Implementation of Solar Distribution Grid for Agriculture Resources through MATLAB

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Abstract- *Solar based distributed generators are the most promising renewable energy technology in low voltage grid networks. Distributed generators are installed to supply local customer load demand as main purpose with a permanent percent power level of connected transformer. Load patterns show variation according to location and utilization habit of the customers such as residential, industrial, agricultural watering purpose. Farmers have the tradition of being stewards of the land, and their investment in renewable energy supports their role of protecting the land, air, and water. Solar energy, like other renewable, offers an opportunity to stabilize energy costs, decrease pollution and green house Gases (GHGs) and delay the need for electric grid infrastructure improvements. Solar energy systems have low maintenance costs, and the fuel is free once the higher initial cost of the system is recovered through subsidies and energy savings (from reduced or avoided energy costs).For many agricultural needs, solar energy. Provides a good alternative. Modern, well-designed, simple-to-maintain, and cost-effective solar systems can provide energy that is needed when and where it is needed. In this paper we have implemented this technique by distributing the power to the fields and the controlling is done using MATLAB software.*

Key Words: SolarPanels-Microcontroller-Microprocessor-Distributionsystems- Agricultural Resources-MATLAB

1.INTRODUCTION

Energy is playing an important role in human and economic development. But this energy, which is primarily available in the form of coal, lignite, oil, natural gas, biomass, hydrates, water...etc are rapidly depleting due to fast industrial growth and rapid growth in population. So there is a need for looking into alternate sources of energy. Research on renewable energies have been initiated first for wind power and then for solar power. So by solar energy, we can generate constant power at all times and helps to fill the energy gap at all times solar energy is genesis for all forms of energy. This energy can be made use of in two ways the Thermal route i.e. using heat for drying, heating, cooking or generation of electricity or through the Photo route which converts solar energy in to electricity that can be used for a myriad purposes such as lighting, pumping and generation of electricity. With its pollution free nature, virtually inexhaustible supply and global distribution- solar energy is

very attractive energy resource. Solar Energy can be utilized for varied applications. So the answer to "Why Solar" question can be sought from two different perspectives: utilizing solar energy for grid-interactive and off-grid (including captive) power generation.

A grid-connected photovoltaic power system or grid-connected PV power system[1] is an electricity generating solar PV power system that is connected to the utility grid. A grid-connected PV system consists of solar panels,one or several inverters, a power conditioning unit and grid connection equipment. They range from small residential and commercial rooftop systems to large utility-scale solar power stations. Unlike stand-alone power systems, a grid-connected system rarely includes an integrated battery solution, as they are still very expensive. When conditions are right, the grid-connected PV system supplies the excess power, beyond consumption by the connected load, to the utility grid. Grid interconnection of PV power generation system has the advantage of more effective utilization of generated power. However, the technical requirements from both the utility power system grid side and the PV system side need to be satisfied to ensure the safety of the PV installer and the reliability of the utility grid. Clarifying the technical requirements for grid interconnection and solving the problems such as islanding detection, harmonic distortion requirements and electromagnetic interference are therefore very important issues for widespread application of PV systems. This paper relates the solar grid distribution for agricultural resources and sharing of electricity between agricultural fields using simulation.

2. EXISTING METHODS

2.1 Common Method of Power Supply to Agriculture:

The common practice of power supply is through overhead transmission lines from the power stations. High voltage overhead conductors are covered by insulation. The conductor material is nearly always an Aluminum alloy, made into several strands and possible reinforced with steel strands. Copper was sometimes used for overhead transmission but aluminum is lighter, yields only marginal reduced performance and costs much less. Overhead conductors are a commodity supplied by several companies worldwide. Improved conductor materials and shapes are regularly used to allow increased capacity and modernize

transmission circuits. Thicker wires would lead to a relatively small increase in capacity due to the skin effect because of this current limitation multiple parallel cables are used for higher capacity needed. Bundle conductors are also used at higher voltages to reduce energy loss caused by corona discharge. Overhead power lines on farms pose a serious risk to farmers, contractors and anyone in the vicinity of high machinery passing close to these lines. Several people have been killed and many more injured as result of making contact, or near contact, with overhead electricity lines during agricultural work.

2.2 Distributed solar power plant and a method of its connection to the existing power grid

Methods and apparatus are provided for using a renewable source of energy such as solar, wind, or geothermal energy. In some embodiments, the method may include generating electric energy from a renewable form of energy at a plurality of locations at which reside an electric power line associated with an electric power grid. The electric energy generated at each location may be transferred to the electric power line to thereby supply electric energy to the electric power grid.

3. PROBLEM STATEMENT:

Power based water pumps cannot be relied on as in India we have huge electricity shortage. Farmers don't get electricity at the time it is required. Sometimes electricity comes during night time and sometimes they don't get it at all. So for them also switching to solar is beneficialTarunKapoor, Joint Secretary, Ministry of New and Renewable Energy and the in charge of the solar programme says."Switching to solar is easy, pumps are already there. You just need to install the PV system and switch to solar. We have different types of pumps for example of 5 HP and 3HP" he further adds. And because solar pumps will save a lot of electricity, it can be be used for other purposes and villages will get more electricity. Pumping water is a universal need around the world and the use of photovoltaic [2] power is increasing for this application. PV powered pumping systems offer simplicity, reliability, and low maintenance for a broad range of applications between hand pumps and large generator driven irrigation pumps. The solar PV powered water-pumping system (DC Surface suction, DC floating, and DC or AC submersibles) can offer a veritable panacea to the problem of finding power to pump water for irrigation in India. Typical pump systems in India are of the DC surface suction type (approximately 86% of solar pumping systems installed in India), DC submersible type (2%), DC floating type (2%), and AC submersible (10%). The system for solar pumping depends on the nature of the well: deep well, bore well, open well etc.

The problems with the grid-powered pumping systems are:

•   Demand for electrical energy far outstrips supply, and the gap continues to widen

•   It is proving increasingly difficult for the government to continue subsidizing the rising costs of generation, transmission and distribution losses, pilferage, etc (to deliver 3600 kWh to a farmer to pump water, 7000 kWh is required to be generated, assuming a diversity factor 2). The loss of revenue to the government is colossal.

•   The capital cost to the government to provide an electrical connection for a single pump-set of 3 hp capacity (sufficient for 2 hectares) is estimated at Rs 1.37 lakh by Andhra Pradesh Transco (2002 figures)

•   The costs and tariffs of electricity continue to rise – the marginal farmer is unable to pay for the electricity)

The photovoltaic [3] (PV) solar panels are semiconductor devices which convert the solar illumination power direct to electricity and their operational characteristics depend on incident sun light (insulation) level and the surface temperature that developed on the cell surface as the insulation, ambient temperature and current flow varies. But facing all benefits of (PV) panels as a source of electrical energy in photo voltaic [8] systems, still there are some drawbacks limiting their use at large scale such as low conversion efficiency of the cell and the high initial cost. Beside this and due to the non-linearity characteristics of the solar cell, (PV) systems need to be tracked at maximum power point (MPPT) to obtain maximum power extraction in certain conditions such as sun light, load, and surface temperature. For the above reason an analogue or digital circuit known as maximum power point tracker (MPPT) is developed and interfaced between the (PV)panel and the load. The System forces the system operating point towards the (MPP) under all varying operating conditions.

In general, the (PV) energy conversion systems of medium and large sizes incorporate three possible approaches of maximizing power extraction. These approaches are sun tracking and (MPPT) or both, however, it is only possible/ feasible to implement (MPPT) for small size systems.

The V-I characteristics of a (PV varies drastically with solar insolation (Light intensity) and the surface temperature) panel are highly non-linear and. It can be noticed that (PV) panel gives maximum power P_{max} at a particular voltage and current where the power P = VI is maximum at different operational condition of the characteristics curve. For maximum output power, the internal resistance of the (PV) panel becomes equal the load resistance. The DC/DC step down converter normally achieves the purpose.

4. THE SOLAR RESOURCE ASSESSMENT

The sun commonly referred to as "a ball of fire in the sky" is the source of solar and all energy on the earth's surface. It is composed of a mixture of gases with a predominance of hydrogen gas. As it converts hydrogen to helium in a massive thermonuclear fusion reaction, mass is converted to energy according to Albert Einstein's formula; $E = mc^2$ As a result of this reaction, the surface of the sun is maintained at a temperature of approximately 5800 degrees Kelvin or 5526.85^0 C. This energy is radiated away uniformly in all directions in close agreement with Planks blackbody radiation formula. The energy density per unit area, $E(\lambda)$, as a function of wavelength, λ, is given by

$$E(\lambda, T) = \frac{2hc^2}{\lambda^5} * \frac{1}{e^{\left(\frac{hc}{\lambda kT}\right)} - 1}$$

h = Planck's constant = $6.626 * 10^{-34} J * s$
c = speed of light = $2.997925 * 10^8 m / sec$
λ = wavelength (m)
k = Boltzmann's constant = $1.381 * 10^{-23} J/K$
T = temperature (K)

In one hour, the earth receives enough energy from the sun to meet its energy needs for a whole year for a long time, man depended on the sun for drying and heating until the petroleum discovery in mid nineteenth century diverted the global energy demand source to overreliance on fossil fuels. The sun radiates solar energy on the earth surface as the earth moves on its own axis and revolves round the sun on an elliptical orbit. This phenomenon makes the suns radiation reaching the earth's surface to vary as the earth moves around the sun. Due to this phenomenon, the parts of the earth nearest to the equator receive more solar energy than parts far from the equator. This phenomenon also supports the reason why there are longer days and nights depending on one's location on the earth and time of the year. The solar energy reaching a solar PV array on the earth surface consists of the main beam which is direct radiation, the diffused beam which is direct radiation affected by atmospheric absorption and the ground reflected beam which is as a result of reflection of the direct beam from the earth surface .

It means that not all the radiation that is released by the sun will reach the solar PV array surface placed on the earth. This makes the orientation of the solar PV array very important for energy absorption. The orientation of the Solar PV array has two major parameters; the slope and the azimuth. The slope is the angle of tilt with reference to the ground horizontal surface and the azimuth is the direction towards which the array surface face. When a solar PV array is installed south of the equator, azimuth is due north and when installed north of the equator, azimuth is due south. The azimuth can be due south or due north depending on the latitude of the site or location on the earth's surface. At noon every day, the sun rays are perpendicular to the earth surface on the equator and give maximum radiation. Any other time of the day, the position of the sun is affected by the latitude, longitude, time of the day and day of the year. The angle formed between the plane of the equator and a line drawn from the center of the earth is called the solar declination angle denoted by δ. The angle of declination is expressed in equation as;

$$\delta = -23.44° \cos\left[\frac{360}{365}(N + 10)\right]$$ --------(1)

Where N is the day of the year and January 1st is day one of the year.

Holding the earth stationary, the time of the day affects the location of the sun in the sky, and this effect is described by an hour angle. The hour angle is calculated as;

$$W=(Ts-12).15°/hr$$ ---------------- (2)

Where Ts is the solar time in hours the value of Ts is 12 hours at solar noon. y an hour angle. It is obtained from the fact that the sun moves across the sky at a speed of 15 degrees per hour. Most solar PV system designers assume that all time dependent data; such as solar radiation and electric load, are specified in civil time, which is also referred to as local standard time of the location. The relationship between solar time and standard time is given in the following equation

$$T_S=T_C+(\lambda/15^0/hr)-Z_C+E$$ ---------------- (3)

Where Tc is the local standard time corresponding to the midpoint of the time step in hourλ is the longitude in degrees, ZC is the time zone in hours east of Greenwich Mean Time (GMT),

E is the eccentric anomaly of the sun due to earth obliquity, currently the earth's tilt is 23.44^0.

The Equations 3.3 and 3.4 mean that the sun covers 15^0 every one hour so when a solar PV array is tilted 15^0after every hour, the array will remain almost perpendicular to the sun and a near maximum power output can be achieved.

4.1 Solar Photovoltaic Array Output

Solar photovoltaic array [4] output is the power output of the solar PV array that will be delivered to the designed solar PV system. Normally the power that is delivered by the solar PV array is lower than its rated capacity [7] because of the effect of the derating factors mainly due to temperature and irradiance. The power output of a solar PV array can be expressed as

$$P_{pv}=Y_{pv}f_{pv}(G_t/G_{t,STC})[1+ \alpha_p(T_c-T_{c,STC})]$$ ----------- (4)

Where,Ppv - Power output of solar PV array

Ypv - Rated capacity of the PV array under STC [kW]

fpv - PV derating factor [%]

Gt - Solar radiation incident on the PV array [kW/m2]

Gt,STC - Incident radiation at STC [1 kW/m2]

α_p= Temperature coefficient of power [%/0C]

Tc - PV cell temperature [0C]

Tc,STC - PV cell temperature under STC [250C].

5. PROPOSED TECHNIQUE:

So, In view of all the above problems with traditional approaches we came here with Microcontroller ArduinoUno Interfacing with MATLAB, design of the system is easy and cost effective. And can be implemented to Real Time Environment that is to the Grid system. In our solar power distribution paper, Arduino Uno micro-controller has been used. A Solid state relay is used as a switching device which acts as a switch between the loads and using this we can distribute the power to the loads available. MATLAB is used as a tool here to control the micro controller and the relay circuit. Hence from our pc we control the operations of the relay circuit and the microcontroller. Attempts have been made to make this pilot paper cost-effective with successful completion for standalone systems and can be expanded further for grid connectivity where real time monitoring system is done by using serial communication where time to time alerts will be sent to server room.

The solar powered feeder approach could also be compared with the existing conventional grid supply. Cost of power up to agriculture feeder is about ₹4/kWh after considering cost of generation and losses while solar power costs ₹6/kWh. Efficient pumps, if integrated into this solar feeder scheme, can bring down the effective cost of solar power for agriculture by about 25 per cent (after accounting for cost of new pumps, which can reduce power requirement by 30-50 per cent). Considering the fixed cost of solar generation (over 20-25 years) and the increasing cost of grid supply, an integrated solar powered feeder with efficient pumps would be cheaper than grid supply in just 5-6 years. This will have added benefits of reliable and better quality (rated voltage) power, leading to lower pump burn-outs.

5.1 Cost Analysis:

With the cost of solar photovoltaic [5] cells falling prices dropped by 50% last year and are now a quarter of what they were in 2008   renewable energy advocates say India is ripe for a solar-power revolution. And it could use it. More than 40% of the countryside is still not connected to the national power grid, and a 2010 report by the National Renewable Energy Laboratory in the U.S. said power demand in India trails supply by 12.7%. Closing this gap "will be critical for India to achieve its growth targets," the report said. Failure to meet that unsatisfied demand could hamper India's growth, the World Economic Forum (WEF) said in a recent report.

A significantly more cost-effective, socially equitable and easier to manage alternative is possible, where agricultural feeder separation has taken place. The ministry of renewable energy (MNRE) has recently announced a new proposal for unemployed youth and farmers wherein 10 GW of grid connected tail-end solar PV plants (0.5-5 MW) will be connected to the distribution substation. Power from these papers would be bought by the distribution company at the rate decided by the State electricity regulator. MNRE is willing to contribute ₹0.5 crore/MW (8 per cent of the capital cost), provided the State sets up a committee and institutes a policy for transparent selection and allocation of papers.
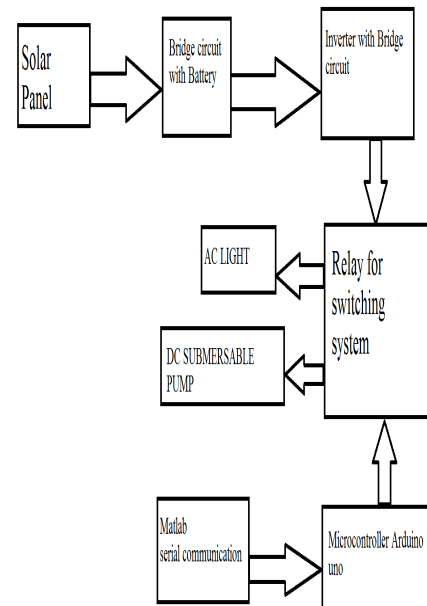
BLOCK DIAGRAM

Fig:1 Block Diagram of Proposed technique

In this paper, first the solar energy received by the solar panel (PCPV3) is converted into the Electrical energy, i.e. DC power. The connection is given from the panel output to the 9V batteries through the Diode (IN4007) to avoid the bi directional flow of current, i.e. to allow electric current to flow in one direction from panel to batteries. This enables the batteries to charge when our kit is kept in sunlight. After charging these batteries are connected to the DC Submersible pumps through the ARDUINO Uno Micro controller and followed by Solid state Relay Driver circuit. Other load we are using in this paper is an AC light. Since it is an AC load, we have installed the inverter[2] (Pulse width Modulated) circuit with its own dedicated battery. Another connection from the diode is given to a battery and from it through the TRIACS we gave connection to the inverter

circuit. As the inverter converts the DC obtained from the battery into AC it is sent to a step up Center tapped Transformer. From then it is connected to the Arduino Uno microcontroller followed by a Solid state Relay driver circuit. Solid state relay driver we used is 3 module one. That is, each module acts as a switch to the respective loads.

The Arduino Uno micro controller is interfaced with PC and it is controlled using the MATLAB software. The program is written in MATLAB in Graphic User Interface so that by just clicking on the commands we can operate and control the loads we are using in the kit. For example when we click on the command "Pump ON" so this command sends signal to the relay driver associated with the submersible pump through the Arduino micro controller and enables the switch to close. Then the current flows to the pump and it works. If we want to turn off the pump we click on "Pump OFF" command which sends signal to the respective relay driver through the Arduino board and commands it to open the switch so that the pump will be turned off.

Like this the AC light is also operated. We can operate all the loads at a time, i.e. both the subsystem loads and the shared loads. The operation and control of the loads is very simple through the PC and can be operated by sitting at our homes by implementing the wireless techniques such as Zigbee transmission. This allows the owner to get complete hold on his power. By using this paper as base we can develop some more papers related to the power sharing and there's a wide scope of business in the future.

5.2 Main Idea Description:

The master input to the proposed technique is solar panel. As per the principle of solar energy ,electricity is generated from the pvpanel.The output of the solar panel is given to a storage device through a mediator called unidirectional diode which allows the flow of current in only one direction.The output of the battery is given to the relay through an inverting bridge circuit

Another input is given through MATLAB [8] to the microcontroller (Arduinouno) using a serial communication. The arduinouno will start switching the relay i.e., when the relay is normally open (NO) the supply starts switching and as a result the DC submergible pumps will be driven, and by inverting it an AC bulb can also be lighten. Therefore microcontroller output is only used to trigger the relay but not the loads given.

By using MATLAB we can analyse the power usage and can also share the electricity generated in one field to another field by connecting it to the grid .This will be very helpful to supply power for agriculture resources in remote areas where continuity of electricity is not possible

Technical Specifications:

Table 1: Technical specifications of the kit

S.no	Element	Specification
1	Solar panel	PCPV3
2	Diode	IN4007
3	Battery	6,9V
4	Triac	BT136
5	Pumps	DC Submergible
6	Light	AC,5W
7	Micro controller	Atmega 328 P

6.RESULTS:

The loads connected to solar grid in this paper are considered as field-1 and field-2 in which field-1 consists of a DC submergible pump and field-2 consists of a DC submergible pump and 5W Bulb. The supply between these two fields can be controlled using MATLAB i.e., a command from MATLAB is dumped into the Arduino Uno and it performs the sharing task which can be observed from a controlling tab appeared on user's pc.
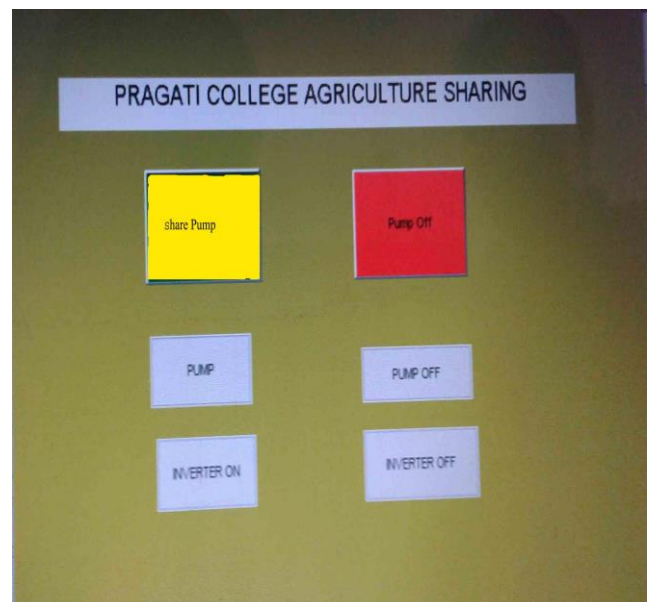

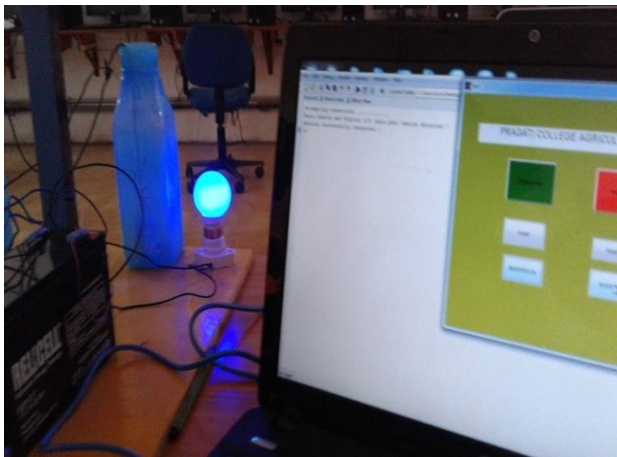**Fig 2.Command window to control the sharing of supply between two fields**

Fig 3: Sharing Electricity to Field-2

Table 2: Tabular representation of result for kit

Input	Sub system	Sharing
111	ON	ON
100	ON	OFF
011	OFF	ON
000	OFF	OFF

The logical state 111 corresponds to the switching on the all loads, i.e. pump, sharing field pump and light. This makes all the loads to turn on. The logical state 100 corresponds to the condition where pump will be turned on while the rest of the loads are in off state. The logical state 011 corresponds to the condition where the pump will be in off state while the rest of the loads are in on state. The logical state 000 corresponds to the state where all the loads are in off state. The whole operation and control is done through the MATLAB installed in our PC. In MATLAB [9], type GUIDE(Graphical User Interface Development Environment), press Enter and click on OK. Then click on file-Preference, in that select push button and drag it into the window. Double click on that button and enter "Pump On". Add another button adjacent to this and name it as "pump off".

Since we are using two |DC submersible pumps, drag another button to the window and name it as " share Pump" then add another button and name it as " pump off" place it adjacent to it. Now add two buttons and name them as "Inverter on" and "Inverter off"which Turns on/off the AC light.

Then add the pumps and AC light to the window and make the connections according to what we have designed in schematic diagram. Connect the Ardunio board in our kit to the pc through the Serial communication cable. Then by clicking on Run the whole program will be ran, recognizes the Arduino board .This displays the command window

comprises of all the above buttons. By clicking on that buttons we can operate and control the loads.

Solid state relay driver we used is 3 module one. That is, each module acts as a switch to the respective loads. The Arduino Uno micro controller is interfaced with PC and it is controlled using the MATLAB software. The program is written in MATLAB in Graphic User Interface so that by just clicking on the commands we can operate and control the loads we are using in the kit. For example when we click on the command "Pump ON" so this command sends signal to the relay driver associated with the submersible pump through the Arduino micro controller and enables the switch to close. Then the current flows to the pump and it works. If we want to turn off the pump we click on "Pump OFF" command which sends signal to the respective relay driver through the Arduino board and commands it to open the switch so that the pump will be turned off.

Like this the AC light is also operated. We can operate all the loads at a time, i.e. both the subsystem loads and the shared loads. The operation and control of the loads is very simple through the PC and can be operated by sitting at our homes by implementing the wireless techniques such as Zigbee transmission. This allows the owner to get complete hold on his power. By using this paper as base we can develop some more papers related to the power sharing and there's a wide scope of business in the future.

7. CONCLUSION:

As per the geographical location of the country, India stands to its benefit and has tremendous scope of generating solar energy. Solar Power Generation alone can cater more than 60-65% of our entire need of power. Apart from above, we also have to focus on Roof Top Solar Energy Generation that may cut down our need to more than 50% need of every house hold.

With the growing world population and thus increasing demand and the need for resource depleting intelligent and efficient in our energy consumption has to have become an imperative. Implementation of the solar grid concept would go a long way in solving many of today's energy issues and problems for agricultural fields. The entire network needs to be improved to meet the requirements, i.e., transmission and distribution level requirements. Research continues to find to make all the desired properties possible the optimal solution and new technologies. Through the use of solar grid technology, energy can be used up to and would not be wasted. This technology also helps to save the earth from global warming. By implementing this concept in agricultural fields we can sort out the problem of electricity crisis and one can also be benefited by sharing this electricity to their respective state boards.

8. FUTURE SCOPE:

Nowadays, many farmers around the world have started implementing solar technologies on their farms. Solar PV and solar thermal technologies can be used in a wide range of applications, when it comes to the farming sector its application is **water pumping.** By interfacing MATLAB to the solar panel and grid it can be used not only for power sharing but also for the automation and controlling of water pumps in the agricultural fields. In fact, solar panels can be used to power an irrigation pump which can then be used to pump water for livestock**. Solar dehydrators** are another type of solar technology that is used in the agriculture industry. Using solar radiation to dry grain and crops is one of the oldest applications of solar energy. Solar dehydrators can dry crops faster than leaving them under the sun after harvest.

This concept can also be further extended to few renewable resources like wind, etc. so that one can generate electricity on their own and can also control and analyse their grid or implemented equipment using MATLAB

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