Annexures

How Solar-Assisted Electric Boats can Empower Fishing Livelihoods: A Kerala Case Study

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Annexure 1

Calculation of total cost of ownership of petrol and solar marine fishing boats

The total cost of ownership metric is defined as the present value of the overall cost of owning the vehicle, considering the economic life of the vehicle and the costs incurred in the financing, operation and maintenance of the vehicle. We use Equation 1 to estimate the TCO of petrol and solar marine fishing boats.

Equation A1: Total cost of ownership of petrol and solar boat

$$TCO = \frac{Cost_{PP}+Cost_{Interest}+Cost_{Repayments}+Cost_{Overhead}+Cost_{Salvage}+Cost_{Fuel}+Cost_{Maintenance}}{Daily\ distance \times Trip\ days}$$

Where:

$Cost_{PP}$ = cost of vehicle paid as down payment at the time of purchase;

$Cost_{Interest}$ = Interest paid on the borrowed amount (80 per cent of the purchase price) over the repayment period of 5 years;

$Cost_{Repayments}$ = Annual repayments made for the borrowed amount over the repayment period;

$Cost_{Overhead}$ = Overheads over and above the cost of the boat including the registration fees, insurance, license fees;

$Cost_{Salvage}$ = Salvage value of the boat at the end of 5 years;

$Cost_{Fuel}$ = cost of fuel expenditure;

$Cost_{Maintenance}$ = cost of maintenance and repair;

$Daily\ distance$ = Daily distance travelled by the boat on every fishing trip;

$Trip\ days$ = number of fishing days over the year.

Annexure 2

Calculation of fishers' income in case of motorised and solar fishing boats

We assume a motorised fishing boat with an outboard motor of 9.9 HP running on diesel, and travels at a speed of 14.82 km/h for a distance of 50 km from the shore (Radhakrishnan et al. 2018). Using this information, we calculate the fuel economy (mileage) of the boat to be 4.94 km/l by using Equation 2

Equation A2: Fuel economy of the boat in kilometres per litre

$$Fuel\ economy = \frac{Speed}{Fuel\ consumed}$$

Where:

$Speed$ = Speed with which the boat travels in kilometres per hour i.e., 14.82 km/h (Radhakrishnan et al. 2018);

$Fuel\ consumed$ = Fuel consumed by the engine in litres per hour, 3 litres per hour (Thandasherry 2021).

Thus, over a round-trip distance of about 100 km in a single day, the motorised boat consumes 20.25 litres of diesel.

We consider a solar fishing boat covering the same distance (i.e., 100 km per day) with a mileage of 1.32 km/kWh (Thandasherry 2020). This results in an electricity demand of 75.76 kWh per day. Since the boat is equipped with solar panels, about 80 per cent of the electricity requirement is fulfilled from them, and the remaining 20 per cent of electricity is consumed at the shore to charge the batteries (Thandasherry 2020).

We assume that both boats employ a crew of five people catching 163.7 kg of fish in a single trip (R. N. Kumar et al. 2017). Assuming a price of INR 24/kg for the catch, each boat generates a gross revenue of INR 3,929 per trip. From the gross revenue, we deduct the fuelling expense and arrive at the net revenue. We assume the prices of diesel and electricity for the state of Kerala for the purpose of this analysis (diesel – INR 90/l after the subsidy of INR 1.5/l, and electricity – INR 5/kWh). These values have been detailed in Table A2.

Table A2: Estimation of net income per person

	Items	Petrol fishing boat	Solar fishing boat
A	Gross revenue	INR 3,929	INR 3,929
B	Fuel expense	INR 1,822	INR 50
C	Net revenue [A-B]	INR 2,106	INR 3,879
E	Amount available for crew share [C]	INR 2,106	INR 3,879
F	Income per person	INR 421	INR 776

Source: CEEW anlaysis

Annexure 3

Calculation of CO2 emissions of motorised and solar fishing boats

We use the CO_2 emission factors of petrol and electricity, and fuel economies of petrol and solar fishing boats to estimate their respective CO_2 emissions.

Equation A3: CO_2 emission estimation of boats

$$CO_2\ emission\ factor = \frac{CO_2\ factor\ of\ the\ fuel}{Fuel\ economy\ of\ the\ boat}$$

Where:

$CO_2\ factor\ of\ fuel$ = 2.2719 kgCO_2/l for petrol and 0.754 kgCO_2/l for electricity (India GHG Program 2015; Soman, Ganesan, and Kaur 2019). In case of solar boats, we assume only 20 per cent of the total energy demand is consumed through the grid-based electricity while the remaining 80 per cent is generated by the solar panels on the boat (Thandasherry 2018).