1. Present and Justify a Problem and Solution Requirements

 Egypt Grand Challenges

* Improve the use of alternative energies

 Alternative energy is usable energy (such as heat or electricity) that comes from renewable or green sources, meaning that it is any source of energy that does not use fossil fuels. The energy produced from an alternative source as Solar power which is both renewable and alternative because it will always be abundant and it does not emit greenhouse gases. Nuclear power, however, is alternative but not renewable, since it uses uranium, a finite resource. It is important to note that while the World Bank considers nuclear energy an alternative energy source, not all energy policy experts agree on how to categorize nuclear energy does not contribute to the greenhouse effect that causes climate change.

 Egypt could realistically and cost-effectively provide 53% of its electricity mix from renewables by 2030, double the expected share of current plans and policies. Taking into account renewable energy, heat, and fuel, renewables could provide 22% of Egypt's total final energy supply in 2030, up from just 5% overall in 2014. Egypt and China are working closely together on the development of renewable energy and new energy vehicles.

 According to the International Renewable Energy Agency (IREA), Egypt’s continued economic development hinges on the energy sector, which accounts for 13.1 % of its GDP. The Egyptian government is aware of the need for a sustainable and diversified energy mix to address the demand of a young and growing population, and renewable energy is thus an irreplaceable ingredient to achieving Egypt’s Vision 2030 development goals.

 Egypt intends to increase the supply of electricity generated from renewable sources to 20 per cent by 2022 and 42 %by 2035, with wind providing 14%, hydropower 2%and solar 25 % of the energy mix. In Alexandria, 14 electric buses are already on the city’s roads, a first for the country as a whole. Egypt reaches more than a hundred million people, and therefore when working to provide personal energy, alternative energy will increase in Egypt and this can be limited to the Egypt Vision 2030.

* Address and reduce pollution fouling our air

 Integrated and sustainable ecosystem is the 5th object from Egypt’s 2030 vision, and that will be achieved by increasing the use of renewable energy.

 Personal energy belongs to renewable energy, it can be used for small scale uses of humans, but if large number of people utilized from their energy that will be so effective. In addition, performing it on large scale will have great impact.

 Energy use promotes economic development while also causing significant environmental issues such as pollution of the air, soil, and water especially when it is from non-renewable sources.

As shown in figure (1), Egypt uses about 50% of oil and its products and 45% of natural gas, in addition 1% of coal, which means 96 % in total usage of non-renewable energy and their usage as they are fossil fuels, they cause huge threat on environment, as they cause air, soil, and water pollution.

Figure (1) shows the sources of used energy in Egypt<https://cutt.ly/fxeEs4A>

First: Air pollution:

 Air is the most element in the ecosystem that is affected by using nonrenewable resources, because of many reasons.

1. Burning fossil fuels produce many harmful gases as Co2 which the increase in its percentage is a serious threat to the environment as it is one of the main causes of greenhouse effect and global warming phenomena, in addition to affecting the health by increasing its percentage in body.

Figure (2) shows the trend of global Co2 emissions from fossil fuels burning from 1990 to 2012.

Figure (2) shows Global CO2 Emissions from Fossil Fuel Burning, Source: Boden, T.A., Marland, G., and Andres R.J. (2015), <https://ageconsearch.umn.edu/record/252818/>

1. So2  is also from the products of fossil fuel burning, power plants, and car exahusts. It is dangerous, because it causes respiratory illnes and mak breat difficult specially in children, further more it is a toxic gas.

Second: Soil pollution:

 As mentioned So2 is from products of burning fossil fuels, in addition to No2, both react with water and some chemicals in atmospheic air forming acidic rains which removes the nutrients and minerals from the soil that are needed for plant growth.

Third: water pollution:

 Co2 emitted from burning fossil fuels react with water of the seas and oceans causing acidificion of water which has great negative efficts on coral reefs, in addition to lossing them, affecting fishes in oceans, tourism when coral reefs disappear.

OA -ocean acidification- is predicted to have an effect on commercial fisheries around the world, putting hundreds of millions of people's food supply at risk.

 In Egypt there is El Dabaa Nuclear Power Plant, which is built to be an alternative energy. Sure, it has advantages as the cheap raw material, large reserves, huge energy capacity, long life time. However, many scientific researches emphasized how dangerous is nuclear power plants and that it is not a clean source of energy, every aspect of nuclear fuel cycle generation releases radioactive materials into water, soil, and air. Furthermore, Nuclear power plants contribute to air pollution and needs a lot of water for the cooling system. In addition to nuclear waste management.

* Improve the scientific and technological environment for all

 Egypt’s vision in improving the scientific and technological is teaching generations that generate and use the knowledge to provide scientific practical solutions to society problems, and export the knowledge within a system that supports innovation and stimulates knowledge-base economy ,and its mission is creating an encouraging environment for science, technology and innovation, capable of producing and marketing knowledge efficiently and effectively, and creating an atmosphere of excellence based scientific competition, in order to increase the growth rate of the national economy, and achieve the type of sustainable development that elevates the society and human well-being to higher levels. The prototype will be a part of improving the scientific field in Egypt (which is Egypt’s vision in 2030) because it is an effective solution for generating electricity for personal use and it provides a practical solution for the society’s problem which is the lack of innovative ideas to generate electric energy.

 If this problem is solved Egypt will be in higher rank in scientific research. It will be from developed countries. Being progressed in the scientific and technological field, will give Egypt an opportunity to progress in the industrial field. A lot of innovative ways can also be used in generating new clean resources of electricity which will reduce the pollution in air and water.

 If the problem is not solved, there will be a problem an environmental because the country will be still using energy from non-renewable resources of energy due to the lack of innovative scientific ways

* Reduce and adapt to the effect of climatic change

 Climate change is considered as one of the greatest global environmental challenges facing humankind. It is the climate transformation regarding wind, temperature and precipitation that is caused by human activities like using non-renewable sources of energy such as burning fossil fuel which increases heat- trapping greenhouse gas level in the atmosphere, and raising earth's average temperature. According to NASA climate change is "a long-term change in the average weather patterns that have come to define Earth’s local, regional and global climates. These changes have a broad range of observed effects that are synonymous with the term." The main cause of climate change is increasing the percentage of greenhouse gases, gases that block heat from escaping earth's atmosphere, such as: water vapor (the most abundant greenhouse gas), Carbon Dioxide gas ($CO\_{2}$), methane ($CH\_{4})$, nitrous oxide (N2O) and Chlorofluorocarbons. Even though Carbon Dioxide absorbs less heat per molecule than greenhouse gases methane and nitrous oxide, it's more abundant and stays in the atmosphere longer, since the beginning of the industrial age the abundance of Carbon Dioxide has increased by 45%. This global issue must have a lot of observable effects on earth, humans and environment; some of its effects are: global temperature rise, warming ocean, shrinking ice sheets, and decreased snow cover and sea level rise. Climate change also affects Egypt and its environment as its large population makes it extremely vulnerable to climate change. The Nile delta is seriously threatened by rising sea level as it would destroy weak parts of the coast, declining precipitation levels, and change weather patterns.

 Impacts of climate change are harmful to mankind and the environment and reducing it would make a difference, there are plenty of ways to reduce climate change, for example: powering homes and small places with renewable energy whether from using solar panels or efficient devices that help saving wasted energy, expanding and restoring forests would help reducing the $CO\_{2}$ percentage in atmosphere, also using electrically-powered vehicles instead of burning fossil fuels which would reduce the greenhouse gases emission, measure the carbon footprint, know how much carbon dioxide gas is emitted, then try ways to manage and reduce it.

Problem to be solved

 In general, the problem that we are working on is about alternative energies. We cannot say that Harvesting personal energy from human activities will be a basic source of energy and we will neglect for example fossil fuel because our personal energy will substitute its usage completely. However, if every human literally everyone utilized from the different types of energies that he or she produce daily like Mechanical, Sound, and Thermal energies and harvested them, and used them for a personal scale like charging the mobile or recharge a remote rechargeable battery or the battery of the coffee mixer that will have a noticeable change, because by utilizing from our wasted energy, we save the electricity that we already have that can be used for something more important and more sufficient like operating a factory for example instead of wasting the electricity on charging a mobile phone that is already fully charged.

 Our project is a device that harvest mechanical energy that is originated from a successive pressure that moves gears inside the gearbox.

**Positive consequences:**

 By harvesting personal energy, we can save this wasted energy in addition to avoiding wasting the electricity that we already have which absolutely if everyone utilized from his or her own energy will have a role in the economic growth by saving the electricity.

In addition, that, it will be a great start from us to use alternative energy on small scales.

**Negative consequences:**

The continuous electricity wasting which affects the economics in general.

Furthermore, we will waste our energy that we can utilize from it in many ways, as we will waste the mechanical energy

Research

 Google scholar was used to search about the grand challenges, and prior solutions. Trusted resources as websites that end with .org, .edu, and gov. websites that end with .net and blogs were avoided because they are untrusted resources.

**Topics that were researched:**

 1.Causes, effects, and consequences of climate change.
 2. Ways to reduce and adapt to climate change.

 3. Improve the scientific and technological environment t for all in Egypt.

* 4.Egypts vision in 2030 in improving the scientific and technological environment for all.

5. hybridized electromagnetic

6. Piezoelectric mechanism in shoes

7.ways to turn human power into energy

8.energy harvesting flooring mechanism, advantages, and disadvantages.

9.Renewable energy CO2/NO2/CO/SO2 sources and their effects on environment
10.Fossil fuels and its effects on environment
11. (EMEH) electromagnetic energy harvester
12.TEEH triboelectric energy harvester
13.Biomechanics and biophysics in energy harvesting
14.Harvesting energy from human activities
15.Smart shoes for mechanical energy harvesting
16.Generating electricity from footsteps

Other Solutions Already Tried

1-Energy Harvesting Flooring:

The Pavegen energy harvesting flooring device is a modular floor tile that transforms kinetic energy from a person's footstep into storable electricity. It is made up of three parts: an electro-magnetic generator, a triangular composite tile, and a weight that triggers the rotational movement of the generator beneath the surface. When the tile is stepped on, the surface compresses, generating electrical power from a hybrid-motion generator inserted inside the tile.



Fig (3) *energy harvesting flooring* *https://www.mdpi.com/1996-1073/13/20/5419*

The design’s strengths:

The structure of a Pavegen tile allows it to compress 5 mm per footstep and produce up to 8 Watts of energy where one footstep is capable of powering an LED-streetlamp for 30 seconds. The average person takes up to 4000 steps in a day which would approximately produce up to 32 kW. A recent Pavegen setup at a large outdoor festival attracted 250,000 steps and the power generated was used to charge 10,000 mobile phones.

The design’s weaknesses:

looking at the bigger picture, when taking 3.5 MJ of daily excess from a single person and multiplying the world population of roughly 10 billion individuals, the result is 3.5 × 1016 joules. Then multiply that by the 365 days in a year for a total of 1.3 × 1019 joules per year. Unfortunately, the overall energy required annually by the public is 5.5 1020 joules.

# 2-Portable Smart Phone Charger Using Human Mechanical Energy by Gear Train with Hand Crank:

Mechanical hand crank mobile charger is a device that utilizes mechanical energy, converts it into electrical energy and charges the mobile. It doesn't require any electrical source. A gear train and intermediate gears for transformation of mechanical energy from hand crank to generator were used.

The design’s strengths:

The hand cranking mechanism generates voltage instantly and quite easily. Furthermore, the gear box train allows us to generate short amount of power through cranking. Also, by going for this alternative source of energy the human footprint on Earth can be reduced as they are using human effort instead of conventional electricity

The design’s weaknesses:

The gear train system is quite bulky, less portable and performs poorly to charge up the latest smart phones. The output voltage was only enough to charge up a simple Li-ion battery which has less current rating used in usual cell phones. The design worked properly in charging up such cell phones which have current rating less than the smart phones.

3-Thermoelectric Energy Scavenging for Wearable Devices:

It’s small-size energy scavenger is placed on the body in which the human being serves as a heat source for the thermopile of the scavenger, but the latter serves as a thermally insulating object. As a result, the body properties, namely, the skin temperature, heat flow, and thermal resistance locally change. This is the result of redirection of heat flow inside the body to colder zones because of thermal insulation provided by the scavenger. Increased thermal resistance of human body, in turn, affects the design of the scavenger.

The design’s strengths:

It is commonly believed that the radiator of a TEG only decreases the thermal resistance of ambient air: the larger its area of contact with air, the lower the thermal resistance of air, and the higher the heat flow. However, this design has shown that the heat flow, increased due to radiator, affects (decreases) the local thermal resistance of human body under the TEG. This positive feedback results in further increase of heat flow locally and helps to produce more power in a wearable energy scavenger per its volume and per unit area on the skin.

The design’s weaknesses:

The measurements performed with the TEG-2 at ambient temperature of −2◦C have shown that a power of 1.2 ± 0.2 mW/cm2 can be produced unobtrusively, with no sensation of cold induced by the device. Most of the time people spend indoors where the temperature is maintained at a comfortable level by either heating or air conditioning. Therefore, on average, wearable TEG will not produce more than 10–30 mW/cm2 in any climate.

II. Generating and Defending a Solution:

Solution and Design Requirements:

 Harvesting wasted energy from human behavior as a source of energy and convert that into another form of energy or another use at a personal scale is the challenge needs to be achieved. Many activities we do everyday release energy which could be used. Movements of hands and legs or from the pressure they do on objects could be a way. Energy is released even when humans are sitting. The solution we are choosing shouldn't require a strong source of energy; it should take the small energy released and use it in an efficient way on small scale by using different mechanisms to harvest it. The device should be connected directly with the source so that nothing is wasted when being transferred which could be achieved by constructing small circuits to transfer this energy, it should be easy to use so it doesn't obstruct the activity. Also, the behavior chosen as an energy source should be unintentional to do on daily basis. The chosen solution is a device that contains gears, generator, re-chargeable battery and a Thermoelectric Generator. When pressing on it to erase the board, a handle is pressed by this action which rotates the gears connected to the generator from the inside storing this energy in the re-chargeable battery, that converts the mechanical energy from muscle power then storing it. On its surface is a Thermoelectric Generator which converts the thermal energy from our hands when holding it also to store it. The device chosen should have design requirements to convert this idea to a design that should be followed when constructing, our design requirements are the efficiency of the process as the energy produced over energy consumed should be high (energy out/energy in). As pressure is applied on the device, it should tolerate this pressure without breakage.

selection of solution:

 After many researches, thinking deeply following the **EDP** steps and search the best solution that can fit these design requirements, we determined our way which is increasing the efficiency

 Where we use gears, a generator, and a battery. The gears convert the kinetic energy from the pressure of the human mechanical energy, and then the generator converts this mechanical energy into another electrical energy (it is stored in a battery that can be used in some home appliances).

Safety: Electricity is stored in a battery, and the device will be made from the outside with an electrical insulating material that will not cause any harm to those who use it.

Selection of prototype:

 Our prototype is a device that will contain gears and a thermoelectric generator (TEC). When pressure is applied to the duster, the gears are going to move converting kinetic energy to mechanical energy. The gears are connected to a generator which will convert the mechanical energy to electric energy, then the electric energy is going to be stored in a rechargeable battery. This stored energy can also be used in operating some home appliances as remotes and clocks. The chosen design requirement is efficiency. It can be tested by calculating the mechanical advantage which is the output divided by the input value. The second part of the project is about a coil and is wrapped around magnet and put that on the bicycle, so when we start to move Paddles, the magnet will turn on around the coil then mechanical energy will turn into electricity. the last part is bracelet that is going to convert kinetic energy to electricity by electromagnetic hybrid. This is going to achieve the seventh goal of the sdgs which is clean and affordable energy.