Study on Grid Tie Solar System

A Project and Thesis submitted in partial fulfillment of the requirements for the Award of Degree of

Bachelor of Science in Electrical and Electronic Engineering

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Certification

This is to certify that this project and thesis entitled "**Study on Grid Tie Solar system**" is done by the following students under my direct supervision and this work has been carried out by them in the laboratories of the Department of Electrical and Electronic Engineering under the Faculty of Engineering of Daffodil International University in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering. The presentation of the work was held on October 2020.

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ABSTRACT

Distribution level solar energy generation has gained importance and popularity, because it helps create a sustainable electricity system while reducing the harmful environmental impacts our current power systems have. The simple model has a photo-current source, a single diode junction and a series resistance, and includes temperature dependences. When settings are right, the grid-connected PV system supplies the additional power, moreover consumption by the connected load, to the utility grid. This study proposes an alternative energy source, a laboratory scale grid-connected photovoltaic system. The control of DC/DC converter is ensured by using perturb and observe method in order to make photovoltaic panels work at maximum power point (MPP) in all cases. A grid-tied solar power inverter does DC-to-AC conversion and minimizes energy transfer losses. The inverter also has an anti-islanding feature, which senses a power outage and prevents back-feeding through isolating the circuit. The circuit's breakers isolate electrical components and protect the circuit.

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Dedicated to

MY PARENTS

With Love & Respect

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List of principal Symbols Abbreviations

PV	Photovoltaic
MPP	Maximum Power Point
MPPT	Maximum Power Point Tracker
$\mathbf{I_L}$	Photo generated Current
$\mathbf{V_{OC}}$	Open Circuit Voltage
$\mathbf{I_{SC}}$	Short Circuit Current
$\mathbf{I_{PV}}$	Photodiode Current
$\mathbf{V_{PV}}$	Photodiode Voltage
C	Capacitor
V	Voltage
I	Current
L	Inductor
R	Resistor
D	Diode
DC	Direct Current
AC	Alternating Current

Chapter 1
Introduction

1.1 General Considerations

The term grid-tied is additionally called grid connected or on-grid. Grid tied solar PV system is an arrangement of your solar panel association wherever in electricity may be drawn from the standard utility grid (main line) also as from it implies, if you're putting in grid-connected solar panel system at home, solar isn't the only source of electricity. It additionally means the house doesn't run out of power. Once the solar panels aren't producing enough electricity, the system will import the shortage from the grid. During this system, the inverters convert DC generated by the solar panels to electricity (AC) corresponding to the voltage of the grid power. The electricity created by the solar system is 1st used to power the house, surplus power that in not consumed within the home, is automatically exported to the electricity grid via a Bi-directional meter, which results in reduction of power bill. Suppose, if your solar system produces twenty units in in the future and if you utilize solely ten units at home, then the balance ten units is distributed to the state public-service corporation, which ends in savings in your electricity bill. Just in case there's a power cut, the inverter stops to perform as a safety feature. This method doesn't have battery backup therefore during power cut you'll not have access to power. Therefore this method are often utilized in area wherever there's rare or too much less power cut. Solar energy is an alternate technology which will hopefully lead us far from our petroleum and gas dependents energy sources. The main problem with solar panel technology is that the efficiencies for solar energy systems are still poor and therefore the prices per kilo-watt-hour (kWh) aren't competitive, in most cases, to vie with petroleum and gas energy sources. We are designed to pure sine wave inverter for tie grid system. The efficiency indicates the percentage of the obtainable solar energy that is genuinely convertor and fed into the utility grid. Nowadays inverters presently consume between 4 and 8% the converted energy within the conversion method that corresponds to whole efficiency of 92 to 96%.

1.2 Background and Motivation

The interest in renewable energy has been revived over previous several years, particularly once world awareness concerning the unwell effects of fossil fuel burning. Energy is that the supply of progress and therefore the mover for economic and social improvement of a nation and its people. No matter however we cry regarding improvement or poorness remission – it is not getting to come back till lights are conferred to our people for seeing, reading and dealing. Plebeian resources or energy sources for example: fossil fuels, oil, natural gas etc. are absolutely used or economically reduced. As a result of we tend to are quickly tedious, our non-renewable resources, decadent the potentially renewable resources and even threatening the permanent resources. It demands immediate attention particularly within the third world countries, wherever solely scarcer sources are accessible for a huge size of population. The civilization relies on power. There is a relationship between GDP progress of growth and electricity rate of growth in a very country. The electricity department in Bangladesh is handled by 3 state delegacies below the Ministry of Energy and mineral resources (MEMR). These are:

- Bangladesh Power Development Board (BPDB).
- Dhaka electrical supply authority (DESA).
- Rural Electrification Board (REB).

Bangladeshis a mostly rural agricultural country of regarding 160 million people situated on the Bay of Bengal in south Central Asia. Many little deposits of coal exist on the north eastern region of the country, however those contains hamate, with lower caloric price and also extremely deep coal which will be fully costly to extractive. Solely 15 August 1945 of the entire population has access to the electricity. In 1990 solely 2.2% of whole households (mostly in urban areas) have piped natural gas connections because of preparation and solely 3.9% of total households used kerosene for preparation. Those are by no means that a nice situation. These can't solely save extreme grid growth price however would keep atmosphere friendly recently a number of experimental land pilot projects are being enterprise by totally different organizations in numerous sectors of alternative energy technologies in Bangladesh.

Chapter 2
Grid Connected PV System

2.1 Introduction

A grid-connected photovoltaic system, or grid-connected PV system is an electricity generating solar PV power grid that's connected to the utility grid. A grid-connected PV system consists of solar panels, one or several electrical converter, a power conditioning unit and grid association implements. Those extent from tiny residential and industrial rooftop systems to huge utility-scale solar power stations. Not like complete power systems, a grid-connected system occasionally contains a mobilized battery solution, as these are so much costly. Once settings are settled, the grid-connected PV system supplies the additional power, moreover consumption by the connected load, to the utility grid.

2.2 Operation

Residential, grid-connected rooftop systems that have a property over 10 kilowatts will meet the load of maximum customers. They will feed extra power to the grid wherever these is worn by alternative users. The feedback is completed by a meter to observe power shifted. Photovoltaic electrical power could also be but mean consumption, within those case the consumer can still buy grid energy, however a smaller quantity than earlier. Whether photovoltaic electrical power enough oversteps average consumption, the energy created by the panels are a lot of in superfluous of the demand. During these case, the superfluous power will deliver income through selling it to the grid. Depending on their contract with their local grid energy company, the patron solely has to pay the value of electricity consumed small value of electricity generated. These can be a negative number whether a lot of electricity is generated than consumed. Moreover, in a few cases, money incentives are delivered from the grid operator to the consumer. Association of the photovoltaic power grid are often done solely through an interconnection contract within the consumer and also the utility company. The contract details the many safety standards have to follow throughout the connection.

Figure 2.2: Photovoltaic Power Station

2.3 Features

Electric power from photovoltaic panels should be converted to electrical energy by an influence electrical converter if it's meant for delivery to an influence grid. The electrical converter sits between the solar panel and therefore the grid, and will be an enormous complete unit or could also be a set of little inverters connected to distinct solar panels as like as an AC module. The electrical converter should monitor grid voltage, waveform, and frequency. The electrical converter should mark out failure of the grid provide and should not provide power to the grid. The situation of the fault current plays an important half decide whether the protection mechanism of the electrical converter would kick in, particularly for lower and average electricity provide network. A protection system should assure that proper operation for faults outsider to the electrical converter on the supply network. In fact to synchronize its alternative current frequency with the grid and also ensure proper direction of power flow, the electrical converter is designed.

2.4 Advantages & Disadvantages

Type of UPQC	Advantages	Disadvantages
Multi-level Converter based	i. High voltage and current can be achieved. ii. Can be developed in different ways – diode clamp / flying capacitor / cascade inverter based.	i. Voltage unbalance could occur between the different levels. ii. Requires excessive number of diode / flying capacity/ inverter. iii. Central control is required and it is complicated. iv. Conduction loss is high. v. Capacity expansion is difficult. vi. Centralized approach.
Multi-modular transformer less	i. No series transformer is required, thus reduces the cost. ii. Capacity expansion is easier than multi-level converter. iii. Redundancy is possible.	i. It requires high number of switching devices to enhance the capacity. ii. Central control is required. iii. Conduction loss and switching loss also high. iv. Due to symmetrical distribution of the load power among the H-bridge inverters, modules may not work at its maximum rating.
Multi-modular (power cell)	i. Single phase power cell topology helps the unit to work at its maximum rating.	i. Number of H-bridge switching device increases, thus increase the switching loss.

Table 2.4: Advantages and disadvantages of Grid connected PV System

Chapter 3

Generation of Electric Energy

3.1 Introduction

The method of generating power from any sources of primary energy is called electricity generation. Electricity is that the set of physical phenomena related to the presence and flow of electrical charge. Electricity offers a large kind of well-known sources, like chemical energy, thermal energy, K.E., energy, rotational energy, solar power, wind energy and heat energy. Here some sources area unit renewable and a few are non-renewable energy. the main parameter selections that has to be created for any new electrical power-generating plant or unit include the alternatives of energy supply, kind of generation system, unit and plant rating, and plant site.

3.2 Renewable energy

Renewable energy is energy which is collected from renewable resources that are generally populated on a human timescale, like daylight, wind, rain, tides, waves, and geothermic heat. Renewable energy usually provides energy in 4 necessary places: electric generation, air and water heating/cooling, transportation, and rural (without grid connected) energy services. New renewable (small hydro, electronic equipment biomass, wind, solar and geothermal) account for an additional 3-dimensional and are growing speedily. At the national level, a minimum of 30 nations round the world have already got renewable energy contributive over two hundredth of energy provide. Renewable energy is accessible in numerous forms as well as Wind, solar and Biomass power. We tend to aim to introduce people to the necessity and advantages of using the natural sources of energy. This is often necessary because the Earth's sources of oil and coal are on the verge of depletion with a huge increase within the demand. Therefore, it has become very essential that people understand the necessity of protective these exhaustible sources of energy and learn the way to manage energy with efficiency.

3.3 Solar Energy

Solar energy, bright light and warmth from the sun, is controlled using a range of ever evolving technologies like solar heating, star photovoltaics, solar thermal electricity, solar design and artificial photosynthesis. Solar technologies area unit generally characterized as either passive solar or active solar depending on the means they capture, convert and distribute solar power. Active solar techniques include the utilization of photovoltaic panels and solar thermal collectors to harness the energy. Passive solar techniques include orienting a building to the Sun, choosing materials with favorable thermal mass or light dispersing properties, and planning areas that naturally flow into air. An electric cell, or cell (PV), could be a device that converts light into current using the photoelectrical impact. The primary electric cell was made by Charles Frits within the 1880s. The German man of affairs Ernst Werner von Siemens was among people who recognized the importance of this discovery. In 1931, the German engineer Bruno linesman developed a photograph cell using silver selenide in place of copper oxide, though the image Se cells converted but I Chronicles of incident light into electricity.

Figure 3.3: Solar Energy

3.4 Hydroelectric Power

A generating station that utilizes the potential energy of water at a high level for the generation of electricity is understood as a hydro-electric power plant. Hydro-electric power stations are usually situated in mountainous areas wherever dams will be built handily and huge water reservoirs will be obtained. In a very hydro-electric power plant, water head is made by constructing a dam across a river or lake. From the dam, water is LED to a water rotary engine. The water rotary engine captures the energy within the falling water and changes the hydraulic energy into energy at the rotary engine shaft. The rotary engine drives the generator that converts energy into electricity. Once flowing water turns blades in a very rotary engine, the shape is modified to mechanical (machine) energy. The rotary engine turns the generator rotor that then converts this mechanical energy into another energy form- electricity. Since water is that the initial supply of energy, we tend to call this electricity power or hydropower for short.

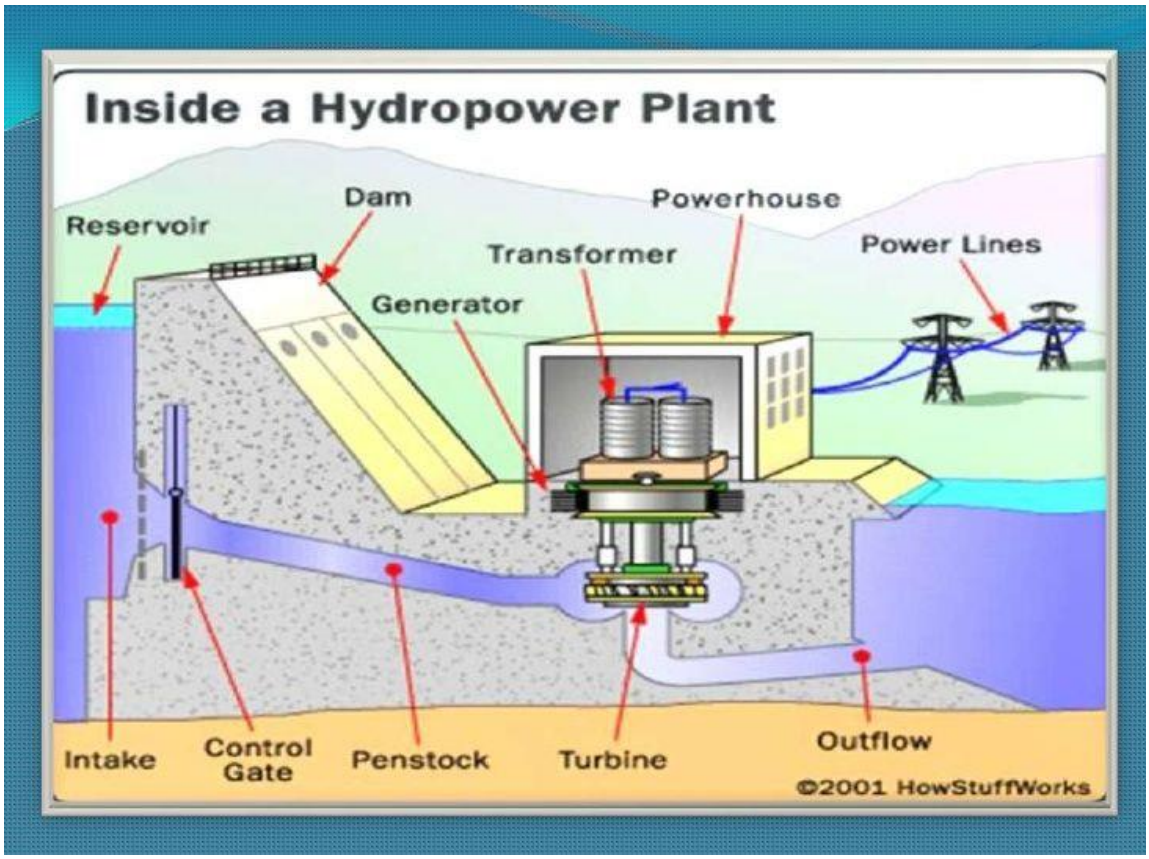

Figure 3.4: Hydro-electric Power Plant

3.5 Wind Power

Wind could be a powerful supply of energy on our planet. Actually several people have seen it in action propellant sailboats across open seas or turning the blades of a farms windmill to grind grain or pump water. Nowadays wind turbines are originally sleeker higher tech versions of the windmills of the past. However rather than using the wind to try and do farm work they're designed to convert wind energy into electricity.

Wind blowing across the turbines blade creates a lot of pressure on one facet of the blade than the opposite. This causes the mechanism of the 3 connected blades to show. This rotation pushes on a series of spinning elements within the body of the rotary engine. That in turn spins a generator manufacturing electricity. As a result of wind is usually blowing somewhere across the surface of the world. It's considered a natural resources and because the only issue needed to show a turbine is moving air. Wind farms emit no greenhouse gases.

However although it's clean and ample, there are variety of reasons we have a tendency to still don't use wind power a lot of wide. the primary and maybe most significant is that the wind doesn't continuously blow a minimum of not perpetually within the same spot and technologies for storing ample electricity for later use are presently too much costly.

Long transmission lines are essential to transfer the electricity to wherever it is required. Finally whereas farms are comparatively price low-cost to control they cost plenty to create specially as compared to existing coal and gas power plants.

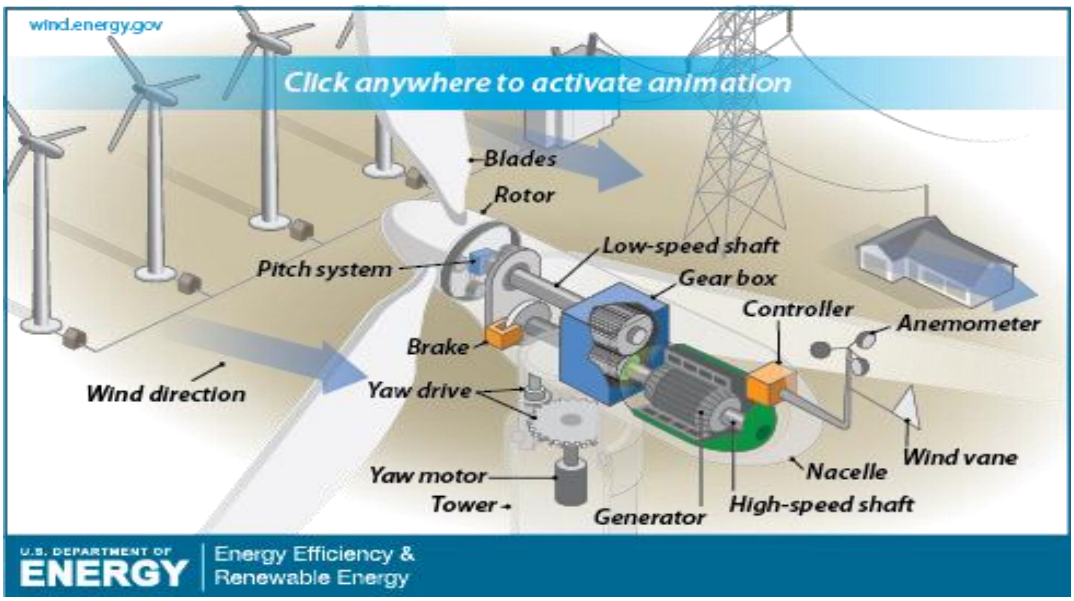

Figure 3.5: Wind Turbine Power Plant

3.6 Geothermal Power

The term geothermal comes from the Greek geo that means earth and thin which means heat. Geothermal energy heat is energy derived from the natural heat of the world. High-temperature underground reservoirs of water or steam, heated by an upwelling of stone. We tap these reservoirs that heats the water that turns the turbines and creates electricity.

Geothermal energy is that the energy acquired by the world. Here the supply of source is earth therefore the name is geothermal. Heat within the world is accessible at a depth of quite 80 kilometers. In some locations it's accessible at a depth from 300 to 3000 meters. Such locations are referred to as energy fields. Geothermal energy is used for heating water, power plant, electricity generation, greenhouse heating etc.

Dry steam powerhouse power plant powerhouse steam is generated directly from the geothermal reservoir. This team is directly supplied to the rotary engine that is coupled with a generator. The water is termed as condensation and its injected back to the world through the injection well. Natural dry steam hydrothermal reservoirs back into too much rare.

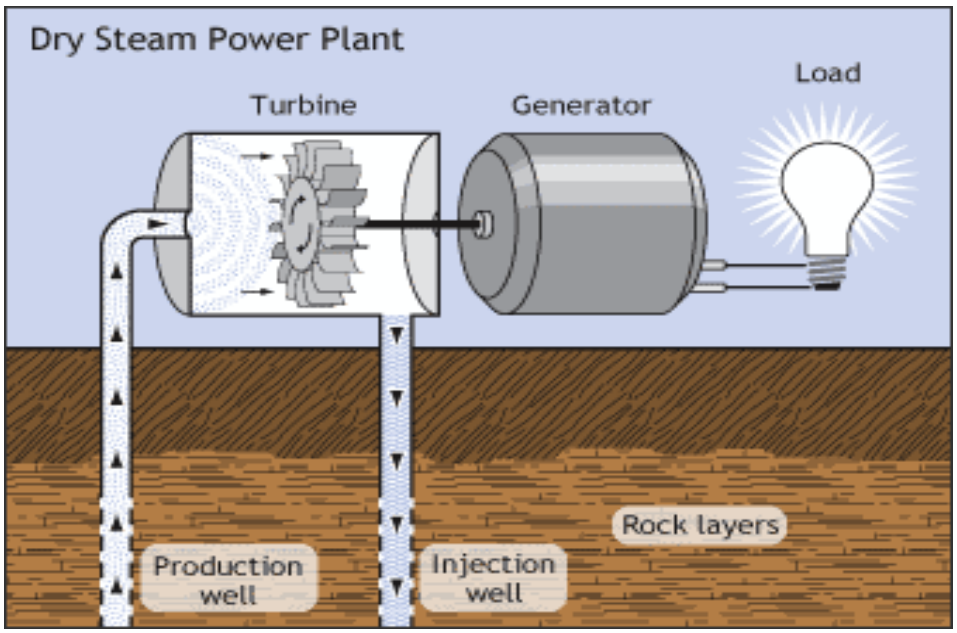

Figure 3.6: Geothermal Power Plant

3.7 Biomass Power

All the organic materials made from plants and animals are called biomass. Biomass is the name for a range of organic materials that can be used to produce energy. Examples include forestry products, energy crops like Miscanthus also known as elephant grass and agricultural byproducts like straw, we can generate heat or electricity from biomass in a way that is close to carbon neutral over the materials life cycle. To understand the environmental benefit of using biomass, let's look at how fossil fuels like coal oil and natural gas are created. Plants absorb carbon dioxide or co2 from the air as they grow. When they died some of the carbon from the co2 remains trapped in the decaying vegetation. Over millions of years these buried layers of vegetation are compressed and transformed into either coal oil or natural gas. The carbon that was removed from the atmosphere is effectively locked underground. Now let's know about two ways you could heat a house the first example uses a fossil fuel coal. Coal is extracted from the ground and transported to the house. This process produces co2 emissions. The fuel is then burnt providing heat co2 from the fossil fuel is released into the atmosphere increasing co2 levels. Coal reserves are being depleted and atmosphere co2 levels are rising.

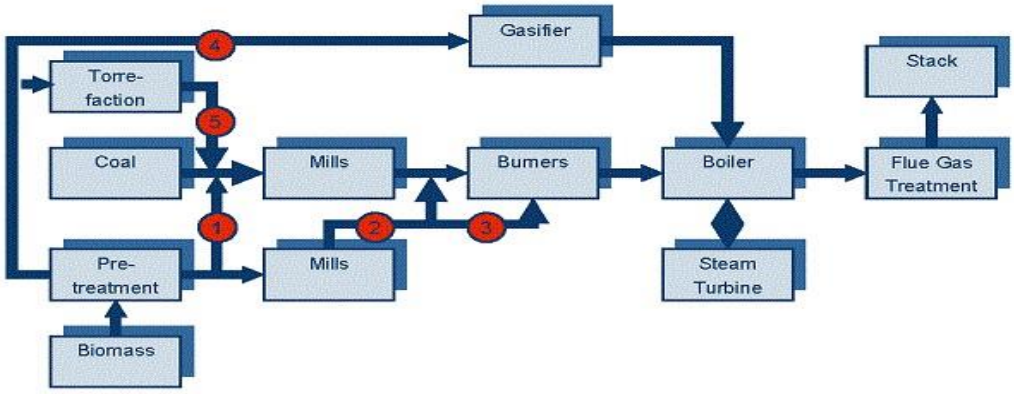

Figure 3.7:- Biomass Confirming in Coal Power Plant

3.8 Grid Tied Solar Electric Systems

Grid Tied solar electrical systems generate electricity noiselessly and without any moving components. Daylight falls on the solar panel (blue, on the roof), generating DC electricity. That DC electricity is converted into home 120V AC electricity by the electrical converter (blue & gray, on the wall). The AC electricity is fed into your electric meter and circuit breaker panel (grey, on the wall). This all happens noiselessly and automatically on a daily basis. Grid intertied power systems are for people who are (or can be) connected to utility company power lines (the "Grid"). They decide to use the Grid to supplement what they're able to create with renewable energy sources just like the sun or wind.

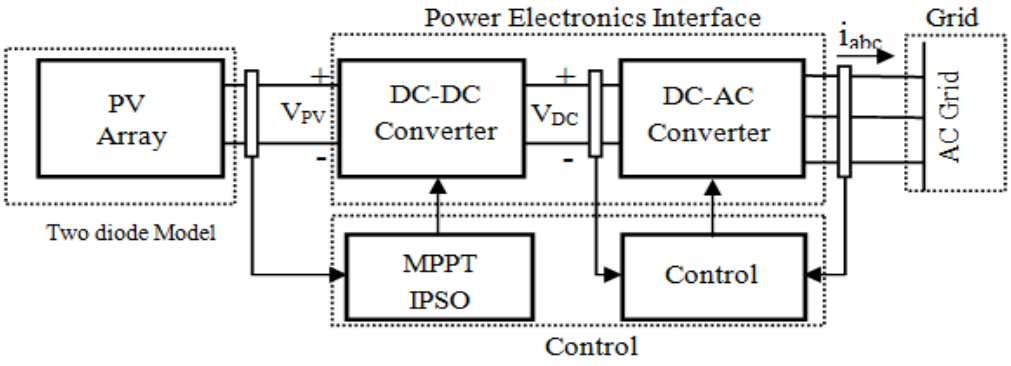

Figure 3.8: Block diagram of Grid tied solar systems

3.8.1 Parts of Grid Tie Solar System

- Solar Panel.
- Maximum Power Point Tracking (MPPT)
- DC To DC Converter.
- DC To AC Converter (Inverter).
- Utility Grid.

3.9 Solar Panel

A solar panel produces electricity even once there's no direct daylight. Therefore even with cloudy skies a solar power system can produce electricity. The most effective conditions, however are bright daylight and also the solar panel facing towards the sun. To advantage most of the direct daylight a solar panel needs to adjusted as best as possible towards the sun. In practice, the solar panels must be designed at an angle to the horizontal plane (tilted). Close to the equator the solar panel ought to be placed slightly tilted (almost horizontal) to permit rain to clean away the mud. A little deviation of those orientations has not a major influence on the electricity production as a result of during the sun moves on the sky from east to west. Panels are usually set to latitude tilt, an angle adequate to the latitude, however performance may be improved by adjusting the angle for summer and winter.

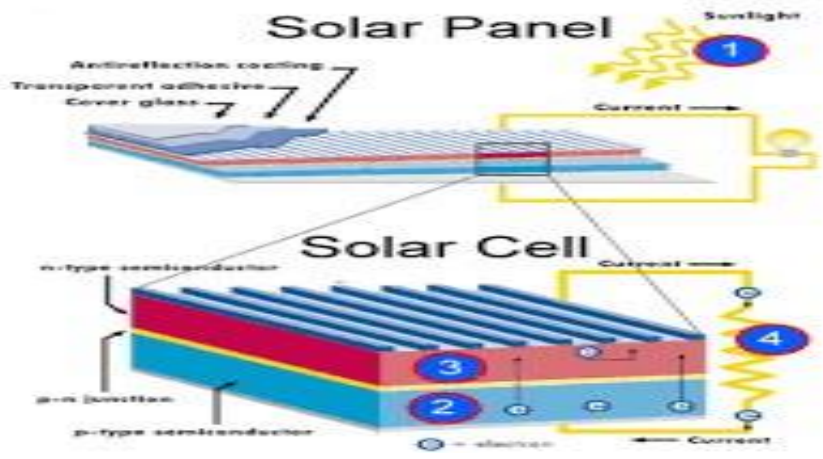

Figure 3.9: Solar Panel

3.10 Basic Principal of Solar Panel

A solar cell or photovoltaic cell could be a device that converts daylight directly into electricity by the photovoltaic effect. Photovoltaic could be a method of generating electric power by converting solar radiation into DC electricity using specially designed p-n junctions that exhibit the photovoltaic effect. When magnetic attraction irradiation falls on such a junction, it transfers energy to associate degree electron within the valence band and promotes it to the conductivity band therefore making an electron-hole pair. The electrons and holes created will currently act as mobile charge carriers and therefore a current is created. This method across a p-n junction is shown in figure

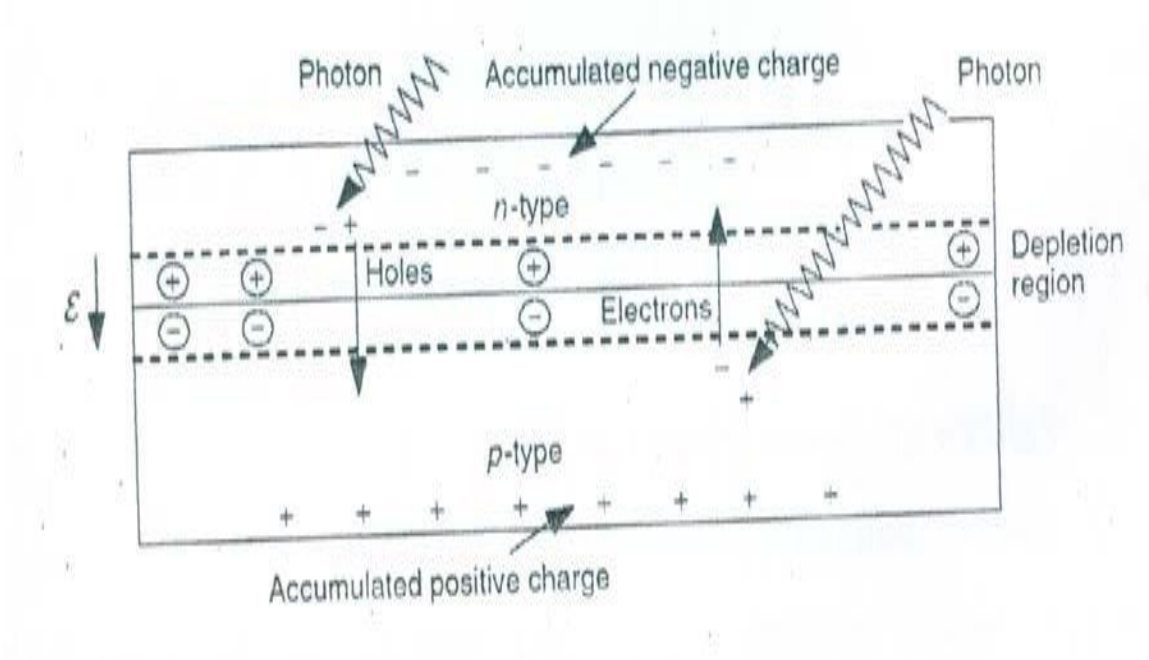

Figure 3.10: Creation of Electron-Hole Pairs by incident electromagnetic irradiation

3.11 Solar Cell

Solar Cell converts light energy into the electrical energy. A solar cell is essentially a p-n junction diode. It utilizes photovoltaic effect to convert lightweight energy into electrical energy.

Although this is often originally a junction diode, however constructional it's little bit totally different kind conventional p-n junction diode. A really skinny layer of n-type semiconductor is fully grown on a comparatively thicker p-type semiconductor. We offer few finer electrodes on the highest of the n-type semiconductor layer. These electrodes don't obstruct light to achieve the skinny n-type layer. Just under the n-type layer there's a p-n junction.

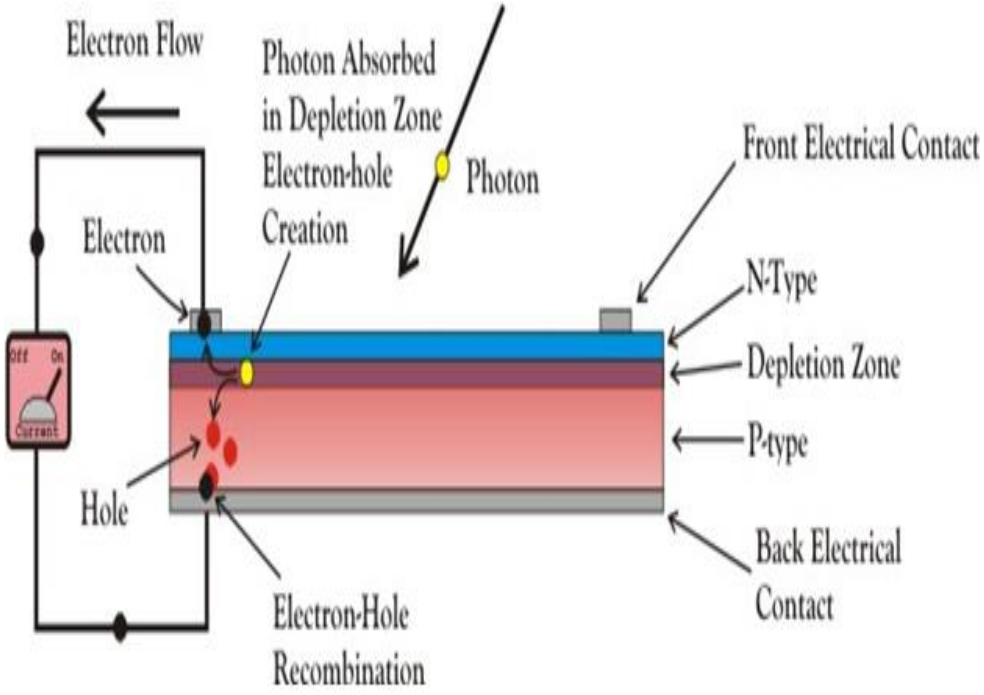

Figure 3.11(a): Solar Cell

When light reaches the p-n junction, the sunshine photons will simply enter within the junction, through very skinny n-type layer. The sunshine energy, within the kind of photons, supplies enough energy to the junction to make a number of electron-hole pairs. The incident light-weight breaks the equilibrium condition of the junction. The free electrons within the depletion region will quickly come to the n-type side of the junction. Similarly, the holes within the depletion will quickly return to the p-type facet of the junction. Once, the new created free electrons return to the n-type side, cannot additional cross the junction because of barrier potential of the junction.

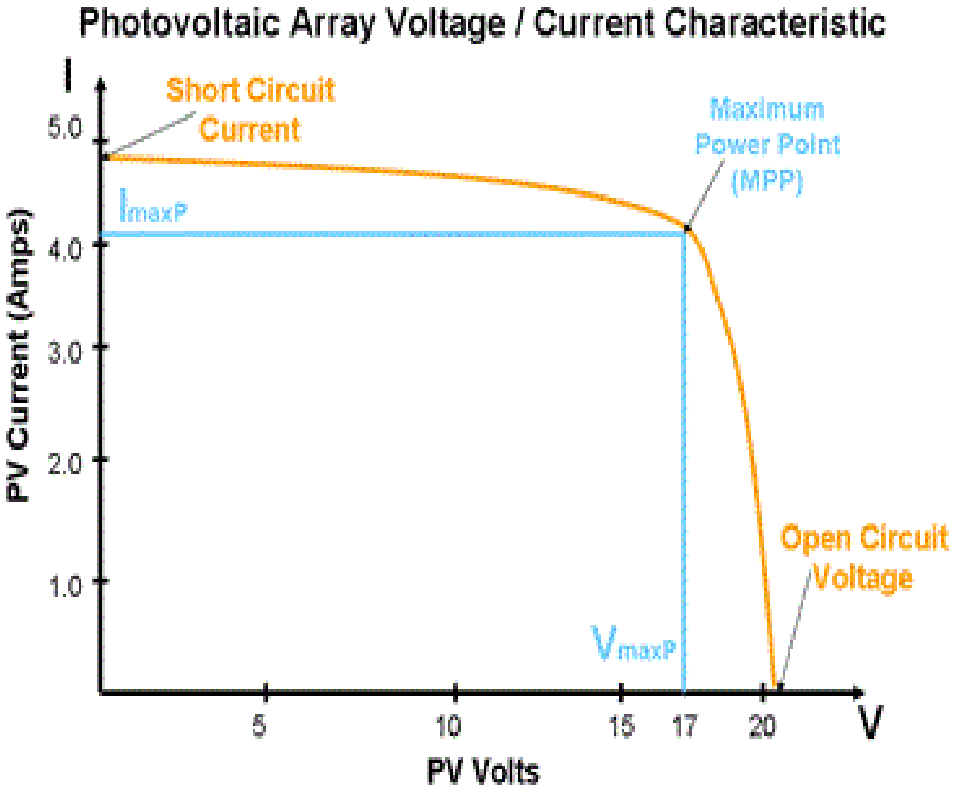

Figure 3.11(b): V-I Characteristics of a Photovoltaic Cell

3.11.1 Operation of a Photovoltaic (PV) Cell

The operation of a photovoltaic (PV) cell required

* The absorption of light, generating either electron-hole pairs or exactions.
* The separation of charge carriers of opposite types.
* The separate extraction of those carriers to an external circuit.

In contrast, a solar thermal collector provides heat by absorbing daylight, for the aim of either direct heating or indirect electric power generation. "Photo electrolytic cell" (photo electro chemical), on the other hand, refers either to a kind of solar cell (like that developed by Edmond Becquerel and electronic equipment desensitized solar cells), or to a tool that splits water directly into gas and oxygen victimization solely solar illumination.

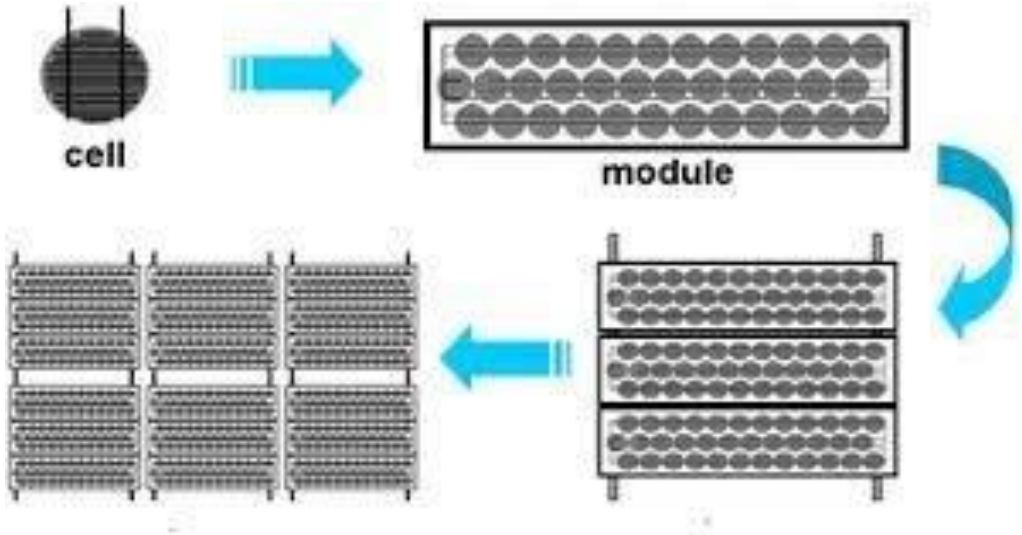

Figure 3.11.1 Construction of Photovoltaic Solar Panel

3.12 Modules

PV modules consist of PV cell circuits sealed in an environmentally protective laminate and are the fundamental building block of PV systems.

3.13 Array

A PV array is the complete power-generating unit, consisting of any number of PV Modules and panels.

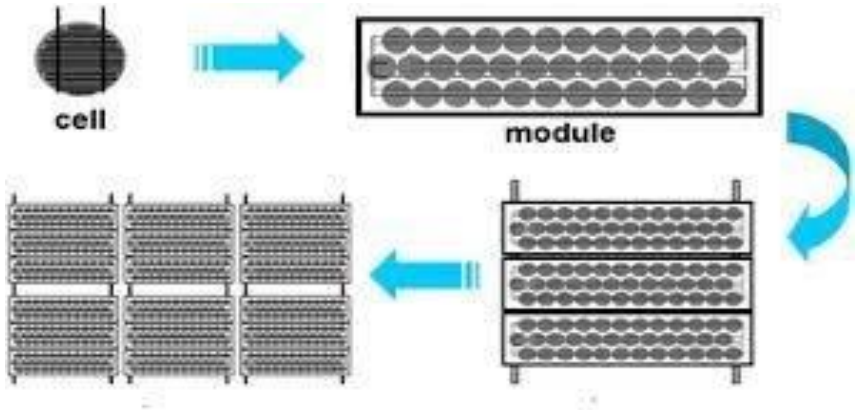

Figure 3.13: Photovoltaic Array

3.14 Photovoltaic Modules

Solar cells consist of a p-n junction made-up in a very skinny wafer or layer of semiconductor. Within the dark, the I-V output characteristic of a solar cell has an exponential characteristic just like that of a diode. Once exposed to light, photons with energy larger than the band gap energy of the semiconductor are absorbed and make an electron-hole try. These carriers are sweptwing apart below the influence of the internal electrical fields of the p-n junction and make a current proportional to the incident radiation. Once the cell is short circuited, this current flows within the external circuit. Once open circuited, this current is shunted internally by the intrinsic p-n junction diode. The characteristics of this diode thus set the open circuit voltage characteristics of the cell.

3.15 DC to AC Converter (Inverter)

Dc to Ac convertor is known as electrical converter. Electrical power is usually transmitted and utilized in the shape of AC. However, some types of electrical generation and storage devices manufacture DC, examples being PV modules and batteries. An electrical converter may be a power electronic equipment that converts DC to AC, permitting the DC power from these generators to be used with ordinary AC appliances, and/or mixed with the prevailing electrical grid. photovoltaic generation is typically interfaced at a grid bus through a PWM electrical converter during which a switch signal is generated by comparison the required sinusoidal output (i.e. the modulated signal or management signal) with high frequency triangle wave (carrier signal). The points of intersection of the modulating signal and also the carrier signal are the points during which the GTOs or thermistors of the electrical converter are switched on by turn.

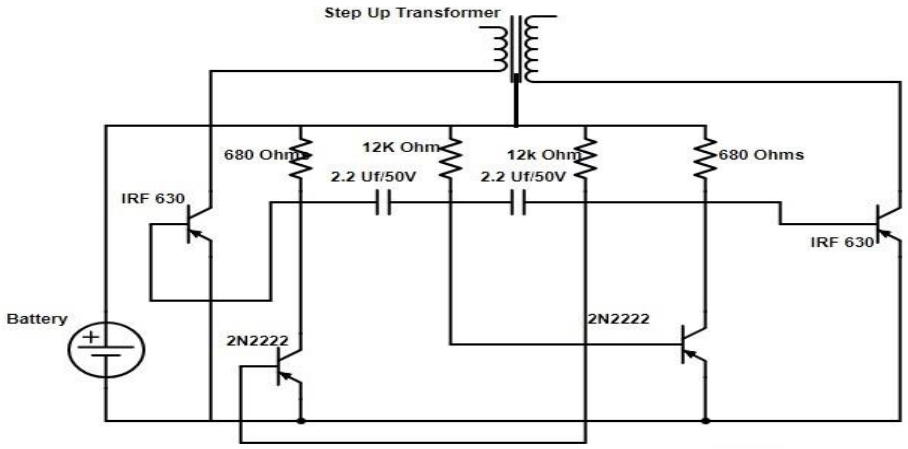

Figure 3.15: DC to AC Inverter

Chapter 4

Utility Grid of Solar System

4.1 Introduction

Photo voltaic (PV) solar power is one of the green energy sources which may play a very important role within the program of reducing greenhouse gas emissions. Although, the PV technology is expensive, it's receiving strong encouragement through numerous incentive programs globally. As a result, large scale solar farms are being connected to the grid. At present Transmission grids worldwide are facing challenges in integration such large scale renewable systems and solar Farms due to their limited power transmission capability. In an extreme state of affairs new lines may have to be created at a really high expense. Price effective techniques so ought to be explored to extend transmission capability. A unique analysis has been reported on the night time usage of a PV solar farm (when it's usually dormant) wherever a PV solar farm is used as a Static Compensator a FACTS device for performing arts voltage control, thereby improving system performance and increasing grid connectivity of neighboring solar farms. It's known that voltage management will assist in up transient stability and power transmission limits, many shunt connected FACTS devices, such as, Static Var. Compensator and static compensator are used worldwide for up transmission capability. This project presents a unique night-time application of a PV solar farm by that the solar farm electrical converter is used as a static compensator for voltage management in order to improve power transmission capability during nights. During day time additionally, the solar farm whereas supply real power output is still created (to operate to work to management) as a static compensator and supply voltage control using its remaining electrical converter MVA capability (left when what's required for real power generation). At the present time voltage regulation is also shown to considerably enhance stability and power transfer limits.

4.2 Theory of Synchronizing

When closing a circuit breaker between two energized components of the power system, it's crucial to match voltages on each side of the circuit breaker before closing. If this matching or "synchronizing" method isn't done properly, an influence system disturbance can result and instrumentation (including generators) may be broken. So as to synchronize properly, 3 totally different aspects of the voltage across the circuit breaker should be closely monitored. The 3 aspects of the voltage are known as the synchronizing variables and are:

- The voltage magnitudes
- The frequency of the voltages
- The phase Sequence

4.3 Synchronizing Method

Modem power plants generally utilize automatic synchronizers. The importance of synchronizing can’t be overdone. All system operators ought to understand the idea and apply of synchronizing. If 2 power systems are synchronized via an open circuit breaker, and also the synchronizing method isn't done properly, solar system is severely broken.

4.3.1 Synchronizing Two Islands

The first situation assumes that 2 islands are about to be connected along using the open circuit breaker as illustrated in Figure one. The 2 islands, since they're independent electrical systems, can have totally different frequencies therefore all 3 of the synchronizing variables should be monitored to confirm they're inside acceptable limits before closing the open circuit breaker.

The system operators for the 2 islands can likely got to alter generator MW output levels (or adjust island load magnitudes) in one or each islands to attain the required adjustment in frequencies and section angles. Voltage management instrumentality (reactors, capacitors, etc.) can also be used as necessary to change voltage magnitudes to inside acceptable levels.

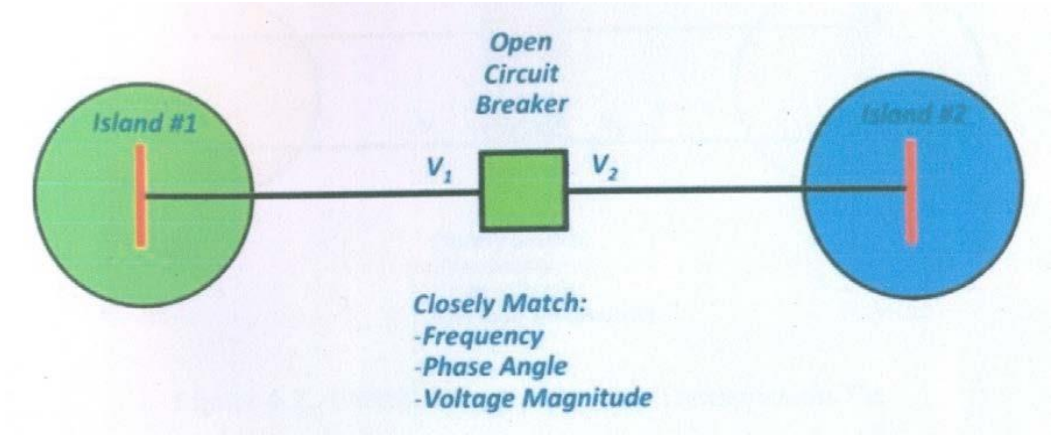

Figure 4.3.1: Synchronizing Two Islands

4.3.2 Establishing the Second Tie

Once the first transmission line is closed interconnecting the 2 islands, the frequency are an equivalent within the 2 areas. Therefore, one in all the 3 synchronizing variables (the frequency) isn't any longer a factor. However, as illustrated in Figure two, the opposite 2 synchronizing variables should still be monitored. Generation and/or voltage management instrumentality could also be to be utilized to make sure the phase angle and voltage magnitude variations are within acceptable limits before closing the second circuit breaker. This method ought to be easier than closing the first transmission line as frequency isnoongora issue.

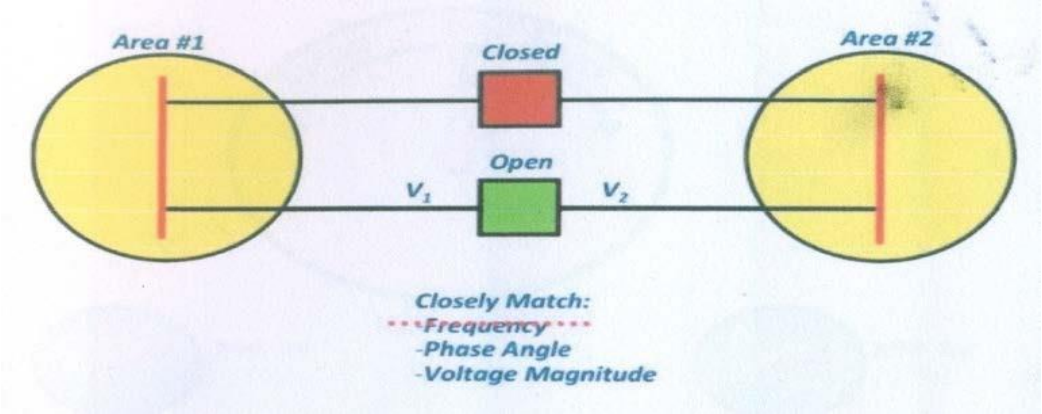

Figure 4.3.2:- Establishing the Second Transmission Tie

4.4 Synchronizing Measuring Equipment

4.4.1 Synchro scope

A synchronizer may be an easy piece of equipment that's used to monitor the 3 synchronizing variables. A basic synchronizer (illustrated in Figure 3) inputs voltage waveforms from the 2 sides of the open circuit breaker. If the voltage waveforms are at a similar frequency, the synchronizer doesn't rotate. If the voltage waveforms are at a unique frequency, the synchronizer rotates in proportion to the frequency difference. The synchronizer needle continuously points to the voltage phase angle difference.

A synchronizer could be a manual device in this an operator should be looking at the "scope" to confirm they shut the circuit breaker at the proper time. The synchronizer is generally mounted above eye level on a "synch panel". The synch panel additionally contains 2 voltmeters so the voltage magnitudes may be simultaneously compared.

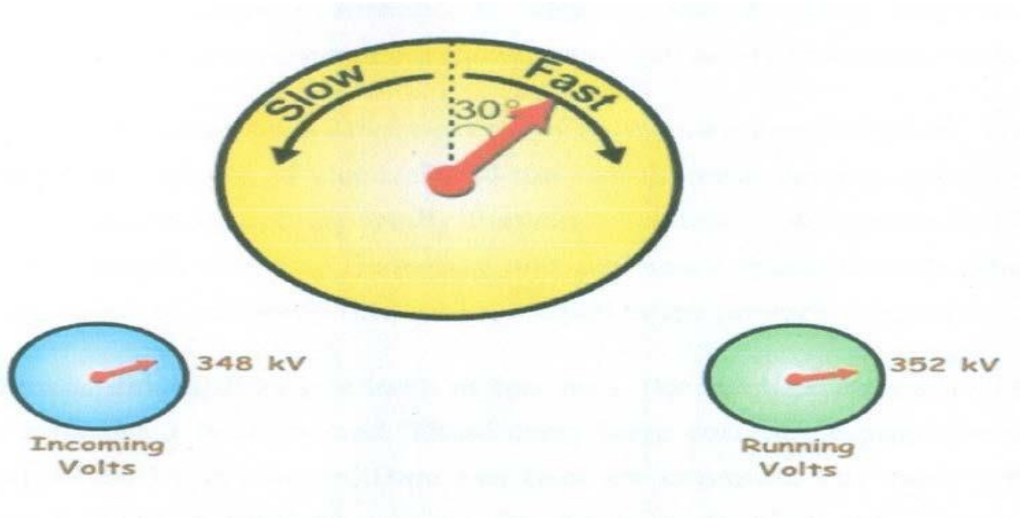

Figure 4.4.1:- Synchro scope in a Synch Panel

4.5 Photovoltaic Systems Monitoring

Monitoring and control of photovoltaic systems is important for reliable functioning and most yield of any solar electrical system. The only observation of an electrical converter is performed by reading values on show - show (usually LCD) is a component of just about every grid-connected electrical converter. Values like PV array power, AC grid power, and PV array current are typically available.

4.6 Electric Switchboard

An electric switchboard may be a device that directs electricity from one source to a different. It's an assembly of panels, every of that contains switches that permit electricity to be redirected. The U.S. National Electrical Code (NEC) defines a switchboard as a large single panel, frame, or assembly of panels on that are mounted, on the face, back, or both, switches, over current and different protecting devices, buses, and typically instruments. The role of a switchboard is to divide the most current provided to the switchboard into smaller currents for additional distribution and

to provide switch, current protection and metering for these numerous currents. In general, switchboards distribute power to transformers, panel boards, management instrumentation, and ultimately to system loads.

The operator is protected from electrocution by safety switches and fuses. There also can be controls for the supply of electricity to the switchboard, returning from a generator or bank of electrical generators, particularly frequency management of AC power and load sharing controls, and gauges showing frequency and maybe a synchronizer. The quantity of power going into a switchboard should equal to the power going resolute the loads.

Inside the switchboard there's a bank of bus bars, flat strips of copper or aluminum, to that the switchgear is connected. These carry large currents through the switchboard, and are supported by insulators. Clean bus bars are common, however many types are currently manufactured with an insulating cover on the bars, leaving connection association points exposed.

4.7 Distribution Board

A distribution board (or panel board) could be a part of an electricity provide system that divides an electric power feed into subsidiary circuits, while providing a protecting fuse or circuit breaker for every circuit, in a common enclosure. Normally, a main switch, and in recent boards, one or additional 'Residual-current devices (RCD) or Residual Current Breakers with Over current protection (RCBO), also will be incorporated.

4.8 Bus bar

In electric power distribution, a bus bar (also spelled bus bar, or generally incorrectly as buss bar or conductor, with the term bus being a contraction of the Latin omnibus - that means for all) could be a strip or bar of copper, brass or aluminum that conducts electricity among a switchboard, distribution board, substation, battery bank or different electrical equipment. Its main purpose is to conduct electricity, to not operate as a structural member.

4.9 Electricity Meter

An electricity meter or energy meter could be a device that measures the quantity of electrical energy consumed by a residence, business, or an electrically powered device.

Electricity meters are usually calibrated in billing units, the foremost common one being the kilowatt hour [kWh]. Periodic readings of electricity meters established billing cycles and energy used throughout a cycle.

Chapter 5

Conclusion and Recommendations

5.1 Conclusion

Electricity is that the basic necessity for the economics of a country. The economic development and also the increase of living standard of people are directly related to the additional use of electricity. Solar energy is connected to the National grid then increase total generation power. So, we study how to connect solar energy to the national grid. That system is extremely complicated however solar source free from price also, there has no environment effect and reliable.

The general trends in the past decade of increasing solar cell efficiency, decreasing PV system prices, increasing government incentive programs, different and several other} other factors have all combined synergistically to reduce the barriers of entry for PV systems to enter the market and expand their contribution to the global energy portfolio. The increase in economic feasibility couldn't come back at a much better time to provide a clean solution for generating energy to meet the quickly rising demand. However, the price procured tapping into the free resource is its intermittent nature and also the problems discovered when integrating the resource into electric power systems. The problems continue to grow as a bigger percent of generation is coming back from renewable sources.

The satisfactory outcomes of the initial solar system performance test indicate the success of the grid-tied solar system development and integration. The system is able to absorb sunlight, apply DC-to-AC energy conversion, and push the AC electricity to the utility grid.

5.2 Recommendation

The following points are worthy of further investigation:

- The proposed operating strategies can be implemented developing and experimental prototype.
- The results of simulation studies can be applied in the practical generation and security analysis of a grid system in which one or more Photovoltaic generation are embedded

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