology are also possible

1.4.1 How do Photovoltaic Work?

Photovoltaic are the direct conversion of light into electricity at the atomic level. Some materials exhibit a property known as the photoelectric effect that causes them to absorb photons of light and release electrons. When these free electrons are captured electric current results that can be used as electricity. The photoelectric effect was first noted by a French physicist, Edmund Becquerel, in 1839, who found that certain materials would produce small amounts of electric current when exposed to light. In 1905, Albert Einstein described the nature of light and the photoelectric effect on which photovoltaic technology is based, for which he later won a Nobel Prize in physics. The first photovoltaic module was built by Bell Laboratories in 1954. It was billed as a solar battery and was mostly just a curiosity as it was too expensive to gain widespread use. In the 1960s, the space industry began to make the first serious use of the technology to provide power aboard spacecraft. Through the space programs, the technology advanced, its reliability was established, and the cost began to decline. During the energy crisis in the 1970s, photovoltaic technology gained recognition as a source of power for non-space applications.

The diagram above illustrates the operation of a basic photovoltaic cell, also called a solar cell. Solar cells are made of the same kinds of semiconductor materials, such as silicon, used in the microelectronics industry. For solar cells, a thin semiconductor wafer is specially treated to form an electric field, positive on one side and negative on the other.

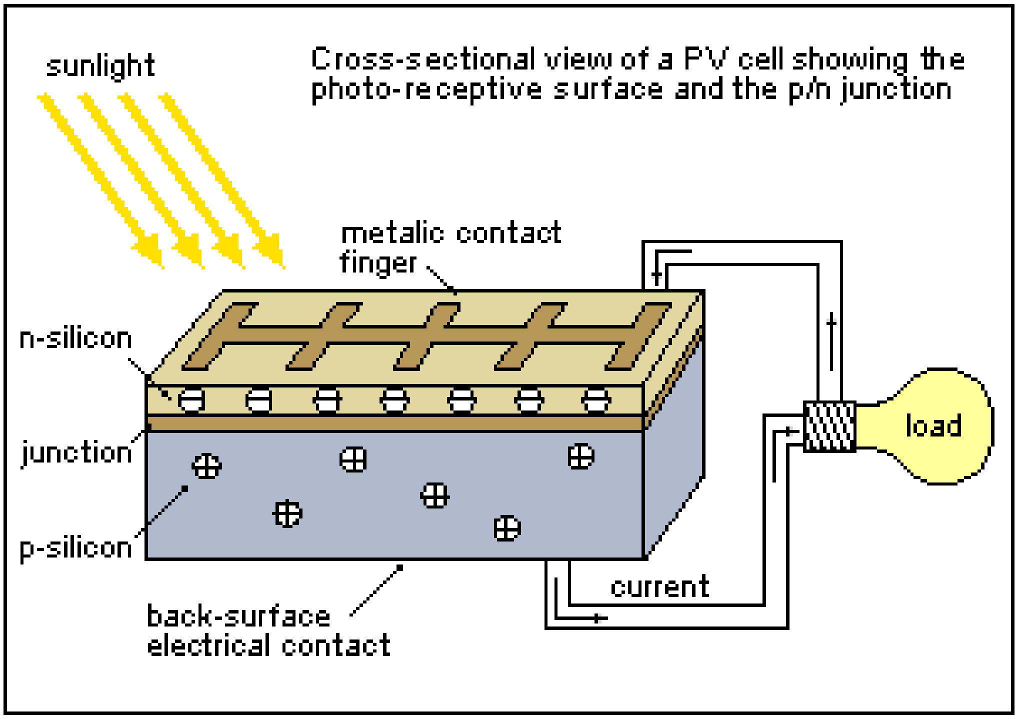


Fig. (1.2)Working principle of a PV cell

When light energy strikes the solar cell, electrons are knocked loose from the atoms in the semiconductor material. If electrical conductors are attached to the positive and negative sides, forming an electrical circuit, the electrons can be captured in the form of an electric current -- that is, electricity. This electricity can then be used to power a load

1.4.2 Solar panel The solar panel is the power source of all photovoltaic installation. It is the result of a set of photovoltaic cells in series and parallel. In order to undertake its analysis, we begin from the study of a photovoltaic cell, main nucleus of the conversion of light to electrical current). Beginning from the electrical circuit that describes a cell, problems due to its association are analyzed.

1.4.3 Load

It is the component responsible to absorb this energy and transform it into work. The diversity, amount and complexity of the behavior of the loads that could be connected to a photovoltaic system make difficult to be modeled.

1.4.4 Regulator

It is the element to protect the battery against to risking situations as overloads and over discharges. The theoretical formulation of the model can be simple, although it is necessary to consider the peculiar discontinuities of the model and the inter performance with the rest of the analyzed models.

1.4.5 Inverter

The inverter allows transforming the DC current to AC. A photovoltaic installation that incorporates an inverter can belong to two different situations, based on the characteristics of the alternating network:

An isolated system, where the inverter is the element of the network and has to feed the set of loads. The inverter is connected to the public network, to which it sends the energy generated by the system.

The model must be able to include both situations.

1.4.6 Converter

The positioning of a converter between the panels and the batteries will improve the whole photovoltaic installation, allowing different controls from the system. Depending on the applied regulation, the panels will contribute to the maximum energy given to the system or the optimal energy for their operation, assuring an efficient charge of the battery.

1.4.7 Different types of Photovoltaic Systems

A photovoltaic system (or PVS) is a system which uses solar cells (arranged into solar panels) to convert sunlight into electricity. And two type of connection as following

Solar Grid Tie Systems

Solar off grid & cabin system

A PVS consists of many components. These include solar cells, mechanical and electrical connections and mountings and means of regulating and/or modifying the electrical output.

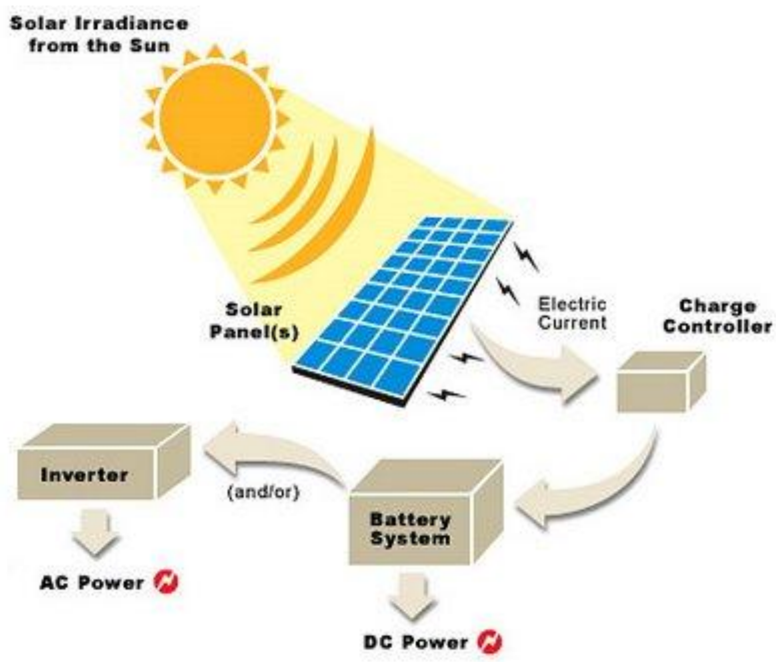


Fig. (1.3) A simple PV system

Due to the low voltage of an individual solar cell, several cells are combined into photovoltaic modules (commonly called solar panels), which are then connected together into a photovoltaic array. The electricity generated can be used directly, stored or fed into a large electricity grid. A PVS may also be combined with domestic electricity generators to create a hybrid system.

A photovoltaic system is generally designed in order to ensure the highest energy yield for a given investment.

1.4.9 Terawatt Challenge

15 TW was the mean total world energy power need during 2005. See The Terawatt Challenge for further information. Space based solar power can provide access to yet much more energy. 10kW/person is the mean power (total - electricity, transportation, heating) used in the developed world. Total Surface Area Required to Fuel the World With Solar

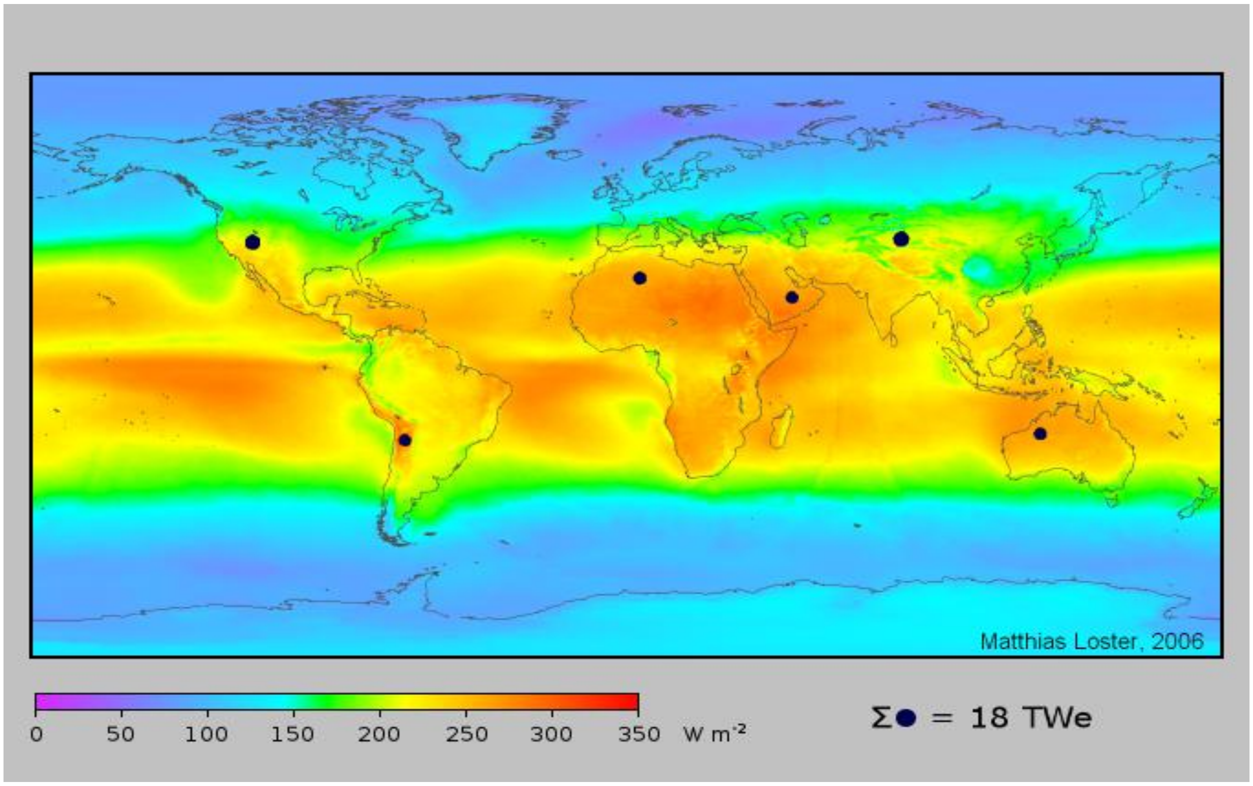


Fig (1. 4)Total Surface Area Required to Fuel the World With Solar

Solar energy production with: photovoltaic panels, free piston stirling generator, bacteries producing hydrogen · direct hydrogen producing photovoltaic [29]

Average solar irradiance, watts per square metre. Note that this is for a horizontal surface; whereas solar panels are normally mounted at an angle and receive more energy per unit area. The small black dots show the area of solar panels needed to generate all of the world's energy using 8% efficient photovoltaic.

Chapter 2

LITERATURE REVIEW

2.1 INTRODUCTION

The energy consumption increasing day by day, supply is depleting resulting in inflation and energy shortage. Limited amount of conventional energy sources remaining and very polluting. Thus we are forced to look for unconventional energy sources. Non-conventional energy sources are unlimited and free, nonpolluting. Since this work is preceding one step ahead and we are try to Belding a hybrid system with use of non conventional energy source. Among of these major applications one of them is solar photovoltaic system and biogas generation. Two approaches are appropriate in order to cope high power availability needs: by increasing the photovoltaic size or by using additional energy source: hybrid power system In this chapter, different critical reviews hybrid connected solar photovoltaic systems and bio generation are explained.

2.2 Earlier Works- An Overview

Several works are going on solar photovoltaic systems and biogas. Some of these are discussed below:

Janani Chakravarthi [1] presented a paper of biogas and energy production biogas can be produced from a number of sources such as municipal waste, corn husk, farmland manure, to name a few. Treating animal waste with the technology of anaerobic digestion can reduce environmental pollution and generate relatively cheap and readily available source of energy in dairy farms. Some advantages of biogas production. The gas produced can be used for space and water heating of farm houses, for cooking, lighting, grain drying and as a fuel for heating greenhouses during cold weather. Stages, new integrated approaches and economic Considerations were briefly discussed. It is likely to grow for decades to come and the rate of growth may depend on several exogenous factors such as cost of conventional energy sources and the people's desire to improve the global environment.

Weidong Gu, Chufu Li, Ming Gu [2] in his paper study on the wind/biogas integration system for power generation give the fermentation temperature range and integration system overcomes the difficulties involving low fermentation temperature of biogas production and uncertainty and fluctuation of wind power in the large-scale use of power, by using the innovative technologies. Structure of the wind/biogas integration system to reduce costs of the whole system and the use of innovative technologies are developed and adopted in the proposed wind/biogas integration system for power generation and to reduce costs of the whole system, the use innovative technologies to increase the efficient wind turbine is developed.

Zhang Yanning, Kang Longyun, [3] in his paper study at of biogas generation (Simulation of Biogas Generation) output power of biogas generation is direct ration to the consumption of biogas; hence the modulation of output power is key to ensure the invariableness voltage of the distributed power system and give the simulation mode of biogas generation by the analyses the work process. Working Process of Gas Engine and generator of biogas generation is generally synchronization generator, which is jointed directly with the gas engine. The output current frequency is described as in mathematic terms. biogas generation is composed by the gas engine and the synchronization motor

A. Gupta, R. P. Saini, M. P. Sharma [4] his presented a paper about performance and use of software program developed in C++computer program at hybrid system and presents a wind, photovoltaic, biomass small/micro hydro and diesel generator based hybrid energy system to generate a continuous power irrespective of the intermittent power outputs from the wind and photovoltaic energy sources and hybrid energy systems using developed computer program and flowchart. The optimization results of hybrid energy model for different values and monthly average streamlines flow in study area and daily average biomass availability in study area. The total potential including all the renewable energy resources and economic analysis has resulted in the calculation of capital cost of energy for different types of resources and optimized cost of hybrid energy system. Employment generation local people will be employed to take off the operation and maintenance of the power system as well as to manage the collection of revenues from each household, which may be used for maintaining the sustainability of the system.

Ajai Gupta, R. P. Saini, M. P. Sharma [5] presented a paper about Hybrid Energy System for Remote Area An Action Plan for Cost Effective Power Generation proposes evaluation criteria presents a general methodological outlook for the formulation of an action plan for the small scale hybrid energy system for small village. The specific values chosen and the assumptions made are subject to large variations depending on a variety of local conditions. Modeling a stand-alone hybrid energy system capable of utilizing various resources, for supplying the basic energy needs of small village or areas has been presented and discussed. The section summarizes step by step for planning hybrid energy systems for small village, and gives the details previous work with respect to the design of small-scale hybrid energy systems. Effective mode of a hybrid system and cost energy system. Supplying the energy needs of a hypothetical typical cluster of villages situated in a remote rural area is considered.

Gianni Celli, Emilio Ghiani, Massimo Loddo, Fabrizio Pilo, Simone Pani [6] a paper about analyze and research Optimal Location of Biogas and Biomass power production requires the use of optimization algorithm to take into account biomass availability, transportation and power facilities as well as all the territory related constraints. The integration of optimization tools within Geographic Information Systems allows better performances. Several causes are contributing to this situation limited market, production costs, high disposal cost of the residues, more severe limits imposed by the laws. Building and Operation cost optimal location of the sites transportation costs of the biomass to the power plants sites, capital and operation expenses, Revenues Disposal cost and it has been roughly depicted the area under study and the distribution of the biomass resources. Combined heat and power production with biomass can help improve the energy efficiency of agricultural industries, and increase environmental sustainability of food. In order to be effective the use of biomass requires a very complicated optimization process to take into account not only the global production of biomasses but also local characteristics. Biomass productions can easily vanish both economic and environmental benefits.

Clint (Jito) Coleman [7] Presented the paper about the hybrid power system operational test results wind/photo voltaic /diesel system documentation advances in reliability and the increasing with the renewable energy conversion technology, hybrid power systems now represent the preferred choice for electrical power at many small sites report will focus on the operational characteristics of the systems as well as describing the power system architecture, control logic, and component performance. This information has been incorporated in all of area Power's hybrid power system designs., long term operational reference data, and computer prediction techniques provide the systems engineer with the necessary information to design a power system precisely, accurately, and with the utmost confidence in its operational characteristics

Steven Durand, Andrew Rosenthal [8] present a paper at photovoltaic hybrid power system comparisons prediction versus field results and discus General System Performance This paper analyzes the various design constraints of such systems and suggests design changes that can improve overall system performance in some cases. Evaluating Hybrid Systems by Operational Mode, Potential Advantages,) according to paper photovoltaic hybrid system is located in the specified location When these systems are included in a hybrid system, the advantages of diesel generators are used primarily to charge the batteries and are operated at higher loads in a more fuel efficient manner, The goal of installing a hybrid system is to realize the potential advantages of reduced fuel use, lower operation and maintenance cost, and greater availability than diesel only systems and Another configuration could use a single small inverter with sufficient over-load capability to allow time for the generator to start during peak-load periods.

Slkyung Kim, Changbong Kim, Jinsoo, [9] The paper present load sharing operation of a 14KW photovoltaic /wind hybrid power In this paper, a design procedure for photovoltaic. The hybrid system is composed of a DC/DC converter for a photovoltaic energy conversion, a DC/DC converter for a wind energy conversion. Hybrid System Configuration, a single system wind energy and photovoltaic energy resource do not supply enough reliable power for all year due to the seasonal power generation pattern. The proposed battery sizing procedure meets the cost-effective and the stable power generation requirements. The method demonstrates a simple tool to determine the desired battery size that satisfies the energy demand from the user with the photovoltaic and wind natural source.

Vicente Salas and Emilio Olias [10] Hybrid Powering System for Stand-Alone Remote Telecom Applications introduces a study of efficiency for analysis of a Hybrid Power System in photovoltaic Battery and Liquefied Petroleum Gas-generator set Low cost and high reliability powering system. Two approaches are appropriate in order to achieve high power availability needs: by increasing the solar penal size or by using additional energy source for example hybrid power system This paper presents the analyses and dimensioning method conducted on one off-grid Hybrid Power System. The life-cycle cost was calculated and hybrid Power Systems can be suitable to meet the fulfill of small telecommunications equipment of low power. And besides, to reduce of total cost improving the availability at the same time Telecom equipment location- and their power Sizing the HPS is necessary to follow the next procedure. Size of the battery Performance Duration the operation of the LPG engine.

Barsoum, N.N. Vacent, P.[11] presented a paper about Balancing Cost, Operation and Performance in Integrated Hydrogen Hybrid Energy System a cost and environmental impact. The paper concern with an investigation of the cost related to hydrogen hybrid system. It was found that under which conditions wind turbines and PV systems could feasibly power electrolyzers to generate and store hydrogen for remote power generation using fuel cells and diesel engines. A system of the combination of different sources has the advantage of the balance and stability. This paper investigates on the modeling of a standalone power system focusing on photovoltaic hydrogen energy systems. Starting from the analysis of the models of the system components. Analyzing it determines whether the system is feasible. Second, it estimates the life-cycle cost of the system. The life cycle cost is a convenient metric for comparing the economics of various system configurations.

Hooman Dehbonei, Chem v. Nayar, Liuchen Chang [12] This paper presents a new modular hybrid power system incorporating photovoltaic and small scale wind generators connected to an AC bus., with engine-driven generators and battery storage. is widely recognized as a viable alternative to conventional small area power supplies, where the renewable energy source and the battery bank are sized to reduce the run-time of the engine driven generator. These systems provide sufficient storage to allow the load to be shifted, therefore ensuring that the generator is always substantially loaded and classified according to their configuration as series or parallel. Use a very high degree of reliability as compared to single-source systems. Applications of hybrid energy systems range from small power supplies for small village households, providing electricity for lighting and other essential electrical appliances, to village electrification. This system has the advantage the PV panels operate at a higher DC-voltage, resulting in greater overall efficiency and a reduction in wiring costs, Extracting more energy from the wind turbine at low wind speeds, Load voltage stabilization, Reactive power support, Reduction in the overall converter power rating and hence cost, Operation in stand-alone and grid-connected modes.

J.T. Bialasiewicz, E. Muljadi, [13] In this paper, present a modular simulation system developed to study the dynamics and to aid in the design of hybrid power systems with diesel and wind turbine generation. give an overview of the dynamics and control aspects of the principal modules of the simulator. The electric machine models can be found. The wind turbine model can be derived. The use of wind energy in the autonomous hybrid power systems that operate in remote areas is not only pollution-free but also highly cost-effective due to the dramatic reduction of diesel fuel consumption ,presented in this paper, demonstrate that the modular simulation system, developed using the visual programming environment, constitutes a very useful tool for analysis and design of such systems.

Ajai Gupta, R. P. Saini, and M. P. Sharma [14] Computerized Modeling of Hybrid Energy System in paper is discuses The role of integrating renewable energy in a hybrid energy system is primarily to save diesel fuel or conventional energy source. The analysis and design of a mixed integer linear mathematical programming model and the optimization is aimed at minimizing the cost function based on demand and potential constraints. System Component Modeling is in detail of Mathematical Model of Hydro Generator, Biomass Generator, and Biogas Generator, Solar photovoltaic Generator, Diesel Generator, Battery Bank, Inverter, Dump Load, and Charge Controller. Variables and constraints associated with Micro hydro Generator, constraints associated with Biogas Generator, Biomass Generator, Diesel Engine Generator, and Battery bank. Model employs generalized integer linear programming to determine the optimum unit cost and operation of the hybrid energy system with a storage facility, using hourly, daily and monthly load demand.

Zhanping You1, Shijun You1, [15] ;Biogas Power Plants Waste Heat Utilization Researches paper discussed the significance of developing biogas power plants in large breeding farms, Biogas internal combustion engines would produce a lot of waste heat in the process of power generation. The continuously, Increasing of livestock breeding in various parts of country, how to dispose feces and sewage produced by live stocks became very urgent. The utilization technology of waste heat of biogas power plants t his would promote local economic development and partly resolve the employment problems of local farmers. This must use cold storages for poultry product storage. Economic and social benefits evaluation of biogas energy was almost 80% after comprehensive utilization of waste heat. Biogas power plants with straw and garbage as raw material could also adopt those schemes in utilization of waste heat.

Jiang Yao-hua, Xiong Shu-sheng, [16] in this paper Research of Biogas as Fuel for Internal Combustion Engine it are introduced briefly component, physical & chemical characteristics of biogas and the problems of running engines Biogas-diesel dual-fuel engine is on the basis of diesel engine, and refitted the intake hybrid system and dual-fuel accommodation system its working principle is to mix biogas and air in mixer to form combustible mixed gas. And some research work and develop of all-biogas engine, The exploration of purification, super pressure and vehicle using of biogas. A successful biogas-diesel dual fuel engine; because of using a small quantity of leading diesel to be pressed and burning to ignite biogas; its energy of fire is higher than the energy of spark-ignition, and Through the high compression ratio, purify and compress biogas, and then use it as vehicle fuel; it has feasibility on technology.

Zhang Yanning, Kang Longyun [17] The paper Renewable Energy Distributed Power System With Wind Power and Biogas Generator. The biogas generation can be supplying the steady electricity and the output power can be control. Thus the authors present the wind-biogas renewable energy distributed power system, the brief Power Flow of System and Capacity of Hybrid System, The wind-biogas system is a complex system which the whole model is difficult to exactly get, thus the control design is the key to the good electricity is discuss .and brief Wind Generator, Biogas Generator. The biogas generator is only restricted by the marsh gas pond. It is controllable and the capacity can be planed. The hybrid system of wind generator and biogas generator keep the stable output electricity.

AlexandreBarin, LucianeCanha [18] Title of paper Renewable Hybrid Systems using Biogas Fuzzy Multi-Sets and Fuzzy Multi-Rules and discussed is uses fuzzy multi-rules and fuzzy multi-sets to evaluate the main characteristics of the operation of renewable sources fuelled by biogas. Besides, this methodology will be also applied in storage energy technologies. Fuzzy logic is one of the most powerful mathematical tools for modeling and controlling by multi rules-based decisions and multi-sets considerations, regarding both quantitative and qualitative parameters. By using the software MATLAB. Presented a study intending to find appropriate renewable hybrid system and fuelled by biogas, by evaluating its main operational characteristics under different scenarios and the importance in use hybrid system fuelled by biogas for the improvement of system management.

Li Wang, Ping-Yi Lin [19] Title of paper Analysis of a Commercial Biogas Generation System Using a Gas Engine–Induction Generator Set, paper presents both field-measured results and dynamic stability analysis of a commercial 100-kW biogas generation system, give Model and Speed Governor Model, Configuration of the Studied bio gas generation set, Determination of Induction generator Parameters. The employed parameters and the model for the studied need to be further improved because they cannot be completely validated by measurement results, including steady-state operating conditions, system Eigen values, and dynamic responses could be confined to a very narrow rotational speed range and under three-phase balanced conditions. The employed parameters of Induction generator the studied are calculated by using the manufacturer's certification data and comparing both field-test data and simulated results under two specific rotational speeds. Stability of a commercial 100-kW bio gas generator set using a gas engine, induction generation set under various rotational speeds and grid voltage variations.

Mayank Aggarwal, Vijit Gupta [20] Title of the paper Biogas as Future Prospect for Energy Dependency and Rural Prosperity in India: Statistical Analysis and Economic Impact and brief discussion are discussing the prospect of biogas in eradicating various problem in a developing country like India, its impact on environment, society etc The need of the hour is to develop a technology that is cheap and do very little damage to the environment or rather provide a suitable solution to above problems. About 2.5 billion people, mostly in Asia, growth prospects of biogas plant, Reason for Slow Growth Rate of Biogas Plants in India. Financial Study of a Biogas Plant that biogas is a promising tool for employment generation, energy self sufficiency and reduction of greenhouse gases .Also it helps in reducing deforestation thus saving lots of species from extinction If applied on large scale it can prove to be a boon for a developing country like India.

Fabio Morea, Giorgio Viciguerra [21] Life Cycle Cost Evaluation of Off-Grid PV-Wind Hybrid Power Systems. This paper presents a design method based on an expert system for the optimization of hybrid power systems used in telecom applications The main difficulty that arises in optimal hybrid system design is the number of variables, that are intrinsically dependent on one another. This dependency tends to be affective wherever there is the need of evaluating different prices or models of components. Hybrid Power systems for off-grid telecom applications have been widely discussed and tested since they can offer a potentially attractive alternative to diesel-based power systems Several software programs are currently available for simulating the operation of hybrid electric power systems, using either simple algorithms or dynamic methods, but none includes all relevant information for telecom applications. evaluation has been carried out to evaluate the potentials of PV-Wind hybrid power systems applied to conventional and If the technology or the components cost vary too much outside the initial values the neural network may lose reliability. In such case a conventional design approach is required.

Guangming LI, Yuanrui CHEN, [22] The Realization of Control Subsystem in the Energy Management of Wind/Solar Hybrid Power System, In this paper, the hardware realization of the energy management and control subsystem of a grid-connected wind/solar hybrid power system has been introduced and give mentioned techniques and most existing literature mainly centralize the modeling, control arithmetic and theory about hybrid power system energy management and control. The emphases on its hardware, communication and how to meet its requests and functions and Experiments show that this system is competent for both grid-connected mode and stand-alone mode. Due to multi-source operation and decentralized distribution of subsystems, how to achieve better energy management and control is one of hot topics on hybrid power generation research. It is composed of grid-connected control module, ac multi-function electric power meters, dc electric power meters, converter etc. The control system is regarded as an agent, and under cooperation with other subsystem, it can be competent for medium-to-large-size of hybrid power systems or other similar applications.

Atideh Abbasi, and Zhenhua Jiang [23] Design and Analysis of a Fuel Cell/Gas Turbine Hybrid Power System This paper describes a fuel cell – gas turbine hybrid power system that aims to increase the system efficiency and decrease the costs by employing the waste heat from the fuel cell stack in the gas turbine. The plant layout of the hybrid system is described, and the dynamic model is presented. The hybrid system is optimized based on particle swarm optimization. The procedure to optimize the hybrid system is presented. The optimization problem is formulated. The proposed method to minimize the cost of the system is described. The implementation of the method explained. The hybrid system consists mainly of a proton exchange membrane fuel cell stack, Pollution control, increasing the efficiency, decreasing fossil fuel use, the resulting system exhibits a synergism in which the combination performs with an efficiency that far exceeds that which can be provided by either system alone and developing economically reliable systems. Modeling of hybrid power system and design of fuel cell/gas turbine hybrid power and power exchange membranes .The objective of this study is to design and optimize the hybrid generation system, which is economic and reliable.

Yuanrui Chen and Jie Wu [24] Agent-Based Energy Management and Control of a Grid Connected Wind/Solar Hybrid Power System In this paper discus a grid-connected wind/solar hybrid power system is proposed. It contains four subsystems: wind turbine generation, solar photovoltaic (PV), storage batteries and loads. Each of them is connected to the AC bus or DC bus and operation modes, i.e., ready, stand by, run, stop, and are defined. It employs agent-based cooperative control strategy to achieve maximum power point tracking, Loads Subsystem, Agent and Multi-Agent System, Solar Photovoltaic Subsystem, Storage Batteries Subsystem, Energy Management and Control Strategy The proposed system is actually a decentralized, complex hybrid system; therefore, a distributed energy management should be applied to it. The system is implemented by using a PLC, some microcontrollers and meters. Some experiments have been done to verify the validity of the proposed scheme. The energy management and control strategies are different from that of small-size stand-alone system. This system employs multi agent system theory, and agents are planned for each subsystem. The agents are relatively independent individuals (each of them could work well to achieve its goal).

2.3 CONCLUSION

From the various earlier works that Hybrid system is design of power generation with renewable energy resource. This is alone and unique system produces a sufficient amount of generation which is meet demand of small village and rural areas. Hybrid system is a system which is fully used of over energy resource and gives healthy environment. The advantages of biogas are manifold. Biogas by itself can positively affect the economy of rural areas and give us clean environment.

2.4Scope of Thesis . We are tried to develop the solar/biogas hybrid system will independently provide a stable power source and daily gas for Thapar University/small area. Hybrid system will independently provide a stable power source from biogas and solar energy. We are trying to economical evaluation of Hybrid Systems for electricity production.

2.5Objective Solar electricity generation is being taken into account from the solar radiation data obtained as follows. The efficiency of the PV modules is considered to be 14.3. Hybrid system is a system which is fully used of over energy resource and gives healthy environment. The advantages of biogas are manifold.

2.6 organization of Thesis

The Thesis has been organization into six chapters. Content of each chapter describe as under ;-

Chapter 1:- Introduction hybrid system biogas and solar energy

Chapter 2:- literature reviews Hybrid system, Biogas generation, the system which is fully used of over energy resource and gives healthy environment.

Chapter 3 Biogas for cooking and Statistical Analysis and Economic analyze for Thapar University

Chapter 4 Biogas and solar power generation Statistical Analysis and Economic for Thapar University.Result, hybrid of biogas and solar energy Statistical Analysis and Economic Impact and brief discussion are discussing the prospect of biogas in eradicating various problems.

Chapter 5 Conclusion and future scope of work

Chapter 3

BIOGAS FOR COOKING ECONOMIC AND STATISTICAL ANALYSIS

3.1Bio gas Plant Model

This is a composite unit of a digester and gas holder wherein the gas is collected and delivered at a constant pressure to gas appliances through a distribution system.

Depending on the amount of raw material to be handled, the digester may be of either a single-chamber or a double-chamber type.

There are two types of processes for anaerobic fermentation: Continuous and bath. The continuous process is suitable for free-flowing suspended materials while the batch process is applicable to light materials. the process is continuous in the sense that as the material to be fermented is charged into the fermentation tank, the same volume of the fermented material overflows from it. There are two types of biogas plants in usage for the production of biogas;-

- The fixed- dome type of biogas plant
- The floating gas holder type of biogas plant

3.1.1 Principle

Biogas is produced as a result of anaerobic decomposition of biomass in the presence of water

3.1.2 Construction

The biogas plant is a brick and cement structure having the following five sections

1. Mixing tank present above the ground level.
2. Inlet chamber: The mixing tank opens underground into a sloping inlet chamber.
3. Digester: The inlet chamber opens from below into the digester which is a huge tank with a dome like ceiling. The ceiling of the digester has an outlet with a valve for the supply of biogas.
4. Outlet chamber: The digester opens from below into an outlet chamber.
5. Overflow tank: The outlet chamber opens from the top into a small over flow tank.

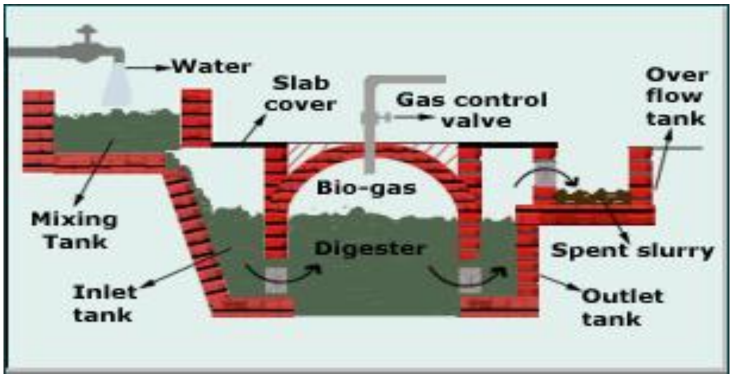


Fig (2.1) Fixed dome type biogas plant

3.1.3 Working Fixed dome type biogas plant

The various forms of biomass are mixed with an equal quantity of water in the mixing tank. This forms the slurry. The slurry is fed into the digester through the inlet chamber. When the digester is partially filled with the slurry, the introduction of slurry is stopped and the plant is left unused for about two months. During these two months, an anaerobic bacterium present in the slurry decomposes or ferments the biomass in the presence of water. As a result of anaerobic decomposition, biogas is formed, which starts collecting in the dome of the digester. As more and more biogas starts collecting, the pressure exerted by the biogas forces the spent slurry into the outlet chamber. From the outlet chamber, the spent slurry overflows into the overflow tank. The spent slurry is manually removed from the overflow tank and used as manure for plants. The gas valve connected to a system of pipelines is opened when a supply of biogas is required. To obtain a continuous supply of biogas, a functioning plant can be fed continuously with the prepared slurry.[30]

Advantages of fixed dome type of biogas plant

- Requires only locally and easily available materials for construction.
- Inexpensive.
- Easy to construct.

Due to the above reasons, this plant is also called the local or Social biogas gas plant.

3.2 Floating gas holder type of biogas plant

3.2.1 Construction of the floating gas holder type plant

The floating gas holder type of biogas plant has the following chambers/ sections:

- Mixing Tank - present above the ground level.
- Digester tank - Deep underground well-like structure. It is divided into two chambers by a partition wall in between.

It has two long cement pipes:

i) Inlet pipe opening into the inlet chamber for introduction of slurry.

ii) Outlet pipe opening into the overflow tank for removal of spent slurry.

- Gas holder - an inverted steel drum resting above the digester. The drum can move up and down i.e., float over the digester. The gas holder has an outlet at the top which could be connected to gas stoves.
- Over flow tank - Present above the ground level

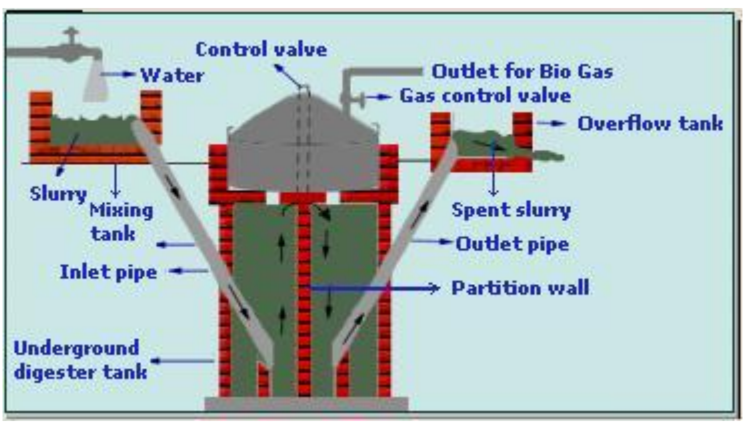


Fig (2.2) Floating gas holder type biogas plant

3.2.2Working

Slurry (mixture of equal quantities of biomass and water) is prepared in the mixing tank. The prepared slurry is fed into the inlet chamber of the digester through the inlet pipe. The plant is left unused for about two months and introduction of more slurry is stopped. During this period, anaerobic fermentation of biomass takes place in the presence of water and produces biogas in the digester. Biogas being lighter rises up and starts collecting in the gas holder. The gas holder now starts moving up. The gas holder cannot rise up beyond a certain level. As more and more gas starts collecting, more pressure begins to be exerted on the slurry. The spent slurry is now forced into the outlet chamber from the top of the inlet chamber. When the outlet chamber gets filled with the spent slurry, the excess is forced out through the outlet pipe into the overflow tank. This is later used as manure for plants. The gas valve of the gas outlet is opened to get a supply of biogas. Once the production of biogas begins, a continuous supply of gas can be ensured by regular removal of spent slurry and introduction of fresh slurry. [30]

3.2.3Disadvantages of floating gas holder type biogas plant

- Expensive
- Steel drum may rust
- Requires maintenance

3.2.4Advantages of biogas as a fuel

- High calorific value
- Clean fuel
- No residue produced
- No smoke produced
- Non polluting
- Economical
- Can be supplied through pipe lines
- Burns readily - has a convenient ignition temperature Uses of biogas
- Domestic fuel
- For street lighting
- Generation of electricity

3.3Advantages of biogas plants

- Reduces burden on forests and fossil fuels
- Produces a clean fuel - helps in controlling air pollution
- Provides nutrient rich (N & P) manure for plants
- Controls water pollution by decomposing sewage, animal dung and human excreta.

3.3.1 Limitations of biogas plants

- Initial cost of installation of the plant is high.
- Number of cattle owned by an average family of farmers is inadequate to feed a biogas plant.

3.3.2 Prerequisites for installation:

Four – five animals, preferable stable-bound for a 2m^3 gas / day plant.

Minimum 45 kgs of dung for a plant producing 2 m^3 gas daily.

Sufficient space for constructing the plant and for location of pits for outlet slurry.

Space must be close to the source of raw material.

Distance between the plant and the kitchen should be within 20 meters in the case of small plants.

Spaces provided should be free from any intrusion of trees which may creep into the digester and cause damage.

Space should be in the sun and away from low-lying areas.

Location should be away from drinking water well.

3.3.3Designs Considerations:

Availability of building materials: Stone, brick masonry, concrete, steel, plastic, etc.

Level of water-table – special designs are available for high water table areas.

Input material to be used: Raw material include cattle dung and other animal excretes, including piggery wastes, poultry droppings, etc., human excretes, agricultural wastes such as straw, leaves, algae, bagasse, aquatic weeds, industrial wastes such as distillery sludge, wastes from tanneries, food industries, paper mills, etc.

The majority of plants are designed to work on either pig or cattle dung, a few for chicken dung or human feaces or a combination of different types of dung. The mode of feeding too changes, depending on type of material. For example, plants using vegetable matter need to be cleaned and refilled at least once or twice a year and thus operate on a batch mode basis.

3.3.4 Purpose for which the plant is required:

If the gas is used exclusively for:

Cooking, then the height of the gas holder is usually one-third the depth of this digester since it never has to hold more gas than for three or four hours use at a time:

Lighting, for which the gas holder must be large enough to hold all the gas generated in 24 hours to be able to deliver it in 4 or 5 hours;

for other applications such as for running refrigerator, incubators, engines, etc. then the gas holder must have at least half of the digester volume.

3.3.5 Amount of fertilizer expected from the gas plant:

About 70% of the total solids put in can be expected to came out, and processing does not change the form or quantity of nutrients present.

Amount of dung that can be collected per animal, bird or human which depends on the diet and size of the animal, degree of confinement, etc.

Size of the plant: The average villager uses about 0.42 cu.m. of gas per cay. The volume of fresh dung (D) available every day multiplied by 80 gives the volume of the digester (P) most suitable to handle that amount of dung.

$$D \times 80 = P.$$

Pit volume divided by 2 gives the volume of gas generated daily (at 30^{o}C). P/2 = G.

The volume of gas divided by amount of gas required by each person gives the number of persons served. This formula is correct if the slurry is made in the proportion of 1:1. The total daily input of slurry, regardless of its proportions should be 1/40 of the pit volume.

The following table gives as estimate of the quantity of dung required for various plant sizes.

Material	Amount of gas (m^3 /Kg of fresh material)	
	Winter	Summer
Cattle dung	0.036	0.092
Night-soil	-	0.04
Pig dung	0.07	0.10
Poultry droppings	0.07	0.16

Table 3.1 Production of biogas from different types of raw material

The composition of the gas produced again varies with the material used for fermentation. this is tabulated below.

Material	Composition of the gas (percentage)		
	Methane	Carbon dioxide	Hydrogen Sulphide etc.
Cattle dung	55-80%	40-45%	Negligible
Night Soil	65%	34%	H_2S 0.6% other gases 0.4%

Table 3.2 Composition of biogas produced from cattle dung and night soil:

Size of plant (gas production/ day) (m^3)	Amount of wet dung required (kg)	No. of animals
2	35-40	2-3
3	45-50	3-4
4	55-60	4-6
6	80-100	6-10
8	120-150	12-15
10	160-200	16-20

Table 3.3 Quantity of dung required for various plant sizes:

Hostel	Room	Person	LPG	kg
PG	288	240	80	1120
A	252	226	60	840
B	282	280	90	1260
C	422	290	80	1120
E	150	150	40	560
G	205	203	40	560
H	480	260	90	1260
I	528	322	80	1120
J	858	570	190	2660

Table 3.4

Use of LPG gas in Thapar university hostel use pre month approximate ;

LPG will replace by Biogas and following economical and statistical analysis

3.4 Economic and Statistical Analysis

Financial Study of a Biogas Plant:

For purpose of financial study let us take case of Thapar university campus. We have taken following assumptions for our calculations based on and taking into consideration the rise in costs over the years. We are assuming that the raw materials like cow dung,

Human wastes and organic wastes are almost of negligible cost.

(1) Total no of families in the campus =100 or 400 person and 1 LPG cylinder used in 1 month.

(2) Out of these 100 families 40 families have more than 5 members where as 40 have less than 4 members and 20 families have more than 2 members on an average.

(3) Cooking gas from plant will be sold at Rs 325 to single families, per month

(4) The compost manure produced will be sold at rate of Rs.500 per ton.

(5) Each family with more than 5 members requires 3.5 cubic meter gas per day, families less than 4 members requires 2.8 cubic meter of gas per day where as families of 2 or less requires 1.25 cubic meter gas per day.

(6) We are analyzing for 2 biogas plants having combined capacity of 300 cubic meters each.

(7) Manure produced will be 52.5 tones per month.

So gas required for all 100 families= (40*5) + (40*4) + (20*2) =400 member 280cubic meter

Our gas production is (300*2) =600 cubic meter Total costs (Fixed + Variable) =

Rs 24, 75,000+Rs 66,000+Rs 4,000=Rs 25, 45,000

Total revenues from used LPG

= (100*325)*12=Rs 390,000(save)

From selling manures = (52.5*12*500)=Rs 3,15,000

Total revenue per year=Rs 390,000+Rs 3, 15,000

=Rs 705000.

With a 3.7 year plant will run free of cost.

3.4.1 Project model

For purpose of financial study let us take case of Thapar university campus. We have taken following assumptions for our calculations based on and taking into consideration the rise in costs over the years. We are assuming that the raw materials like cow dung

1.	Plant Capacity for Captive Power Generation	300 M3/day
2.	Plant Model	40 days HRT , vertical kVIC
3.	Total no of families in the campus =100 1 LPG cylinder used in 1 month	400 human

4.	5 members requires 3.5 cubic meter gas per day[20]	$3.5 \div 5 = 0.7m^3$
	400 person required gas per day	$400 \times 0.7 = 280m^3$
5.	Total costs (Fixed + Variable) =	Rs 24, 75,000+Rs 66,000+Rs 4,000=Rs 25, 45,000
6.	Total cost of the project	Rs. 25,45,000.00
7..	SAVINGS :	
	• Cooking gas from plant will be sold at Rs 325 to single families, per month	100cylinder XRs.325 =Rs.32500
	12 months	32500×12=390,000Rs
	• Manure sale/use per year @ Rs. 500/- ton	630 X Rs. 500.00 =Rs.3,15,000.00 Rs
	• Net savings /year	Rs 390,000+Rs 3, 15,000 =Rs 705000.
	• Pay Back	43Months or 3year7months

Money Requirement and Revenue Generation of Biogas Plant [20]

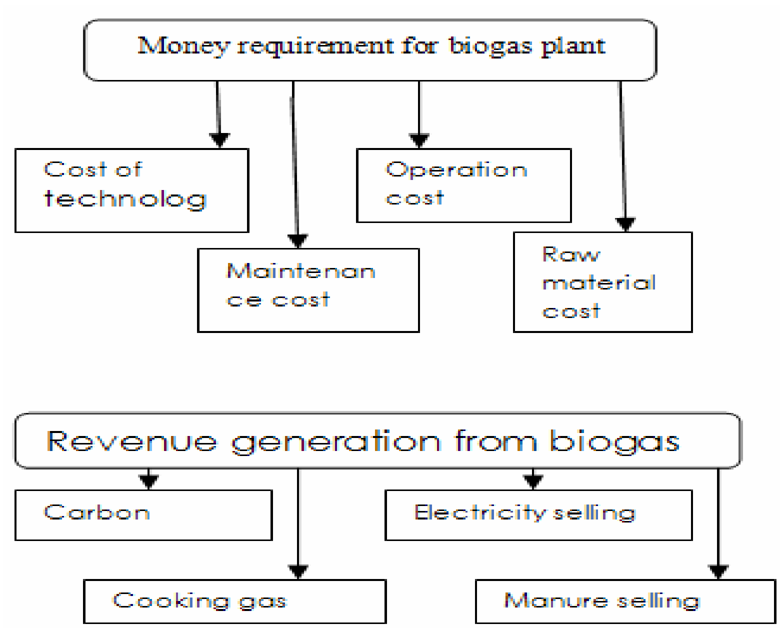


Figure Revenue Generation of Biogas Plant

Anaerobic digester design has continued to evolve over the years, but systems are generally variations around the theme of the floating-dome and the fixed-dome design. Often construction materials vary, or loading positions differ. Table , below, shows some of the most common biogas plants that are recognized by the government

Table: 3.5 Plant type Different types of biogas plant recognised by MNES (Ministry of Non-Conventional Energy Sources). After Gate, 1999.[26]

1. Floating-drum plant with a cylinder digester (KVIC model).
2. Fixed-dome plant with a brick reinforced, moulded dome (Janata model).
3. Floating-drum plant with a hemisphere digester (Pragati model).
4. Fixed-dome plant with a hemisphere digester (Deenbandhu model).
5. Floating-drum plant made of angular steel and plastic foil (Ganesh model).
6. Floating-drum plant made of pre-fabricated reinforced concrete compound units.

7. Floating-drum plant made of fibreglass reinforced polyester.

3.5 BIOGAS UTILISATION

3.5.1Properties:

Biogas, which has the following properties, can be used as a fuel for cooking, heating, lighting and running engines.

The properties are -

- Non -poisonous nature
- Burns with clean bluish Bootless flame
- No offensive smell
- Has a very high octane rating
- Easy to produce
- Boiling point: - 181. 5°C
- Critical temperature: - 82°C
- Critical pressure: 42 atmospheres
- Calorific value: 4700-6000 kcal/m^3 (20-24 MJ/m^3)
- Specific gravity: 0. 86
- Flame speed factor: 11.1 (This is a low figure and hence the flame tends to "lift off" burners which are not properly designed)
- Inflammability in air: 6-25% biogas mixed with air will burn. (This is a relatively narrow range and thus biogas is safer than any other commonly used household gases)
- Thermal efficiency in standard burner: 60%
- Has higher heating value than producer gas, coal gas, and water gas.

Some of the uses and biogas requirements for various purposes are given below**:**

Application	Specification	Consumption of m^3/hr
Cooking/person/day		0.336-0/42
Lighting (40 CP/amp/hr)		0.28
Gas Engine (for running/hr/horsepower)		0.448-0.504
Generating/kwh electricity		0.616
Gas stove	5 cm. dia. burner 10 cm dia burner 15 cm dia. burner	0.322 0.462 0.63
Gas lighting	1 mantle lamp 2 mantle lamp 3 mantle lamp	0.070 – 0.084 0.14 0.168
Refrigerator	45 cm x 45 cm x 360 cm	0.042 – 0.056
Boiling water		0.28/gallon

Table 3.6: Biogas consumption for various purposes

The following is a comparison of calorific values of fuels:

FUEL	**UNIT**	**Calorific Value**	
		(MJ)	**(kcal)**
Biogas	m^3	20	(4700)
Electricity	kWh	3.6	(860)
Kerosene	litre	38	(9100)
Charcoal	kg	29	(6900)
Firewood	kg	20	(4700)
Butane	kg	46	(10900)
Cattle-dung cakes	kg	8.8	(2100)

Table 3.7 Calorific value of biogas and other major fuels.

3.5.2 The following illustration the uses and equivalents of biogas.

1 m^3 of biogas replaces

3.5.3 Uses and equivalents of biogas

1 lb of LPG

0.52 litre of diesel oil

0.8 litre of gasoline

0.62 litre of kerosene

1.1 litres of alcohol

1.5 m^3 of town gas

1.4 kg of charcoal

4.7 kwh of electricity

3.47 kg of firewood

0.43 kg of butane

12.30 kg of cattle dung cake

3.5.4 Utilization device

Burners and stoves:

Biogas cannot be burned on the stoves used for natural gas or any petrol-bised gas, Its flame speed factor is slower than natural gas and thus when biogas is fed to a burner built for natural gas the flame tends to lift off from the burner. Biogas fed at a lower pressure would stay on the burner, but may not burn efficiently and less heat would be recovered from each cubic meter of the gas.

Cover the top of the inlet and outlet opening, especially of the Chinese type plants, firmly to avoid accidental falling of calves, children, etc.

Mix recommended quantity of dung free from earth and gravel with water in 4:5 proportion and feed the mixture daily into the inlet chamber. Specific gravity of the slurry should be 1.045-1.90.

Mix dung and water till there are no lumps which may otherwise cause reduced gas production.

Purge air from all delivery lines by allowing gas to flow for an interval prior to first use.

Stir the slurry several times a day to enhance gas production.

Use good-quality and efficient burner and other gas appliances.

Clean the burner fortnightly.

Light the match first before opening the gas cork.

Remove the condensed water from the pipeline periodically.\

Remove floating solid material found if any between the digester wall and the gas holder.

Install a safety pressure gauge in the kitchen near the window.

Repair the plant in case of major gas leakages being observed.

Paint gas holder annually preferably with black enamel paint.

Use the digested slurry as such for manuring of crops or for hastening the process of composting.

Keep patience for production of gas during initial filling of the plant with slurry.

Dont's :

While mixing the slurry do not put :

Any earth in the mixing-pit of the gobar. It will fill up the bottom of the digester pit and cause problems.

Any straw or grass, etc., in the mixing pit. If any does get in remove it before letting the slurry into the digester pit.

Do not let any oil, soap or detergent into the plant as these substances kill the bacteria and stop all gas production.\

Do not put any animal bedding (sawdust used in chicken houses) in the gas plant.

Never build up gas pressure inside the gas plant for over a long period.

Never pour acid in the digester as this will increase production of H_2S.

Never allow any person to enter the gas plant when it is full of dung slurry.

Never inhale the gobar gas to avoid any health hazard.

Never use more than 40% urine to avoid increase in ammonia which will give less gas and poorer quality and in course of time may stop gas production.

No smoking, no candles, no fires, no matches, no lamps or other open flame to be used in case of small of unburnt gas.

Chapter 4

SOLAR/BIOGAS HYBRID POWER GENERATION

4.1Running I.C. Engines

4.1.1Diesel Engines: Use of biogas in diesel engines in limited to the stationary engine since (gas pressure is slightly above atmospheric pressure and cannot be transported to long distances. Existing diesel engines can be modified to run on dual fuel while still retaining the ability to use diesel fuel only [27].

The following points should be considered while modifying the diesel engine:

- Compression ratio: Original compression ration should be retained, and advance injection angle should not be charged to ensure normal running of the engine on dual fuel and diesel and also facilities maintenance and repair.
- Modification of the intake: To provide biogas after the air filters into the inlet pipe, the intake should be modified. Some of the designs suggested for the introduction of biogas into the intake are shown below.

In order to give the proper biogas/air mixture gas inlet devices are designed to suit different engine designs and inlet pipes.

4.1.2 Starting: Diesel fuel is only used for starting.

4.1.3 Operation: The biogas valve is opened slowly after the engine has been running with diesel fuel for a while. Due to the action of the spend governor, the diesel fuel supply will be reduced. In order to ensure smooth running and better fuel consumption, while the engine is operating, the biogas valve should be opened or closed in response to the change in engine speed or load. The engine should be operated on as steady a speed as possible while running on biogas.

In order to stop the engine the biogas valve should be closed first, followed by the throttle valve.

4.1.4 Maintenance: There is no significant difference in maintenance when the engine is run on biogas.

Petrol engines: These engines can run on 100% biogas.

4.1.5 Air intake: This is the same as that used for diesel engines. An alternate design is given below.

A plastic bag provided near the gas inlet so that the engine can suck in gas more easily is found to be advantageous for engine less than 10hp.

Application	Specification	Consumption of m^3/hr
Cooking/person/day		0.336-0/42
Lighting (40 CP/amp/hr)		0.28
Gas Engine (for running/hr/horsepower)		0.448-0.504
Generating/kwh electricity		0.616
Gas stove	5 cm. dia. burner 10 cm dia burner 15 cm dia. burner	0.322 0.462 0.63
Gas lighting	1 mantle lamp 2 mantle lamp 3 mantle lamp	0.070 – 0.084 0.14 0.168
Refrigerator	45 cm x 45 cm x 360 cm	0.042 – 0.056
Boiling water		0.28/gallon

4.1 D**ata chart Biogas consumption for various purposes**

Material	**Amount of gas (m^3 /Kg of fresh material)**	
	Winter	**Summer**
Cattle dung	0.036	0.092
Night-soil	-	0.04
Pig dung	0.07	0.10
Poultry droppings	0.07	0.16
Human waste	-	0.025

4.2 Data chart Production of biogas from different types of raw material:

Human waste of 200 person produce $5m^3$ of biogas and 12KWhr energy from biogas engine [25]

Size of plant (gas production/ day) (m^3)	Amount of wet dung required (kg)	No. of animals
2	35-40	2-3
3	45-50	3-4
4	55-60	4-6
6	80-100	6-10
8	120-150	12-15
10	160-200	16-20

4.3 Data chart Quantity of dung required for various plant sizes:

4.1.6 Biogas power plants are a combination of anaerobic digestion systems with associated electricity generators such as gas turbines or gas engines. The electricity they produce is classified as renewable or green energy. Feedstock into the biogas power plants must be biodegradable in order to produce methane. Suitable feed stocks include (but are not limited to):

Biodegradable Waste
Sewage
Kitchen Waste
Food Waste
Farm Waste
Organic component of Mixed Municipal Waste
Biomass
Animal Waste

The more complex and efficient a biogas plant the more expensive it will be for the locality. Biogas plants can be simplified to produce gas for villages in countries where organic wastes are available and funds are limited. Alternatively, in more developed countries pressure in the form of legislation and high energy costs is increasing the amount of projects generating renewable energy from waste

4.2. Project models for power generation

4.2.1 project model

Biogas based Electricity Generation cum Composting (by NADEP method) can be installed and commissioned based on about 150–200cattle,3000 human waste.

1.Salient features of the project are as follows**:** Power generation from human waste

Sr.No.	ITEM DETAILS	
1.	Plant Capacity for Captive Power Generation	85 M3/day
2.	Plant Model	40 days HRT , vertical kVIC
3.	Daily human waste requirement for the plants	3000 human waste
4.	Human waste of 200 person produce $5m^3$[25]	
	Producing of biogas by per person	$5 \div 200 = 0.025m^3$
	3000 human waste is produce	$3000 \times 0.025 = 75m^3$
5.	$5m^3$ biogas generate 12 kwhr [25]	
	Generation of per $meter^3$	$12 \div 5 = 2.4$ kwhr
	$75m^3$ biogas generate	75x2.4 =180kwhr
6.	Total cost of the project	Rs. 20,00,000.00
7.	Recurring expenditure /annum	Rs. 1,20,000.00

8. SAVINGS :

• As electricity bill per year @ Rs. 4.00/unit	65,000 units XRs.4.00 =Rs.2,60,000.00
• Manure sale/use per year @ Rs. 500/- ton	450 X Rs. 500.00 =Rs.2,25,000.00
• Net savings /year	Rs.3,65,000.00
• Pay Back	55Months or 4year8months approximate

A project on Biogas based Electricity Generation cum Composting (by NADEP method) can be installed and commissioned based on about 150–200cattle. Human waste both plant.

4.2.2.project model second Salient features of the project are as follows: Power generation from cattle waste

Sr.No.	ITEM DETAILS	
1.	Plant Capacity for Captive Power Generation	85 M3/day
2.	Plant Model	40 days HRT , vertical kVIC
3.	Daily cattle waste requirement for both the plants	150-200 cattle waste
4.	cattle waste of 200 cattle produce 7.2m^3	
	Producing of biogas by per	7.2÷200 =0.036m^3
	cattle is produce	2100kg×0.036=75m^3
5.	5m^3 biogas generate 12 kwhr [25]	12÷5 =2.4 kwhr
	Generation of per meter^3	75x2.4 =180kwhr
	75m^3 biogas generate	

6. Total cost of the project — Rs. 20,00,000.00
7. Recurring expenditure /annum — Rs. 1,20,000.00

8. SAVINGS :

- As electricity bill per year @ Rs. 4.00/unit — 65,000 units XRs.4.00 =Rs.2,60,000.00
- Manure sale/use per year @ Rs. 500/- ton — 850 X Rs. 500.00 =Rs.4,25,000.00
- Net savings /year — Rs.5,65,000.00
- Pay Back — 48Months or 4year approximate

The following reading had taken between 01th May2009 to 31th April 2010.from main substation of power consumption Thapar University data chart (4.4) following;-

Date	KWH	KWAH	Load KW	Power factor	Consumption Diff.
07/05/09	1097469	1258455	89.116	0.885	
12/05/09	1107496	1269699	89.572	0.889	10027
22/05/09	1117922	1281346	83.055	0.882	10426
24/05/09	1121345	1285175	82.393	0.901	3423
25/05/09	1122978	1287019	98.088	0.842	1633
26/05/09	1125100	1289410	88.357	0.888	2122
27/05/09	1126486	1290984	111.35	0.885	1386
27/05/09	-	1294077	112.924	0.927	
28/05/09	1129229	1294080	94.107	0.899	2743
31/05/09	1134134	1299641	54.477	0.847	4905
01/06/09	1134948	1300542	58.729	0.869	814
01/06/09	1135543	1301268	80.516	0.868	595

02/06/09	1136356	1302220	51.434	0.865	813
02/06/09	1137146	1303130	59.305	0.859	790
03/06/09	1137790	1303882	44.422	0.841	644
03/06/09	1138360	1304532	64.927	0.865	570
04/06/09	1139128	1309444	46.825	0.832	768
04/06/09	1139795	1306206	91.954	0.884	667
07/06/09	1142424	1309299	47.594	0.873	2629
07/06/09	1143320	1310361	43.761	0.867	896
08/06/09	1144863	1312153	50.821	0.856	1543
09/06/09	1146048	1313549	84.882	0.874	1185
10/06/09	1147428	1315164	54.13	0.86	1380
14/06/09	1151422	1319848	53.824	0.858	3974
15/06/09	1152663	1321301	58.665	0.861	1241
16/06/09	1153279	1322021	69.596	0.847	616
17/06/09	1154166	1323076	55.539	0.843	887
19/06/09	1156275	1325577	51.11	0.837	2109
22/06/09	1158635	1328323	52.105	0.884	2360
23/06/09	1159594	1329394	67.562	0.887	959
28/06/09	1164067	1334456	58.487	0.897	4473
0107/09	1167017	1337824	39.364	0.857	2950
2/07/09	1167981	1338941	48.32	0.866	964
4/07/09	1169910	1341166	53.116	0.847	1929
6/07/09	1171497	1342990	49.579	0.876	1587
13/07/09	1178748	1351283	78.125	0.879	7281
12/08/09	1226464	1404865	140.18	0.922	47716
26/08/09	1251177	1422726	1397.6	0.898	24713
02/09/09	1262301	1445233	103.64	0.893	11124
03/09/09	1264459	1447651	80.771	0.859	2158
05/09/09	1267396	1457400	111.65	0.903	2937
09/09/09	1274728	1459203	80.231	0.853	7332

10/09/09	1276473	1461194	76.173	0.854	1745
11/09/09	1277377	1462236	79.04	0.852	904
12/09/09	1279270	1464461	64.122	0.84	1893
13/09/09	1280639	1466040	74.297	0.875	1369
14/09/09	1282385	1468012	86.564	0.888	1746
16/09/09	1285514	1471548	97.011	0.874	3129
17/09/09	1287006	1473239	93.892	0.879	1492
19/09/09	1289829	1476454	99.006	0.877	2833
20/09/09	1291428	1478267	93.685	0.879	1599
21/09/09	1292947	1479987	100.79	0.874	1519
22/09/09	1294625	1481897	99.364	0.879	1678
26/09/09	1300542	1488591	70.473	0.878	5917
27/09/09	1301597	1489806	63.478	0.864	1055
28/09/09	1302844	1491253	70.51	0.861	1247
29/09/09	1304407	1493032	94.838	0.864	1563
30/09/09	1305859	1494700	97.557	0.872	1452
04/10/09	1311543	1501216	77.116	0.84	5684
05/10/09	1313718	1503704	98.639	0.877	2175
07/10/09	1317374	1507853	92.029	0.863	3356
11/10/09	1324072	1515587	73.559	0.851	6698
12/10/09	1324771	1516408	92.3	0.686	699
12/10/09	1325787	1517582	72.974	0.846	1016
13/10/09	1327475	1519547	78.857	0.84	1688
14/10/09	1328922	1521218	66.708	0.849	1447
16/10/09	1330743	1523371	39.843	0.833	1821
18/10/09	1332237	1525183	39.289	0.833	1494
19/10/09	1333214	1526377	51.314	0.834	977
20/10/09	1334382	1527747	63.884	0.85	1168
21/10/09	1335808	1529417	64.437	0.842	1426
2210/09	1337065	1530879	69.438	0.854	1257

25/10/09	1340532	1534956	62.644	0.84	3467
26/10/09	134727	1536375	56.772	0.821	1195
27/10/09	1342847	1537688	56.362	0.831	1120
28/10/09	1343963	1538998	60145	0.837	1116
29/10/09	1345130	1540347	48.649	0.859	1167
02/11/09	1349261	1545226	47.531	0.801	4131
03/11/09	1350349	1546520	57.636	0.838	1133
04/11/09	1351600	1548004	60.235	0.828	1251
05/11/09	1352906	1549569	56.578	0.815	1306
07/11/09	1355233	1552336	58.213	0.831	2327
08/11/09	1356363	1553665	60.183	0.843	1130
09/11/09	1357579	1551118	61.494	0.852	1216
10/11/09	1358914	1556693	60.591	0.838	1335
12/11/09	1361468	1559698	62.37	0.828	2554
14/11/09	1363829	1562464	63.76	0.85	2361
15/11/09	1364974	1563806	57.21	0.834	1145
16/11/09	1366142	1565197	63.626	0.834	1168
17/11/09	1367498	1566802	64.65	0.831	1356
18/11/09	1368677	1568189	69.292	0.865	1179
19/11/09	1369997	1569729	68.476	0.845	1320
21/11/09	1372548	1572702	57.914	0.85	2551
22/11/09	1373687	1574010	59.254	0.852	1139
23/11/09	1374666	1575139	63.831	0.849	979
24/11/09	1375682	1576310	60.115	0.86	1016
25/11/09	1377025	1577886	64.76	0.857	1343
26/11/09	1378361	1579447	64.785	0.834	1336
27/11/09	1379445	1580702	59.594	0.847	1084
29/11/09	1381852	1583452	62.634	0.847	2407
30/11/09	1383043	1584830	63.989	0.851	1191
01/12/09	1384314	1586302	64.408	0.859	1271

02/12/09	1385579	1587775	67.365	0.845	1265
04/12/09	1388001	1590574	66.889	0.85	2422
05/12/09	1389163	1591917	61.466	0.864	1162
11/12/09	1395638	1599327	59.435	0.911	6475
19/12/09	1403020	1607950	40.856	0.834	7382
20/12/09	1403618	1608641	35.088	0.84	598
21/12/09	1404404	1609554	46.169	0.846	786
22/12/09	1405151	1610427	45.26	0.815	747
23/12/09	1405987	1611250	40.273	0.856	836
24/12/09	1406504	1611992	41.582	0.854	517
26/12/09	1408015	1613752	38.37	0.865	1511
27/12/09	1408700	1614547	40.796	0.852	685
29/12/09	1410157	1616236	42.265	0.86	1457
30/12/09	1410903	1617094	45.268	0.864	746
12/01/10	1424200	1631722	100.65	0.946	13297
11/02/10	1461825	1673115	52.983	0.837	37625
03/03/10	1483267	1697996	61.872	0.905	21442
04/03/10	1484560	1699527	65.042	0.886	1293
04/03/10	1485210	1700302	63.552	0.815	650
05/03/10	1486273	1701561	45.46	0.834	1063
06/03/10	1487092	1702534	48.69	0.89	819
06/03/10	1487578	1703099	62.933	0.819	486
07/03/10	1488788	1704468	66.836	0.822	1210
09/03/10	1490496	1706539	55.936	0.879	1708
10/03/10	1491555	1707782	59.852	0.87	1059
10/03/10	1492284	1708566	60.831	0.84	729
11/03/10	1492498	1708901	54.544	0.859	214
11/03/10	1492967	1709213	58.672	0.838	469
13/03/10	1495032	1711895	57.854	0.828	2065
15/03/10	1496592	1713737	63.885	0.85	1560

15/03/10	1496934	1714163	60.888	0.868	342
16/03/10	1498195	1715602	69.836	0.868	1262
17/03/10	1499225	171836	67.634	0.872	1030
18/03/10	1500544	1718331	76.235	0.864	1319
19/03/10	1501723	1769693	65.319	0.853	1179
20/03/10	1502846	1770204	60.666	0.866	1123
21/03/10	1503882	1771308	58.889	0.878	1036
22/03/10	1505171	1723705	58.648	0.863	1289
01/04/10	1518338	1738762	72.391	0.876	13167
02/04/10	1519994	1738762	75.541	0.862	1656
05/04/10	1522995	1740650	60.627	0.885	3001
08/04/10	1527491	1744099	103.31	0.889	4496
10/04/10	1531130	1749184	69.197	0.89	3639
23/04/10	1553877	1753302	78.932	0.883	22747
30/04/10	1565210			0.875	11333

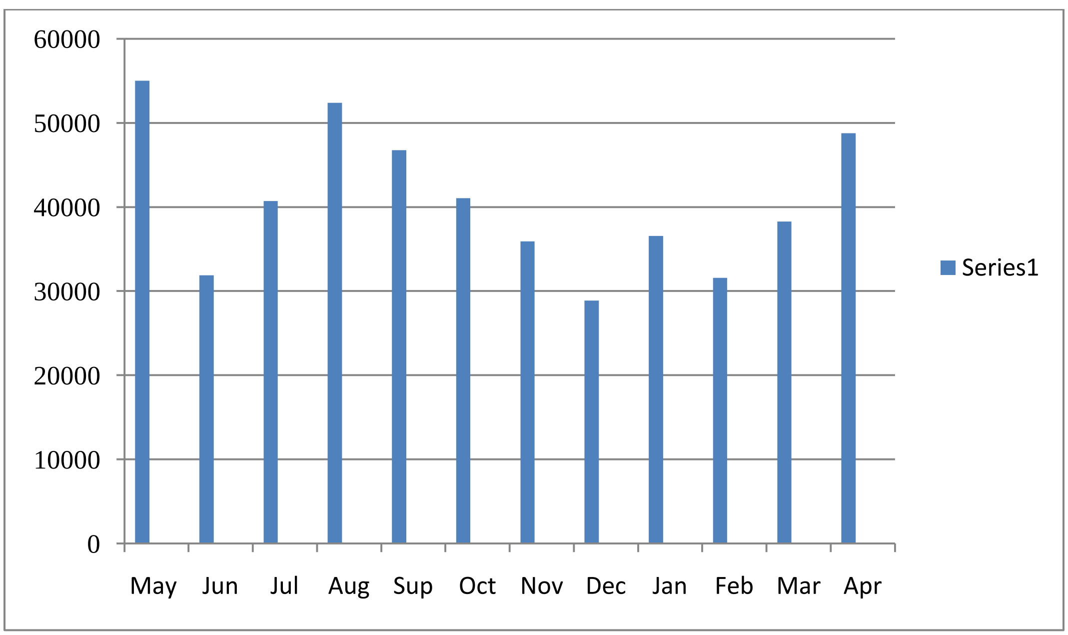


Fig 4.1 The bar chart electricity Consumption in Thapar university May 2009 - Apr2010.

The flowing data May 2009 to April 2010, take approximate value due to correct data error

	Month	Kwh		Month	Kwh
1	May 2009	54997	7	November 2009	35893
2	June 2009	31880	8	December 2009	28882
3	July 2009	40709	9	January 2010	36549
4	August 2009	52398	10	February 2010	31577
5	September 09	46746	11	March 2010	38288
6	October 2009	41036	12	April 2010	48772

Table 4.5 Monthly electricity Consumption in Thapar University

Power (electricity) Consumption per month = 487677÷12=40639.75Kwh/M

Power consumption per day = 487677÷365=1336.10137Kwh/d

Plant 1 is produce power generation 180KWH/D

Plant 2 to produce max power generation 180Kwh/D

Total power generation 360Kwh/d

Month	Consumption	Average
May	54997÷31	1774.0967
June	31880÷30	1062.6666
July	40709÷ 31	1313.1935
August	52398÷31	1690.258
September	46746÷30	1558.2
October	41036÷31	1323.7419
November	35893÷30	1196.4333
December	28882÷31	931.6774
January	36549÷31	1179
February	31577÷28	1127.75
March	38288÷31	1235.0967
April	48772÷30	1625.7333

Table 4.5 monthly peak value of power consumption

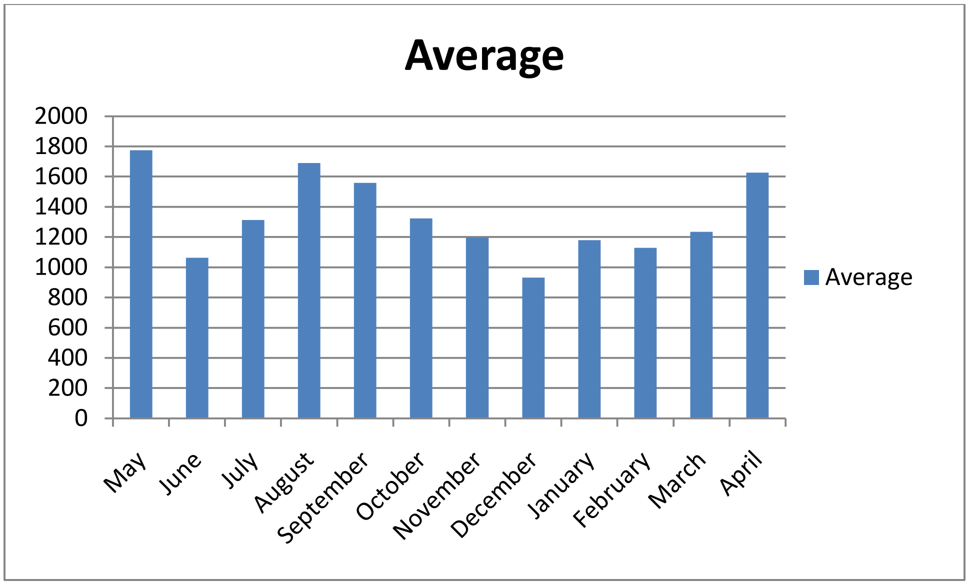


Fig 4.2 Average electricity consumption of the month

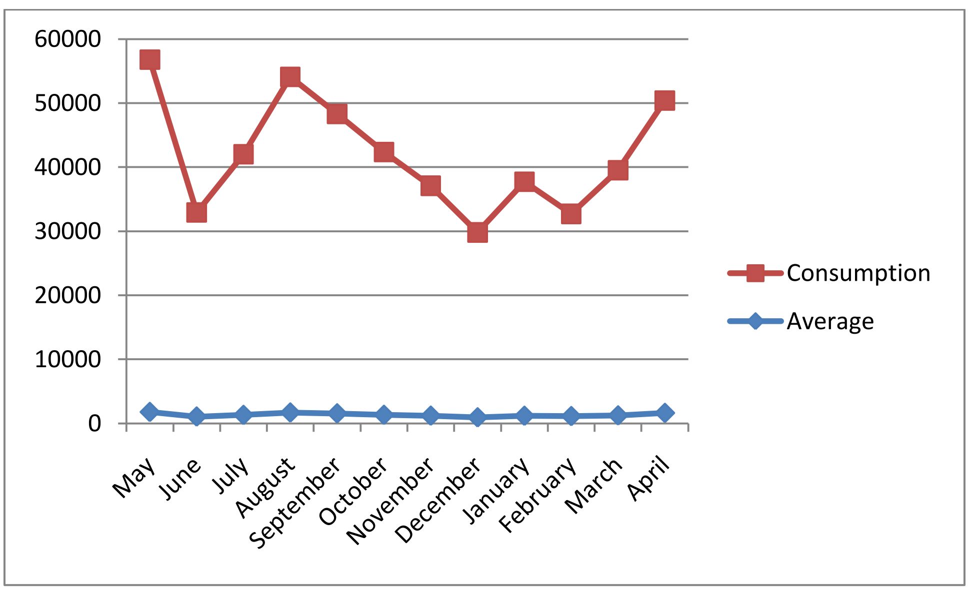


Fig 4.3 Average of the month with consumption of electricity

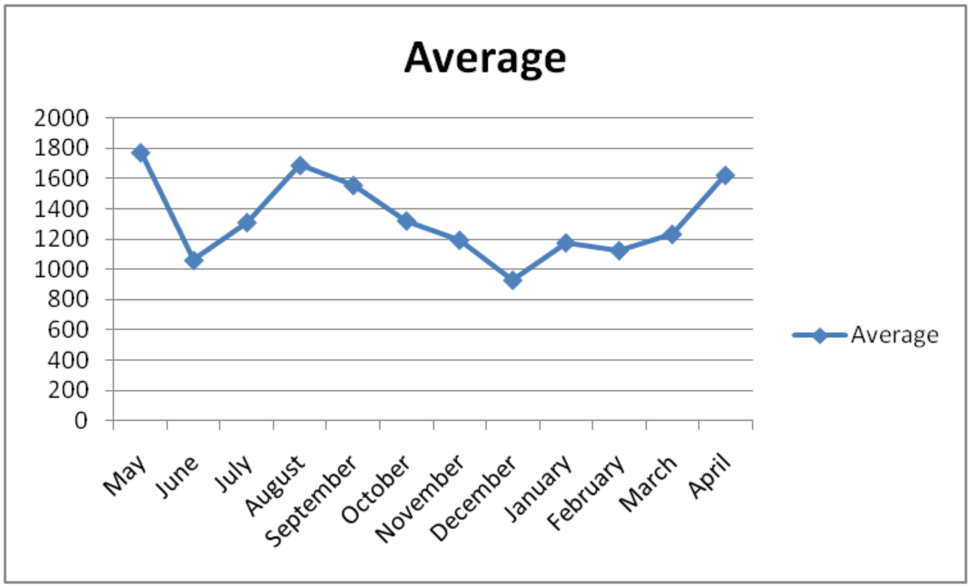


Fig 4.5 Max and min electricity consumption of months

4.2.2 Solar Electricity Generation

Solar electricity generation is being taken into account from the solar radiation data obtained as follows. The efficiency of the PV modules is considered to be 14.3%. The radiation data for the month of April has been given as a sample. The roof top BIPV systems will be considered in the different academic blocks of Thapar University campus.

Solar Radiation Data & Calculation of Average Output April 2010

Table : Solar Radiation Data & Calculation of Average Output April 2010 (Time: 9 AM)

Date	PV Module Efficiency	Solar Radiation (Watt/m^2)	Output (Watt/m^2)	Total Output (Watt/m^2)	Average Output (Watt/m^2)
01.04.2010		481.25	68.81875		
02.04.2010		498.125	71.231875		

03.04.2010		505	72.215		
04.04.2010		480.625	68.729375		
05.04.2010		499.375	71.410625		
06.04.2010		528.75	75.61125		
07.04.2010		575.625	82.314375		
08.04.2010		413.75	59.16625		
09.04.2010		509.375	72.840625		
10.04.2010	14.3%	511.875	73.198125	2034.443125	67.81477083
11.04.2010		499.375	71.410625		
12.04.2010		444.375	63.545625		
13.04.2010		551.25	78.82875		
14.04.2010		555	79.365		
15.04.2010		569.375	81.420625		
16.04.2010		514.375	73.555625		
17.04.2010		501.25	71.67875		
18.04.2010		343.75	49.15625		
19.04.2010		239.375	34.230625		
20.04.2010		479.375	68.550625		
21.04.2010		432.5	61.8475		
22.04.2010		450.625	64.439375		
23.04.2010		483.75	69.17625		
24.04.2010		316.875	45.313125		
25.04.2010		565.625	80.884375		

26.04.2010		531.25	75.96875		
27.04.2010		451.25	64.52875		
28.04.2010		479.375	68.550625		
29.04.2010		511.875	73.198125		
30.04.2010		302.5	43.2575		

Table: Solar Radiation Data & Calculation of Average Output April 2010 (10 AM)

Date	PV Module Efficiency	Solar Radiation (Watt/m^2)	Output (Watt/m^2)	Total Output (Watt/m^2)	Average Output (Watt/m^2)
01.04.2010		672.5	96.1675		
02.04.2010		693.75	99.20625		
03.04.2010		685.625	98.044375		
04.04.2010		651.875	93.218125		
05.04.2010		721.875	103.228125		
06.04.2010		719.375	102.870625		
07.04.2010		772.5	110.4675		
08.04.2010	14.3%	660.625	94.469375	2778.221875	92.60739583
09.04.2010		644.375	92.145625		
10.04.2010		724.375	103.585625		
11.04.2010		679.375	97.150625		
12.04.2010		612.5	87.5875		
13.04.2010		733.75	104.92625		

14.04.2010		721.25	103.13875		
15.04.2010		752.5	107.6075		
16.04.2010		678.75	97.06125		
17.04.2010		678.125	96.971875		
18.04.2010		291.875	41.738125		
19.04.2010		601.875	86.068125		
20.04.2010		627.5	89.7325		
21.04.2010		343.75	49.15625		
22.04.2010		605.625	86.604375		
23.04.2010		668.125	95.541875		
24.04.2010		613.75	87.76625		
25.04.2010		728.75	104.21125		
26.04.2010		684.375	97.865625		
27.04.2010		646.25	92.41375		
28.04.2010		616.25	88.12375		
29.04.2010		670	95.81		
30.04.2010		526.875	75.343125		

Table: Solar Radiation Data & Calculation of Average Output April 2010 (11 AM)

Date	PV Module Efficiency	Solar Radiation (Watt/m^2)	Output (Watt/m^2)	Total Output (Watt/m^2)	Average Output (Watt/m^2)
01.04.2010		808.75	115.65125		

02.04.2010		808.75	115.65125		
03.04.2010		801.25	114.57875		
04.04.2010		770.625	110.199375		
05.04.2010		861.25	123.15875		
06.04.2010		857.5	122.6225		
07.04.2010		913.75	130.66625		
08.04.2010	14.3%	809.375	115.740625	3333.776875	111.1258958
09.04.2010		820	117.26		
10.04.2010		862.5	123.3375		
11.04.2010		819.375	117.170625		
12.04.2010		733.125	104.836875		
13.04.2010		866.25	123.87375		
14.04.2010		881.875	126.108125		
15.04.2010		866.875	123.963125		
16.04.2010		791.875	113.238125		
17.04.2010		803.75	114.93625		
18.04.2010		543.75	77.75625		
19.04.2010		589.375	84.280625		
20.04.2010		737.5	105.4625		
21.04.2010		642.5	91.8775		
22.04.2010		710.625	101.619375		
23.04.2010		786.25	112.43375		
24.04.2010		830	118.69		

25.04.2010		876.875	125.393125		
26.04.2010		825.625	118.064375		
27.04.2010		765.625	109.484375		
28.04.2010		683.75	97.77625		
29.04.2010		780	111.54		
30.04.2010		464.375	66.405625		

Table: Solar Radiation Data & Calculation of Average Output April 2010 (12 NOON)

Date	PV Module Efficiency	Solar Radiation ($Watt/m^2$)	Output ($Watt/m^2$)	Total Output ($Watt/m^2$)	Average Output ($Watt/m^2$)
01.04.2010		840	120.12		
02.04.2010		860.625	123.069375		
03.04.2010		866.875	123.963125		
04.04.2010		846.25	121.01375		
05.04.2010		928.125	132.721875		
06.04.2010		927.5	132.6325		
07.04.2010		961.875	137.548125		
08.04.2010	14.3%	838.125	119.851875	3517.531875	117.2510625
09.04.2010		845.625	120.924375		
10.04.2010		798.75	114.22125		
11.04.2010		871.875	124.678125		
12.04.2010		811.25	116.00875		

13.04.2010		921.25	131.73875		
14.04.2010		920	131.56		
15.04.2010		940.625	134.509375		
16.04.2010		856.875	122.533125		
17.04.2010		842.5	120.4775		
18.04.2010		528.75	75.61125		
19.04.2010		571.25	81.68875		
20.04.2010		778.75	111.36125		
21.04.2010		452.5	64.7075		
22.04.2010		735	105.105		
23.04.2010		866.875	123.963125		
24.04.2010		866.875	123.963125		
25.04.2010		923.125	132.006875		
26.04.2010		880	125.84		
27.04.2010		795.625	113.774375		
28.04.2010		708.75	101.35125		
29.04.2010		828.125	118.421875		
30.04.2010		784.375	112.165625		

Table : Solar Radiation Data & Calculation of Average Output April 2010 (1 PM)

Date	**PV Module Efficiency**	**Solar Radiation (Watt/m^2)**	**Output (Watt/m^2)**	**Total Output (Watt/m^2)**	**Average Output (Watt/m^2)**
01.04.2010		865.625	123.784375		

02.04.2010		839.375	120.030625		
03.04.2010		857.5	122.6225		
04.04.2010		817.5	116.9025		
05.04.2010		914.375	130.755625		
06.04.2010		883.75	126.37625		
07.04.2010		907.5	129.7725		
08.04.2010	14.3%	806.25	115.29375	3451.036875	115.0345625
09.04.2010		881.25	126.01875		
10.04.2010		780.625	111.629375		
11.04.2010		829.375	118.600625		
12.04.2010		793.75	113.50625		
13.04.2010		897.5	128.3425		
14.04.2010		892.5	127.6275		
15.04.2010		883.125	126.286875		
16.04.2010		851.25	121.72875		
17.04.2010		843.75	120.65625		
18.04.2010		543.125	77.666875		
19.04.2010		551.25	78.82875		
20.04.2010		746.25	106.71375		
21.04.2010		534.375	76.415625		
22.04.2010		687.5	98.3125		
23.04.2010		900	128.7		
24.04.2010		857.5	122.6225		

25.04.2010		905	129.415		
26.04.2010		854.375	122.175625		
27.04.2010		775.625	110.914375		
28.04.2010		720	102.96		
29.04.2010		779.375	111.450625		
30.04.2010		733.75	104.92625		

Table: Solar Radiation Data & Calculation of Average Output April 2010 (2 PM)

Date	PV Module Efficiency	Solar Radiation (Watt/m^2)	Output (Watt/m^2)	Total Output (Watt/m^2)	Average Output (Watt/m^2)
01.04.2010		780	111.54		
02.04.2010		702.5	100.4575		
03.04.2010		753.75	107.78625		
04.04.2010		740.625	105.909375		
05.04.2010		731.25	104.56875		
06.04.2010		798.125	114.131875		
07.04.2010		816.25	116.72375		
08.04.2010	14.3%	678.75	97.06125	3087.37	102.9123333
09.04.2010		800.625	114.489375		
10.04.2010		625.625	89.464375		
11.04.2010		736.25	105.28375		
12.04.2010		746.875	106.803125		

13.04.2010		805	115.115		
14.04.2010		781.875	111.808125		
15.04.2010		783.125	111.986875		
16.04.2010		741.25	105.99875		
17.04.2010		746.25	106.71375		
18.04.2010		704.375	100.725625		
19.04.2010		598.125	85.531875		
20.04.2010		634.375	90.715625		
21.04.2010		450.625	64.439375		
22.04.2010		626.875	89.643125		
23.04.2010		818.125	116.991875		
24.04.2010		750	107.25		
25.04.2010		785.625	112.344375		
26.04.2010		755.625	108.054375		
27.04.2010		685.625	98.044375		
28.04.2010		665	95.095		
29.04.2010		695.625	99.474375		
30.04.2010		651.875	93.218125		

Table: Solar Radiation Data & Calculation of Average Output April 2010 (3 PM)

Date	PV Module Efficiency	Solar Radiation (Watt/m^2)	Output (Watt/m^2)	Total Output (Watt/m^2)	Average Output (Watt/m^2)

01.04.2010		609.375	87.140625		
02.04.2010		491.25	70.24875		
03.04.2010		578.125	82.671875		
04.04.2010		576.25	82.40375		
05.04.2010		566.25	80.97375		
06.04.2010		620.625	88.749375		
07.04.2010		639.375	91.430625		
08.04.2010	14.3%	540	77.22	2301.2275	76.70758333
09.04.2010		610	87.23		
10.04.2010		405	57.915		
11.04.2010		563.75	80.61625		
12.04.2010		555.625	79.454375		
13.04.2010		626.875	89.643125		
14.04.2010		615	87.945		
15.04.2010		623.125	89.106875		
16.04.2010		526.875	75.343125		
17.04.2010		583.125	83.386875		
18.04.2010		573.75	82.04625		
19.04.2010		450	64.35		
20.04.2010		488.75	69.89125		
21.04.2010		340	48.62		
22.04.2010		466.875	66.763125		
23.04.2010		631.25	90.26875		

24.04.2010		588.125	84.101875		
25.04.2010		611.25	87.40875		
26.04.2010		583.125	83.386875		
27.04.2010		416.875	59.613125		
28.04.2010		511.25	73.10875		
29.04.2010		371.875	53.178125		
30.04.2010		328.75	47.01125		

Table: Solar Radiation Data & Calculation of Average Output April 2010 (4 PM)

Date	PV Module Efficiency	Solar Radiation (Watt/m^2)	Output (Watt/m^2)	Total Output (Watt/m^2)	Average Output (Watt/m^2)
01.04.2010		383.75	54.87625		
02.04.2010		215.625	30.834375		
03.04.2010		378.125	54.071875		
04.04.2010		373.125	53.356875		
05.04.2010		367.5	52.5525		
06.04.2010		396.875	56.753125		
07.04.2010		430	61.49		
08.04.2010	14.3%	223.125	31.906875	1380.933125	46.03110417
09.04.2010		395.625	56.574375		
10.04.2010		361.875	51.748125		
11.04.2010		366.25	52.37375		

12.04.2010		367.5	52.5525		
13.04.2010		418.125	59.791875		
14.04.2010		393.125	56.216875		
15.04.2010		411.25	58.80875		
16.04.2010		335.625	47.994375		
17.04.2010		310.625	44.419375		
18.04.2010		295	42.185		
19.04.2010		253.75	36.28625		
20.04.2010		334.375	47.815625		
21.04.2010		221.25	31.63875		
22.04.2010		276.25	39.50375		
23.04.2010		422.5	60.4175		
24.04.2010		390.625	55.859375		
25.04.2010		397.5	56.8425		
26.04.2010		383.75	54.87625		
27.04.2010		120	17.16		
28.04.2010		258.125	36.911875		
29.04.2010		172.5	24.6675		
30.04.2010		3.125	0.446875		

The possible plant rating is then considered

Peak Variation & Possible Plant Rating

Months	Peak Output ($Watt/m^2$)	Average Peak Output ($Watt/m^2$)
September	102.9467593	
October	98.17016204	
November	71.46425	
December	56.93546	94.66075866
January	60.228025	
February	96.72928571	
March	115.8357661	
April	117.2510625	

Load Calculation of different blocks

The load calculations for the different blocks are tabulated below:

Table: Load Calculation for E-Block

Room No.	Fans	Tube Lights	Power Plugs	Total Load
E-101	6 × 80 = 480 W	10 × 40 = 400 W	1 × 1 = 1 KW	1.88 KW
E-102	6 × 80 = 480 W	10 × 40 = 400 W	1 × 1 = 1 KW	1.88 KW
E-103	6 × 80 = 480 W	10 ×40 = 400 W	1 × 1 = 1 KW	1.88 KW
E-104	6 × 80 = 480 W	10 × 40 = 400 W	1 × 1 = 1 KW	1.88 KW
E-105	6 × 80 = 480 W	10 × 40 = 400 W	1 × 1 = 1 KW	1.88 KW
E-106	6 × 80 = 480 W	10 × 40 = 400 W	1 × 1 = 1 KW	1.88 KW

E-107	6 × 80 = 480 W	10 ×40 = 400 W	1 × 1 = 1 KW	1.88 KW
E-108	6 × 80 = 480 W	10 × 40 = 400 W	1 × 1 = 1 KW	1.88 KW
E-201	5 × 80 = 400 W	8 × 40 = 320 W		720 W
E-203	5 × 80 = 400 W	8 × 40 = 320 W		720 W
E-204	5 × 80 = 400 W	8 × 40 = 320 W		720 W
E-205	5 × 80 = 400 W	8 × 40 = 320 W		720 W
E-206	5 × 80 = 400 W	8 × 40 = 320 W		720 W
E-207	5 × 80 = 400 W	8 × 40 = 320 W		720 W
E-208	5 × 80 = 400 W	8 × 40 = 320 W		720 W
E-209	5 × 80 = 400 W	8 × 40 = 320 W		720 W
E-210	5 × 80 = 400 W	8 × 40 = 320 W		720 W
E-211	5 × 80 = 400 W	8 × 40 = 320 W		720 W
E-212	5 × 80 = 400 W	8 × 40 = 320 W		720 W

Table: Load Calculation for F-Block

Room No.	Fans	Tube Lights	Power Plugs	Total Load
F-102	9 × 80 = 720 W	12 × 40 = 480 W	1 × 1 = 1 KW	2.2 KW
F-103	9 ×80 = 720 W	12 × 40 = 480 W	1 × 1 = 1 KW	2.2 KW
F-104	9 × 80 = 720 W	12 × 40 = 480 W	1 × 1 = 1 KW	2.2 KW
F-105	9 × 80 = 720 W	12 × 40 = 480 W	1 × 1 = 1 KW	2.2 KW
F-106	9 × 80 = 720 W	12 × 40 = 480 W	1 × 1 = 1 KW	2.2 KW
F-107	6 ×80 = 480 W	16 × 40 = 640 W	1 × 1 = 1 KW	2.2 KW
F-201	9 × 80 = 720 W	14 ×40 = 560 W		1280 W
F-202	9 × 80 = 720 W	14 × 40 = 560 W		1280 W
F-203	9 × 80 = 720 W	14 ×40 = 560 W		1280 W
F-204	9 × 80 = 720 W	14 × 40 = 560 W		1280 W
F-205	9 × 80 = 720 W	14 × 40 = 560 W		1280 W
F-206	9 × 80 = 720 W	14 × 40 = 560 W		1280 W
F-207	9 × 80 = 720 W	14 × 40 = 560 W		1280 W
F-208	9 × 80 = 720 W	14 × 40 = 560 W		1280 W

Table: Load Calculation for B-Block

Room No.	Fans	Tube Lights	ACs	Computers & Accessories	Coolers	Power Plugs	Total Load
B-106	12 × 80 =960 W	12×40 =480 W					1440 W
B-107	5 × 80 =400 W	6 × 40 =240 W					640 W

B-108	1 × 80 =80W	2 × 40 =80 W					160 W
B-108A	1 × 80 =80W	2 × 40 =80 W					160 W
B-109	5 × 80 =400 W	6 × 40 =240 W					640 W
B-110	1 × 80 =80W	2 × 40 =80 W		1 × 300 =300W	1 × 200 =200 W		660 W
B-111	5 × 80 =400 W	10 × 40 =400 W					800 W
B-201	8 × 80 =640 W	7 × 40 =280 W		8 × 300 =2400W	3 × 200 =600 W	1 × 1 =1KW	4.92 KW
B-202	9 × 80 =720 W	7 × 40 =280 W	1×2 =2KW	8 × 300 =2.4KW	1 × 200 =200 W	1 × 1 =1KW	6.6 KW
B-203	8 × 80 =640 W	8 × 40 =320 W		10 × 300= 3KW	2 × 200 =400 W	1 × 1 =1KW	5. 36 KW
B-204	1 × 80 =80W	2 × 40 =80 W					160 W
B-205A	1 × 80 =80W	2 × 40 =80 W					160 W
B-205	2 × 80 =160 W	2 × 40 =80 W		1 × 300 =300W			540 W
B-206	2 × 80 =160 W	8 × 40 =320 W	1×2 =2KW	1 × 300 =300W			2.78 KW
B-207	2 × 80 =160 W	2 × 40 =80 W		1 × 300 =300W			540 W
B-208	2 × 80 =160 W	2 × 40 =80 W		1 × 300 =300W			540 W
B-209	4 × 80 =320 W	4 × 40 =160 W		4 × 300 =1200W			1360 W

Table: Load Calculation for Link between B and C Block

Room No.	Fans	Tube Lights	ACs	Computers & Accessories	Coolers	Power Plugs	Total Load
L-107	1 × 80 =80 W	2 × 40 =80 W		1 × 300= 300 W			460 W
L-107A	1 × 80 =80 W	2 × 40 =80 W		1 × 300 = 300W			460 W
L-108	2 × 80 =160 W	3 × 40 =120 W		1 × 300 = 300W			580 W
L-109	2 × 80 =160 W	8 × 40 =320 W	1×2 =2KW	1 × 300 = 300W			2.78 KW
L-110	1 × 80 =80 W	2 × 40 =80 W					160 W
L-111	1 × 80 =80 W	1 × 40 =40 W					120 W

L-111A	1 × 80 =80 W	2 × 40 =80 W		1 × 300 = 300W			460 W
L-112	1 × 80 =80 W	1 × 40 =40 W					120 W
L-112A	1 × 80 =80 W	1 × 40 =40 W					120 W
L-208	2 × 80 =160 W	2 × 40 =80 W			1 × 200 =200 W		440 W
L-208A	2 × 80 =160 W	6 × 40 =240 W		2 × 300 = 600W		1 × 1 =1KW	2 KW
L-209	2 × 80 =160 W	2 × 40 =80 W		1 × 300 = 300W			540 W
L-211	2 × 80 =160 W	2 × 40 =80 W		1 × 300 = 300W			540 W
L-212	2 × 80 =160 W	2 × 40 =80 W		1 × 300 = 300W			540 W
L-213	2 × 80 =160 W	2 × 40 =80 W		2 × 300 = 600W			840 W
L-214	2 × 80 =160 W	2 × 40 =80 W		1 × 300 = 300W			540 W

Table: Load Calculation for C Block

Room No.	Fans	Tube Lights	ACs	Computers & Accessories	Power Plugs	Total Load
C-103	3 × 80 =240 W	4 × 40 =160 W	1 × 2 = 2 KW		1 × 1 =1KW	3.4 KW
C-104	5 × 80 =400 W	6 × 40 =240 W				640 W
C-105	1 × 80 =80 W	2 × 40 =80 W				160 W
C-105A	1 × 80 =80 W	2 × 40 =80 W				160 W
C-106	1 × 80 =80 W	1 × 40 =40 W		1 × 300 =300W		420 W
C-107	1 × 80 =80 W	1 × 40 =40 W		1 × 300 =300W		420 W
C-108	2 × 80 =160 W	3 × 40 =120 W		1 × 300 =300W		580 W
C-109	2 × 80 =160 W	8 × 40 =320 W	1 × 2 =2KW	1 × 300 =300W		2.78KW
C-110	1 × 80 =80 W	1 × 40 =40 W				120 W

Table: Load Calculation for Link between C and D Block

Room No.	Fans	Tube Lights	Computers & Accessories	Coolers	Total Load
1	2 × 80 =160 W	8 × 40 =320 W	2 × 300= 600W	1 × 200 =200 W	1280 W
2	2 × 80 =160 W	8 × 40 =320 W	2 × 300 =600W	1 × 200 =200 W	1280 W
3	2 × 80 =160 W	8 × 40 =320 W	2 × 300 = 600W	1 × 200 =200 W	1280 W
4	2 × 80 =160 W	8 × 40 =320 W	2 × 300= 600W	1 × 200 =200 W	1280 W
5	2 × 80 =160 W	8 × 40 =320 W	2 × 300 = 600W	1 × 200 =200 W	1280 W
6	2 × 80 =160 W	8 × 40 =320 W	2 × 300 = 600W	1 × 200 =200 W	1280 W
7	2 × 80 =160 W	8 × 40 =320 W	2 × 300 = 600W	1 × 200 =200 W	1280 W
8	2 × 80 =160 W	8 × 40 =320 W	2 × 300 = 600W	1 × 200 =200 W	1280 W
9	2 × 80 =160 W	8 × 40 =320 W	2 × 300 = 600W	1 × 200 =200 W	1280 W
10	2 × 80 =160 W	8 × 40 =320 W	2 × 300 = 600W	1 × 200 =200 W	1280 W
11	2 × 80 =160 W	8 × 40 =320 W	2 × 300 = 600W	1 × 200 =200 W	1280 W

Table: Load Calculation for D Block

Room No.	Fans	Tube Lights	Total Load
D-201	11 × 80 = 880 W	12 × 40 = 480 W 14 × 10 = 140 W	1500 W
D-202	11 × 80 = 880 W	12 × 40 = 480 W 28 × 10 = 280 W	1640 W
D-203	5 × 80 = 400 W	20 × 10 = 200 W	600 W
D-204	5 × 80 = 400 W	22 × 10 = 220 W	620 W
D-205	6 × 80 = 480 W	16 × 40 = 640 W	1120 W
D-206	11× 80 = 880 W	28 × 40 = 1120 W	2000 W
D-207	6 × 80 = 480 W	11 × 40 = 440 W	920 W

Table: Energy Consumption of Each Block

Name of Block	Total Load (KW)	Energy Consumption per day (KW-hr)	Energy Consumption per month (KW-hr)
E	22.96	137.76	3030.72
F	23.36	140.16	3083.52
B	27.46	164.76	3624.72
Link between B & C	10.7	64.2	1412.4
C	8.68	52.08	1145.76
Link between C & D	14.08	84.48	1858.56
D	8.4	50.4	1108.8

Roof Area of different Blocks

Roof Area of E-block

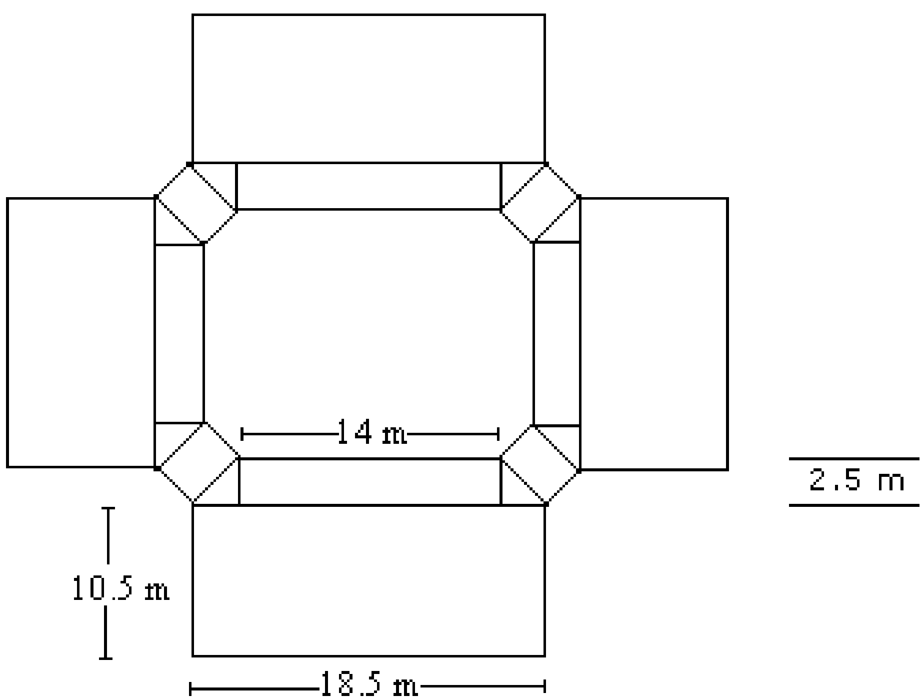


Fig. () Map of E -block

Total roof area = $(14 \times 2.5 \times 4) + (10.5 \times 18.5 \times 4) = 917\ m^2$

Roof Area of F-block

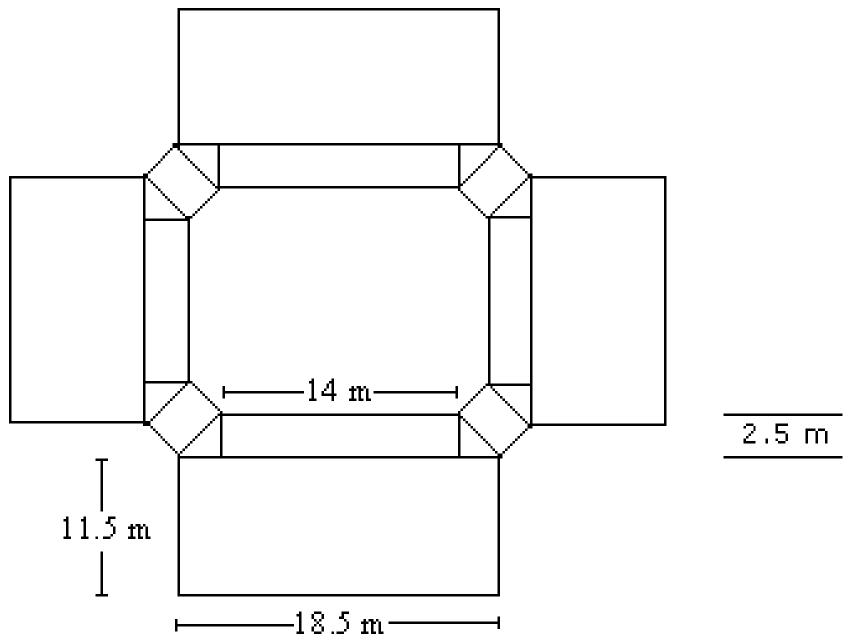


Fig.(4.1) Map of F -block

Total roof area = $(14 \times 2.5 \times 4) + (11.5 \times 18.5 \times 4) = 991\ m^2$

Roof Area of B, C and D-blocks

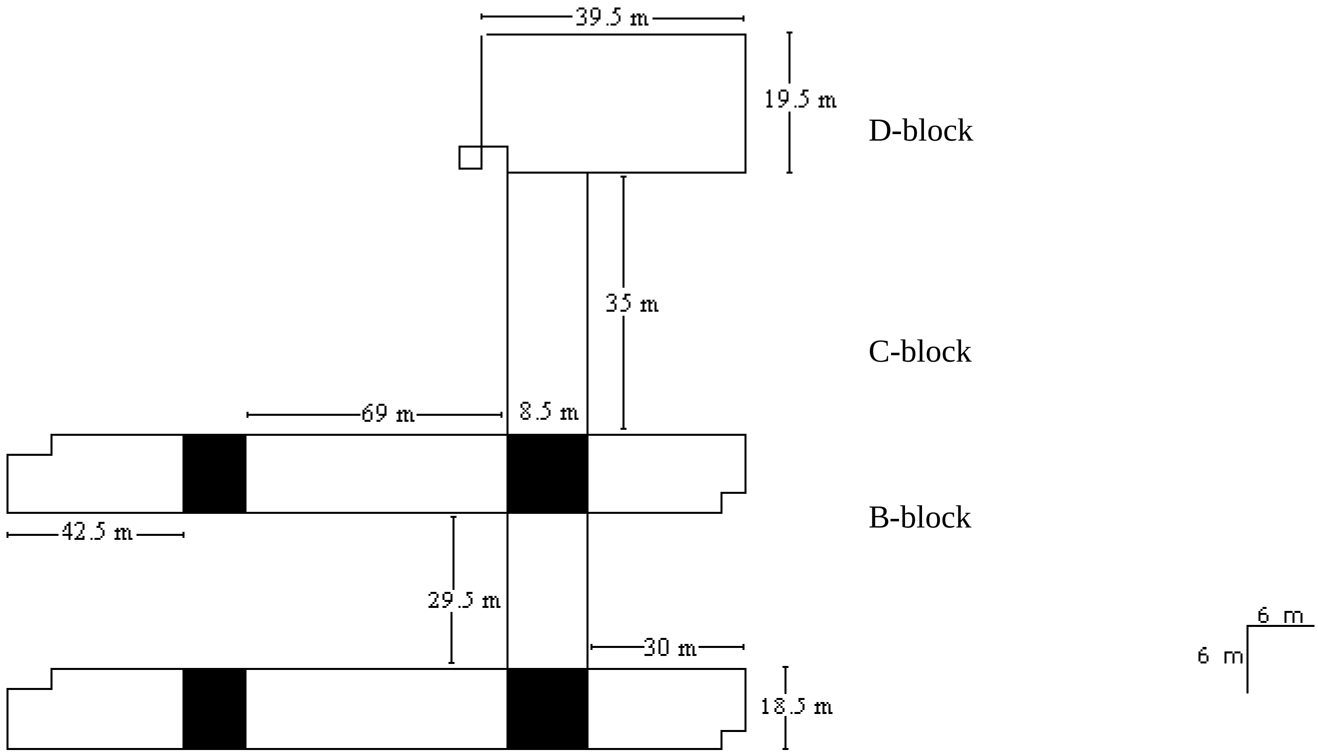


Fig.(4.3) Map of B, C and D -block

Area of B-block = 519 m^2

Area of C-block = 519 m^2

Area of D-block = 734 m^2

Area of link between B and C blocks = 250 m^2

Area of link between C and D blocks = 297 m^2

Energy Calculations

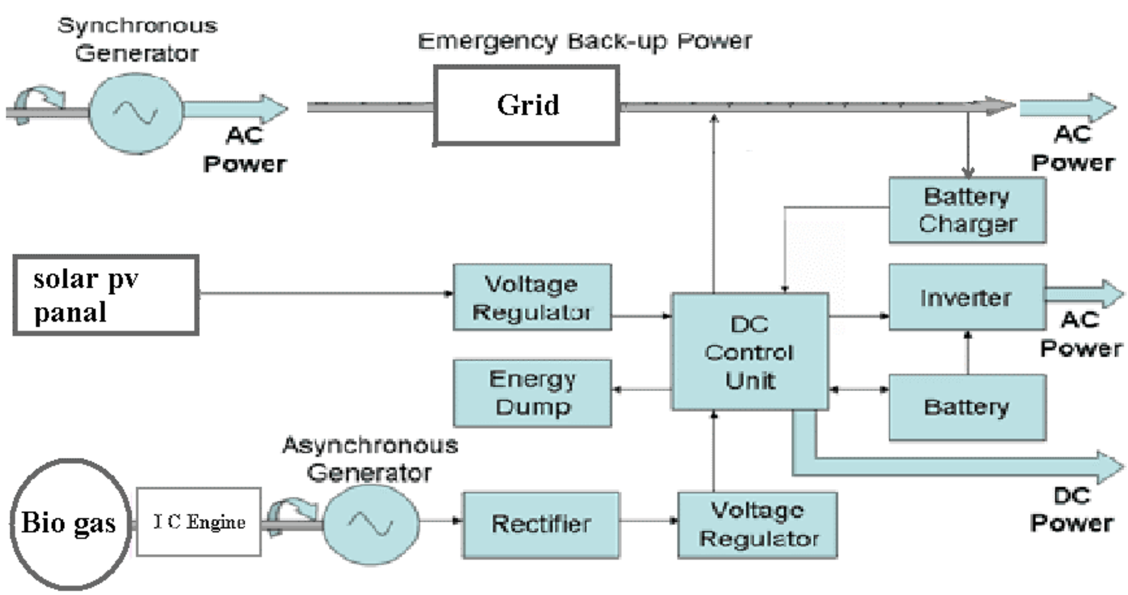
Table: Energy generated from each Block

Total energy generated from each block = Effective area × Average peak output

Name of Block	Available Area (m^2)	Effective Area (m^2)	Average Peak Output (W/m^2)	Possible Plant Capacity (KW)	Energy Generated per day (KW-hr)	Energy Generated per month (KW-hr)
E	917	733		69	414	12420
F	991	792		74	444	13320
B	519	415		39	234	7020
Link between B and C	250	200	94.66075866	18	108	3240
C	519	415		39	234	7020
Link between C and D	297	237		22	132	3960
D	734	587		55	330	9900

4.3**Hybrid system**

Hybrid systems are usually a combination of photovoltaic with wind turbines and/or generators running on diesel or bio fuels/biogas is also used. Power generated by the PV array during the day is stored in the battery bank through an energy manager, which controls the complete system. Diesel generators are expensive to run, and may also require frequent maintenance support. A judicious mix of solar and other renewable technologies, coupled with a diesel generator / grid, can offer a techno-commercially viable solution that will power the backbone of rural connectivity. The resultant hybrid system thus offers an optimal solution at a substantially lower cost. It is ideal for electrification of remote villages in India. Cutting edge technologies based on latest research to integrate dual power sources in the most ideal way.



Hybrid Power System

Fig.4.6 A hybrid PV system

The other form of power generation is usually a type which is able to modulate power output as a function of demand. India is equipped to offer reliable off-grid and hybrid solutions for all energy needs for small area/ especially rural area, where powering critical loads are often a challenge. However more than one form of renewable energy to be used, e.g. wind/geo-thermal and solar/biomass/biogas. The photovoltaic power generation serves to reduce the consumption of non renewable fuel.

4.3.1 How does it work?

The solar generation is combining with biogas generation. The output is stored in the battery bank. This energy is drawn by the electrical loads through the inverter, which converts DC power into AC power. The inverter has in-built protection against short-circuit, overheating, low battery voltage and overload. The battery bank is designed to feed the loads up to a certain number of days with no sun or wind/biogas, depending upon the system requirement.

The solar panel is the power source of all photovoltaic installation. Photovoltaic (PV) are solid-state, semi-conductor type devices that produce electricity when exposed to light. The word photovoltaic actually means "electricity from light." Many hand-held calculators run off power from room light, which would be one example of this phenomenon. Larger power applications for this technology are also possible.

Prime over system is running by I.C. Engines use of biogas in diesel engines. Existing diesel engines can be modified to run on dual fuel while still retaining the ability to use diesel fuel only, Petrol engines: These engines can run on 100% biogas

Biogas is a type of gas that is formed by the biological breakdown of organic matter in an oxygen deficient environment. It is counted as an eco-friendly bio-fuel. Biogas contains 60% methane and carbon dioxide. It can be employed for generating electricity and also as automotive fuel. Biogas can be used as a substitute for compressed natural gas (CNG) or liquid petroleum gas (LPG).

Biogas power plant are produce following generation;-

Plant 1 is produce power generation 180KWH/D

Plant 2 to produce max power generation 180Kwh/D

Total power generation 360Kwh/d

Solar power plant are produce following generation;- The efficiency of the PV modules is considered to be 14.3%. The radiation data for the month of April has been given as a sample. The roof top BIPV systems will be considered in the different academic blocks of Thapar University campus total generation It is not fulfill the demand of one day 1336Kwh/d so we are connect grid but some load sharing which is use full to reduce load from grid.

4.4CONCLUSION

Hybrid system is design of power generation with renewable energy resource. This is alone and unique system produces a sufficient amount of generation which is meet demand of Thapar University and small areas. Hybrid system is a system which is fully used of over energy resource and gives healthy environment. The advantages of biogas are manifold. Biogas by itself can positively affect the economy of rural areas and give us clean environment. systems will be considered in the different academic blocks of Thapar University campus total generation It is not fulfill the demand of one day 1336Kwh/d so we are connect grid but some load sharing which is use full to reduce load from grid.

Chapter 5

CONCLUSION AND FUTURE SCOPE OF WORK

5.1 Conclusion

To promote efficient technologies which could meet / supplement the energy demands of the people with locally available renewable energy Sources. We are tried to develop the solar/biogas hybrid system will independently provide a stable power source and daily gas for Thapar University/small area. Hybrid system will independently provide a stable power source from biogas and solar energy. We are trying to economical evaluation of Hybrid Systems for electricity production. Larger biogas plants generate and feed electricity into mainstream power grids. Smaller biogas production units can support lighting and cooking requirements.

5.2 Future scope of work

Drawbacks in biogas plant operation;
An important drawback in popularizing biogas production is the high initial capital investment. It Has been shown that in countries that have abundant forests (like India) show little success with digesters for small farms since the farmers cannot afford the high cost of initial investment of equipment. Methane forming bacteria are highly sensitive to thermal variations, therefore close monitoring of temperature is required. In large centralized farms, transportation of manure can be expensive. Farm labor that may be employed elsewhere is required for regular and unscheduled maintenance. This may pose a problem in farms where there are few hands. Overall, technical knowledge of the digestion and electric power generation process and good management are required for profitable operation. Also, anaerobic digesters can be farm safety hazard. Because the anaerobic digesters are designed to seal out oxygen, death by asphyxiation is a possibility. Toxic gases like hydrogen sulfide and ammonia tend to accumulate inside a digester. Therefore, extensive safety mechanisms have to be set up to prevent mishaps. Such safety features further increase the cost of operation of the plan.

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