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# Solar And Wind Powered Electric Bus

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***Abstract:*** At present, the available buses used for public transport require large quantity of fossil fuel which creates a demand for fossil fuel, where in fossil fuels are exhaustible in nature. In most of the developing countries buses are large in numbers, constitutes primary mode of public transport. To make the mass transport pollution free, it is time to upgrade the existing buses to run on alternate green fuel. This bus is more efficient and carbon free as compared to buses running on fossil fuels, as it uses alternate sources to drive the bus. During daytime solar energy charges the bus with the help of solar panel, the battery at standstill or in movement. Even during movement, the wind energy extracted is used to charge the battery using turbines mounted on top of Bus. The wind energy output depends on speed of bus.

***Keywords: Fossil fuels, solar panel, electric bus, wind energy***

## 1. INTRODUCTION

Currently, one of the greatest engineering issues to tackle is the need for clean energy sources. Much of the world is highly dependent on natural gases and coal to produce electricity. Although this power source is abundant, it is shown to assist in global warming. Furthermore, extraction methods such as fracking are shown to have detrimental effect on the environment, namely earthquakes. source of energy being heavily studied is solar energy. Until recently, the efficiency of the solar panels, used in collection of solar energy, was too low for it to be a viable option for replacing energy obtained from fossil fuels. Advances in materials has paved the way for using solar energy as a renewable resource that is slowly meeting the energy demands that society has become accustomed to. For this project, the concept of a solar vehicle will be designed and fabricated. The project is focused on the design of an electric driven vehicle that can regenerate power using solar & wind energy technology. If this type of vehicle became a standard commercial vehicle, the demand for fuel would decrease substantially. Designing this vehicle for practicality is the primary difficulty. The vehicle is being designed to house one driver; practically, there would be need for additional space for other passengers and materials. Another consideration in the use of solar energy to power a vehicle is that the solar panel must be efficient enough to generate enough power for propulsion in a reasonable amount of time. This leads to a variety of decisions that must be considered during the design process.

Both mechanical and electrical engineering considerations must be taken into account for the project. Components will be purchased and manufactured from raw materials to suit the application. Some components will need to be machined to specifications due to the abnormal size of the vehicle. Decisions will be made based on monetary constraints and fabrication feasibility. A solar-powered bus is a bus that is charged by solar panels which convert solar energy to electric power & is then used to fuel the bus. This bus is the more efficient and cheapest shortcut to a greener life. During the daytime, solar energy charges the bus with the help of a solar panel, the battery at standstill or in movement. Using solar energy reduces the load on the vehicle's alternator, Solar & Wind Powered Electric Bus which in turn helps in saving fuel and reduces carbon emissions. Even during movement, the wind energy extracted is used to charge the battery using turbines mounted on top of Bus. The wind energy output depends on the speed of the bus. Indeed, the excess energy can be stored in the battery, which can be used at night or when the weather is not capable of generating power. The main source of Air pollution in city environments is caused by vehicle exhaust fumes. Which happens to release a huge amount of carbon monoxides into the atmosphere affects greenhouse gases, which causes climate change and global warming. Solar power is the best desire for a clean & green sustainable future. Buses with solar panels reduce operational costs & harmful gases, thereby de-carbonizing public transport. This report discusses the concept which will make the electrical bus more efficient as compared to the current electric bus by encouraging the use of green energy & low-emission technologies. An electrical bus is driven by both the sources solar and wind, which is abundant in nature. Whereas the current electric buses use fuels to drive the bus. Photo-voltaic(PV)

panel will charge the battery bank and the wind turbine will also charge the battery bank and with the help of the charge controller the bank will discharge the battery and drive the motor.

## 2. LITERATURE SURVEY

In [1], the paper presents the design, simulation and control of a Hybrid Electric Vehicle (HEV) based on renewable energy sources [Kaldellis and Spyropoulos, 2017]. The proposed HEV design utilizes solar energy, wind energy, Fuel Cell (FC) which generates energy from Proton Exchange Membrane (PEM) and a Super Capacitor (SC) to meet the strong torque requirements. The vehicle incorporates a battery pack in conjunction with a SC for the power demands and FC as the backup energy supply. The design aims to ensure zero carbon emission, energy efficiency and light weight that will incorporate the use of in-wheel motors to eliminate the mechanical transmissions. To meet the vehicles power demands, the selection of energy sources are controlled by a rule based supervisory controller which follows a logical sequences that prioritize energy sources with the SC as a source in vehicle stop-and-go situations while battery will act as the primary source, FC as a backup supply and wind and solar power to recharge the battery. The controller also controls the energy flow from the alternator and monitors regenerative braking while switching to solar charging when the vehicle is parked.

In [2], naturally the possibility of using renewable in the charging process has also been addressed in the literature. [Fuentes et al., 2017] analyzed the model of a solar-powered vehicle-sharing system based on building integrated PVs which seems to be especially interesting for urban areas where the development of wind generation is strongly limited. [Fathabadi, 2017] proposed a novel grid-connected PV-powered charging station. The author focused on the process of effectively converting solar energy into electricity based on a precise maximal-power-point tracking technique. Fathabadi developed his model [Fathabadi, 2017] and equipped the charging station with a wind generator. According to the author this was the first study to ever consider such a hybrid as a viable power source for EV charging stations. In [Fathabadi, 2018] a concept of utilizing solar and wind energy in plug-in electric vehicles was proposed. What seems as a follow up of recent studies, the authors equipped the EVs charging station with a battery and fuel cell in order to increase the power station reliability.

## 3. OUTCOME OF LITERATURE SURVEY

Solar & Wind energy has been used in many applications for long time. Early usage of wind energy was in boat sailing. In the past decade, more and more interest in using wind energy for generating electricity had caught the attention of too many scientists, politician and common people. That was driven by high energy prices, scarcity of oil production and increase awareness among ordinary people to use environmentally friendly products as people became more environmentally conscience. One possible way to be environmentally friendly is to drive vehicles that run on renewable energy. Many vehicles in the market use renewable energy sources either in a hybrid fuel-electric form like Toyota Prius or in a hybrid hydrogen fuel-cell-electric form like Honda FCX. When driving during nice conditions (e.g. down the hill) the engine dis-engages from fuel and switches to a DC operation mode using the batteries which drives the motor. Lots of progress has been made on large-scale deployment of electric vehicles such as Plug-in Hybrid Electric Vehicle (PREV) to serve as battery storage. The concept of utilizing electric vehicles as battery energy storage system to increase the flexibility in power system operation has been proposed almost two decades ago. Recent studies showed that renewable energy resources such as solar & wind combined with electric energies are playing a major role in power production. A wind turbine mounted on the vehicle is used to generate electricity which in turn charges a bank of batteries. The Batteries drive 3-phase DC motor that moves the vehicle. A smart charging subsystem is proposed to enable charging the batteries.

## 3. PROBLEM STATEMENT

As can be seen it consists of two variable energy sources in the form of photovoltaic panels and wind generation. The charging station has some storage potential in the form of backup batteries which can be used when demand does not match supply from solar–wind sources. Apart from this it is connected to the local energy network, which is used both as a source of energy when solar–wind generation and storage is not sufficient to cover the demand, and as a surplus energy acceptor when energy surpluses from solar–wind generation occur. There are several parameters which describe the time during which the bus is at the charging station. The first is “duty time” – how long may be spent charging the bus to a given level. This given level is the minimum accumulated energy sufficient for performing tasks. “Reliability” describes the probability of successfully charging the batteries to the required level in time. The longer the procedure duration, the lower the level of battery charge, and a lower acceptable level of reliability facilitates the use of variable renewable energy sources, as it makes the unstable energy flux inherent in variable renewable energy sources more tolerable.

## 4. OBJECTIVES

- To design and build prototype bus based on solar and wind energy
- To utilize renewable energy efficiently
- To preserve non renewable energy sources

## 5. METHODOLOGY

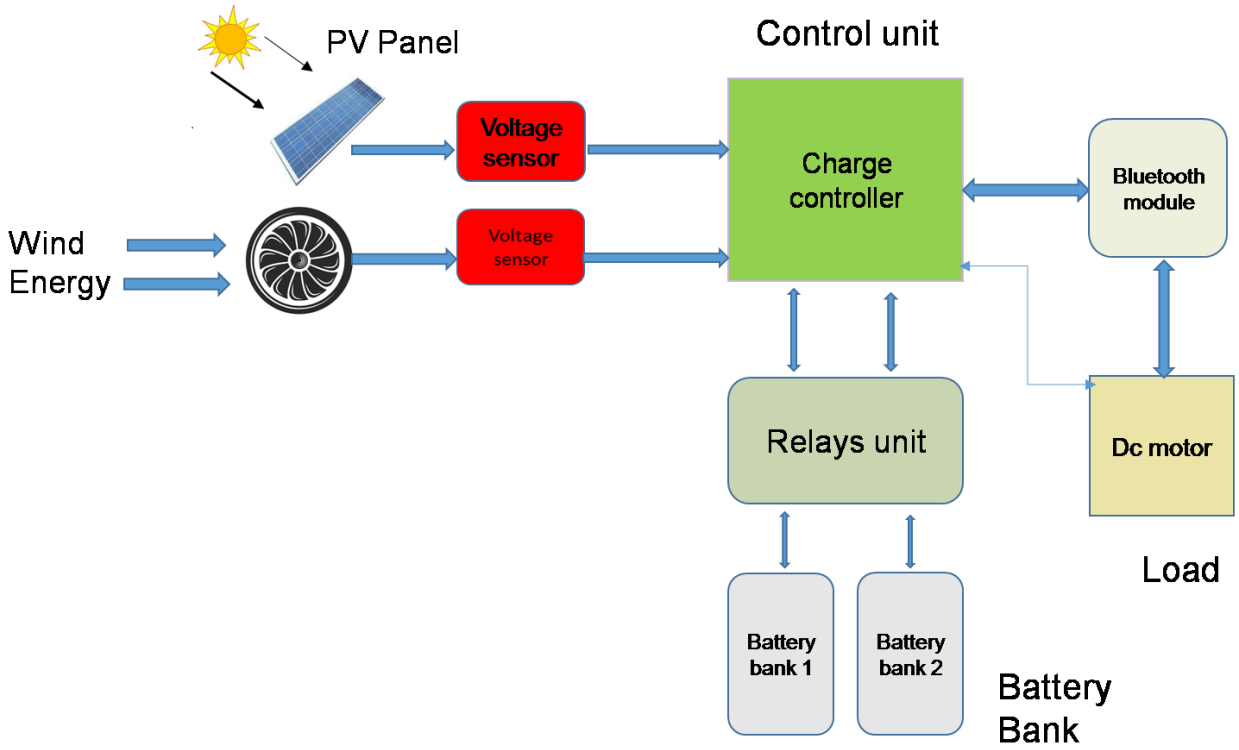


Fig.5.1: Block Diagram of Solar & Wind Energy Charging System

The block diagram of Solar & Wind Energy Charging System is as shown in figure 5.1. An electric bus is driven by both solar and wind energy by means of photovoltaic panels and wind turbines. Solar & Wind energy stores excess energy when demand is low and release it when demand is high. The use of solar energy to power a vehicle is that the solar panel must be efficient enough to generate enough power for propulsion in a reasonable amount of time.

The lithium-ion battery bank will be initially charged & placed inside the bus. While starting the bus, the charge in the batteries will be supplied to the relays unit & DC motor through charge controller. The solar energy will be generated using solar panels, which will be used for charging the battery bank while the movement of bus or at standstill. Solar & Wind energy stores excess energy when demand is low and release it when demand is high. A wind turbine mounted on the vehicle is used to generate electricity which in turn charges a bank of batteries. The batteries drive 3-phase DC motor that Solar & Wind Powered Electric Bus moves the vehicle. A smart charging subsystem is proposed to enable charging the batteries.

When the battery bank 1 discharges, the charge controller will take the supply from battery bank 2 at this moment battery bank 1 will be charging. After the battery bank 1 charges, the battery bank 1 will supply the power & the other bank will get charges. The wind energy output depends on speed of the bus. The wind energy which is generated is used for the applications inside the bus or it can be used as fast charger in case of emergency. The data of battery condition such as charging and discharging of battery bank, power consumption and power generated will be observed in android mobile. The Control and operation is done through android mobile with the help Bluetooth module.

## 6. RESULTS AND DISCUSSIONS

A four Li-ION batteries of 3.2V are connected in series, whereas the total output of these batteries is 12.8 V approximately. The capacity of the battery is 6000 mAh similarly other two battery packs will be employed out of which one will be used as an additional unit. A solar charge controller is used to supply the battery with controlled input from the solar panel which leads in the efficient charging of the battery. This battery management unit is the most important unit from where other sources are connected with the equipment. In future Li-Polymer battery will be used & in place of solar charge controller voltage relay and voltage sensors will be employed to reduce the weight of the battery and it reduces the space required for the battery placement.

## 7. ADVANTAGES AND DISADVANTAGES

### ADVANTAGES

- Environment Friendly - Electric buses have clean energy and can be a good alternative to diesel transportation vehicles to reduce environmental pollutants.
- Better Working Condition - The electric bus is much quieter than a diesel bus, giving travelers a more pleasant experience and significantly reducing the environmental noise.
- Easy Maintenance - The cost of maintenance is about 25% lower than the maintenance cost of a diesel bus, since the electric motor doesn't need the same level of services the diesel engine needs.
- Economical - Electric engine's energy losses are significantly lower than diesel engine's energy losses, so the cost per kilometer of electric bus travel is about a third of the cost of a diesel bus ride.

### DISADVANTAGES

- High Cost - As of today, the electric bus is significantly more expensive than a diesel bus, but the cost is expected to go down.
- Limited Range - The conventional charging system limits the driving distance. Charging systems that enable long driving distance are very expensive.
- Adjustments must be made to the energy system according to the area in which the bus operates.
- Building a working plan (schedule) for an electric bus should consider a variety of parameters about the energy system. •
- Real-time energy system monitoring is required to prevent malfunctions and delays.

## 8. APPLICATIONS

- Commercialized four-wheel drives
- Usable in areas where fuel-based vehicles are not permitted
- For public transport

## 9. CONCLUSION

Our overall goal of this paper is to research, design, build and test working prototype of solar and wind-powered electric bus. A solar-powered bus will have zero emission levels, as they don't utilize non-renewable resources & burn fuel. The electric motors generate electricity that doesn't emit greenhouse gases or other pollutants. The process of this project will be concentrated primarily on design, construction, and alternative energy sources.

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