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Entitled

**ENERGY ANALYSIS OF THAPAR UNIVERSITY
CAMPUS**

Submitted in partial fulfilment of the requirement

For the award of degree of

Masters of Technology

In

Energy Technology and Management

By

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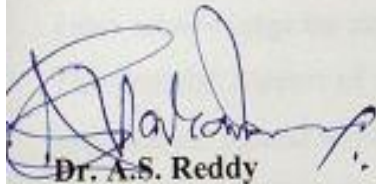


**SCHOOL OF ENERGY AND ENVIRONMENT
THAPAR UNIVERSITY, PATIALA
(Declared as Deemed-to-be-University u/s 3 of the UGC Act, 1956)
JULY 2016**

CERTIFICATE

This is to certify that thesis entitled, “Energy Analysis of Thapar University Campus ” submitted by **Vineet saxena** in partial fulfilment of the requirements for the award of degree of **Masters of Technology in Energy Technology and Management** at **Thapar University, Patiala** is an authentic work carried out by him under my supervision and guidance.

To the best of my knowledge, the matter embodied in this thesis has not been submitted in part or full to any other university/ institute for award of any Degree.



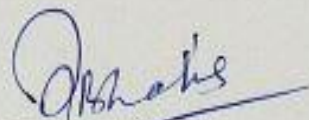
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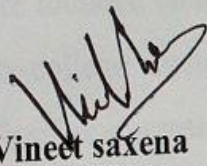
Thank you for making this a reality.

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DECLARATION

I, the undersigned, hereby declare that the research work presented in this thesis entitled “**Energy Analysis of Thapar University Campus**” submitted for the award of the degree of Masters in Technology has been carried out by me under the supervision and guidance of **Dr. A. S. Reddy, School of Energy and Environment, Thapar University, Patiala.**

Further, I declare that no part of this Dissertation has been submitted for a degree or any other qualification of any other university or examining body in India or abroad.



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ABSTRACT

An energy audit provides a path to determine how and where energy is wasted and to identify method of energy conservation. College and universities regarded as a small town due to their large area, various activities taking place in university campus, which effected the energy consumption. Energy analysis of educational institute presented in this thesis work takes into account the yearly electricity consumption by different systems and electricity bills. Energy analysis in dissertation is focused on energy conservation by using advanced technology systems. Energy analysis of Thapar University campus is completed and various weak areas are founded on account of energy wastage. In this dissertation, several methods are suggested to college management to reduce energy wastage. In this dissertation design of Micro Gasifier suggested which is environment friendly and it reduces LPG consumption in hostels.

Keywords: Energy Analysis, Energy Management Plan, Design of Micro Gasifier

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1.1 Overview

Energy plays an important and effective role in our daily activities. Energy utilization by human being shows degree of civilization and development of a country. Due to increase in population, urbanization and industrialization energy demand is increasing. Now energy conservation is a main concern. The whole world is going towards the path of energy saving. The idea energy conservation and management starts from power plant (generation), through transmission and goes on up to the distribution system. Energy conservation is not only good for country's growth but also maintain sustainable environment. Worldwide maximum electricity generated by coal, combustion of coal is not good for environment. Distance between energy demand and supply is regularly increased. This gap can be reduced by energy management and energy auditing. Energy management and auditing is a best approach for energy conservation. By doing energy auditing wastage of energy can be reduces. Now day's energy conservation is a big issue because fossil fuel reserved decreases day by day. In upcoming years renewable source of energy full fill the requirement of energy. Electrical energy can be utilized with minimum losses after once being produced. Unfortunately, it represents a highly refined form of energy that is normally produced through a variety of relatively inefficient generation cycles. Roughly two-thirds of the original energy available in a fossil or atomic fuel is dissipated as waste heat to the atmosphere. Obviously, there is little to be gained by improving a motor or transformer's efficiency one or two percent when they are already well over 90 percent efficient.

Combustion is the most developed and most frequently applied process used for solid biomass fuels because of its low cost and high reliability. It is estimated that three billion people worldwide cook with traditional stoves. These stoves generally consist of three stones and an open fire and produce harmful emissions that are known to cause fatal illnesses [1].The interest in using biomass residue pellets for heating purposes is increasing. Clean and dry residue pellets are an ideal fuel for combustion in small-scale installations. Micro gasifier stoves are very useful to burn solid biomass. Micro gasification technology have a good efficiency [2].Micro gasifier convert dry biomass to wood gas and charcoal before the gas is burned. This gasification process needs heat and the absence of oxygen. The flame which

offers sufficient heat for cooking is fed by the ascending wood gas and oxygen. These advanced stoves made by good quality material. The development of micro gasification is relatively new in the cooking energy sector. A gasifier cook stove powered by wood-gas from dry biomass and reducing the negative health effect of house hold air pollution from cooking.

1.2 Educational Institutions and Energy

India is a hub of educational institute. These educational institutes occupy large amount of electricity because it have academic blocks, residential block, cafeteria and sport ground. There is lot of opportunities for energy saving. Proper energy management is necessary for educational institute because various type of equipment used in educational institute. Energy sources which are used in educational institute are electricity, LPG cylinder and Diesel.

1.3 Basic Logic to Reduce Electricity Bill

- Switch off the fan , light and other electrical appliance when not in use
- Low efficiency equipment replace by higher efficiency or five star rating equipment
- All users have a awareness about energy waste
- Improve power factor
- Replace old FTL (florescent tube light) by LED (light emitting diode) light.
- Reduces working hours of street light.
- Sodium vapour light replace by LED light.
- Use renewable source like solar heater
- Regular maintenance and repair of instrument

1.4 Energy analysis

Energy analysis and energy audit play an important role to reducing energy consumption. It also gives information about area of improvement as needed. For energy analysis collection of data is a preliminary step. Energy analysis is an assessment of data and information to give a latest valuation of performance as well as performance pattern over time.

1.5 Energy Management of Educational Institution

The objective of energy management plan is reducing the energy consumption in university after realization of considerable effect in terms of energy wastage. Due to energy wastage electricity bill increases regularly. Reason behind wastage is awareness of users and uses of inefficient equipment. Energy management plan helps to find out the energy wastage and method to reduce the energy wastage. Energy management is necessary for educational institute because educational institute uses large amount of electricity. Energy management should be adopted to slash the power bills and save precious energy for the nation. In fact it is quite possible to save the energy cost to the Institution year after year.

1.6 Work Objectives

- Energy analysis of Thapar university campus
- Design and development of Micro gasifier
- Energy conservation and management on the bases of energy analysis.

1.7 Content of the Dissertation

Chapter 1- Introduction – It gives the information about energy analysis of educational institute and overview of gasifier.

Chapter 2 - Overview of Thapar University Campus – It gives brief information about Thapar university area and facilities of campus.

Chapter 3- Literature Review- This chapter provide information about energy analysis and energy management. It also provides the knowledge of gasifier.

Chapter 4- Methodology- It provide the information about approach followed for energy analysis and design of gasifier.

Chapter5- Energy Analysis of Thapar University – This chapter provide information about number of electrical equipment, type of electrical equipment and power consumption by that equipment. Also gives information about LPG and diesel consumption.

Chapter 6- Development and Design of Micro Gasifier – This chapter provide information about design and working of micro gasifier

Chapter 7-Conclusion– This chapter provide conclusion of energy analysis..

2.1 Introduction

Thapar University is situated in Patiala. It was established in 1956 and founder of Thapar University was Mr. Karam Chand Thapar. Thapar University covered 250 acres area.

Thapar University got a 27 position in list of best engineering college in India. It is today identified through the prime Deemed Universities, which transmit technical education to the country. Thapar University is an example of initiate experiment of mutual project between private sector and public in Higher Technical Education. Thapar University is a good campus with fantastic potential for growth of endemic technology, which is circulate to engineering industries. Thapar University have a green and environment friendly campus. Thapar University divided in to two parts one is Thapar technical campus and R & D section (SAI Lab) .Thapar University rivalry to maintain good environment that boost scholarly survey and research, a quality of creative independence and a broad commitment to academic excellence. The Thapar Technological Campus has an eleven hostel with all necessary facilities. There is a Nava Nalanda library. Reading room of this library is always open for student. Recently Thapar University collaborate with Trinity university of Ireland. A Centre of Relevance and Excellence (CORE) has been set up at Thapar University by TIFAC Mission REACH of Department of Science & Technology, Govt. of India in its first phase of setting up eight CORES at various Institutes and Universities spread all over the country. Thapar University and DST, Govt. of India has been mutually established the Science and Technology Entrepreneurs Park. Thapar University has impressively grown in size and activities during the last five decades of its existence. The project is an educational project over a land area of 249.13 acres. The built up area of the project is 309416.91 sq. m. Land was allotted to Patiala Technical Education Trust by his highness Yadavindra Singh. The total cost of the project is Rs.111.67 corers. Till date, 90% construction activity has been done in the university. Main objective of Thapar University is sustainable development of student, not only to provide education.

2.2 Land Description of University Campus

The land use of the area is examined. The project site is covered in Master Plan of Patiala as Educational/Institutional area. The project is surrounded by residential area in 500m radius and it is surrounded by many buildings like Mini Secretariat and Central Jail on eastern side, Punjab Pollution Control Board and Industrial Institute of training on southern side. There is no Protected Forest, Ecologically Sensitive area, National Park, Biosphere reserve and Wildlife sanctuary found within 10 km radius of the project site. The University has an easy access to land, power, water, transport and communication and approach through road. The land use of the University is given in Table 2.1

S. No.	Description	Area in m ²
1.	Plot Area	1008194.06
2.	Built up Area	309416.91
3.	Ground Coverage	106386.33
4.	Green Area	248274
5.	Parking Area	18783

Table 2.1 shows land description of Thapar University

2.3 Location of Thapar University

Location and coordinate (longitude and latitude) of Thapar University are described by a table and map which are given below.

Longitude and Latitude	30°84”N 76°03 ”E
Plot Area:	1008194.06 sq.m/ 249.13 acres
Proposed Ground Coverage:	105622.9416 sq.m/ 26.10 acres
Total Built-up area:	309416.91 sq. M
Green Area	248274 sq.m/61.39 acres
Maximum Height of Building:	34.76m

Parking area	18783 sq.m/ 4.64acres
Total Population:	Floating Population-3830 Residential Population-4925

Table 2.2 shows location of Thapar university campus



Figure 2.1 shows location of university campus

2.4 Academic Areas

Thapar university academic area are divided in to seven blocks B,C,D,E,F, TAN and G block. All blocks are well constructed and in good condition. Thapar university consist eight departments and five schools, which offers different programmes like Bachelor of Technology (B.tech) ,Master of Technology (M.tech), Master of Engineering (M.E), Master of Science (M.Sc.), Master of Computer Applications (M.C.A.) and Doctor of Philosophy (Ph.D.) degrees.

Departments of Thapar University

- Chemical Engineering
- Civil Engineering
- Computer Science and Engineering
- Department of Biotechnology
- Electrical and Instrumentation Engineering
- Electronics and Communication Engineering
- Mechanical Engineering Department
- Department of Distance Education (DDE).

Schools of Thapar University

- School of Chemistry and Biochemistry
- School of Humanities and Social Sciences
- School of Mathematics
- School of Physics and Material Science
- School of Energy and Environment.

Centre of Information Technology and Management (CITM) and Centre for Industrial Liaison and Placement (CILP) are also located in campus. Reading room of Thapar university campus is having a good infrastructure; it provides a good atmosphere for study.

2.5 Residential Areas

Thapar University provide good residential facilities for faculty and student. Faculty and non teaching staff residential quarter divided in many category. List of faculty and non teaching staff quarters is given below

Sr. No.	Type of Quarters	No. of Quarter
1	Type A	22
2	Type B	26
3	Type C	16
4	FRA	24
5	FRB	24
6	A Type	4
7	B Type	3
8	C Type	10
9	D Type	12
10	Type 4 (old)	8
11	Type 4 (new)	28
12	Type 3 (old)	8
13	Type 3 (new)	38
14	Servant Quarters	46

Table 2.3 shows detail of staff residential quarters

Detail of Boys and girls hostel is listed in Table 2.4, which also describe the capacity of each hostels:

Sr. No.	Hostel Name	Capacity
1	Hostel A	252
2	Hostel B	282
3	Hostel C	320
4	Hostel D	212
5	Hostel E	237
6	Hostel G	234
7	Hostel H	480
8	Hostel I	407
9	Hostel J	1014
10	Hostel PG	288
11	FRC	192

Table 2.4 shows type and capacity of hostels

Hostel A, B,C ,D,H,J are boys hostel and Hostel G, I, E, FRC are a girls hostel.

2.6 Other Areas

The University has several playgrounds like tennis, cricket, football and well-maintained athletic track. Thapar University has a swimming pool and Gymnasium-cum-Badminton Hall with all modern facilities. There is COS complex (Cultural Open-air Shopping) which has a different variety shops including, fast food stores, general store, laundry shop, juice bars etc. COS complex has an open theatre for cultural activity. University has a STP (sewerage treatment plant). Water purify by this plant is used for farming and irrigation. Health care centre is also located in university campus and there is a facility for any emergency. There are two cafeterias and two ahar point for food and refreshments. For electricity supplies there is four substation and eight transformers.

3.1 Electrical Energy Management and Auditing

3.1.1 Introduction

The distance between electricity supply and demand is continuously rising due to huge utilization of electrical energy in industries as well as domestic use after independence. This distance between supply and demand of electrical energy can be reduced by the electrical energy conservation which is considered as a new source of energy (renewable source) and environmental friendly. The electrical energy conservation is beneficial for economics, with a short modest investment and payback period. There is a good scope of electrical energy conservation in different sectors like domestic, industry, agriculture and educational institutes [3]. Electrical energy can be utilized with minimum losses after once being produced. Unfortunately, it represents a highly refined form of energy that is normally produced through a variety of relatively inefficient generation cycles. Roughly two-thirds of the original energy available in a fossil or atomic fuel is dissipated as waste heat to the atmosphere. Obviously, there is little to be gained by improving a motor or transformer's efficiency one or two percent when they are already well over 90 percent efficient [4]. All industries consume the large amount of electrical energy and i.e. why, it is necessary to insure a loss free and energy efficient system in industries. The developing countries where electrical energy source are limited and production of electricity is very costly, there is energy conservation energy conservation studies are important [5]. Due to cyclic and in cyclic type loads low-frequency waveform modulation and voltage flickering problem arises. That introduces light flickering, service interruption and loss of service reliability and security problems. Capacitors alone are usually not effective in compensating for these nonlinear type loads [6].

3.1.2 Electrical Energy Generation

The fossil fuels for example coal, oil and natural gas, nuclear energy, and water (hydroplant) are frequently used energy sources in the electricity power plant. The renewable source of energy is also used for electricity generation, renewable source of energy are hydrogen cell, , solar energy, waste materials and wind [6]. The applications of distributed photovoltaic (PV) generation systems in both residential and commercial structures have rapidly increased for decades. Nevertheless, since the cost per watt of the PV system is very high compared with other energy sources, current research focuses both on increasing the energy capture from PV panels and improving the energy conversion efficiency of the power conditioning stage [7]. About 71 % of power generating capacity in India is from coal based thermal power plants . Efficiency of conventional power plant is around 35% and left 65% of energy is lost in form of heat. The main source of loss in the conversion process is the heat emitted to the surrounding water or air due to the inherent force of the different thermodynamic cycles played a important role in power generation. Thermal energy from the burned coal can be used for direct applications and indirectly producing steam, hot air , hot water for chilled water and dryer or for process cooling [8]. A typical coal-fired power plant consumes approximately 7-10% of its own gross output, or even up to 12% when the power plants has anti-pollution facilities[9].

3.1.3. Electrical Energy Transmission and Distribution

Transmission and distribution systems are used to transport electrical energy from power generating site to user place [10]. The next step from the power plant to transport A.C power over long distances at voltages like 220kV & 400 kV[8]. Direct current transmission technologies are used for of long-distance transmission [10]. For transmission of power on cross-country towers three phase voltage is stepped up to a higher voltage for transmission in power plant [8]. Contact-less electrical energy transmission system has become more and more attractive in power transmission area because there is no direct physical contact or electrical connection between the energy transmission system and the power receiver [11]. HVDC power transmission systems have a overhead DC line, MI DC cable, extruded DC cable, oil-filled (OF) DC cable, gas-insulated DC line and superconducting cable systems. Overhead line is the most cost beneficial system for power transport over a long distance [10]. .Two main use of HVDC system: 1) Join two ac networks by frequency-control

philosophies (back-to-back) or 2) to transport huge amounts of D.C power via long distances [12]. The sector of electricity distribution and transmission desired a good methodology for optimization of energy distribution network based on the criterion of lower price of energy distribution. As a supplement to the network optimization, have to use methodology which is totally based on software, which enables the analysis of investment outlays for different network types [13]. . Voltage collapse and abnormally up or down voltages have been diagnose with even high frequency and complexity on distribution system [14]. Network increasing day by day due to connecting new energy customer. So load is also increasing by connecting new consumers in the network make necessary investment in network growth at all voltage levels [13]. The improvement of energy efficiency is a priority at world level. For these objective significant amounts are invested in researches and respectively in the implementing of new technological solutions. The monitoring of energy consumptions represents one of the major objectives in order to improve the energy efficiency [15]. For improving efficiency of transformer and transmission line, we have to use electromagnetic in 3-phase 4-wire power distribution system. The electromagnetic (theory) balancing technology uses the higher voltage phase to produce the lower voltage phase. A relative balanced 3-phase voltage is use to improve the unbalanced degree of 3-phase voltage, and the loss of transformer and transmission line can be reducing [16].

3.1.4 Electrical Energy Application

Electrical power converted in to mechanical power by electrical drive. As energy conservation and factory automation both are expanding businesses, the lot of electrical drives produced worldwide keeps growing [16]. Energy management embodies engineering, design, applications, operation, and maintenance of electrical drives to provide for the efficient use of the electrical energy. The modification or the design of a system to use minimum overall energy where the potential or real energy conservation are justified on an cost effective or economic basis. Optimization also involves factors such as aesthetic acceptability of the space, healthful working conditions and practical aspects of productivity, comfort, and public relations [17].

3.1.4.1 Electrical Drives

Motor

Electrical motor is capable to convert electrical energy in to mechanical energy. In industries 26% of the fuel is consumed as electricity and 69% of the electricity is consumed for motor drives [18]. For electrical energy conservation in dc motor select the motor size to closely match the load. Since the brush current density is less and it does not regulate and film well, an oversized motor runs inefficiently and select high efficient supply [17].For high efficient synchronous motor four things can be considerable, which are written below

A. Connection of the Excitation System Power Supply to an Uninterruptable Power Supply.

B. Increase of Shaft Inertia

C. Protection Relaying

- Over current settings Adjustments
- Under Voltage (UV) Settings Adjustments
- Out of Step Protection Adjustment
- Combined Under Voltage (UV) and Out of Step Protection Adjustments

D. Excitation Voltage Controller's (EVC) Mode of Operation [19].

Pump

The pump is a composition of a stator and stator housing, and an armature and armature housing. Both housing (stator housing & armature housing) represent concentric fixed tubular bodies. The working of armature housing is configured to permit production fluids to flow there through. The stator and armature are assembled in interchangeable and connectible parts called "modules", which are attached in series. In one aspect, the electrical operation of coils within the stator is protected from individual coil failure or short-circuiting by wiring them in parallel, rather than in series [20]. The inner flow in the compound impeller of high speed is more complex than that in a conventional one and the problem of cavitations is becoming more and more serious. There are still many problems demanding prompt solution because some of the negative consequences including the slowdown in performance, the increase of vibration and noise generation when cavitation occurs in a centrifugal pump. The

failure of material which is caused by cavitation will make the pump work abnormally and greatly shorten the pump's service life which will eventually lead to machine being scrapped [21]. Adapt to load variation with VSD (variable speed drives) or sequencing control of multiple units. Stop working multiple pumps add a booster pump in the problem area or add an auto start for an on-line spares [8]. The simulations of cavitation flow on the pump with inducers fixed before impellers are still rare. The features of the inducer are, it has excellent suction performance; it can improve the suction conditions of the main impeller [21]. Some points written below for energy conservation in pump

- Chose a pump that had a good capacity in accordance with the desire. Bad selection of pump lead to huge wastage of energy. A pump with 80-85% efficiency at rated flow may have only 65% efficiency at half the flow.
- Appropriate sized pump connect with the motor for reduce losses.
- Use of synthetic flat belts in place of V-belts, it can save energy around 10%.
- Use of throttling valves to vary flow of fluids is a wasteful practice. We have to use VSD in place of throttling valve. Throttling valve has a lot of power losses.
- Perfect installation of the pump system, including coupling of motor, shaft alignment and pump is a must. Transmission of drive among between pumps and motors is very important. Loose belts are also cause of energy loss.
- Regular maintenance is very important for pumps, its increase efficiency around 10-15%
- A positive displacement pump with VSD (variable speed drive) is used to decrease losses in pump [22].

Fan & Blower

For ventilation and industrial process air is provided by the fan & blower. Fans and blowers are defined as rotary bladed machines that utilize an impeller, fit to a bearings and shaft, to give a continuous flow of gas, typically air, passing through it. The input/output pressure ratios show the difference between a fan and blower. Fans have a specific ratio up to 1.11, whereas a blower has a specific ratio between 1.11 and 1.20, per the ASME (American Society of Mechanical Engineers) [23]. The design of the blower housing is just as essential as the blower selection. By modifying the housing design, the quantity and shape of flow

exiting the housing can be controlled. First, the impeller and inlet ring geometry was directly carried into Icepack from a CAD model provided by the manufacturer [24]. Benefits of VSD device in fan and blower are given below

- Small flow variations can be adapted more rapidly by a VSD than by other control modes, which improves process control performance.
- Fan capacity may be a real bottleneck for some plants. VSD over speed may provide the additional capacity needed.
- Soft starting and reduction in speed reduces fan wear, particularly in bearings and seals. This results in reduced maintenance costs [25].

3.1.4.2 HVAC (Heating, ventilation and Air Conditioning)

The economic studies of thermal storage air conditioning scheme in a large-scale commercial architecture were investigated. The first investment, running price and power energy consumption of ice storage air conditioning system is very high compare to other energy consumption sources [26]. The Heating, Ventilation and Air Conditioning (HVAC) and refrigeration system forward the heat energy from or to the building environment or products. Energy in form of heat or electricity is used to power mechanical equipment constructed to transfer heat from a colder, low-energy level to a hotter, high-energy level [27]. For decreasing the electrical energy consumption in buildings or office without compromising comfort and indoor air quality. One of the best ways to achieve energy conservation has been to layout HVAC system configurations combining different components for this purpose. For low initial investment and running price direct evaporative cooling (DEC) system is common. It significantly increases the thermal performance in office cooling and ventilation with very less electrical energy consumption [28]. Refrigerator replace by solar cooling system, which are running by solar energy. In solar air conditioning cooling system Absorption cooling is essentially an air-conditioner driven not by electricity, but by a heat source. Absorption chillers can be seen as a vapour compression system where the compressor has been replaced by the absorber [29]. Some important point written below to save energy in HVAC systems

- Avoid space heaters if your building has centralized heating

- Regular check that your adjustable speed drives (ASDs) is working properly. If adjustable speed drives working constantly at high speed, they use more electrical energy than the directly connected motor. To report percentage of operation, ASD have a output monitor system. If motor working at medium or low speed uses one eight the electrical energy of a motor working at high speed
- At the same time never use air conditioner and dehumidifier together, because air conditioner reduce moisture from the air, while a cooler add moisture to decrease room temperature. Running both at the same time increase electricity bill, because they use opposite methods for cooling space or place
- Every month have a service technician measure the carbon dioxide in your gas burner. The higher emission of CO₂ / CO shows the good efficiency of the unit [30].

3.1.4.3 Lighting System

Lighting is important for everyone. The power consumption by the industrial lighting varies between 2 to 10% of the total power. Innovation and continuous improvement in the field of lighting, has given rise to tremendous energy conservation opportunities in this area [31]. Condition of light is very important to every building because to be giving a perfect illumination source to each of room. Light design is important compare to selection of luminaries [32]. There are many factor that affect performance of lighting such as paint colours, reflection factor, maintenance factor and utilization factor [33]. Light Emitting Diodes LEDs and induction Lamps LVD are more efficient and effective compare to compact florescent lamps(CFLs) and florescent tube light. It was more effective that if current lights source like CFL and FTL are replaced by new electrical energy efficient lights such as LEDs or LVD lamps, the overall lighting load on transformer/ generators will decrease near about 50% or more without any compromising in light quality in building [34]. Some important point for energy conservation in light system are written below

- Turn off all the lights and lamp at night, including task, restroom and office lights, when they are not in use.
- All incandescent lamp bulbs replace by the fluorescent to reduce energy consumption. It reduces consumption near about 75%.

- Remove all incandescent bulbs and replace by CFL (Compact fluorescent Lamp) or LED bulbs.
- Use solar street light in place of metallic halide
- By using power reducers, ballasts and multi-level switching reduce excess lighting. Some ballast used small part of electrical energy even when light is not operating [30].
- Installation of High Pressure Sodium Vapour (HPSV) lamps, where colour rendering is not critical.
- Grouping of lighting system, to give greater flexibility in lighting control
- Use electronic ballast in place of conventional ballast, because energy loss in electronic ballast is very low [31].

3.1.5 Energy Auditing

An energy audit is a comprehensive method that analysis where energy is usage and how much amount of energy is usage in a campus, building or industry. Collected data from energy audit can be used to introduce energy management and energy conservation measures (ECM) [35]. Energy auditing is important for energy conservation, by doing energy auditing we reduce the electricity bill in any industry. First of fall analyzing the current position of the energy consumption in industry, point out problems related to energy using and tapping the potentials of energy conservation in industry, possible or desired energy-saving measures are put forward and compiled the audit reports[36]. Energy utilization audit, energy saving audit and energy management potential analysis is a main phase of energy audit. Energy audit is best approach to determine the integrated systems working in a building structure. By using two approaches determine the energy consumption in a building, which approaches are 1.Observing the current electricity usage pattern. 2. Check previous electricity bills of the building. In Building survey collect load data of existing electrical devices, accessories, heating and cooling systems [37].

Goal of Energy Audit

- Transparently diagnose types and costs of energy use
- Identify and analyze more cost-effective ways of using energy

- By doing economic review on those alternatives and determine which ones are beneficial or cost effective for industry [38].

Type of Energy Auditing

The type of Energy Audit to be execute on

- Operation of industry as well as type of industry
- Potential and magnitude of cost reduction desired
- Depth to which final audit is needed

Energy Audit can be divided into the two parts:

- Preliminary Audit
- Detailed Audit [39].

Preliminary Audit

Preliminary audit take less time, step followed in preliminary audit is written below

- This audit consists of a walk-through check up of a facility to identify maintenance, operational or deficient equipment issues and to also diagnose areas which need further evaluation
- This audit includes performing economic calculations and may include performing testing to identify real energy consumption and losses
- It uses existing data and easily available data [38].

Detailed audit

Detailed audit having a ten step, which are given below

- Conduct a condition inspection
- Establish the audit mandate
- Establish the audit scope
- Analyse energy consumption and costs
- Compare energy performance
- Profile energy use patterns
- Inventory energy use

- Diagnose Energy Management Opportunities (EMOs)
- Assess the benefits
- Report for action

Conduct a condition inspection

This is the first step of energy auditing, inspection of the industry can be done by the energy auditor after that energy auditor take a informal interviews of engineers and manager for knowing the problem related to energy. After that energy auditor make a team to collect the data and energy pattern in industry.

Establish the audit mandate

Obtain liability from organization management and find the plan and outcomes of the audit.

Establish the audit scope

Make a list of energy consuming device for energy auditing.

Analyse energy consumption and costs

Compiled old and current electric bill of industry and analyse the electric bill. Calculate average energy consumption in a month.

Compare energy performance

Resolve energy use indices and compare them internally from one amount to a different, from one facility to an identical one at intervals your management or organization, from one system to an identical one, or outwardly to best practices offered at intervals your business

Profile energy use patterns

Examine the time analogy of energy consumption, such as the electricity demand profile

Inventory energy use

Make a list of all electrical energy consuming instrument in the industry audit area and calculate their consumption and demand characteristics.

Diagnose Energy Management Opportunities (EMOs)

For decrease energy waste in industry use all technological and operational approaches.

Assess the benefits

Calculate benefit for energy auditing in industry and also calculate other benefit like reduction in carbon emission or harmful gases emissions

Report for action

Finally prepare the audit report, this report have a appropriate information to reduce energy consumption in a industry. Communicate Energy auditor Report for successful implementation [40].

3.2 Literature Review of Micro Gasifier

Research paper [1] describes that fuel size and geometric variation of stove impact burn rates and emissions production, and must therefore be examined for any pattern and implementation.

Research paper [41] advised that present method for the production of charcoal is very inefficient. Pyrolysis process in TLUD is efficient procedure and good approach to produce bio char.

Research paper [42] describe that TLUD stove are gives clean burning and TLUD stoves has a good efficiency. Different types of fuels are often burned, but some fuels have higher burning characteristics than others.

Research paper [43] establish the system and they got fixed carbon (FC) = 85.2%, volatile matter (VM) = 11.5% and Ash = 2.3% from bio char, which was produce by TLUD process. Energy produce by bio char is more compare to traditional kilns.

Research paper [44] suggested that quality of soil improved by bio char. Bio char produce by TLUD process also increased cat ion-exchange capacity resulting in improved soil fertility.

Research paper [45] describes that initial biomass played an important role in the final composition of bio char. He was found that the air flow and insulation considerably influenced the chemical composition of the bio char.

4.1 Electrical Energy Analysis

Main objective of the study is Electrical Energy Analysis of the Thapar Technology Campus and development of Energy Management Plan for the Thapar Technology Campus. Approach followed for achieving the target is represented here briefly. The approach enclosed the four aspects of study

- 1 Preliminary survey
2. Electrical energy analysis
3. Review of the current electrical energy management practices
4. Development of electrical energy management plan

4.1.1 Preliminary Survey

Preliminary survey involved formal visit of the campus. Main objective of the visit was to get familiar with the places, activities and people that important for energy analysis and management. People that matter were mentioned concerning the work and concerning the sort of facilitate and cooperation expected from them. Important activities of the campus were finding from the Preliminary survey.

4.1.2 Electrical Energy Analysis

For the Electrical energy analysis Thapar technology campus was divided into five parts:

- Academic area
- Hostel areas
- Staff Residential areas
- Sport ground
- Other areas

Approach followed for electrical energy analysis is written below

- As for the Academic campus, Measurement of Electrical energy consumption by all electrical equipments was taken into account. Labs in the academic campus equipped with different instruments were made and their power rating was determined.
- Counting of electrical energy appliance which are use in class rooms and academic section.
- Counting of electrical energy appliance which are use in canteen.
- Counting of electrical energy appliances which are use in hostel and hostel mess.
- Since there is a rare possibility of usage of Instruments in the Residential Campus Area, the measurement and calculations were made only for the basic electrical equipments such as Fans, Lighting and air-conditioning systems etc.
- Counting of street lights.
- For the Sports campus though, Lighting are used only in evening and night timings but all of the lightings were installed with Metal Halides Lamps only for which electrical measurements for made
- Counting of electrical motors and pumps.
- Prepared a list how much energy consumed by each electrical appliance.
- Consulted junior engineer about energy consumption by appliance.

4.1.3 Review of Current Electrical Energy Management Practices

The significant information can be extracted by reviewing the research paper. Significant method compiled from Bee books for energy conservation. Extract useful information from energy audit reports which were written by energy auditors. Read effective method from internet for energy conservation and energy management in educational institute. Efforts were also made to assess the potential for energy conservation and management.

4.1.4 Development of Electrical Energy Management Plan

Energy management plan each of the identified significant energy aspects was developed. The plan included brief description of what will do for the management of the energy aspect, identification and detailing of the facilities needed for the management of the energy aspects

and the organizational setup suggested for the management. Monitoring and measurement requirements were also identified and indicated.

4.2 Micro Gasifier

Main objective of study is reducing LPG cylinder consumption in Thapar technical university campus and design gasifier for cooking. Approach followed for achieving the target is represented here briefly. The approach enclosed the four steps

- Preliminary survey of hostel and calculation
- Review of the micro gasifier paper and books
- Design of micro gasifier

4.2.1 Preliminary Survey of Hostel and Calculation

This survey involved reconnaissance visit of the hostel. Purpose of the visit was to collect LPG cylinder data from hostel mess manager. Collect detail that how many student and faculty eat per day in hostel. The energy calculation for the biomass requirement (in reference to the conventional LPG burner) by gasifier in kg/hr for one meal per person keeping in consideration the efficiency of stove.

4.2.2 Literature Review of Micro Gasifier

The significant information can be extracted by reviewing the research papers and books. Read about different micro gasifier and find out which gasifier is more efficient for campus hostel. Fuels, design, primary and secondary air requirements, and combustion and emissions related knowledge extract from research papers and books.

4.2.3 Design of Micro Gasifier

Approach followed for design the gasifier is represented here briefly. The approach enclosed the different aspect of study

- The reactor (gasification chamber) diameter and dimensions are designed according to the biomass fuel requirement taking into consideration either small or medium scale development.
- Material selection of the stove.
- Fuel and starter fuel selection for the stove.
- Accommodation for natural passage for primary air required for gasification.

5.1 Electricity Distribution System in Thapar University

Punjab State Power Corporation Limited supply electricity in Thapar university campus. There are eight transformers and seven diesel generator for electricity distribution. Table of Transformer and diesel generator is given below

Transformer Detail

Sr. No.	Power rating(kVA)	No. of Transformer
1	1000	2
2	500	4
3	315	1
4	250	1

Table 5.1

Diesel Generator Detail

Sr. No.	Power rating(kVA)	No. of Diesel Generator
1	500	1
2	400	3
3	380	1
4	320	1
5	115	1

Table 5.2

5.2 Energy Analysis of Thapar University

Mainly three types of energy used in Thapar university campus, which are electrical energy, energy from LPG cylinders and energy from diesel generator. Table of electrical energy consumption, LPG cylinder consumption and diesel consumption are given . By doing energy analysis we get the information about energy wastage and also knows how to save energy. Table of energy consumption equipment in Academic area, residential area and sport area is on next page.

5.2.1 TAN BUILDING

There is a list of electrical energy appliances in tan building and calculate per year energy consumption by this appliances.

Sr. No	Name of equipment	No of equipment.	Rating of equipment(W)	Average running hour per day	Total running day in Year	Energy consumption per Year(kWh)
1	CFL	748	36	6	215	34737.12
2	CFL	56	22	8	300	2956.8
3	FAN	100	60	6	155	5580
4	EXHAUST FAN	6	80	12	215	1238.4
5	WATER COOLER	2	750	10	215	3225
6	LIGHT(METAL HALIDE)	3	250	8	365	2190
7	PROJECTOR	18	450	6	215	10449
	TOTAL					60376.32

Table 5.3 List of electrical appliances in TAN building

5.2.2 F BLOCK

There is a list of electrical energy appliances in F block and calculate per year energy consumption by these appliances.

Sr. No.	Name of equipment	No of equipment	Rating of equipment(W)	Average running hour per day	Total running day in Year	Energy consumption per Year(kWh)
1	FTL	210	52	6	215	14086.8
2	FTL	40	46	8	300	4416
3	FAN	127	80	6	155	9448
4	EXHAUST FAN	4	80	12	215	825.6
5	WATER COOLER	2	750	10	215	3225
6	PROJECTOR	14	450	6	215	8127
	TOTAL					40128.4

Table 5.4 List of electrical appliances in F block

5.2.3 E BLOCK

There is a list of electrical energy appliances in E block and calculate per year energy consumption by these appliances.

Sr. No	Name of equipment	No of equipment	Rating of equipment(W)	Average running hour per day	Total running day in Year	Energy consumption per Year(kWh)
1	FTL	218	52	6	215	14623.44
2	FTL	38	46	8	300	4195.2
3	FAN	127	80	6	155	9448
4	EXHAUST FAN	4	80	12	215	825.6
5	WATER COOLER	2	750	10	215	3225
6	PROJECTOR	14	450	6	215	8127
	TOTAL					40444.4

Table 5.5 List of electrical appliances in E block

5.2.4 B BLOCK

There is a list of electrical energy appliances in B block and calculate per year energy consumption by these appliances.

Sr. No	Name of equipment	No of equipment	Rating of equipment(W)	Average running hour per day	Total running day in Year	Energy consumption per Year(kWh)
1	FTL	156	52	6	215	10464.48
2	FAN	98	80	6	155	7291.2
3	EXHAUST FAN	8	80	12	215	1651.2
4	WATER COOLER	1	750	10	215	1612.5
5	PROJECTOR	12	450	6	215	6966
						27985.38

Table 5.6 List of electrical appliances in B block

5.2.5 C BLOCK

There is a list of electrical energy appliances in C block and calculate per year energy consumption by these appliances.

Sr. No	Name of equipment	No of equipment	Rating of equipment(W)	Average running hour per day	Total running day in Year	Energy consumption per Year(kWh)
1	FTL	68	52	6	215	4561.44
2	FAN	45	80	6	155	3348
3	EXHAUST FAN	6	80	12	215	1238.4
4	WATER COOLER	1	750	10	215	1612.5
5	PROJECTOR	8	450	6	215	4644
						15404.34

Table 5.7 List of electrical appliances in C block

5.2.6 D BLOCK

There is a list of electrical energy appliances in D block and calculate per year energy consumption by these appliances

Sr. No	Name of equipment	No of equipment	Rating of equipment(W)	Average running hour per day	Total running day in Year	Energy consumption per Year(kWh)
1	FTL	167	52	6	215	11202.36
2	FAN	77	80	6	155	5728
3	EXHAUST FAN	6	80	12	215	1238.4
4	WATER COOLER	1	750	10	215	1612.5
5	PROJECTOR	9	450	6	215	5224.5
						25005.76

Table 5.8 List of electrical appliances in D block

5.2.7 G BLOCK

There is a list of electrical energy appliances in G block and calculate per year energy consumption by these appliances

Sr. No	Name of equipment	No of equipment	Rating of equipment(W)	Average running hour per day	Total running day in Year	Energy consumption per Year(kWh)
1	LED	1088	36	6	215	50526.72
2	LED	99	40	10	300	11880
3	LED	51	28	12	300	5140.8
2	FAN	516	60	6	150	27864
3	EXHAUST FAN	18	55	12	215	2554
4	WATER COOLER	3	750	12	150	4050
5	PROJECTOR	27	450	6	215	15673.5
						117689

Table 5.9 List of electrical appliances in G block

5.2.8 Air Conditioning System

There is a list of Air conditioner systems in department, residence and academic block. Also calculate per year energy consume by the air conditioner.

Sr. No	Name of Department	No. of equipment	Total TR	Rating of equipment(kWh)	Average running hour per day	Total running day in Year	Energy consumption per Year(kWh)
1	COMPUTER SCIENCE	51	93.5	113.4782	6	110	74895.61
2	C.I.T.M	26	44.5	54	6	110	35640
3	DIRECTORATE	18	33	40	9	110	39600
4	ECED DEPTT	40	56.5	68.57	6	110	45256
5	GUEST HOUSE	15	21	25.48	8	40	8153.6
6	CMS Department	23	33.5	40.65	8	110	35772
7	C.I.L..P.	11	14.5	17.59	10	110	19349

8	C-HALL	19	37.5	45.51	6	15	4095.9
9	E.E.D	16	29.5	35.80	6	110	23628
10	CIVIL ENGG.	14	24.5	29.73	6	110	19621
11	BIO-TECHNOLOGY	23	41	49.49	6	110	32663
12	SAI LABS	29	43.5	52.79	6	110	34841
13	HOSTEL-I	72	102.5	124.40	10	110	136840
14	HOSTEL-H	45	89	108.016	10	110	1118817.6
15	PG HOSTEL	3	3	3.64	10	110	4004
16	HOSTEL-J	11	21.5	26	10	110	28600
17	HOSTEL-A	2	3	3.64	10	110	4004
18	HOSTEL-B	10	18	21.84	10	110	24024
19	HOSTEL-C	6	11.5	13.95	10	110	15345
20	HOSTEL-E	7	10.5	12.74	10	110	14014
21	HOSTEL-G	6	9	10.92	10	110	12012
22	FRC	9	13.5	16.38	10	110	18018
23	MECHANICAL ENGG	28	53	64.32	6	110	42451.2
24	HEALTH CENTRE	4	6	7.2	8	120	6912
25	CHEMICAL ENGG	8	13	15.77	6	110	10408.2
26	DISTANCE EDUCATION	3	4.4	5.3	6	110	3498
27	C.WORKSHOP	12	18.5	22.45	6	110	14817
28	AUDITORIUM AC PLANT	5	82.5	100.12	6	110	66079.2
29	SEE	4	4.4	5.34	6	110	3524.4
30	S.C.B.C	16	24.5	29.73	6	110	19621
31	S.P.M.S.	40	63.5	77	6	110	50820
32	S.O.M	15	27.5	33.37	6	110	22024.2
33	D BLOCK	17	28.5	34.58	4	110	15215.2
34	R&D LAB	6	9	10.92	4	110	4804.8
35	LIBRARY	9	129.75	157.47	12	145	273997.8
36	FACULTY RESIDENCE	218	327	396.87	10	145	575461.5
37	OTHER PLACES	77	114	138.35	8	110	121748
	TOTAL						2980576

Table 5.10 List of Air Conditioning System

5.2.9 Lighting System

There is a list which describes the lighting system of Thapar University and Category of lights, which are used in university campus. Per year energy consumption of lights are measured.

Sr. No	Name of equipment	No of equipment	Rating of equipment(W)	Average running hour per day	Total running day in Year	Energy consumption per Year(kWh)
1	FTL	2808	52	8	305	356279.04
2	FTL	1241	46	8	305	139289.84
3	FTL	1950	28	8	305	133224
4	CFL	487	36	8	305	42778.08
5	CFL	247	18	8	305	10848.24
6	CFL	2478	11	8	305	66509.52
7	LED	110	36	8	305	9662.4
8	LED	80	15	8	60	576
9	LED	55	30	8	60	792
10	LED	20	40	8	365	2336
11	Street light	77	175	8	365	39347
12	Street light	45	85	8	365	11169
13	Metal halide	53	250	8	365	38690
14	Metal halide	55	400	2	300	13200
15	Metal halide	72	500	2	300	21600
	TOTAL					886301.3

Table 5.11 List of Lighting System

5.2.10 Fan and Exhaust Fan

There is a list which describes the number of fan and exhaust fans in Thapar University. It also describes per year energy consumption by fans.

Sr. No	Name of equipment	No of equipment.	Rating of equipment(W)	Average running hour per day	Total running day in Year	Energy consumption per Year(kWh)
1	FAN	2172	80	12	200	417024
2	FAN	2697	60	12	200	388368
3	CELING FAN	107	55	12	200	14124
4	EHAUST FAN	73	80	12	300	21024
5	EXHAUST FAN	79	55	12	300	15642
6	EXHAUST FAN	1258	40	12	300	181152
	TOTAL					1037334

Table 5.12 List of Fan and Exhaust Fan

5.2.11 Motors

There is a list which describes the number of motors in Thapar University. It also describes per year energy consumption by motors

Sr. No	Name of equipment	No of equipment.	Rating of equipment(W)	Average running hour per day	Total running day in Year	Energy consumption per Year(kWh)
1	MOTOR(10HP)	3	7350	24	365	193158
2	MOTOR (5HP)	2	3675	24	365	64386
3	MOTOR(48HP)	3	35280	10	365	386316
4	MOTOR (25HP)	1	18375	4	365	26827.5
5	MOTOR (7.5HP)	2	5512.5	4	225	9922.5
6	MOTOR (2HP)	2	1470	2	280	1646.4
7	MOTOR	8	370	2	120	710.4
8	MOTOR	6	750	2	120	1080
9	MOTOR	4	500	2	120	480
	TOTAL					684526

Table 5.13 List of Motors

5.2.12 Refrigeration System

There is a list which describes the number of Refrigerator in Thapar University. It also describes per year energy consumption by Refrigerator systems.

Sr. No	Name of equipment	No of equipment.	Rating of equipment(W)	Average running hour per day	Total running day in Year	Energy consumption per Year(kWh)
1	REFRIGERATOR	23	400	24	300	66240
2	REFRIGERATOR	165	275	24	365	397485
3	REFRIGERATOR	58	250	24	365	127020
4	REFRIGERATOR	21	335	24	365	61626
5	REFRIGERATOR	7	135	24	365	8278
6	REFRIGERATOR	6	130	24	365	6832
7	REFRIGERATOR	78	225	24	200	84240
8	WATER COOLER	26	750	16	200	62400

9	WATER COOLER	14	550	162	200	249480
	TOTAL					1063603

Table 5.14 List of Refrigeration Systems

5.2.13 Miscellaneous Electrical Systems

There is list which describes the list of other electrical equipment in Thapar university campus. Per year energy consumption by different equipment is given below

Sr. No	Name of equipment	No of equipment.	Rating of equipment(W)	Average running hour per day	Total running day in Year	Energy consumption per Year(kWh)
1	COMPUTER	361	70	8	300	60648
2	COMPUTER	531	110	8	300	140184
3	COMPUTER	64	150	8	300	23040
4	PRINTER & SCANNER	167	200	2	300	20040
5	PHOTOSTAT MACHINE	14	750	2	300	6300
6	HOT AIR OVEN	6	1500	24	350	75600
7	LIFT	9	9000	10	300	243000
8	WASHING MACHINE	376	500	4	68	51136
9	GEYSER	327	2000	2	150	196200
10	MICRO WAVE OVEN	53	950	3	300	45315
11	UPS(20KVA)	6	17200	4	315	130032
12	UPS(200KVA)	1	172000	4	315	216720
13	UPS(10KVA)	2	8600	4	315	21672
14	BLOWER(5HP)	2	1470	24	365	25754.4
15	COOLER	67	200	8	140	15008
16	TV(OLD)	10	120	4	365	1752
17	TV(LCD)	98	70	4	365	10015.6
18	TV(LED)	14	55	4	365	1124.2

19	MOBILE CHARGER	4744	10	4	365	69262.4
20	LAPTOP	3000	65	6	365	427050
	TOTAL					1779854

Table 5.15 List of Miscellanies Electrical Systems

5.2.14. Lab Instrument

There is a list of Lab instrument which uses more electrical energy comparison to other lab equipment.

Sr. No	Name of equipment	No of equipment	Rating of equipment(W)	Average running hour per day	Total running day in Year	Energy consumption per Year(kWh)
1	AUTOCLAVE	7	3000	4	200	16800
2	INCUBATOR SHAKER	7	355	24	350	20874
3	BOD INCUBATOR	8	640	24	350	43008
4	HM 5030 PG	13	18	2	110	51.48
5	HM 5035 FG	18	22	2	110	87.12
6	2 CHANNEL OSCILLOSCOPE	16	195	2	110	686.4
7	SPECTRUM ANALYZER	1	200	2	110	44
8	KLYSTRON POWER SUPPLY	23	100	2	120	552
9	VSWR METER	12	100	2	110	264
8	CRO(20MHZ)	1	250	2	110	55
9	MUFFLE FURNACE	12	1800	4	300	25920
10	VSM	1	3000	10	300	9000
	TOTAL					117342

Table 5.16 List of Lab Instrument

5.2.15 LPG (Liquid Petroleum Gas) Consumption

There is list which describes the number of LPG cylinder used in a hostel. IT also shows that per year LPG consumptions in university campus.

Sr. No.	Hostel Name	No. of Cylinder(14.2kg)	No. of Cylinder(19kg)	Per year total LPG consumption(Kg)
1	Hostel –J	705	764	24527
2	Hostel –A	440	-	6248
3	Hostel-B	624	-	8860.8
4	Hostel-C	720	-	10224
5	Hostel-E	450	-	6390
6	Hostel-D	500	-	7200
7	Hostel-G	440	-	6248
8	Hostel-H	850	300	17770
9	Hostel-I	610	46	9536
10	Hostel-PG	428	-	6163.2
	TOTAL			103167

Table 5.17 List of Gas Cylinder

5.2.16 Diesel Consumption

There is list which describes the Diesel consumption by D.G set in one year.

Month	2013 (in Litres)	2014 (in Litres)	2015 (in Litres)
JANUARY	-	1970.91	2182.11
FEBRUARY	787	2889.465	2282.67
MARCH	1965	2889.465	3831.42
APRIL	1965	1906	3920.76
MAY	1964.43	nil received	NA
JUNE	1942.35	5917.2	6820.23
JULY	3838.38	1972	2028
AUGUST	3796.2	3867.8	3976.4
SEPTEMBER	3754.94	1915.38	1675.8
OCTOBER	1856.92	1896.22	1907.33
NOVEMBER	1837.54	4243.25	4102
DECEMBER	1970.91	4240.28	4201.4

Table 5.18 shows the list of Diesel Consumption

5.3 Result and Discussion

5.3.1 Detail of Electricity Bills

There is a bill detail of Thapar University, which shows the electrical energy consumption in university campus. This bill is divided in to two part R& D section and TU campus. Table 5.18 shows the bill detail.

Sr. No.	Month	R & D section (kWh)	TU campus (kWh)	Total (kWh)
1	JUNE 2015	101390	596450	697840
2	JULY 2015	112820	709910	822730
3	AUGUST 2015	112390	944400	1056790
4	SEPTEMBER 2015	108440	952520	1060960
5	OCTOBER2015	67400	678350	745750
6	NOVEMBER2015	40440	408600	449040
7	DECEMBER 2015	41890	509110	551000
8	JANUARY2016	47660	512010	559670
9	FEBRUARY2016	42710	481300	524010
10	MARCH2016	46460	514560	561020
11	APRIL2016	81280	777990	859270
12	MAY2016	127440	916800	916800
13	Total	930320	8002000	8932320

Table no 5.19 shows the Electrical Energy Consumption in Thapar University

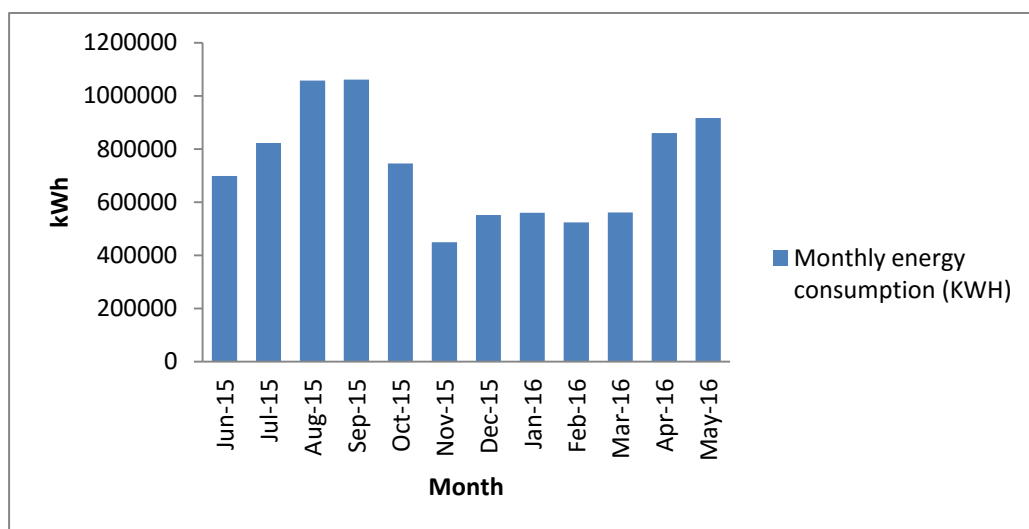


Figure 5.1 shows the Electrical Energy consumption in Thapar University

Table and Figure shows that electricity consumption higher in summer, because in summer air condition systems, refrigerator systems and fans are regularly used. For decreasing electricity consumption we have to do energy analysis of campus.

5.3.2 Result

We discussed about energy analysis in Thapar university campus. Total power consumed by different electrical appliance or systems in a year is given.

Sr. No.	Name of system	Yearly Power consumption (kWh)
1	LIGHTING SYSTEM	1022545
2	AIR CONDITIONING SYSTEMS	2980576
3	FAN	1115613
4	REFRIGERATOR	1082165
5	MOTORS	684526
6	MISCELLANEOUS ELECTRICAL SYSTEM	1839065
7	LAB EQUIPMENT	117342
8	OTHER EQUIPMENT	90488
9	Total	8932320

Table 5.20 Shows Energy consumption by Electrical Systems

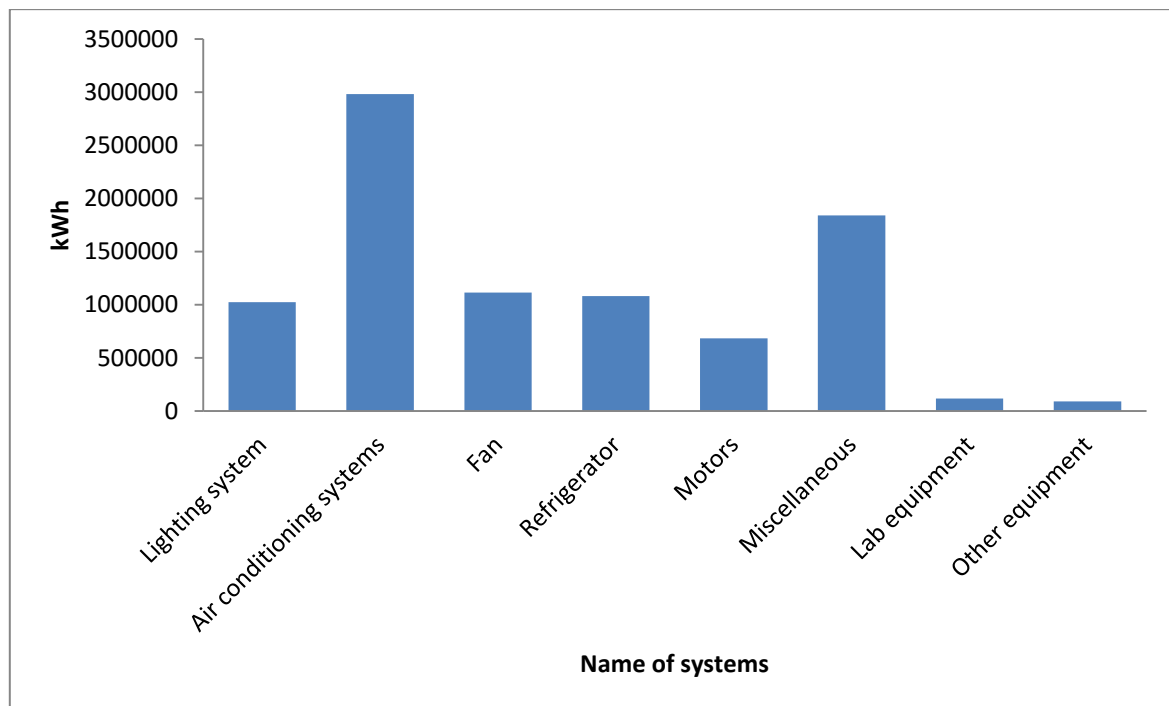


Figure 5.2 Shows Energy consumption by Different Systems

Table 5.19 and figure 5.2 shows energy consumption by different systems, Table described that maximum energy consumed by air conditioning systems, lighting systems, fans, refrigerator and motors.

5.3.3 Plans for Electrical Energy Conservation

Lighting system

Above result shows power consumes by lighting system is 1022545 kWh in a year. We can replace FTL T8 (52 and 46 W) by T8 LED, it only consume 18w and provide better illumines compare to FTL. Life cycle of LED is more comparing to FTL light Power consumption by 4946 FTL is 419826kWh in a year. If these FTL is replaced by 4946 T8 LED (18W), than it consume only 199786kWh per year. So we can save 220039 kWh or 13, 28966 Rs in a year. The cost of per LED is 700Rs. So the cost of 4946 LED is 3474800 Rs, but it will recover in three year. After cost recovery we can save 13 lakh Rs yearly. Our power consumption decreases 220039 kWh yearly. If sodium vapour light replaced by LED (45W) than we can save 39829 kWh per year and cost of 39829kWh is 238974 Rs per year. By replacing FTL and sodium vapour street light we can save 1567940 Rs yearly.

Air conditioning systems

Table 5.19 shows that energy consumption by air conditioning systems is maximum; it is 2980756 kWh per year. During auditing for last 12 months it is observed that most of the air conditioner works on a 18° C. If all air conditioner set at 26° C temperature, we can save 20% power and it is near about 596151 kWh. Per kWh cost is 6 Rs, so we can save 3576906 Rs yearly. In summer season air conditioning requirement is higher in north. As we know Thapar university comes under the north region. During audit it is observe that most of the Air conditioner have been operating for the last 10-15 year, which are consumed more electricity. If old air conditioner is replace by inverter air conditioner or rated air conditioner, this approach saves 30% electricity consumption.

Fans

Table 5.19 shows that energy consumption by fans is 1115613 kWh, which is very high. During it is observed that most of the fans are old, so function of fans below its rated capacity. In Thapar university campus 2646 old fans are used, which consumed 452289kWh yearly. If these old fan((80W) replace by 45W fan, than we can save 197877 kWh per year.

So per year saving by replacing fan is 1187262 Rs. Initial cost for purchasing 45W fan will be recovered in five year.

Repair and Maintenance:

In Thapar university campus many equipment like motor, refrigerator and air conditioner have a low efficiency. So the wastage of electrical energy is higher. I suggest the management to regular service, repair or maintenance these electrical equipment for increasing the efficiency. Regular maintenance decreases the energy consumptions.

Due to the above recommendation we can save 10, 53896 unit / year. Net yearly saving is 63, 23,376 Rs.

6.1 Introduction

India faces a big challenge in providing access to adequate and cheap energy. Still these days, forests are destroyed by human beings and inhale life-shortening smoke as a result of they cook food with solid fuel. Near about 85% of rural population are relying on universal biomass fuels and bio waste for their cooking energy requirements and near about 45% population do not have electricity connection, according to the UNIDO report. Dozens of various stoves are tested to varied degrees with the ARC instrumentality and methodologies. After collection Hundreds of different test results. The two measured emissions are carbon monoxide (CO) and particulate matter (PM). “More than half of the global population lacking clean cooking facilities lives in India, China and Bangladesh,” says the UN report. “Here, India sits at the top as the country with the largest population lacking access to clean fuel for cooking.” The above facts & present situations require serious introduction of Micro Gasifier (Top-Lit Updraft Gasifier) .

6.2 Background

Micro gasifier are designed to decrease the per meal fuel consumption and to control smoke emissions from open cooking. Traditional cook stove replaced by an improved one and micro gasifier reduce negative health effect. Micro gasifier has a four step for output heat

Drying

In this process moisture present in biomass is evaporated in to atmosphere and left a solid biomass.

Pyrolysis

In this process solid biomass converted into volatile vapours and a solid residue (char).

Wood-Gas Combustion

Gas produce by Pyrolysis process called wood gas. Wood gas is a combination of hydrogen and carbon mono-oxide and it react with secondary air (in presences of oxygen) and produce flame.

Char Gasification

A solid residue produce after Pyrolysis processes called char. Oxygen reacts with the solid char in the fuel bed and produce carbon monoxide which adds to the wood-gas cloud of combustible gases.

6.3 Approach

- Collect data from hostel and calculate that how much energy or LPG consumption by per person in a one meal.
- The reactor (gasification chamber) diameter and dimensions are designed according to the biomass fuel requirement taking into consideration either small or medium scale development.
- Accommodation for natural passage for primary air required for gasification.

6.4 Calculation

Table 6.1 shows LPG cylinder consumption by Hostel J from January 2015 to December 2015.

Month	No. of cylinder (19kg)	No. of cylinder (14.2kg)	Total LPG Consumption in a Month(Kg)
January	70	105	2821
February	45	80	1991
March	35	35	1162
April	55	74	2095.8
May	70	50	2040

June	65	40	1803
July	65	40	1803
August	60	85	2347
September	60	70	2134
October	60	75	2205
November	60	55	1921
December	60	55	1921
Total	705	764	24243.8

Table 6.1

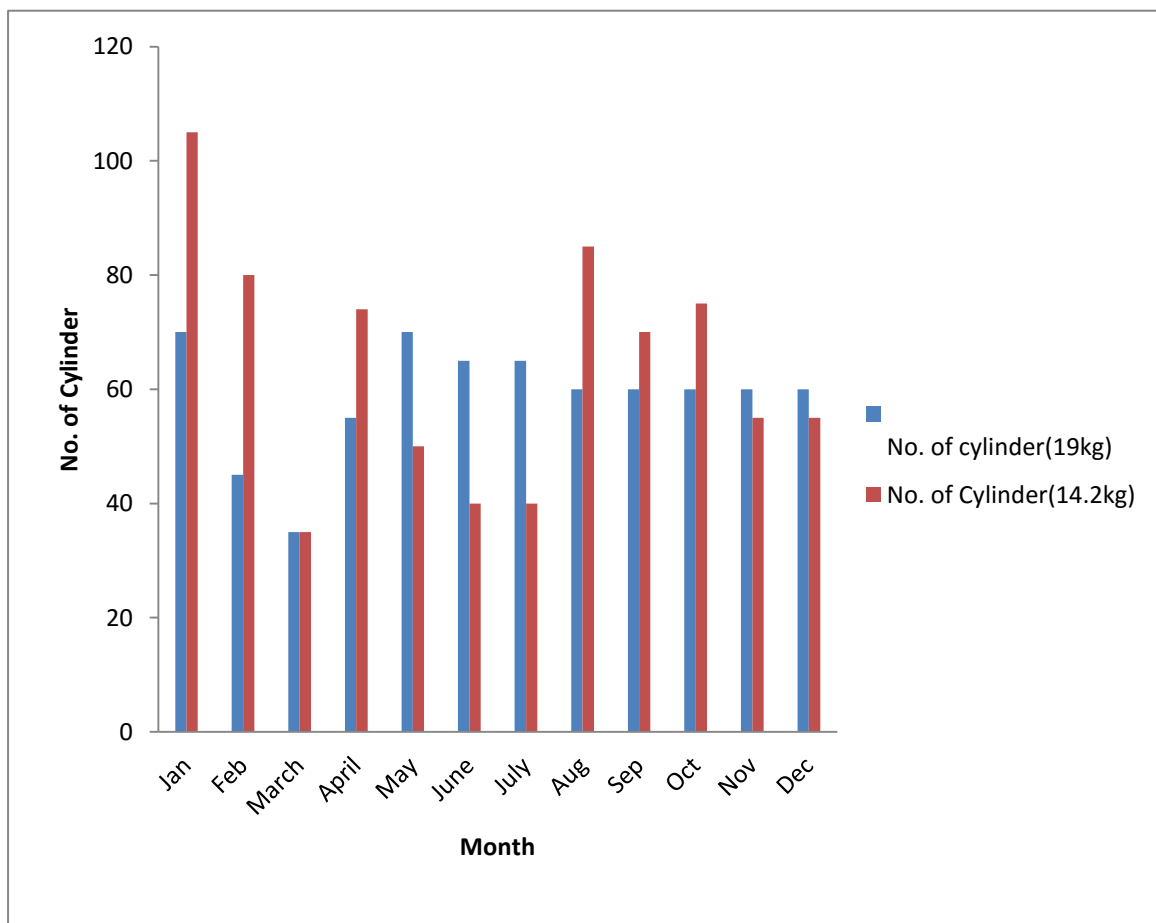


Figure 6.1 shows no of cylinder use in j hostel

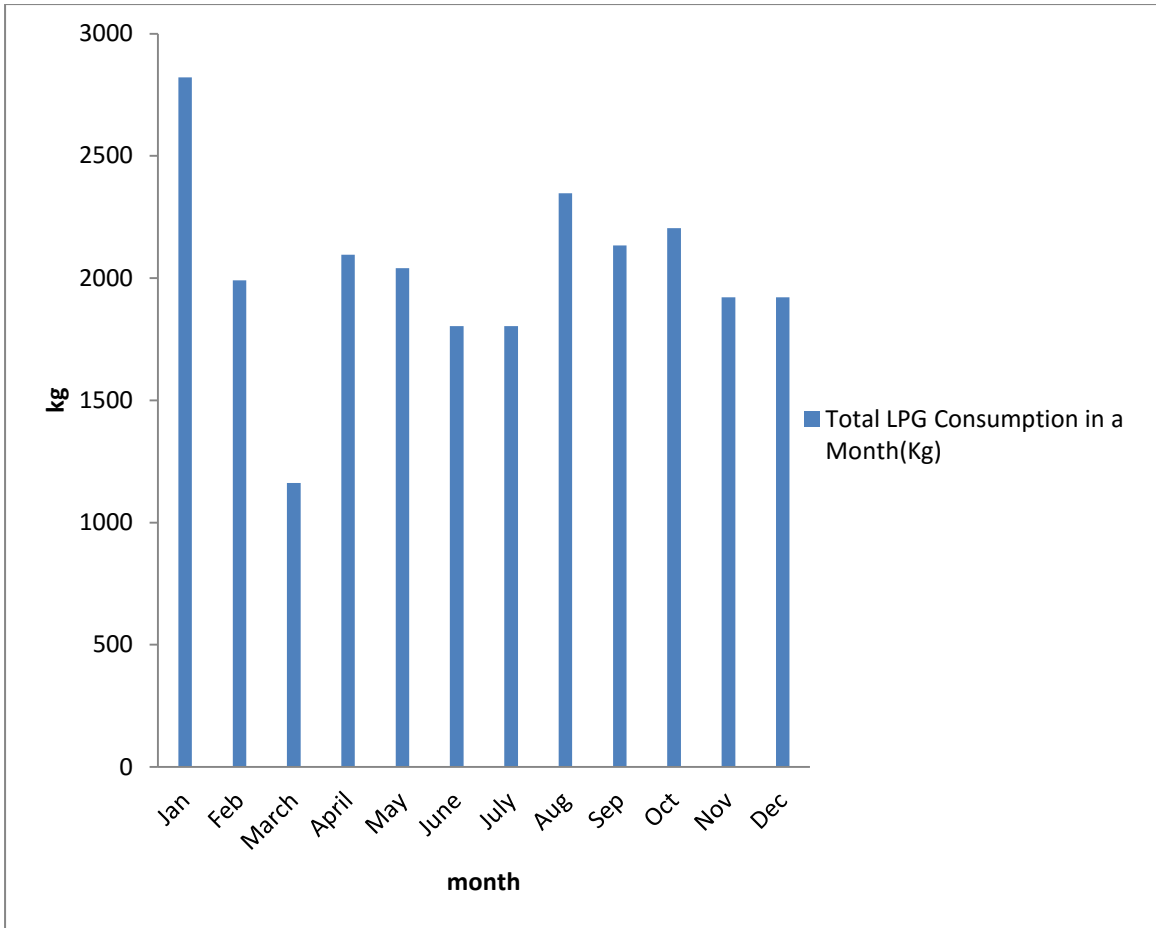


Figure 6.2 shows per month total LPG consumption

Total LPG per year (kg) = 24243.8

Mess working day = 340 days

Per day LPG Consumption = $\frac{24243.8}{340} = 71.27$ kg

No. of student/Guest = 950

Per person LPG consumption = 0.07 kg/day

(1 Kg = 13.6 kWh)

0.026 kg/day = 1.02 KWH/day = 877.6 kcal/day

(1kWh= 860.42 kcal)

According to above data and calculation per person energy consumption is 877.6kcal/day

6.5 Design of Micro Gasifier (Top Lit Up Draft)

Inner cylinder, lower part (Fuel chamber)

Lower half of inner cylinder is a important part of TLUD Micro gasifier, this lower part known as the fuel cylinder or fuel chamber. For attain maximum temperature or peak temperature, it should be made of steel. Diameter of fuel chamber is 8 to 8.5 inches (200 to 212.5mm) and height of fuel chamber is 5 to 5.5 inches (125 to 137.5mm). Lower section of fuel chamber has a well-sealed. There is no chance of any leakage.

Primary air inlet

In fuel chamber, there should be a constructed a horizontal air duct, which is made by steel sheet. Diameter of duct is 4 inches (100mm). Structure of duct is cylindrical because it allows easy blowing when, during cooking, the user require high rate of heat generation. Primary air should distribute freely inside the fuel chamber, under the grate that supports the fuel directly above. We never want that air flow along the walls because it creates incomplete combustion and unequal rate of Pyrolysis. So we have to cut bottom half (underside) of the central portion of air duct. Length of the metal for duct is 11to13inches (275 to 325 mm), being 1.5 inch at the inner end for tabs to be bend inside, remaining 6.5 inches (162.5 mm) inside the fuel cylinder, near about 5 inches (125 mm) continuing as the outside. The outside portion could be shortened late Figure 6.2 shows the primary air inlet



Figure 6.3 Primary air inlet

Fuel grate

The division of the horizontal duct that is inner side of lower fuel container provide support to metal grate. Metal grate holds up the fuel. Stretched steel with a small mesh (1/8 inch or 3 mm spaces) is best for complete combustion. According to size of fuel pieces grate size can be vary. The grate can be located in place by pressure against the sides and/or by a

sufficiently long screw coming up through the bottom of the fuel cylinder, continuing through the upper part of the primary air inlet duct, and finally through the grate.

Outer cylinder

Purpose of outer cylinder is:

- Work of outer cylinder provides channel and pre-heat the secondary air. This secondary air rises and crosses up the top of the inner fuel cylinder in the gap under the concentrator lid. It also reduces the high heat which the fuel cylinder is subjected
- concentrator lid support by outer cylinder
- Outer cylinder supports the fuel chamber near about 12 to 16 mm above the bottom of the unit. It reduces chance of damage from heat, which is generated by inner chamber.

Diameter of the outer cylinder is 1 to 1.5 inches (25mm to 35mm) larger than the inner cylinders. The gap between two main cylinders is near about .6 to .8 inches. Diameter of the outer cylinder is slightly less than 10 inches (250mm) because we have to place concentrator lid over the cylinder. So the diameter of outer cylinder is 9 to 11 inches (225 to 275mm) and height of outer cylinder is 14(350mm) inches. The outer cylinder has a rectangular hole for primary air inlet duct. The area of this rectangular hole is 5 x 6 inches (125 to 150mm). Figure 6.3 shows the outer cylinder



Figure6.4 Outer cylinder

Handle

Handles are necessary for the Micro gasifier. It provides user's convenience. Handle do not affected the gasification and combustion operation of the TLUDs. Important thing about handle is that position, length, shape, safety, and conduction of heat. The radial handle is 10 inches (250mm) long and this is made by non-heat-conductive (usually wood).

Concentrator lid, with handle

The concentrator lid is a flat plate of steel with a 3.5inch (87.5 mm) hole in the centre. The metal should cover the whole top of the outer cylinder. It should be detachable for easy placement and removal. Diameter of concentrator lid is 9.5 to 11.5 inches (237.5 to 287.5mm) .It have a downward collar edge of 1.5 to 2.5 inches (37.5 to 62.5 mm) is required to reduce the effect of wind in under the lid . Never make the collar tall because the lid should be easily lifted. Handle of lid concentrator made by non- conductive heat material (Wood).

Upper part of the inner fuel chamber

This is the last component to be assembled because it plays a important role in micro gasifier. It is related to variations relating to the different parts, secondary air supply and the materials. From top side height difference between inner cylinder and outer cylinder is .5 inches (12.5mm).This gap provide entry of secondary air. If the gap is too small resulting insufficient secondary air, extra Pyrolysis and incomplete combustion .If the gap is large, the situation is reversed the natural draft will provide extra secondary air , due to this extra secondary air very less amount of heat reach to the pot. Diameter of upper part of the inner fuel chamber is 4.9 to 5.4 inches (122.5 to 135 mm) and height of this chamber is 9.5 inches (237.5 mm).

Riser

For natural draft riser is require. It is also known as a short internal chimney before the flames and heat reaches utensil. Diameter of cylindrical riser is 5 to 5.5 inches (125 to 137.5 mm).It is placed at the centre of concentrator lid. The height of riser is 4.5 to 5.5 inch (112.5to 137.5 mm).

Damper

Damper is use to control primary air. It located at the top of outer duct, which is outside the fuel chamber. Structure of damper is cylindrical. Diameter of damper is 4.2 inches and it controls the primary air. We can regulate the flow of air by damper. It is made by steel sheet and we can operate it manually[46]

6.6 Front View of Micro Gasifier With Dimension

Figure 6.5 shows the front view of designed Micro gasifier (Top lit up Draft) with dimension.

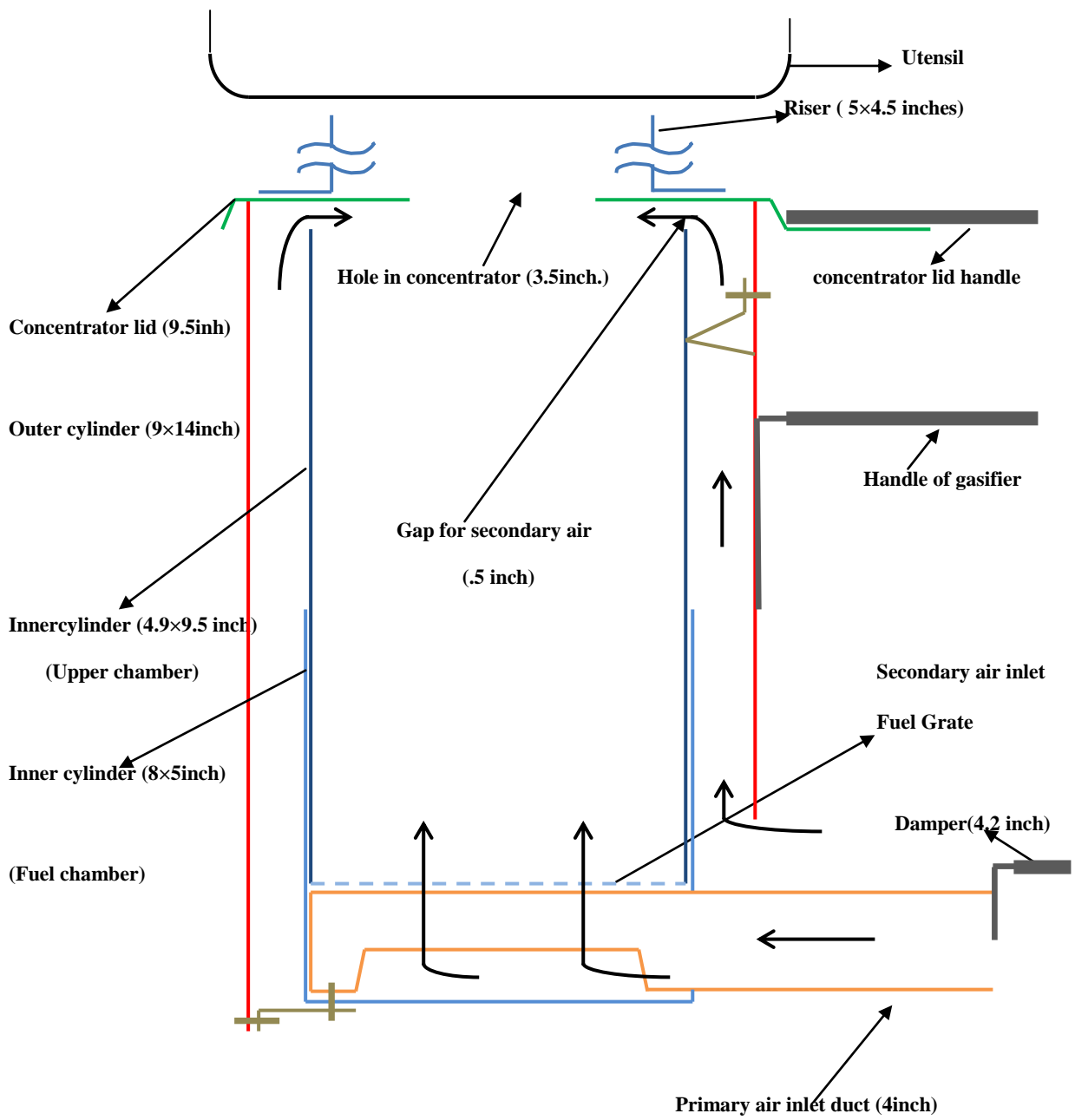


Figure 6.5 shows Front view of Gasifier

6.7 Working of Micro Gasifier

To know the working of Micro gasifier we have to apply some principles to optimise it's working. Four stage or steps of Micro gasifier working are written below

- Drying
- Pyrolysis
- Wood gas Combustion
- Char gasification

Drying

In this processes biomass heat up to 100 C. Moisture contain which are present in biomass is evaporate in atmosphere. Solid biomass left after drying processes. By doing this processes efficiency Micro gasifier will increase and complete combustion take place in reactor. Problem of smoke also reduce for doing this step.

Pyrolysis

After drying processes we get solid biomass. First of fall solid biomass in form of pellet put in the fuel chamber. Solid biomass put on the fuel grate after that small amount of starter fuel is used to burn biomass. When solid biomass attain 300 °C , Pyrolysis processes is starts. Pyrolysis processes take place in absence of oxygen. Primary air duct provide air for this processes. Primary air creates turbulence for complete combustion. Pyrolysis processes produce wood gas. Wood gas is a mixture of carbon mono oxide and hydrogen. Wood gas moves to upward direction due to natural draft. Wood gas is a combustible gas. After Pyrolysis process solid residue left, this solid residue called char. We can further use it as a fuel and it also use in soil for increasing soil retention.

Wood Gas Combustion

This process is required oxygen which is providing by secondary air. From Pyrolysis process wood gas produce which is mixture of carbon mono-oxide and hydrogen. Wood gas moves

upward from fuel chamber to concentrator lid. Where it is react with oxygen, oxygen is present in secondary air. Now the mixture of wood gas and secondary is ready to burn. This mixture is ignited by a spark and flame will generate. This process is known as combustion. Wood gas combustion is exothermic oxidisation reactions. After ignition of gas riser cover the concentrator lid. We can use heat from gas for cooking purpose.

Char gasification

Char gasification is an exothermic oxidisation reaction. Char require oxygen for gasification. Further we can use char for cooking process. In this step solid char converted in to ash. Char gasification is independent of the combustion processes and it only take place when excessive oxygen reaches the red hot char while it is still hot enough to react.(500C). Oxygen reacts with char and produce carbon mono-oxide. This carbon mono-oxide adds to the wood gas cloud of combustible gas. After this process char is converted in ash, which is not combustible. Figure 6.6 shows the working of Micro gasifier

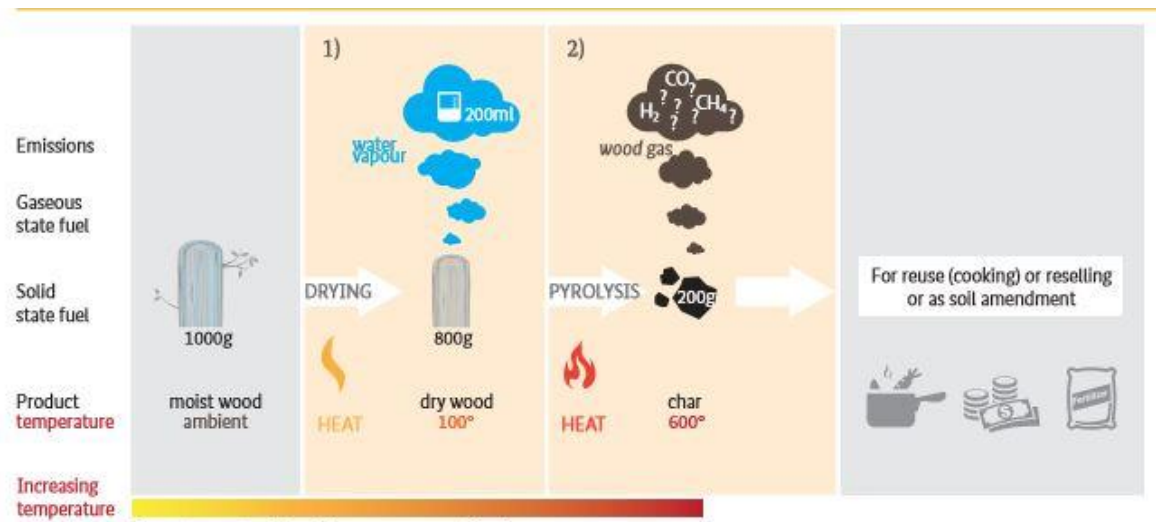


Figure 6.6 shows the working of Micro gasifier combustion process [45]

Energy consumption data of Thapar University is collected and analyzed. From literature review various methods and new technology were suggested to reduce the energy wastage in University campus. From electrical energy data analysis realize that maximum energy consume by air conditioning systems, lighting systems and fans. If all the old lighting systems is replaced by LED lights and old fans are replaced by rated fans, we can save very large amount of electricity. Life of advance technology systems is more and maintenance cost is very less. Investment for this approach will be covered in a few years .It is observed that in university campus students are not aware about energy conservation so programme related to energy conservation run by management. In university campus large amount of electric geysers are used, it can be replaced by solar geysers. It is also observed that old sodium vapour metal halide used for street light, which consume more power and provide less illumines. So all sodium vapour halide are also replaced by LED. Regularly maintenance and repair of appliance reduce the energy consumption. During the time of survey it is observed that maximum air conditioner works on a 18°C , if temperature of air conditioner is set on 26°C , this approach saves 20 % electricity consumption. As a result of which electrical energy consumption of the university is decreases and a significant saving of 10, 53,896 kWh (63, 23,376 Rs) is calculated. Some suggestions were also describe to increase the efficiency of electrical equipment air of the institution. LPG consumption in hostels is 103167 kg per year. If Micro gasifier used for cooking, we can save LPG consumption.

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ANNEXURE

Air Conditioner

S.N	LOCATION	QTY
1	UG-CS LAB	7
2	UG-CS LAB (SERVER ROOM)	1
3	SYSTEM ANALYST (VP SINGH)	1
4	ASSOC.PROF. S.MANINDER SINGH (OFFICE)	1
5	PROF.Mrs seema bawa OFFICE	1
6	PHD LAB	2
7	HEAD OF DEPTT. (OFFICE)	1
8	RESEARCH LAB (old cyber)	2
9	ME-CSE LAB (A-B block 2nd floor)	4
10	ME-IS LAB (A-B block 2nd floor)	4
11	COMP GAMING (A-B block 2nd floor)	4
12	COMP MACHINE LEARNING LAB 2ND F	4
13	UG-LAB-1 (A,B)	5
14	ME-SE LAB	3
15	UG CS LAB 1-A RN 307 G BLOCK	3
16	UG CS LAB 1-B RN 308 G BLOCK	3
17	UG CS LAB 1-C RN 309 G BLOCK	3
18	RESEARCH LAB (ROOM NO 201) G	2
19	DIRECTOR'S OFFICE (hot & cold)	1
20	DIRECTOR'S OFFICE	1
21	DIRECTOR'S PA OFFICE (hot & cold)	2
22	B.O.G. OFFICE	4
23	COMMITTEE ROOM	2
24	DEAN OFFICE (DOCA) L-101	1
25	DEAN OFFICE (DOR&SR) L-102	1
26	DEAN OFFICE (DOR&SR) L-102	1
27	COE ROOM L 103	1
28	DEAN OFFICE (DOAA) L-104	1
29	DEAN OFFICE (DOSA) L-105	1
30	OLD DYPUTY DIR OFFICE	2
31	WIRWLESS MOBILE COMM.LAB C BLOCK	6
32	DSP LAB C 203	4
33	DEPTT. LIBRARY (1ST FLOOR - C- BLOCK)	2
34	VLSI LAB	5
35	ANTTENNA RESEARCH LAB (MR. KHANNA LAB)	3
36	SIGNAL PROCESSING LAB (PHD STUDENT)	1
37	MICRO CONTROLLER EMMBEDDED LAB C202	2

38	TEXAS SPONSORED LAB	2
39	HOD OLD OFFICE ROOM(L-208)	1
40	PCB LAB	3
41	ANTTenna & MICROWAVE LAB (B 202)	2
42	V.I. LAB	2
43	BIOMEDICAL LAB	2
44	DEPTT. LIBRARY	1
45	I.S.D. LAB	3
46	POWER SYSTEM SIMULATION LAB	3
47	FREESCALE LAB	4
48	BIO MEDICAL RESEARCH LAB	1
49	RESEARCH LAB 1 (DBTS)	3
50	RESEARCH LAB 2	2
51	Research lab 3	2
52	RESEARCH LAB 4	1
53	Assoc Prof. M GOSH OFFICE ROOM	1
54	BIOINFORMATICS LAB	2
55	PRACTICAL LAB	1
56	PRACTICAL LAB	1
57	SEMINAR ROOM (DBTS)	1
58	HEAD'S OFFICE (DINESH GOYAL)	1
59	LAB 3 (MICRO BIOLOGY LAB)	1
60	PAU/ADMIN Office	1
61	HEAD'S Office (N. CHANDRA)	1
62	Meeting room NO 114	2
62	Lab Inchage office	1
63	fuel & oil test lab R no. 113	1
63	R no. 112	1
65	Image analysis lab R no. 110	1
66	Toxi lab R no 205	1
67	instument lab (2)Rno.204	1
68	instument lab (4)Rno.209	1
69	instument lab (5)Rno.210	2
70	Microbiology lab Rno.202	4
71	XRD ROOM	3
72	Prof. incharge office	1
73	SEM&EDS ROOM	3
74	Soil testing lab block 2	1
75	N.M.R. LAB	2

Lab equipment

1	LAMINAR AIR FLOW CLASS-1	7
2	REFRIGERATED CENTRIFUGE(HITACHI)	4
3	AUTOCLAVE	5
4	UV-VIS SPECTROPHOTOMETER	5
5	WATER BATH	5
6	HOT AIR OVEN	2
7	REFRIGERATED MICRO CENTRIFUGE	3
8	BINOCULAR MICROSCOPE	33
9	WEIGHING BALANCE OPEN TYPE	3
10	WEIGHING BALANCE CLOSETYPE	5
11	REFRIGERATOR	9
12	MICROWAVE	5
13	MAGNETIC STIRRER	3
14	VORTEX	4
15	DEEP FREEZER(-20 C)	5
16	ULTRA FREEZER(-80 C)	2
17	INCUBATOR SHAKER	7
18	CONDUCTIVITY METER	2
19	Shoe Rack 4'x5'x14"	1
20	Display Board 4'x3'	1
21	Matalab (Installed in PC's)	15
22	Optsim V. 4.0 Software	1
23	Scanner SJ4670 HP	1
24	Laserjet Printer HP 2015	1
25	Scanner HP4890	1
26	Microsoft Office 2003	5
27	Upgrade Version of Optism 4.6	1
28	HP Laserjet Prinert 3 in 1	1
29	Hp 1522 nf Printer	1
30	UP600 University Programme for T16000 DSP	1
31	IBM Laptop Core 2	2
32	Matalab MW-RF -Tool Box	25
33	Video & Imaging Kit SMT 8039	1
34	Curve Tracer	1
35	Logic analyzer	2
36	Digital multimeter	4
37	Capacitance substitution box	6
38	Resistance substitution box	6
39	HM-5030 Function generator	2
40	HM-5035-Pulse generator	4
41	Stepper motor 6kg/cm	6
42	Analog Multimeter	1

43	Breadboard MU-112	7
44	Breadboard MU-124	120
45	Breadboard MU-123	2
46	Breadboard MU-121	11
47	Digital trainer	9
48	O/P power supply (FPS-844)	18
49	12 bit 16 channel A/D and D/A convertor card	2
50	Digital input output timer counter card	2
51	IEEE-488 Adapter card	2
52	16 channel opto isolated card	2
53	Stepper motor controller card	2
54	Stepper motor driver card	3
55	EDWDM (Component)	1
56	DWDM Extension	1
57	BER (COM)	1
58	Spectrum analyzer (WDM) 8000 Base Unit/ optical	1
59	Two Channel Oscilloscope TDS 2000 (Tektronix)	1
60	Artifix 5 user software for DWDM optical network	1
61	fiber optics kit MCM40/EV	2
62	power meter	1
63	Digital multimeter	1
64	Scientific PSD3304 multiple power supply	1
65	Sciencetech ST251 CRO	1
66	PHILIPS PM 2525 multimeter	1
67	Laser transmitter model no 400	2
69	O/E converter model no 310A	2
70	AVR Microcontroller Kit	2
71	Graphical LCD Display Interface	1
72	Sensor Interface Board	1
73	Temperature Measurement Board	1
74	Motion Control of a CAR model	1
75	ARM-7 Development Board	3
76	PC Interface Development Board	1
77	Embedded Biometric Application system	2
78	Embedded 8051 TCP/IP Application Board	2
79	8085 Microprocessor Kit	20
80	Stepper Motor Interface Module	20
81	Musical Tone Generator Interface Module	20
82	ADC/DAC Temperature Interface Module	17
83	Elevator Interface Module	20
84	DC Motor Interface Module	20
85	Traffic Light Interface Module	20