

Utilizing Wind Blowing Between Two Tall Buildings As A Free Electric Source

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Abstract – This paper presents a study on the feasibility of capitalizing the wind energy produced between two tall buildings. A system is designed to “capture” the energy. Used computer fans are arranged so as to obtain maximum possible voltage output. The voltage output is fed to a dc to dc converter, which is then stored in capacitor banks. The challenges are to i) boost up small voltage produced by the fans and ii) be able to store the charges in capacitor banks for a relatively long period. All the systems design are analyzed and the results are concluded.

Keywords-component; free electric source; dc to dc converter; capacitor bank;

I. INTRODUCTION

The past 100 years has shown that the fossil fuel was the only source of energy that can satisfies consumer’s energy requirement. However, the diminishing of fuel reserve and the intention to secure the supply for generation world over has made certain countries use renewable energy. Between all those available renewable energies, the chosen green energy that has the potential to be developed is wind energy [1], but the disadvantage is that wind power generation is intermittent, depending on weather conditions. There are many uses of electrical energy produced by a wind turbine. Converting wind energy into electric energy enables the user to store energy in a battery, transmit it over long distances, or convert the energy into many different forms (mechanical energy, heat, etc.).

Wind is one of the most important and the most technically suitable energy source. It has a lower production cost than solar thermal electricity. It saves land since land area within a wind farm is still available for cultivation. It creates more employment, in particular for the local people, because the installation, operation and maintenance of wind turbines and wind farms are almost exclusively in rural areas and generally of modest scales [2].

The speed of wind blowing between two obstacles is different than the speed of wind that blows freely. It can be

utilized as a free electric source by placing wind turbine and then generate the energy. This project undertakes the wind blowing two tall buildings as the renewable energy to charge cell phones. The data related to the wind is important on generating the energy of the system. The system for charging cell phones used computer fans as the wind turbine. How much energy capture by the computer fan will affect the system function ability of. Enough energy need to be generated in other to match the energy needed for charging cell phones. For the system designing part, energy storing when it is generated from the computer fan needs to be considered too.

II. BUILDING BLOCK

A. Fan

The wind turbine that is being used to “capture” the energy from the wind is used computer fans. Computer fan is also called as axial fan. The axial-flow fans have blades that force air to move parallel to the shaft about which the blades rotate. Axial fans blow air along the axis of the fan, linearly, hence their name [3].

Computer fans often use two phase brushless motors to reduce electrical noise and to extend fan life. They are made with the winding on the inside of the motor (stator), and the magnet on the outside (rotor) [4]. Two phase motors are typically more complicated and expensive than one phase motors (unidirectional current) but they have the advantage of a controlled starting direction. Both motors consist of a permanent magnet on the rotor, containing at least one pole pair, and a stator that contains an electrical winding (Figure 3). Current is placed in the coil to create a magnetic field that interacts with the permanent magnet, resulting in a torque on the rotor [4].

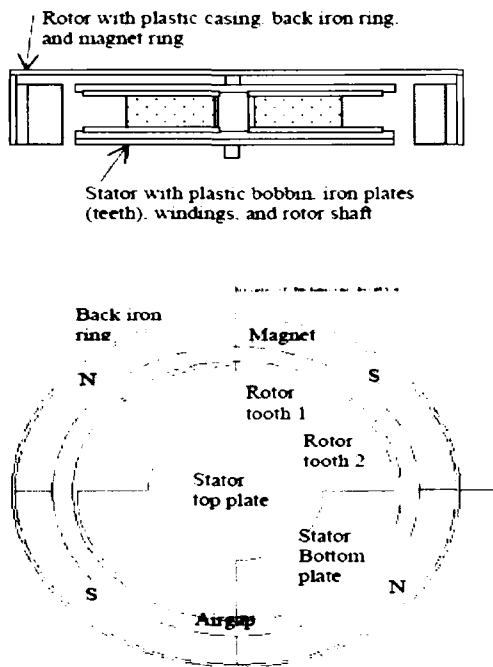


Figure 1 Parts of brushless motor computer fan

B. Voltage amplifier

Voltage amplifier increases the voltage of an input signal, delivering an output signal that is larger than the input by a specified ratio. Since the voltage that is produced from the computer fans is too small, there is need of a voltage amplifier to boost up the voltage to a value that suitable to charge cell phones. The input voltage is a direct current (dc) voltage, then dc to dc converter is used to convert it to a larger voltage.

The conversion of rectified dc voltage to any specified dc output voltage can be carried out employing a chopper circuit [5].

The boost chopper output voltage is obtained as

$$V_o = V_s \left(\frac{T}{T - T_{on}} \right) \quad (1)$$

$$V_o = \frac{V_s}{1 - \delta} \quad (2)$$

where δ = Duty ratio of the chopper

C. Energy Storage System

The operation of an energy storage element is that to store the excess energy whenever the generation exceeds the load and to use it whenever needed. It is important to take into consideration the charging and discharging characteristics of the storage element.

Electrical energy in an ac system cannot be stored electrically. However, energy can be stored by converting the ac electricity and storing it electromagnetically, electrochemically, kinetically, or as potential energy. Each energy storage technology usually includes a power

conversion unit to convert the energy from one form to another. Two factors characterize the application of an energy storage technology. One is the amount of energy that can be stored in the device. This is a characteristic of the storage device itself. Another is the rate at which energy can be transferred into or out of the storage device.

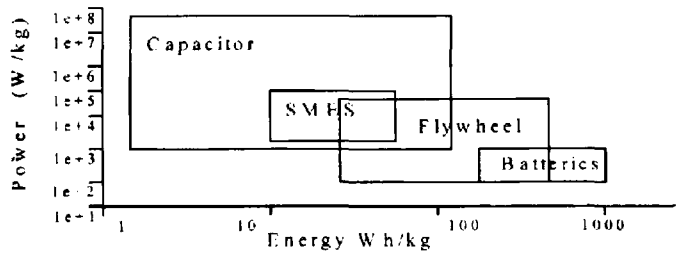


Figure 2 Specific power versus specific energy ranges for near-to-midterm technology [6]

The energy ranges for near-to-midterm technologies are projected in Figure 4. Integration of these four possible energy storage technologies with flexible ac transmission systems (FACTS) and custom power devices are among the possible power applications utilizing energy storage.

1) Superconducting Magnetic Energy Storage (SMES)

SMES systems have attracted the attention of both electric utilities and the military due to their fast response and high efficiency (a charge-discharge efficiency over 95%). Possible applications include load levelling, dynamic stability, transient stability, voltage stability, frequency regulation, transmission capability enhancement, and power quality improvement. When compared with other energy storage technologies, today's SMES systems are still costly [6].

An SMES unit is a device that stores energy in the magnetic field generated by the dc current flowing through a superconducting coil. The inductively stored energy (in joules) and the rated power (in watts) are commonly given specifications for SMES devices, and they can be expressed as follows [6]:

$$E = \frac{1}{2} LI^2 \quad (3)$$

$$P = \frac{dE}{dT} = LI \frac{dI}{dT} = VI \quad (4)$$

where L is the inductance of the coil, I is the dc current flowing through the coil, and V is the voltage across the coil. Since energy is stored as circulating current, energy can be drawn from an SMES unit with almost instantaneous response with energy stored or delivered over periods ranging from a fraction of a second to several hours.

2) Battery Energy Storage Systems (BESS)

Batteries can store dc charge. They are one of the most cost-effective energy storage technologies available, with energy stored electrochemically. A battery system is made up of a set of low-voltage/power battery modules connected in parallel and series to achieve a desired electrical characteristic. Batteries are "charged" when they undergo an internal chemical reaction under a potential applied to the terminals. They deliver the absorbed energy, or "discharge," when they reverse the chemical reaction [6].

Due to the chemical kinetics involved, batteries cannot operate at high power levels for long time periods. In addition, rapid, deep discharges may lead to early replacement of the battery, since heating resulting in this kind of operation reduces battery lifetime. There are also environmental concerns related to battery storage due to toxic gas generation during battery charge/discharge. The disposal of hazardous materials presents some battery disposal problems. The disposal problem varies with battery technology. For example, the recycling/disposal of lead acid batteries are well established for automotive batteries [6].

3) Advanced Capacitors

Capacitors store electric energy by accumulating positive and negative charges (often on parallel plates) separated by an insulating dielectric. The capacitance, C , represents the relationship between the stored charge, q , and the voltage between the plates, V , as shown in (5). The capacitance depends on the permittivity of the dielectric, ϵ , the area of the plates, A , and the distance between the plates, d , as shown in (6). Equation (7) shows that the energy stored on the capacitor depends on the capacitance and on the square of the voltage [6]:

$$q = CV \quad (5)$$

$$C = \frac{\epsilon A}{d} \quad (6)$$

$$E = \frac{1}{2} CV^2 \quad (7)$$

$$dV = i \times \frac{dt}{C_{tot}} + i \times R_{tot} \quad (8)$$

The total voltage change when charging or discharging capacitors is shown in (8). Note that and are the result from a combined series/parallel configuration of capacitor cells to increase the total capacitance and the voltage level. The product determines the response time of the capacitor for charging or discharging [6].

Capacitors are used in many ac and dc applications in power systems. DC storage capacitors can be used for energy storage for power applications. They have long seen use in pulsed power applications for high-energy physics

and weapons applications. However, the present generation of dc storage capacitors sees limited use as large scale energy storage devices for power systems. Capacitors are often used for very short-term storage in power converters. Additional capacitance can be added to the dc bus of motor drives and consumer electronics to provide added ability to ride voltage sags and momentary interruptions [6].

4) Flywheel Energy Storage (FES)

Flywheels can be used to store energy for power systems when the flywheel is coupled to an electric machine. In most cases, a power converter is used to drive the electric machine to provide a wider operating range. Stored energy depends on the moment of inertia of the rotor and the square of the rotational velocity of the flywheel, as shown in (9). The moment of inertia (I) depends on the radius, mass, and height (length) of the rotor, as shown in (10). Energy is transferred to the flywheel when the machine operates as a motor (the flywheel accelerates), charging the energy storage device. The flywheel is discharged when the electric machine regenerates through the drive (slowing the flywheel) [6].

$$E = \frac{1}{2} I\omega^2 \quad (9)$$

$$I = \frac{r^2mh}{2} \quad (10)$$

III. METHODOLOGY

In producing the output from the computer fans, they are tested in series and parallel arrangement in order to get the voltage that is greater than the voltage of one computer fan. But at first, the computer fans is measured the voltage of each of them can produce. A multimeter is used to measure the voltage from a load that is connected to the computer fans arrangement. The test used the wind that blow from standing fan which have 3 speeds with a distance of 1m. The lowest speed is being used. The results will then being recorded in a table.

For the voltage booster, a dc to dc converter is being used. An operational amplifier is being tested to amplify the input voltage. The circuit is simulated using Multisim before the experiment part take place. Figure 4 shows the flow diagram of the experimental process.

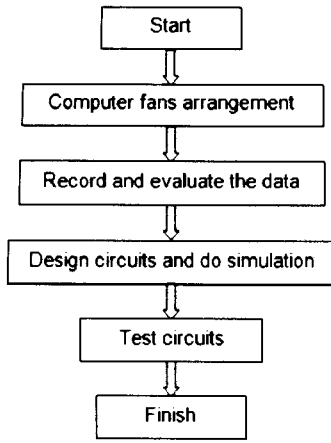


Figure 3 Flow diagram

IV. EXPERIMENTAL

A. Computer Fans Arrangement

10 used computer fans are being measured the voltage that each computer fan can produce as in Figure 5 below. The range of voltage of each tested computer fan is between 0.015V~0.005V. So, 16 computer fans are decided to be used to get the voltage that much higher.

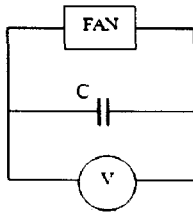


Figure 4 Voltage for each computer fan

The fans need to be arranged correctly so as to get the input voltage greater than one fan. The first arrangement is two fans are connected in series with a load, as in Figure 6 below. The voltage for each fan is 0.032V and 0.05V, respectively. The measurement voltage from this circuit is 0.03V, meaning there is no voltage increment.

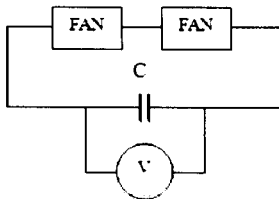


Figure 5 First arrangement

Figure 7 shows the second fans arrangement, which by adding another load in series with the first load. But still, the output voltage is 0.03V.

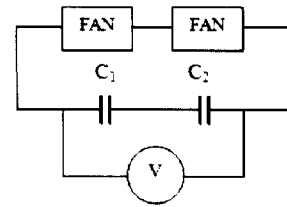


Figure 6 Second arrangement

The fan is then connected in parallel with a load and then in series with each other and a load. Figure 8 shows the arrangement. The output is still the same which the voltage did not increase.

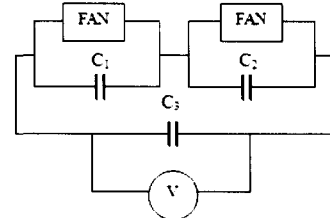


Figure 7 Third arrangement

The next arrangement is the fans are connected parallel with each other with a load as shown in Figure 9. The measurement voltage is 0.08V which means the voltage is greater than other arrangement and there is voltage increment.

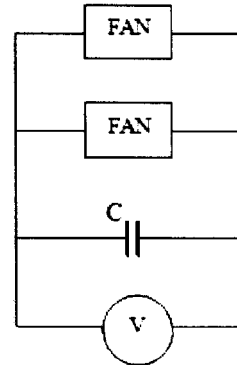


Figure 8 Forth arrangement

This system is then added more computer fans so that higher voltage can be produce by connecting them in parallel. Table 1 shows the number of computer fans and also the voltage for each increment of computer fan in that system with the voltage it can produce, with three different wind speeds of standing fan. Remind that, each computer fan has different voltage that it can produce. The distance from the computer fans to the standing fan is set to 1m.

Table 1

No. of computer fan	Voltage (mV)		
	Speed 1	Speed 2	Speed 3
1	20	23	25

2	69	79	87
3	78	95	102
4	70	94	111
5	95	118	138
6	105	138	160
7	110	168	191
8	120	180	205
9	130	201	228
10	138	225	270
11	145	249	278
12	170	257	293
13	186	266	313
14	202	280	330
15	211	278	345
16	235	291	355

From Table 1, as the number of computer fans increasing, the voltage does not increase that much which means the increment slow down, as shown in Figure 10 below:

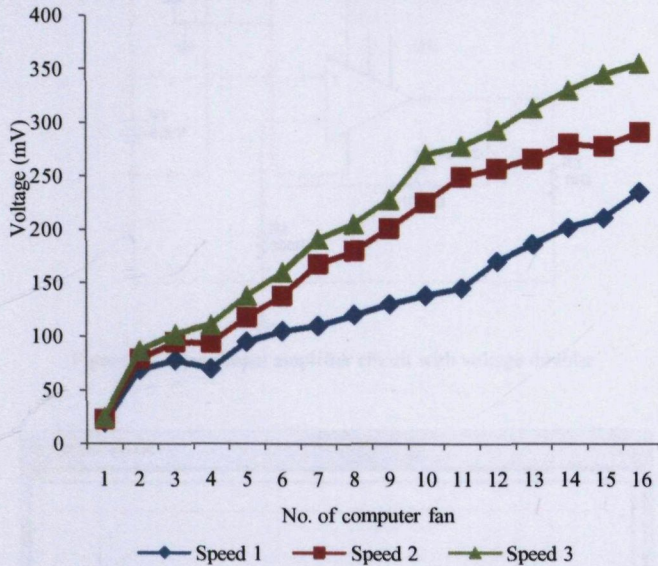


Figure 9 Voltage computer fans can produce for different wind speed

From the taken voltage measurement, maximum voltage that computer fans can produce is 0.35V. A system to amplify the input voltage is then being designed.

B. DC to DC Converter

An operational amplifier circuit could amplify the input voltage as shown in Figure 11 and the result obtained is shown in Figure 12.

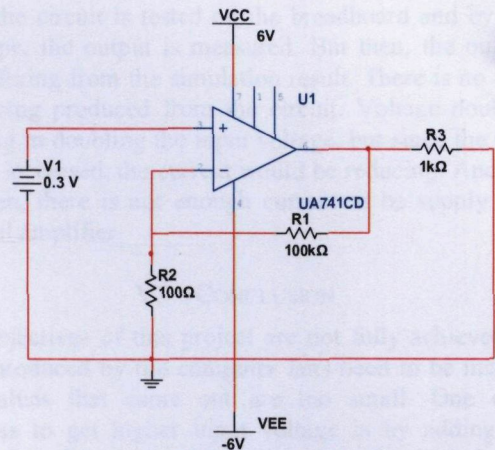


Figure 10 Operational amplifier circuit

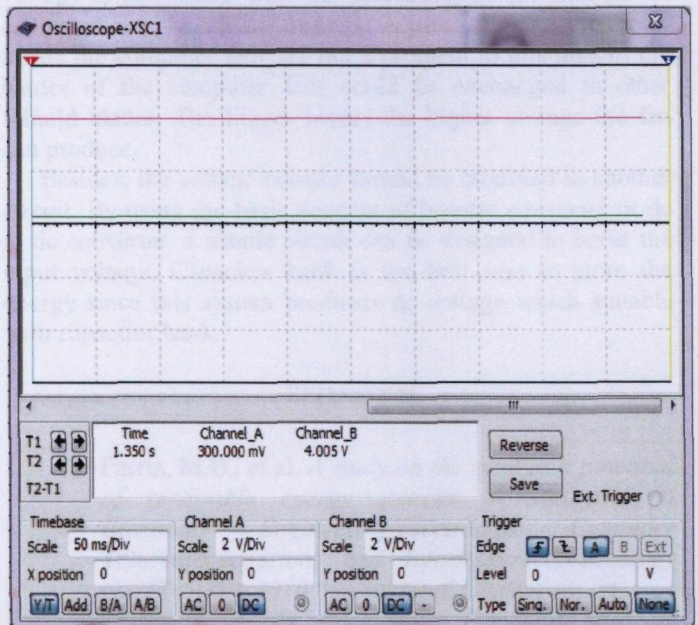


Figure 11 Simulation for operational amplifier

The circuit is injected with input voltage of 0.3V, and the output from the simulation is 4.005V. The operational amplifier type is UA741CD. It needs supply voltage, V_{CC} , to make it operate and functioning. Since this project only depend on the energy generated from the wind, it is impossible to use 0.3V from the input voltage as the supply voltage. Voltage doubler (Figure 13) could be used to amplify input voltage to the operational amplifier supply voltage.

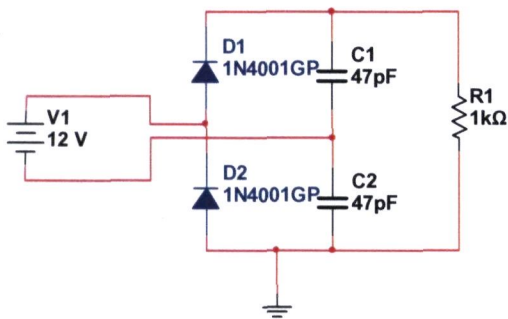


Figure 12 Voltage doubler

Figure 14 shows the circuit of voltage doubler being included into the operational amplifier circuit. That circuit is then simulated using Multisim and the graph and output from the circuit is shown in Figure 15. The output from the simulation is 2.399V.

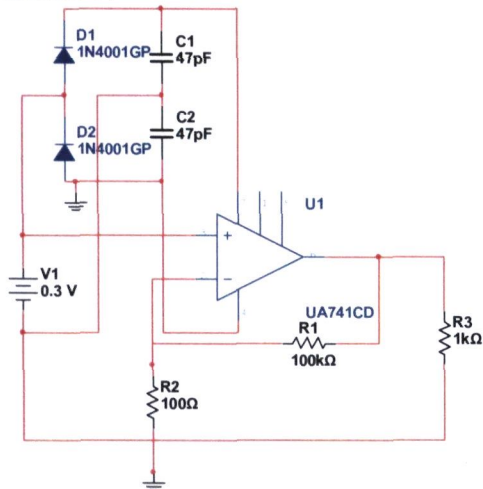


Figure 13 Operational amplifier circuit with voltage doubler

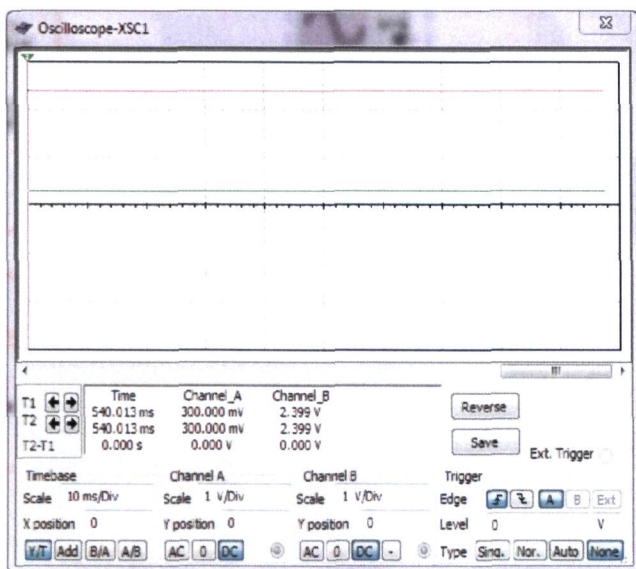


Figure 14 Simulation for operational amplifier and voltage doubler circuit

Then the circuit is tested on the breadboard and by using oscilloscope, the output is measured. But then, the output is totally differing from the simulation result. There is no output voltage being produced from the circuit. Voltage doubler is functioning in doubling the input voltage, but since the output voltage is increased, the current would be reducing. And when this happen, there is not enough current to be supply to the operational amplifier.

V. CONCLUSION

The objectives of this project are not fully achieved. The voltages produced by the computer fans need to be increased as the values that came out are too small. One of the suggestions to get higher input voltage is by adding more computer fans. It is proven from this research which the input voltage is increasing with the increasing of the number of computer fans, which are arranged in parallel. Since the motor inside the computer fans are not a problem to this matter, the blades of the computer fans could be exchanged to other rebuild blades. The bigger blades the higher voltage the fan can produce.

Besides, the voltage booster should be modified to another circuit. By using the basic concept of booster converter or dc to dc converter, a simple circuit can be designed to boost the input voltage. Capacitor bank is the best way to store the energy since this system produces dc voltage which suitable with capacitor bank.

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