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SUSTAINABLE POWER MANAGEMENT THROUGH SOLAR INTERGRATION.

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Abstract:

Today, solar energy is being used to power a diverse variety of commercial applications, including solar water heaters and pumps, as well as standalone solar-powered dwellings and structures. As solar cells collect the sun's rays, they may be utilised to generate electricity. Power consumption in our nation is at an all-time high and expected to rise more in the coming days as a consequence of these factors. In order to alleviate the country's power shortfall, this initiative primarily focuses on the conversion of extra solar energy into useful electricity. Solving the problem of power shortages is as simple as converting solar energy into electricity and connecting it to the grid. Solar cells may be used to collect solar energy, which can then be used to create direct current voltage. An IGBT-based three-phase six-pulse inverter will be utilised to convert this direct current power to an alternating current voltage. Signal inverter output signals may include higher order harmonics, which may create interference if they are not removed by filtering. Using a Phase Locked Loop (PLL) base control system, the filtered alternating current voltage may be synchronised with the power grid power grid.

Keywords— Solar cells, Grid, Dc chopper, Phase Locked Loop.

INTRODUCTION

It's because solar energy is such a crucial source of renewable energy that it's divided into two kinds of technologies that are defined by the way they absorb, distribute, or convert solar power into electricity. Despite the fact that both passive and active solar technologies collect and distribute sunlight, active solar technologies convert the sun's rays into electrical currents. Renewable solar energy sources include photovoltaic systems, concentrating solar power systems, and solar water heating systems. Solar energy is the primary source of most of the world's energy, and it comes in numerous forms. Orienting a structure toward the Sun, choosing materials with suitable thermal mass or light dispersion capabilities, and creating regions that circulate air in the surrounding environment are all components of passive solar architecture, which reduces energy demand.

It is the photovoltaic (PV) technology that converts sunlight directly into electricity in the solar energy conversion area. In addition to the fact that this method produces no noise or pollution, it also makes them strong, reliable, and long-lasting in nature. Using photovoltaic (PV) technology, collecting the sun's rays is a simple and elegant technique of doing so.

As a second option, Grid Tie Systems (sometimes referred to as grid tie systems) (also known as grid tie systems)

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Solar photovoltaic (PV) systems that are linked to a utility grid and produce electricity for the grid are known as grid-connected systems. The solar panel, the power conditioning unit, electrical converters, and a grid synchronizer are all incorporated in a grid-connected system. It also has a built-in battery, making it even more convenient to use. However, modest residential roofs are, but larger commercial roofs are not. When everything is running well, it may create a large amount of electricity in addition to being linked to the utility grid. Because the solar power may not be sufficient to meet the customer's needs, the utility company's infrastructure may be necessary to provide the client with electricity. Excess energy may be injected back into the grid via these devices. Using feed-forward, a metre is permanently installed to measure the flow of power. Rooftop systems with a capacity of less than 10 kilowatts that are linked to the grid may meet most users' needs, which can be found in most circumstances. The consumer is responsible for paying the difference between the cost of power consumed and the value of electricity produced, depending on their agreement with their local grid energy supplier. Negative amounts are presented on the screen if the organisation produces more power than it uses.

LITERATURE REVIEW

On-site solar power is provided by two different types of solar panels at this time. A fixed panel is one that is put at a convenient angle depending on the geographical location of the installation site and has a constant tilt angle. The amount of time spent irradiating, on the other hand, is just a little more than six hours every day on average. Revolving solar panels are the second kind of solar panel. They may be configured to either spin at a certain angle at a predetermined interval or to revolve at a predetermined angle and time. Continuous monitoring and pre-programmed procedures are both inefficient, which is a shame since they are effective in certain situations. A high torque is required by a motor working at a very low speed, which in turn requires a big current, which results in an increase in driving power for the vehicle. The system rotates at predetermined small angles while utilising the second strategy, regardless of whether or not the new position contributes to the creation of more energy. In actuality, it is feasible that the recovered energy will be completely absorbed by the driving mechanism, resulting in the reversal of the intended effect.

These two drawbacks have been addressed in this new technique, which is shown in the next section. The use of a microcontroller-based control mechanism in this system allows for the most efficient harvest of solar energy possible. To achieve this, a tracking system known as the PILOT and a rotating system for cells known as the PANEL are built, with the PILOT serving as the primary tracking system. First and foremost, the system is oriented toward the east, where it will stay until the sun rises in the east. When this happens, the PILOT's position in relation to the sun is maintained. This is performed by the use of a light-to-frequency converter (LTF) placed on a tiny electric motor. This converter makes certain that the PILOT is always pointed in the direction of the sun. In addition to light-dependent resistors (LDRs), the PILOT and PANEL are both equipped with light-dependent resistors (LDRs), with one on the PILOT and one on the PANEL. Instantaneously after the completion of each PILOT positioning manoeuvre, the comparison operation begins. Unless the voltage generated by the PILOT LDR is larger than the voltage induced by the PANEL LDR plus a predefined offset, the PANEL moves to a new location and the procedure is performed once more. As a consequence, the PANEL will only go to a new region if the latter creates more energy than the prior one throughout its journey. Towards the conclusion of each day, after the sun has gone down, the system returns to its starting position and waits for the beginning of the following day.

Methodology

Thus, it is conceivable to conclude that the proposed technique maximises solar energy extraction to the greatest extent possible. According to a comparative study, as compared to fixed panels, there is an increase in energy extraction of around 40%. It was discovered via the study process that the optimised system had a major advantage over the continually rotating panel. In actuality, it was revealed that the energy savings on the consumption side accounted for somewhat more than 20% of the overall savings in energy. In peak hours, when the most energy is used, the panel only rotates a few times, making it even more energy efficient in this respect (in the case in hand only three times). In addition, the system's genius lies in the fact that it can be implemented with a single small PILOT that consumes very little current, enabling it to direct thousands of panels with ease. The future of solar energy extraction appears to be extremely promising as a result of significant advances in cell design, which is on the verge of reaching 50 percent efficiency, combined with an optimal panel orientation, such as the one proposed here, and the resulting reduction in energy consumption, to name a few factors.

It is necessary to transform a variable direct current produced by the solar array into a fixed direct current dependent on the solar irradiation received by the cell. The DC-DC chopper is used to convert the fluctuating DC output of the solar cell into a consistent DC quantity that can be utilised by the inverter to ensure that the device operates properly and for an extended period of time. Electronic devices that operate in the active (linear) mode are able to operate at higher power levels because linear regulators are transformed into switching regulators in this mode of operation. Because it requires a voltage or current divider in order to work, it is inefficient owing to the fact that it is limited to output voltages lower than the input voltage and has a poor power density due to the need of a low frequency line transformer, among other factors. It is feasible to get very high energy conversion efficiency by using switching regulators. Therefore, they make use of power electronic switches, which are only capable of switching between two states: on and off. The operational frequency of transformers, filter inductors, and capacitors will be larger than the maximum frequency, which will result in lighter components. Using power electronic semiconductor switches, switching regulators are capable of operating in both the on and the off modes. Electronic switches of the present age have the capability of operating at very high frequencies. The frequency of operation increases according to the size of the operating frequency. Furthermore, when the operating frequency of converters is raised, the dynamic features of the converters become more favourable as well.
A description of the functions of direct current to direct current converters is given below.
The following characteristics are shared by an alternating current to direct current converter.

• The duty cycle ratio is used to assess whether the input DC voltage should be increased or decreased.When faced with fluctuations in load and line variations, it is able to maintain a steady direct current output voltage.In order to lower the threshold voltage ripples on the direct current output voltage, the voltage ripples must be increased to a level that is below it.There is a physical barrier between the source of the input and the load created by this device.

Step-up or boost converter for use in step-up or boost applications

This circuit design includes the following components: an input voltage source (VS), a boost inductor (L), a controlled switch (S), a diode (D), a filter capacitor (C), and a load resistance (R). FIG. 3.1 depicts the circuit diagram of a boost converter, which is presented in the next section. When the switch S is activated at this moment, the current flowing through the boost inductor increases linearly, and the diode D is switched off at the same time. In response to deactivation of the switching device S, the energy stored by the inductor is released via the diode and into the circuit's output RC circuit.

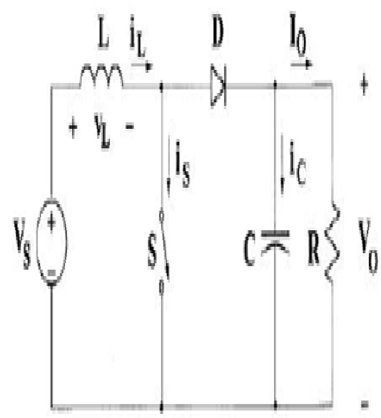

Fig 3.1 Step-up or Boost Converter

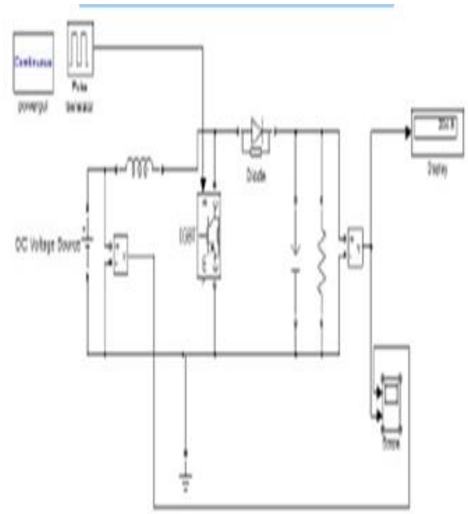

Fig 3.2 Matlab – Simulink circuit for Boost Converter

This particular chopper's function is to step up the constantly fluctuating DC input voltage to a fixed value at the output. The value of the output voltage generated by the switch is determined by the duty cycle of the pulse generator that controls the switch. The boost converter is used in lieu of the Buck-Boost converter, and it is the output voltage of the solar panel that is always less than the voltage required for the system to function properly. When the voltage on the source side is larger than the voltage on the load side, buck converters may be used. The solar panel's output, on the other hand, is never more than the quantity of energy needed by the load it is powering.
Boosters and multipliers that convert between different formats are examples of this.
The switch and pulse generator displayed in Fig. 3.2, as well as the boost converter shown in Fig. 3.2, are all simulated with the help of the Matlab programming language. In this case, a duty cycle of 50 percent may be used to calculate the output for the circuit under consideration. It is possible to calculate the values of the capacitor and inductor for a certain duty cycle, as well as the voltages at the input and output. Adjusting the output voltage of the power supply may be accomplished by adjusting the switching frequency and duty cycle of the power supply. The boost converter's output image is shown in FIG. 3.3, which is a depiction of the picture. As shown in Fig. 2, the configuration of the converter may be changed with the help of the pulse generator, which is displayed further down the page.

Results:

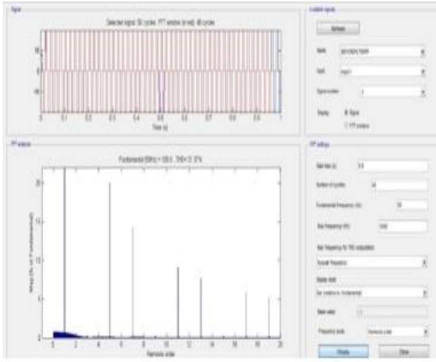

Fig 6.4(a) FFT analysis of the waveform before filter

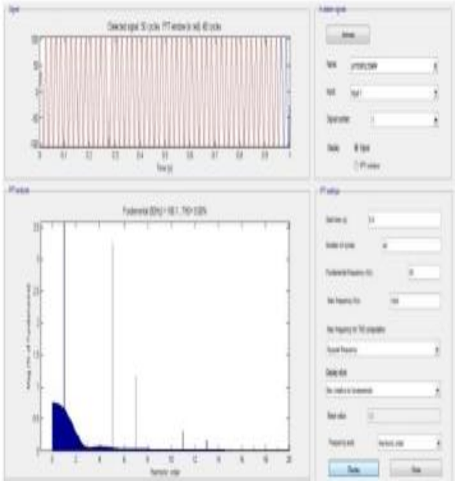

Fig 6.4(b) FFT analysis of the waveform after filter

The direct current (DC) voltage output from the chopper is converted to sinusoidal alternating current (AC) voltage with a power frequency of 50 Hz by means of a six-pulse inverter. When a second order low pass passive filter is used to filter out the harmonic content of the inverter's output, which is high owing to the inverter's high harmonic content, the harmonic content of the output is reduced. Figures 1 and 2 illustrate the FFT analysis of the waveform before and after the filter is applied, respectively. Figure 1 shows the waveform before the filter is applied. The output waveform of the filter is illustrated in Fig. 6.4, which has already been addressed earlier (a&b).

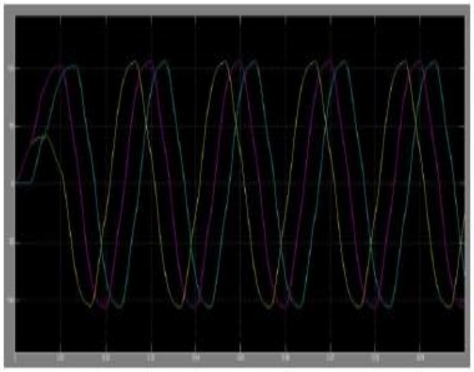

Fig 6.5(a) Output waveform before filter

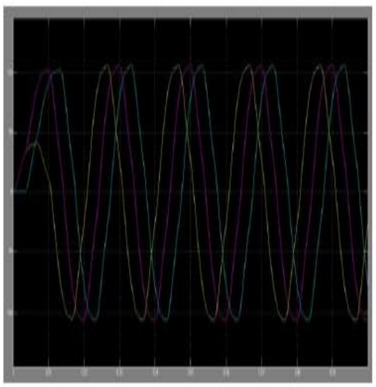

Fig 6.5(b) Output waveform after filter

It is necessary to monitor and synchronise the phases of signals in communications and signal processing systems, and a digital phase lock loop (DPLL) is used to accomplish this purpose. Along with the capacity to synchronise an inverter to the grid, the circuit has the capability of recovering synchronisation and altering the phase, amplitude, or distortion of grid power, among other things. It is possible to get DPLLs in a number of configurations and variants are available. DPLLs are often divided into two categories based on the nature of the sampling procedure: uniform DPLLs and non-uniform DPLLs. Non-uniform digital tan lock loops, as opposed to the uniform kind with a fixed time-delay unit, have quicker initialization times and need fewer circuit components, as shown in the time-delay digital tan lock loop (T-D-DTL) (TDTL). Once the filtering process is completed, the output of the inverter will be pure sinusoidal, and it will be sent into the grid. Before an inverter can be synchronised, the output of the inverter must be compared to the frequency, voltage, and phase of the power grid. It will be necessary to utilise a feedback loop to monitor and manage the synchronisation.

CONCLUSION

Simulations in Simulink are carried out at various levels of irradiance and load in order to model the solar panel in accordance with its specifications, and simulation results are compared with the features of the delivered solar panel. Once a solar panel's output voltage is supplied into a boost DC chopper, it is converted to a DC voltage by the chopper itself. Consistent output is generated regardless of the fluctuation in solar output voltage throughout the daytime because of the DC chopper's duty cycle. There is a resistive load to cope with in an autonomous system that does not have batteries.

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