DESIGN OF ENERGY EFFEICIENT BUILDING

A Thesis report Submitted towards the partial fulfilment of requirements of the degree of

MASTER OF ENGINEERING

In

POWER SYSTEMS & ELECTRIC DRIVES

Submitted by:

GAGAN WADHWA
Roll No: 800841022

Under the Supervisions of:

MR. PARAG NIJHAWAN
Assistant Professor

&

MR. SHAKTI SINGH

Assistant Professor

ELECTRICAL AND INSTRUMENTATION ENGINEERING DEPARTMENT

THAPAR UNIVERSITY, PATIALA, PUNJAB-147004

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CERTIFICATE

I hereby certify that the work which is being presented in the thesis entitled "**Design of energy efficient building**", in partial fulfillment of the requirement of the award of degree of Master of Engineering in **Power Systems & Electric Drives** submitted in Electrical & Instrumentation Engineering Department of Thapar University, Patiala, is an authentic record of my own work carried out under the supervision of **Mr. Parag Nijhawan and Mr. Shakti Singh** Assistant. Professor, EIED.

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

15/07/2010
(GAGAN WADHWA)

This is to certify that the above statement made by candidate is correct and true to best of my knowledge.

15/07/2010
(PARAG NIJHAWAN)
Assistant Professor
EIED, ThaparUniversity,
Patiala.

10/07/10
(SHAKTI SINGH)
Assistant Professor
EIED,ThaparUniversity,
Patiala.

Countersigned by

15/7/10
(DR. SMARAJIT GHOSH)
Professor & Head
EIED, Thapar University,
Patiala

(DR. R.K SHARMA)
Dean (Academic Affairs)
Thapar University,
Patiala.

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ABSTRACT

This report is an overview of design of energy efficient building by using solar based energy efficient technologies. The purpose of this thesis is to examine the cost and feasibility of using photovoltaic solar power to assist in the rebuilding of the infrastructure. The thesis examines available solar equipment and technologies coupled with requirements for operation, installation and maintenance of such systems. The report addresses available commercial solar equipment and emerging technologies that enhance such systems. This section addresses areas including installation, operation, maintenance, and durability

Finally, the report presents the results of investigations on the application of photovoltaic PV power generating systems for utilization in Thapar university j-hostel with a typical residential load. Generation and storage units for each system are properly sized in order to meet the annual load and minimize the total annual cost to the customer. In addition, an economic analysis has been performed for the PV scenarios and is used to justify the use of renewable energy versus constructing a line extension from the nearest existing power line to supply the load with conventional power.

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LIST OF OBSERVATION

PV	-	Photovoltaic
BIPV	-	Building Integrated Photovoltaic
KWh	-	Kilo Watt Hour
MW	-	Mega Watt
MPPT	-	Maximum Power Point Tracking
NPC	-	Net Power Consumption
ODC	-	Overall Discounted Cost
PI	-	Profitability Index
R	-	Resistance
HVAC	-	High Voltage Alternating Current
PVC	-	Poly Vinyl Chloride
PTC	-	Power Test Centre
EC	-	Energy Consumption
STC	-	Static Array
AC	-	Alternating Current
DC	-	Direct Current
BOS	-	Balance of System Equipment

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1.1INTRODUTION OF ENERGY EFFICIENT BUILDING

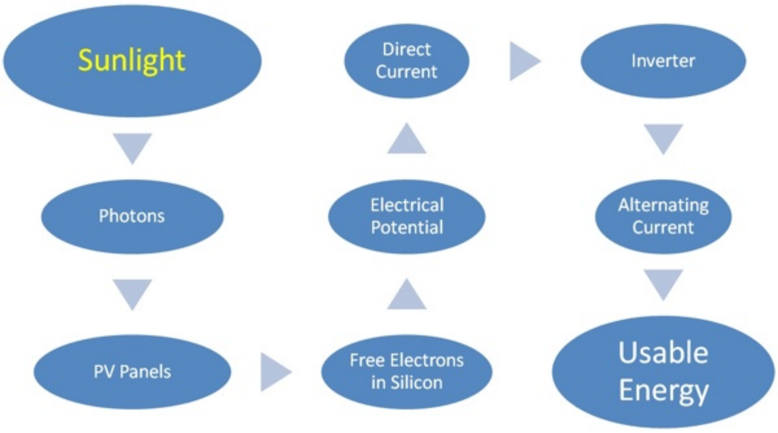
Buildings are designed and used today to contribute the serious environmental problems because of excessive consumption of energy and other natural resources. Energy efficiency in new constructions can be affected by adopting an integrated approach to building design. Many of these buildings have high energy consumptions when compared to other efficient buildings some buildings appeared to be energy efficient in the design stage but evolved into energy-guzzling buildings by the time the building was actually occupied. We have also observed traditionally designed buildings that are claimed to be energy efficient simply by installing a single efficiency device that are only the best affect of a tiny fraction of the building’s total energy use. Designers of other buildings have claimed that their buildings are efficient simply because they meet the minimum efficiency regulations. The energy regulations, energy rating schemes, shared-savings programs, and utility forecasts are all based on some aspect of energy efficiency. The operation of buildings has a tremendous impact on the world’s natural resources and the environment. Buildings are a major source of the pollution that causes urban air quality problems, and the pollutants that contribute to climate change. They account for 49 percent of sulphur dioxide emissions, 25 percent of nitrous oxide emissions and 10 percent of particulate emissions of which damage urban air quality. Buildings produce 35 percent of the country's carbon dioxide emissions the chief pollutant blamed for climate change. The solution to overcoming these problems will be to build them green and smart so that they consume non-renewable energy to produce a minimum of pollution and cost a minimum of energy dollars while increasing the comfort, health and safety of the people who live and work in them. The resources are utilized to maintain the working and living conditions are significantly contribute to the use and waste of resources that have a negative effect on the environment. Simple measures can be implemented to improve energy use to enable the city to contribute to creating a more sustainable environment. The intent of energy efficient building design is to reduce the need for energy consumption electricity, natural gas etc for heating, cooling and lighting. Use of materials with low embodied energy also forms a major component in energy efficient building designs.

1.2 IMPORTANCE OF ENERGY EFFICIENT BUILDING.

The traditional approach to architectural design and thinking is a static one in which the building has been optimally sized and finished. In this procedure and especially as far as service go optimums sizing means calculating the agreed upon extreme conditions and then sizing the different elements accordingly. A building feels hot or cold it behaves like that it should be able to put on or take off extra clothing be able to sit out wind in the sun or shade as necessary. Traditional buildings consume more of the energy resources than necessary negatively impact the environment and generate a large amount of waste. Smart green building practices offer an opportunity to create environmentally friendly and resource-efficient buildings through using an integrated approach to design and operate. Among other advantages smart green buildings promote resource conservation including energy efficiency and renewable energy features consider environmental impact and waste minimization and reduce operation and maintenance costs. National and local programs encouraging green buildings are growing and reporting successes, while hundreds of demonstration projects and private buildings across the country provide tangible examples of what green building can accomplish in terms of comfort, aesthetics and energy and resource efficiency .

1.3 INTRODUCTION TO SOLAR ENERGY

The energy consumption in the world particularly in the industrialized countries has been growing at alarming rate. Fossil fuels which today meet major part of the energy demand are being depleted quickly. World bas started running out of oil and it is estimated that 80% of the world's supply will be consumed in our lifetimes. Coal supplies may appear to be large but even this stock may not last longer than a few decades. More over the pollution hazard arising out of fossil fuel-burning is become quite significant in recent years. Nuclear power has proposed a number of problems and nuclear fusion is still a speculative technology. Thus we are forced to look for unconventional energy sources such as geothermal ocean tides, wind and sun. It is also hoped that these alternative energy sources will be able to meet considerable part of the energy demand. Various types of unconventional energy sources are such as geothermal ocean tides, wind and sun. All unconventional energy sources have geographical limitations but Solar energy has less geographical limitation as compared to other unconventional energy sources because solar energy is available over the entire globe and only the size of the collector field needs to be increased to provide the same amount of heat or electricity. It is the primary task of the solar energy system designer to determine the amount of quality and timing of the solar energy available at the site selected for installing a solar energy conversion system so among all these solar energy seems to hold out the greatest promise for the mankind. It is inexhaustible, non-polluting and devoid of political control. Solar water heaters, space heaters and cookers are already on the market and seem to be economically viable. Solar photo voltaic cells, solar refrigerators and solar thermal power plants will be technically and economically viable in a short time. It is optimistically estimated that 50% of the world power requirements in the middle of 21st century will come only from solar energy. Enough strides have been made during last two decades to develop the direct energy conversion systems to increase the plant efficiency 60% to 70% by avoiding the conversion of thermal energy into mechanical energy. Still this technology is on the threshold of the success and it is hoped that this will also play a vital role in power generation in coming future.



1.4 BENEFITS OF SOLAR ENERGY

1. Solar energy is renewable. We never have to worry about running out of sunlight or using it all up. The sun is a consistent power source meaning it's always going to be there every day.
2. Solar energy is environmentally friendly. Compared to fossil fuels which release greenhouses gases, carcinogens and carbon dioxide, solar cells don't release anything into the air
3. Solar panels are extremely reliable. There are no moving parts so you don't have to worry about replacing anything. In fact, most people generate electricity for 1000s of hours with little or no maintenance.
4. Solar cells make no noise while collecting energy. There are no other renewable energy sources that are completely silent.
5. In the long run, solar electricity is cheaper than buying it from the power company. There is a start up cost, but then it starts paying for itself. Once you break even, everything after that is profit. Compare this to paying a monthly bill and getting no return on investment.
6. There is a huge variety of solar panel systems available. Some can cost tens of thousands of dollars, and some cost just a couple hundred. This means anyone can get into solar, there's an entry point for just about everybody.
7. You're not required to connect to the power grid. You can be completely self-sufficient and live off-the-grid. Imagine never paying another monthly bill or hook-up charge.
8. Sell excess electricity. If you build a large enough solar panel system, you can make your electric meter spin backwards! Most power companies will gladly buy or credit you for this excess electricity. Contact your local power companies for more details.

9. Government tax credits. Most governments will provide some kind of tax credit or incentive for people purchasing solar energy systems. On average, rebates usually cover 20-30% of the system cost. Contact your local representatives for more details.

Solar technology is constantly improving. Solar installations are increasing by an incredible 50% every year, most of which are small homemade systems. Learn how to make your own solar panels and use the benefits of solar energy to your advantage.

1.5 ENERGY FROM SUN

In one minute, the sun provides enough energy to supply the world's energy needs for one year. In one day, it provides more energy than the world's population could consume in 27years. The energy is free and the supply is unlimited. All we need to do is find a way to use it. Since India has abundant sources sunlight and it can cater to all the energy needs of the country. The country receives an average radiation of 5 KWh per square metre per day and with 2300 to 3200 sunshine hours per year. The potential of solar photovoltaic has therefore been estimated at 20 MW per square km and that of solar thermal applications at 35 Mw per sq m.

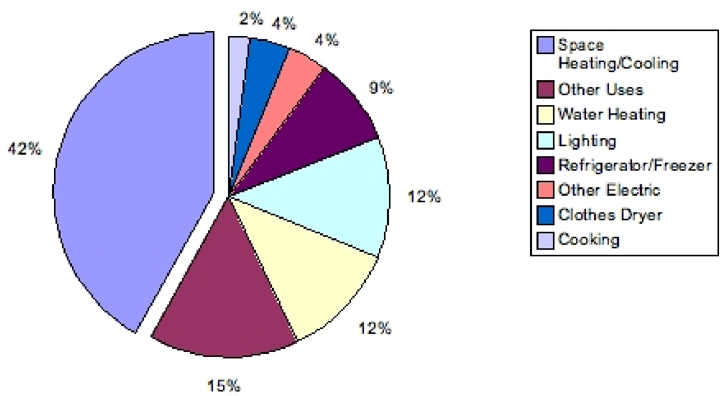


Figure1: Energy consumption

1.6 ENERGY SCENARIO IN INDIA 2010

In India and all over the world, a variety of sources of energy are in use. Like firewood, agricultural waste, animal dung and human power are the traditional sources of energy which are still continue to meet the bulk of energy requirements in rural India. These traditional fuels are gradually getting replaced by commercial fuels such as coal, petroleum, natural gas and electricity. It has been estimated that 60% of total energy requirement in India is derived from commercial fuels and non-commercial fuels contributes the rest 40%. Total energy produced in the form of electricity, is 60% from coal, 25% from hydel power, 4% from diesel and gas, 2% from nuclear power and less than 1% from non-conventional sources like solar, wind, ocean, biomass, etc. In developing country like India-greater the availability of energy, more is the shortage. There is phenomenal increase in power generating capacity, still there is no electricity in many rural areas and even cities, and electricity available is 30% less than the requirements.

	1996-2001	2001-2010	2010-2020	2020-2030	2030-2040
Biomass	2%	2.2%	3.1%	3.3%	2.8%
Large hydro	2%	2%	1%	1%	0%
Small hydro	6%	8%	10%	8%	6%
Wind	33%	28%	20%	7%	2%
PV	25%	28%	30%	25%	13%
Solar thermal	10%	16%	16%	11%	7%
Solar thermal electricity	2%	16%	22%	18%	15%
Geothermal	6%	8%	8%	6%	4%
Marine	-	8%	15%	22%	21%

Table 1: Energy Renewable Technologies

Energy is the prime mover of economic growth and is vital to the sustenance of a modern economy. Future economic growth crucially depends on the long-term availability of energy from sources that are affordable, accessible and environmentally friendly. India ranks sixth in the world in total energy consumption and needs to accelerate the development of the sector to meet its growth aspirations. The country, though rich in coal and abundantly endowed with renewable energy in the form of solar, wind, hydro and bio-energy has very small hydrocarbon reserves 0.4% of the world's reserve India, like many other developing countries, is a net importer of energy, more than 25 percent of primary energy needs being met through imports mainly in the form of crude oil and natural gas. The rising oil import bill has been the focus of serious concerns due to the pressure it has placed on scarce foreign exchange resources and is also largely responsible for energy supply shortages. The sub-optimal consumption of commercial energy adversely affects the productive sectors, which in turn hampers economic growth.

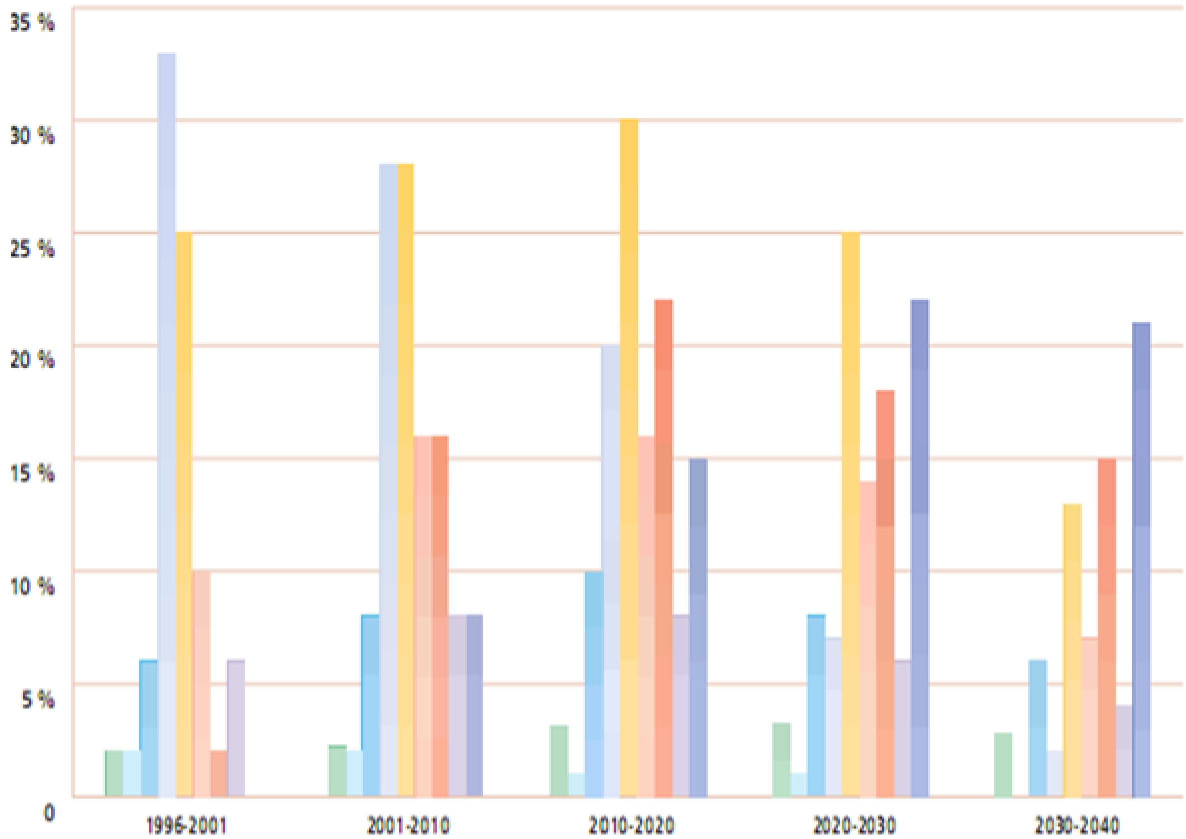


Figure 2: Energy Renewable Technologies

If we look at the pattern of energy production, coal and oil account for 54 percent and 34 percent respectively with natural gas, hydro and nuclear contributing to the balance. In the power generation front, nearly 62 percent of power generation is from coal fired thermal power plants and 70 percent of the coal produced every year in India has been used for thermal generation.

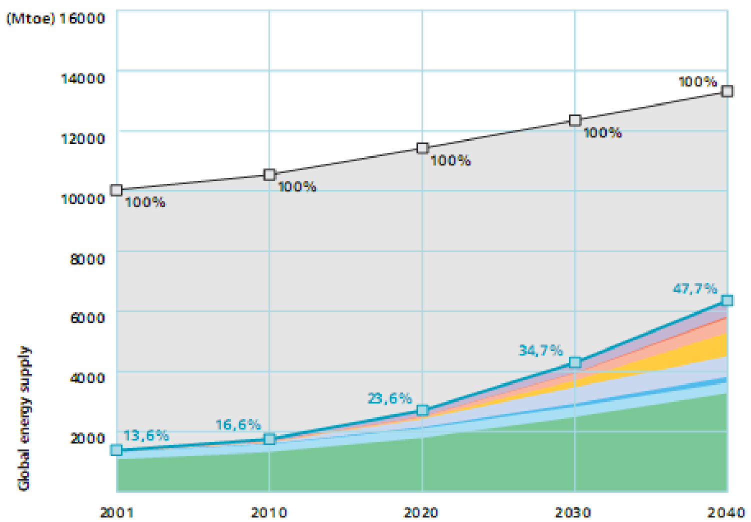


Figure 3: Global Energy Supply

1.7 LITRATURE VIEW

Several works are going on energy efficient building and photovoltaic systems. Some of these are discussed below:

Guide booklet of energy efficient building [1] Energy consumption in residential buildings in amounts to 22% of the total energy consumption in the country, so applying energy efficient principles in these buildings is of major importance. However, the design of most residential buildings does not take into account energy efficient principles such as proper orientation and layout, and the need to maximize the benefits from natural elements such as sun and wind, which can lead to much more effective heating and cooling.

Ajit K. Gupta. [2] India – eu cooperation in renewable energy pecial focus on solar energy. India has made considerable progress in harnessing new and renewable sources of energy such as solar. A renewable power capacity of over 13,500 MW has been installed, which is about 8% of the total installed capacity in the country and contributes about 3% to the electricity mix. Major contribution of 9500 MW has come from solar power. Renewable energy is also being deployed for a variety of decentralized applications. Over 1.5 million solar lighting systems have been deployed,

Renewable energy scenario upto 2040 [3] Renewable sources of energy are in line with an overall strategy of sustainable development. They help reduce dependence on energy imports, or do not create a dependence on energy imports in countries that will have increased energy needs in the future, thereby ensuring a sustainable security of supply. Furthermore, renewable energy sources can help improve the competitiveness of industries and have a positive impact on regional development and employment. Renewable energy technologies are suitable for off-grid services, serving those in remote areas of the world without having to build or extend expensive and complicated grid infrastructure.

Photovoltaic system design [4] Photovoltaic solar generation has become of considerable interest in recent years. ‘Capacity credits’ for renewable energy are being established to promote the use of alternative forms of generation. As an example there has been a concentration of interest in solar generation sources, with an average of over three hundred sunny days per year, much of the focus is on residential solar energy. Solar power alone is a non dispatch able source, but when combined with other assets, such as battery storage, it can be dispatch able.

“Photovoltaic Systems” [5] PV systems are being installed by Texans who already have grid-supplied electricity but want to begin to live more independently or who are concerned about the environment. Photovoltaic’s offer consumers the ability to generate electricity in a clean, quiet and reliable way. Photovoltaic systems are comprised of photovoltaic cells, devices that convert light energy directly into electricity. Because the source of light is usually the sun, they are often called solar cells. The word photovoltaic comes from “photo,” meaning light, and “voltaic,” which refers to producing electricity. Therefore, the photovoltaic process is “producing electricity directly from sunlight.” Photovoltaic are often referred to as PV. Photovoltaic (PV) systems convert sunlight to electric current. You are already familiar with some simple PV applications in today’s society, such as calculators and wristwatches. More complicated systems provide power for communications satellites, water pumps, and the lights, appliances, and machines in homes and workplaces. Many road and traffic signs along highways are now powered by PV.

“Solar Photovoltaic” [6] Photovoltaic power generation has been receiving a considerable attention as one of the most promising energy alternatives. To evaluate the performance of the PV modules exposed to different climatic conditions. The I-V characteristics, open circuit voltage, Short circuit current. The maximum output power and the efficiency of PV modules should be determined. Kendal (1992) concluded that the increase of solar radiation incident on the PV module increases most of the parameters affecting the module performance especially, short circuit current maximum power, and module efficiency. It is know that the yearly optimum tilt angle of flat plate PV modules to collect the maximum yearly incident solar energy is equal to the local latitude, Duffle and Beckman (1991).

Tymandra Blewett, Margaret Horne and Robert Hill [7] proposed a “method to avoid shadowing of building integrated photovoltaic systems”. Shadowing decreases the output power of module by high performance losses, often much higher than originally estimated. In urban areas shading cannot be avoided and therefore methods to accurately predict PV facade and/or roof system shading patterns must be developed. By utilizing a Heliodor, normally used by architects to predict natural interior lighting effects, accurate seasonal shading by surrounding structures can be assessed on a 3D scale model of the proposed PV array. In order to test this Heliodor Prediction Method they have made comparisons between photographs of the shading on both the model of and actual Northumberland Building PV Facade in the UK.A study of the Northumberland Building's annual shading has been undertaken and photographs taken under Heliodor conditions. Two days were chosen for each month of the year and then hourly photographs taken for each of those days. These photographs have been examined throughout the past year in order to establish accuracy for such a prediction method.

H.MauNs, M.Schmid, B.Blersch, P. Lechner and H. Schade [8] presented summary of “amorphous silicon (a-Si) module incorporation for building-integrated photovoltaic systems” The thin-film technology based on amorphous silicon (a- Si) offers a range of attractive features that are ideally suited for building-integrated photovoltaic installations (BIPV). Solar modules can be designed for roofs and facades, and thus perform various functions, namely electricity generation, thermal insulation, shading, and even satisfy aspects of architectural design. Semitransparent modules are also available that exhibit a colour-neutral see-through effect. Compared to other PV technologies, a-Si modules show only a minor reduction in power output at elevated temperatures and at lower light levels. They had also described the factors affecting the cost of a BIPV system and some examples of BIPV system.

"Kazuya Yosliioka, Tadashi Saitoh and Toshikazu Yamamura" [9] presented the performance monitoring of a building-integrated PV system located in an urban area . The building has 3 rated power of 76kW array consisting of sub-arrays installed on the north, south and west walls and north and south roofs. The field data acquisition has been continued since June 2001. Monitoring results were reported on the building integrated PV system introduced for MINAMI Tradc Building in Kobe, Japan. The system has been operating without any trouble to date. In addition to the performance monitoring, simulation for produced DC energy was carried out using PVFORM with METPV data for Kobe to compare between the both each other. Monthly energy output semis to mainly depend on the length of daytime for each month. But it was found that the weather conditions, seasonal sun elevation and constructions around the system have also an effect on system energy performance.

"Buying a Photovoltaic Solar Electric System": [10] http://www.energy.ca.gov/reports/500-99-008.PDF A brief guides (or effectively constrains) the design process. A certain amount of floor area will need to be located on a particular site, access to daylight will be required in many of the spaces, and costs will limit floor-to-ceiling heights, and so forth. An 'image' of the building usually results from the brief. For example, a brief that made no reference to PVs but called for a typical low-energy design suitable, for example, for suburban offices, might result in the building sketched One feature of it, and almost every other building is that it uses solar energy - for day lighting throughout the year and as passive solar gain in the winter. What PVs do is provide an additional use of the sun's energy to produce electricity.

"Standard for Flat-plate Photovoltaic Modules and Panels" [11] Flat plate collectors (FPC) are by far the most used type of collector. Flat-plate collectors are usually employed for low temperature applications up to 80°C. Flat plate collectors are permanently fixed in position and require no tracking of the sun. The collectors should be oriented directly towards the equator, facing south in the northern hemisphere and north in the southern. Flat-plate collectors have been built in a wide variety of designs and from many different materials. They have been used to heat fluids such as water, water plus antifreeze additive, or air. The collector should also have a long effective life, despite the adverse effects of the sun's ultraviolet radiation, corrosion and clogging because of acidity, alkalinity or hardness of the heat transfer fluid, freezing of water, or deposition of dust or moisture on the glazing

"Inverters, Converters, and Controllers for Independent Power Systems" [12] Inverters are used for DC voltage to AC voltage conversion. According to output voltage form they could be rectangle, trapezoid or sine shaped. The most expensive, yet at the same time the best quality inverters, output voltage in sine wave. Inverter input voltage depends on inverter power, for small power of some 100 W the voltage is 12 or 24 V, and 48 V or even more for higher powers. Large inverters could be connected in parallel when higher powers are required. For large systems 3-phase inverters are available in the market. Inverters connecting a PV system and the public grid are purposefully designed, allowing energy transfers to and from the public grid.

"Optimized Dispatch of a Residential Solar Energy System" [13] optimized dispatch of a residential solar energy system using linear programming has been shown. The energy system consists of a PV solar panel and an energy storage subsystem. The energy cost of a typical residential load was minimized by optimizing a daily cost function while maintaining several constraints, including serving the load, conservation of energy, and equipment ratings. The algorithm shown is, in effect, the control strategy for a residential solar system with energy storage. Under certain conditions this dispatch technique can significantly decrease the energy bill of the user as shown in the examples. Since a daily load is assumed prior to finding the optimized dispatch, this method is offered as an evaluation tool.

"Effect of coupled heat and mass transfer on the performance of absorptive solar system" [14] Absorption cooling offers the possibility of using heat to provide cooling. For this purpose heat from a conventional boiler can be used or waste heat and solar energy. When the latter systems are used absorption systems minimize also the adverse effects of burning fossil fuels and thus protect the environment. Absorption systems fall into two major categories, depending on the working fluids. These are the ammonia-water systems, in which ammonia is the refrigerant and lithium bromide-water systems in which water vapour is the refrigerant. This paper initially introduces the two systems and then outlines recent patents in this area. The future trends of research in this area would be on other refrigerant pairs which will be more effective.

"Introduce of buildings Solar Energy panel Building Design" [15] Buildings, as they are designed and used today, contribute to serious environmental problems because of excessive consumption of energy and other natural resources. The close connection between energy use in buildings and environmental damage arises because energy-intensive solutions sought to construct a building and meet its demands for heating, cooling, ventilation, and lighting cause severe depletion of invaluable environmental resources.

“Building requirements” [16] presented summary of amorphous silicon (a-Si) module incorporation for building-integrated photovoltaic systems. The thin-film technology based on amorphous silicon (a- Si) offers a range of attractive features that are ideally suited for building-integrated photovoltaic installations (BIPV). Solar modules can be designed for roofs and facades, and thus perform various functions, namely electricity generation, thermal insulation, shading, and even satisfy aspects of architectural design. Semitransparent modules are also available that exhibit a colour-neutral see-through effect. Compared to other PV technologies, a-Si modules show only a minor reduction in power output at elevated temperatures and at lower light levels. They had also described the factors affecting the cost of a BIPV system and some examples of BIPV system.

“Performance analysis of portable photovoltaic power generation systems based on measured data in Mongolia” [17] Within the application of the photovoltaic solar energy, the grid connected PV systems have known a considerable development in the last years, and everything seems to indicate that they will continue expanding with vigour in the future, under protection of the increasing taking of conscience on the environment problems that entails the present structure of the electricity production. These systems are characterized because all the energy that produces is sent to the grid. It can be considered as domestic installation those whose power tip is below 5 kW. These small domestic installations are designed to satisfy part of the power demand of the user. Thus, it himself consumes energy of the photovoltaic installation or the grid, depending on this level of power demand and hour of the day.

“Optimal tilt angles of solar collector and sunray refector” [18] Te optimal angles depend on the geographical position and on the investigation period (day, week, month, etc.) when the position of a solar collector will be stationary. It is very important, because the trajectory of the sun changes. Te intensity of solar radiation energy, sunlight duration per day and per year change as well. Designed to find the optimal angles of a solar collector .We have estimated the sun position, sunlight duration per day and per year, the geographical position and geometrical parameters. In the case of a solar collector with a sunray reflector, both parameters the cross-section of solar rays falling into a solar collector and the cross-section of solar rays falling into a sunray refector have been estimated

“Generation unit sizing and cost analysis for stand- alone, photovoltaic PV system” [19] The results of investigations on the application of photovoltaic (PV), PV power generating systems for utilization as stand- alone systems. A simple numerical algorithm has been developed for generation unit sizing. It has been used to determine the optimum generation capacity and storage needed for a stand-alone PV.PV system for an experimental site in a remote area in Montana with a typical residential load. Generation and storage units for each system are properly sized in order to meet the annual load and minimize the total annual cost to the customer. In addition, an economic analysis has been performed for the above three scenarios and is used to justify the use of renewable energy versus constructing a line extension from the nearest existing power line to supply the load with conventional power. Annual average hourly values for load, wind speed, and insulation have been used.

"Unit sizing and control of hybrid solar power system" [20] The proposed analysis employs linear programming techniques to minimize the average production cost of electricity while meeting the load requirements in a reliable manner, and takes environmental factors into consideration both in the design and operation phases. While in autoiionious systems, the environmental credit gained as compared to diesel alternatives can be obtained through direct optimization, in grid-linked systems emission is another variable to be minimized such that the use of renewable energy can be justified. A controller that monitors the operation of the autonornoud grid-linked system is designed. Such a controller determines the energy available from each of the system components and the environmental credit of the system. It then gives details related to cost, unmet arid spilled energies, and battery charge and discharge losses

2.1INTRODUCTION

Photovoltaic's offer consumers the ability to generate electricity in a clean, quiet and reliable way. Photovoltaic systems are comprised of photovoltaic cells. Photovoltaic cell is a device that converts light energy directly into electricity. Because the source of light is usually the sun, they are often called solar cells. The word photovoltaic comes from "photo" meaning light, and "voltaic" which refers to producing electricity. Therefore the photovoltaic process is producing electricity directly from sunlight. Photovoltaic are often referred to as PV. Photovoltaic systems convert sunlight to electric current. The PV applications are in today's society such as calculators and wristwatches. More complicated systems provide power for communications satellites, water pumps and machines in homes and workplaces. Many road and traffic signs along highways are now powered by PV.

PV systems produce some electric current any time the sun is shining but more power is produced when the sunlight is more intense and strikes the PV modules directly as when rays of sunlight are perpendicular to the PV modules. While solar thermal systems use heat from the sun to heat water and PV does not use the sun's heat to make electricity. Instead of electrons freed by the interaction of sunlight with semiconductor materials in PV cells create an electric current. PV modules are much less tolerant of shading than are solar water-heating panels. When siting a PV system, it is most important to minimize any shading of the PV modules. PV allows you to produce electricity without noise or air pollution—from a clean, renewable resource.

2.2 PHOTOVOLTAIC SYSTEM

PV cells convert sunlight directly into electricity without creating any air or water pollution. PV cells are made of at least two layers of semi-conductor material. One layer has a positive charge, the other negative. When light enters the cell and some of the photons from the light are absorbed by the semiconductor atoms and free electrons from the cell's negative layer to flow through an external circuit and back into the positive layer. This flow of electrons produces electric current. To increase their utility of individual PV cells are interconnected together in a sealed and weatherproof package called a module. When two modules are wired together in series then the voltage is doubled while the current stays constant. When two modules are wired in parallel then the current is doubled while the voltage stays constant. To achieve the desired voltage and current modules are wired in series and parallel into what is called a PV array. The flexibility of the modular PV system allows designers to create solar power systems that can meet a wide variety of electrical needs, no matter how large or small. Types of solar system are grid connected PV system, Stand-alone Systems

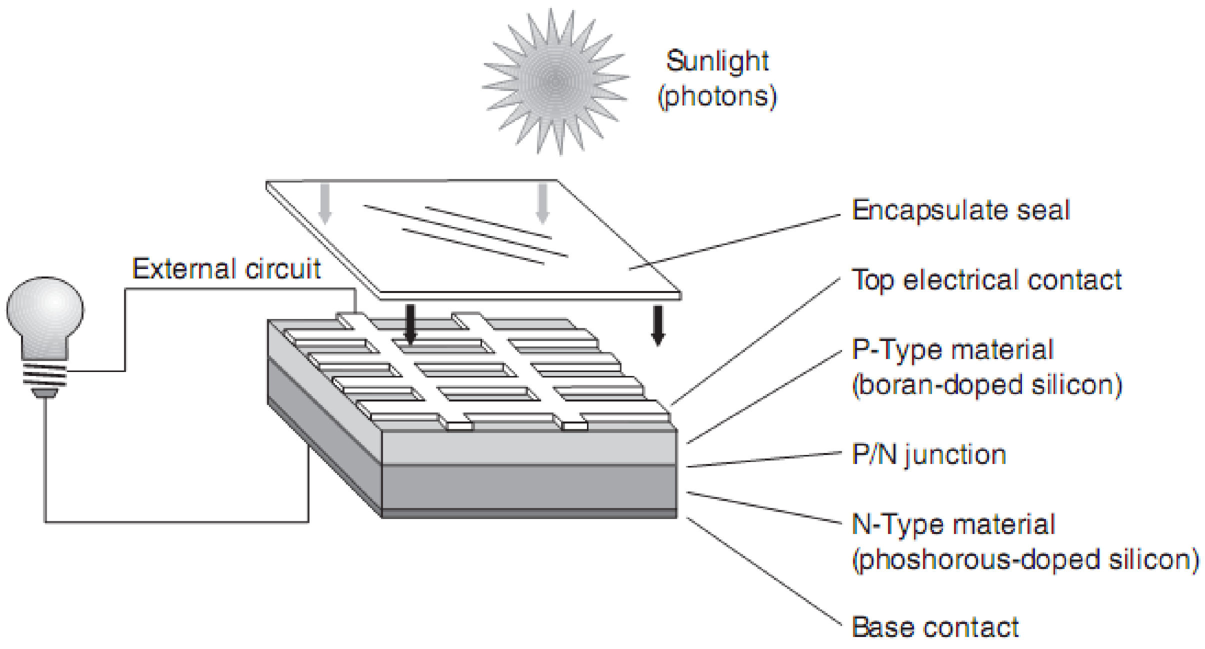


Figure 4: Solar Cell Construction

2.3 GRID CONNECTED PV SYSTEM

Grid-connected PVsystem allow the customer-generator to get credit for electric energy produced by the PV system. The PV system is connected at the customer's breaker panel and if the power generated is greater than the load and the power runs in reverse through the meter and in backwards. The net-metered customer is to be reimbursed by the electric distribution company at the full retail rate for each kilowatt-hour produced by the customer during a billing period and at the end of the billing period the customer will be compensated if they generated more than they used during the period. In other words, the electric utility meter on the building can backup whenever the PV system produces more electricity than is being consumed and if at the end of the billing period the building still has generated more than it consumed, the distribution company will pay for the excess. Net metering laws are generally in place in order to encourage renewable energy generation. Before the homeowner buys or installs any generation equipment to be net metered, they should call their electric utility service provider, and find out from them all of the utility requirements and rules for installing and interconnecting a generator.

2.3.1. Grid Connected PV System without Battery Backup

The simplest and most cost effective PV design for many sites is the "Grid Tie some times referred to as intertied or utility-interactive system. This system cannot provide backup power during periods when the electric grid is down even if the sun is shining but for sites with fairly reliable grid power this is usually the best system choice. Grid connected Systems use a photovoltaic array to generate electricity which is then fed to the mains grid via a grid interactive inverter. When the solar array generates more power than is being used in the building, the surplus is exported to the grid. When the solar array generates less power than is being used in the building, the difference is imported from the grid

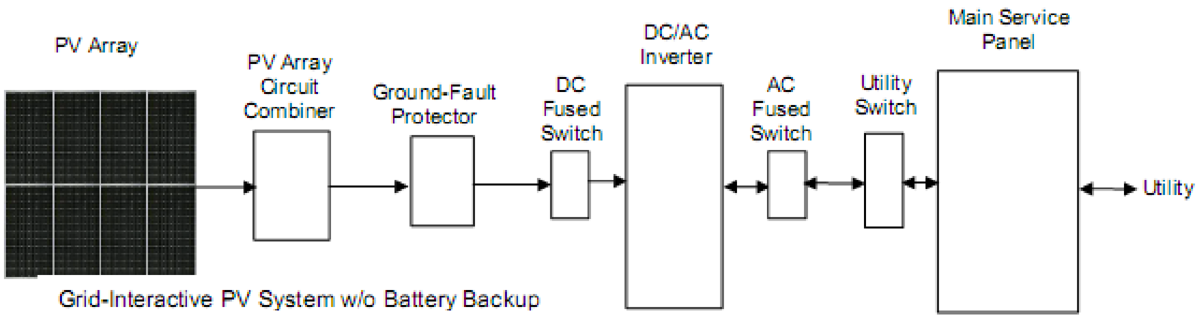


Figure 5: Grid Connected without battery backup

.2.3.2 Grid Connected PV System with Battery Back

The "Grid-Tie With Battery Backup" PV system incorporates one or more special AC circuits which are not directly connected to the electric grid like the rest of the building, but are always powered through the inverter and/or charge controller. These circuits may power a refrigerator, selected lights, computers or servers. The dual function inverter can supply the utility grid with any excess power produced by the system like the "grid-tie" inverter, plus the inverter works with the PV modules and battery bank through the charge controller to provide AC power to the backup circuits when the grid is down. The charge controller manages the battery voltage, keeping them fully charged when the grid is live and preventing them from being depleted when the system is drawing power from them.

2.4 STAND-ALONE PV SYSTEM

The Off-Grid or Stand-Alone PV System incorporates large amounts of battery storage to provide power for a certain number of days and nights in a row when sun is not available. The array of solar panels must be large enough to power all energy needs at the site and recharge the batteries at the same time. Most Off-Grid systems benefit from the installation of more than one renewable energy generator and may include Wind or Hydro power. A gas generator is often employed for emergency backup power.

2.5 PHOTOVOLTAIC CELL

Photovoltaic cells are made of semiconducting materials that can convert incident radiation in the solar spectrum to electric currents. PV cells are most commonly made of silicon and come in two varieties crystalline and thin-film type as detailed in Table 3. When a photon is absorbed by a semiconducting material it increases the energy of a valence band electron thrusting it into the conduction band. This occurs when the energy of incident photons is higher than the band gap energy. The conducting band electron then produces a current that moves through the semiconducting material. The amount of current generated by photon excitation in a PV cell at a given temperature is affected by incident light in two ways:

1. By the intensity of the incident light.
2. By the wavelength of the incident rays.

The materials used in PV cells have different spectral responses to incident light, and exhibit a varying sensitivity with respect to the absorption of photons at given wavelengths. Each semiconductor material will have an incident radiation threshold frequency, below which no electrons will be subjected to the photovoltaic effect. Above the threshold frequency, the kinetic Energy of the emitted photoelectron varies according to the wavelength of the incident radiation, but has no relation to the light intensity. Increasing light intensity will proportionally increase the rate of photoelectron emission in the photovoltaic material. In actual applications, the light absorbed by a solar cell will be a combination of direct solar Radiation as well as diffuse light bounced off of surrounding surfaces. Solar cells are usually coated with anti-reflective material so that they absorb the maximum amount of radiation possible. PV cells can be arranged in a series configuration to form a module, and modules can then be connected in parallel-series configurations to form arrays When connecting cells or modules in series they must have the same current rating to produce an additive voltage output and similarly, modules must have the same voltage rating when connected in parallel to produce larger currents.

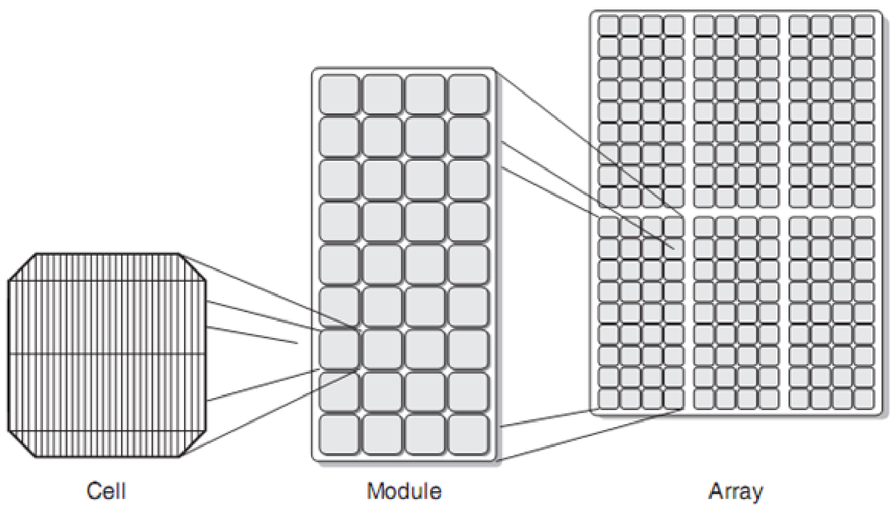


Figure 6 - Solar Panel Configurations

2.6 INSTRUMENTS FOR MEASURING SOLAR RADIATION AND SUNSHINE

Solar radiation flux is usually measured with the help of a pyranometer or a pyrheliometer. A pyranometer is an instrument which measures either global or diffuse radiation falling on a horizontal surface over a hemispherical field of view. A sketch of one of pyranometer as installed for the measurement of global radiation is shown in figure. Basically the pyranometer consist of a black surface which heats up when exposed to solar radiation. Its temperature increases until the rate of heat gain by solar radiation equal the rate of heat loss by convection, conduction and reradiation. The pyrometer is used commonly in India. It has its hot junction arranged in the form of a horizontal circular disc of diameter 25mm and coated with a pecial black lacquer having a very high absorptive in the solar radiation wavelength region.

The pyranometer can also be used for the measurement of diffuse radiation. This is done by mounting it at the centre of a semicircular shading ring. The shading ring is fixed in such a way that its plane of the path of the sun‘s daily movement across the sky and it shades the thermopile element and the two glass domes of the pyranometer at all times from direct sunshine. Consequently, the pyranometer measures only the diffuse radiation received from the sky. The duration of bright sunshine in a day is measured by a sunshine recorder. The sun rays are focused by a glass sphere to a point on a card strip held in a groove in a spherical bowl mounted concentrically with the sphere. Whether there is bright sunshine, the image formed is intense enough to burn a spot on the card strip. Thus, a burnt trace whose length is proportional to the duration of sunshine is obtained on the strip.

Figure 7: Solar Radiation Recorder

2.7 SOLAR RADIATION

Most solar radiation is measured for horizontal surfaces. A typical daily record of the global and diffuse radiation flux measured on a clear is shown in figure. It is seen that a fairly, smooth variation with the maximum occurring y day. We will around noon is obtained on a clear day. In contrast, an irregular variation with many peaks and valleys may be obtained on a cloudy day. We will use the symbols I_g and I_d to represent the instantaneous values of the global and diffuse flux plotted and express these quanties in W/m^2. Since solar radiation fluxes do not normally change rapidly with time.

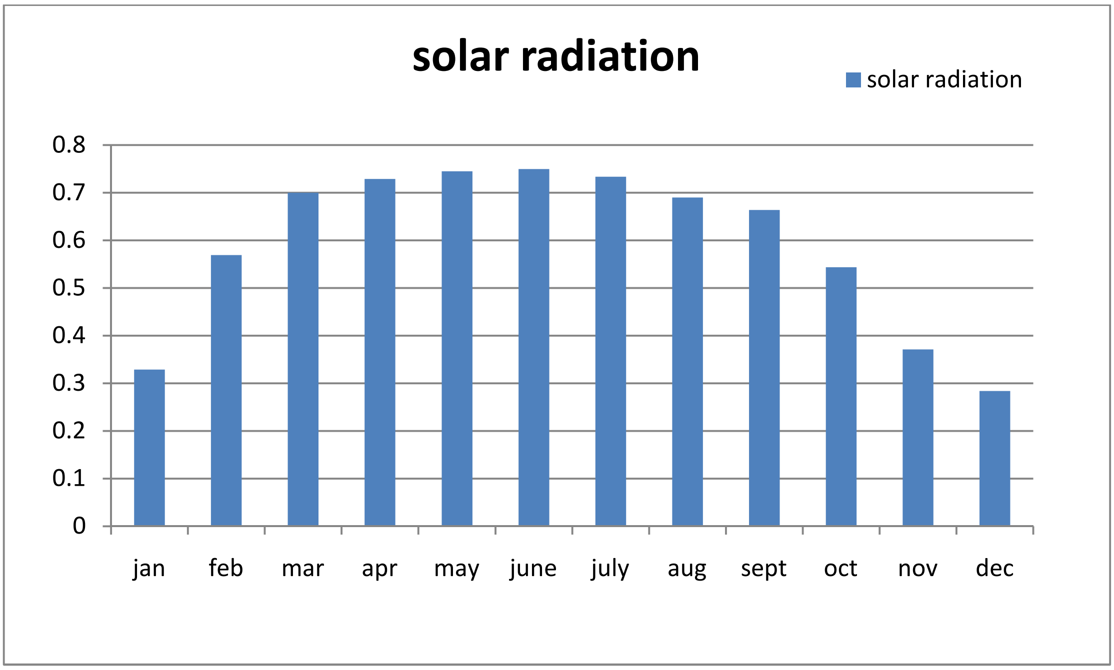


Figure 8: Record of global and diffusion radiation flux measured on a clear day

Solar radiation fluxes are sometimes reported in Langley's per hour or per day. The unit Langley has been adopted in honour of Samuel Langley who made the first measurement of the spectral distribution of the sun.

A solar designer is primarily interested in average value for a location. The average is usually done over all days of a month and indicated by a bar over the symbol. A general idea of the availability of solar radiation over different regions can e obtained by constructing solar radiation maps. The annual average daily radiation daily global radiation received over the whole country is around 450 Langley's per day. Peak values are generally measured in April or may. In contrast, during the monsoon and winter months and the daily global radiation decrease to about 300-400 Langley's per day.

MONTHS	DAILY ENERGY $KWh/m^2/d$
Jan	.329
Feb	.569
Mar	.700
Apr	.729
May	.745
June	.750
July	.734
Aug	.690
Sept	.664
Oct	.544
Nov	.371
Dec	.284

Table 2: Daily Radiation $KWh/m^2/d$

2.8 SOLAR RADIATION GEOMETRY

The beam energy falling on a surface having any orientation, it is necessary to convert the value of beam flux coming from the direction of the sun to an equivalent value corresponding to the normal direction to the surface.

If Θ is the angle between an incident beam of flux and the normal to plane surface, then equivalent flux failing normal to the surface is given by $I_{bn} \cos \theta$. The angle Θ can be related by a general equation to Φ the latitude, β the slope γ the surface azimuth angle, δ the declination, and ω the hour angle.

The latitude Φ of a location is the angle made by the radial line joining the location to the centre of the earth with projection of the line on the equatorial plane. By convention, the latitude is measured as positive for the northern hemisphere. It can vary from $-90^0 + 90^0$. The slope β is the angle made by the plane surface with the horizontal. It can vary from 0^o to 180^0.

The surface azimuth angle γ is the angle made in the horizontal plane between the horizontal line due south and the projection of the normal to the surface on the horizontal plane. It can vary from $-180\ ^0 + 180^{0.}$ The hour angle ω is an angular measure of time and is equivalent to 15^o per hours. It also varies from $-180\ ^0 + 180^{0.}$ The convention of measuring it from noon based on local apparent time, being positive in the morning and negative afternoon.

It can shown that

$$\cos \Theta = \sin \Phi (\sin \delta \cos \beta + \cos \delta \cos \gamma \cos \omega \sin \beta) + \cos \Phi (\cos \delta \cos \omega \cos \beta - \sin \delta \cos \gamma \sin \beta) + \cos \delta \sin \gamma \sin \omega \sin \beta \quad (2.7.1)$$

Special cases of above equation are normally required. Some of these are follows:

Vertical surface $\beta = 90^0$,

$$\cos \Theta = \sin \Phi \cos \delta \cos \gamma \cos \omega - \cos \Phi \sin \delta \cos \gamma + \cos \delta \sin \gamma \sin \omega \quad (2.7.2)$$

Horizontal surface $\beta = 0^{0,}$

$$\text{Cos } \Theta = \sin \Phi \sin \delta + \cos \Phi \cos \delta \cos \omega \qquad (2.\ 7.\ 3)$$

The angle Θ in this case is the zenith angle Θ_z . The complement of the zenith angle is also used quit often in calculations. It is called the solar altitude angle and will denote by the symbol α. Some of the above angles are shown below.

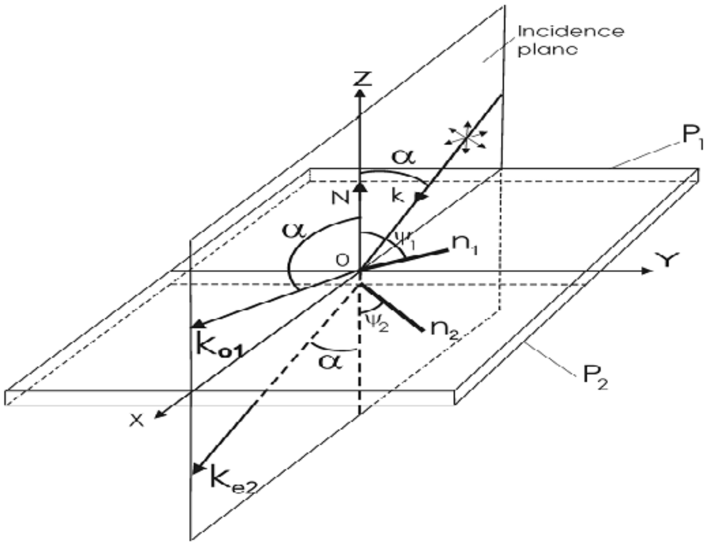


Figure 9: Different tilt angle

2.9 BUILDING INTEGRATED PHOTOVOLTIC SYSTEM

Building integrated photovoltaic's, the integration of photovoltaic cells into one of more of the exterior surfaces of the building envelope, represents a small but growing photovoltaic application. In order for building owners, designers, and architects to make informed economic decisions regarding the use of building integrated photovoltaic's, accurate predictive tools and performance data are needed. A building integrated photovoltaic test bed has been constructed at the National Institute of Standards and Technology to provide the performance data needed for model validation. The facility incorporates four identical pairs of building integrated photovoltaic panels constructed using single-crystalline, polycrystalline, silicon film, and amorphous silicon photovoltaic cells. One panel of each identical pair is installed with thermal insulation attached to its rear surface. The second paired panel is installed without thermal insulation. This experimental configuration yields results that quantify the effect of elevated cell temperature on the panels' performance for different cell technologies. A facility has been built to provide experimental data needed to validate and improve predictive performance tools for building integrated photovoltaic panels

Cell Technology	Single Crystalline	Poly Crystalline	Silicon Film	Triple-Junction Amorphous
Panel Dimension s (m x m)	1.38 x 1.18	1.38 x 1.18	1.38 x 1.18	1.37 x 1.48
Front Cover	6 mm glass	6 mm glass	6 mm glass	Tefzal
Encapsulate	EVA	EVA	EVA	
Backsheet/Color	Tedlar/Charcoal	Tedlar/Charcoal	Tedlar/Charcoal	Stainless Steel
Cell dimensions (mm x mm)	125 x 125	125 x 125	150 x 150	119 x 340
Number of Cells (in series)	72	72	56	44
Adjacent Cell Spacing (mm)	2	2	2	
Vertical Border Width(mm)	100	100	51	8
Top Border Height(mm)	72	72	55	11
Bottom Border(mm)	70	70	29	5
Recessed Distance to PV Cell (mm)	12	12	12	9
Glazing Covered by PV Cells %	63	69	80	88
Total Cost ($)	1324	1123	995	578
Price/Watt($/W)	8.66	8.43	10.75	4.52
Rated Power (W)	153	133	93	128
Cell Area (m2)	1.020	1.128	1.341	1.780
Aperture Area (m2)	1.682	1.682	1.682	2.018
Coverage Area (m2)	1.160	1.160	1.371	1.815

Table 3.Measured Test Analysis Data

2.9.1 Potential of Building Integrated Photovoltaic System

The potential of building integrated photovoltaic an analysis of the building stock with respect to suitability of the building skin for photovoltaic development is required. Some building surface will have technical limitation; other will have limited capabilities to generate photovoltaic power due to inadequate orientation, inclination or shading effects. The available area corrected for potential suitability is referred to as BIPV potential. The BIPV potential thus comprises the area in the building stock that is suitable for photovoltaic system use under architectural and solar aspects. To analyse and compare different building and solar data sets as well as potential studies already carried out around the world can help to model an approach to calculate the BIPV potential with its essential elements and to develop comprehensive easy-to-use rules of thumb. Finally, BIPV potential figure calculated using different methodologies are confirmed thanks to the knowledge acquired and the approach validated on an international level.

The objectives of this study are with respect to the BIPV potential:

1. To assess and compare different approaches, potential estimates.
2. To formulate an accepted and valuated methodology.
3. To develop a comprehensive set of rules of thumbs.

In the end, the BIPV potential calculations and estimates lead to a number of general findings useful to incorporate in future photovoltaic.

2.9.2 Methodology

The existing different approaches and data sets imply, of course, studies of lower, intermediate and higher accuracy. A number of potential studies have either rough assumption or a poor data and therefore low accuracy. This can be justified by hinting at the huge area potential and at the fact those photovoltaic still experiences economic restrictions much more than technical ones. Accurate BIPV potential studies are part of the fundamental base to evaluate the market potential and their target and focus groups, to assist the photovoltaic industry and the building sector, utilities, energy policy makers and to provide information to planners and lawmakers.

An assessment of the BIPV potential starts with a determination of the total cost and façade area, which is subsequently corrected for architectural suitability for a solar utilization. However, in the metrology presents in this report, BIPV potential calculation are based on ground floor area figures., which are transformed into roof and façade surface figures. The BIPV potential can subsequently be calculated by applying factors for solar yield and architectural suitability to the gross roof and façade surfaces.

Architectural and solar suitability are describes as follows:

1. Architectural suitability includes corrections for limitation due to construction, historical consideration, shading effects and use of the available surface for other purposes.
2. Solar suitability takes into account the relative amount of irradiation for the surface depending on their orientation, inclination and location as well as the potential performance of the photovoltaic system integrated in the building.

Solar – architectural suitability in relative terms and result in utilization factors. These utilization factors reflect the BIPV potential in most significant relative terms. In order to extract absolute figures in square meters and kilowatt hours, the relative figures have to be combined with the building areas and the solar irradiation available.

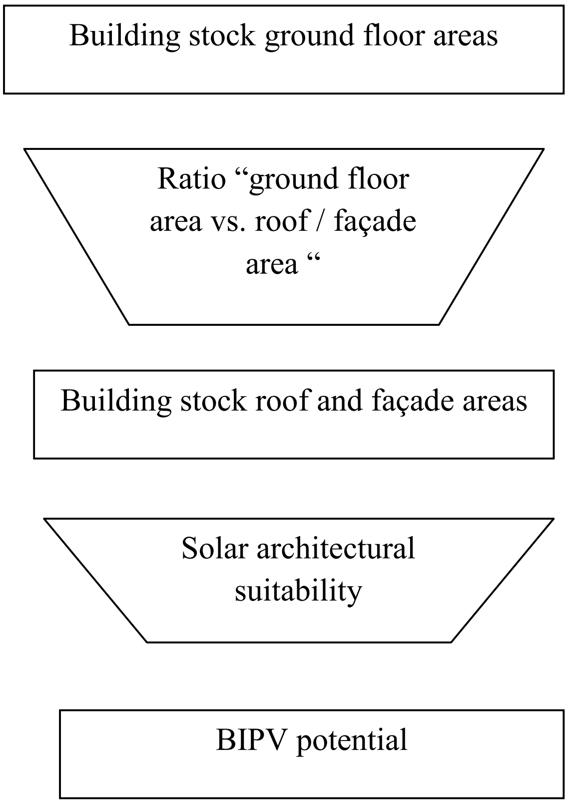


Figure 10: Factors for the BIPV potential

2.9.3 Analysis and comparison of existing potential estimates and case studies.

The methodology is useful to analysis and compares a set of available estimates and case studies. The different case studies show the wide range and variety of methods to assess the BIPV potential. The results communicated so far can be explained by differences in the building stock but a great deal is due to methodological differences, especially the way of evaluating architectural and solar suitability.

Architectural Suitability: A cross country weighted value for the suitable part of the building area taking into account constructions, shading and historical elements is on average 60% for roof areas and 20% for façade areas.

Solar Suitability: A good solar yield is allowing some simple but corroborated generalization of hourly, daily, seasonal and annual solar yield values- understood as 80% of the maximum local annual solar input, separately defined for slope and facades and individually for each location. Allowing only roof or façade areas with solar yields above this threshold reduces the available area potential depending on the solar conditions in the specific location. This factor is close to 50% for facades and approximately 55% for roofs.

2.10 ADVANTAGES OF PHOTOVOLTAIC SYSTEM

1. Electricity produced by solar cells is clean and silent. Because they do not use fuel other than sunshine. PV systems do not release any harmful air or water pollution into the environment; deplete natural resources or human health.
2. Photovoltaic systems are quiet and visually unobtrusive. Small-scale solar plants can take advantage of unused space on rooftops of existing buildings.PV cells were originally developed for use in space where repair is extremely expensive if not impossible.
3. PV still powers nearly every satellite circling the earth because it Solar energy is a locally available renewable resource. It does not need to be imported from other regions of the country or across the world. This reduces environmental impacts associated with transportation and also reduces our dependence on imported oil. And, unlike fuels that are mined and harvested, when we use solar energy to produce electricity we do not deplete or alter the resource.

A PV system can be constructed to any size based on energy requirements. Furthermore, the owner of a PV system can enlarge or move it if his or her energy needs change. For instance, homeowners can add modules every few years as their energy usage and financial resources grow. Ranchers can use mobile trailer-mounted pumping systems to water cattle as the cattle are rotated to different fields.

2.11 DISADVANTAGES OF PHOTOVOLTAIC SYSTEM

1. Some chemicals like cadmium and arsenic are used in the PV production process. These environmental impacts are minor and can be easily controlled through recycling and proper disposal.
2. Solar energy is somewhat more expensive to produce than conventional sources of energy due in part to the cost of manufacturing PV devices and in part to the conversion efficiencies of the equipment. As the conversion efficiencies continue to increase and the manufacturing costs continue to come down, PV will become increasingly cost competitive with conventional fuels.
3. Solar power is a variable energy source, with energy production dependent on the sun. Solar facilities may produce no power at all some of the time, which could lead to an energy shortage if too much of a region's power come from solar power

Solar technologies are used for making the building energy efficient by producing the electricity from PV technologies and also introduce the proper ventilation and decrease the lightning load. Energy efficient building reduces the peak electricity load which increases day by day by making imbalance all the aspect. Here, the photovoltaic technologies are used for making the building energy efficient.

3.1 PHOTOVOLTAIC SYSTEM COMPONENTS

There are general types of electrical designs for PV power systems for homes systems that interact and include battery backup. Typical System Components are:

3.1.1. Photovoltaic Array

A photovoltaic array is a group of photovoltaic modules put together to generate electricity. A PV array may consist of one module to thousands of modules and the output of the array may vary from a few watts to tens of Megawatts depending on the number and output of the modules. A photovoltaic array produces direct current that is used to power the load. This can range from charging a battery in a calculator to powering a communications system to powering a building or city.

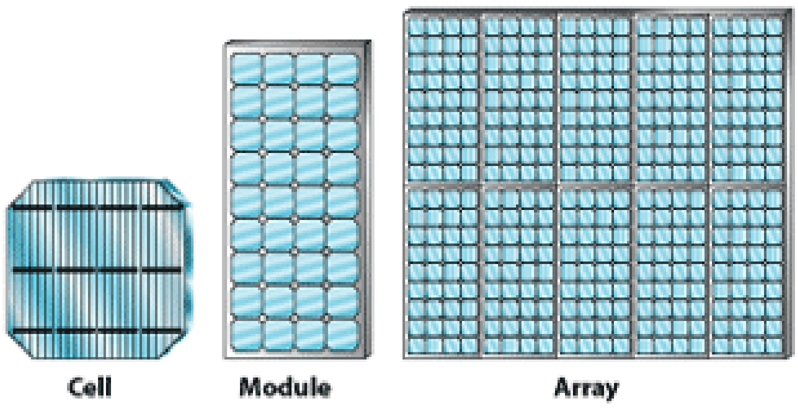


Figure 11: PV array

When a PV array is connected to the utility grid, it must first be connected to an inverter that changes the direct current to alternating current. Most inverters run at about 90% efficiency. The most common PV module that is 5 to 25 square feet in size and weighs about 3 to 4 lbs./ft^2. Often sets of four or more smaller modules are framed or attached together by struts in what is called a panel. This panel is typically around 20 to 35 square feet in area for ease of handling on a roof. This allows some assembly and wiring functions to be done on the ground if called for by the installation instructions.

3.1.2. Balance of system equipment (BOS)

BOS includes mounting systems and wiring systems used to integrate the solar modules into the structural and electrical systems of the home. The wiring systems include disconnects for the dc and ac sides of the inverter, ground-fault protection, and over current protection for the solar modules. Most systems include a combiner board of some kind since most modules require fusing for each module source circuit. Some inverters include this fusing and combining function within the inverter enclosure

3.1.3. DC-AC inverter

Inverters are used for DC to AC conversion. According to output voltage form they could be rectangle, trapezoid or sine shaped. The best quality inverters output voltage in sine wave. Inverter input voltage depends on inverter power for small power of some 100 W the voltage is 12 or 24 V and 48 V or even more for higher powers. Large inverters could be connected in parallel when higher powers are required. For large systems 3-phase inverters are available in the market. Inverters connecting a PV system and the public grid are purposefully designed allowing energy transfers to and from the public grid. According to working principle we have many different types of inverters, such as central inverters for wide power range from 1 kW to up to 100 kW or even more, string inverters and module inverters. Central inverters are used in large applications. Many times they can be connected according to the master-slave criteria, when the succeeding inverter switches on only when enough solar radiation is available or in case of main inverter malfunction. Inverters connected to module strings are used in wide power range applications allowing for more reliable operation. Module inverters are used in small photovoltaic systems. Such solutions are applicable to larger systems however in practice cheaper and less reliable solution of central inverter or string inverters are used. Special design inverters are available for the purposes of hybrid systems. In most cases a powerful inverter includes charge regulator electronics, and not only the inverter. Modern inverters are the most sophisticated electronic devices implemented in photovoltaic systems. On top of high reliable electronics which must be used, great care should also be taken on lightning protection. Inverters are based on microprocessor circuits or IGBT transistors. This is the device that takes the dc power from the PV array and converts it into standard ac power used by the house appliances.

3.1.4. Metering

This includes meters to provide indication of system performance. Some meters can indicate home energy usage. Net metering is a policy that allows homeowners to receive the full value of the electricity that their solar energy system produces. The term net metering refers to the method of accounting for a photovoltaic system's electricity production. If more electricity is produced from the PV system than the home needs the extra kilowatts are fed into the utility grid. In the event of a power outage safety switches in the inverter automatically disconnect the PV system from the line. This safety disconnect protects utility repair personnel from being shocked by electricity flowing from the PV array into what they would expect to be a dead utility line.

At the end of the month if the customer has generated more electricity than that used the utility credits the net kilowatt-hours produced at the wholesale power rate. But if the customer uses more electricity than the PV system generates, the customer pays the difference. The billing period for net metering may be either monthly or annually. In some states, the excess generation credits at the end of each billing period are carried over to the next billing period for up to a year. Essentially, the power grid acts as the customer's battery backup, which saves the customer the added expense of purchasing and maintaining a battery system.

3.1.5. OTHER COMPONENTS*:* - Utility switch (depending on local utility).

3.2 SOLAR PANEL INSTALLED IN BUILDING WITH BATTERY BACKUP

This type of system incorporates energy storage in the form of a battery to keep critical load circuits in the house operating during a utility outage. When an outage occurs the unit disconnects from the utility and powers specific circuits in the home. These critical load circuits are wired from a subpanel that is separate from the rest of the electrical circuits. If the outage occurs during daylight hours the PV array is able to assist the battery in supplying the house loads. If the outage occurs at night the battery supplies the load. The amount of time critical loads can operate depends on the amount of power they consume and the energy stored in the battery system. A typical backup battery system may provide about 8kWh of energy storage at an 8-hour discharge rate which means that the battery will operate a 1-kW load for 8 hours. A 1-kW load is the average usage for a home when not running an air conditioner. A battery backup system may include some or all of the following:

1. Batteries and battery enclosures
2. Battery charge controller
3. Separate subpanel(s) for critical load circuits

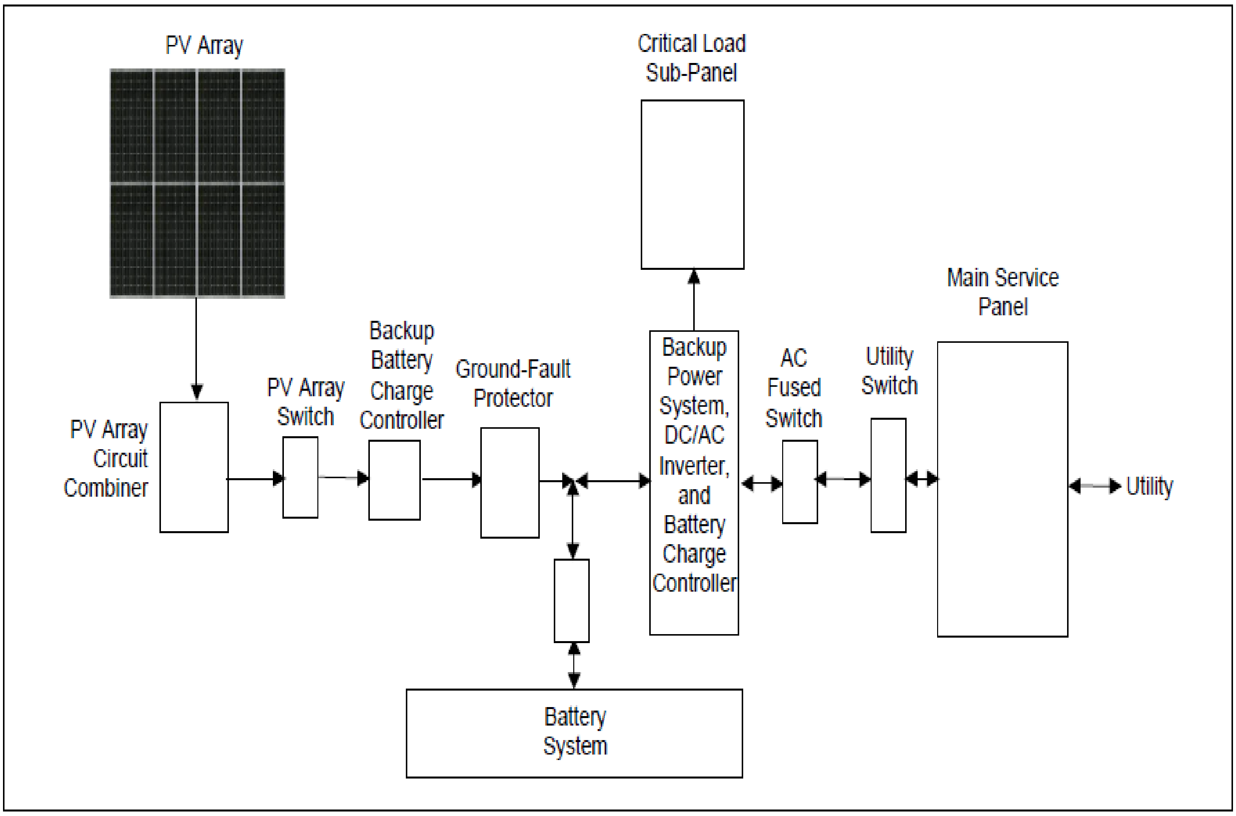


Figure 12: PV system with battery system

3.3 MOUNTING OPTION

There are several ways to install a PV array at a residence. Most PV systems produce 5-to-10 Watts per square foot of array area. This is based on a variety of different technologies and the varying efficiency of different PV products. A typical 2- kW PV system will need 200-400 square feet of unobstructed area to site the system. Consideration should also be given for access to the system. This access space can add up to 20% of needed area to the mounting area required.

3.3.1 Roof Mount

Often the most convenient and appropriate place to put the PV array is on the roof of the building. The PV array may be mounted above and parallel to the roof surface with a standoff of several inches for cooling purposes. Sometimes, such as with flat roofs, a separate structure with a more optimal tilt angle is mounted on the roof. Proper roof mounting can be labour intensive. Particular attention must be paid to the roof structure and the weather sealing of roof penetrations. It is typical to have one support bracket for every 100 Watts of PV modules. For new construction, support brackets are usually mounted after the roof decking is applied and before the roofing materials is installed. The crew in charge of laying out the array mounting system normally installs the brackets. The roofing contractor can then flash around the brackets as they install the roof. A simple installation detail and a sample of the support bracket is often all that is needed for a roofing contractor to estimate the flashing cost.

Figure 13: Roof Mount PV System

Masonry roofs are often structurally designed near the limit of their weight-bearing capacity. In this case the roof structure must either be enhanced to handle the additional weight of the PV system or the masonry roof transitioned to composition shingles in the area where the PV array is to be mounted. By transitioning to a lighter roofing product there is no need to reinforce the roof structure since the combined weight of composite shingles and PV array is usually less than the displaced masonry product.

3.3.2. Shade Structure

An alternative to roof mounting is to mount the system as a shade structure. A shade structure may be a patio cover or deck shade trellis where the PV array becomes the shade. These shade systems can support small to large PV systems. The construction cost with a PV system is a little different than for a standard patio cover especially if the PV array is acts as part or the entire shade roof. If the PV array is mounted at a steeper angle than a typical shade structure, additional structural enhancements may be necessary to handle the additional wind loads. The weight of the PV array is 3-to-5 lbs/ft2 which is well within structural limits of most shade support structures. The avoided cost of installing roof brackets and the associated labour could be counted toward the cost of a fully constructed patio cover. The overall cost of this option will likely be higher than roof mounting, but the value of the shade often offsets the additional costs. Other issues to consider include Simplified array access for maintenance Module wiring if visible from underneath, must be carefully concealed to keep the installation aesthetically pleasing cannot grow vines, or must be diligent about keeping it trimmed back from modules and wiring.

Figure 14: Patio Cover or Desk Shade

3.4 ESTIMATING SYSTEM OUTPUT

PV systems produce power in proportion to the intensity of sunlight striking the solar array surface. The intensity of light on a surface varies throughout a day so the actual output of a solar power system can vary substantial. There are other factors that affect the output of a solar power system. These factors need to be understood so that the customer has realistic expectations of overall system output and economic benefits under variable weather conditions over time.

3.4.1. Factors Affecting Output

The factor's which affected the output of the photovoltaic system are explained as follows:

3.4.1.1 Standard Test Conditions

Solar modules produce dc electricity. The dc output of solar modules is rated by manufacturers under Standard Test Conditions. These conditions are easily recreated in a factory, and allow for consistent comparisons of products, but need to be modified to estimate output under common outdoor operating conditions. A manufacturer may rate a particular solar module output at 100 Watts of power under STC and call the product a 100-watt solar module. This module will often have a production tolerance of -5% of the rating, which means that the module can produce 95 Watts and still be called a 100-watt module. To be conservative, it is best to use the low end of the power output spectrum as a starting point.

3.4.1.2 Temperature

Module output power reduces as module temperature increases. When operating condition on the roof is a solar module will heat up substantially and reaching inner temperatures of 50-75^{o}C. For crystalline modules a typical temperature reduction factor is 89% or 0.89. So the 100-watt module will typically operate in the middle of a spring or fall day under full sunlight conditions.

3.4.1.3 Dirt and dust

Dirt and dust can accumulate on the solar module surface, blocking some of the sunlight and reducing output. Although typical dirt and dust is cleaned off during every rainy season it is more realistic to estimate system output taking into account the reduction due to dust build-up in the dry season. The operating with some accumulated dust may operate on average. The measured under well-controlled factory conditions. The dc power generated by the solar module must be converted into common household ac power using an inverter. Some power is lost in the conversion process, and there are additional losses in the wires from the rooftop array down to the inverter and out to the house panel. So the 100-watt module output reduced by production tolerance, heat, dust, wiring, ac conversion, and other losses will translate into about 68 Watts of AC power delivered to the house panel during the middle of a clear day.

3.4.2. Installation Labour Effort

Installation effort is very sensitive to specific house layouts and roofing type. An experienced crew can install a 2 kW non-battery PV system in two-to-four person-days. Systems with large solar arrays are relatively less effort per watt of power and kWh of energy than smaller systems because the installation of the inverter and other hardware required by all PV systems is spread over more solar modules. Systems with battery backup are more labour intensive than non-battery systems because of the additional wiring required for wiring the critical load subpanel. A battery system can add 50-100% to the time required for the installation.

3.4.3. Incentives to Reduce Costs

The several local utilities is to reduce the system costs. The EC buy downs are calculated by multiplying 200 times the adjusted peak dc power from the system in Watts up to a maximum of 50% of the system cost. This level of rebate can reduce the cost of systems by 30 to 50 percent or more and result in much more favourable economics for the owner. An owner can incorporate a basic 1 kW solar power system for as little as 1, 50,000 and 50,000. If the system is included in the mortgage of the home this small increment in house payment may be offset by an equivalent reduction in the monthly utility bill.

3.4.4. Estimating Electrical Energy Savings

A solar power system is a lower electric utility bill resulting from the energy that the solar system produces. The energy savings to a homeowner can be estimated by simply multiplying the annual energy in kWh that a PV system might produce times the utility electric energy rate. These rates vary by local utility are likely to increase from their current values. Estimated energy savings from small and large PV systems in Thapar university, j-hostel are presented below to illustrate the kinds of savings that can be achieves.

Solar array (STC)	Estimated Annual Energy
138 KW	12,08,880 KWh

Table 4: Sample Annual Electric Utility Bill Savings

3.5. SUPPLIES AND SYSTEM QUALIFICATIONS

When choosing a supplier and specifying a PV system, the following are a series of general guidelines to help guide the decision-making process.

3.5.1. Pre-Engineered Systems

When owner considers an HVAC system for a home, they do not buy a compressor from one manufacturer and a cooling coil from another company, and a fan from a third company and then put these pieces together. The equipment manufacturers have engineered a packaged system that is designed to work together. Each model of a home may need a slightly different unit based on the size and layout, but those variations have been designed into the product. In the same way, the components of a PV system should be engineered to work together as a unit accounting for variations in system size for different homes.

Since the PV industry is in the early stages of development, there is a wide range of competency levels among PV system integrators. Unless the installer is familiar enough with the technology to recognize whether the system integrator is competent, it is much safer to stay with a firm that provides pre-engineered systems. Pre-engineering may not guarantee a flawless system, but the concerns over product compatibility and specification of individual components have been addressed in the system design.

3.5.2. Warranties

There are several types of warranties that come with a system or can be purchased in addition to a standard warranty. These include (1) product warranties covering defects in manufacture; (2) system warranties covering proper operation of equipment for a specific time period 5 or 10 years (3) annual energy performance warranties covering the guaranteed output of the PV system. The installer to guarantee proper system installation often covers the system and annual energy performance warranties.

It is common these days to see warranties on PV modules of 20 or more years. Although this is impressive and indicates the level of confidence manufacturers place in the longevity of their products there are many other components in these systems that may not have the same life expectancy. Inverters may have 10-year, five-year, or even one-year warranties. This must be considered when reviewing the cost of inverters and other system components.

3.5.2.1. System warranties

It is equally important to look for entire system-level warranties of five years or more. This indicates that the manufacturer has taken many other operational issues into account. Since these systems generate electrical power it is helpful to have system performance included as part of the warranty. The equipment to perform this test is expensive but the fact that a company would know enough to specify this type of warranty is an indication that they are confident in their system design. The intent of this requirement is to improve customer acceptance of PV systems.

3.5.3 Annual energy performance warranties

Although there are very few companies selling systems with this type of warranty, an energy performance warranty guaranties that the system will perform consistently over a period of time. This is particularly helpful in ensuring that the customer receives the bill savings that they expect. This type of warranty is more common with energy efficiency retrofit projects for commercial and industrial clients. Adequate metering to verify the system power output and energy generation is necessary to help the system owner understand whether the system is operating properly, or has warranty-related performance issues. With an adequate meter the customer can readily identify when the system is malfunctioning.

3.6 SOLAR ENERGY COLLECTOR

Solar energy collectors are special kind of heat exchangers that transform solar radiation energy to internal energy of the transport medium. The major component of any solar system is the solar collector. This is a device which absorbs the incoming solar radiation, converts it into heat, and transfers this heat to a fluid (usually air, water, or oil) flowing through the collector. The solar energy thus collected is carried from the circulating fluid either directly to the hot water or space conditioning equipment or to a thermal energy storage tank from which can be drawn for use at night and/or cloudy days.

There are basically two types of solar collectors: non concentrating or stationary and concentrating. A non concentrating collector has the same area for intercepting and for absorbing solar radiation whereas a sun-tracking concentrating solar collector usually has concave reflecting surfaces to intercept and focus the sun’s beam radiation to a smaller receiving area, thereby increasing the radiation flux. Solar energy collectors are basically distinguished by their motion, i.e., stationary, single axis tracking and two-exes tracking, and by their operating temperature.

3.7APPLICATION OF SOLAR SYSTEM TECHNOLOGIES

1. Utilities and independent power providers deliver solar energy from a centralized location to customers in relatively populated areas via state or regional grids.
2. On-grid solar energy originates from a central location, but private residences, government agencies or businesses that install small PV solar systems (5-8 kW) on or around their structures are decentralized.
3. Retrofitted or new PV systems may be roof-based or ground-based. On buildings, they may be retrofitted on existing buildings integrated into the walls, windows or roofs when buildings are constructed BIPV or building integrated PV.
4. Major home builders are starting to make solar standard in new construction
5. Other PV applications include water pumps, street lights or carports (mostly off-grid). Finally there are space-based applications.

Energy efficient building is defined as the building human being with health, comfort and safety spaces to reside work and live, while saving energy, land, water, raw material and other resources, and the minimum impact on the environment. Energy buildings and energy-saving buildings had been built since 1960's, and the energy buildings were built until 1990's by many developed countries. Some green building evaluation standards had been issued one after another since 1990.

4.1 DESIGN OF ENERGY EFFECIENT BUILDING

Design of smart building's are both energy efficient and secure against attacks has become a topic of urgent focus in light of the increasing energy costs and the recent terrorist are. Buildings use energy for powering their Heating, Ventilation and Air-Conditioning HVAC systems and studies have shown these systems to consume as much as 20-30 % of the total energy consumption in India Increased building automation and building systems integration are viewed as two critical areas that can decrease the HVAC energy usage and increase security of the building's occupants. To be effective, these technologies must be guided by mathematical models of building systems. Indeed analysis with respect to performance, robustness, and cost for efficiency, security and other metrics can suggest improvements in building control laws for the existing buildings, and, eventually, allow for architecture design as well as performance cost trade studies for new buildings. The primary difficulties preventing an effective treatment whether analysis or designs of many of these transport problems in buildings are:

4.1.1 Complexity

If one is interested in analyzing a building architecture for resulting temperature distribution it is perhaps possible to compute with the fundamental equations at a room-level. However the computation cost in carrying out such an analysis based on the same fundamental equations, for a building is prohibitive. Obtaining control solutions using detailed complex models is simply not feasible or even desirable - because any optimal control solution designed with complex model will itself be complex high dimensional.

4.1.2 Multiple scales

Computational complexity arises because there are multiple spatial and temporal time-scales in the problem. Any approach that resolves the smallest of these scales is simply not computationally tractable. Additionally presence of time-scales that are separated by orders of magnitudes leads to numerically stiff problems.

4.1.3 Uncertainty

Building represents an ever-changing environment with uncertain disturbances heat-loads due to weather patterns uncertain architecture doors open versus closed and uncertain problem parameters. Effective resolution of all of these problems would require a systematic and long-term research. Incorporating an airflow pattern into an energy simulation modelling and analysis tool is not straightforward. If one incorporates a velocity field generated using a calculation corresponding to an airflow pattern directly one can end up with a very complex high-dimensional model that is not very useful for dynamic analysis and control. Indeed as pointed before complexity is the primary barrier that prevents effective model-based computations, analysis and architecture and control systems design for building systems.

Public and residential buildings are good targets for improved energy efficiency because they represent roughly one-third of national energy consumption. Buildings of all types are the single largest contributor of greenhouse gases which total nearly half of all emissions. These numbers demonstrate how buildings serve as a logical starting point for reducing energy demand and improving environmental quality. While there were a variety of opinions on the ideal course of action, participants generally agreed that the following categories of recommended actions had the greatest potential to generate energy efficiency gains. Energy efficient design principles addressed in this policy include:

1. Energy efficient building requirements.
2. Building and room orientation,
3. Glass and windows choice
4. Window placement, sizing and shading.
5. Insulation
6. Ventilation
7. Use of thermal mass (heat absorbing) materials inside the house
8. landscaping,
9. Use of energy efficient systems and applications

4.2 ENERGY EFFECIENT BUILDING REQUIRMENT

All new development, including significant additions dealing with principle living areas, increasing the gross floor area by more than 50%, and 2 storey additions shall be designed so that primary indoor and outdoor living areas including courtyards and balconies and primary work areas are orientated on the north side of the building to achieve maximum natural lighting and access to winter sun. Applications will be considered on their merit, with strategies for achieving a reasonable level or performance in the hands of applicants and their designers.

4.3 BUILDING OREINTATION

Properly orientated buildings take advantage of the seasonal sun movement by allowing the winter sun into the building, but excluding summer sun. This has the effect of improving the amenity to habitable and working areas by accessing the natural heating, cooling and lighting elements. During winter the north face of the building receives significantly more solar energy 3-4 times than east west sides. The northern side of the building is therefore a good location for living and primary working spaces that are continually occupied during the day and which usually have the largest heating and lighting requirements. The time delay in heat penetrating the building also allows the benefits of such orientation to last well into the night.

The movement of the sun is the most important natural element to take into account when designing an energy efficient house. Since the sun is the main source of heat a major principle of energy efficient design is to allow that heat into the house in the winter, and exclude it in the summer. Fortunately this is easily achievable since the angle of the sun changes from season to season. During the summer months the sun rises in the north east and

Seasons	Day	Horizontal rise (α)	Noon altitude (β)
Summer	June 21 (longest day of the year)	28^o south	82^o
Winter	December 21 (shortest day Of the year)	28^o north	35^o

Table 5: Horizontal and Noon Rise angle

Ascends slightly southwards until it becomes almost perpendicular to the earth's surface at noon, after which it descends again towards the North West. The main heat gain of a house during the summer comes from the roof, as well as from the east and west facades. Therefore it is important to shade and obscure the roof and any east and west facing windows and walls. During the winter months the path of the sun is much shorter - it rises in the south east, and remains at a low angle as it

4.4 GLASS AND WINDOW CHOICE

Glass doesn't stop most heat transfer on its own. It's not an insulating material. Most of the insulation value provided by a normal window comes from the very thin layer of still air that sits next to the glass on either side. Still air is a very good insulator. Double glazing is a good way to reduce heat transfer through windows because it traps a layer of still air between two panes of glass and the air does the insulating. If instead of air there's a layer of special-purpose gas the insulation and sound-proofing qualities can be increased further. The glass itself can also be engineered to have better properties. Some types of glass are designed to block high percentages of incoming heat energy while only reducing the visible light by a small amount. These glasses are useful on any windows that are exposed to regular sunlight but are hard to shade. Thermo chromic glass is a kind of glass that gets better at stopping heat the hotter it gets. There are also types of glass designed to stop heat loss from inside. These are called low-emittance or low-e glasses. Low-e glass has a special coating on one side that reflects radiant heat. In cold climates the coating's set facing into the room to keep the heat in, and in warm climates it's set facing outside to stop the heat entering. They will also reduce the amount of sun entering in both winter and summer, so aren't recommended for reducing incoming summer heat on north windows. The three qualities you may want to look at when choosing glass for a window are the U-value the shading coefficient and the solar heat gain coefficient.

The U-value is the inverse of the R-value used in insulation – it's a measure of how quickly heat will pass through a material. Look for a low U-value - the lower the U-value, the better the window is at trapping heat inside in winter.

1. The solar heat gain coefficient is a measure of how well the window blocks heat from sunlight, as compared to an open hole in the wall. It's a number between 0 and 1, and the lower the number, the less it transmits. Look for a low number if you live in a warm climate and a high number if you live in a cold climate.
2. The shading coefficient is similar to the solar heat gain coefficient, but compares the window's heat blocking to an ordinary thin glass window instead of an open hole in the wall.
3. The frame a window's in is also important in reducing heat loss. Timber frames are much better insulators than aluminum frames, as aluminum has virtually no heat transfer resistance. Thermally-improved or thermally-broken aluminum frames have a better performance than plain aluminum frames.
4. Windows are now being sold with an energy rating that will help you compare the energy efficiency of different types of windows and select the best kind for the different parts of your house. The rating means that for every star it's got, the window can save you 9% of the energy for heating or 12% of the energy for cooling. So a five star window can save 60% of cooling energy and 45% of heating energy that would normally be lost through the window.

4.5 SOLAR RADIATION ON TILTED SURFACE

Solar equipments for absorbing radiation are tilted at an angle to the horizontal. The flux is the sum of the beam and diffuse radiation falling directly on the surface and the radiation reflected into the surface from the surroundings.

4.5.1 Beam Radiation

The ratio of the beam radiation flux falling on a tilted surface to that falling on a horizontal surface is called tilt factor for beam radiation. It is denoted by the symbol r_b . For the case of a tilted surface facing south,

$$\text{Cos } \Phi_z = \sin \Phi \sin (\Phi - \beta) + \cos \delta \cos \omega \cos (\Phi - \beta) \qquad (4.5.1.1)$$

While for a horizontal surface

$$\text{Cos } \Phi_z = \sin \Phi \sin \delta + \cos \Phi \cos \delta \cos \omega \qquad (4.5.1.2)$$

Hence $r_b = \{\text{Cos } \Phi / \text{Cos } \Phi_z\}$ (4.5.1.3)

4.5.2 Diffuse Radiation

The tilt factor $r_{b\ for}$ diffuse radiation is the ration of the diffuse radiation flux falling on the tilted surface to that surface to that falling a horizontal surface. The value of this tilt factor depends upon the distribution of diffuse radiation over sky and on the portion of the sky done seen by tilted surface.

$$r_b = (1+\cos \beta)/2 \qquad (4.5.2.1)$$

Since (1+cos β)/2 is the radiation shape factor for a tilted surface with respect to the sky.

4.5.3 Reflected Radiation

Since (1+cos β)/2 is the radiation shape factor for a tilted surface with respect to the sky, it follows that (1-cos β)/2 is the radiation shape factor for the surface with respect to the surrounding ground. Assuming that the reflection of the beam and diffuse radiations falling on the ground is diffuse and isotropic, that the reflectivity is ρ, the tilt factor for reflected radiation is given by

$$R_r = \rho\ (1-\cos \beta)/2 \qquad (4.5.3)$$

Site latitude [north or south]	Tilt angle
0^o-10^o	10^o
11^o-20^o	Latitude +5
21^o-45^o	Latitude +10
46^o-65^o	Latitude +15
>65^o	80^o

Table 6: Solar Panel Tilt Angle

The tilt angle helps in taking the solar radiation. The type of tilt angle is explained above which is used for calculating on different position.

4.6 WINDOW PLACEMENT, SIZING AND SHADING

Windows should be carefully designed as they serve several functions in an energy efficient house. They act as solar collectors, trapping heat from the sun. They also act as ventilators, providing cross ventilation. They are also important lighting tools. However, a window can lose heat five to ten times faster than an equivalent area of wall. Therefore the design of windows should achieve a balance between its functions.

4.6.1South-facing windows

The best size for south facing windows largely depends on the location of the house. In cooler, hilly areas larger window sizes are more suitable, provided they are double glazed and air-tight. In warmer areas, smaller window sizes are better and shading overhangs become important.

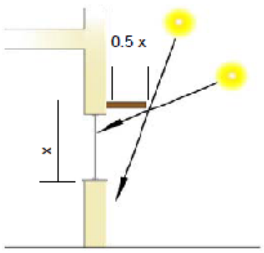


Figure 15: In section (South-facing windows)

4.6.2 East and west-facing windows

The area of these windows should be kept to a minimum. Full vertical screening external shutters or deciduous trees are the only shading devices that can block low sun in the early and late summer. However, western windows are also important for cross ventilation because of the direction of the prevailing summer breeze.

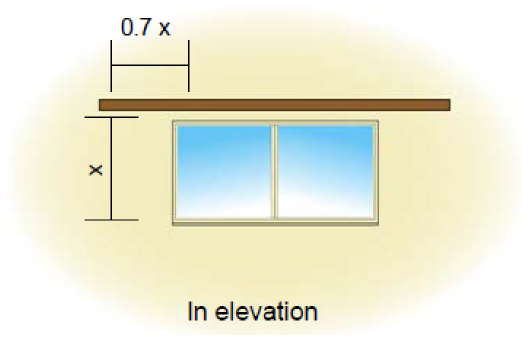


Figure 16: In elevation (East and west-facing windows)

4.7INSULATION

The Office of Energy suggests that energy efficient house design can achieve an average internal temperature of 50 Celsius warmer in winter and 10o Celsius cooler in summer, than poorly designed homes. Insulation of a building can impact significantly on energy use, as 20% of all heating is lost through the roof. A combination of insulation techniques (Floor, roof, and wall) can reduce fuel bills by up to 40%.Insulation alters the rate at which a building loses or gains heat. Insulation is not a heat store; it just makes it harder for heat to pass through a wall, roof or floor. R values, often shown on building materials, are a measure of insulation that is resistance to heat flow. This is the ability to keep heat in or out depending on the season.

If the R value is low the insulation potential of the subject material is low. The recommended insulation for ceilings is R2.5 - R3.5, for wall and floor a minimum insulation of R1.5. The roof is the most important element to control heat gain/loss, and usually easiest and cheapest place to improve insulation performance of a new or existing building. The recommended R values below are for ceiling and wall insulation, not for the roof and wall materials themselves. Ventilating the roof void above the insulation layer is an important method to disperse trapped summer heat.

4.8 VENTILATION

Building is make energy efficient after providing suitable ventilation for fresh air and cool breezes as by installing the HVAC system to decrease the air-conditioning load after ensure they are efficiently used

The two area of efficient building will be highlighted;

1. Fitting ceiling into low cost houses.
2. More efficient use of ventilating and air condition (HVAC) system in the building.

4.8.1 Fitting ceiling in low building:

The best way to make a building more efficient is to reduce the flow of heat into and out of the houses. This achieved through insulation. Insulation keeps a house cooler on a hot day and warmer on a cold day. The large amount of heat is lost through the roof and the most efficient way is to insulate a building is to fit a ceiling. In areas with cold winter a ceiling can reduce space heating cost up to 50%.

The low cost houses build by government don't have ceiling filled like PEDA. Installing a ceiling will therefore have several benefits:

1. Less money spent on heating in impoverished household.
2. Improved indoor air quality, health and comport.

3. Less energy used means non renewable sources being used and less co_2 being produced.
4. In poor building that cannot afford heating, ceiling will have a positive effect on the health of household.

4.8.2 Efficient use of heating, ventilation and air conditioning system:

HVAC system contribute an estimated 54oo MW to electricity demand in peak periods. This is approximately 24% of India's current peak demand consumption below point make HVAC up to 20% more efficient:

1. The fresh air is used to cool a building down at the start of the day. The outside air even in summer is fresh and cool early in the morning and by switching the air conditioning system's fans on the cool, natural air is drawn into building. Not only does it lower the inside but it also fuses out the stale air from the previous day. In this way the building is cool and fresh when the student arrives.
2. Slight adjustment to the temperature setting of the air conditioning system can result in substantial savings. The difference between the inside and outside temperature should not exceed 10 degree Celsius. This means that air conditioners can be set a degree. The air conditioning not have to work quit so hard to maintain the desired temperature but health wise it is also wiser to not subject the body to serve temperature contrasts. If the outside temperature is 35 degree for example the inside temperature is maintained at degree instead of 20 degrees, a 33 # saving in energy consumption will be realized.
3. HVAC technology has also improved greatly over the last few years and efficiencies of these systems are far better. For example some new air conditioning system is 30% more efficient than their older counterparts.

If consumers of the building installed 100% ceiling by 2020 or to achieve its targets by 2040, 550 thousand MWH of electricity will have been saved. In power station terms in 2040 it will negate the need for an 8MW facility.

4.9 TYPES OF VENTILATION

Ventilation is the best way to reduce the air condition electricity bill after introducing the building which receives proper ventilation. Types of ventilations are:

4.9.1 Natural ventilation

Most of the buildings need mechanical ventilation for most climates it is able to provide a reliable and constant sources of fresh air. It can be a good way for solving dealing with indoor air moisture source. Instead of mechanical ventilation, natural ventilation can also be another option for providing fresh air or your home as well as for minimizing the bills for air conditioning.

4.9.2 Natural cross ventilation

Cross ventilation is a condition where the windows on the opposites of the house are open. It means that high and low pressure zones which is created by the wind for providing the fresh air is used. If the natural cross ventilation is used the placement of the opening such as doors and should be paid attention. In other words the house should be located to the orientation of the dominant wind breezes and their patterns.

4.9.3 Natural stack ventilation

This type of ventilation is using the effect of the chimney. It means that the tendency of heated air is raised in the chimneys. In this type of ventilation the warmed indoor air rises up from the living area through the top part of the building such as attic. As a result it is providing you cold air. It can apply by designing an exit window in high located place and on the opening in low location.

4.10ENERGY EFFICIENT AIR-CONDITION

When choosing between units with similar prices, capacities and features energy efficient should be the deciding factor. Even through energy efficient unit may be higher priced it may the best buy. High efficiency appliances cost less to operate and can pay back the extra initial cost many times over during their lifetimes.

All room air conditioner bear bright yellow energy guide labels which provide information on energy efficiency. Energy guide label as part of the energy policy and conservation act of 1975. The label displays and energy efficiency rating in large black number. The higher the rating the more efficient the appliance. Central air conditioners are rated according to their seasonal energy efficiency ratio. These way air conditions consume 25% less energy.

4.11 USE OF THERMAL MASS MATERIAL INSIDE THE HOUSE

Thermal mass is the concept that defines the material’s ability to absorb and store heat. Dense materials such as stone, concrete and brick heat up and cool down very slowly. They have a high thermal mass, which means that they store heat for longer hours before starting to radiate it again. Lightweight materials such as fibber concrete, metal sheets, wood and gypsum board have a low thermal mass, and accordingly heat up and cool down quickly.

4.11.1 Having internal walls and other internal surfaces floors, counters, furniture etc. comprised of materials with a high thermal mass is most beneficial for homes which have good solar access from southern facing windows. For example laying dark tiles on the floor where the low angle winter sun hits will maximize the absorption of heat. However if solar access is limited large amounts of thermal mass can increase the building's heating requirements in winter. Do not use thermal masses at locations that receive direct sun light during the summer.

4.11.2 If high thermal mass materials are used for the external walls, make sure to provide proper sandwich insulation separating external wall surfaces from internal ones. Otherwise they will cause overheating of the interior spaces during summer and will require considerable energy to cool them down. In general, higher thermal masses on external walls are recommended in cooler climates e.g. the northern highlands.

4.11.3 Using low thermal mass materials for external walls would also require insulation to stop heat loss through the walls during the winter. In general lower thermal mass external walls are recommended in hot areas.

4.12 LANDSPACING

Deciduous trees shade the house during the summer, but allow the sun through during the winter. Using deciduous creepers to shade west facing walls provides a cooling effect on hot summer afternoons but be careful to plant them in a way that does not block summer breezes. Plantings evergreens in the direction from which cold winter wind comes would help shield the building. These winds come from western and south western direction. Un-shaded paving to the south, east and west of the house should be avoided as it can cause heat to be reflected into windows during the summer. Ground covers plants or mulches can help reduce this problem. If using a water element such as a fountain or pool, try placing it to the side from which breezes come in before entering the house. This will help cool the air before it reaches the inside of the house. Investigate the wind regime that is particular to your location to make the most of desirable cooling summer breezes, or to reduce the impact of hot summer or gusty winter winds.

4.13 USE OF ENERGY EFFECIENT APPLICATIONS

Systems such as lighting, heating, cooling, hot water, and other appliances should be energy efficient. This can be done by carefully selecting highly efficient and performance systems that do not waste energy.

A global economic analysis methodology is proposed in order to simplify the cost and the profitability assessment of energy and services delivered by photovoltaic systems. As examples, equations and graphic tools derived from this methodology give directly the overall discounted cost of electricity delivered by grid-connected PV power plants and the ODC of water delivered by a stand-alone PV pumping system. The main criteria used for profitability analysis of PV projects are reviewed: net present value, internal rate of return and profitability index (PI). A simple method with associated equations and graphic tools is presented in order to assess the profitability of PV projects from their PI.

5.1 ROOF AREA

Solar roof panels may also be photovoltaic panels, used to generate electricity. These types of solar roof panels are most often seen in smaller home use, as large facilities often find thermal heating to be more efficient. Solar roof panels in this case consist of large photovoltaic arrays which are placed on the roof of the house. The roof is an ideal location for photovoltaic panels, because it tends to catch more direct sunlight than other locations on a piece of property, and also reduces the visual footprint of the solar panels, which many people find unsightly. Solar roof panels may also refer to a new type of photovoltaic system, known commonly as solar shingles. These are similar in operation to traditional photovoltaic panels, but are smaller, and have what most people consider being a much nicer aesthetic. Solar shingles are about the size of normal roofing shingles, and a similar colour. They are installed on the roof, and in many cases are indistinguishable from normal roofing materials.

PV CAPACITY RATING (W)		250	300
PV MODULE EFFICIENCY (%)	4	75	150
	8	38	75
	12	25	50
	16	20	40

Table 7: Roof Area

5.2 NUMBER OF ELECTRICAL EQUIPTMENT CONNECTED IN J-HOSTEL

S No	Name of Block	No of Room’s	Fan		Light	L.C.D	Refrigerators
1	Entry		8		18	1	
2	Administration Block		4		4		
3	Mess living room		2		4		
4	Guest room	4	4		8		3
5	Mess Store		3		4		
6	Corridor	7 Floor 2 Block	2		15		
7	Mess Washing Room		6		6		
8	Mess Bathroom		3		8		
9	Main Mess		4		9		
10	Mess		34		15		
11	Rooms	846	846		846	84	84
12	Entrance				12		
13	Total		916		991	85	87

S No	Name of Block	Oven	Gizer
1	Rooms		
2	Mess Bathroom		1
3	Main Mess	2	2
4	Rooms		64
5	Total	2	67

Table 8: Total electrical equipment of j-hostel

5.3 TOTAL LOAD OF EQUIPTMENT IN KW

This is the total of total equipments' which are installed in j-hostel of Thapar University. But some of the equipments' are not in use and are not necessary to installed but installed in the hostel.

S No.	Appliance	Load (KWh)
1	Fan	54.96
2	Light	54.50
3	Refrigerator	17.40
4	L.C.D	10.20
5	Oven	3
6	Gizer	100.20
Total load		240 (kwh)

Table 9: Load of all equipments of j-hostel

5.4 TOTAL LOAD IN USE BY J-THAPAR UNIVERSITY CONSUMERS

This is the load table of electrical equipment which is in use and total load is 159 which is decrease from 240KWh.

S No.	Electrical Equipments	No of Equipments In Use	Load (KWh)
1	Fan	671	40.26 KWh
2	Light	654	35.97 KWh
3	Refrigerator	65	17.40 KWh
4	L.C.D	63	7.80 KWh
5	Oven	2	3 KWh
6	Gizer	46	55.20 KWh
TOTAL LOAD IN USE			160 KWh

Table10: Load in use

5.5 TOTAL ENERGY CONSUMTION PER DAY WITHOUT SOLAR SYSTEM

S No.	Electrical Equipments	Average hours usage & no. of equipments in use	Energy consumption by the equipments per day
1	Fan	13 hrs and 671 fan in use	13 * 54.96 = 714.78 KWh
2	Light	13 hrs and 654 light in use	15 * 54.50 = 817.45 KWh
3	Refrigerator	24 hrs and 65 in use	65 * 17.40 = 1131 KWh
4	L.C.D	4 hrs and 63 in use	4 * 10.20 = 40.80 KWh
5	Oven	4.5 hrs and 2 in use	4.5 * 3 = 13.5 KWh
6	Gizer	4hrs and 46 in use	4* 100.20 = 400.80 KWh

Table 11: Energy consumption per day

5.6 AIR – CONDITION LOAD

Air -condition are not installed in the house till date but it will be installed after few months. So, it must be to make building energy efficient by proving proper ventilation or using air-conditioning saving stragerties which are already discussed.

S. NO.	Calculations	No. of equipments’	Ratings	Result
1	Initial cost of air condition	1	1000 watts	RS 12,000
2	Initial cost of air condition	736	1000 watts	RS 8,83,200
3	Running cost of air condition	1	1000 watts	RS 1800
4	Running cost of air condition	736	1000 watts	RS 13,24,800
5	Energy consumes per months	736		$317952 * 10^6$ KWh
6	Unit consumes per months	736		454217 KWh
7	Cost of unit consumes per months	736		RS 20,43,977

Table 12: Normal air condition result

The difference between the normal and solar air condition is that the gas is changed back into a liquid so that it may be used again. A regular air conditioning system uses a compressor to increase the pressure on the gas, forcing it to become a liquid again through the use of the condenser coil. The change of state of the refrigerant, starts to take place approximately 2/3rd’s of the way down the condenser. This Solar Air Conditioning System uses a different method. It uses the solar heat from the sun to superheat the refrigerant which enables the refrigerant to begin changing state at the top 2/3rd’s of the condenser coil. By using this method it reduces the superheat of compression required to achieve the cooling process in the conventional cooling systems as well as utilizing more of the condenser cooling face of the coil. The Solar A/C process allows more of the refrigerant to change state back into a liquid faster as well as allowing the transformation of more liquid into the metering device.

S. NO.	Calculations	No. of equipments'	Ratings	Result
1	Initial cost of air condition	1	1000 watts	RS 75,000
2	Initial cost of air condition	736	1000 watts	RS $552*10^6$
3	Running cost of air condition	1	1000 watts	RS 1200
4	Running cost of air condition	736	1000 watts	RS 8,83,200
5	Energy consumes per months	736		$211968*10^6$KWh
6	Unit consumes per months	736		302811 KWh
7	Cost of unit consumes per months	736		RS 13,62,649

Table 13: Solar air condition result

S.NO.	Calculations	Saving
1	Running cost	RS 4,41,600
2	Energy consumes per months	$105684* 10^6$ KWh
3	Unit consumes per months	151406 KWh
4	Cost of unit consumes per months	RS 6,81,328

Table: saving of energy

5.7 SOLAR SYSTEM SPECIFICATION

This specification describes the requirements for solar power systems that operate compression-cycle vaccine refrigerators or combined refrigerator-icepack freezers. Qualified suppliers are also free to offer the installation and maintenance services described in this document, although the provision of these services is not a condition for pre-qualification. On-going supply of spare parts is a mandatory requirement.

Characteristics	300W
Maximum Power(Pm)	300W
Power Tolerance	±3%
Voltage at max power(Vmp)	34.9V
Current at max power(Imp)	8.6A
Open circuit voltage(Voc)	43.2V
Short circuit current(Isc)	9.46A
Operating Temperature	-40°C to +85°C
Maximum System Voltage	1000V

Table 14: Electrical Specifications of solar panel

Solar Cell	Monocrystalline silicon solar cell 125*125mm (5 inch) 72 cells in a 6x12 matrix connected in series
Dimensions (L*W*H)	1580*808*50mm (62.2"*31.8"*2" inch)
Weight	26.5Kg
Pallet Dimensions (L*W*H)	1610*840*120mm (63.4"*33*4.7" inch)
Junction Box	IP65 rated
Resistances	227g stell ball fall down from 1m height and 60m/s wind
Frame	Anodized aluminum alloy. Color: Silver
Limited Warranty	2 Years Workmanship. 90% power output for 10 years, 80% output for 20 years

Table 15: Mechanical Specifications

NOCT	48℃±2℃
Current temperature co-efficient	0.06±0.01%/K
Voltage temperature co-efficient	-(78±10)MV/K

Table 17: Temperature specification

5.8 SIZING OF PV GENERATION

In this section, an iteration algorithm is described for determining the number of PV panel needed for the stand-alone system. The algorithm uses the hourly average power demand to determine PV generation capacities required to meet the demand while minimizing an objective function which will be the total annual cost to the customer (Fc). Fc is the sum of the annual cost of the capital (Cc) over the life of the generating system and its annual maintenance cost (Cm).

$$Fc= Cc+ Cm$$

The costs can be broken up into the annual costs of the PV array, storage and backup generation, as follows:

$$Cc= Cc_{pv}+ Cc_{store}+ Cc_{backup} + C_{csh}$$

$$Cm= Cm_{pv}+ Cm_{store}+ Cm_{backup} +Cmsh$$

The objective function Fc is also constrained to minimize the magnitude of the difference between the generated power (Pgen) and the demand (Pdem) over a given period of time.

$$\Delta P= Pgen+ Pdem$$

On an average day, the battery is required to cycle between the positive and negative peaks of the energy curve. Therefore, the battery should at least have a capacity equal to the difference between the positive and negative peaks of the energy curve. For this type of application, batteries designed specifically for cycling should be used. These batteries have a life time of about to obtain this life time, they should not be cycled through more than 80% of their rated capacity. Hence, the number of batteries required for the needed storage capacity can be found as follows:

$$\text{Required storage capacity} = \text{Max} \int \Delta P dt + \text{Min} \int \Delta P dt$$

Number of batteries= required storage capacity / (.8) (rated capacity of each battery)

The iteration procedure adopted for selecting the number of PV panel needed for a stand-alone system to meet a specific load is follows:

1. Select commercially available unit size for PV panel and storage battery.
2. Since the rating for the PV panel keep the number of pv panel until the system is balanced i.e., the curve of P versus time for the system has an average of zero over of time.
3. Report step 2 for different number of PV panel.
4. Calculate the total system annual cost for each combination of no. of panel the satisfaction the requirement in step 2.
5. Choose the combination with the lowest cost

5.9 CALCULATION OF PV PANEL

The iteration optimization procedure discussed above has been used for component sizing for a PV system to supply the electrical power needs of a hostel. The annual average hourly load profile for the hostel is in fig. this dada taken from is a good representation of the electrical demand of a hostel being an average hourly demand curve, is shown a continuous plot. If the hourly demand data is assumed to be discontinuous

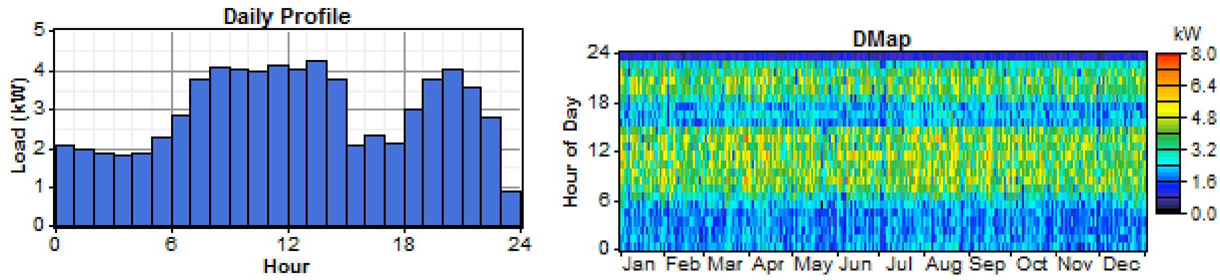


Figure 17: Daily load profile

The rating and capital cost of the system components chosen for this study. An estimated cost of 81,300 has been used for the backup generator.

The total annual cost (Fc) for each configuration is obtained using equation

$Fc = Cc + Cm$

$Cc = Cc_{pv} + Cc_{store} + Cc_{backup} + C_{csh}$

$Cm = Cm_{pv} + Cm_{store} + Cm_{backup} + Cmsh$

The price for components, installation and other costs is known as “balance of system cost”. In this the BOS cost is taken as 50% of the cost of PV panels. Therefore, to account for this cost of the PV panel is multiplied by 1.5.To obtain the components interest factors needed for calculating the annual cost, an interest rate of 6% was used.

$F_{c\ solar} =$ [(370 panel)(1.5)(7510/panel)+(16)(5)$(6650)_{store}$ + 1,02,105](.08718)+ (1.5)(370)(0.298 kwh/day/panel) (365)

$F_{c\ solar}$ = RS 4, 32,639 = $8652

C_{pv} = (370 PV panels) (1.5) (7510/panel) = RS 41, 68,050 = $ 83361

$C_{maint.}$ = [(0.25(370 panel) (0.298 PV generated kwh/panel/day)] (356days/year) (11.4699 years compound interest)

C_{maint} = RS 1, 15, 301 = $ 2306

$C_{battery.}$ = present value of the cost of battery for the solar panel system for 20 years

= (44 batteries) (6650) (5installement over 20 years)

= RS2, 92, 600 = $ 13034

$C_{back\ up}$ = cost of backup generator

= RS 4, 10,300 = $ 8206

$C_{capital} = C_{battery} + C_{pv} + C_{backup} + C_{maint.}$

= 2, 92,600 + 41, 68,050 + 4, 10,300 +1, 15, 301

= RS 49, 86,251 = $ 99725

Dep. = present value of depreciation of the component of the pv system over 5 years assuming a 30% tax bracket and an interest rate of 6%

Dep. = [($C_{capital}$) (4.213 compound interest factor)(0.3)]/5

Dep. = [(49, 86,251)*4.213*.3]/5 =RS 12, 60,424 = $ 25,208

5.10 MODEL OF THE SYSTEM

The model of the system shows the various simulation output waveforms ,result and calculation which is must kept be know before installing the pv panel. These model calculations also show the saving of electricity in KW which is produced by the module and from the whole system of the PV after taking the radiation from the sunlight.

5.10.1 PRIMARY LOAD MODEL INPUTS

The load details are inputs to the simulations. The load inputs describe the electric demand that the system must serve. The load is the input which is taking from the j-hostel of the Thapar University, Patiala. This input show the peak load and base load which is in use by the consumer of the hostel. One important factor for electricity energy output produced by the PV modules is the sum of the global radiation (= the sum of the direct and indirect solar radiation) received by the PV surfaces in a certain angle and orientation. To make it visually clearer, the position of the sun in June and December in India (28º11'S) and (28º35'N) at its 12.00 local solar time.

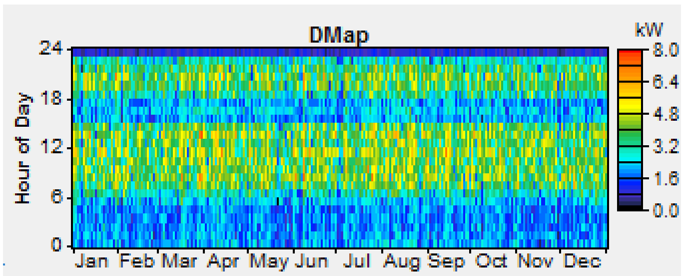


Figure 18: D-MAP of the year

Based on this climate condition, the PV integration in Jakarta is preferably on the building roofs or as PV roofs. The electricity energy output will be the highest in comparison with the PV façade integration because it has the highest global solar radiation on horizontal surface. This model calculation is obtained which represents the load which is in use j-hostel of Thapar university campus.

	Baseline	Scaled
Average (KWH/d)	70.5	70.5
Average (KW)	2.94	2.94
Peak (KW)	7.45	7.45
Load factor	0.395	0.395

Table 16: Baseline and scaled of average and peak power

5.10.2 PV INPUTS

The basic consideration of PV roof integration is to use the open "useless" flat roof spaces in the city and cover it with PV modules to form the grid connected PV system. The electricity product can then be used by the building itself or distributed to the local grid. In tropical climate with its high solar radiation, this PV grid connected system could supply additional electricity energy to the city. There are already many modern buildings, which have flat roof surfaces, which could be used as place for PV modules. Some general guidance for PV integration in buildings for getting the most electricity output are :

The sum of global solar radiation on the PV surface should be based on the local global radiation measurement. Clean PV module surface. The PV surface should periodically be cleaned; therefore the cleaning of the PV surface should be as easy as possible.

1. Appropriate PV surface angle.
2. Shadow free.
3. PV generator working temperature.

The PV input is taking according to the calculation from the capital cost analysis of the PV system. The result representing is:

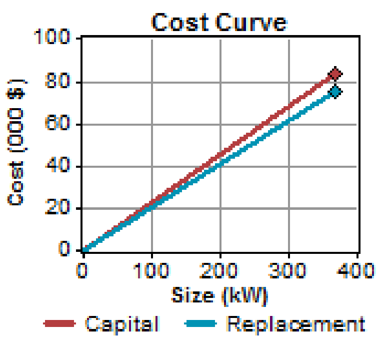


Figure 19: Cost curve

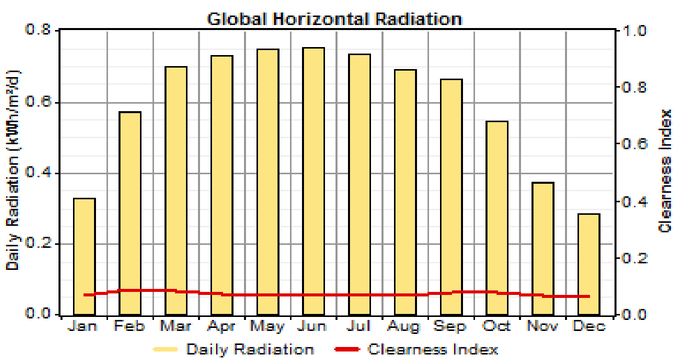


Figure 20: Daily radiation

This is the cost curve which represents the capital and replacement cost with the properties of lifetime(years) which represent the limit of the system after that period the system will be or will not replaced. The simulation result obtained after this solar radiation tables recorded from the daily radiation obtained from the Thapar University, Patiala.

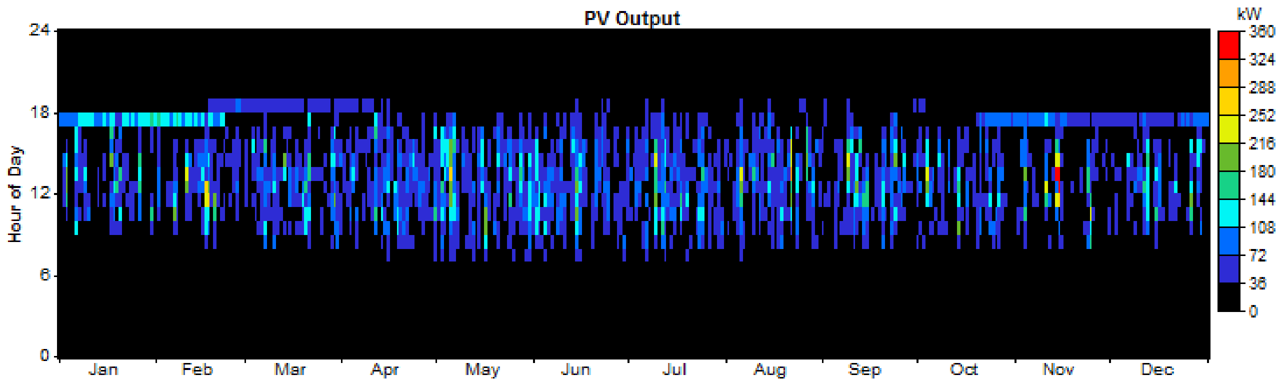


Figure 21: PV output

5.10.3 BATTERY INPUTS

Batteries are used to provide energy storage or backup power in case of a power interruption or outage on the grid. The Trojan battery is used which is connected with the solar panel for providing the backup under the night time when solar radiation's are not able for generating the electricity.

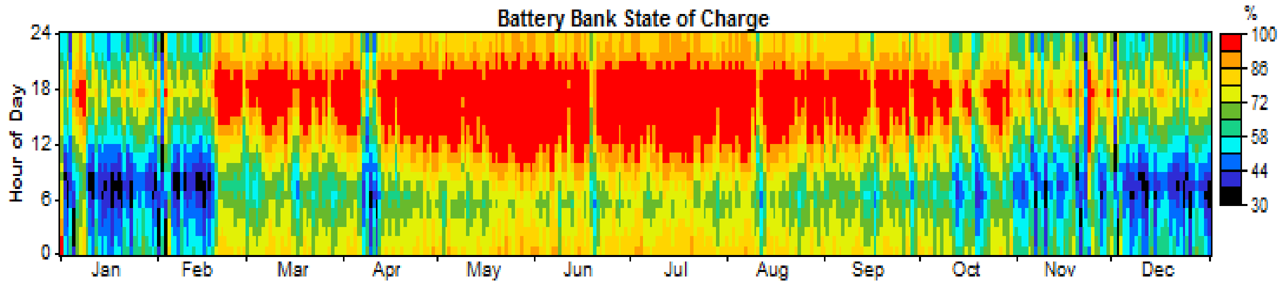


Figure 22: Battery inputs

This output is obtained from the model which the part of the energy efficient is building in this the type of battery which is already being shown and also show the cost curve of capital cost and replacement. The nominal voltage is 6v, nominal capacity is 360 AH (2.16 KWh) and the life throughput of one battery is 1,075 KWh.

5.10.4 CONVERTER SIMULATION

Solar Converters Inc. is a manufacturer of highly efficient power control products for the renewable energy field. What makes us so unique is our products can work with any renewable power source to charge virtually any battery voltage or type to operate virtually any load. We have successfully designed and manufactured many custom controllers to solve unusual system configurations. To address the needs of the renewable energy enthusiast and optimize the value and performance of your renewable energy system, we have developed several product lines of rugged and highly functional Linear Current Boosters, Battery Equalizers, Power Tracker™ charge controllers with Maximum Power Point Tracking (MPPT), Cathodic Protection Controllers, Generator Starters, Battery Desulphators, Constant Voltage Pump Drivers, Voltage Controlled Switches, Solar Lighting Controllers, DC-DC Converters, and more. Our products will do voltage conversions between battery and equipment voltage classes. This is especially useful when long distances are required between the renewable power source and the equipment to be used. This allows smaller wire to be used substantially reducing the wiring cost to the extent that the controller more than pays for itself in wire savings.

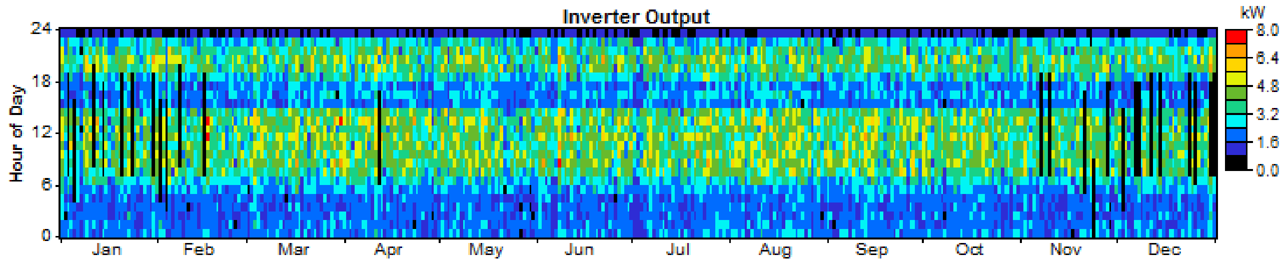


Figure 23: Inverter Output

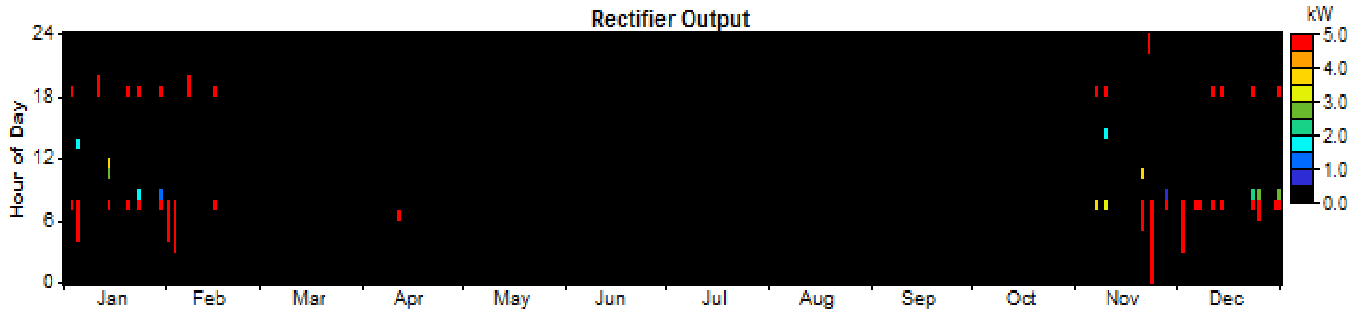


Figure 24: Rectifier Output

5.10.5 EXAMINE OPTIMIZATION RESULT

Homer simulates system configuration with all of the combinations of components that we specified in the component inputs. HOMER discards from the result all infeasible system configuration, which are those that o not adequately meet the load given either the available resources or constrained that you have specified.

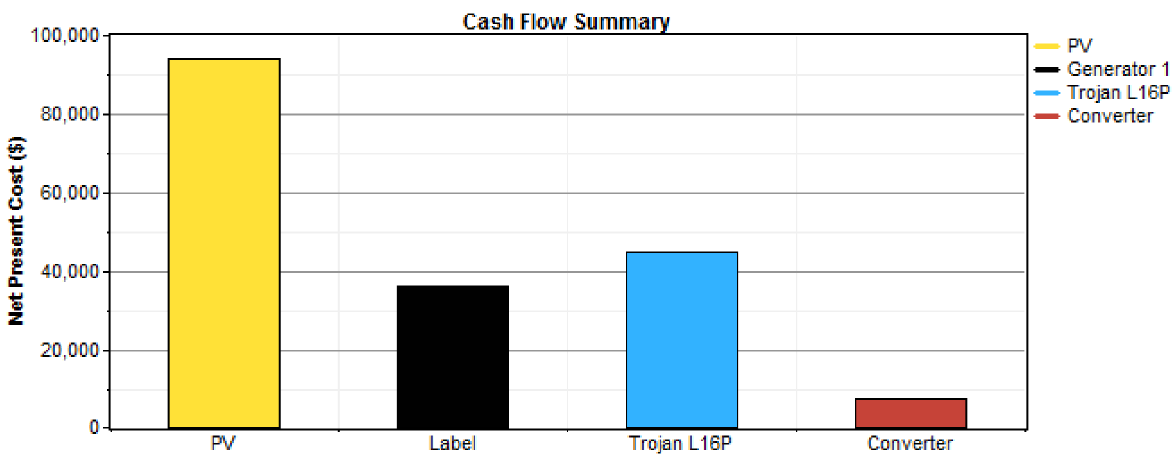


Figure 25: Cash flow summary

. In the overall optimization results table, homer displays a list of the four system configurations that it found to be feasible. They are listed in order of most cost-effective to least cost-effective. The cost-effective of a system configuration is based on its net present cost, displayed under the heading “Total NPC” in the result tables. For this one diesel/battery configuration In the simulation result, we can obtain many technical and economical details about each system configuration that homer simulates. For example, click the electrical tab, and note that the 81.4% of the total electric energy produced by the system is excess electricity or energy that is not used by the system and goes to waste.

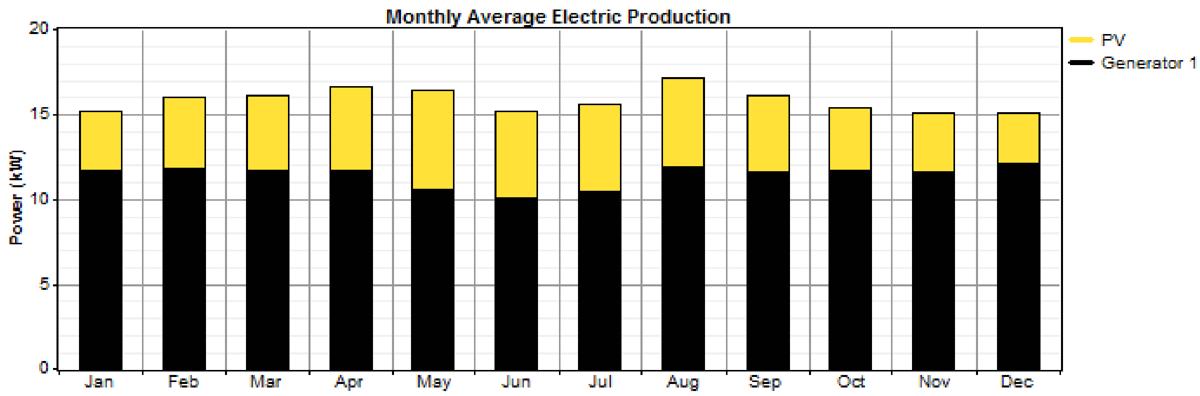


Figure 26: Monthly Average Electric production

5.11 BREAKEVEN ANALYSIS

The break-even cost for photovoltaic (PV) technology is defined as the point where the cost of PV-generated electricity equals the cost of electricity purchased from the grid. This target has also been referred to as “grid parity” and may be expressed in $/KW of an installed system. Achieving PV breakeven is a function of many var) tables, including the solar resource, local electricity prices, and various incentives. As a result, for a country like the India, where these factors vary regionally, there can be considerable variation in break-even cost. In this report, we provide an updated analysis of PV break-even costs for residential customers in the India, and we evaluate some of the key drivers of PV breakeven both regionally and over time. Currently, the break-even cost of PV in the United States varies by more than a factor of 10 despite a much smaller variation in solar resource. Overall, the key drivers of the break-even cost of PV are non-technical factors, including the cost of electricity, the rate structure, and the availability of system financing, as opposed to technical parameters such as solar resource or orientation. This analysis of the break-even cost of PV represents neither a market depth analysis nor an estimate of likely consumer adoption, but it does provide insight about the potential viability of PV markets.

Energy from the PV system = (kW of PV) x (kWh/kW-year)

Energy from the PV system = [(138) * (24)* (365)] = 12, 08,880 kWh/year

Energy bills savings = (kWh/year) x (Commercial Rate)/ 100

Energy bills savings = [(1208880) * (4.5)] /100 = RS 54399 year

Capital cost of PV panel / 8760 = (kW of PV) * (no. of months in a year) * (Commercial rate) * (No. Of year in which cost recover)

Cost of solar panel recover = 5 years.

S. NO.	Results	
1	No. of PV system	370
2	PV production	1,50,900 KWh/m^2/d
3	No. of Batteries	44
4	Capital cost of PV system	RS 12,60,426
5	Energy from PV system	12,08,800 KWh/year
6	Energy bill savings	RS 54,399/years
7	Running cost saving using solar air-condition	RS 4,41,600
8	Saving of Unit consumes per month by using solar air condition	1,51,406 KWh
9	Cost saving of solar air conditioner	RS 6,81,328

Table 18: Overall Result

6.1 CONCLUSION

In this thesis we have shown some of the problems in moving from this simple goal to practical measures. First, we showed how the strategy for creating an efficiency regulation will have an enormous impact on the energy savings. Minimizing the life cycle cost of a building or appliance typically results in much greater savings than by eliminating the units with the worst performance or even exceeding the performance of the best unit presently available. Solar photovoltaic technology has many advantages which are discussed earlier in first chapter and in this third chapter the detail technology of SPV system is discussed. It is clear that the PV system can provide some relief towards future energy demands. Potential of photovoltaic system in Patiala district of PUNJAB is trying to find out Buildings are more complicated than appliances because their design involves many more energy trade-offs. For buildings no single indicator of efficiency is likely to give a fair ranking. Indeed rankings of efficiency are likely to fluctuate depending on the indicator chosen. There is no single correct indicator of efficiency, but it’s important to recognize the bias that may result when using just one. Even with these limitations, we think that it is still possible to identify some characteristics of an efficient building.

Finally, we raised the special case of defining a zero energy building. Here, small changes in the definition translate into vastly different technical consequences for the design of the building and its relationship to the utility.

6.2 WORK IN FUTURE

The solar photovoltaic system can design on the basis of test data. But in this report we analyze the various cost of the PV system. In my thesis work I shall calculate the pv production, maintenance cost,depreciation,operating cost and related graphs will plot and result for showing the variation. Also will observing the peak value in different day, the monthly average peak will calculate and variation of the monthly peak for a whole year and the average annual peak will calculate. Thus from these data we can estimate the rating of solar PV system for j-hostel, Thapar university, Patiala. A detailed Cost analysis can be conducted considering carbon credit to show whether it is economically viable or not.

REFRENCES

[1] Yuhong luo"energy efficient building", Guide booklet .

[2] Ajit K. Gupta "Renewable energy pecial focus on solar energy", proceeding on internal communication, pp1-4, 2008.

[3] Energy council, "Renewable energy scenario upto 2040" energy council", 1-16.

[4] Jansson, "photovoltaic system design", ieee proceeding in system design, vol.1, pp 235-240, 2010.

[5] Renewable energy the infinite power of Texas, "Introduction to Photovoltaic Systems", seco fact sheet no. 11, pp 254-262

[6] Mr Ramesh Kamal, "Solar Photovoltaic – Potential & Prospects" ieee proceeding on solar potential, vol.2, pp 8-12, 1995.

[7] Tymandra Blewett, Margaret Horne and Robert Hill, "Helidon Prediction of Shading on Building Integrated Systems", proceeding of 8th IEEE word conference on photovoltaic specialists,vol.3, pp 1393-1396, 1997

[8] H. MauNs, M. Schmid, B. Blersch, P. Lechner, H. Schade, "BIPV Installation Worldwide in ASI Technology". Proceeding of 3rd IEEE world conference on photovoltaic energy conversion. Vol.3, pp. 2375-2378, 2003.

[9] Neethi rajagopalan, Melissa M Bilec, Amy E. Landis, "comparative life cycle assessment of insulating concrete forms with traditional residential wall sections", ieee proceedings on international symposium,vol.1,pp 1-5,2009

[10] Henry Oman, "Buying a Photovoltaic Solar Electric System", ieee proceedings on photovoltaic system,vol.3 PP 1-5, 1984

[11] List of Certified PV Modules: http://www.energy.ca.gov/greengrid/certified_pv_modules.html

[12] Jim faith, "Standard for Flat-plate Photovoltaic Modules and Panels", proceeding on UL Standard 1703, pp 770-773, 1991

[13] M.penailillo, "Inverters, Converters, and Controllers for Independent Power System", ieee proceeding on energy conversion, vol.1, pp 194-201, 2007.

[14] Robert j, "Recommended Practice for Utility Interface of Photovoltaic (PV) System", ieee proceeding on PV system, vol.1, pp 929-2000, 1997.

[15]P.R, Robinson "Recommended Practice for Qualification of Photovoltaic (PV) Modules", ieee proceeding on pv quantification,vol. 1,pp 1-3,2001

[16] Environmental benefits of PV systems can be found at the following USEPA website:

http://199.223.18.230/epa/rew/rew.nsf/solar/index.html.

[17] Patrick M. Corrigan, and Gerald T. Heydt, "Optimized Dispatch of a Residential Solar Energy System", ieee proceeding on photovoltaic specification,vol.2,pp 1361-1366,2009

[18]Qian Ding "Evaluation of Index for Green Zoology Building", ieee proceeding on natural comutation, vol.1, pp506-510, 2008.

[19] Rahman, "Element of energy efficient Building", ieee proceeding on energy conservation, vol.2,pp 364-369,1995.

[20] Hawing Shi, "Theoretical Study on Comprehensive Assessment of Green Building",ieee proceeding on technology application,vol.1,pp 614-617 ,2006

[21] Wassila chekirou, "Effect of coupled heat and mass transfer on the performance of absorptive solar system", ieee proceeding on method,vol.1, pp5-8,1995.

[22] James Fisher ,"Introduce of buildings Solar Energy panel" ieee proceeding on building design,vol.1,pp 786-790. October, 3, 1997.

[23] J.S.Siva Prasad and B.G.Femandes ,"Grid Connected Photovoltaic Applications" ieee proceeding on system applications,vol.3,pp8-12, 2008.

[24] Xiao Yuejun, "Building requirements", ieee proceeding on building design, pp 432-438, 2005.

[25] Hawing Shi, "Theoretical Study of Green Building", ieee proceeding on green building, pp91-94,2007.

[26] Amarbayar Adiyabat, Kosuke Kurokawa, "Performance analysis of portable photovoltaic power generation systems based on measured data in Mongolia", ieee proceeding on system analysis, pp654-660, 2002.