Solar - Electric Hybrid Ecofriendly Quike

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Abstract--**Sun's energy is the energy source. It is certainly not an alternative energy. All terrestrial life, and most marine life, depends on the sun's generous energy. We have developed the solar electric hybrid quike (SEHQ) for transport of people (2 members of maximum of 150 kg), goods (150 kg) and any other miscellaneous items from one place to the other within the college campus, which is helpful to reduce the physical work and save transport time for office subordinates in the college campus. The main parts of the SEHQ is rims, wheel hubs, tyres, tubes, hub motors, solar panel, CPVC pipe frame, charger, batteries. The paper is organized into five main parts, first part after a general description of history of solar hybrid vehicle, second part the issues relative of hybrid solar vehicles review work of last 10 years, SEHQ design mode, fabrication of SEHQ, finally last part conclusion of solar electric hybrid vehicle. SEHQ is eco-friendly, which gives a good impact to the environment as a conventional vehicle. Moreover, multipurpose solar electric hybrid vehicle makes use of electric power as well as solar power because of wherever solar energy is not sufficient (if sunlight is not available / rainy day) then we can charge the battery with conventional electric power, so SEHQ can work in all seasons.**

Keywords: SEHQ, CPVC pipes, Solar Panels, Hub Motors, Dreuillers.

I. INTRODUCTION

ENERGY is essential base of the economic development. To ensure sustainable development of national economy, there must be energy which can be continually provided for support. In the past 200 years, the energy system based on coal, oil, natural gas and other fossil fuel greatly promoted the development of human society. Today in the 21st century, there is no problem as important as sustainable energy. Faced with limited fossil fuel resources and higher environmental challenges, it is particularly important to adhere to energy conservation, improve energy efficiency and rely on scientific and technological progress, development and utilization of new and renewable sources.

II. LITERATURE REVIEW

The research team at Auroville Renewable Energy and Auroville Center for Scientific Research (AuroRE/CSR), India, embarked on several initiatives to provide their township with greener and more sustainable transport options (Ref.1). This team deals with some of the successful designs which have materialized from these efforts, such as a pedal-powered four wheeler/quadricycle as well as a solar hybrid vehicle which are currently undergoing further improvements. Some of those are the following.

Solar/Hybrid Vehicle: The prototype called "Namuna", which means "an example" or "a character", is a hybrid four wheeler with an automatic transmission. It is capable of running entirely on either solar electricity or liquid fuel (petro or bio-based), or on a desired combination of either solar electricity or fuel. This hybrid feature that is both unique and useful was developed in Auroville. As much as 40% of the energy captured can be lost in transferring it from the solar panel or grid to a battery system. To avoid this, Namuna attempts to use the energy directly from the solar panel and meets any extra demand using the battery bank first, and then fuel if necessary. Battery storage is necessary when driving in shaded areas, less sunlight, cloudy days or during the night as well as when the power requirement is greater than the direct solar energy supplied from the vehicle's solar photovoltaic canopy (for example under fast acceleration, on sandy roads, or while carrying an extra load). This transition between direct power usage from the panel to substitution of power from the battery or fuel when necessary, occurs smoothly, without any involvement of the driver. The exemplary feature of Namuna is that it needs to be parked in a sunny spot – which also means less competition from any other vehicle for parking. While parked under direct sunlight it generates energy. When the vehicle is driven at a slow speed or when it is parked in the sun the net excess power gets stored in the battery.


'Namuna' - the Solar Hybrid vehicle

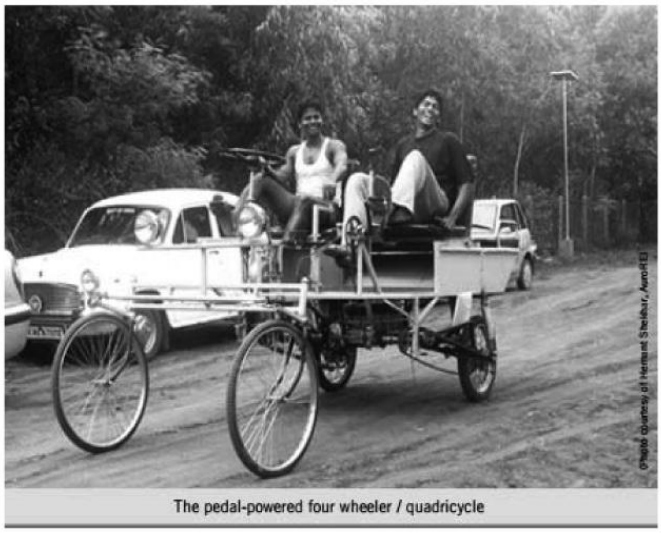

Figure1. Pictures of Solar/Hybrid four wheeler developed in Auroville.

Namuna was launched officially on Earth Day in 2007. To date, Namuna has run 2000+ kms within Auroville. It can travel at a maximum speed of 60 kmph on a good (tarmac) road. Though the speed is lower while running on earth roads, Namuna has proven to be resilient enough to deal with very rugged road conditions.

Pedal-Powered Four-wheeler/ quadricycle: A pedal powered vehicle is clearly one of the most eco-friendly alternatives. However, in Auroville and on use in other rural roads even the most ardent cyclist will find it difficult to carry another person or transport goods on a bicycle. Cycle rickshaws that exist in India and several other developing nations are probably an answer but they are not very easy on the rider. It has a strong suspension, a tough chassis to take the structural stresses of travelling on a rugged terrain, a wide width that allows it to be more stable even on undulating roads, and a substantial height to minimize the ground turbulence which in turn reduces the kicking up of dust from the road. The vehicle can be pedaled by one or two riders. Each of the two riders has independent gears. Thus, while two people are riding, each rider is able to pedal according to his/her ability or strength by choosing the desired gear. The vehicle is large enough to carry two extra passengers or an equivalent load. A battery bank and motor is provided to assist in riding when desired. There are plans to add a canopy in the near future which will be equipped with a solar panel to recharge the battery while also providing shade.

Morris Brenna *et al.* [2] investigated the potential and the technical benefits of photovoltaic charging systems in the context of electric mobility, in terms of energy supply. Suitable mathematical functions have been developed to estimate the energy production from PV systems. The coefficients of the equations have been obtained by taking as reference the climatic conditions typical of the North Italy (Milan) and allow evaluating the energy production as a function of tilt, azimuth and month. The photovoltaic system analyzed in this work is a solar carport combined with a charging system for two electric cars. The aspects linked to the energy flows, considering the production of PV system, the absorption by charging vehicles and the imported and exported energy to the utility grid are evaluated, highlighting the technical sustainability of the project. Different scenarios are analyzed in terms of absorption profiles and energy. The most significant results of this work is the percentage of energy coming from the PV system to the electric vehicles with respect to the energy required by the charging point, that ranges from 1-3% to 56-72%. Moreover, the energy flows strongly depends on month. The maximization of the energy flow from PV system to electric vehicle requires quite long and low power charges that allow exploiting the hours when production of the photovoltaic shelter is high. However, an energy storage system is necessary.

Bhubaneswari Parida *et al.* (Ref 3) discussed on the photovoltaic technology, its power generating capability, the different existing light absorbing materials used, its environmental aspect coupled with a variety of its applications. The different existing performance and reliability evaluation models, sizing and control, grid connection and distribution have also been discussed.

Based on the literature survey performed, venture into this research was amply motivated by the fact that a little research has been conducted to utilize renewable energy sources such as solar energy operated vehicles with minimum self weight and fabrication time (just 2 weeks).

III. NEED OF SOLAR POWERED VEHICLES FOR INDIAN REGION

Pressure on Indian Government: As per the reference 12 and 13, Indian government decided to reform industrial policies especially in energy sector. Presently the government is giving subsidies on fuel (petroleum, diesel and LPG) also on kerosene for people who are under BPL (below poverty line). According to the annual report given by Ministry of Finance, Government of India, in the year 2011-2012, India's imports registered a five to six fold increase in the last decade from US$ 51.6 billion in the year 2000, to US$ 329 billion in year 2010. So to reduce this, plan better energy policies such as providing solar photovoltaic panels, batteries and chargers with subsidized prices for every houses, also promoting solar bikes, three and four wheelers to the public with one time subsidy and mounting solar panels on street lights covering villages, municipalities and cities then after span of five years all these policies given best results which will improve economy of the country. Figure 2 shows the various steps needed to implement of energy sources in decentralized form.

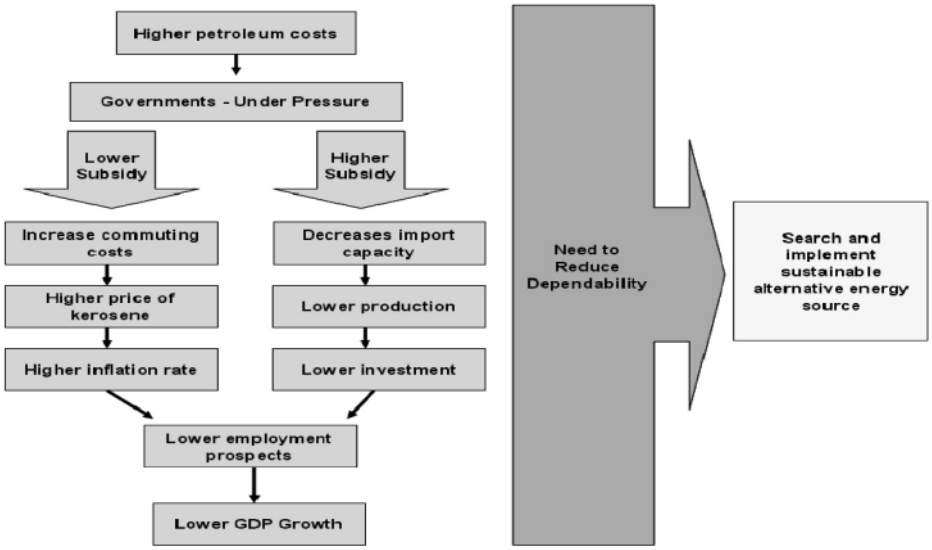

Figure 2. Schematic diagram of implementation of sustainable energy sources in decentralized form.

*SEHQ suitable for Andhra Pradesh Environment:*Andhra Pradesh Climate is generally hot and humid. The major role in determining the climate of the state is played by South- West Monsoons. Summers in Andhra Pradesh last from the month of March to June. During these months the mercury level is quite high.

In the coastal plain, the summer temperatures are generally higher than the rest of the state. In summer temperature generally ranges between 20C and 40C at certain places the temperature as high as 45 degrees on a summer day. Hours of sunshine range in Andhra is between 3.6 hours per day in July and 10.2 hours per day in February. On balance there are 2877 sunshine hours annually and approximately 7.9 sunlight hours for each day. On balance there are 0 days annually with measurable frost and in January there are on average 0 days with frost. Annual Average solar radiation in Andhra Pradesh: 5.18 (kWh/m2/day).Solar Energy perfectly fits for the Andhra Pradesh climate.

IV. ELEMENTS OF SOLAR - ELECTRIC HYBRID VEHICLE:

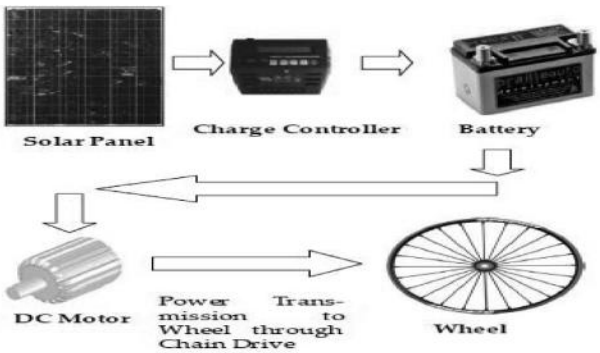

Figure 3. Diagram of solar power system.

V. DESIGN AND SELECTION OF ELEMENTS OF SEHQ

Battery selection for SEHQ: The most important criteria for solar vehicle battery selection are listed below:
a. More weight will increase the rolling resistance and more power will be needed.
b. Batteries capacity should be enough to absorb the current from the PV during the day and should not be easily damaged.
c. Voltage Choice of total battery voltage must be decided early at design stage. It must be suitable to be used with the photovoltaic array and the operating voltage of the motor and controller.

Nowadays the photovoltaic technology is improving rapidly and the application has expanded widely. Yet, for any application, system cost and efficiency are the critical factors that should be considered.

Type of Battery Batteries used in solar powered vehicles perform three main functions: (i) to store electricity gained from the PV during daytime; (ii) to supply direct current when it is required; (iii) as a medium to smoothen the fluctuation of the current and voltage output from the array into the loads. In this review, it was found that there are three classes of battery which are widely used for the storage of electricity for the solar powered vehicles.

Battery Charging Voltages and Currents: To charge a battery, the charging voltage must be higher than the battery voltage or at least equal. As per the motor power requirement [5, 6], a 12 V- 80 A-hr. lead acid battery is feasible for the solar three-wheeler. “Trickle charging” (charging in low amps, 2 to 10 amps) is always better for any battery charging; it increases battery life and decreases electricity pilferage. Here, the charge

controller will charge the battery at around 16.2 volts and 6 amps. A full day of sunlight (6 hours) will charge it fully if it's not fully discharged when hooked up.

The Photovoltaic Power System: The power supply system for a solar vehicle consists of an array of photovoltaic cells (ref.9), a set of batteries as an energy buffer and optionally some kind of converter to match the voltage of the solar array with the battery voltage (Fig 4). If the conversion ratio of the converter is varied by a controller to constantly adjust the operating voltage of the solar panel to its point of maximum power (Vmp), it is being operated as a Maximum Power Point Tracker (MPPT).

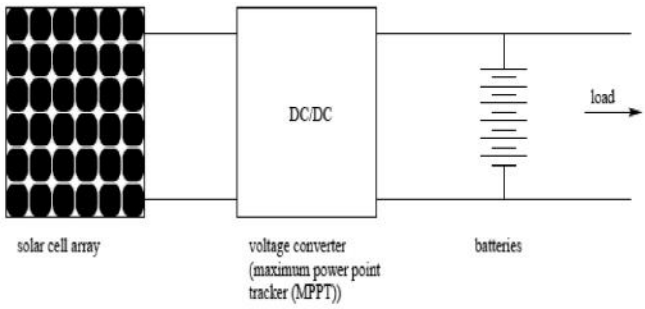

Figure 4. Power train of a solar powered vehicle.

Selection of Motor: Motors used in Electric cars most of them are DC motors [10, 11]. The major reasons of using DC motor are these motors are cheap and the making procedure of controller for DC motor is simple than AC motor. There are 2 main types of DC Motors used in Electric Cars. One is Brushed DC Motors and another is Brushless DC Motors (BLDC Motors).

As our greatest concern on designing a cost effective SEHQ, among the two types of DC motor Brushless DC motor is most suitable for us because of its long life span, almost zero maintenance cost and high efficiency. Motor that is used in the project would be 800 watt Brushless DC motor.

VI. SIMPLE STEERING MECHANISM DESIGNING AND SELECTION

Steering mechanism of a vehicle is used for controlling direction of the vehicle. It actually moves both front wheels in a same angle when the vehicle changes its direction. All the steering mechanism using all over the world are much more complicated. At the beginning for our project we design a steering mechanism which is much easier than the mechanism generally used in vehicle. In the design the front wheels are attached with two cylindrical pipes. Two steel sheets are attached with those pipes. These two sheets are slightly joined with steel rod which has screwing in outside.

Another vertical steel rod with screwing in outside joined with it with a small pinion. The steering is attached with same kind of screwing horizontal steel rod. This steel rod is connected to the vertical rod with a small pinion. When steering moves right then it rotates the horizontal rod in front results vertical rod goes down because of the screwing and then lower rod moves left which moves the wheel to right and when the steering moves left then the wheel moves to opposite. The steering is directly joined with a vertical steel rod and under that rod there is another bearing is attached.

VII. DRAWING AND DRAFTING OF SEHQ

In the present work a complete drawing and drafting of solar hybrid quadricycle vehicle have been prepared using CATIA V5R19 software. After complete analysis of this drawing by using ANSYS 13.0 it is find out bear capability of load, stress, and strain of front & rear collision of frame. A completed data are analyzed to examine the technical aspects of the SEHQ.

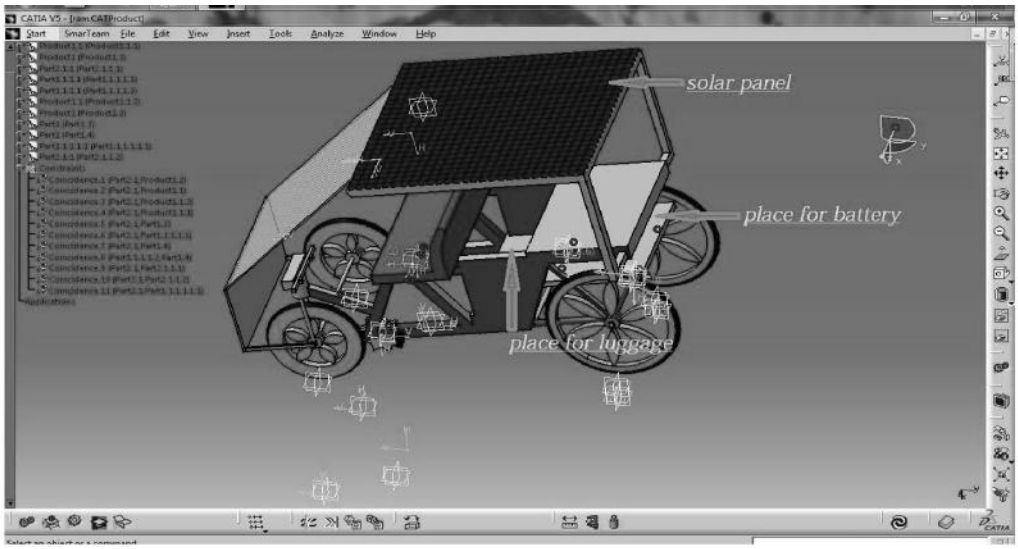

Figure 5. CAD Design of SEHQ.

VIII. FINAL ASSEMBLY

All the parts mention in section 5 are assembled by step by step, and then test run was conducted. In the test run some problems (related to mounting of front wheels) identified, then again modify the front wheels assembly with modification in the steering mechanism. Finally, We have developed the solar-electric hybrid vehicle (SEHQ) for transport of people (2 persons of maximum of 150 kg self weight), goods (150kg, provision is provided in both front and back sides) and any other miscellaneous items from one department to other within the college campus, which is helpful to reduce the physical work and save the transport time for office subordinates (OS) in the college campus.

Figure 6. Photo image of finished SEHQ.

VII. CONCLUSION

Use of solar energy in SEHQ for inland navigation of developing countries can help a lot to reduce fossil fuel dependency and minimize cost. The SEHQ is designed both electrically and mechanically for a particular weight carrier and particular distance. So if the number of passenger and distance changes then photovoltaic cell, emergency battery and engine specification should change according to the condition. Based on simple design, cost minimization, efficiency and reliability, this proposed SEHQ can be a best option for pollution free green inland vehicle system. Because of flexibility and modularity in design, desired modification (change of wheels, seat, height of the chassis etc.) if needed, can easily be done to meet up any individual requirement.

Though it is solar operated but it can also be charged with grid electricity if desired. Long distance (over 35 km/day) travelling is not possible by this solar four-wheeler due to limited energy storage and it may not perform well during consecutive cloudy/ rainy days. Again, the volume/size of the solar panel cannot be increased for increased energy demand due to limited space over head (roof). However, more efficient solar panel or solar power tracker can be used to extract more (maximum possible) energy from the sun to meet up increased energy demand.

Nickel-Cadmium batteries though expensive are ideally more suited to PV system than the lead-acid battery and can be used for better performance; it also has less weight and no damage if the battery remains fully discharged for long periods.

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