

## A Survey: Energy Harvesting For Low Power Application By Solar Energy

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**Abstract:** In today's world we are facing various issues regarding energy. In some places plenty of energy is available still they doesn't have the proper techniques to conserve that energy for greater efficiency. There are various form available for generation of electricity. Those forms are conventional and may harm most to the environment. In our primary and secondary studies we have studied that energy can be generated by basically two types' conventional type and non-conventional type. The main objective is non-conventional generation. Many of us knows that we can generate plenty amount of energy through non-conventional sources. But we all know that generating energy through the non-conventional sources is very expensive. So we are not going to generate any energy from non-conventional, we are going to harvest an energy from it. The basic difference between harvesting and generating is that in generation we generate comparatively large amount of energy for supplying the overall utility (Household load/ Commercial loads) and in the harvesting we uses the energy which is having no any use. Waste energy in case of solar is that rays coming from window/ reflected rays from mirror etc. Basically there are different types of harvesting modules available in the market. In our module we are going to use a supercapacitor. Now we all know that the cost of supercapacitor is very high compared to batteries but for saving the cost we are going to use the combination of small size of supercapacitor.

**Keywords:** Conventional type, Harvesting, non-conventional type, supercapacitor, waste energy

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### I. Introduction

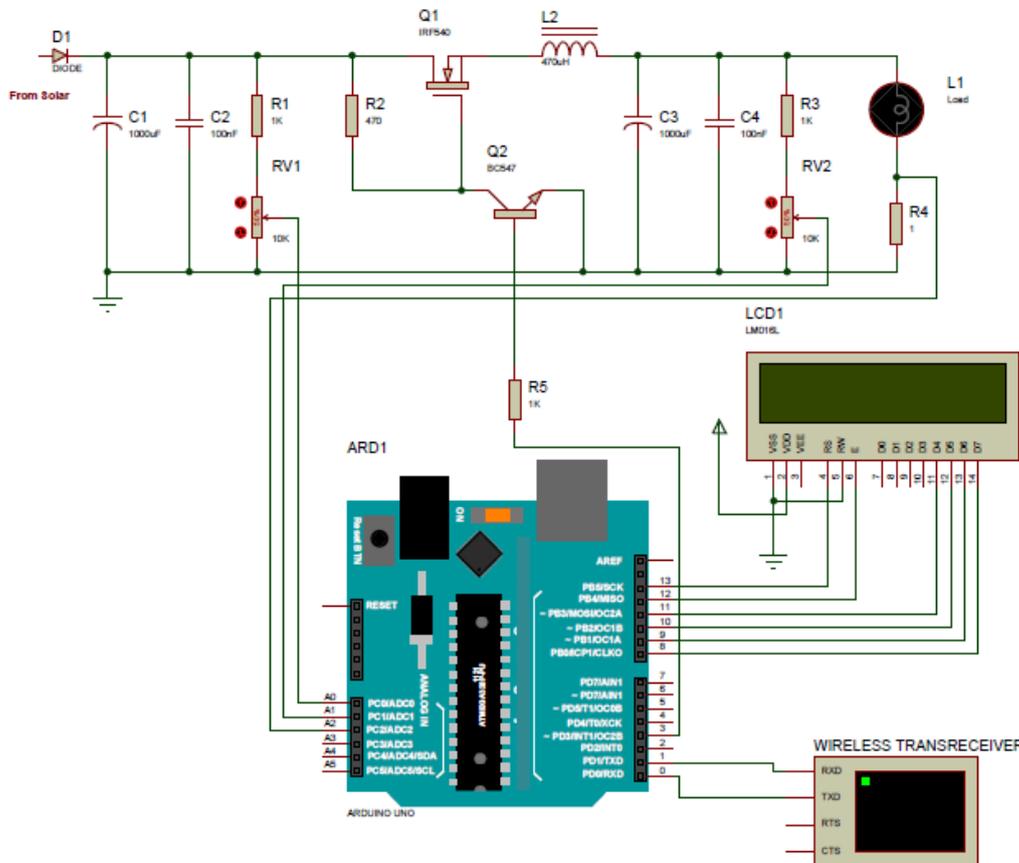
In recent years the use of non-conventional system are in the developing criteria. There are many industries available in the market who motivates public for use of non-conventional systems. Use for solar energy, wind energy is now developing. As we basically knows that for generation of energy from wind we have to use turbine which is very expensive. And generating energy from solar we have to use the solar panel the cost of panel are not that much high but for generating high amount of power we must require large numbers of panel in combination. In this system we are only harvesting the power which is obviously very less but it can be you use for many low power devices like different sensors, controllers, actuators. Main advantage of this harvesting system is that the size is very small and it is not complex to understand anyone can easily understand how the overall system works [3]. For generation from solar energy the main component is a charge controller. Charge controller is nothing but the device which maintains the charging charge in a particular region. There are two types of charge controllers available in the market which uses for solar generation one is PWM (Pulse Width Modulation) and another one is MPPT (Maximum Power Point Tracking). Both controllers adjust their charging rates which is dependent on battery charging level which is much closer to the battery maximum capacity.

For solar harvesting the MPPT (Maximum Power Point Tracker) is used [9]. MPPT works on the basic principle of maintaining the power input at its highest point so that we can generate more amount of energy. Basically harvesting is used for low consumption modules for examples different sensors, actuators, controllers, signaling systems. In this project we are going to generate very less amount of energy but that energy is suitable for the low power consumption modules and systems [1]. The energy which we are getting from the solar is further stored into the storage systems. In general there are two types of storage technologies which are commonly used one is battery and another capacitor (ultra/super capacitor). Basically Li-ion batteries are used for this type of projects. The charging and discharging cycles in batteries are very slow compared to super capacitors. Batteries can be degrade overtime (aging effect) also its chemical components inside the cage may also degrade overtime. Resulting to this conditions the batteries may face the problem of low power density and cause of this it may possible that their ability to retain the energy also degrade. So studying all these things the battery is not an efficient for low power modules as it having various problems in charging discharging cycles. After seeing this about batteries lets now see the introduction about the supercapacitor. [6]

In the supercapacitor the energy which is stored is in the form of electrostatically on the surface of the material used. Supercapacitor does not face any chemical reactions. The main advantage of the supercapacitor is

that it has very high charging and discharging cycles without losing their storage abilities. Cause of this the charging time of supercapacitor is very quick. In this project we are going to use the combination of small supercapacitor so that cost can be saved. For demo purposes we are generating very less amount of power and for that we using combination of two 2.7 V Supercapacitors.

## II. System Architecture:



**Fig.1** system architecture

Above fig shows the system architecture. We are using basic arduino circuit. This is nothing but the circuit board where we can easily install various types of circuit which can be further used for implementation.

## III. Arduino

**Arduino Board:** The arduino board is a microcontroller board which is based on ATmega 328. This board has 14 digital input/output pins (in this 6 can be used as PWM output), 6 analog input, 16 MHz crystal oscillator, and reset button. Arduino has everything which is needed for microcontroller connection with the computer with the help of USB cable or for power supply with AC to DC adapter or battery to get this thing started. The UNO differs from all preceding boards in that it does not use any FTDI USB to serial driver chip. [7]“Uno” is nothing but the Italian word which marks the upcoming release of arduino 1.0. The Uno and the arduino are the reference versions for the development of arduino for moving forward. The Uno is the latest in the series of USB Arduino boards & the reference model for arduino platform for development. Arduino is computer hardware and Software Company which designs and manufactures different types of interactive objects that used for controlling and sensing the actual processes in the physical word. [7] Arduino board is used for varieties of microprocessor and microcontroller. The board are equipped with sets of digital and analog inputs and outputs pins that can easily interface with various expansion board and many more other circuit boards. The Arduino board allows and features the serial communication interface which further include the universal serial bus (USB) on some sort of module, which are used for loading program files from computer or laptops ( Personal Computer). The microcontroller used in the system are basically programmed by using a Dialect of feature from C and C++. [7]

### **III. Processes**

Every system has its own way to give the output of any input that way is called as Processes. Processes can be like practical processes or theoretical processes. It is nothing but a way on which your whole system operates. In any energy harvesting systems there are certain processes which are similar with respect to any of the source. Mainly it has following types of processes like collecting input, filtering/recreating and obtaining an output. Focusing this there are also similar process which are used for Solar harvesting too.

- 1) Collecting the input (Collection of Solar)
- 2) Filtering and generating (Improvising the quality)
- 3) Communicating (Display/trans-receiver)

Above processes are nothing but the flow of Solar Harvesting. Now let's see the detailed prospective of each

#### **{1} Collecting the Input:**

The collecting process in the solar harvesting is carried out by the means of solar panel. As we all know that this is an energy harvesting not generating so we does not required any large size of panel. Any small size of solar panel is suitable for this project. There are different types of solar panels which are used for generating power. [2]

Following are the main types of solar panels that are used.

##### **1) Crystalline Silicon**

- a. Monocrystalline type
- b. Polycrystalline type

##### **2) Thin film solar cell**

Let us see all these types of solar panel in brief

##### **1) Crystalline silicon:**

This is the most basic and commonly used type of solar panel construction. Almost 80-90% of solar panels are based on the silicon variation for implementing the panel. The crystalline silicon basically has two types one is Monocrystalline and another one is Polycrystalline type. This types can be distinguished by their construction and silicon structure used.

##### **a. Monocrystalline type:**

This type of construction is also called as single crystalline silicon. This type of solar panel can be easily identify just by seeing. It have even color & uniform look. This type of panel has main advantage that the purity of silicon is very high. Image shown below is the monocrystalline type solar panel.

This type of solar panel constructed by ingots of silicon which are shaped into cylindrical form. For lower cost and performance the monocrystalline type is optimized by cut out from four side of cylindrical ingots to make the better silicon wafer. This four side cutout from cylindrical ingots gives this type of panel a better characterized look [4].

##### **b. Polycrystalline silicon:**

The overall things used in polycrystalline is similar as monocrystalline construction. The only difference between poly and mono is that it does not required to satisfy the Czochralski process. The Czochralski process is nothing but a method of crystal growth used to get the single crystal of semiconductor.

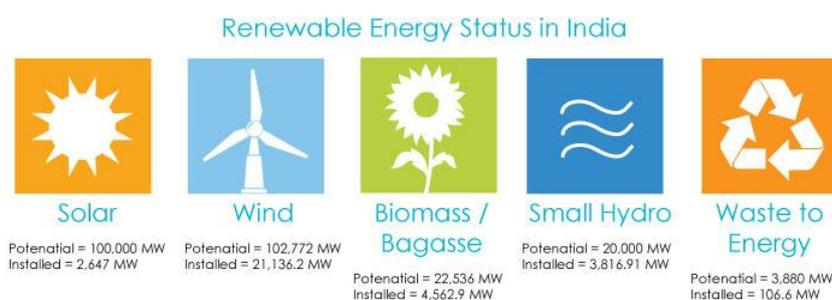
This type of solar panel is commonly used for various processes.

##### **2) Thin film solar cells (TFSC):**

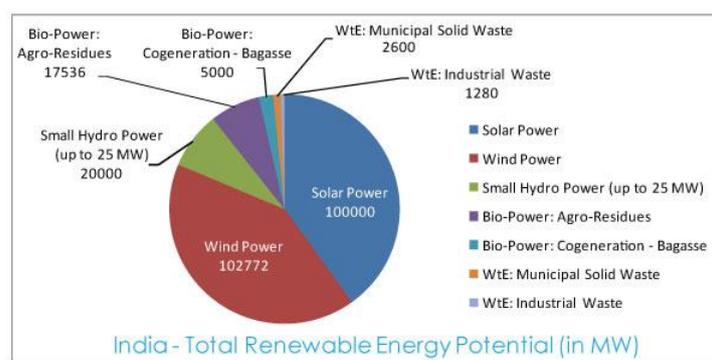
This types of cells are works on very simple principle that depositing one or more than one thin layer of photovoltaic material on to the substrate to form a structure. This is also known as thin film photovoltaic cell (TFPV).

This type of cell looks so decent and uniform as compared to all the type.

{2} Filtering and generating (Improvising the quality):



Expected Indian RE Market Size by 2022 = US\$ 83.35 billion



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Fig.9 status of renewable energies in India

Filtering of any generation is very important from the application point of view. For filtering of solar energy firstly we have to maintain its range in a permissible limit. For solar generation we are using MPPT for this function MPPT is nothing but maximum power point tracking which tracks the maximum amount of solar energy that gives superior charging current [6].

MPPT is nothing but a basic type of converter which is also called as DC-DC converter. It is an electronic tracking or we can say digital tracking. Main working function of MPPT is that it observe the output coming from the solar panel and compare it with the voltage of battery [9]. After this MPPT analyze the best power that can put out to charge the battery. This power is further converts into the high AMPs into the battery. This will maintain the overall voltage across battery equal. Modern type of MPPT have highest efficiency of 93%-98% [1].

Value	Description	min	max
$V_{solar}$	Solar panel voltage	6 V	25 V
$I_{solar}$	Solar panel current	5 mA	2.5 A
$P_{solar}$	Input solar power to the system	0.1 W	15 W
$V_{MPP}$	Max. power point voltage of the solar panel	6 V	20 V
$V_{SC}$	Supercapacitor block voltage	3.6 V	25 V
$I_{SCin}$	Charging current of the sup. block	0 A	4 A
$I_{SCout}$	Discharging current of the sup. block	4 mA	3 A

Table.1 Minimum and maximum values.

Above table shows the minimum and maximum values on which the system is going to operate. MPPT is DC-DC converter with very high efficiency. It takes the input from the solar panel and simultaneously it converts it into high frequencies [8]. After this it will convert this into the different DC voltages and currents. This will exactly matches the required specifications for battery from panel. The operating range of MPPT is very high it is about 20-80 KHz. The main advantages of using high frequencies is that we can designed the circuit which is having very high efficiencies. The transformer and other components which we use for construction of the MPPT is of very high efficiency because that are used for high frequencies.

For storing power in this project we are going to use combination of two small size of supercapacitor. Supercapacitor has main advantage that its charging and discharging rate and cycles both are very high compared to any other storing devices [8]. This will make the supercapacitor more advantages than any other. Also comparing the size, supercapacitor requires very less space. Supercapacitor charges and discharges very fast so that this is very useful for low power applications.

### **{3} Communication:**

For any system it is really very important to communicate with the observer so that it can give the analysis to the system. There are mostly three types of communication devices that are used in practice which are Bluetooth module, GSM module and Zig-Bee module. Recently there are certain new things also added for communication with the system. Those are Wi-Fi & LTE. For our project we only need the basic system so that we can analyse the real time operation of devices. There is also one module which is present in market that is CC2500 Trans receiver module. The cost of this device is much more less than any other communication devices. So in our project we are going to use CC2500 Trans receiver module. This module was manufactured by Textra technologies PVT Ltd. This RF module can be easily used for application where two way data transmission or multiway data transmission required. Also this kind of RF has features the multimaster and multislave also it has reliable transmission operation. Size of this is very small and does not require any extra space. Range factor of these types of modules are very important this module has good range for communication.

CC2500 automatically switches from Transmission mode Tx to Receiving mode Rx. It can be easily mounted on the system. As this transceiver is PLL based it does not require any tuning for operation it tunes itself. CC2500 checks errors of data (CRC) [4].

### **IV. Applications:**

As we all know that this system is nothing but the small size of self-generating power unit. The system takes waste energy into account for generation of electricity or for any other real time operating things. Main application of this project is that to aware a people about the renewable energies. This system can be implemented where we cannot able to install large size of generating units. Following are some applications of solar harvesting systems.

- Can be used in remote locations.
- Can be used on battle field.
- Can be used to power up different types of sensors for army, navy and air force.
- Can be used where electricity not available.
- Can be used to supply power to the counters, relays or different types of digital electronic sensors (which requires less than 5-10V)
- Can be used in highly radioactive zone to collect the data from object.
- Can be used for wildlife tracking.
- Basically can be used everywhere, where small amount of power is required.

The main application of this system is that to aware people to avoid use of electricity for small applications like different sensors, actuators, counter etc.[11] they can use this harvester for that. For improving the harvester efficiency the MPPT is used which gives us really good results.

In application we can also store this energy for future use or we can directly use that energy to real time applications like counters.

There are lots of application where we can use this system. Suppose there is one building we have. Let's see some possibilities where we can use this system. Firstly from entering into building we have camera's which power electronic device are so we can use this harvester there. Secondly some future buildings have the counter or thumb entrance, [5] this is also an electronic device which operates on low power application so we can use this harvester there also. Thirdly lights in the lift and in the corridor, if those are LED's then definitely we can use the harvester output there also. So there are lots more things where we can avoid use of conventional system and we use the harvester for that.

The main thing is that the cost of this harvester is much less than any solar inverter and this also not requires lot space with the small panel and efficient storing device we can use this system.

### **V. Future Scope:**

Implementing the harvester is itself a futuristic idea. But for this project there are some constraints that are come which we can use for improving the system in the future. Main future scope for this system is that to use the cheaper storing technology instead of costly. In this project we are using the supercapacitor whose cost

is very high. Next future scope for this system is that to use more simplified and more advance display, which shows you the percentage of energy left and which gives us notification of how much energy can be generated by analyzing the atmosphere.

Coming to some complex issues we can also attach this harvester circuitry with some more input types like we can attach wind turbine to the system so that more amount of energy we can get. In this you can easily add more incoming sources of energies like pressure input, vibrations etc. which does not consume electricity instead it gives small amount of energy.

## **VI. Conclusion:**

In the conclusion of this project we learn that there are different types for generating the power from solar source. Solar harvesting gives us the main things on which we can use different low power application devices. Main purpose is that to use the harvesting technics for different task where we can avoid use of electricity. The cost of harvester is quite high sometimes because of supercapacitor. We can use batteries also. Also for cost saving we are going to use CC2500, this used similar as zigbee but the cost of this device is very cheap compare to other communication devices. We can use batteries instead of supercapacitor for cost saving

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