Portable Self-Sustaining Electric Generator

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Abstract

The proposed project is the idea of the researcher which addresses the needs of the community of having a less fuel, less pollutant and less worry about the source of electricity. This paper is a proposal for possible solution on the fuel shortage in the market and global warming. It includes the lay-outing, designing and identifying components for the proposed project. Components of the Portable Self-Sustainable Electric Generator have been identified. The researcher came up with a final design with the components' configuration and specifications. Hopefully, the development of this project has been recommended.

Keywords: *Portable, Generator, Sustain, Electric motor*

Introduction

Electric generators come with different forms. Generation of electricity from different primary sources where waterfall is the famous among it have been made. Wind energy was also a source of the electrical energy in other countries that wind is continuously blowing. Solar panels have been also converted solar power to electrical power which is now abundant in many tropical countries. Those mentioned, the prime movers were all come from naturally made sources.

Portable generators were made possible with the use of fuel, diesel or gasoline. They were proven useful in many ways in different part of the globe. Many things have been also done for the improvement of such generator; lessen the noise generated, smoke free, less fuel consumption, portability, etc. The biggest problem still is the rising price of the fuel in the market which is very needed to make the generator runs.

Wind turbines were proven also as one the sources of electrical energy to those countries with continuous blows of wind. Concepts behind were the almost the same with the motor generators, they both have primary mover which is the mechanical part that make and produces electrical energy. In the Philippines, even though there were winds to power up the turbine, but the continuity of the wind blowing was not that every time and every day depending on the season and the climate. But there were places in the country that according to some experts could be a source of wind farming.

The town of Bangui in Ilocos Norte is one of the few shining examples in the region that wind power could be used to provide affordable and clean energy for a vast chunk of a province's population and industry. The geography of Bangui is perfect for the wind farms. The coast faces the South China Sea – a very favorable body of water to face, considering all the monsoon activity that happens in the area (Espina, 2010).

The idea of using a prime mover that is also having electricity as the fuel of the prime mover of the electric generator have been conceptualized while studying the idea of having a wind turbine as source of electricity. Putting up a wind turbine in the Philippines might result with non-continues generation of electricity since there are times that no wind blows.

The electric generator itself will supply the electricity to the prime mover of the proposed project, while also generating electricity for the load. Two motors will be use in the said scenario of the project. There will be controller with an embedded system that will control, monitor and maintain the system.

Objectives of the Study

General Objective

Conceptualization of a portable fuel-free electric power generator.

Specific Objectives

1. Identify the components needed
2. Conceptualize the design lay out
3. Come up with a finalized design

Technical Data and Information

In normal motoring mode, most electric motors operate through the interaction between an electric motor's magnetic field and winding currents to generate force within the motor. In certain applications, such as in the transportation industry with traction motors, electric motors can operate in both motoring and generating or braking modes to also produce electrical energy from mechanical energy. Found in applications as diverse as industrial fans, blowers and pumps, machine tools, household appliances, power tools, and disk drives, electric motors can be powered by direct current (DC) sources, such as from batteries, motor vehicles or rectifiers, or by alternating current (AC) sources, such as from the power grid, inverters or generators. Small motors may be found in electric watches. General-purpose motors with highly standardized dimensions and characteristics provide convenient mechanical power for industrial use. The largest of electric motors are used for ship propulsion, pipeline compression and pumped-storage applications with ratings approaching a megawatt. Electric motors may be classified by electric power source type, internal construction, application, type of motion output, and so on. Devices such as magnetic solenoids and loudspeakers that convert electricity into motion but do not generate usable mechanical power are respectively referred to as actuators and transducers. Electric motors are used to produce rotary or linear torque or force (Electric Motor, 2013). Applying those parts and components of DC or AC motors to produce electricity in the proposed projects will be come to mind for the prime mover but for the main source; it will be then a reference in doing so since the researcher is thinking of doing a homemade stator, series of magnets with alternate north and south polarity. The researcher will test how much powers the generator will produce and how much power the prime mover will need to actuate.

An Inverter is a device which converts/changes AC power to DC power. Most commonly used inverters have an input of 12v DC and 240v AC with a frequency of 50/60 Hz. Although the AC output can be adjusted by the preset/potentiometer on the circuit to give 110V AC. Another thing to consider during the construction project of inverter is where it will be used (Mirish, 2011). It is very necessity in the proposed project for fewer burdens in the production of more circuit which will convert DC to AC or vice versa. In an electric motor the moving part is the rotor which turns the shaft to deliver the mechanical power. The rotor usually has conductors laid into it which carry currents that interact with the magnetic field of the stator to generate the forces that turn the shaft. However, some rotors carry permanent magnets, and the stator holds the conductors (Electric Motor, 2013).

The stationary part of a motor, dynamo, turbine, or other working machine about which a rotor turns is the stator or it is a portion of a machine that remains fixed with respect to rotating parts, esp. the collection of stationary parts in the magnetic circuits of a machine (stator). In case of the prime mover it will be part of the motors itself while in the main source, it will be made by the researcher.

Windings are wires that are laid in coils, usually wrapped around a laminated soft iron magnetic core so as to form magnetic poles when energised with current. Electric machines come in two basic magnet field pole configurations: *salient-pole* machine and *nonsalient-pole* machine. In the salient-pole machine the pole's magnetic field is produced by a winding wound around the pole below the pole face. In the *nonsalient-pole*, or distributed field, or round-rotor, machine, the winding is distributed in pole face slots. A shaded-pole motor has a winding around part of the pole that delays the phase of the magnetic field for that pole. Some motors have conductors which consist of thicker metal, such as bars or sheets of metal, usually copper, although sometimes aluminum is used. These are usually powered by electromagnetic induction (Electric Motor, 2013).

A commutator is a mechanism used to switch the input of certain AC and DC machines consisting of slip ring segments insulated from each other and from the electric motor's shaft. The motor's armature current is supplied through the stationary brushes in contact with the revolving commutator, which causes required current reversal and applies power to the machine in an optimal manner as the rotor rotates from pole to pole. In absence of such current reversal, the motor would brake to a stop. In light of significant advances in the past few decades due to improved technologies in electronic controller, sensorless control, induction motor, and permanent magnet motor fields, electromechanically commutated motors are increasingly being displaced by externally commutated induction and permanent magnet motors (Electric Motor, 2013).

Mentioned in the previous paragraphs were the parts and technical data of the motors, inverters and other components. There were no doubts that the existing products were quality assessed and usable but the gas generated by those products (fuel powered generators) was harmful. Portable and standby generators produce dangerous carbon monoxide (CO) gas, which can be deadly if inhaled (Gromicko). It was also evident that the rising of fuel prices were enormously high. Petrol has become an indispensable part of our day-to-day life, and we can’t imagine our life without it. But the petrol prices are sky rocketing, and it is eventually going to affect each and everything that we use in our day to day life. Poor people are already working hard to earn square meal a day and this hike is definitely going to paralyze these already-burdened people. Within three years petrol price has increased 10 times and is still increasing. It is nothing but adding fuel to the fire. Petrol hike directly or indirectly affects all the major sectors like transportation, textiles, auto, FMCG etc, for manufacturing & transportation. This affects the prices of daily essential commodities which are transported on a daily basis (Singh).

Another reason of proposing the project was that the project might contribute in the less consumption of fuel and might also be producing less pollutant.

Survey of Related Literature

The re-emergence of the wind as a significant source of the world's energy must rank as one of the significant development of the late 20th century. The advent of the steam engine, followed by the appearance of other technologies for converting fossil fuels to useful energy, would seem to have forever relegated to insignificance the role of the wind in energy generation. In fact, by the mid 1950s that appeared to be what had already happened. By the late 1960s, however, the first signs of a reversal could be discerned, and by the early 1990s it was becoming apparent that a fundamental reversal was underway. That decade saw a strong resurgence in the worldwide wind energy industry, with installed capacity increasing over five-fold. The 1990s were also marked by a shift to large, megawatt-sized wind turbines, a reduction and consolidation in wind turbine manufacture, and the actual development of offshore wind power. During the start of the 21st century this trend has continued, with European countries leading the increase via government policies focused on developing domestic sustainable energy supplies and reducing pollutant emissions. To clearly understand what was happening, consider five main factors. First of all there was a need. An emerging awareness of the finiteness of the earth's fossil fuel reserves as well as the adverse effects of burning those fuels for energy had caused many people to look for alternatives. Second, there was the potential. Wind exists everywhere on the earth, and in some places with considerable energy density. Wind had been widely used in the past, for mechanical power as well as transportation. Certainly, it was conceivable to use it again. Third, there was the technological capacity. In particular, there had been developments in other fields, which, when applied to wind turbines, could revolutionize the way they could be used. These first three factors were necessary to foster the re-emergence of wind energy, but not sufficient. There needed to be two more factors, first of all a vision of a new way to use the wind, and second the political will to make it happen (James F. Manwell, Jon G. McGowan and Anthony Rogers, 2009).

Although wind is an abundant source of energy, and the same is true for solar energy, one has to bear in mind that it is not a continuous source with a constant supply. Any renewable energy, although plentiful, suffers from two major drawbacks; it is a low-level energy and it is not continuously available. Being a low-level energy implies that we cannot expect to have a wind turbine with same capacity as a thermal plant. A thermal plant (steam and gas turbines) can have a capacity of 500 MW or more with only one or a few turbines, whereas for that capacity we may need at least 200 wind turbines in an onshore wind farm. Moreover, a 500 MW thermal power plant is normally capable of delivering that much power on a continuous basis, whereas the output of a wind turbine depends on the wind and fluctuates with the time of the day and the month of the year (Hemami, 2012).

Output estimation of the wind turbines (Gipe, 2004)

Swept Area Method

$$A = \pi(D/2)^2$$

Where:

A= area of the rotor
D = diameter of the rotor

$$AEO = \left(\frac{P}{A}\right)(A)(\%efficiency)\left(8760\,\frac{h}{yr}\right)\left(\frac{1kW}{1000W}\right)$$

Where AEO = annual energy output
P/A = power per area

In this estimation tool, if the diameter of the rotor is 12 inches (0.305m) and at a speed of 10mph and approximately 100W/m^2, the possible AEO is 19.18kWh/yr.

An electric generator is a device designed to take advantage of electromagnetic induction in order to convert movement into electricity. A generator is designed to obtain an induced current in a conductor as a result of mechanical movement, which is utilized to continually change a magnetic field near the conductor. The generator thus achieves a conversion of one physical form of energy into another – energy of motion into electrical energy- mediated by the magnetic field that exerts forces on the electric charges. In this sense, generator is the opposite of an electric motor, which accomplishes just the reverse: the motor converts electrical energy to mechanical energy of motion, likewise mediated by the magnetic field. As far as the physical principles are concerned, electric generators and motors are very similar devices; in fact, an actual generator can be operated as a motor and vice versa (Meier, 2006).

The stator and rotor are made from iron plus 0.5 %silicon very low carbon steel sheet. The shapes are stamped out of the thin gauge sheet and stacked together to make the solid shapes. Sometimes the individual stamped segments have an insulating coating to cut down on heating in the machine but that would be most common in large and/or expensive machines. Big electrical machines are made from iron alloys with up to 3.5% silicon (Yahoo Answers).

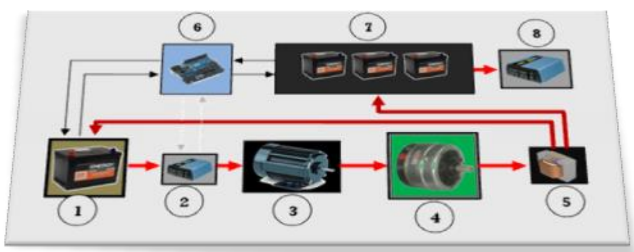
In very small electric motors which run on dc (direct current) a permanent magnet made of iron - or of some other alloy of elements capable of being magnetised - is used to create the two poles of the stator. The rotor is built-up using windings made of insulated copper wire wound onto poles made of layers of well-insulated thin cast iron sheets which are called "laminations". The thin sheets must be well insulated from one another to minimize power wastage caused by internal eddy currents that are induced as the rotor's poles continually break the stator's magnetic field. In larger motors, which may run on either dc or ac (alternating current), the stator's magnetic field is created by field windings made of insulated copper wire wound around pole pieces which are not permanently magnetized. For use with ac the stator, like the rotor, must be constructed either: using laminations of thin cast iron sheets, well insulated from one another, to minimize power wastage caused by internal eddy currents that are induced into the stator by the field winding, or using a non-magnetic material, such as aluminum, which cannot have eddy currents induced into it (Martinel).

Cables are normally used for a low-voltage application, where the overhead line erection is impractical. Normally, cables are placed under the ground but sometimes it is also handed on towers. Since copper is normally used in cables, the cost of conductor is high in the case of cable compared to overhead lines where aluminum conductors are used. Another cost involved in cables is the cost of insulation which is air in the case of overhead lines. The erection costs of overhead lines are higher than that of the cable (Singh S. N., 2008).

Technical Design and Specifications

Design Layout and System's Components

The following diagram was conceptualized depending on the idea taken from experience and other related literature.



1. Power Source of the Primary Mover
2. Inverter (12vdc – 110vac)
3. Primary Mover
4. Generator (AC/DC)

5. Transformer
6. Controller
7. Series of Battery for the Load
8. Inverter for the Load (12VDC to 220VAC)

Figure 1 Conceptual Layout and Components of the Proposed Project

Figure 1 shows the ideas of the researchers of the configuration and possible components of the project. In this layout, power source of the primary mover which a battery so that there is the saving of electricity so that whenever there is a need to stop the system and start it again there is already an electricity to do it. The (2) inverter in between 1 and 2 is placed if in case that the researcher decided to use an AC motor or else that will be a step-up transformer. (3) Primary mover should have enough power to move the generator's shaft. (4) Generator will then generates AC electricity that will subjected to transform to DC by the use of the (5) transformer. The researcher is thinking of making a DC generator so that components will be lessened. (6) Controller will be programmed to detect if the batteries in the system are already full charged then it will stop charging nd/or stop the system and if it detected that the batteries were already reached the discharge level then it will automatically turn on charging or turn on the system. (7) Series of batteries were conceptualized to preserve more electrical energy for future need or even during the operation. Lastly is the (8) inverter for the load if it is AC appliances.

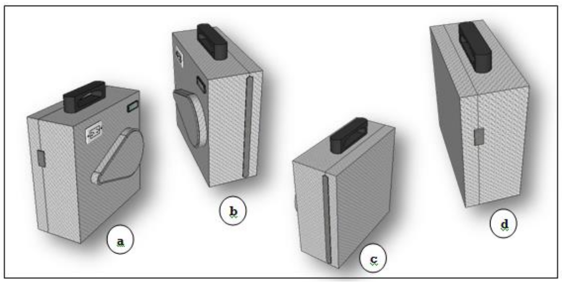


Figure 2 Conceptual Packaging of the Proposed Project

Figure 2 shows the idea of the researcher on how the project will be put into one package. Figure 2 (a) shows the front view of the packaging of the project. Figure 2 (b) shows the other side of the front view. Figure 2 (c) and (d) show the back view of the packaging.

Materials Specifications

Components of the proposed project with its specifications include in this part of the documentation. In the following table, Table 1, the researcher included the needed components and its specification where in the dimensions of the components were also suggested as well as the height and weight.

Packaging

The researcher has searched on the best plate for the project so that the packaging will be economical and safe for the user of the proposed project. Packaging of the proposed project will be metal plate coated with rubber plate for the insulation and safety.

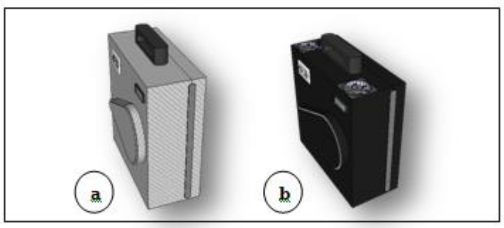


Figure 3 Packaging

Figure 3 shows the concept of the researcher in the packaging of the proposed project. Figure 3 (a) is the first plate which is metal plate. Figure 3 (b) is the second coat of the project which is the rubber plate. In this case the researcher added exhaust fan for some cooling system.

Selection Process

The researcher has been adapting the selection process of Thales (Thales, Thales)**.**

1. Preselection
2. Evaluation to Deliver Performance
3. Competition
4. Final Selection
5. Performance Management

Final Design set-up

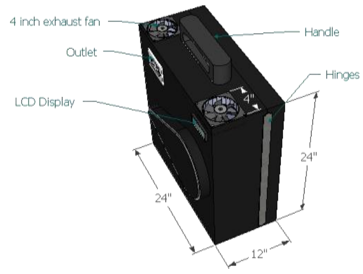


Figure 4 Final Packaging Design of the Portable Self-Sustaining Generator

Figure 4 shows the dimension of the final design of the project. In which the LCD display has been added for the simple monitoring of the system itself.

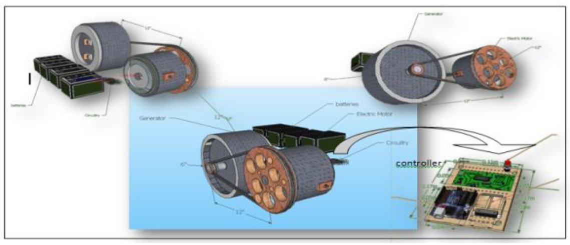


Figure 5 Different 3D Views of the Components' Connection of the Proposed Project

Figure 5 shows the views of the connection of the components inside the packaging wherein the generator and the electric motors are given emphasis in the figure since they are the two main characters in the project.

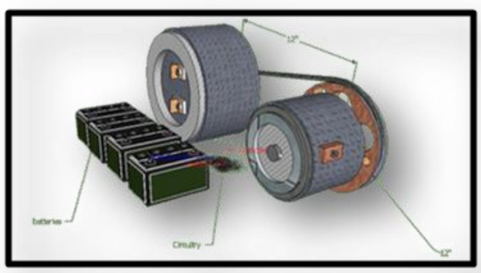


Figure 6 Rear View

Figure 6 shows the rear view of the components connection inside the packaging of the proposed project.

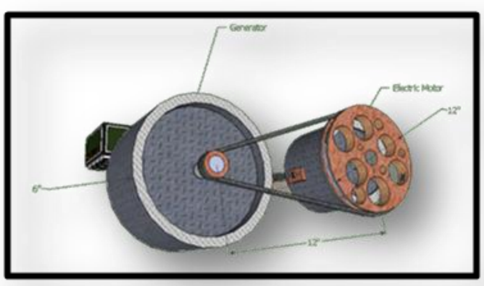


Figure 7 Front View

Figure 7 shows the front view of the components' connection inside the packaging of the proposed project.

Summary of Findings, Conclusions and Recommendations

Summary of Findings

The researchers have identified the needed components for the realization of the project. Inverters, transformer, electric motor, generator, batteries, controller and wires were the components of the self-sustaining power generator. Materials needed have been also identified for the packaging of the project. The conceptualization of the design have been done by using the selection process of the components and depending also in the needed flow of the project with respect to the concepts behind every components. The researcher has come up with the final design and specifications of the project.

Conclusions

1. Different components needed in the proposed project have been identified.
2. The researcher conceptualized the design layout with respect to the literature surveys and some experience in the field.
3. Final design has been formulated.

Recommendations

1. The researcher is recommending the development of such project.
2. Test the efficiency of the project in terms of the accuracy of the output voltage, reliability of the output, safety, life span of the project and other parameters as suggested by the standard body for a standard portable generator.

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