

Design of Solar Powered Air Conditioning System

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INTRODUCTION

Now-a-days the temperature of the earth is increasing day by day also the continuous increase in the level of pollution because of various reasons like green house gas emissions, industrialisation, etc. But now everyone wants the earth as it was in ancient days. Therefore the natural resources are rapidly coming into picture. Because the content of non renewable sources are going decreases day by day. For that purpose everyone is diverting from non renewable sources to renewable sources which are easily available and highly efficient.[1]

The development of renewable energy is on the rise worldwide because of the growing demand on energy, high oil prices, and concerns of environmental impacts. In recent years, progress on solar-powered air conditioning has increased as nowadays, air conditioning system is almost a must in every building if we want to have a good indoor comfort inside the building. Therefore, this project focuses in the design and construction of a air conditioner which runs on alternate current but with the help of a photovoltaic system. conditioning system integrated with photovoltaic (PV) system which consists of PV panels, solar charger, inverter and batteries. The air conditioning system can be operated on solar and can be used in non-electrified areas. As we all known, solar energy is cost effective, renewable and environmentally friendly.

TYPES OF SOLAR SYSTEM

There are two types of solar systems: -

1. ON GRID
2. OFF GRID

ABSTRACT

The demand of air conditioning is increasing due to the effect of climate change and global warming. If we still rely on the conventional electric air conditioning it will be harmful in future because electricity is generated from fossil fuels, the greenhouse gas emission would continuously worsen global warming, in turn the demand of air conditioning would be further increasing. Also the rate of electricity is increased by 6% which will goes on increasing in future. The solar powered air conditioners which are available in market are direct current air conditioners, we are designing a system for running a current air conditioner on solar which runs on alternate current.

So in order to reduce the global warming and the green house gas emission effect we should adopt the natural way for the generation of electricity which in turn reduces the cost of electricity by conventional way. As the temperature of the earth is increasing day by day, the need of cooling is also increasing. But the bitter truth is that the temperature of earth is always goes on increasing. So in future there should be the need of centralized air conditioning. And as temperature increases we will get more amount of solar energy.

KEYWORDS: Temperature increases, electricity, air conditioning system

Let's see the difference between them,

1. ON GRID: -

On-grid means your solar system is tied to your local utility's GRID. This is what most residential homes will use because you are covered if your solar system under or over-produces in regard to your varying energy needs. All this means for you is that your utility system acts as your battery space. If you are producing more energy with your solar panels or system than you are using, the excess energy is sent to your grid's power company, allowing you to build credit that you can cash out with at the end of the year, in a process called net metering. Being grid-tied is beneficial because you don't have to buy an expensive battery back-up system to store any excess energy.

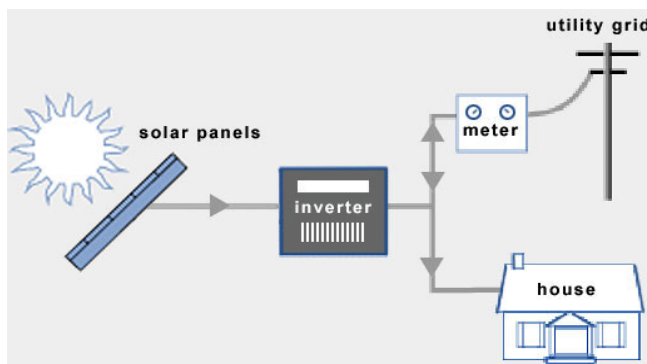


Figure 1:- On grid system

2. OFF GRID: -

Being off-grid means you are not connected in any way to your grid's power system or utility company. This is appealing because you are 100% self-sustaining your energy use. However, there are disadvantages because off-grid systems require you to purchase back-up battery which can be expensive, bulky, and not very environmentally friendly which defeats the purpose of going solar (save money and live greener)

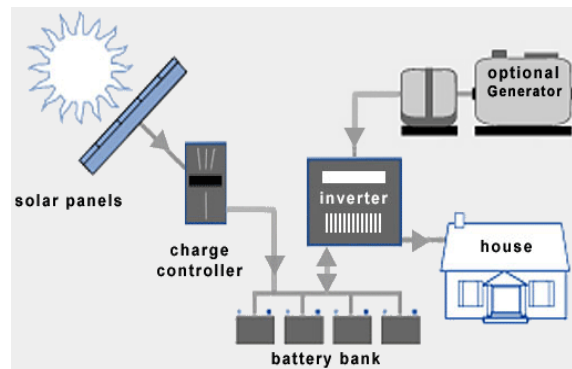


Figure 2: - OFF Grid System

SELECTION OF COMPONENTS FOR SOLAR POWERED AIR CONDITIONING

I. Solar Panel

Table 1: - Types of solar panels and their efficiencies

Solar cell type	Efficiency rate	Advantages	Disadvantages
Monocrystalline Solar panels	20%	High efficiency rate; optimised for commercial use; high life-time value	Expensive
Polycrystalline solar panels	15%	Lower price	Sensitive to high temperatures; lower lifespan & slightly less space efficiency
Thin-film solar panels	7-10%	Relatively low costs; easy to produce & flexible	Shorter warranties & lifespan
Concentrated PV cell	41%	Very high performance & efficiency rate	Solar tracker & cooling system needed (to reach high efficiency rate)

Lets See one by one

➤ **1st Generation Solar Panels**

These are the traditional types of solar panels made of monocrystalline silicon or polysilicon and are most commonly used in conventional surroundings

A. MONO CRYSTALLINE SOLAR PANELS: -



Figure 3:- Mono Crystalline Solar Panel

The mono crystalline solar cells are also known as single crystalline cells. They are incredibly easy to identify because they are a dark black in colour.

To make solar cells for mono crystalline solar panels, silicon is formed into bars and cut into wafers. These types of panels are called "mono crystalline" to indicate that the silicon used is single-crystal silicon. Because the cell is composed of a single crystal, the electrons that generate a flow of electricity have more room to move.

Additionally, mono crystalline cells are also the most space-efficient form of silicon solar cell. They also have the advantage of being the ones that last the longest out of all the silicon-based solar cells. In fact, many manufacturers will offer warranties of up to 25 years on this type of system – a warranty that lasts half of their expected life.

Mono crystalline panels have a high power output, occupy less space, and last the longest. Of course, that also means they are the most expensive of the bunch. Another advantage to consider is that they tend to be slightly less affected by high temperatures compared to polycrystalline panels.[2]

Here are the advantages of mono crystalline solar cells:

1. They have the highest level of efficiency at 15-20%
2. They require less space compared to other types due to their high efficiency
3. Manufacturers state that this form of solar cell lasts the longest, with most giving them a 25-year warranty.
4. They perform better in low levels of sunlight, making them ideal for cloudy areas

Here are the disadvantages to mono crystalline solar cells:

1. They are the most expensive solar cells on the market, and so not in everyone's price range
2. The performance levels tend to suffer from an increase in temperature. However, it is a small loss when compared to other forms of solar cell
3. There is a lot of waste material when the silicon is cut during manufacture

B. POLY CRYSTALLINE SOLAR PANELS



Figure 4: - Poly Crystalline Solar Panel

The polycrystalline solar cells are also known as poly silicon and multi-silicon cells. They were the first solar cells to be developed when the industry started in the 1980s. Most interestingly, polycrystalline cells do not undergo the same cutting process as the mono crystalline cells. Instead, the silicon is melted and then poured into a square mould. This is what creates the specific shape of the polycrystalline.

One of the benefits of this process is that the solar cells become much more affordable. This is because hardly any silicon is wasted during the manufacturing process. However, they are less efficient than mono crystalline solar cells, and also require a lot more space. This is due to the fact that they have lower levels of purity than the single crystalline cell models.

Polycrystalline solar panels are also made from silicon. However, instead of using a single crystal of silicon, manufacturers melt many fragments of silicon together to form the wafers for the panel. Polycrystalline solar panels are also referred to as “multi-crystalline,” or many-crystal silicon. Because there are many crystals in each cell, there is to less freedom for the electrons to move.[2]

➤ Advantages of polycrystalline solar cells:

1. The manufacturing process is cheaper and easier than the mono crystalline cells.
2. It avoids silicon waste

➤ Disadvantages to polycrystalline solar cells:

1. High temperatures have less negative effects on efficiency compared with mono crystalline cells. This makes the polycrystalline cells more attractive to people in warmer areas as the price is lower
2. Efficiency is only around 13-16% due to low levels of silicon purity. So they are not the most efficient on the market
3. They have lower output rates which make them less space efficient. So more roof space is needed for installation.

➤ 2nd Generation Solar Panels

These cells are different types of thin film solar cells and are mainly used for photovoltaic power stations, integrated in buildings or smaller solar power systems.

A. THIN-FILM SOLAR CELLS (TFSC)



Figure 5: - thin-film solar cells

If you are looking for a less expensive option, you might want to look into thin-film. Thin-film solar panels are manufactured by placing one or more films of photovoltaic material (such as silicon, cadmium or copper) onto a substrate. These types of solar panels are the easiest to produce and economies of scale make them cheaper than the alternatives due to less material being needed for its production.

Thin film solar cells are the new generation solar cells that contain multiple thin film layers of photo voltaic materials. The thin film solar cells (TFSC) are also known as Thin Film Photo Voltaic cell (TFPV). The thicknesses of thin film layers are very less as (few nano meters) compared to traditional P-N junction solar cells. [2]

According to the type of photo voltaic material used, the thin film solar cells are classified into four types. They are

1. Amorphous silicon (a-Si) and other thin-film silicon (TF-Si)
2. Cadmium Telluride (CdTe)
3. Copper indium gallium deselenide (CIS or CIGS)
4. Dye-sensitized solar cell (DSC) and other organic solar cells

They are also flexible which opens a lot of opportunities for alternative applications and is less affected by high temperatures. The main issue is that they take up a lot of space, generally making them unsuitable for residential installations. Moreover, they carry the shortest warranties because their lifespan is shorter than the mono- and polycrystalline types of solar panels. However, they can be a good option to choose among the different types of solar panels where a lot of space is available.

1. Advantages

1. Easy to handle
2. More flexible than conventional solar cells
3. Available as thin wafer sheets
4. Cheaper than traditional panels

2. Disadvantages

1. Less efficiency (20 to 30% of light converted into electricity)
2. Complex structure
3. Need to be very careful in handling
4. Can't be used in astronomical devices.

➤ **3rd Generation Solar Panels**

3rd generation solar panels include a variety of thin film technologies but most of them are still in the research or development phase

B. CONCENTRATED PV CELL (CVP AND HCVP)



Figure 6: - Concentrated PV cells

Concentrated PV cells generate electrical energy just as conventional photovoltaic systems do. Those multi-junction types of solar panels have an efficiency rate up to 41%, which, among all photovoltaic systems, is the highest so far.

The name of such CVP cells is related to what makes them so efficient, compared to other types of solar panels: curved mirror surfaces, lenses and sometimes even cooling systems are used to bundle the sun rays and thus increase their efficiency.

By this means, CVP cells have become one of the most efficient types of solar panels, with a high performance and efficiency rate of up to 41%. What remains is the fact, that such CVP solar panels can only be as efficient if they face the sun in a perfect angle. In order to reach such high efficiency rates, a solar tracker inside the solar panel is responsible for following the sun. [2]

➤ **Advantages:-**

1. Carbon-free
2. Can serve as a drop-in replacement for conventional fuels to make steam
3. Operating costs are low
4. Can utilize thermal storage to better match supply with demand

➤ **Disadvantages:-**

1. Intermittent
2. Low energy density
3. Construction/installation costs are high
4. They require a considerable amount of space

CALCULATION FOR NUMBER OF SOLAR PANELS REQUIRED: -

Lets take an example

We have an air conditioner with 1610 W power consumption required in college board room

Then,

$$\text{Power consumption (W)} \times \text{number of working hours}$$

$$1610 \times 3 = 4830 \text{ Wh/day}$$

Convert this to Watt Hours by multiplying the AH figure by the battery voltage (e.g. 12V).

$$\text{Battery Capacity (Ah)} \times \text{Battery voltage}$$

$$150 \times 12 = 1800 \text{ Wh}$$

The power generation rating of a solar panel is also given in Watts. To calculate the energy it can supply to the battery, multiply Watts by the hours exposed to sunshine, then multiply the result by 0.85 (this factor allows for natural system losses).

$$\text{Panel Power (W)} \times \text{hours of sunshine} \times 0.85$$

$$330 \times 5 \times 0.85 = 1402.5 \text{ Wh}$$

So,

$$\frac{\text{Total Wh/day}}{1402.5} = \frac{4830}{1402.5} = 3.44 \approx 4$$

So for the 1610W power consumption air condition we require 4 solar panels.

Diode:-



Figure 8: - Diode

This is usually installed on every panel on the back side in order to prevent the reverse flow of current. Bypass Diodes are used in parallel with either a single or a number of photovoltaic solar cells to prevent the current(s) flowing from good, well-exposed to sunlight solar cells overheating and burning out weaker or partially shaded solar cells by providing a current path around the bad cell. Blocking diodes are used differently than bypass diodes.

Solar inverter

Though the power required by the air conditioner in 1610W, but it is without the starting current. Including starting current the power required is around 2300W. For that purpose we are going to select the inverter of around 3kVa. A solar inverter is one of the most important elements of the solar electric power system. It converts the variable direct current (DC) output of a photovoltaic (PV) solar panel into alternating 240V current (AC). This AC electricity then can be fed into your home to operate your appliances.



Figure 7: - Inverter and Batteries

SOLAR BATTERIES

A battery is needed because the appliances use electricity at different times and at different rates than the panels produce. For the system to work properly, the battery should be of the deep-discharge type and be large enough to store enough energy to operate the appliances at night and on cloudy days. Also, for the battery to last a long time, it should not be discharged too much or too often. In sizing a battery, it is important to install one large enough to operate the appliances for at least five days without recharging. In climates that have long periods of cloudy weather, a larger battery may be needed.

➤ Battery capacity =

$$\begin{aligned} \text{Watt} &= \text{voltage} \times \text{amp} \\ &= 230 \times 7.22 \\ &= 1660.5\text{W} \end{aligned}$$

As we are selecting 12 V Battery

$$\begin{aligned} &= \frac{1660.5}{12} \\ &= 138.37 \text{ Ah} \end{aligned}$$

Therefore we selected 150Ah 12 V battery

CONCLUSION:-

As the temperature of earth is increasing day by day in future there is a lot of scope for solar power plants. Also the rate of electricity is increasing day by day but the necessity of it is always as usual like in various industries, school, colleges, hospitals where the shut down of power may cost much more. For that purpose solar energy which is infinite is used and power plants can be generated.

By using the solar energy we can charge our batteries and can run different application for hours without interruption. By using the calculation given in the paper we can calculate the number of panels, number of batteries required and we can approximately design a system at our home.

REFERENCES

[1] I. Dauta, M. Adzriea, M. Irwantoa, P. Ibrahima, M. Fitraa, Solar Powered Air Conditioning System Energy Procedia 36 (2013) 444 – 453

[2] Askari Mohammad Bagher, Mirzaei Mahmoud Abadi Vahid, Mirhabibi Mohsen. Types of Solar Cells and Application. *American Journal of Optics and Photonics*. Vol. 3, No. 5, 2015, pp. 94-113. doi: 10.11648/j.ajop.20150305.17