

**SOLAR POWER BANK FOR THE SMALL BOATS OF RURAL AREAS****Ranajay Maji¹, Dr. Abhijit Chakraborty^{2*} and Sujay Biswas³**

¹Lecturer, Dept. of Mechanical engineering, Technique Polytechnic Institute Hooghly, West Bengal, India.

²Principal, Technique Polytechnic Institute Hooghly, West Bengal, India.

³Lecturer and In-Charge Department of Mechanical Engineering, Technique Polytechnic Institute, Dist-Hooghly, West Bengal, India.

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Corresponding Author*Dr. Abhijit Chakraborty**

Principal, Technique
Polytechnic Institute
Hooghly, West Bengal,
India.

ABSTRACT

Accessibility to the rural area is critical due to its high level isolation and lack of infrastructure, which restricts people's mobility to long walks, river boats or by some other means of transportation. But the mobility faces its own drawbacks related to fuel cost and the availability. The people does not getting the equal opportunity to meet

their requirement. Electric boats coupled with solar energy by means of photovoltaic system represent an alternative for those areas where people are died because of lack of transportation. They have their own small boats or dinghies for fishing and which can easily pass through the narrow trench and tunnels but for travel a long distance is not familiar with time and money. Therefore this paper aims to present a technical solution of poor transportation system which can change their way of living. As they have a limited amount of resources for their day to day life they could not borrowed the extra cost of solar panels or the batteries and which they install in a small boat for their limitation. Also use of conventional diesel or petrol as a fuel may cause the major water and noise pollution for the water habitat. That's why solar energy is used advantageously.

KEYWORDS: Solar boat, solar energy, Solar Mission, Green Energy Production.

INTRODUCTION

The modern day researchers focused to develop a pollution free transport system for land, air as well as water. This is because the source of conventional energy become exhausted very rapidly for globalisation. It is thus concluded that the nonconventional energy sources are best for sustain our civilisation. And form this solar energy should preferred much than any other non-conventional sources due to its availability. But the sun was not shine for 24 hours and in cloudy weather also. Thus the instrument which are depend on the light of sun to convert energy by the help of photovoltaic cell cannot generate power to drive the vehicles. It is also the fact that the friendliness of solar panels and instruments to the ground level people is out of reach for their isolation from the modern civilisation and poor implication of infrastructure. The people depends on the river transport faces ultimate challenge both from naturally and economically and also the transportation causes significant environment pollution in the river. So to develop their way of life, the communication should be improved first. So the small boats are very much useful to connect them with the outer world and reduces the river pollution. But the small boats has its own carrying capacity, load bearing capacity, space and limitation with maximum total weight for navigation in river or lakes. So the installation of solar instruments on it may hamper the propulsion and the speed getting lower due to the extra weight of solar panel, metal structure, batteries. Thus we concentrate on the basic fact that the boat do not suffer under extra weight and it balanced on the water with some flexibility which draws out the maximum efficiency from the sun without compromising the design. Because of its special feature it is eco-friendly and very quiet in operation and the rechargeable batteries act as a power bank which collect power form the sun directly and supply it for the propulsion of the boats. This battery provide power as well in night or cloudy condition as it is independent of sun light. Once the battery getting charged it will used in the boats or dinghies as well as for other transportation purposes. Unfortunately limitation for electric boats are high installation cost, minimum efficiency and low speed for the limited space in a boat. But to providing floats, rechargeable batteries and charging stations along the travel route the small boat and dinghies are most useful for the region where people are isolated from the modern technology.

LITERATURE REVIEW

Using solar energy is not a new concept for all. Many researches, papers and project was taken by many respected people form the early stage of our civilisation. And by the help of the non-conventional energy source the development of rural areas also not new for us.

Finding alternative sources of energy that are both economical and environment friendly is crucial for increasing agricultural productivity and improving the quality of life in rural communities.

Pecen and others wrote “Renewable energy based capstone design applications for an undergraduate engineering technology curriculum”, by Department of Industrial and Technology of University of Northern Iowa USA in 2003. Jones in 1948 published the book “Small Boat Engine Manual”. Cornell Maritime Press. Duarte in 2007 published “Design of boat powered with electric battery of hydrogen fuel”. In the year of 1997, has been written the paper about solar power plant, where this work was implanted in the Vila Campina that is a small village in the Amazonas Brazil (NOBREGA, 1997). Joore and Wachter, wrote in 2009 “Frisian solar boat design a multi-level innovation analysis”. In the same direction, Leiner wrote “Research solar power boat – data management and online visualization”. Sousa, Simonetti and Norena, Wrote in 2009 “Efficiency optimization of a solar boat induction motor drive”.

Bronstein wrote “Taschenbuch der Mathematik “published by Verlag Harri Deutsch”, this is a handbook enough used in the Germany's academies. Watson published by Elsevier, “Practical Ship Design”. Spagni, published in 1994 “Marinates, Research, General Principals and Guidance for the Application of Glass Reinforced Composites Offshore”. A new FAO publication, "Solar photovoltaic for sustainable agriculture and rural development", suggests that photovoltaic solar energy systems may be part of the solution, and finally, Solar energy systems, together with wind energy and other renewable energy applications, are the only technically viable solution to deliver the energy required by isolated rural communities," says Gustavo Best, FAO Senior Energy Coordinator in a radio interview. "Small amounts of energy can make a tremendous difference, making it possible to improve rural lives, enhance agricultural productivity and create new opportunities to earn income."

OBJECTIVE

As early said that the aim of this paper is to present a model for the betterment of the isolated region of the countries by replacing their small boats or dinghies used in the river for fishing or transportation by an energy source obtained non-conventionally from the sun, without changing the existing one. Now a days the boat used by them are pulled either manually or uses diesel fuel to run the generator of the boat, which run the electric motor. So, find a source of new alternative energy to reduce the consumption and the cost of conventional fuel.

The solar electric boat is one of the alternative energy that can possibly solve this problem. But the solar driven boat cannot be used at night or cloudy weather because there is no sunlight to produce energy. However, to use solar energy installation of solar panels need much space, and the space is limited for these kind of small boats. Again this kind of installation increasing the load on the boat which directly affect the carrying capacity of the boat. This problem can be solved by using rechargeable batteries that can supply current to the electric motor of the solar boat without changing the boat design. And use of air floats can adjust the extra load of the batteries.

It is a flexible design, instead of used for river or water transportation, it is used for overland transportation and may use in other purpose also.

CASE STUDY

The **Cleghorn Manufacturing Co. Pvt. Ltd.**, Kolkata has manufactured their 4 seated paddle boat name '**Pearl**' since 1963 whose **length is 11'** and **breadth is 5'** having a **draft of 3'**. But for a particular purpose they installed a solar panel on it for converting it into a solar paddle boat for tourism purpose in '**Eco-park**' Kolkata. But when they installed the solar system on it along with batteries, wrought iron structure, module, motor and gear box the draft increase near about 8 -10 inch which does not maintain its stability and the carrying capacity is reduced to 2 person only. Although the motor was installed to propel it propeller, the speed is just increase from a manual paddle boat but does not obtain best result because of higher draft. The control is lost and for ordinary people it is not possible to control and this solar boat cannot fulfil the technical requirement. Thus to change an existing boat to its solar form is always a challenge and if it goes wrong the overall project is not economically feasible. Thus the greatest challenge in converting a small boat to solar is to maintain its stability characteristics. Adding solar panel on the top would affect the stability in adverse manner. This becomes critical in this vessel since this is used in river or lakes. The system design to optimize the combination of panel size, battery size, number, rating of motor etc. be another challenge. The panel size and battery backup size had to be right to ensure that the system is effective.

METHODOLOGY

The case study clearly indicate that to change the existing boat to a solar boat we cannot afford extra load on it. Because the people use this kind of small boat never want to compromise their life style and their limited resources. Thus the first important step to make a

small boats or dinghies for the rural area is to locate the river route through which they travel most. Then we have to calculate the distance travel by a boat for a single charge of the batteries with maximum utilization capacity. In that way a detail analysis of path and power consumption between two successive charging of the battery is to be determined, which help for the designing of the boat which is economically feasible and technically sound.

Analysis

For a successful conversion of small boats into a solar boat we have to focused on few basic requirement:

- a) To know the trading route or the fishing route of the rural areas through maximum people communicate with the outer world. Because without this detail information we cannot construct the solar charging station.
- b) Detail knowledge about the boat is required. Because if we know the length, breadth, carrying capacity, draft etc. of a boat we can easily change converts this boat as per requirement.
- c) The current of the river is much important to obtained best possible efficiency from the Lithium-ion battery.
- d) As we could not place any panel or structure on it the load of motor and the batteries can easily be compensate by using floats.
- e) As The system is 100% eco-friendly and do not create any air or water pollution.
- f) The advancement of the design make the system much flexible which can be used for many other purpose also.
- g) Finally Government can save on the subsidy provided for the conventional fuel to the fishing community or the people of the rural areas and redirect this funds to other projects. If government provide subsidy for installing 'solar recharge station' at the bank of river, definitely it will help to develop the life of those people who really depend on the small boats and the river.

Design Concept

Basically while we design the boat we will always stay focused on some basic technical and economic aspects. The design consists of–

Solar Panel

Solar panels does not fitted on the top of the boat, which means we do not need any stainless steel structure, without compromising on normal operation and stability of the small boats or

dinghies. Instead of it we placed this solar panel at some distance as a solar charging station of the river bank on the basis of particular route through which maximum communication takes place. Following are the specification of the solar panel –

1. Rated peak power ($P_{\max.}$) = 300 W.
2. Voltage at maximum power = 63.12 V
3. Current at maximum power = 4.75 A
4. Open circuit voltage = 77 V.
5. Short circuit current = 5 A.
6. Fill Factor (F.F) = 77%
7. Input power = 65 – 1000V DC

Motor and Gear Box

Electric outboard motors of similar power as the conventional fuel outboards that it is replacing. The motor is fitted near the back end of the boat which is directly coupled with the propeller by a gear box. The motor r.p.m output is 92 or 93 and the propeller is rotate about 3 time faster than the motor r.p.m by the gear box.

Battery

The batteries are installed in the fore part of the boat to counter the weight of motor and propeller installed behind the boat. One set of battery placed on the portside and the other set of battery is placed on starboard. To ensure a good maintenance for each battery is a hatch in the deck installed. In general 2 – 4 no of 12V and 100 AH battery, approximately of 15 Kg each are used for propulsion of the boat. The battery should be connected in series connection.

Float

The weight of battery, propeller and motor will put extra load on the boat, we use air balloon integrated with the boat to counter the extra weight and provide better stability while in operation.

Rudder

A hull is placed just behind the propeller to move the boat in a particular direction. All the system is fitted by means of screw-thread or nut bolt which help to dismantle those thing quickly while the people wanted to pull it manually.

Propeller

A propeller is a type of fan that transmits power by converting rotational motion into thrust. A conventional water propeller is the most commonly used type of propeller. The propeller must transfer all the solar panel power to the water to drive the ship. Keep the shaft angle low to maximize forward thrust component and minimize the vertical thrust component.

Proposed Model



Figure 1: Available Small Boats.

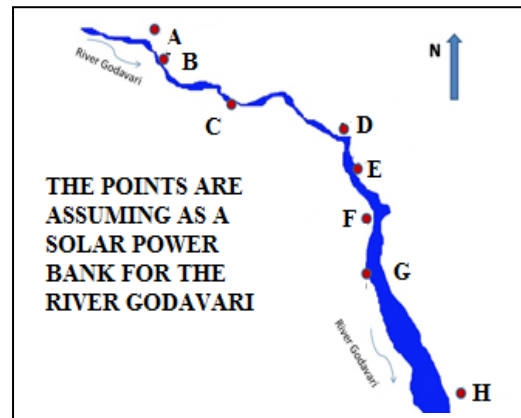


Figure 2: Route Map for Placing the Power Bank.

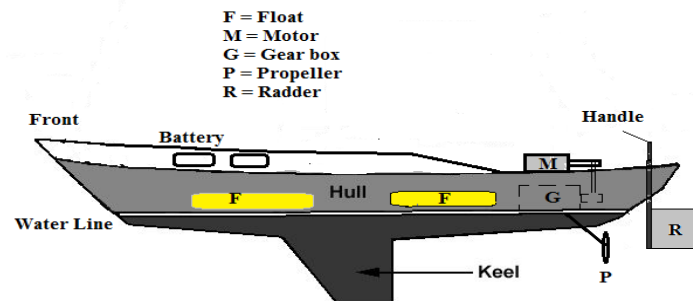


Figure 3: The Proposed Model on Existing Small Boats.

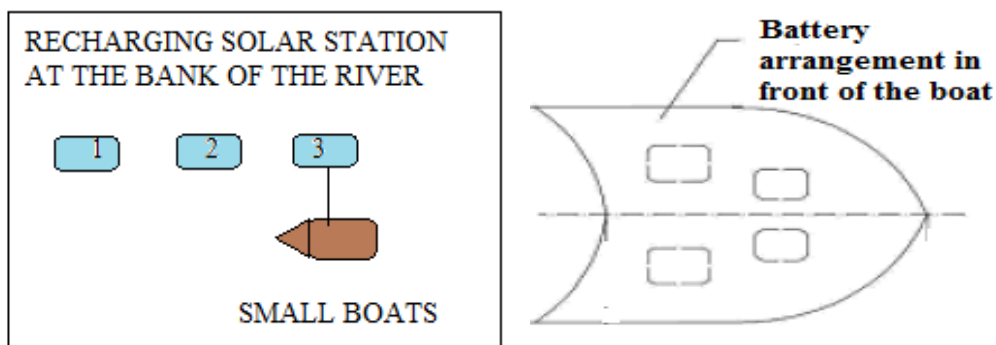


Figure 4: Solar Bank Placing Besides the River & the Battery Arrangement.

CONCLUSION

Solar energy used for this purpose is most acceptable for saving our conventional energy sources and saving our mother nature from the pollution and fuel cost as well. Besides, this in the absence of sun light the photovoltaic cell does not perform well to drive the boat. Thus to make the system more secured and sustainable, solar bank is introduced with the existing small boats and dinghies. Both the mechanical and electrical part of the boat has been designed which make it more acceptable, efficient, reliable and economic.

For this design the economic point is consider as far as possible, and doing so we conclude that the lead-acid battery is the best option to keep the boat lighter and make it portable for any other purpose. Many projects are taken by the government of India for our people who lived it the most isolated part of our country. And the alternative source of our conventional fuel provides benefit for our social, economic and environmental balance.

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