

Renewable Energy Solutions for Sustainable Fishing Practices and Improved Livelihoods of the Fisherfolk in the South West Coast of India

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Abstract

This paper looks at the application of renewable energy solutions for sustainable fishing practices and improved livelihoods of the fisherfolk in the south west coast of India. This region is featured with the indigenous coastal community which is known for their traditional and sustainable fishing practices. At the same time, they are considered to be one of the most economically deprived communities. This is mainly because limited fish catch and the increasing operation cost that creates financial instability. The current practices of fishing methods highly depend on the diesel and the existing study results suggesting 70% of the total expense is spent for voyage alone. This leads to increased financial burden on the fishermen as well as generating an environmental problem in terms of increased carbon emission and pollution. In this context, the study is focused upon critical analysis of the usage of solar panel on fishing vessels that are used for the pilot project previously and its techno financial analysis. The data were collected from the fisher folk through interactions with them in their livelihood areas and secondary data from the peer reviewed sources. The results show solar energy could effectively reduce fuel consumption and improved economic efficiency. However, the pilot project could not continue and extend to many areas as the capital investment was high and limited financial support. The study recommends a new model of integrated solar and conventional fuel model and policy framework to include a financial model reducing the primary cost burden on the fisherfolk.

Keywords: Renewable Energy, Solar, Fisherfolk, India, Policy

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Introduction

The south west coast of India is known for marine friendly and sustainable traditional fishing practices (Panipilla & Dr. Johnson Jament, 2017). Fishermen from the districts of Trivandrum (Kerala state) and Kanyakumari (Tamil Nadu state) in South India are unique for their fishing skills and associated traditional knowledge incorporated with modern technology. However, the recent tropical cyclone disaster Ockhi had exposed their socio-economic vulnerability to the rest of the world through media reports and social media attention (Patil, 2018).

The fishing skill and these fishermen's hard work do not reflect on their socio-economic status due to various reasons such as economic habits like spending and saving, lack of technology, marketing constraints, exploitation of the middlemen, lack of investment from successive governments and similar other issues (Sarkar, 2012). Depleting fish resources and increasing operational cost make their livelihood much more difficult to sustain. Climate change conditions, warming in the Arabian ocean and Indian ocean, destructive fishing practices at the shore and marine pollution (Cinner et al., 2012) have forced the fish wedge to migrate towards further deep into the Indian ocean. As a result, the voyage time and operating cost is increased and the fishermen are forced to go to deep sea for venturing their fishing expeditions. This leads to the diminishing of earning capacity and hence a financial difficulty in the community, makes them depended upon external sources of funding for their survival.

Under these circumstances Association of Deep Sea Going Artisanal fishermen (ADSGAF), a fishermen organization based in Kanyakumari District, Tamil Nadu, India has launched a mission to introduce solar panels on fishing vessels to reduce the fuel consumption in the year 2010. Four years later in 2014 their first batch of solar panel enabled deep sea fishing vessels were launched as a pilot project (Suchitra, 2015). The project was widely celebrated and its results were positive on the fishermen's edge as the solar panels could substitute all their auxiliary power demands. Before the introduction of solar enabled lighting system, fishermen used to run main engine to get light during idle times (mostly during fish catching time) which causes huge waste of fuel. According to an estimate, the fuel consumption for auxiliary power demand is about 30% of the total fuel consumption (Babu & Jain, 2013). This suggests that the solar energy could save 30% of the total voyage cost which would be ultimately benefitting the fishermen. At the same time, it is important to acknowledge that there is no adequate legislation or policy interventions addressing offshore practices as well as limited financial support to the project. Meanwhile private companies had introduced auxiliary generators which are converted bike engines whose life cycle has already ended and price is one tenth of the initial cost of the solar module. As there were no financial supports for solar modules, fishermen went with the use of auxiliary generators where primary investment is comparatively less. In addition to this, it was found that there was no awareness or policy framework to make the customers understand the long term financial and environmental benefits of solar power.

Under these circumstances in 2018 Travancore Marine Corporation had started to revise and analyse the technical challenges, policy frameworks, financial assistance and way forward to make the marine fishing sector energy efficient and less carbon

emitting. This is also in line with enabling to meet the intended nationally determined contribution (Union Environment Ministry, 2015).

Analysis

It is reported that in the south west coast of India especially Kanyakumari district has 1050 (Bino, 2015) deep sea artisanal fishing vessels. They are mechanized fishing boats and are capable of voyage more than 30 days in the deep sea. However, they do not use destructive fishing method like the deep-sea trawling vessels. Their primary and main catching method is hook and line fishing which is arguably the most sustainable type in the world as this method do not catch juvenile fishes and destruct fish habitats like reefs. For the artisanal deep-sea fishing vessels, the main power requirements are for propulsion and auxiliary power demands such as lighting and charging. The size of the boats usually starts from 50 feet length to 60 feet length. Depending upon the size and weight carrying capacity of the vessel, the fuel requirement for the propulsion varies. The interview with fishermen demonstrated that the fuel consumption of the existing engines varies 1 liter of diesel to 2 liters of diesel per nautical mile. The total diesel consumption goes up to 8750 USDper annum and above depending on the voyage distance. Wide practice among boat operators where they used main propulsion engine to light and charge devices even during idle hours which itself consumed around 30% of the diesel fuel. Then the ADGAF intervened at 2010 and installed solar panels on the top of the boats as a pilot project. This was the preliminary attempt to make fishing vessels energy efficiency. Four solar panels of 250 W capacity each were installed on the top of the wheel house with a maximum capacity of 1KW connected with inverter and battery. The entire module was enough to satisfy the auxiliary power demands. Whilst adopting hook and line fish catching the fishes are caught at night time and fishes have to be separated from the hooks manually. The solar powered lights were helpful for the fishermen as cited by the previous pilot project head Vincent Jain. It had increased the efficiency and reduced the accidents usually happened to the fishermen while removing fish from the hooks at dim lights. The overall cost of the module was reported to be around 4350 USD(Babu & Jain, 2013) at 2013. It was subsidized by various agencies and funds were provided to the pilot project. Here came the challenge of financial viability of the project. As it was a pilot project and completely funded, fishermen whose boats were included in the project had to pay nothing. Hence there was no financial model or repayment system to expand another fishing boat. Considering the huge primary investment cost of the module, the boat owners were not ready to install the solar module on the vessels despite knowing the benefits of it. Here came another turning point in the sector when the old bike engines were converted to generators and supplied to the vessels as auxiliary generators at cheaper cost less than 300 USDwhich is less than one tenth of the total cost of the solar module. These petrol fuel run auxiliary generators had reduced the potential market of solar modules in the sector. It is also important to note that the carbon emission that could be reduced by solar modules per year is 19500 kg CO₂ per year per boat (Babu & Jain, 2013) . Despite being a climate change combat technology there got no policy interventions and financial supports. Before going to the next level of study into artisanal deep-sea fishing vessels' energy efficiency and its future, it is important to understand the possible reasons behind the failure of solar module project and why it had not got enough acceptance beyond the pilot project phase.

The project was financially backed by National Bank for Agriculture and Rural Development (NABARD) and supported by Bay of Bengal project and implemented through the association of artisanal deep sea going fishermen. The fishermen got the solar module freely accessible and no cost involved in it. After 5 years looking at those solar panel fixed vessels it is understood that there was no technical follow up happened after the installation. However, there was no further development regarding market model. From the policy analysis point of view, it is important have a business model for the sustainable existence of the product in the market. However, considering the huge quantity of the market and the carbon reducing possibilities ADGFA failed to take the pilot project forward. In this case, it was not followed green technology policy practices where government's initiatives to provide market assistance for the green technologies to compete with the conventional technologies, when they are introduced for the first time. Under the absence of green protocols in the marine sector, motor vehicle companies introduced cheaper auxiliary generators, which were converted two-wheeler engines whose life cycle has already ended. These engines were sold at a price one by tenth of the initial cost of the solar module units. Considering efficiency and emission of outdated generators, it is important to understand in a macroscopic view point that the economic and environmental impacts produced by them are very high and underrated by the responsible climate action agencies. It is very disappointing fact that neither climate change action policies nor responsible government sector took the artisanal marine fishing vessels accounted in their action plans and visions.

Now looking at the technical side of the project there would be more revelations on why the model didn't sustain in the market.

- The SPV panels were mounted on top of the wheelhouse with maximum power production of 1kWp. Total cost of the system to the end customer was 3650 USD.
- The fishing boats remain idle in mid sea at night during fish catches, when lighting is required to attract fish. The stored solar power will take care of the energy requirements during this time for about 3 – 5 hours. Saving about 30 liter of diesel every day. (Babu & Jain, 2013) Mounting the panels elsewhere will affect their stability at the violent sea. It is also a cause of discomfort for the untrained artisanal fisherman hindering their movement on the boat.
- Most of the technical and economic advantages were nullified with the introduction of altered motorbike engines as power generators in fishing boats for auxiliary power supply with petrol as its fuel. Their capital cost was much lesser (approx. 300 USD), required little maintenance and can run on a liter of petrol for a single night.
- After the installation, no technical feedback or follow up was undertaken due to which there is very little data about the success of the project. Moreover, only one boat fitted with SPV modules is operation now.

Case Study

For the case study an artisanal fishing vessel from the district of Kanyakumari, Tamil Nadu. The dimensions of the vessel are as follows. Length 19.5-meter, breadth 5.57 meter and depth 3 meter respectively. It has a 6-cylinder 140 HP Ashok Leyland brand engine.

Fuel type- Diesel

Power Requirements – Propulsion and Auxiliary power demand

Number of voyage days- Average 30 days

Fuel Consumption – 1-liter diesel per nautical mile.

Auxiliary power consuming units - 5 units of 50W LED lamp, 15W LED tube light, charging units.

Cost Analysis -

Vessel cost- 87350 USD

Engine cost- 7280 USD Auxiliary power cost analysis

Table 1: Auxiliary power cost analysis (Source: Market interview)

Cost of auxiliary generator	20000 INR
No of auxiliary generators	2
Capacity of generator	750VA
Fuel type	Petrol
Working hours	5 hrs/ day
Total fuel consumption	1 liter
Total operational cost	1.15 USD/ day

Now consider two different auxiliary power generation cases; Solar and hydrogen fuel cell.

Capital cost of solar- 1460 USD/ kWp

Operational cost –30 USD/ year

Based on the auxiliary power requirement a comparison of possible fuel options was done. They are existing petrol generators, solar photovoltaics and solid oxide fuel cells respectively.

Power source comparison for 1KW auxiliary power demand

Table 2: Power source comparison for 1 KW auxiliary power demand (Source: Market interview)

	Petrol Generators	SPV	SOFC
Capex	450 USD	2200 USD	1460 USD(mass prod)
Opex	75 USD	30 USD	45 USD
Life	3 yrs	15 yrs	20 yrs
Fuel	Petrol	Nil	Natural gas
Maintenance	High	Low	Low
User friendliness	High	Average	Low
Impact on environment	Pollution,Leakage	e-waste	Very low, Rare earths

It is understood from the comparison that petrol generators are cheaper and user friendly but highly polluting. Where as solar photovoltaics have high capital cost but operating cost is very low. Solid oxide fuel cells are very promising but for the time being they are futuristic technologies.

Considering all these conditions, SPV power systems for auxiliary power supply in fishing boats is not viable in technical as well as economic terms. Based on these understandings, energy requirements problems of fishing vessels require a fresh approach. Data from on field observations and deploying a questionnaire had helped to understand the areas which interventions are required.

The main areas identified where absence of proper freezing technology in the artisanal deep-sea fishing vessels and conventional IC engines mostly refurbished from heavy automobiles. Each area is separately addressed in the below session.

Freezing units: At present the freezing method practiced is primitive method of stacking fish and ice in multiple layers. They usually carry 400 to 900 blocks of ice where one block is 60Kg and costs 1.15 USD. It is important to consider the fact that the average voyage time is 30 days in which minimum ten days are required to travel back after the catching of fish. The quality of the fish reduces in this method and the income reduces considerably. It is understood that to preserve the quality of the caught fish it is important to freeze it between -2 degree Celsius to -20 degree Celsius (Heen, 1982).

Engines: They are mostly refurbished engines of capacity ranging from 140 HP to 450 HP. These engines are poorly maintained and polluting marine environment.

Now considering the above-mentioned two factors an analysis for freezing unit on an average sized fishing vessel was done and the observations were as follows.

- Maximum SPV module possible - 2kWp, due to structural constraints and working space for an average of 10 workers on board each vessel.
- Freezing requirement – 8 (5ft X 5ft X 4ft) compartments to freeze about 20-ton fish. Each compartment will draw power to the tune of about 500W with total power drawn 4kW at full capacity.
- The alternator coupled with the engine has to be replaced to deal with the extended power requirement of the freezing unit.
- Engine should be continuously tuned ON during the entire voyage to keep the fish at the required temperature till it is taken for processing. This will be an extra burden as additional fuel cost.
- Powering the freezing unit with solar power is practically impossible. Using batteries to power the unit to remove the load from the engine is extremely ambitious considering the volume and weight of the battery pack.

Conclusion and Way forward

The deep-sea artisanal fishing sector falls into the categories of sustainable transportation, livelihood and behavioral patterns. It requires an interdisciplinary and multidimensional approach to deal with the sector. It is understood from the above-mentioned studies that the existing working model of solar photovoltaics (used for the auxiliary power demand) are not technically and financially feasible for the fisher folk. Due to spatial constraints there can't be installed adequate number of solar panels on the top of vessels to meet all the power requirements. In a comparative analysis it is found that fuel cells are promising and has a future in the sector when mass production begins. The next important and most crucial aspect is the introduction of a scientific freezer technology. As of now main propulsion engine can be the only source of power for the proposed freezer in the vessel. But step by step interventions with new technologies can reduce the excessive dependency on conventional fuel as a result of the introduction of freezer in the vessel. As a beginning phase changing materials shall be introduced in the freezer so as to reduce the power consumption. It

is important to introduce a cold chain network for the fishing sector of India and the pilot project shall be tested at the south west coast of India.

Unlike the agricultural sector the fishing sector requires off shore technologies as well while designing the cold chain network. Thus, the preliminary stage if the cold chain network begins from the fishing vessels and extends to the landing centers and supply chain etc. Phase changing materials incorporated freezers which consume power from renewable energy sources such as solid oxide fuel cells would create a promising future and potential carbon emission reduction. Since the total number of mechanized vessels in the Indian shores 58911 (Mohamed, 2015) the collective potential of the sector to contribute national determined contribution is considerable. Besides the green technology intervention improves the livelihood of the fisherfolk and act as a catalytic agency in the mission of protecting the ocean and attaining the United Nation's sustainable development goal 14 which is connected to life below water. This project can be integrated to the UN mission of Decade of Ocean Science for Sustainable Development.

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