2011 2nd International Conference on Environmental Science and Technology
IPCBEE vol.6 (2011) © (2011) IACSIT Press, Singapore

GREEN ENERGY—EZOWATT

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***Abstract*—A piezowatt generator that will produce electricity from the stress experienced by the roads due to the movement of automobiles is proposed. The main principle behind this is the piezoelectric effect. The energy is produced from the consumer's participation and it does not require any separate source of input energy.**

Keywords — Piezoelectric effect, mechanism, efficiency

I. INTRODUCTION

"**Piezo**", derived from the Greek language piezein, which means to squeeze or press, is a prefix used in: Piezoelectricity. The piezoelectric effect [2] was first discovered in 1880 by Pierre Curie and Jacques Curie, two French physicists who were also brothers. It is defined as the generation of an electric charge in certain non-conducting materials, such as quartz crystals and ceramics, when they are subjected to mechanical stress (such as pressure or vibration), or the generation of vibrations in such materials when they are subjected to an electric field. Some of the naturally occurring crystals that exhibit piezoelectric effect are quartz, Rochelle salt, topaz, tourmaline. The man-made ceramics are Barium titanate, lead titanate, lead zirconate titanate etc. We are presenting the paper based on this principle by generating electricity from the stress experienced by the roads due to the movement of automobiles. According to this, the piezoelectric crystals are placed below roads over which the automotives move. So when the deformation is produced in the crystals, a potential is produced which may be stored in a battery grid or can be supplied directly to the lamp posts side by.

II. PIEZOELECTRIC EFFECT

The nature of the piezoelectric effect is closely related to the occurrence of electric dipole moments in solids. The latter may either be induced for ions on crystal lattice sites with asymmetric charge surroundings (as in $BaTiO_3$ and PZTs) or may directly be carried by molecular groups (as in cane sugar). The dipole density or polarization (dimensionality [Cm/m^3]) may easily be calculated for crystals by summing up the dipole moments per volume of the crystallographic unit cell. As every dipole is a vector, the dipole density ***P*** is also a vector or a directed quantity. Dipoles near each other tend to be aligned in regions called Weiss domains. The domains are usually randomly oriented, but can be aligned during *poling* (not the same as magnetic poling), a process by which a strong electric field is applied across the material, usually at elevated temperatures.

Of decisive importance for the piezoelectric effect is the change of polarization ***P*** when applying a mechanical stress. This might either be caused by a re-configuration of the dipole-inducing surrounding or by re-orientation of molecular dipole moments under the influence of the external stress. Piezoelectricity may then manifest in a variation of the polarization strength, its direction or both, with the details depending on the orientation of ***P*** within the crystal, crystal symmetry and the applied mechanical stress. The change in ***P*** appears as a variation of surface charge density upon the crystal faces, i.e. as a variation of the electrical field extending between the faces, since the units of surface charge density and polarization are the same, [C/m^2] = [Cm/m^3]. In fact, however, piezoelectricity is not caused by a change in charge density on the surface, but by dipole density in the bulk. For example, a 1 cm^3 cube of quartz with 2 Kilo Newton (500 lbf) of correctly applied force can produce a voltage of 12,500 V. [1]

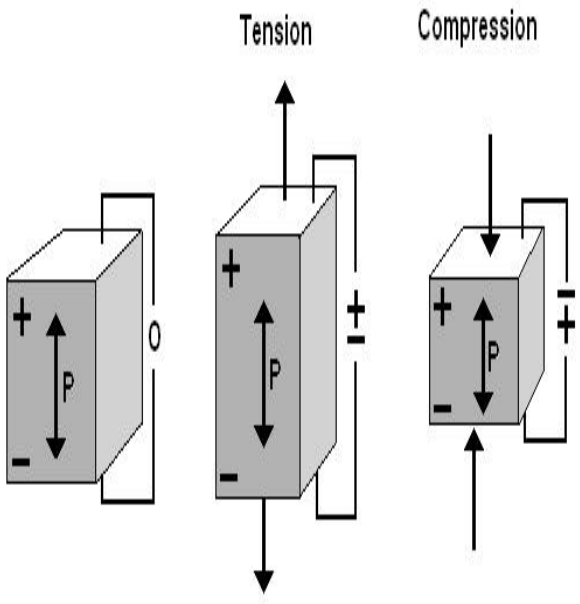

Figure 1. shows a design of Converse Piezoelectric effect

Piezoelectric materials also show the opposite effect, called **converse piezoelectric effect** [3] shown in figure 1, where the application of an electrical field creates mechanical deformation in the crystal. The Curies, however, did not predict the converse piezoelectric effect. The converse effect was mathematically deduced from fundamental thermodynamic principles by Gabriel Lippmann in 1881. The Curies immediately confirmed the existence of the converse effect, and went on to obtain quantitative proof of the complete reversibility of electro-elasto-mechanical deformations in piezoelectric crystals.

A traditional piezoelectric ceramic is a mass of crystals, each consisting of a small, tetravalent metal ion, usually titanium or zirconium, in a lattice of larger, divalent metal ions, usually lead or barium, and O2- ions. When these crystals are subjected to a electric field, the dipole movement gets aligned and it lengthens leading to deformation in the crystal after the application of voltage. [1]

III. CONCEPT

The energy consumed by the vehicle (sourced in the fuel combustion) utilized for a variety of applications; one of them is to overcome rolling resistance. A typical asphalt road can be described as a visco-elastro-plastic material, with elasticity being its dominant material characteristic. When a vehicle passes over a road, the road deflects vertically. This deflection is released as thermal energy. For a road with embedded piezoelectric generators, part of the energy the vehicle expands on roads deformation is transformed into electric energy (via direct piezoelectric effect) instead of being wasted as thermal energy (heat).

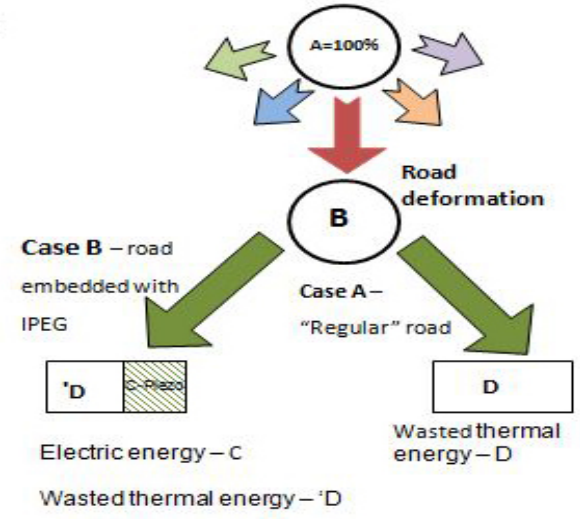

Figure 2. shows a design of Traverse of energy

IV. WORKING

Only part of the energy from the fuel combustion of the vehicle is used for moving the car along the road or run useful accessories, such as air conditioning. The rest of the energy is lost to engine inefficiencies. The energy expended on the vehicle's movement is mainly used to overcome rolling resistance, resistance occurring when the wheel is moving forward on the road surface. In addition to the energy used to move the wheel forward (in the horizontal direction), part of the fuel combustion is wasted on creating a deformation in the asphalt, which is basically the product of the loaded wheel's influence on the road surface.

A typical asphalt road can be described as a visco-elasto-plastic material, with elasticity being its dominant material characteristic. When a vehicle passes over a road, the road deflects vertically. The deflection is proportional to the weight of the vehicle and the asphalt stiffness. The only source for harvesting electric energy is this part of mechanical energy related to the asphalt vertical deformation, which is a percentage from the total energy of the vehicle (energy of the fuel combustion).

It is known that the vertical load of the vehicle's wheels yields compression stress, diminishing with depth. Piezoelectric generators are embedded at a depth of about 5 cm; the area where the compressions stress is maximal. The external load results in the deformation in both the asphalt layer covering the generators and the generators, similar to the typical deformation in a piezoelectric column loaded under axial load.

The deformation of the generator and the shortening of the piezoelectric columns embedded in the generators, generate charges on the piezoelectric columns that are the source for the electric energy. The energy needed to deform the road is a function of various parameters such as: the surface quality of the road, asphalt type, environment temperature and others.

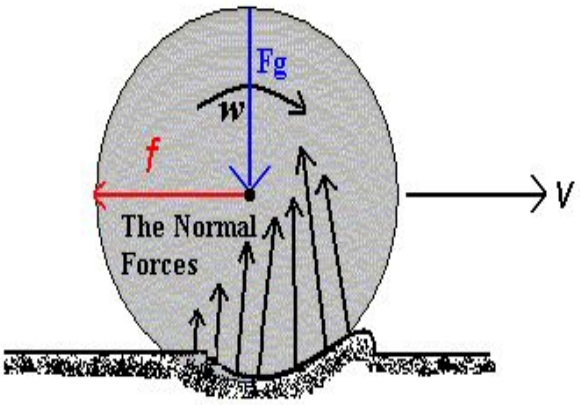

Figure 3. shows Production of electricity from roads

V. MECHANISM & EFFICIENCY

Now this whole concept is the key to the piezowatt technology. Those crystals exhibiting the piezoelectric effect are laid 5 cm below the surface of the road. A vehicle passing down a road way and causes deformation of the road. Every time the vehicle moves over the crystal, the piezoelectric crystal is slightly deformed. Generally all the energy wasted on the piezoelectric crystal deformation is transferred into electricity via PIEZOWATT. It converts the

mechanical energy of the road deformation into electricity which is either stored in batteries or connected directly into the grid. This energy harvested can be supplied road lighting, stoplights, speed sensors, road side hoardings etc.

From the figure 4, it is seen that the piezoelectric crystals are embedded in the red marked spots. For example when a truck moves, the deformation is produced and the corresponding potential is produced according to the graph from the figure 1. This is supplied to the nearby lamps for lighting.

It is found that when one vehicle moves for every second, in a road span of 1Km embedded with these piezoelectric crystals, then power of 240.12Kw could be produced. A typical mercury vapor lamp requires around 500W.Hence the energy derived from the piezoelectric crystals will be adequate enough for lighting these lamps on the roadside. The busier the roadway the more energy is produced.

Similarly this concept can be installed in pedestrians, Airports, Railway lines etc. The solution harvests the energy wasted during human movement (e.g. walking, driving).The popular indoor locations for such implementation would be major public transportation stations, e.g. shopping malls, entertainment parks etc.

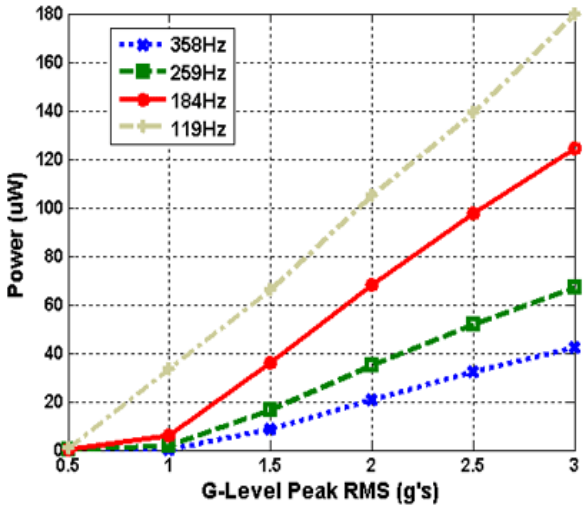

Figure 4. shows the efficiency graph of piezowatt

VI. HIGHLIGHTS OF PIEZOWATT

A. Advantages

1) Movement of vehicles are always constant is busy roads and highways.

2) So, power can be generated constantly by this concept.

3) Power generated from 'Piezowatt' concept is Greenpower and no harm to the environment.

4) This power can be very well utilized for the street lightning and other small scale purposes.

B. Disadvantages

1) Implementing this concept is a little bit tedious.

2) The present day roads need to be relayed again in order to implement this concept.

3) This will result in traffic congestions all over the city and needs a critical plan of implementation and management.

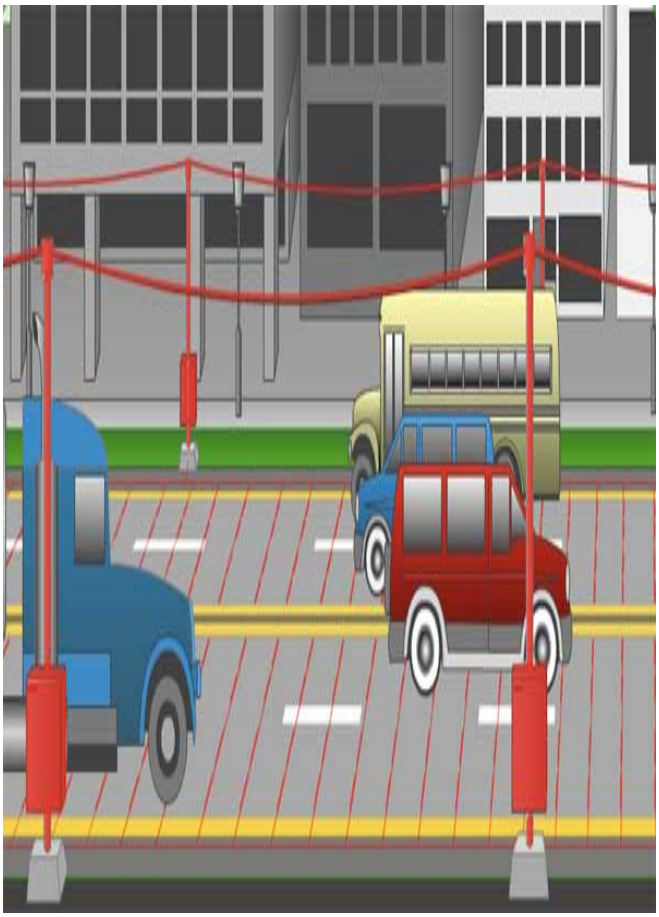

Figure 5. shows the graphical model of the concept

VII. CONCLUSION

We thus conclude that this thought will be a revolution in power production and curb down the energy costs thereby improving our country's economy. This energy is produced by consumers' participation without requiring any kind of input energy. Further concentration in the work would result in the better production of energy. We can see a better dimension of this piezoelectric concept in the futuristic world.

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