1.1 Project leader

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Main discipline(s) and skill(s):
Bachelor of Electrical Engineering
Skills: PLC (Programmable Logic Controller), Wonderware in Touch, Electronics

I had participated projects based on renewable energy such as wind turbine, solar pond, piezoelectric, etc. And this project relevant to my study as a student of Electrical Engineering.

As a student of Electrical Engineering, I always try to find a way to create an innovation in renewable energy. My projects in this path are: Implementing wind turbine in the city, sound-driven piezo for generating back up energy in plane.
SECTION 2: SHORT DESCRIPTION OF MY PROJECT

2.1 Project information

Project name: Noise-Energy Harvester: Collecting Energy from Sound and Noise for Generating Streetlight

Project category:
- ☐ INNOVATIVE SOLUTION
- ☑ COLLABORATIVE RESEARCH PROJECT

Video name: Noise-Energy Harvester

2.2 Issue(s) addressed:
1. Piezoelectric
2. LED
3. Using alternative energy for generating streetlight

2.3 Short description of the Project

(300 characters max.)
Noise-Energy Harvester is a system that converts sound of noise from transportation noise engine in the city into electricity which is stored into a battery to turn on pedestrian lamps. This system allow collecting energy to have an inexhaustible-vast alternative energy considering the high noise-vibration in the crowded city.

2.4 Illustration of my Project

The diagram shows the design and concept of Noise-Energy Harvester
SECTION 3 – DETAILED PRESENTATION OF MY PROJECT

3.1 Context
Energy is a main problem nowadays. It’s really difficult to imagine our life without electricity. We need more feasible source to produce electricity. Oh the other hand, in the modern life there is a lot of noise pollution in the roads, factory, airports, industries, etc. This is the opportunity for us using this waste of energy to return again the kind of energy. We see there are two rivals of Noise-Energy Harvester that are also feasible to be implemented in the city. Those are Solar Cell and Wind Turbine. Solar Cell is weather-dependable energy source, and can only be used in certain condition. Wind turbine also weather-dependable, it can only be used in certain wind speed, and not all cities have this good condition. Many cities have slow average wind speed, such as in Indonesia.

3.2 Main issues
The main issues of this project are:
1) In this modern era, the most common thing we encountered is noise pollution. We almost meet it everywhere.
2) A lot of noise that is natural come from the city is have not been already used as a potential source of energy (airport, road, factory, etc)
3) A new device that can produce electricity from vibration is developed. That is Sound-Driven piezoelectric, have great sensitivity.
4) Streetlight is a main part of the city to light the pedestrian street of city with energy consumption about 2 kWh per day (low pressure sodium).

3.3 Detailed description of innovative solution OR of research process
The concept of Sound-Energy Harvester on Streetlight consist of four main parts:

1. **Piezo-Ball Energy Collector**
The system of piezo ball energy collector consists of vibration snare completed with resonance system which is integrated to sound-driven piezoelectric. From the vibration, the crystals strain and create a voltage. A ball-shaped makes it possible to catch noise energy from various directions.

![Picture (2) The main shape of Ball Energy Collector](image)

Inside the ball there are three main parts that made Ball-Energy collector supplies electricity to the battery then generating LED lamps.
Resonance Room have a role to multiply the vibration that come from the environment. The second layer is Sound-Driven Piezo. This is the main part of the system that can harvest energy from noise/sound around the environment. The last layer is Electronic Circuit which collects whole energy and transports it to the battery.

**Principle of work**

Piezo electric materials are transducers its crystals could convert mechanical strain to electricity. The crystals are formed naturally e.g. quartz, bone, DNA... whereas artificially ZnO, lithium niobate, Lead Metaniobate the sound energy could be converted into electricity using piezo electric material. Let us see the properties of piezo electric material. Certain single crystal materials exhibit the following phenomenon: when the crystal is mechanically strained, (here sound energy) or when the crystal is deformed by the application of an external stress, electric charges appear on the crystal surfaces; and when the direction of the strain reverses, the polarity of the electric charge is reversed. This is called the direct piezo electric effect, and the crystals that exhibit it are classed as piezoelectric crystal. So it could be seen that when the sound energy is applied to the piezoelectric material it create strain in the crystal then it reverse it and the strain is converted into electric energy. This direct piezo electric effect property of an piezo electric material could be used for making the device to convert sound energy to electric energy.

Piezo converter (srb) -a device could be made using piezo electric material which will collect the sound wave which are travelling near it and that sound wave will be used to cause a strain due to pressure created by its oscillation in the piezo crystal and that will create the disturbance in its atoms resulting in the flow of electric charge on the surface of the crystal thus sound energy could be converted into electricity as the piezo electric material convert mechanical strain to electric energy. And thus this sound energy could be used to perform various tasks by converting it into useful electric energy (IJETAE ISSN 2250-2459, Volume 2, Issue 10, October 2012)

**Sound-Driven Piezoelectric Nanowire-Based Nanogenerators**
A new method for generating electricity from sound has been developed. By combining both Material Engineering and Nanotechnology, we can create Piezoelectric Material more sensitive, reliable, and uses less area.

This research conducted by Seung Nam Cha and his colleagues, and bring interesting results.

![Picture (6) Proposed Mechanism of Generating Electricity](image)

Proposed mechanism for power generation in the sound-driven piezoelectric nanogenerator. The as-received nanogenerator with no sound wave application. Electrons flow from the top electrode to the bottom side through the external circuit by the negative piezoelectric potential generated at the top side of the ZnO nanowires under direct compression by the sound wave. At this time, the positive potential is generated around the top PdAu electrode. The piezoelectric potential dissipates when the external pressure on the top PES substrate is momentarily removed in the rarefaction mode of the sound wave. Electrons flow back via the external circuit till neutralizing the positive potential around the top electrode (Sound-Driven Piezoelectric Nanowire-Based Nanogenerators, Seung Nam Cha)

![Picture (7) 3D Diagram of Ball-Energy Collector Concept](image)

2. **Battery**
The system uses battery for energy storage. So, the electricity produced by Ball-Energy Collector is saved in battery, and from the battery the energy is ready to use. This is because using battery enhances its reliability, when the noise from the environment decreases, the LED Lamps still turning on.
3. **LED Lamps**

This system uses LED lamp because has many advantages. The benefit using LED lamp are:

1) **Long Life**

   Long life time stands out as the number one benefit of LED lights. LED bulbs and diodes have an outstanding operational life time expectation of up to 100,000 hours. This is 11 years of continuous operation, or 22 years of 50% operation.

2) **Energy Efficiency**

   Todays most efficient way of illumination and lighting, with an estimated energy efficiency of 80%-90% when compared to traditional lighting and conventional light bulbs. This means that about 80% of the electrical energy is converted to light, while a ca. 20% is lost and converted into other forms of energy such as heat.

3) **Ecologically Friendly**

   LED lights are free of toxic chemicals. Most conventional fluorescent lighting bulbs contain a multitude of materials like e.g mercury that are dangerous for the environment. LED lights contain no toxic materials and are 100% recyclable, and will help you to reduce your carbon footprint by up to a third.

4) **Durable Quality**

   LEDs are extremely durable and built with sturdy components that are highly rugged and can withstand even the roughest conditions.

5) **Zero UV Emissions**

   LED illumination produces little infrared light and close to no UV emissions.

6) **Design Flexibility**

   LEDs can be combined in any shape to produce highly efficient illumination. Individual LEDs can be dimmed, resulting in a dynamic control of light, color and distribution. Well-designed LED illumination systems can achieve fantastic lighting effects, not only for the eye but also for the mood and the mind.

7) **Light Dispersement**

   LED is designed to focus its light and can be directed to a specific location without the use of an external reflector, achieving a higher application efficiency than conventional lighting.

8) **Low-Voltage**

   A low-voltage power supply is sufficient for LED illumination. This makes it easy to use LED lighting also in outdoor settings, by connecting an external solar-energy source and is a big advantage when it comes to using LED technology in remote or rural areas (http://www.ledluxor.com/top-10-benefits-of-led-lighting)
**Principle of Storage and Generating LED Lighting**

The principle of generating electricity is quite simple: Rectify the output of the Piezo Electric generator and then send it to a small battery for storage. From here, the energy can be used in any the user desires. It would be ideal to power LED lights which consume small amounts of power (ISSN 2231-1297, Volume 3, Number 6 (2013), pp. 747-754)

![Diagram of Piezo Electric Generator and Battery](image1)

**Picture (9). General Principle converting AC Voltage from piezo to power LED Lightning**

![Diagram of Lightning System](image2)

**Picture (10) 3D Diagram of Lightning System**

4. **Piezo-Floor**

Piezoelectric Floor is an additional source of streetlight. It generates electricity when people walk on it. The combined both sound and pressure energy resources give more reliable and extra charge to battery.

![Diagram of Piezo-Floor](image3)

**Picture (11) Piezo-Floor gives extra charge to battery**
**Principle of Work**

Mechanical Vibration triggers piezoelectric material to strain and generates AC Voltage. This voltage then converted to DC Voltage with rectifier. DC voltage charges the battery.

![Flowchart](image)

Picture (12) Flowchart Mechanical Vibration produces electricity

### 3.4 Partners’ roles in the Project

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<tr>
<th>Role</th>
<th>Responsibilities</th>
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<tbody>
<tr>
<td><strong>Project Leader (Ardiansyah)</strong></td>
<td>1. Collaborating, coordinating partners with stakeholders and mentor.</td>
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<td></td>
<td>2. Gives certain schedule and timeline of research</td>
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<td></td>
<td>3. Manage and evaluates the progression of research</td>
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<tr>
<td><strong>Technical Developer (Hendra Antomy)</strong></td>
<td>1. Conducting research related to electrical and mechanical devices, proposing concept of effective and efficient idea.</td>
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<td>2. Determining and designing appropriate component of devices.</td>
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<tr>
<td><strong>Creative Art and Design Developer (M. Januar Fathoni)</strong></td>
<td>1. Bringing Concepts to 3D Animation, picture, etc</td>
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<td>2. Designing size, elegance and material will be used.</td>
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### 3.5 Related opportunities for the development of prototypes and/or testing

Chance for the development of prototypes is high because:

1. Materials for conducting research (Piezoelectric, LED Lamps, Battery) are not hard to look for.
2. Piezoelectric is a new breakthrough in renewable energy, in 2013 80% of people lives in the city *(Sneijder Electric, 2012)*. Harvesting energy using piezoelectric is prospectus.
3. Sound-energy harvesting is a new research that needs more attention, because people lives in the city can’t avoid noise and sound in daily life (factory, car, crowded of people, etc)