DESIGN & IMPLEMENTATION OF A SOLAR POWER SYSTEM

This Project is Submitted to the Department of Electrical and Electronic Engineering (EEE) in Partial Fulfillment of the Requirement for the Degree of "Bachelor of Science in Electrical & Electronic Engineering".

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DECLARATION

We hereby declare that, this project has been done by us under the supervision of **Md. Mahmudur Rahman, Senior Lecturer, Department of EEE**, Daffodil International University. We also declare that neither this project nor any part of this project has submitted elsewhere for award of any degree or diploma.

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ABSTRACT

The world is using all the resources to meet the daily demands of energy and it is quite expectable that in the near future we will run out of any natural resources like ore/mineral/petroleum etc.

As a result, renewable energy solution has achieved a great demand today to save the natural resources and also to tackle the crisis of energy. Solar energy is rapidly gaining its popularity as an important source of renewable energy.

In this project a basic solar power system has been designed.

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Chapter-1

1.1 Introduction:

A most important & significant look in our modern civilization is —energy‖ of different forms. Many necessary functions can be at a stand still with out energy. So energy is a part of our life. There are various form of energy consumption process such raw energy in falling water, in deposits of coal, oil and gas etc are most well known form.

Energy sources which are regenerated after a regular time cycle are commonly known as renewable sources of energy like hydro power, solar energy, wind energy, tidal energy, biomass fuels etc. In a particular location available renewable energy sources are finite quantity, which depends on their respective characteristics feature. When renewable energy sources is extracted at a higher rate then its regenerative rate is becomes non renewable. Energy produced from renewable natural resources & technologies.

The present energy demand is increasing day by day in Bangladesh due to various reasons such as increasing population, the aspiration for improved living standard and general economic and industrial growth. The power generation system is principally depended on imported petroleum oil and own natural gas. On the other hand, as the information about the deposits of fossil fuels in Bangladesh, if they are consumed at the present rate, the reversed natural gas and coal will be exhausted by the year 2020 to 2030. To reduce the dependency on imported fuel and the pressure on natural gas, the present power generation system must be diversified and at the same time indigenous energy resources have to be explored and developed. It may be mentioned that concern for environment is a now a universal issue and conventional energy gives rise to greenhouse gases with adverse consequences for health and climate. In these perspectives, harnessing of renewable energies and development of relative technologies is a highly important strategic option. Communities in rural areas and mainly in remote areas of Bangladesh have very little possibilities to participate on the national electricity supply. Therefore, and in the context of environment protection, renewable energies can contribute substantial to the delivery of alternative energy to the users etc. are some of the key issues that determine the need for technological inventions in solving energy problems in the rural areas.

1.2 Definition of Energy:

Energy:

Energy is the measure of a physical system. It defines the quality of the changes and processes, which take place in the Universe, beginning with movement and finishing with thinking.

1.3 Renewable Energy:

Renewable energy is energy generated from natural resources such as sunlight, wind, rain, tides, and geothermal heat which are renewable (naturally replenished). In 2006, about 18% of global final energy consumption came from renewable, with 13% coming from traditional biomass, such as wood-burning. Hydroelectricity was the next largest renewable source, providing 3% of global energy consumption and 15% of global electricity generation. Wind power is growing at the rate of 30 percent annually, with a worldwide installed capacity of 121,000 megawatts (MW) in 2008, and is widely used in European countries and the United States. The annual manufacturing output of the photovoltaic industry reached 6,900 MW in 2008, and photovoltaic (PV) power stations are popular in Germany and Spain. Solar thermal power stations operate in the USA and Spain, and the largest of these is the 354 MW SEGS power plant in the Mojave Desert. The world's largest geothermal power installation is The Geysers in California, with a rated capacity of 750 MW. Brazil has one of the largest renewable energy programs in the world, involving production of ethanol fuel from sugar cane, and ethanol now provides 18 percent of the country's automotive fuel. Ethanol fuel is also widely available in the USA. While most renewable energy projects and production is large-scale, renewable technologies are also suited to small off-grid applications, sometimes in rural and remote areas, where energy is often crucial in human development. Kenya has the world's highest household solar ownership rate with roughly 30,000 small (20–100 watt) solar power systems sold per year. Some renewable-energy technologies are criticized for being intermittent or unsightly, yet the renewable-energy market continues to grow. Climate-change concerns, coupled with high oil prices, peak oil, and increasing government support, are driving increasing renewable-energy legislation, incentives and commercialization.New government spending, regulation and policies should help the industry weather the 2009 economic crisis better than many other sectors.

Main forms/sources of renewable energy

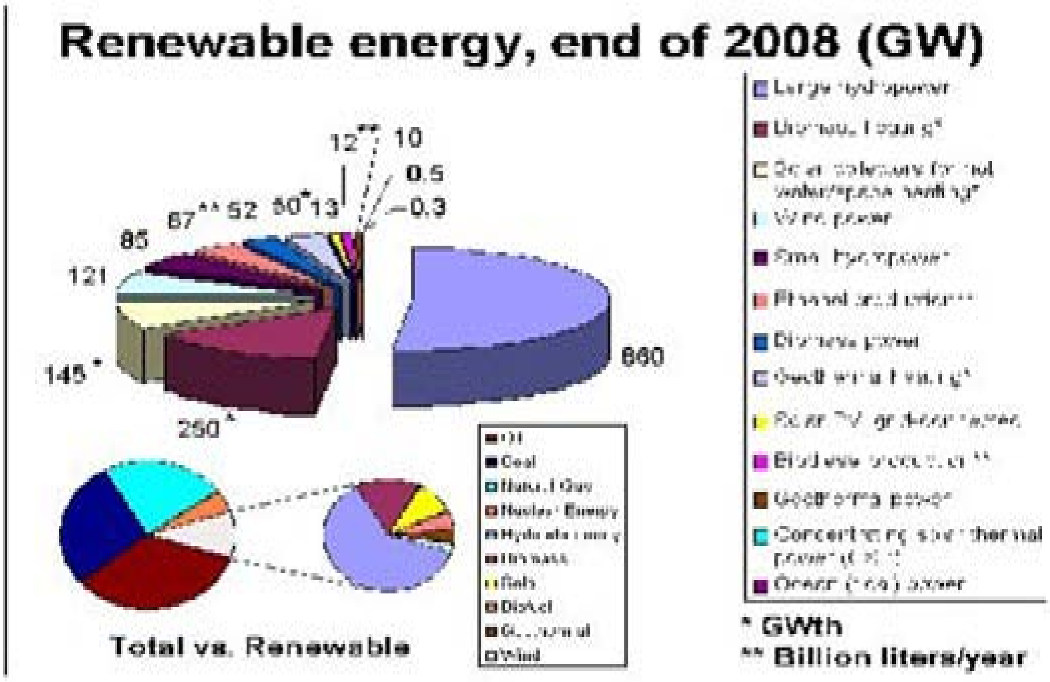


Figure: Renewable energy,end of 2008(GW)

1.4 Types of Renewable Energy

Biomass

Geothermal Energy

Wind Energy

Photovoltaic (PV) Cells

Hydropower

Hydropower:

Hydropower is the largest source of renewable energy. This renewable source of energy provides 10% of the nation‘s electricity. As of now, there are 77,000 Megawatts of hydropower, enough to provide 35 million homes with energy. Converting flowing water into usable energy produces hydropower. Most of this water comes from rivers and is released through turbines to produce energy. Although this power source does not release pollution, it can possibly harm fish and wildlife, displace people, and alter the quality of water. Better technology is trying to reduce the loss of aquatic life, but the problem with this technology is that it is highly expensive and takes a long time to build.

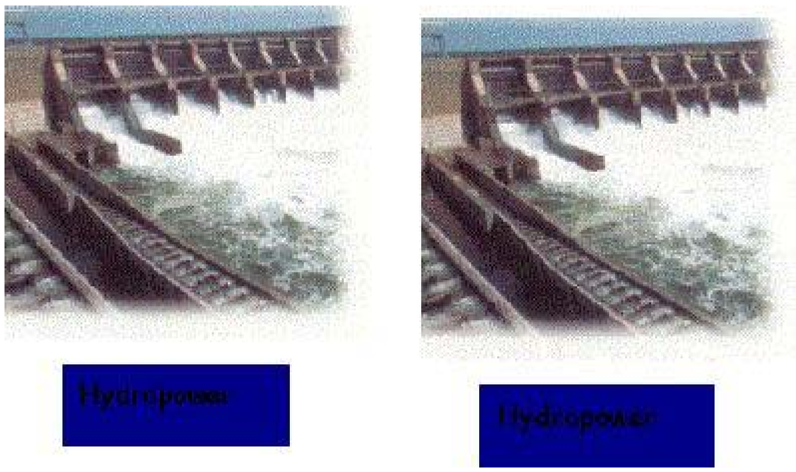


Figure: Hydro Power

Biomass/Bio energy:

Biomass makes up about 7,000 Megawatts of renewable electricity. Biomass fuels stem from industrial processing, such as forestry and wood products, agriculture and wood products, and construction and transportation. Biomass can replace coal in power plants because it produces less sulfur dioxide than coal. Mill operations seem to be the main source of biomass energy in the U.S. Europe, on the other hand, draws its main source of bio energy from urban wood waste. Third world countries make timber their main source of bio energy. According from statistics from the International Energy Agency, 11% of the world derives its energy from biomass. Developing countries use about 35%, while the poorest ones use roughly 90%. One way to convert biomass into usable energy is through gasification—converting biomass to gas and burning it in a gas turbine.

Wind Energy:

Wind energy produces about 2,500 Megawatts of energy, and generates a mere .1% of our electricity. The wind rotates blades around a hub, which is connected to the main shaft. The main shaft spins a generator. The size of turbines is determined by how much energy is needed. Small wind turbines are usually used for homes, farms and ranches. Other ways to use wind energy include grinding grain and pumping water.

Wind is classed in categories of 1 through 7, with 7 being the highest and 1 being the lowest. A good wind source that has a class of 3 or higher is the east coast and along the Appalachian Mountains. North Dakota is an excellent wind source.

The disadvantages of wind energy are that again, the technology is very expensive, the machinery is known to be noisy, birds have been killed by running into the turbines, and the wind might not be present at certain times throughout the year.

Fig: Wind Energy

Photovoltaic (PV) Cells:

Solar Module:

PV cells produce electricity from sunlight. Materials used in computer chips are similar to materials used in PV cells. These materials absorb sunlight, which frees the electrons from their atoms and allows them to generate electricity. PV cells are great because they don‘t require high maintenance, are very reliable, and don‘t produce pollutants.

Geothermal Energy:

Geothermal energy is capable of producing about 2,800 Megawatts of energy per year, 0r roughly .2% of the energy in the U.S. Geothermal energy is produced from naturally occurring steam and hot water from under the Earth‘s surface. The steam rotates a turbine, which in turn powers an electric generator. Also, hot water can be used to directly heat building. The downside to geothermal energy is that land sites is very hard to find and extremely rare. A positive fact is that geothermal energy is very cost effective and reliable.

1.5 Advantages of Renewable Energy:

With the goal of reducing air pollution and advancing public health, renewable energy methods like solar and wind are being embraced around the world. Renewable energy has several environmental and economic benefits.

Environmental Benefits:

Because renewable energy sources like solar and wind do not require the use of fossil fuels, they do not emit carbon dioxide. Carbon dioxide is a bi-product of burning coal and gas. By reducing the amount of fossil fuels we burn, we are decreasing the amount of pollutants and chemicals being emitted into the atmosphere.

Wind Energy:

Electricity generated by wind through turbines is a fast-growing renewable energy source around the world. These turbines can be placed on land or offshore. One turbine can create enough energy to power 500 homes that use average levels of electricity.

Solar:

Solar energy is generated through the sun's heat. To put into context the immense power of the sun, the entire supply of coal, oil and natural gas is equivalent to the power put off by the sun in just 20 days. This energy can be harnessed through the use of photovoltaic solar panel that can be put on roofs, atop building and even on cars.

Public Health:

Pollution coming from power plants taints our air supply and causes asthma. Through the use of renewable energy, we could eliminate these harmful substances in the air, leading to a healthier population.

Cost and Supply:

Once the solar panels are installed and the windmills are put up, renewable energy is essentially free. It costs nothing to use the suns rays, and taking advantage of a windy day is free. Furthermore, the supply of wind is not going to diminish. The sun's rays are also prevalent and will exist for millions of years.

Chapter 2

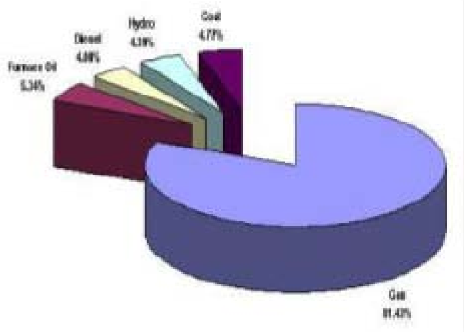
Renewable Energy in Bangladesh

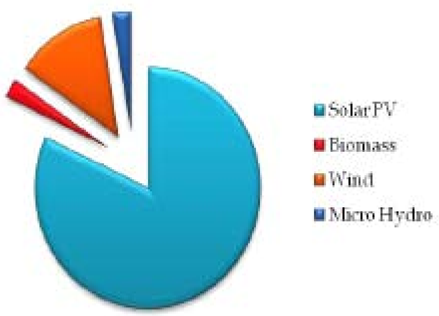
2.1 Renewable Energy Technologies Suitable for Bangladesh:

Different types of renewable energy technologies (RET) applications suitable for Bangladesh are described in the subsequent headings.

- Solar Thermal
- Solar photovoltaic (SPV)
- Biomass
- Small Hydro
- Waste Energy

2.2 Present Scenario of Conventional and renewable energy(Electric power) Utilization in Bangladesh:





Bangladesh Total insulated power in grid electricity is 5254 MW

Hydro	**230 MW**
Furnace Foil	**280 MW**
Coal	**250MW**
Diesel	**200MW**
Gas	**4285MW**

Total insulated power off grid electricity is 22.55 MW	
Micro Hydro	**0.1MW**
Biomass/Biogas	**0.5MW**
Wind	**2.5MW**
Solar	**18.55MW**

2.3 Significant Progress of Renewable Energy Technology in Bangladesh:

Total installed Power for off grid electricity is 20 MW from RE

Technology	Capacity	Implementing	Financial partner
		Agency	
Solar PV stand	365,000 SHS and	14 partner	IDCOL (World
alone system with	its integrated	organizations of	Bank, GEF, GTZ
ownership model	capacity is 18.5	IDCOL like RSF,	and KFW, ADB,
	MW	GS, BRAC etc.	IDB)
Solar PV stand	6000 SHS	REB	World Bank, GEF,
alone system (fee			GTZ and French
for services)			grant
Centralized PV	300 KW	LGED , BPDB	UNDP, GOB
system			
Micro Hydro	10KW	LGED	UNDP
Biomass/biogas	400 KW	Private/Public	IDCOL, GTZ
Wind	2.5 MW	BPDB	UNDP, WB
Improved Cooking	80,000 nos	Pos of GTZ	GTZ
Stove			

Source: www.reein.org

2.4 Government Support in Renewable Energy Sector in Bangladesh:

Sector	**Opportunity**
Government policy	Government setup a target that at least 5% electricity by 2015 and 10% by 2020 will be generated from RE
Duty & VAT	Government wipe out all sort of duty from renewable energy commodities
Tax Holiday (according to RE policy)	According to declared RE policy, Renewable energy company will enjoy 5 years tax holiday from its inception however current budget doesn't support it
Manufacturing plant for PV module	Duty of capital machinery for assembling of PV module is exempted.

2.5 Ongoing Renewable Energy Technology (RET) Projects in Bangladesh:

Renewable energy development project- REB/IDCON.

Sustainable rural energy- LGED

Solar & Wind resource assessment project- RERC, DU

SHS project- Grameen Sakti.

PREGA- REB/BPDB

GTZ funded project – REB.

Biogas pilot project – LGED.

RET in Asia- CMES/KUET

SHS project- BRAC.

CHT SHS project- BPDB.

RET feasibility study- BCSIR.

SHS project-TMSS.

Solar home lighting system- Centre for mass education in science (CMES) Solar home system- Integrated Development Foundation (IDF)

Wind power generation- BPDB

Hybrid system- Grameen Sakti, BRAC.

Chapter 3

Energy and Sun

3.1 Definition of Energy:

Energy is the measure of a physical system. It defines the quality of the changes and processes, which take place in the Universe, beginning with movement and finishing with thinking. The unity and the connection between the movement forms of substance, their lively capacity of mutual transformation, allowed the measuring of different forms of substance through a common aspect: energy.

3.2 Types of Energy:

The name of energy forms is related to:

1.The way energy is perceived (for example: mechanical energy, electrical energy, energy of light)

2.What carries the energy (for example: thermal energy)

3.The origins of energy (for example: nuclear energy, hydraulic energy, wind energy , geothermal energy, and solar energy).

3.3 Sun:

The Sun

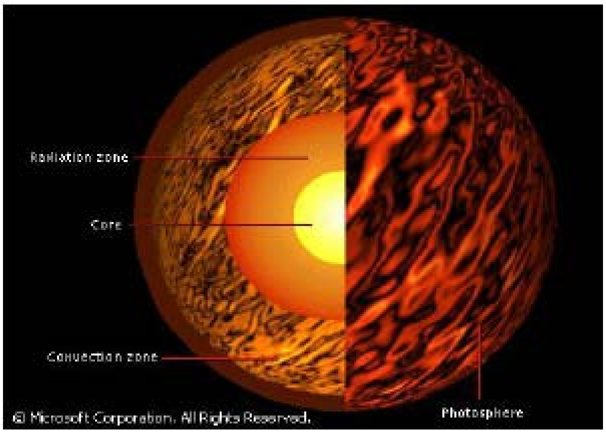


figure : The source of all energy

3.4 Surface temperature:

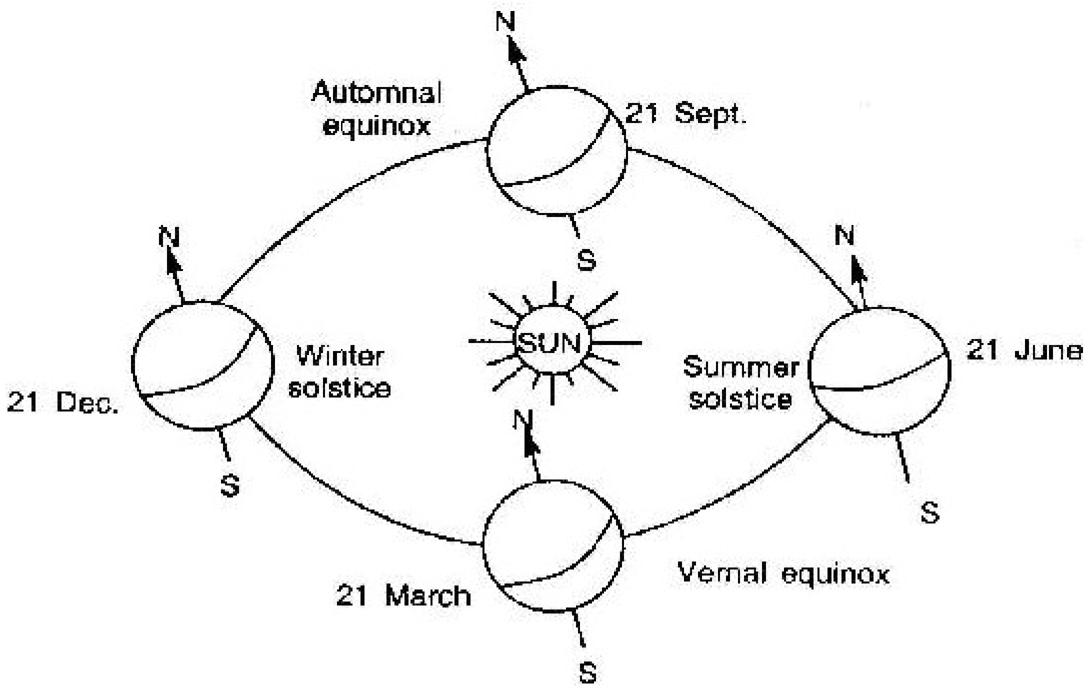
We know that the sun is a sphere of diameter 1,400,000 km, that its outer regions are hot gases, mostly hydrogen and helium, and that its surface temperature is about 6,000 degrees Celsius (about 11,000 degrees Fahrenheit). Any surface at that temperature will generate heat and light. The burners of an electric stove or a toaster oven, for example, are not at 6,000 C., but when they're turned on they are "red hot"; they emit heat and light and the light is red. If we could raise the temperature to 6,000 C. they would become "white hot", and emit light very much like the sun's. Similarly, a fire is a region of gases at a temperature high enough to generate heat and light.

So the question becomes not so much why is there heat and light, but where does the energy come from to keep the surface temperature of the sun at 6,000 degrees?

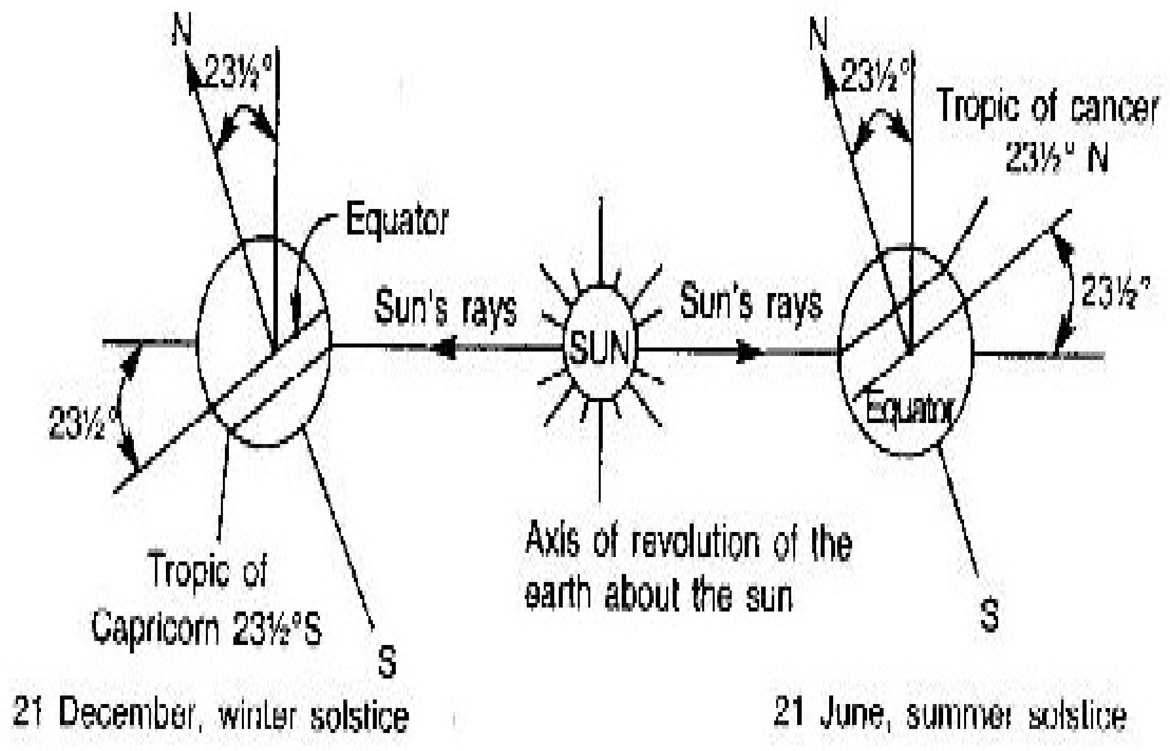
3.5 Conversion of sunlight into electricity:

Light knocks loose electrons from silicon atoms. Free electrons have extra energy. Internal electric field (junction) pushes electrons to front of cell. Electric current flows on to other cells or to the load. Cells never ―run out‖ of electrons.

<u>Sun -Earth relation-1</u>



Sun Earth Relation-2



3.6 Extraterrestrial radiation

It is also important to know the spectral distribution of extraterrestrial radiation, i.e. the radiation that would be received in the absence of atmosphere. The extraterrestrial solar spectrum at mean earth sun distance can be divided into following three main regions, usually divided into wave bands (1 micron = 1m = 10-6, mm = 10-6 meter).

.Ultraviolet region (l < 0.38 mm). Percentage of solar radiation 7%. Visible region (0.38 < l < 0.78 mm) Percentage radiation 47.3%.

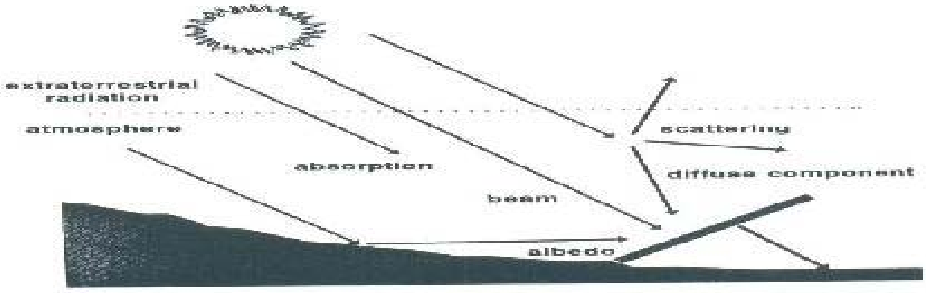


Figure: Extraterrestrial radiation

Extraterrestrial radiation at any time of the year is given by

$$Ion = Isc \;\; 1\; 0.033\cos \quad \frac{360\, n}{365}$$

where Isc is the solar constant and Ion is the extraterrestrial radiation measured on a plane normal to the radiation on the n' day of the year counted from January 1st as n=1.Solar Constant is defined as the energy from the sun received on a unit area of the surface perpendicular to radiation at mean earth sun distance. WRC adopted a value of 1367W/m2

3.7 Equation of time:

E = 229.2(0.000075+0.001868 B- 0.032077 sin B - 0.014615 cos 2B- 0.04089sin2B)Where, B = (n-1)360/365 and n is the day of the year.

Monthly averaged daily global radiation (kWh/m2/day)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
4.02	4.64	5.01	5.37	4.83	4.22	4.00	4.13	4.15	4.23	4.04	3.80	4.37

3.8 Solar Energy Spectrum:

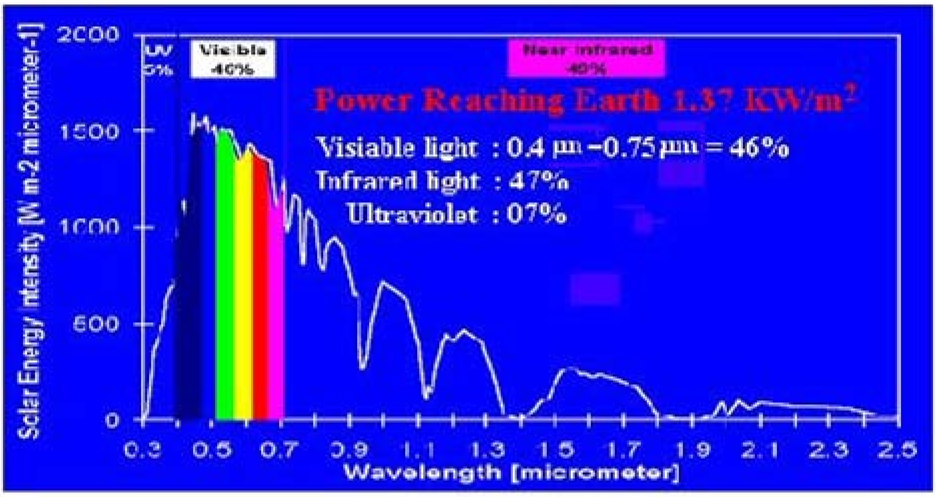


Figure :Spectrum of Solar Radiation

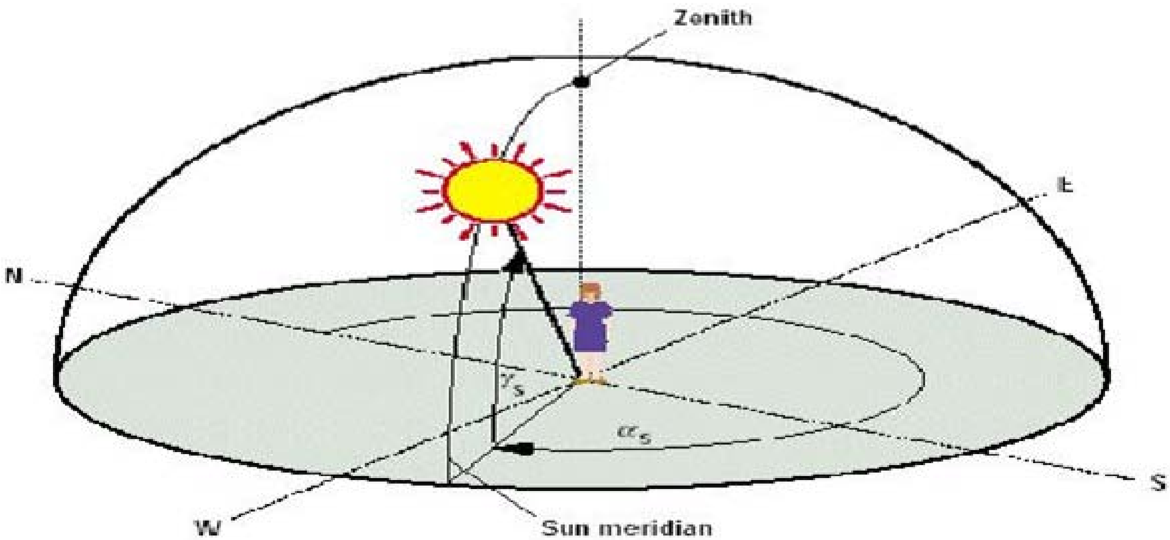


Figure :Defintion of the angles for the description of the position of the sun

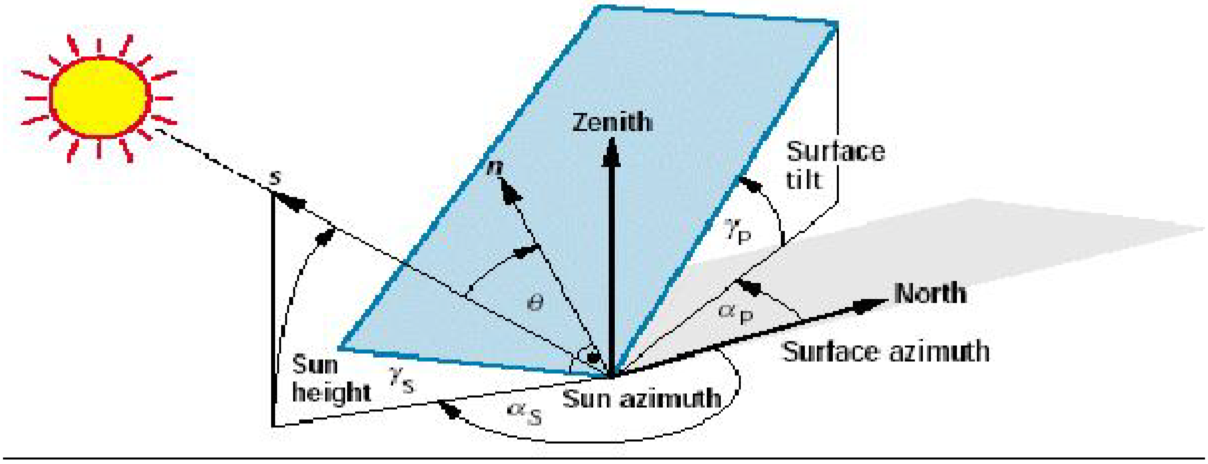


Figure : Angles to define the position of the sun and the orientation of a tilted

Chapter 4

Aspects of Solar Energy in Bangladesh

4.1Solar energy uses:

➢Solar energy uses in various respects. Such as;

➢Generate electricity using photovoltaic solar cells.

➢Generate electricity using concentrated solar power.

➢Generate electricity by heating trapped air, which rotates turbines in a solar updraft tower.

➢Heat buildings, directly, through passive solar building design.

➢Heat foodstuffs, through solar ovens.

➢Heat water or air for domestic hot water and space heating needs using solar- thermal panels.

➢Heat and cool air through use of solar chimneys.

➢Generate electricity in geosynchronous orbit using solar power satellite.

➢Solar air conditioning.

4.2Solar Photovoltaic:

4.2.1 Photovoltaic:

Becquerel first discovered that sunlight could be converted directly into electricity in 1839, when he observed the photogalvanic effect. But the first solar cell, developed by Chapin, Fuller and Pearson, revealed in 1954. It had an efficiency of 6% only. In 1956, the invention of 10% efficient silicon solar cell was reported. Only two years later, the first solar cells were used on the Vanguard I orbiting satellite. Since then, the use of solar electricity (also known as photovoltaics) is going on increasing year by year and some have been in continuous outdoor operation on Earth or in space for over 30 years.

4.2.2 Advantages of Photovoltaic:

Photovoltaic has shown, since the 1970s, that the human race can get a substantial portion of its electrical power without burning fossil fuels (coal, oil or natural gas) or creating nuclear fission reactions. Photovoltaic helps us avoid most of the threats associated with our present techniques of electricity production and also has many other benefits. Photovoltaic has shown that it can generate electricity for the human race for a wide range of applications, scales, climates, and geographic locations. It can provide electricity to remote transmitter stations in the mountains allowing better communication without building a road to deliver diesel fuel for its generator. It can supply electricity to the community in an island, which is very far from utility grid, or can supply electricity to the people of poor countries like African countries, where people are scattered and grid electricity is not feasible.Fossil-fuel plants have many disadvantages: a wide range of environmentally hazardous emissions, parts which wear out, steadily increasing fuel costs, they are not modular (deployable in small increments), and they suffer low public opinion (no one wants a coal burning power plant in their neighborhood). Photovoltaic suffers none of these problems. Some other advantages of photovoltaic are given below-

Fuel source of photovoltaic is vast and essentially infinite.No emissions, no combustion or radioactive fuel for disposal.

Low operating cost.

No moving parts.

No high temperature corrosion or safety issue.

High reliability in modules (>20 years).

Completely modular (small or large increment is possible).

Quick installation.

Can be integrated into new or existing building structures.

Can be installed at nearly any point-of-use.

Daily output peak may match local demand.

High public acceptance.

Excellent safety record.

4.3 Solar Heating:

Figure : The family living in this house enjoys hot water heated by the sun with a solar thermal system

Solar heating harnesses the power of the sun to provide solar thermal energy for solar hot water, solar space heating, and solar pool heaters. A solar heating system saves energy, reduces utility costs, and produces clean energy. The efficiency and reliability The family living in this house enjoys hot water heated by the sun with a solar thermal system
of solar heating systems have increased dramatically, making them attractive options in the home or business. But there is still room for improvement.

4.3.1 Solar Heating Basics:

Solar heat can be used for solar water heating, solar space heating in buildings, and solar pool heaters. Solar water heaters and solar space heaters are constructed of solar collectors, and all systems have some kind of storage, except solar pool heaters and some industrial systems that use energy "immediately." The systems collect the sun's energy to heat air or a fluid. The air or fluid then transfers solar heat directly to a building, water, or pool.

4.3.2 Solar Heating in Use:

Since the early 1970s, the efficiency and reliability of solar heating systems and collectors have increased greatly, and costs have dropped. Today's solar thermal systems are used for solar water heating, solar pool heating, and in solar space heating.

4.4 Solar Thermal Electricity:

Solar energy can also be used to make electricity. Some solar power plants, like the one in the picture to the right in California's Mojave Desert, use a highly curved mirror called a parabolic trough to focus the sunlight on a pipe running down a central point above the curve of the mirror. The mirror focuses the sunlight to strike the pipe, and it gets so hot that it can boil water into steam. That steam can then be used to turn a turbine to make electricity.In California's Mojave Desert, there are huge rows of solar mirrors arranged in what's called "solar thermal power plants" that use this idea to make electricity for more than 350,000 homes. The problem with solar energy is that it works only when the sun is shining. So, on cloudy days and at night, the power plants can't create energy. Some solar plants are a "hybrid" technology. During the daytime they use the sun. At night and on cloudy days they burn natural gas to boil the water so they can continue to make electricity.

4.5 Solar Cooking:

Solar cookers use sunlight for cooking, drying and pasteurization. Solar cooking offsets fuel costs, reduces demand for fuel or firewood, and improves air quality by reducing or removing a source of smoke. Concentrating solar cookers use reflectors to concentrate light on a cooking container. The most common reflector geometries are flat plate, disc and parabolic trough type. These designs cook faster and at higher temperatures (up to 350 °C) but require direct light to function properly.

Figure : Solarcooking dish

4.6 Solar Water Heater:

Where heat from the Sun is used to heat water in glass panels in our roof. This means we don't need to use so much gas or electricity to heat our water at home. Water is pumped through pipes in the panel. The pipes are painted black, so they get hot when the Sun shines on them. Many homes used solar water heaters.

Figure: Solar water heating mechanism

Today, solar water heaters are making a comeback. They heat water for use inside homes and businesses. They also heat swimming pools like in the picture. Panels on the roof of a building, like this one on the right, contain water pipes. When the sun hits the panels and the pipes, the sunlight warms them.

4.7 Solar dryer:

Agricultural and other products have been dried by the sun and wind in the open air for thousands of years. The purpose is either to preserve them for later use, as is the case with food; or as an integral part of the production process, as with timber, tobacco and laundering. In industrialized regions and sectors, open air-drying has now been largely replaced by mechanized dryers, with boilers to heat incoming air, and fans to force it through at a high rate. Mechanized drying is faster than open-air drying, uses much less land and usually gives a better quality product. But the equipment is expensive and requires substantial quantities of fuel or electricity to operate.

4.7.1 Solar dryer Application:

For centuries people of various nations have been preserving dates, figs, apricots, grapes, bananas, pineapples, other fruits, herbs, cassava, yams, potatoes, corn, peas, onions, garlic, carrots, peppers, milk, coffee, meat, and fish by drying.

But drying is also beneficial for hay, copra (kernel of the coconut), tea and other income producing non-food crops. It is worth noting that until around the end of the 18th century when canning was developed, drying was virtually the only method of food preservation.

4.7.2 Solar Drying Can Improve Agricultural Products:

Dehydration of vegetables and other food crops by traditional methods of open-air sun drying is not satisfactory, because the products deteriorate rapidly. Furthermore, traditional methods do not protect the products from contamination by dirt, debris, insects, or germs. A study by Akwasi Ayensu from the Dept. of Physics at the University of Cape Coast, Cape Coast, Ghana demonstrates that food items dried in a solar dryer were superior to those which were sun dried when evaluated in terms of taste, color, and mould counts. He asserts, and many others agree that solar drying systems must be developed to utilize this energy resource to improve food preservation. This translates into quality products that can be stored for extended periods, easily transported at less cost while still providing excellent nutritive value.

Chapter 5

Solar PV Equipment

5.1 Solar cells:

Photovoltaic (PV) or solar cells are PN junction Semiconductor devices. It converts sun light into direct current electricity. Groups of solar cells are electrically connected into PV modules, arrays. PV modules or arrays can be used to charge batteries .This system can be used to power any number of Electrical loads. PV systems can produce alternating currents or Inverter. Compatible with any conventional appliances and operate in parallel with and interconnected to the Utility grid.

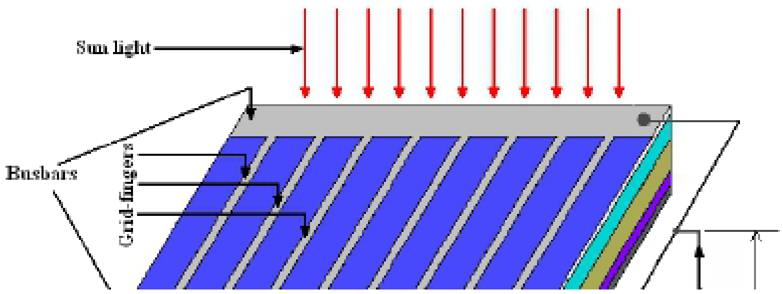
Solar cells often are distinguished by their type of semiconductor junction-

(A)Homojunction (n + p layer is of the same material)

(B)Heterojunction (n + p layer is of different material)

(d)MIS (Metal / Isolator / Semiconductor

(e)SIS (Semiconductor / Isolator / Semiconductor)



5.1.1 Connect cell to make modules:

- One silicon solar cell produces 0.5V to 0.6V
- Usually 36 cells are connected together to make a Module
- Such one module has enough voltage to charge 12 volt batteries and Run pumps and motors
- PV Module is basic building block of a PV power system
- Modules can be connected to produce more power

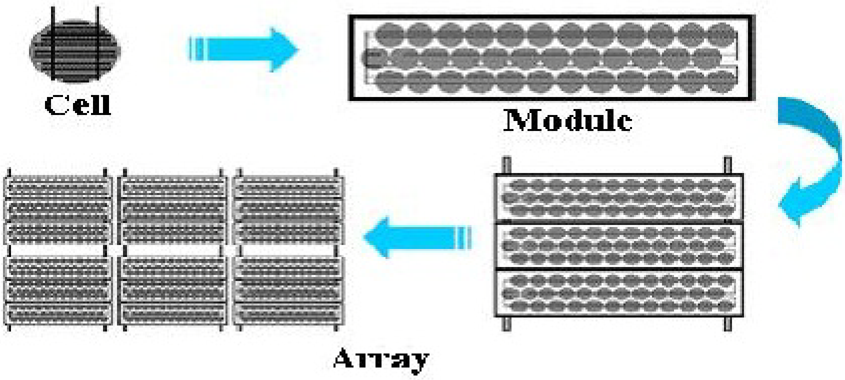


Figure 1 : Cells, Modules, Panels and Arrays

5.1.2 Types of Solar Cells:

Solar cells can be classified according to semiconductor materials of the cell, according to the crystalline structure of the material, and according to the number of junctions of the cell. According to the crystalline structure of the material there are three types of solar cells.

1. Single-crystalline or mono crystalline cells
2. Multi-crystalline or polycrystalline cells and
3. Amorphous cells

Fig : Amorphous solar Polycrystalline Single Crystal

5.1.2.1.Monocrystalline Cells

Monocrystalline cells are the most important type, because they have the highest conversion efficiency (25%), and the base material, which is extremely pure silicon, is already well established in the field of semiconductor production. Currently, the methods of producing silicon single-crystals are primarily either the Czochralsky process or the floating zone technique. In the Czochralsky process, monocrystalline silicon grows on a seed, which is pulled slowly out of the silicon melt. With both methods, silicon rods are produced, which are cut into slices of 0.2 to 0.4 mm thickness. The discs (wafers) produced in this way, then, undergo several further production steps. These are, for instance:

a. Grinding and cleaning

b. Doping

c. Metallization

d. Antireflection coating

Figure: Monocrystalline Cells

5.1.2.2 Polycrystalline Cells:

The manufacturing process for monocrystalline silicon is highly energy-intensive and therefore very expensive. For this reason, in many cases polycrystalline silicon (Poly- Si) is preferred. Poly-Si develops, when a silicon melt is cooled down slowly and controlled. The yielded silicon ingot is sliced and further processed, as described before. The pulling of the single-crystal can be omitted this way. Inside the Poly-Si crystal, there are crystalline regions, which are separated by grain boundaries. The losses occurring at these grain boundaries cause the lower efficiency (less than 20%) of polycrystalline cells compared with monocrystalline ones. Despite this disadvantage, the importance of polycrystalline cells is growing, because of the lower production costs.

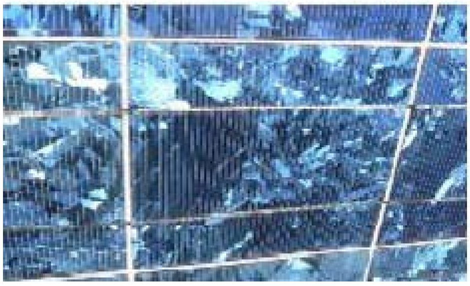


Figure: Polycrystalline Cells

5.1.2.3 Amorphous Cells:

In order to avoid the energy-intensive production process mentioned above, and to avoid the cutting loss of the slicing process, a vapor-phase technique has been developed in which a thin film of silicon is deposited from a reactive gas such as silane (SiH_4) on a carrier material like glass and doped in a further step. The semi conducting material grown in this way is called amorphous silicon. This technology has two disadvantages: first, the conversion efficiency is considerably low, i.e., less than 10%; second, the cells are affected by a degradation process during the initial months of operation, which reduces the efficiency furthermore.

These disadvantages are compensated by the -

Relatively simple and inexpensive manufacturing process

The possibility of producing cells with a larger area

The lower energy consumption and

Easy to use in small electronic equipment.

Figure : Amorphous Cells

5.2 Charge Controller:

Charge controller is an electronic device which is used in solar system. A solar charge controller is needed in virtually all solar power systems that utilize batteries.

The job of the solar charge controller is to regulate the power going from the solar panels to the batteries. Overcharging batteries will at the least significantly reduce battery life and at worst damage the batteries to the point that they are unusable.

The most basic charge controller simply monitors the battery voltage and opens the circuit, stopping the charging, when the battery voltage rises to a certain level. Older charge controllers used a mechanical relay to open or close the circuit, stopping or starting power going to the batteries. Modern charge controllers use pulse width modulation (PWM) to slowly lower the amount of power applied to the batteries as the batteries get closer and closer to fully charged. This type of controller allows the batteries to be more fully charged with less stress on the battery, extending battery life. It can also keep batteries in a fully charged state (called —float‖) indefinitely. PWM is more complex, but doesn‘t have any mechanical connections to break.

The electricity produced in the solar panel is stored in the battery. The electricity stored in the battery is used at night. This whole process is monitored by the charge controller.

A typical charge controller (Phocos) is shown in the figure bellow-

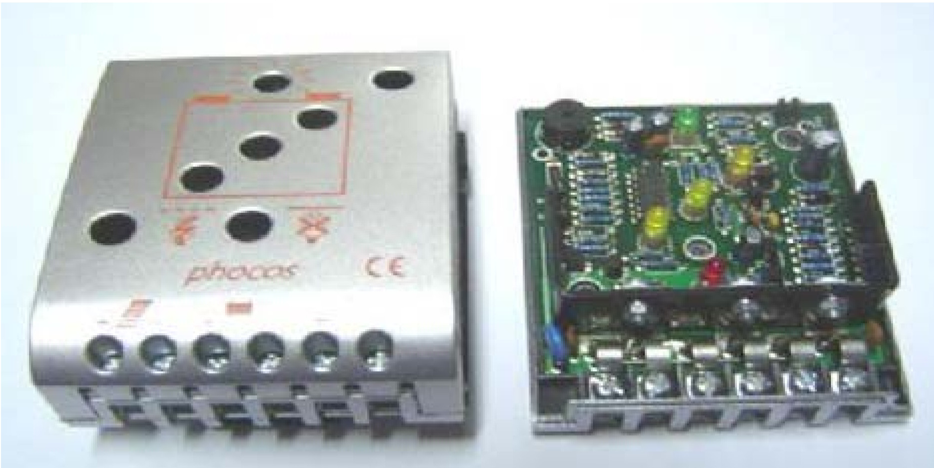


Figure: Charge controller

5.2.1Function of charge controller:

The main function of a charge controller or regulator is to fully charge a battery without permitting overcharge while preventing reverse current flow at night. Other functions are-

- Stop the process of the battery when it is fully charged.
- Disconnect the load during low voltage.
- Disconnect the load during high voltage.
- Monitor the battery voltage, state of charge, SOC etc.
- To give alarm during fault condition.
- Current measurement.

- Detect when no energy is coming from the solar panels and open the circuit, disconnecting the solar panels from the batteries and stopping reverse current flow.

Charge controller is used for co-ordination and control among the battery, load and solar panel. Charge controller stores the electricity in the battery during day time and supplies the same to the load (mainly lamp) at night. On the other hand, if battery is fully charged, Then charge controller can directly supply electricity to the load (Fan, mobile charger etc) from the solar panel during day time.

A charge controller or charge regulator is mainly worked as a voltage regulator. Generally it controls the voltage and current of the solar panel to save in battery. Solar panel mainly produces 16 volts to 21 volt and 14 volt to 14.4 volt is required to keep the battery in full charged state. The charge controller woks as a ―Buck converter‖ to minimize this voltage level. Charge controller is mainly a ―Chopper‖ or ―DC-DC converter‖. Buck converter is usually used in the solar panel which converts the high level DC voltage to the low level DC voltage.

5.2.2 Block diagram of processing of charge controller:

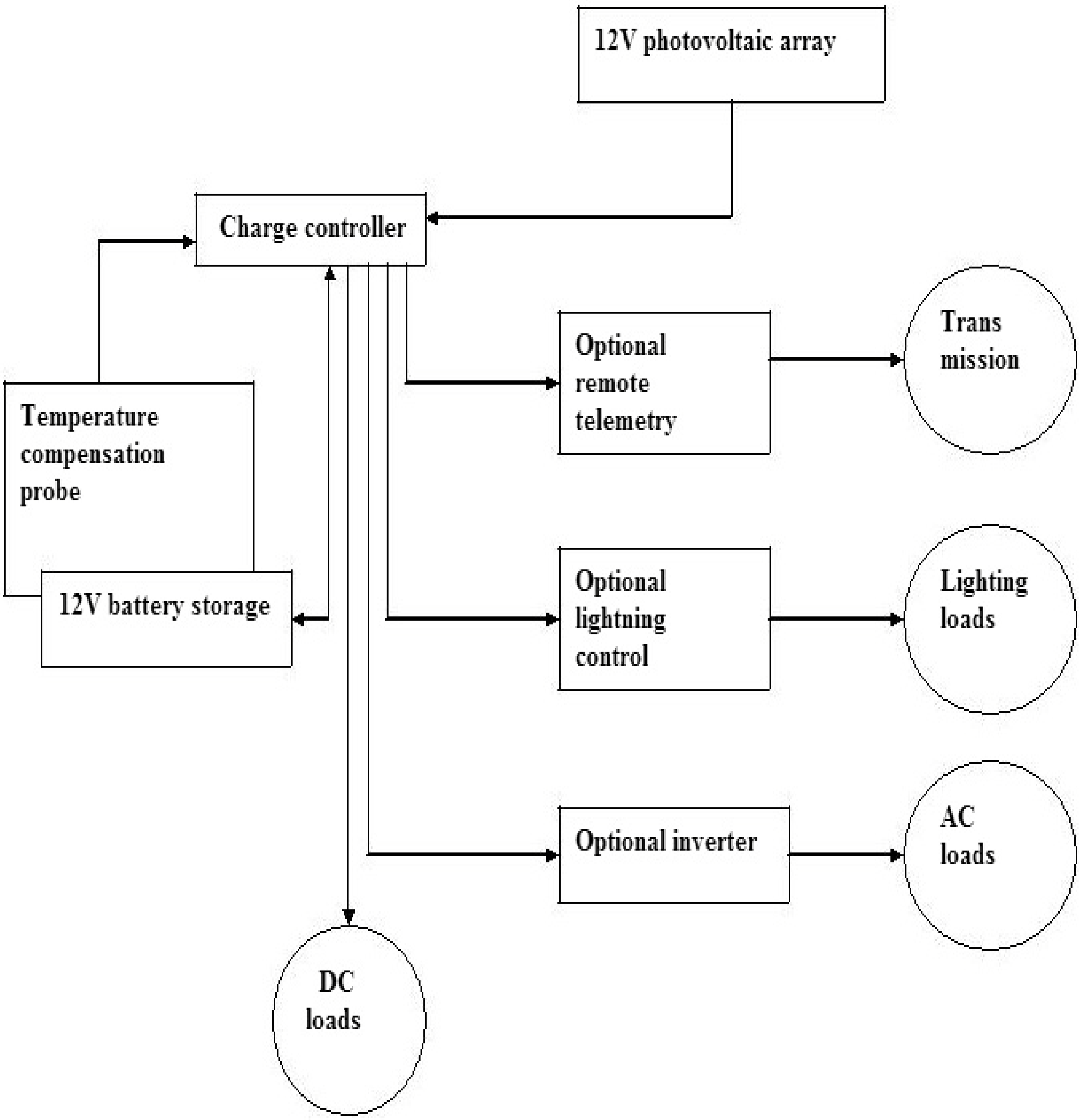


Figure: Block diagram of processing of charge controller

5.2.3 Types of Charge controller:

Charge controller connection mainly two types-

1. Parallel or shunt controller
2. Series controller

5.2.3.1 Parallel Controller:

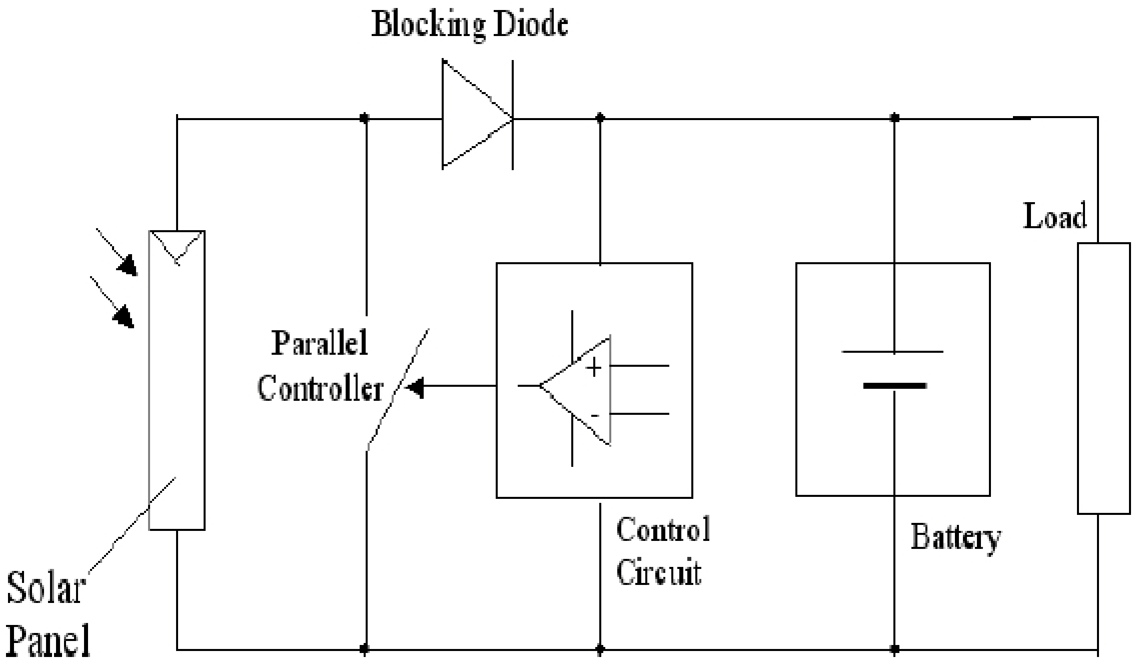


Figure : Use of Shunt controller in solar home system

In this system, charge controller is in parallel with the battery and load. When the battery is fully charged, then the solar panel is short circuited by the controller.

In this system, a ―Blocking diode‖ is needed. So that reverse current would not flow from battery to the panel. When the battery is charged through this blocking diode, it gets hot.

Disadvantages of shunt controller:

- Lose of electricity
- When the panel is short circuited, huge amount of short circuit current (Isc) flows through the switch (FET).
- Shunt controller gets hotter compared to series controller.
- There is a chance of hot spot on the panel.

5.2.3.2 Series Controller:

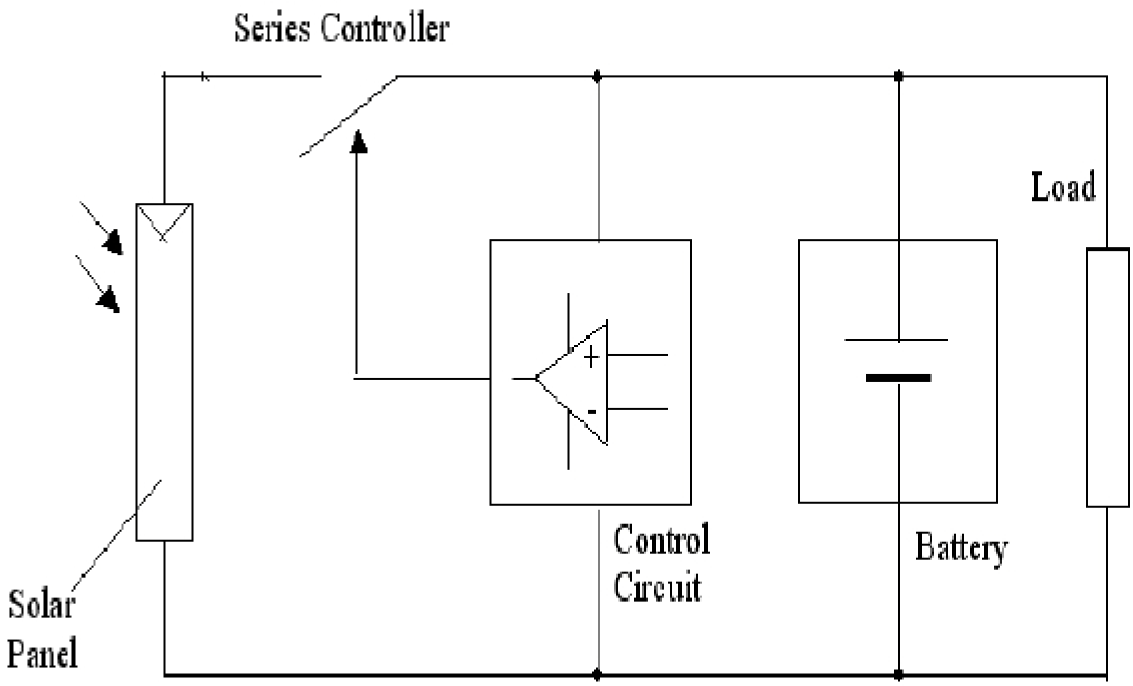


Figure: Use of Shunt controller in solar home system

In this system, charge controller is connected in between with the solar panel and battery. In order to terminate the flow of electricity to the battery, the series controller must be removed from the battery. There‘s no need of blocking diode in this system, but in many reasons it is used to terminate the process of discharging at night. The resistance should be maintained as low as possible in order to minimize lose of the electricity.

Advantages of series controller:

- Blocking diode is not required.
- Series controller switch is handled with low voltage compared to shunt controller.
- Low switching noise.
- It is possible of precision charge and PWM of the battery.
- No chance of hot spot like the shunt controller.

5.2.4 Panel charging and characteristics of controller:

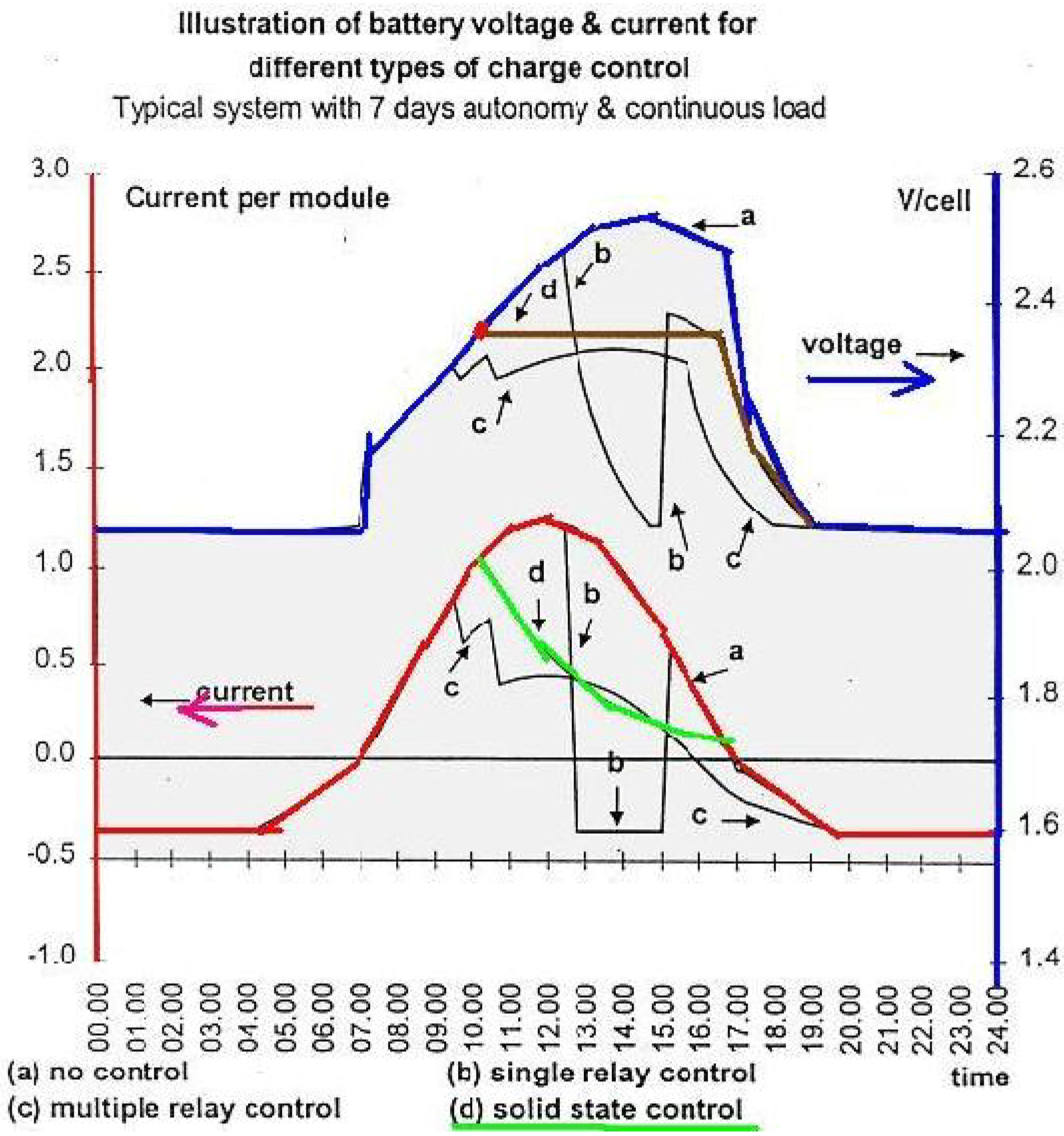


Figure : Relation between different types of charge controller and battery voltage and current

Above figure shows how different kinds of charge controller controls the voltage and current. The upper curve shows the battery voltage and the lower curve shows panel current. a,b,c,d indicates controller‘s action.

5.2.5 Charge Controller Operation:

Fixed Set Point:

To terminate the panel current when it reaches to the maximum voltage level and then continue it again when it reaches to the minimum voltage level is called ―Set point‖.
The relation between charging-discharging of a battery and voltage is shown in the figure bellow-

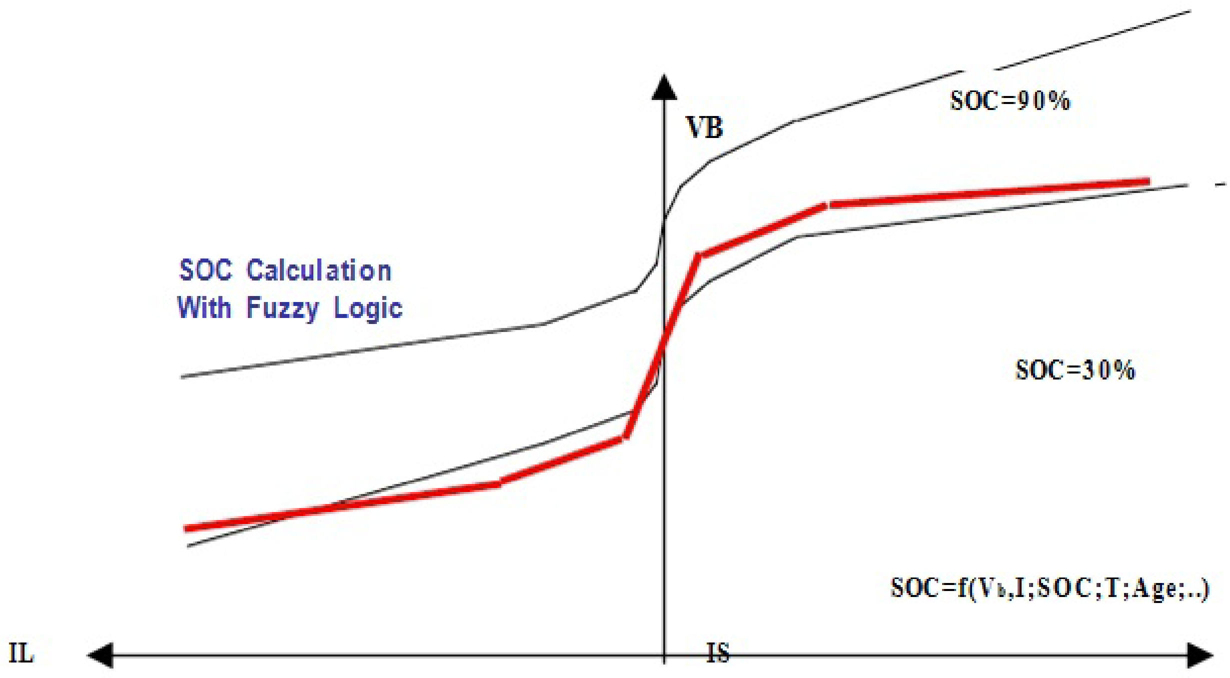


Figure : Set point of controller (Micro-controller based)

There‘s a possibility of the damage of the battery (50-100%) if the voltage level is set as the red dotted line of the above figure.
We can match the controller‘s voltage-current with the state of charge (SOC) by using micro-controller and Fuzz logic. This will reduce the probability of damaging the battery(10-20%).

5.2.6 Selection of charge controller:

Solid state series controller is suitable for small system (4 ampere). Solid state shunt controller is suitable for the system of 4 to 30 ampere.

A good controller must have following features-

- Low voltage disconnection.
- Battery charging current indicator (LED or meter).
- Battery voltage indicator (LED or meter).
- Sense lead. Adjustable set point.
- Ability of Communication (for large system).
- Data logger
- Computer interface

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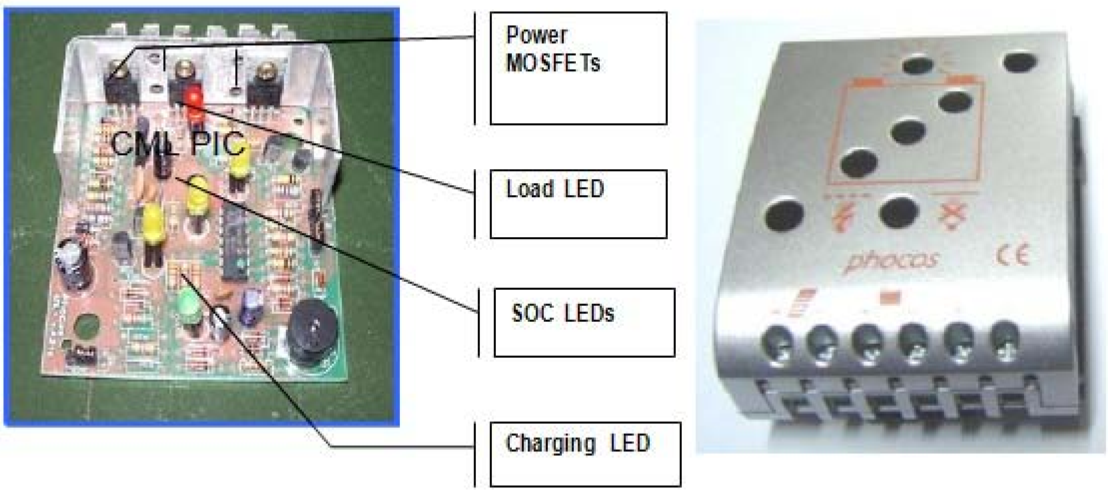
5.2.7 Voltage setting of controller:

The following factors are responsible for the voltage setting of controller-

- Types of battery
- Charging characteristics of charge controller



- Size of the battery
- Maximum panel current
- Depth of last charge

Figure : A solid state series controller and its various parts

5.2.8 MPPT Charge controller:

MPPT charge controller is a maximum power point tracker which is an electronic DC to DC converter which takes the DC input from the solar panels, changes it to high frequency AC and converts it back to a different DC current to match with the batteries. This is a solely electronic tracking system and not concerned with the panel system at all.

Figure : Phocos MPPT 100/20(20amp)

5.3 Battery:

5.3.1 Battery Storage:

Batteries are often used in PV systems for the purpose of storing energy produced by the PV array during the day, and to supply it to electrical loads as needed (during the night and periods of cloudy weather).

Other reasons batteries are used in PV systems are to operate the PV array near its maximum power point, to power electrical loads at stable voltages, and to supply surge currents to electrical loads and inverters.

In most cases, a battery charge controller is used in these systems to protect the battery from overcharge and over discharge.

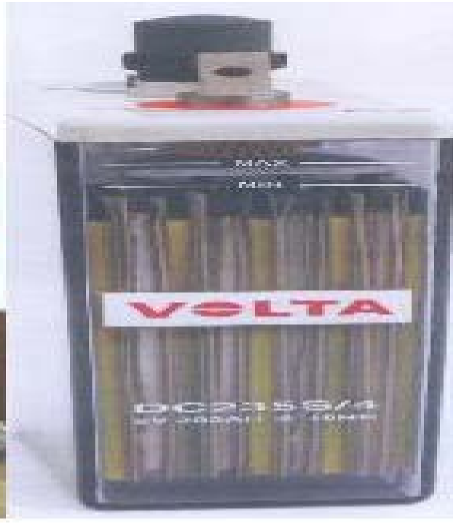


Figure : 12 volt, 100 Ah solar battery 2 volt, 200 Ah

Industrial battery

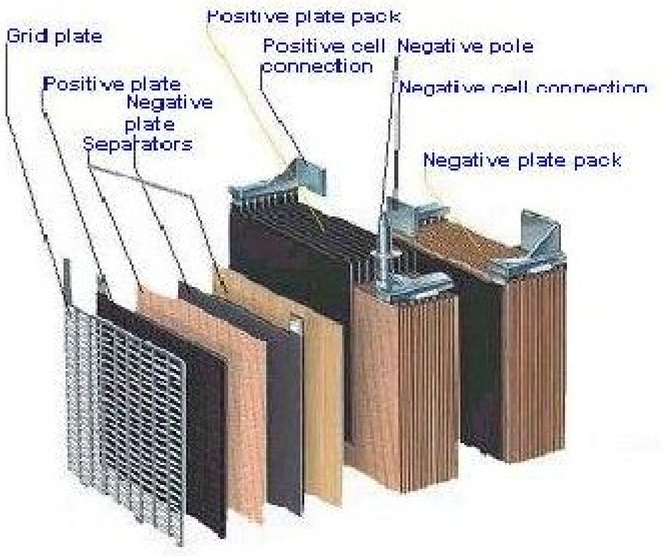


Figure : Battery

5.4 Inverter:

An inverter is an electrical device that converts direct current (DC) to alternating current(AC); the resulting AC can be at any required voltage and frequency with the use of appropriate transformers, switching, and control circuits.

Inverters are commonly used to supply AC power from DC sources such as solar panels or batteries. The electrical inverter is a high-power electronic oscillator. It is so named because early mechanical AC to DC converters was made to work in reverse, and thus was "inverted", to convert DC to AC.

5.4.1 Applications:

An inverter converts the DC electricity from sources such as batteries, solar panels, or fuel cells to AC electricity. The electricity can be at any required voltage; in particular it can operate AC equipment designed for mains operation, or rectified to produce DC at any desired voltage. Designed to provide 115 VAC from the 12 VDC source provided in an automobile. The unit shown provides up to 1.2 Amps of alternating current, or just enough to power two sixty watt light bulbs

Figure : Inverter

5.4.6 String inverter:

Figure : String inverter

- Good look
- Available in small- and medium-sized PV power station
- User-friendly Interface
- Power level 1.5KW to 6KW.

5.4.7 Power plant inverter:

- Professional design for large-sized PV power station
- Transformer type and transformer less type
- Satisfy different requirement, predigest design of power station

Figure Power plant inverter

5.4.8 Grid tie inverter:

A **grid-tie inverter** or a (GTI) is a special type of Inverter (electrical) that is used in a renewable energy power system to convert direct current into alternating current and feed it into the utility grid. The technical name for a grid-tie inverter is "grid- interactive inverter". They may also be called synchronous inverters. Grid-interactive inverters typically cannot be used in standalone applications where utility power is not available.

Figure : Inverter for grid connected PV

Chapter 6

Solar System Design

6.1 Solar home system design:

Basic Components:

1.Module

2.Battery

3.Charge Controller

4.Load

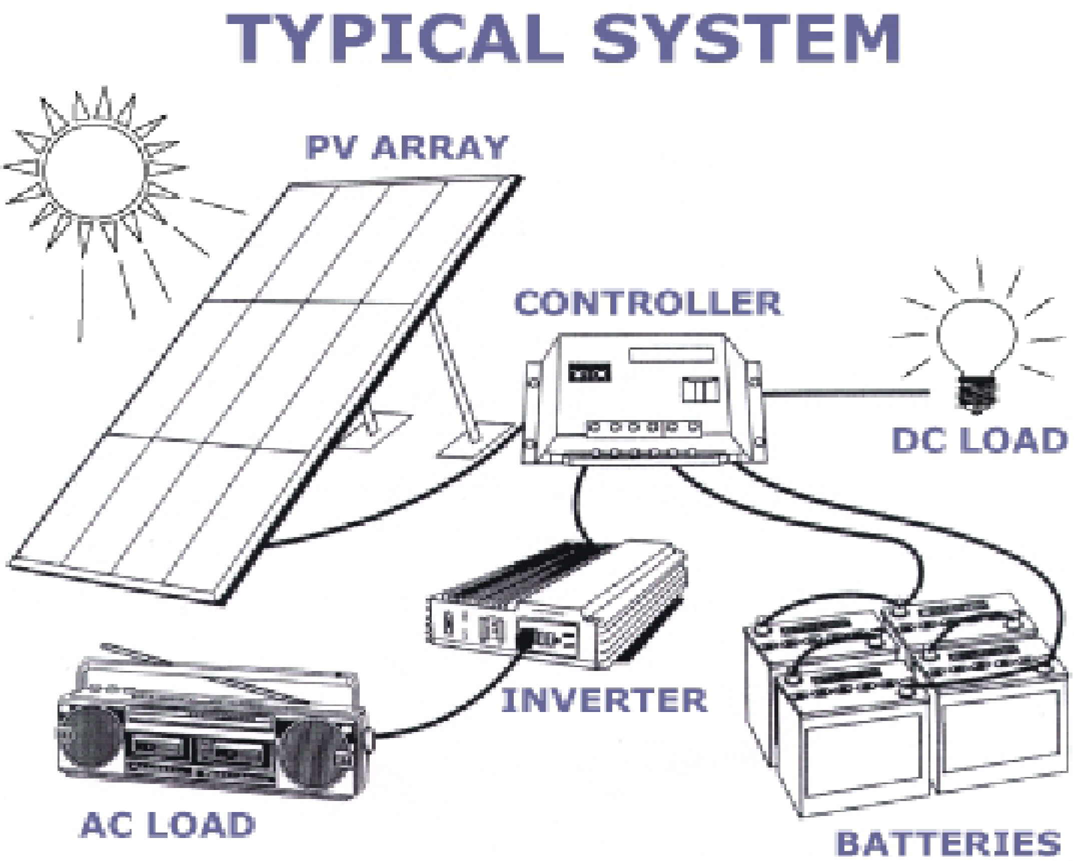
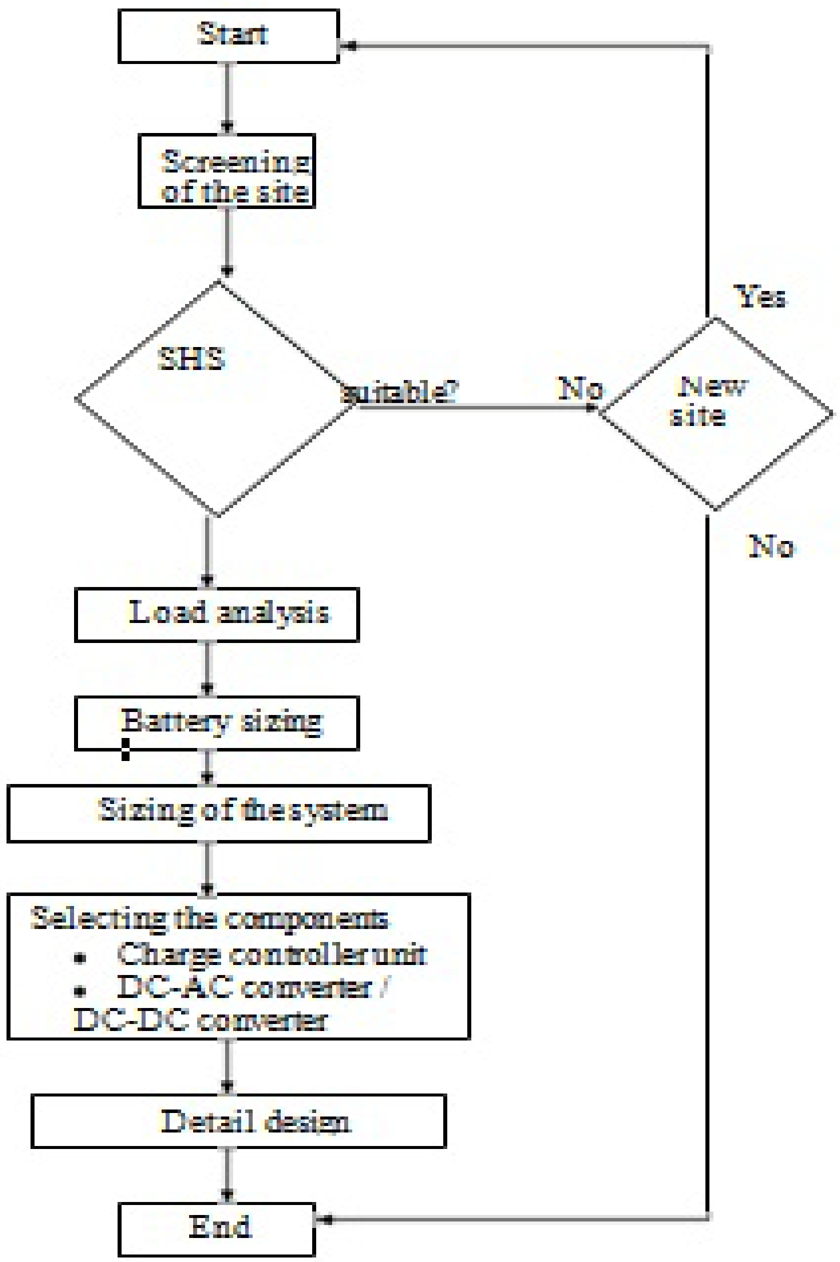


Figure : A typical solar home system design

6.1.1 Flow chart of solar home system design process:



The process of solar home system design is shown in the above flow chart. The process is started with the site screening. It means that it must be located in a place where there is enough sunlight. Then first stage is load estimation and after that battery sizing. Then other components of the system such as charge controller unit and voltage converter (if needed) are selected. In this way, the whole system design is processed. But one thing must be remembered that Infrastructure Development Company Limited (IDCOL) has published some standard for solar system design in Bangladesh. A designer must have knowledge about that.

6.1.2 Site screening:

In this part of the design, we will first analysis the location of the installation of the solar system where there is available sunshine. As we know sunshine isn‘t equal in all places so this part very important. Because the price of the whole system depends on it.

6.1.3 Load determination:

To find out the daily average load, we need some calculation. For example, a family consists of five persons using TV for 2 hours, three Fluorescent lamps for 5 hours, Video cassette player for 1.5 hours daily.

So power requirement of various types of loads are given bellow:

Item /loads	Rated power
TV	25W
Fluorescent lamp	15W
Radio	12W
Video cassette player	12W

Solution: The daily energy needed for the given family =2*40+2*12+3*5*15+1.5*12=347W h

6.1.4 Battery sizing:

The following characteristics are needed for a solar home system battery:

1. For deep cycle, long lifetime
2. Low maintenance
3. High charging capacity
4. The ability of completely discharge
5. Low internal discharging rate
6. Reliability
7. Minimum change under excessive temperature

6.1.5 Array sizing:

Array sizing of a PV system means the calculation of the number of PV modules.

6.1.6 Selection of charge controller:

Functional parameter of solar home system charge controller

1. Maximum current receive from PV panel
2. Ability of maximum power supply on the load

3. Mark it low voltage level
4. Mark it high voltage level
5. Electric protection from thunder
6. Good regulation
7. Protection from reverse polarity
8. Adjust with system voltage

6.1.7 Selection of converter:

A solar home system use for appliance needs ac and dc voltage. As Solar module output voltage is dc, so this system dc-dc converter or dc-ac converter needed. Some of the load is connected necessary converter.

6.1.8 System wiring:

From PV module up to system component electric wiring is needed. Voltage drop occurs in internal resistance of the wire. Solar home system this voltage drop should keep under a limit.Wire cost is very important and wire length must be small size. Connection the solar component under dement must be fulfill:

System must be safe

These wire are not make defect for system components performance

Each components works according their maximum performance

If possible use centralized 12volt dc system

If possible use centralized 24volt dc system

Wire Standard Size :

Cross sectional area(mm^2)	Wire Gauge(AWG or SWG)	Current Rating (A)
1.0	18	10
1.5	16	15
2.5	14	20
4.0	12	30
6.0	10	35
10.0	8	50
16.0	6	70
25.0	4	90

Maximum length of wire for 0.6 volt drop in 12 volt system:

Cable size(mm²)	Maximum cable Length (m) for various load Requirement							
	Load power(w)	24	36	48	60	72	96	120
	Current at 12 v (A)	2	3	4	5	6	8	10
1.5		12	8	7	5	5	4	3
2.5		20	13	10	8	7	6	5
4.0		31	21	16	13	11	8	7
6.0		46	31	23	19	16	12	10
10		76	51	38	31	26	20	16

Maximum length of wire for 1.2 volt drop in 12 volt system:

Cable size(mm²)	Maximum cable Length (m) for various load Requirement							
	Load power(w)	48	72	96	120	144	192	240
	Current at 12 v (A)	2	3	4	5	6	8	10
1.5		23	16	12	10	8	7	5
2.5		38	26	20	16	13	10	8
4.0		61	41	31	25	21	16	13
6.0		91	61	46	37	31	23	19
10		151	101	76	61	51	38	31

6.1.9 A small size 12 volt home system Design:

Let, according to under table for 90Wh/day design a 12 volt solar home system. Here 40Wp module (Isc = 2.54a, Imp = 2.31A & nominal voltage = 12) and 12volt, 55 Ah battery (DOD = 60%, Efficiency = 80%) will use. Here must remain low cost battery &module will used.

Load type(230 AC load)	Device watts(w)	Daily use (hours)	No. of unit	Total watts	Total watt-hours per day
Fluorescent lamp	7.5	3	3	22.5	67.5
TV 14‘‘	15	1.5	1	15	22.5
Total				37.5	90

IEE & NSE standard solar home system cabal voltage drop maximum 5%

So, maximum power loss 5%

And inverter efficiency 90%

Battery sizing:90

DC Wh/day = --------------- =105.26

0.9*0.95

105.26

Daily load Ah = --------- =8.77 Ah

12v

Battery efficiency = 80%

DOD = 60%

If autonomy of battery 3 day

8.77*3

So Amp-hour for battery = ---------- = 54.8 Ah

0.6*.08

As battery voltage is 12 volt and system volage is 12 volt, and output of battery is 55 Ah then here one battery is needed.

Array sizing:

Daily PV module output = 12*2.31*4.2

= 116.42 Ah

Daily avg. pick insulation = 4.2 hours

Summarizing 20% loss PV array sizing

So this system requirement DC watt-hours = 105.26 Wh/day

105.26

So no. of module =--------------- = 1

116.42*.8

Charge controller size

Given Isc = 2.54A

Charge controller design current = 1.25*2.54A = 3.175A

37.5

Maximum DC current =---------- =3.47A

12*0.9

Here needed charge controller rating = 3.5A

Wire size:

Design current = 3.17A

Maximum load current = 3.47A

Current from PV module to charge controller = 3.175*1.25 = 4.0A

So, wire size 1.0mm²

6.1.10 a big size 24 volt home system Design:

Let, according to under table for 2090Wh/day design a 24 volt solar home system. Here 50Wp module (Isc = 3.22A, Imp = 2.94A & nominal voltage = 12) and 2volt, 660 Ah battery (DOD = 60%, Efficiency = 80%) will use. Here must remain low cost battery &module will used.

Load type(230 AC load)	Device watts(w)	Daily use (hours)	No. of unit	Total watts	Total watt-hours per day
CFL	11	5	6	66	330
TV 14‘‘ color	60	3	1	60	180
Computer	400	2	1	400	800
Mobile charger	4	4	4	16	64
Fan	60	6	2	120	720
Total				662	2090

IEE & NSE standard solar home system cabal voltage drop maximum 5%

So, maximum power loss 5%

And inverter efficiency 90%

All appliance input voltage = 230volt

Battery size

2090

DC Wh/day = --------------- =2444Wh

0.9*0.95

2444Wh

Daily load Ah = --------- =102Ah

24v

Battery efficiency = 80%

DOD = 60%

If autonomy of battery 3 day

102*3

So Amp-hour for battery = ---------- = 638Ah

0.6*0.8

As battery voltage is 2 volt and system voltage is 24 volt,

So 12 battery are needed

Output of battery is 660 Ah

Battery requirement 638Ah

Array sizing

Daily PV module output = 12*2.94*4.2

= 148.2 Ah

Module nominal voltage = 12V

Daily avg. pick insulation = 4.2 hours

Summarizing 20% loss PV array sizing

So this system requirement DC watt-hours = 2444Wh/day

2444

So no. of module =--------------- = 21

148.2*0.8

For getting 24V, 2 no of module connect in series and like this 11 no of set connect in parallel are needed

Charge controller

Given Isc = 3.22A

Total short circuit current = 11*3.22A = 35.42A

Charge controller design current = 1.25*35.42A = 44.275A

662

Maximum DC current =---------- =31A

12*0.9

Here needed charge controller rating = 45A

Inverter size

Size of the inverter = 662/(.9) *1.25= 920W

So 1.0KW inverter is needed

Wire size

Design current (PV array to charge controller)= 44.275A

Maximum load current (charge controller to inverter) = 33A

Current from PV module to charge controller = 44.275*1.25 = 55.34A

So, wire size $16mm^2$

6.1.11 Design of 50 watt solar PV system:

Array sizing:

If energy demand is 50W, Rate of insulation is 4.2 KW/m^2 and efficiency is 0.7 then,

The size of module = 50/(4.2* 0.7)=17W

But 17W module is not available. So we need 50Wp PV module.

No of PV module:

If, per day energy output is Pdm, module output voltage is Vmm and current is ILm then,

Per day energy output is,

Pdm=ILm*D*Vmm

No of module

Nm=PAR/Pdm

Where,

Nm= No of module

PAR= Per day energy requirement

Battery sizing:

If the system voltage 12V, Battery depth of discharges 70% and autonomy 3 days then we need, we know,

P=VI

If energy demand is 50WH, then,

For, 12 volt‘s battery, we need power= 50WH/ 12V = 4.16Ah

Autonomy of 3 days, So 4.16*3 = 12.48 Ah

But, depth of discharge is 75%

So, power = 12.48Ah/(0.75*0.8) = 20.8Ah[If efficiency is 80%]

So, we need to battery those absorbed of capacity is 21 Ah

So, we need = 21 /100 = 0.21 = 1 battery

Standard size of wire:

For the wire selection we need to concentrate below the characteristic:

Length of wire

Wire receptivity

Cross sectional area of wire

Flow of electricity of wire

If, L = length

I = Amperes,

ρ = Receptivity,

a = Area of wire,

Then,

Voltage drop, Vd = 2LIρ /a

Where,

ρ = 0.0183 Ώ /m /mm²

6.1.12 Design of 60 watt solar PV system:

Array sizing:

If energy demand is 60W, Rate of insulation is 4.2 KW/m² and efficiency is 0.7 then,

The size of module = 60/(4.2* 0.7)=20.40W

But 21W module is not available. So we need 50Wp PV module.

No of PV module:

If, per day energy output is Pdm, module output voltage is Vmm and current is ILm then,

Per day energy output is,

Pdm=ILm*D*Vmm

No of module

Nm=PAR/Pdm

Where,

Nm= No of module

PAR= Per day energy requirement

Battery sizing:

If the system voltage 12V, Battery depth of discharges 70% and autonomy 3 days then we need, we know,

P=VI

If energy demand is 60WH, then,

For, 12 volt‘s battery, we need power= 60WH/ 12V = 5 Ah

Autonomy of 3 days, so 5* 3 = 15 Ah

But, depth of discharge is 75%

So, power = 15 Ah / (0.75*0.8) = 25 Ah [If efficiency is 80%]

So, we need to battery those absorbed of capacity is 25 Ah

So, we need = 25 /100 = 0.25 = 1 battery

Standard size of wire:

For the wire selection we need to concentrate below the characteristic:

Length of wire

Wire receptivity

Cross sectional area of wire

Flow of electricity of wire

If, L = length

I = Amperes,

ρ = Receptivity,

a = Area of wire,

Then,

Voltage drop , Vd = 2LIρ /a

Where,

ρ = 0.0183 Ώ /m /mm^2

6.1.13 Design of 110 watt solar PV system:

Array sizing:

If energy demand is 110W, Rate of insulation is 4.2 KW/m^2 and efficiency is 0.7 then,

The size of module = 110/ (4.2* 0.7) =37.41W

But 38W module is not available. So we need 50Wp PV module.

No of PV module:

If, per day energy output is Pdm, module output voltage is Vmm and current is ILm then,

Per day energy output is,

Pdm=ILm*D*Vmm

No of module

Nm=PAR/Pdm

Where,

Nm= No of module

PAR= per day energy requirement

Battery sizing:

If the system voltage 12V, Battery depth of discharges 70% and autonomy 3 days then we need, we know,

P=VI

Chapter 7

10 watt solar power system

The sun is a renewable energy source that's free and plentiful. Some people power their entire home with solar energy. A few even sell back the energy to the electricity grid for a profit. Our society can't continue to work on oil, and with rising gas prices and more frequent power outages, solar energy seems to be the way to go.

The objective of this project is to build a small solar power system as a supplementary for home power needs and with the goal of keeping major home appliances and necessary gadgets active without the concern of weather and grid status. Here, it's explained below the detail procedure to build a 10-watt solar power system.

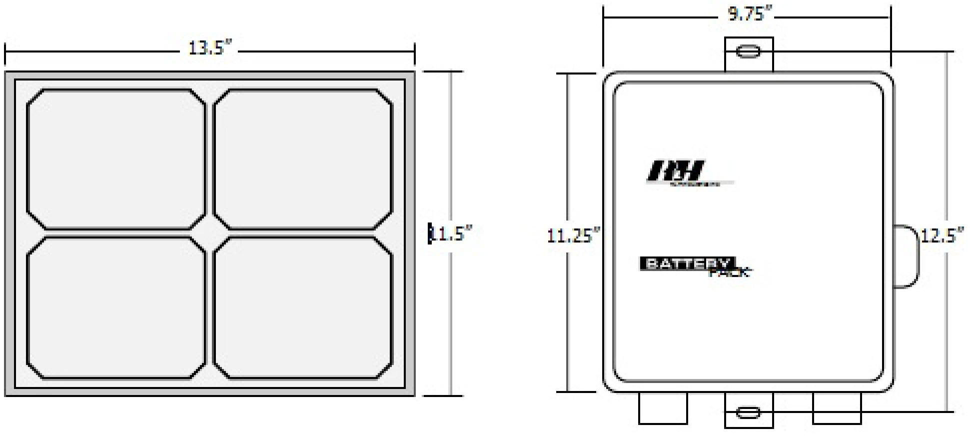
7.1 MATERIALS

1.	10 -watt solar panel	1 piece
2.	Charge controller(3-10A)	1 piece
3.	Inverter (20 watt)	1 piece
4.	Battery (7Ah)	1 piece
5.	MK box(plastic)	1 piece
6.	Multi socket	1 piece
7.	7 watt energy light	1 piece
8.	Light holder	1 piece
9.	Wooden Box()	1 piece
10.	Screw 5”,3”,	10 piece
11.	Royal screw	10 piece
12.	Washer +nuts	15-20 piece
13.	1.5 Rm wire	1 meter
14.	Scotch tape	1 piece
15.	Flexible cable	2 meter

7.2 TOOLS

1. Hand Drill with full box
2. Wire cutters
3. Pliers
4. Screw Driver
5. AVO meter

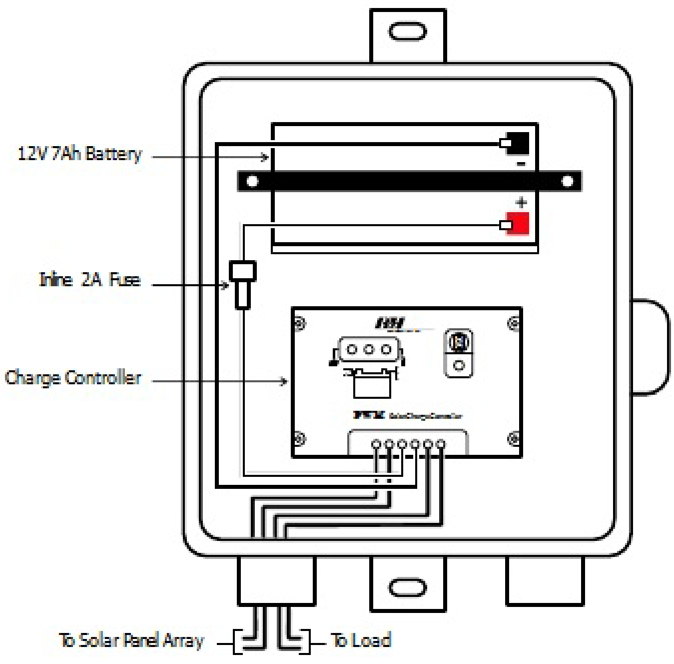
7.3 Dimensional Information



10W Solar Panel
(Front View)

12V 7Ah Battery and Charge Controller Cabinet

7.4 Connection Diagram



12V 7Ah Battery and Charge Controller Cabinet
(inside View)

7.5 Specifications

SOLAR ARRAY	TYPE	10W Solar Panel
	RATED MAXIMUM POWER (Pmax)	RATED MAXIMUM POWER (Pmax)
	TOLERANCE	± 3%
	VOLTAGE @ Pmax (Vmp)	17.6V
	CURRENT @ Pmax (Imp)	0.57A
	SHORT CIRCUIT CURRENT (Isc)	0.61A
	OPEN CIRCUIT VOLTAGE (Voc)	21.6V
	NOMINAL OPERATING CELL TEMPERATURE	47°C ± 2°C
	CELL TYPE	Mono
	WIND LOADING	50lbs/sq. ft.
	PANEL DIMENSIONS	H 11.5" x W 13.5" x D 1" (290mm x 340mm x 25mm) PANEL ASSEMBLY
	PANEL ASSEMBLY WEIGHT	7.5 lbs. (3.2 kg)
	STANDARD TEST CONDITIONS	AM -1.5 STC=1000W/m2 TC=25°C
BATTERY	VOLTAGE	12VDC
	\	
	CAPACITY	7Ah
	BATTERY TYPE	Deep Cycle, Sealed Gel, Lead acid
	HOUSING (ea.)	Polypropylene UL 94-V0/File E50955

7.6 Work Procedure

At first design the project layout with Microsoft visio.Then a wooden box cabinet has to be build as required in the design. Setup the solar pannel in top of the cabinet with an angle of 45 degree. Inside the cabinet a frame has to be created for the battery. Plan the installation of the battery pack and solar panel array prior to installation. For best results, mount the battery pack in a cabinet as close to the panels as practicable. Mount the cabinet, then install and connect the batteries prior to connecting the solar panels as referred in the wiring diagram. Charge controller has been setup in front of the cabinet to view the present status. For DC to AC conversion and to achieve AC output, setup Inverter inside the cabinet. Then connect to the inverter with battery. A 1.5 RM cable has to be connected between solar panel and Charge controller.

7.7 Connection Diagram

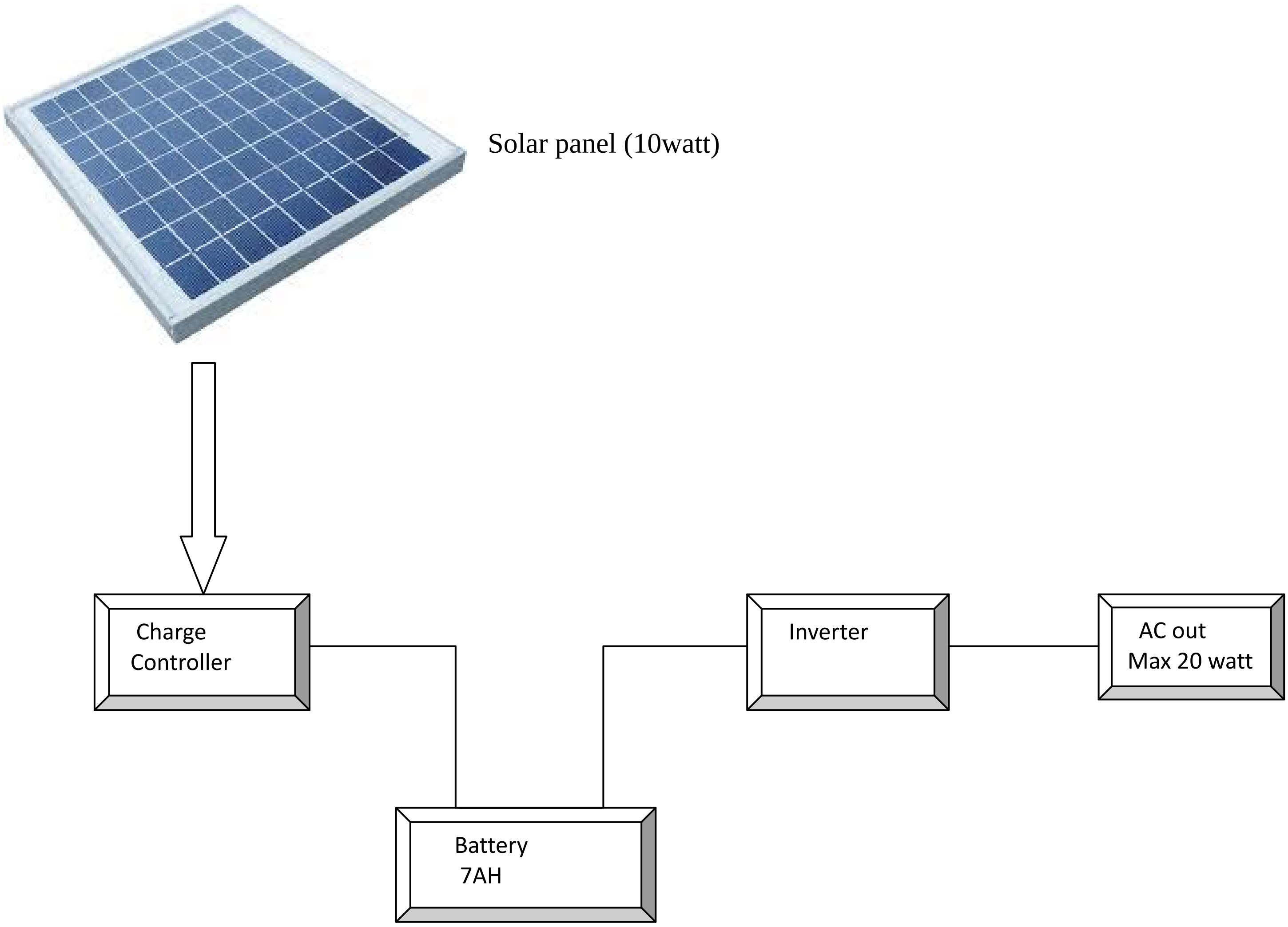


Fig: 10 watt solar power system

7.8 Load calculation

Maximum 20 watt

Load type(230 AC load)	Device watts(w)	Daily use (hours)	No. of unit	Total watts	Total watt-hours per day
Fluorescent lamp	7	3	1	7	21
Mobile charger	12	2	1	12	24
Total				45	45

Real Picture of Project

Figure: Solar Panel

Figure: Side View

Figure: Charge Controller

Figure: Internal View

Conclusions

Solar energy technologies generate electricity without producing air or water pollution. Solar thermal energy technologies may require cooling water, but most of this water can be recycled. Only small amounts of hazardous materials are produced in the manufacture of photovoltaic cells and CSP equipment and essentially none in other solar thermal applications. According to the U.S. Environmental Protection Agency (EPA), CSP plants do not damage the land, but merely take it out of use for other applications such as agriculture. Wildlife habitat may be displaced from land used for such systems, however.[104]

Solar electricity can reduce carbon emissions by offsetting the need for carbon-producing fuels. For example, Applied Materials has installed solar panels at its manufacturing plant in Austin that will generate about 33.7 MWh annually and eliminate about 54,000 pounds of carbon emissions each year.[105]

Solar PV represents a true zero carbon emission generation option.Solar PV technology offers significantly lower capital and operating costs than Diesel power technologyHigher solar radiation levels such as at Blochistan would lower electricity cost.The nature solar energy source makes it more preferred, practical energy solution.

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