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## Hybrid Electricity Generation from Solar PV, Speed Breaker and Traffic Sound for Automatic Street Light

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### Abstract

The conventional energy resources are limited in nature therefore, it is necessary to shift the focus towards the other renewable energy resources. Energy has become essential for the progress of human civilization. The thrust for new and renewable energy resources are leading to continuous and extensive research. Renewable sources are preferably used as single system such as wind energy, geothermal, biogas and photovoltaic (PV)-alone configuration. The economic aspects of these renewable energy technologies are not sufficiently promising. Research work on renewable sources are going on, keeping in the mind the limitation and economic aspect of various renewable sources , it is tried to design different combination of other less utilized renewable sources with leading renewable sources like wind and solar PV to develop an integrated renewable energy systems. This paper proposed a scheme which helps to optimize the renewable resources of power generation, in which hybrid electricity is generated by the combination of solar PV, speed breaker and traffic sound which is further utilized for street light application.

**Keywords:** Solar Photovoltaic (PV), speed breaker, traffic sound, piezoelectric material.

### 1. Introduction

The increasing need of energy and limited nature of conventional energy resources lead a steady growth in renewable energy. Recent technologies introduce new approaches for utilization and development of renewable energy resources. The present scenario of research work in the field of renewable energy sources observed a shift towards the combination of

more than one renewable energy resource such as a hybrid system of less utilized renewable sources with leading renewable sources like wind and solar. Hybrid systems based on a combination of various renewable energy sources with wind or solar photovoltaic and others are discovered under the various schemes. One part of the whole combination depends on the utilization of kinetic energy of the vehicles that gone wasted. The number of vehicles passing over speed breaker on the roads are increasing day by day .The kinetic energy of vehicles is trapped by setting up an electro-mechanical unit beneath speed breaker, known as piston/ tank assembly, which further can be used for power generation. This power can be stored can be supplied to street lights, traffic lights, and nearby areas for various consumption of electricity [2].

There is an emerging field in which sound from various sources is trapped it is new in the list of renewable energy sources. In the applications of communication system sound is converted in the electrical signals to travel over the medium of communication system. One of the best examples of conversion of sound energy into electrical signals is conversion of sound by diaphragm present in the microphone [2].This electrical signals travel towards the speakers and then again converted back to sound. In this area an LDR sensor has been installed at a certain range when an article crossing this limit street light became active at full intensity.

This paper is organized in sequential manner where all three processes of power generation are discussed separately.

## 2. Experimental Details Electricity Generation from Speed Breaker

The schematic diagram of electricity generation from speed breaker is shown in fig.1. The working of electricity generation from speed breaker can be understood on the basis of schematic diagram shown in fig.1

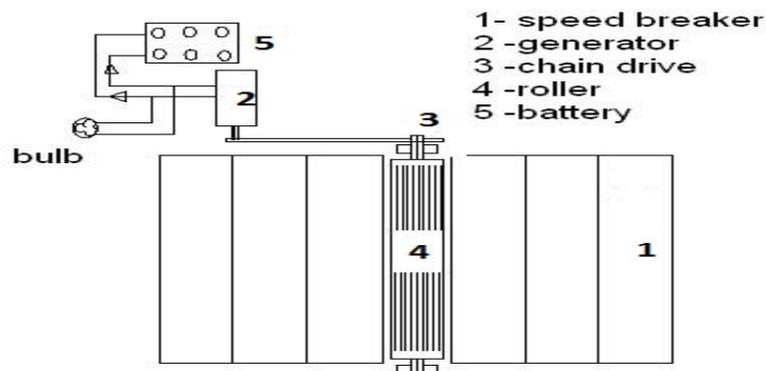


Fig1: Schematic Diagram of Electricity Generation from Speed Breaker.

When a vehicle passes over the dome of speed breaker by pushing it downwards, the springs attached to the dome are compressed and the rack, which is connected to the bottom of the dome, also moves downward in reciprocating motion. Reciprocating motion of rack is converted into rotary motion of gears rotating in opposite direction. A flywheel is mounted on the shaft whose function is to regulate the fluctuation in the energy and to make the energy conversion uniform. Shafts are connected through a belt drive and dynamos rotate with specified revolution per minute (rpm). The dynamo converts the mechanical energy and this energy is proportional to the traffic density. The basic concept behind the whole phenomenon is Faraday's law of electromagnetic induction which state that, when an armature rotates between the magnetic fields, an electro motive force (e.m.f.) is induced in it [3]. So, for inducing this e.m.f. armature coil has to rotate, and for rotating this armature it is connected to a long shaft. In this way rotational kinetic energy of moving vehicles is utilized. The electrical output can be improved by arranging these systems in series. This generated power can be amplified and stored by using different electrical devices.

### **3. Mechanism involved is Electricity Generation from Speed Breaker**

The major mechanism involved in generation of from power speed breaker is

1. Crank shaft mechanism
2. Roller mechanism
3. Rack and pinion mechanism

### **4. Equipment Required**

**4.1. Rack and Pinion Gears:** The rack and pinion gears are used to convert rotary motion into translatory motion. The rack is the flat toothed part.

**4.2. Ball Bearings:** A ball bearing carries a load by placing round elements between the two pieces.

**4.3. Spur Gear:** It is a positive power transmission device with definite velocity ratio. It is preferred for adjusting some linear misalignment.

**4.4. Fly Wheel:** The primary function of flywheel is to act as an energy accumulator. It reduces the fluctuations in speed also It absorbs the energy when demand is less and releases the same when it is required.

**4.5. Shafts:** It is a rotating element, which is used to transmit power from one place to another place. It supports the rotating elements like gears and flywheels. It must have high torsional rigidity and lateral rigidity.

**4.6. Springs:** It is an elastic body whose function is to distort when loaded and to recover its original shape when the load is removed. It cushions, absorbs or controls energy either due to shocks or due to vibrations [4].

**4.7 Electric Dynamo:** It converts mechanical energy into electrical energy. The dynamo uses rotating coils of wire and magnetic fields to convert mechanical rotation into a pulsing direct electric current through “Faraday’s law of electromagnetic induction”.

## **5. OUTPUT POWER FROM SPEED BREAKER**

Let us consider, the mass of a vehicle moving over the speed breaker

$$= 250\text{Kg (Approximately)}$$

Height of speed breaker = 10 cm

$$\text{Work done} = \text{Force} \times \text{Distance}$$

$$\text{Force} = \text{Weight of the Body}$$

$$= 250 \text{ Kg} \times 9.81$$

$$= 2452.5 \text{ N}$$

Distance travel by body = Height of the speed Breaker

$$= 0.10 \text{ m}$$

$$\text{Output power} = \text{Work done/sec}$$

$$= (2452.5 \times 0.10)/60[3]$$

$$= 4.0875 \text{ Watts (For One Pushing force)}$$

Power developed for 1 vehicle passing over the speed breaker for one minute = 4.0875 watts

Power developed for 60 minutes (1 hr)

$$= 245.25 \text{ watts}$$

Power developed for 24 hours = 5.866 KW

This power is sufficient to letting four street lights at the roads during night time.

## **6. EXPERIMENTAL INVESTIGATION FOR SPEED BREAKER**

The experimental investigation is performed by placing the speed breaker arrangement in a pit. Vehicles move over the speed breaker arrangement and the voltage generated is measured by a multimeter and the various observations against speed of vehicle and load of vehicle are plotted. The graphs are presented in fig 4.2.

Total load = 360 Kg (Vehicle weight + man weight)

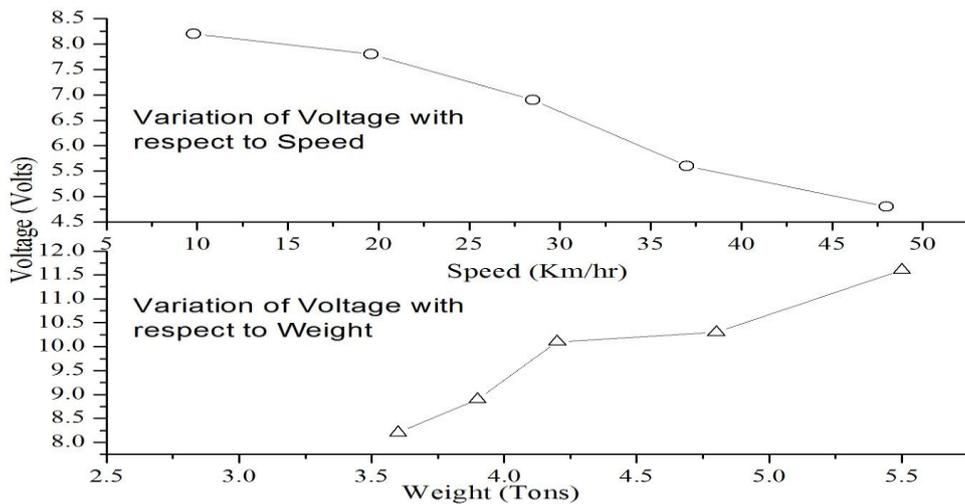


Fig.2: Graph between Voltage generated Vs Speed and load of vehicles.

## 7. GENERATION OF ELECTRICAL ENERGY FROM SOLAR ENERGY

Solar panels are directed at solar south in the northern hemisphere and solar north in the southern hemisphere of earth at an angle decided by the geographic location of where the system are to going be installed. Angle of the solar array is set within a range of between site-latitude-plus 15 degrees and site-latitude-minus 15 degrees, depending on whether a slight winter or summer condition is desirable[4] The electrical charge consolidated in the PV panel and directed to the output terminals produces a low voltage (DC) - usually 6 to 24 volts. It is presumed that at "peak sun", 1000 W/m<sup>2</sup> of power reaches the surface of the earth. One hour of full sun provides 1000 W/m<sup>2</sup> the solar energy received in one hour on a cloudless summer day on a one-square meter surface directed towards the sun[4].

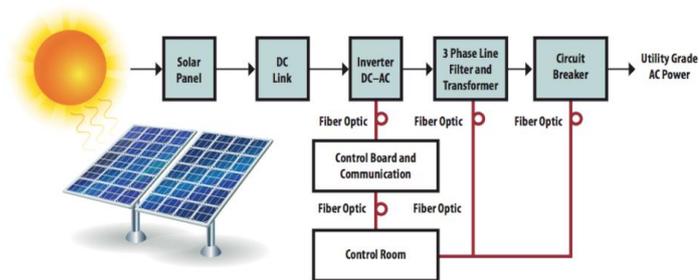


Fig. 3: Electricity Generation from Solar PV System.

### 7.1 Solar Panels

The output of a solar panel is usually stated in watts, since the intensity of sunlight contacting the solar panel varies throughout the day, we use the term "peak sun hours" as a method to smooth out the variations into a daily average.

## **7.2. Charge Controller**

A charge controller monitors the battery's state-of-charge to insure that when the battery needs charge-current it gets it, and also insures the battery isn't overcharged.

## **7.3 Battery**

The deep cycle (DC) batteries used are designed to be discharged and then re-charged hundreds or thousands of times. These batteries are rated in Amp Hours (Ah).

## **7.4 Inverter**

An inverter is a device which changes DC power stored in a battery to standard 120/240 VAC electricity (also referred to as 110/220). Most solar power systems generate DC current which is stored in batteries. Nearly all lighting, appliances, motors, etc., are designed to use ac power.

## **7.5 Thin Film**

Thin film modules are constructed by depositing extremely thin layers of photosensitive materials on a low-cost structure such as glass, stainless steel or a polymer foil. These are manufactured from amorphous silicon (a-Si), copper indium diselenide (CIS, CIGS) and cadmium telluride (CdTe) as well as hybrid cells consisting of amorphous silicon and a microcrystalline layer.

## **7.6 Energy Payback**

The expected lifetime of a solar generator is about 25 years. This is because the energy used, especially during the production of solar cells is seen to far outweigh the electricity eventually generated. Recent studies show that, present-day systems already have an energy payback time (EPBT) the time taken for power generation to compensate for the energy used in production of three to four years.

## **8. Generation from Traffic Sound**

The concept of conversion of sound waves to generate energy is not a new idea. The acoustic heat engine has been in use for decades [5]. Devices which utilize heat to create sound and then energy have no moving parts. There is no maintenance, so to convert sound to electrical energy a transducer is needed. These transducers are designed for the 20Hz to 20 KHz range. This is the range of frequencies over which the transducer or microphone is considered to have a useable output [5]. The electrical current generated by a microphone is very small and referred to as MIC-level, this signal is typically measured in milli volts which amplified and used in combination of other renewable energy resources. Sound is a mechanical form of

energy which travel in the form of wave, mechanical wave that is an oscillation of pressure this pressure created by the sound could be used to convert it into electric energy or other form of energy. Also according to law of thermodynamics mechanical energy could be converted into electricity piezoelectric material converts mechanical strain into electric energy. This property of piezoelectric material could be used to make a device which would be able to sustainably convert the sound energy to electric energy. For example speaker or woofers when sound comes from it its diaphragm come forth and back its movement is seen in these manner that it could use this disturbance of sound wave to convert it into electricity across it.

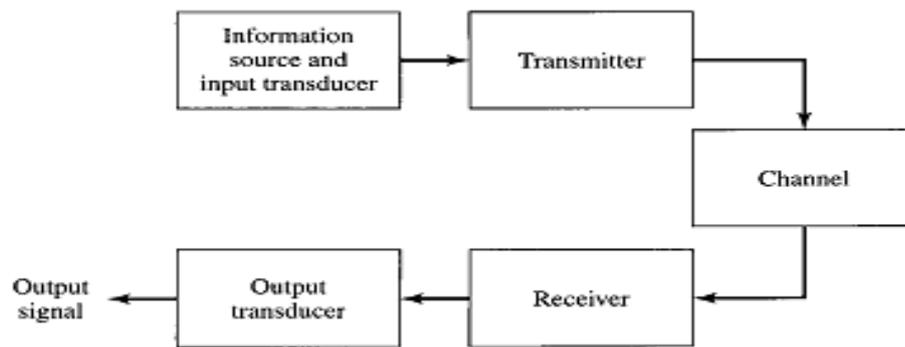


Fig.4: Block Diagram Of convert sound to an electrical signal.

As per Faradays law, generated e.m.f is given by

Generated voltage = E.m.f =velocity of conductor X Magnetic field X length of conductor

Thus, the oscillation created by the sound wave could be converted into electricity and as the frequency is high the movement will be fast due to it, we will get appreciable amount of electric energy. It would work similar as the working of turbine [6].

But it has certain limitation that it will be efficient only in the places where high decibel of sound is available e.g. nuclear power plant, industries using huge and noisy machines.

### 8.1 Piezoelectric Material

Piezoelectric materials are the crystals which converts mechanical strain to electricity, The crystals are formed naturally e.g. quartz, bone, whereas artificially ZnO lithium niobate, Lead Metaniobate. The sound energy could be converted into electricity using piezoelectric material.

### 8.2 Ultrasonic Transducer

Transducers are devices that transform energy from one form to another. There are many types of transducers, but at their most basic, they can be divided into two groups as input (sensor) and output (actuator). Actuators take an electronic signal and convert it into

physical energy. A stereo speaker works by transforming the electronic signal of a recording into physical sound waves.

### 8.3 Combining Transducers

Many devices work by combining sensors and actuators to convert energy from one form to another and then back again. Ultrasound imaging also works by converting energy multiple times. These waves bounce back to the machine, where a transducer converts them into electrical signals again.

### 8.4 Microphones

A microphone is an example of a transducer, a device that changes information from one form to another. Sound information exists as patterns of air pressure; the microphone changes this information into patterns of electric current. The recording engineer is interested in the accuracy of this transformation, a concept he thinks of as fidelity.

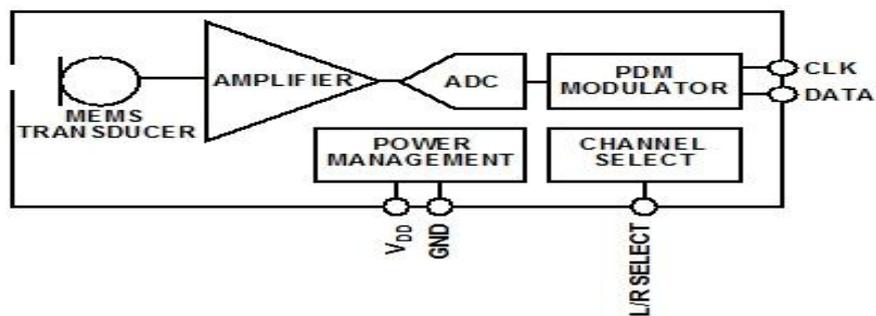


Fig 5: Block Diagram of Microphone.

### 8.5 Sound in Electrical Form

Sound in electrical form can be amplified, mixed and recorded. We can convert the acoustical waveform into an electrical waveform of the same shape and amplitude becomes voltage (V), and air particle motion becomes electrical current (I) - electrons playing the role of air particles.

### 9. Block Diagram

The sound of the traffic is used to generate the electricity with the help of microphone which consist of transducers which convert the acoustic signals into electrical energy. The battery is used which stores the electricity generated from all three sources and the amount of electricity generated can be known from the voltmeter. For the purpose of not wasting the electricity generated during the day time the sensor is used which automatically switch off the light when the light falls on it. It could be used in lighting the street lights by using the noise

pollution made by vehicles; it could also be used in industries, airport runways and nuclear power stations.

## 10. CONCLUSION

The generation of electricity using the vehicle weight can be considered as an input in power generation using speed breaker. Different mechanisms can be used to convert the mechanical energy into the electrical energy from the speed breaker. It is known to us that sound is a mechanical form of energy which travels in the form of wave. A mechanical wave is an oscillation of pressure, this pressure created by the sound could be used to convert it into electric energy or other form of energy by using piezoelectric property of materials. In the night only half lights are switched on automatically on with the help of automated switching system and other half lights switch on only when any vehicle came in specified range on the road, If there is no vehicle on the road then half lights are automatically off. Generation of electricity at low cost. Operating cost is less. Stored electricity can be used for other purposes. Convert the totally waste energy in some useful work. The street lighting is flashes by batteries. This will help the government for economic purpose and give the way to utilize their energy for other purposes.

## 11. References

1. R.S. Selvaraj, V. Sivamadhavi, Magnitude of Green House Effect and the contribution of Carbon di oxide, Recent Advances in Space Technology Services and Climate Change (RSTSCC), 13-15 Nov. 2010, no. 41 – 44, Chennai.
2. S. Srivastava, A. Asthana, Produce Electricity By The Use Of Speed Breakers, Journal of Engineering Research and Studies, 2(1), April-Jun 2011.
3. N. H. Samrat, N. Ahmad, I. A. Choudhury, Z. Taha, Technical Study of a Standalone Photovoltaic–Wind Energy Based Hybrid Power Supply Systems for Island Electrification in Malaysia, Research Article plos One, 29, 2015.
4. S. Negi and L. Mathew, Hybrid Renewable Energy System: A Review International Journal of Electronic and Electrical Engineering. ISSN 0974-2174, 7(5), 535-542, 2014.
5. D. Mukherje, S. Chakrabarti, Non-conventional power plants, New Delhi, 2005.
6. M. Russ, Sound Synthesis and Sampling, 3(2). Focal press, Abingdom, Oxon, 2008.
7. B. Robyns, A. Davigny, B. François, A. Henneon, J. Sprooten, Electricity Production from Renewable Energies, 1, Wiley publication, 2012.

8. R. A. Aziz, S. S. Cohen, H. Dubost, M.L. Klein, Inert Gases: Potentials, Dynamics, and Energy Transfer in Doped Crystals (Springer Series in Chemical Physics), 2.3, Springer-Verlag, 2011.
9. A. Gupta, V. Goel, V. Yadav Conversion of Sound to Electric Energy, International Journal of Scientific & Engineering Research, 5(1), 2146 ISSN 2229-5518 January-2014.
10. Y. Chen and C. Chung Chang, lightning rabbit – an application of sound energy to produce more electricity, APEC Youth Scientist Journal, 3.
11. J. Park, Y. Kim, D. Kang Propagation Characteristics and Effects of Road Traffic Noise, Korean Society of Environmental Health, 34(4), 311-315, 2008.
12. F. Arif Khan, P.Sarkar, S. Rahman, F. Yasmeen, Zigbee Sensor Based Automatic Room Light Controller with Visitor Counter, International Journal IJCSIT ACEIT-16 proceedings.
13. F. Arif Khan, A. Faiz Minai, Hardware Implementation of a Solar-Wind Hybrid Street Light in Proc. Renewable Energy and Energy Management (NCREEM), 77-82, 2011.
14. F. Arif Khan, A. Faiz Minai, Analysis Of Multi-Source Renewable Distributed Energy Generation, in Proc. at NCETMEE-12 CD-ROM at Integral University Lucknow, 2012.

**Table 1:** Relation between speed and voltage generated

<b>S.No.</b>	<b>Speed of Vehicle(Km/hr)</b>	<b>Voltage generated(Volts)</b>
1	10	8.93
2	20	7.32
3	30	6.05
4	40	5.65
5	50	4.03