Economic Calculation and Gas Emissions from Solar Energy Utilization on Fishing Vessels 10 and 30 GT in the South Coast of Java Island

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***Abstract*—Today, the world is getting worse cause the energy crisis. One of the solution to overcome the energy crisis is by reducing dependence on fossil energy sources by utilizing alternative energy sources. One of the energy is solar energy. In Indonesia, efforts to utilize solar energy have several advantages which are energy is available in large quantities. Solar energy in Indonesia has an intensity between 0.6 - 0.7 kW / m2, and energy is obtained for free. The study was conducted on the southern coast of Java Island which is located at Ujung Kulon and Palabuhan Ratu. The research method uses an experimental set up where primary data is obtained from the directly into filed. At the research located in Ujung Kulon using the object of a 30 GT fishing vessel research had the potential of laying solar panels as many as 24 pieces with a total investment cost of 20 years amounting to Rp.234,600,000 and total investment for ship auxiliary engines of Rp.11,393,466,345.55. For research at Pelabuhan Ratu using the research object of 10 GT capacity fishing vessel had the potential of laying solar panels as many as 20 pieces with a total investment cost of 20 years amounting to Rp.93,120,000 and total investment for ship auxiliary engines of Rp. 328,963,732.03. The value of long-term investment for 20 years shows that the value of PLTS investment is more profiTable than the value of investment in the auxiliary engine. The use of PLTS is very environmentally friendly .It does not produce any exhaust emissions, while the total level of exhaust emissions in auxiliary engines for 1 year on a 30 GT fishing vessel is 2052,944 tons and on a fishing vessel, 10 GT capacity is 29,837 tons.**

Keywords*—solar energy; solar panel; invesment in PLTS; gas emission; fishing vessel

I. INTRODUCTION

Energy is a major need throughout human history. In Indonesia Energy from fossils is the main choice for use. Indonesia's very high population growth cannot be balanced with nature, as a result, the depletion of petroleum reserves that produce energy. One effort to explore energy is to reduce dependence on fossil energy by utilizing alternative energy.Solar energy is one of the renewable energy sources that can answer alternative energy needs. The geographical conditions that Indonesia has as an archipelago that has a long coastline and a vast ocean are more value for the use of solar energy.

Solar energy is one of the energies that are being actively developed at this time by the Indonesian government because as a tropical country, Indonesia has considerable solar energy potential. Based on solar irradiation data collected from 18 locations in Indonesia, solar radiation in Indonesia can be classified as follows: for western and eastern Indonesia with irradiation distribution in the Western Region of Indonesia (KBI) around 4.5 kWh / m 2 / day with monthly variations of around 10%; and in Eastern Indonesia (KTI) around 5.1 kWh / m 2 / day with a monthly variation of around 9%. Thus, Indonesia's average sunshine potential is around 4.8 kWh / m 2 / day with a monthly variation of around 9%.

Solar energy is a renewable energy source that can answer alternative energy needs.Ujung Kulon and Pelabuhan Ratu are one of the beaches located in the south of the island of Java. Many of the communities around the coast work as fishermen. Traditional fishing communities generally use diesel for vessel or boat engines, as well as kerosene for petromax lamp fuel. The problem of the revocation of kerosene subsidies will make a big problem for fishermen in Indonesia, because all their activities use petroleum.

Solar energy in Indonesia has an intensity between 0.6 - 0.7 kW / m2 (Manan, 2009). For Indonesia, the use of solar energy has several advantages, which are, energy is available in large quantities, and Indonesia is a tropical region where the average sunshine is 6 hours a day with very favorable weather, and the energy is obtained by free. The consumption of fuel oil in the shipping sector is quite large, especially as a source of electricity and fuel to move ships. The high price of fuel does not at all benefit the shipping industry and fishermen as motorized vessel users, so that fuel oil is a consideration for the use of electricity in ships as well as fuel to drive the ship's engines.Using solar panels as alternative energy will be very beneficial for fishermen because in terms of maintenance, the economy and the impact on the environment of the use of solar power plants are very good. Therefore, this research will analyze the economic comparison between the use of auxiliary engines and PLTS.

With the above problems, it is necessary to conduct a study on the use of solar panels for the electricity needs of the fishing vessel. There needs to be a study on the cost of using solar panels on fishing vessels for the efficiency of solar costs for auxiliary engines, which are currently getting higher. The study was conducted by observing the fields directly, namely Palabuhanratu, Sukabumi and Ujung Kulon, Banten. The results show that the use of solar panels get a profiTable investment although the initial cost is very high. Using a solar energy with solar panel does not emit gas at all.

The use of fossil fuels is one of the causes of global warming and acid rain due to gas emissions produced and discharged into the environment. With the increasingly widespread environmental issues, especially in the field of maritime, the Marine Environment Protection Committee (MEPC) as one of the units in the International Maritime Organization (IMO) has revised Annex VI MARPOL to reduce levels of sulfur oxide (SOx), NOx, and CO2 emissions in ship gradually. The Annex VI MARPOL revision was carried out in order to succeed the IMO TIER III regulation. For all ships that will enter the territorial waters of a country that has ratified Annex VI MARPOL, it is required to meet the standards in accordance with these regulations. Therefore, at present various researches have been carried out to reduce exhaust emissions from ships, one of which is the use of a Solar Panel system as an alternative power that can be applied on board, especially on fishing vessels.

II. METHODOLOGY

The research method used in this study is an experimental and analysis method, which is to test and analyze energy requirements by utilizing solar energy as an alternative power on fishing vessels. In this study, technical analysis and economic value were carried out to design a system for the use of alternative power, namely solar power on fishing vessels.

A. *Economic Calculation*

1. Calculation of Investment Costs for PLTS and Auxiliary Engines

   Based on secondary data from PLTS and auxiliary engines that already exist from the survey results in the field. Investment costs for PLTS are like the main components for making PLTS in fishing vessels such as solar panels, inverters, MPPT Solar charge controllers, batteries and cables along with maintenance and operational costs for 1 year to 20 years. Investment costs for auxiliary engines such as the price ofauxiliary engines and maintenance costs and their operations for 1 year to 20 years.

2. Economic Analysis of PLTS on Each Fishing Vessel.

   Analysis of ROI (Return On Investment) calculations is carried out based on the provisions of the Minister of Energy and Mineral Resources Regulation No. 17 of 2013 concerning the purchase of electricity by PLN from Photovoltaic Solar Power Plants, which states that the purchase of electricity from PLTS will be set at US $ 25 cents / kWh (Twenty-five cents United States dollars per kilowatt hour).

Assumption :

1 US $ = Rp. 14,432 (August 2018)

Then:

0.25 US $ = Rp.3608 (August, 2018)

Then the income generated per year from the PLTS on each ship is:

Rp.3608 x Total power produced by PLTS per year

3. Investment Return Time (Payback Period)

   Payback Period = Total Investment / Net cash flow (1)

   The shorter the payback period from the period required by the company, the investment project will be better and more accepTable.

4. Calculation of Net Present Value (NPV)

   NPV = Rt / Present Wort Factor (2)

   $NPV = Rt / (1 + i)^t$ (3)

   Where:
   NPV = Net Present Value
   Rt = cash inflows
   i = Interest Rate
   t = Time of Cash Flow

5. Exhaust Emission Estimates

   To find exhaust emissions, each stage can be used as follows:

   Ei (upstream): t x k x d (4)
   Ei (downstream): t x k x d (5)
   Ei (trip): t x k x d (6)

   Where :
   t: time
   k: fuel consumption
   d: engine power

   Whereas to find the total emissions from pollutants are as follows:

Ei (Total) = Ei (upstream) + Ei (downstream) + Ei (trip) (7)

III. RESULTS AND DISCUSSIONS

A. *Calculate the estimated investment cost of PLTS on a fishing vessel.*

PLTS energy costs differ from the energy costs for conventional plants. This is because PLTS energy costs are influenced by high initial investment costs with low maintenance and operational costs. The initial investment costs for PLTS that will be developed on fishing vessels include costs such as costs for PLTS components and maintenance and operational costs. The cost for this PLTS component consists of costs for purchasing major components such as solar panels, inverters, cables, and batteries.

TABLE I. ESTIMATION OF THE INVESTMENT COST OF PLTS EVERY COMPONENT OF A 30 GT CAPACITY FISHING VESSEL

No	Type	Spec	Unit	Quantity	Price (Rp)	Total (Rp)
1	Solar Panel Shinyoku Polycrystalline	250 Wp	Unit	24	3,500,000.00	84,000,000.00
2	Baterai VOZ Valve Regulated Lead-Acid-GEL 12-200	200 ah - 12 V	Unit	14	4,500,000.00	63,000,000.00
3	Controller charge/MPPT	80 A	Unit	3	6,000,000.00	18,000,000.00
4	Inverter	10000 watt	Unit	3	12,000,000.00	36,000,000.00
5	Cable		M	50	10,000.00	500,000.00
6	Total					195,500,000.00

TABLE II. ESTIMATION OF THE INVESTMENT COST OF PLTS EVERY COMPONENT OF A 10 GT CAPACITY FISHING VESSEL

No	Item	Spec	Unit	Quantity	Price (Rp)	Total (Rp)
1	Solar Panel Polycrystalline	50 Wp	Unit	2	650,000	1,300,000
2	Baterai VOZ Valve Regulated Lead-Acid-GEL 12-28	28 ah - 12 V	Unit	2	765,000	1,530,000
3	Controller charge/MPPT EPEVER	20 A	Unit	1	2,000,000	2,000,000
4	Cable	-	M	10	10,000	100,000
5	Inverter	1000 watt	Unit	1	800,000	800,000
	TOTAL					**Rp.5,730,000**

In Table I & II is the total of the estimated investment cost of PLTS on each fishing vessel, for purse seine fishing vessels with a capacity of 30 GT the investment cost is Rp.195,500,000 and for fishing vessels, the capacity of 10 GT the investment cost is Rp. 5,730,000.

B. Calculate Estimation of PLTS Maintenance and Operational Costs

Maintenance and operational costs per year for PLTS, generally calculated at 1-2% of the total initial investment costs (Jais et al, 2012; S.G., Ramadhan et al, 2016). Based on these references, in this study, the percentage of maintenance and operational costs per year of PLTS which includes costs for solar panel cleaning, maintenance, and inspection of equipment and installation will be set at 1% of the total initial investment costs. The percentage determination of 1% is based on the fact that Indonesia only experiences two seasons, namely the rainy and dry seasons so that the cleaning and maintenance costs of its solar panels are not as large as those in countries that experience four seasons in one year. In addition, this percentage determination is also based on the wage level of workers in Indonesia which is cheaper than the wage level of workers in developed countries. The amount of maintenance and operational costs (M) per year for PLTS that will be developed are as follows:

M = 1% x Investment Costs on Each Ship (8)

TABLE III. ESTIMATED MAINTENANCE AND OPERATIONAL COSTS

No	Ship type & capacity	Value of Investment	Maintenance & Operational Value	Results
1	Traditional Fishing Vessel type purse seine with a capacity of 30 GT	Rp.195,500,000	1%	Rp.1,955,000
2	Traditional FishingVessel Pole in Line capacity of 10 GT	Rp.5,730,000	1%	Rp.57,300

In Table III is the result of calculation of estimated maintenance and operational costs of PLTS on each fishing vessel for a year, for purse seine fishing vessels with a capacity of 30 GT maintenance and operational costs amounting to Rp.1,955,000, and for fishing vessels the capacity of 10 GT is 57,300. If an estimated solar panel age reaches 20-25 years, the total maintenance and operational costs are assumed to be 20 years as follows:

TABLE IV. ESTIMATED MAINTENANCE AND OPERATIONAL COSTS FOR 20 YEARS

No	Ship type & capacity	Maintenance & Operational Costs	*Lifetime PLTS (year)*	Results
1	Traditional Fishing Vessel type purse seine with a capacity of 30 GT	Rp.1,955,000	20	Rp.39,100,000
2	Traditional FishingVessel Pole in Line capacity of 10 GT	Rp.57,300	20	Rp.1,146,000

In the Table IV above the result of the calculation of estimated maintenance costs and operation of solar power plants on each fishing vessel for 20 years, for purse seine fishing vessels with a capacity of 30 GT the maintenance and operational costs are Rp.39,100,000 and for fishing vessel capacity of 10 GT is Rp. 1.146,000.

C. Total investment of PLTS on each fishing vessel

The total investment of PLTS is the total estimated cost for PLTS on each vessel, covering the total investment costs and added maintenance costs along with the PLTS operation for 20 years shown in Table V.

TABLE V. TOTAL COST OF INVESTING IN PLTS ON EACH FISHING VESSEL

No	Ship Type & Capacity	Investment Costs	Maintenance & Operational Costs	Results
1	Traditional Fishing Vessel type purse seine with a capacity of 30 GT	Rp.195,500,000	Rp.39,100,000	234,600,000
2	Traditional FishingVessel Pole in Line capacity of 10 GT	Rp.5,730,000	Rp.1,146,000	6,876,000

In the Table above is the result of the calculation of the total investment cost of PLTS on each fishing vessel, for traditional fishing vessels of the purse seine type with a capacity of 30 GT the total investment cost of the PLTS is Rp.234,600,000 and for fishing vessels the capacity of 10 GT the total investment cost of the PLTS for the pole in line fishing vessel is Rp.6,876,000

D. Economic Analysis of PLTS on Each Fishing Vessel.

In Table VI, the results of the analysis of ROI calculations are carried out based on the regulations of the Minister of Energy and Mineral Resources No. 17 of 2013 concerning the purchase of electricity by PLN from photovoltaic solar power plants on each fishing vessel, for fish vessels with a capacity of 30 GT the cash calculation results obtained are amounting to Rp.33,778,998 per year and for fishing vessels with a capacity of 10 GT the results of the cash calculation were Rp. 12,958,493 per year.

TABLE VI. CALCULATION OF RETURN ON INVESTMENT (ROI)

No	Ship Type	Price/kWh (Rp)	Power (kWh/thn)	Result
1	Fishing Vessel 30 GT	3608	9362.25	Rp.33,778,998,-
2	Fishing Vessel 10 GT	3608	3591.6	Rp.12,958,493,-

E. Pay Back Period

The total investment needed to make PLTS on each fishing vessel is:

TABLE VII. TABLE 7. CALCULATION OF PAYBACK PERIOD

No	Ship Type	Total Investment	Net Cash Flow	Results
1	Fishing Vessel 30 GT	Rp.234,600,000	Rp.33,778,998,-	6,9
2	Fishing Vessel 10 GT	Rp.93,120,000	Rp.12,958,493,-	7,2

From the calculation results in Table VII, Payback Period on a 30 GT fishing vessel has a Payback Period for 6.9 years or rounded up to 7 years and for a 10 GT fishing vessel has a payback period of 7.2 years or 7 years and 4 months.

F. Net Present Value

The NPV calculation is made with a projected calculation of revenues and costs that occurred for 20 years (based on the use of interest rates of 11% every year).

TABLE VIII. NPV VALUE OF PLTS IN FISHING VESSEL 30 GT FOR 20 YEARS

No	Investasi	Arus kas Masuk	Tingkat Suku Bunga (i=11%)	Nilai Kas
0	Rp.234,600,000	-	1	Rp.(234,600,000.00)
1		Rp.33,778,998	0.89	Rp.30,063,308.22
2		Rp.33,778,998	0.79	Rp.26,756,344.32
3		Rp.33,778,998	0.70	Rp.23,814,193.59
4		Rp.33,778,998	0.63	Rp.21,192,943.35
5		Rp.33,778,998	0.56	Rp.18,862,192.48
6		Rp.33,778,998	0.50	Rp.16,788,162.01
7		Rp.33,778,998	0.44	Rp.14,940,450.82
8		Rp.33,778,998	0.39	Rp.13,298,791.51
9		Rp.33,778,998	0.35	Rp.11,836,160.90
10		Rp.33,778,998	0.31	Rp.10,532,291.58
11		Rp.33,778,998	0.28	Rp.9,373,671.95
12		Rp.33,778,998	0.25	Rp.8,343,412.51
13		Rp.33,778,998	0.22	Rp.7,424,623.76
14		Rp.33,778,998	0.20	Rp.6,607,172.01
15		Rp.33,778,998	0.17	Rp.5,880,923.55
16		Rp.33,778,998	0.15	Rp.5,235,744.69
17		Rp.33,778,998	0.14	Rp.4,658,123.82
18		Rp.33,778,998	0.12	Rp.4,144,683.05
19		Rp.33,778,998	0.11	Rp.3,688,666.58
20		Rp.33,778,998	0.10	Rp.3,283,318.61
		NPV		**Rp.12,125,179.29**

TABLE IX. NPV VALUE OF PLTS IN FISHING VESSEL 10 GT FOR 20 YEARS

No	Investasi	Arus kas Masuk	Tingkat Suku Bunga (i=11%)	Nilai Kas
0	Rp.93,120,000	-	1	Rp.(93,120,000.00)
1		Rp.12,958,493	0.89	Rp.11,533,058.77
2		Rp.12,958,493	0.79	Rp.10,264,422.31
3		Rp.12,958,493	0.7	Rp.9,135,737.57
4		Rp.12,958,493	0.63	Rp.8,130,158.51
5		Rp.12,958,493	0.56	Rp.7,236,022.49
6		Rp.12,958,493	0.5	Rp.6,440,371.02
7		Rp.12,958,493	0.44	Rp.5,731,541.45
8		Rp.12,958,493	0.39	Rp.5,101,758.69
9		Rp.12,958,493	0.35	Rp.4,540,655.95
10		Rp.12,958,493	0.31	Rp.4,040,458.12
11		Rp.12,958,493	0.28	Rp.3,595,981.81
12		Rp.12,958,493	0.25	Rp.3,200,747.77
13		Rp.12,958,493	0.22	Rp.2,848,276.76
14		Rp.12,958,493	0.2	Rp.2,534,681.23
15		Rp.12,958,493	0.17	Rp.2,256,073.63
16		Rp.12,958,493	0.15	Rp.2,008,566.42
17		Rp.12,958,493	0.14	Rp.1,786,976.18
18		Rp.12,958,493	0.12	Rp.1,590,007.09
19		Rp.12,958,493	0.11	Rp.1,415,067.44
20		Rp.12,958,493	0.1	Rp.1,259,565.52
		NPV		**Rp.1,530,128.72**

In the Table VIII & IX above shows that the NPV value for each fishing vessel is Positive. So it can be concluded, PLTS investment in each fishing vessel can be accepted or run. When compared to the age of solar panels which are estimated to reach 20 years, then from the ROI analysis obtained the design of solar power plants is very beneficial for shipowners and fishermen in Indonesia, especially in the Ujung Kulon and Pelabuhan Ratu areas which are the locations of research.

G. Estimated Investment Cost of Auxiliary Engines in Each Fishing Vessel.

Calculating estimated investment costs in auxiliary engines on each fishing vessel is seen based on the auxiliary engine power specifications on each vessel, which includes investment in auxiliary engine prices and operating costs for 20 years that show on Tbale 10 below.

TABLE X. THE PRICE OF AUXILIARY ENGINES IN EACH SHIP

No	Ship type	Capacity	Engine	Type	Price (Rp)
1	Fishing Vessel 30 GT	30 GT	Mitsubishi	PS 135	50,000,000
2	Fishing Vessel 10 GT	10 GT	Firman	FPG1500L	4,000,000

H. Estimated Maintenance and Operational Costs of Auxiliary Engines

Calculating estimated maintenance and operational costs of auxiliary engine for each fishing vessel includes the cost of ship engine maintenance and fuel costs for 1-20 years.

TABLE XI. MAINTENANCE COSTS

No	Type & Ship Capacity	Engine Merk	Power (Kw)	Yearly Maintenance Costs
1	Fishing Vessel 30 GT	Mitsubishi	101	Rp.14,425,000.00
2	Fishing Vessel 10 GT	Firman	2.24	Rp.1,985,000.00

Based on the above Table XI, the maintenance cost of auxiliary engines per year on each vessel varies depending on the power capacity and specifications of the auxiliary engine. For a purse seine fishing vessel with a capacity of 30 GT has a maintenance cost of Rp. 14,425,000.00 per year and a 10 GT pole in line capacity fishing vessel are as large as Rp. 1,985,000.00. To get a 20-year maintenance and operational projection it is assumed to use the average inflation rate in Indonesia for the last 3 years from the 2016-2018 Bank Indonesia INFLATION (Consumer Price Index) Report of 3.7% assumed to be the highest value of 5%.

In the Table XII above is the total cost of maintenance and operation of auxiliary engines on each fishing vessel. For fishing vessels Purse Seine Traditional 30 GT has a total cost of Rp.476,976,387.93, and for traditional pole in line fishing vessels with a capacity of 10 GT has a total cost of Rp.65,635,918.89.

TABLE XII. MAINTENANCE COSTS FOR A 30 & 10 GT FISHING VESSEL FOR 20 YEARS

No	Maintenance and Investment costs 30 GT	Maintenance and Investment costs 10 GT
1	Rp.14,425,000.00	Rp.1,985,000.00
2	Rp.15,146,250.00	Rp.2,084,250.00
3	Rp.15,903,562.50	Rp.2,188,462.50
4	Rp.16,698,740.63	Rp.2,297,885.63
5	Rp.17,533,677.66	Rp.2,412,779.91
6	Rp.18,410,361.54	Rp.2,533,418.90
7	Rp.19,330,879.62	Rp.2,660,089.85
8	Rp.20,297,423.60	Rp.2,793,094.34
9	Rp.21,312,294.78	Rp.2,932,749.06
10	Rp.22,377,909.52	Rp.3,079,386.51
11	Rp.23,496,804.99	Rp.3,233,355.83
12	Rp.24,671,645.24	Rp.3,395,023.63
13	Rp.25,905,227.50	Rp.3,564,774.81
14	Rp.27,200,488.88	Rp.3,743,013.55
15	Rp.28,560,513.32	Rp.3,930,164.22
16	Rp.29,988,538.99	Rp.4,126,672.44
17	Rp.31,487,965.94	Rp.4,333,006.06
18	Rp.33,062,364.23	Rp.4,549,656.36
19	Rp.34,715,482.45	Rp.4,777,139.18
20	Rp.36,451,256.57	Rp.5,015,996.14
TOTAL	Rp.476,976,387.93	Rp.65,635,918.89

TABLE XIII. FUEL REQUIREMENTS FOR EACH AUXILIARY ENGINE

No	Type & Ship Capacity	Type & Ship Capacity	Power (Kw)	Operating Duration (Hours)	Fuel Needs (Tons / day)
1	Fishing Vessel 30 GT	Mitshubishi	101	10	0.1818
2	Fishing Vessel 10 GT	Fusinda	2.24	6	0.00336

TABLE XIV. FUEL NEEDS FOR EACH AUXILIARY ENGINE PER YEAR

No	Type & Ship Capacity	Fuel Needs (Tons / day)	Operating Period for 1 Year (Hours)	Fuel Needs Results (Ton / yrs)
1	Fishing Vessel 30 GT	0.1818	3510	63.81
2	Fishing Vessel 10 GT	0.00336	2106	1.18

TABLE XV. FUEL PRICES PER YEAR

No	Type & Ship Capacity	Fuel Needs (Tons / day)	Price of diesel fuel and gasoline (Rp)	Results of fuel consumption costs / yr
1	Fishing Vessel 30 GT	63.81	5150	Rp.328,630,770.00
2	Fishing Vessel 10 GT	1.18	6650	Rp.7,842,744.00

To get a projection of the auxiliary fuel consumption cost for each fishing vessel for 20 years that show on Table 16, it is assumed to use an average fuel increase every year by 5%. The fuel price is got by Table XII, XIV, & XV.

TABLE XVI. FUEL PRICES FOR 30 GT FISHING VESSELS FOR 20 YEARS

No	Fuel Prices for 30 GT Fishing Vessel	Fuel Prices for 10 GT Fishing Vessel
1	Rp.328,630,770.00	Rp.7,842,744.00
2	Rp.345,062,308.50	Rp.8,234,881.20
3	Rp.362,315,423.93	Rp.8,646,625.26
4	Rp.380,431,195.12	Rp.9,078,956.52
5	Rp.399,452,754.88	Rp.9,532,904.35
6	Rp.419,425,392.62	Rp.10,009,549.57
7	Rp.440,396,662.25	Rp.10,510,027.04
8	Rp.462,416,495.36	Rp.11,035,528.40
9	Rp.485,537,320.13	Rp.11,587,304.82
10	Rp.509,814,186.14	Rp.12,166,670.06
11	Rp.535,304,895.45	Rp.12,775,003.56
12	Rp.562,070,140.22	Rp.13,413,753.74
13	Rp.590,173,647.23	Rp.14,084,441.43
14	Rp.619,682,329.59	Rp.14,788,663.50
15	Rp.650,666,446.07	Rp.15,528,096.67
16	Rp.683,199,768.37	Rp.16,304,501.51
17	Rp.717,359,756.79	Rp.17,119,726.58
18	Rp.753,227,744.63	Rp.17,975,712.91
19	Rp.790,889,131.86	Rp.18,874,498.56
20	Rp.830,433,588.46	Rp.19,818,223.48
TOTAL	Rp.10,866,489,957.62	Rp.259,327,813.14

TABLE XVII. TOTAL FUEL COSTS FOR FISHING VESSELS FOR 20 YEARS

No	Type & Ship Capacity	Total Cost of Fuel Consumption
1	Fishing Vessel 30 GT	Rp.10,866,489,957.62
2	Fishing Vessel 10 GT	Rp.259,327,813.14

In Table XVII is the result of calculating the total cost of fuel for fishing vessels for 20 years. For traditional fishing vessels, the purse seine type with a capacity of 30 GT has a total cost of Rp. 10,866,489,957. For 10 GT is Rp. 259,327,813. The total of the maintenance and operational costs of auxiliary engine for 20 years is shown in the following Table:

Total Maintenance and Operational = Total Cost of Fuel Consumption + Maintenance Engine and Operational Costs for 20 years that show in Table XVIII.

TABLE XVIII. TOTAL MAINTENANCE & OPERATION OF FISHING VESSELS FOR 20 YEARS

No	Type & Ship Capacity	Total Cost of Fuel Consumption	Total Auxiliary Engine Maintenance Costs	Total Maintenance & Operations
1	*Purse Seine* 30 GT	Rp.10,866,489,957.62	Rp.476,976,387.93	Rp.11,343,466,345.55
2	*Pole in line* Tradisional 10 GT	Rp.259,327,813.14	Rp.65,635,918.89	Rp.324,963,732.03

I. *Total investment of Auxiliary Engines in Each Fishing Vessel*

The total investment of Auxiliary Engine is the total estimated cost for auxiliary engines in each vessel, covering the total investment costs and added maintenance costs along with the operation of the auxiliary engine for 20 years shown in Table1 & 2.

Total Investment = Investment Cost + Maintenance and operational costs

TABLE XIX. TOTAL COST OF AUXILIARY ENGINE INVESTMENT FOR 20 YEARS

No	Type & Ship Capacity	Investment Costs	Maintenance & Operational Costs	Result
1	Fishing Vessel 30 GT	Rp.50,000,000.00	Rp.11,343,466,345.55	**Rp.11,393,466,345.55**
2	Fishing Vessel 10 GT	Rp.4,000,000.00	Rp.324,963,732.03	**Rp.328,963,732.03**

In Table XIX is the result of the calculation of the total investment costs of Auxiliary Engines/generators on each fishing vessel, for traditional fishing vessels of purse seine type with a capacity of 30 GT total investment costs of Rp. 11,393,466,345.55, and for fishing vessels the capacity of 10 GT is Rp. 328,963,732.03.

J. Auxillary Emissions On Every Fish Ship

Standards for motor vehicle transport emissions can be seen in the Table20 below.

TABLE XX. EXHAUST EMISSION STANDARDS

No	Air Quality Parameters	Element	Emission Factor (gr / liter)
1	Sulfur Dioksida	SO_2	0.5985
2	Timbal Hitam	Pb	0.07
3	Oksidan	O_3	0.6821
4	Nitrogen Oksida	NO_2	13.542
5	Partikulat < 10 μm	PM_{10}	0.6033
6	Dust	-	0.5985
7	Karbon Monoksida	CO	1.145
8	Karbondioksida	CO_2	32

TABLE XXI. FUEL CONSUMPTION FOR EACH FISHING VESSEL PER DAY

No	Type & Ship Capacity	Engine Merk	Operating Duration (Hours)	Power (Kw)	Fuel Consumption (Ton)
1	Fishing Vessel 30 GT	Mitsubishi	10	101	0.1818
2	Fishing Vessel 10 GT	Firman	6	2	0.003

Fuel Consumsion fishing veseel 10 & 30 GT is get from Table XXIII. Power from the vessel data.

TABLE XXII. GAS EMISSIONS AUXILIARY ENGINE OF FISHING VESSEL 30 & 10 GT PER DAY

No	Air Quality Parameters	Emission Factor (ton / liter)	Fuel Consumption (Ton)	Emission Aux. EngineFish vessel 30 GT (Tons / day)	Emission Aux. EngineFish vessel 10 GT (Tons / day)
1	Sulfur Dioksida (SO2)	0.000599	0.1818	0.000108807	0.00000201
2	Timbal Hitam (Pb)	0.00007	0.1818	0.000012726	0.00000024
3	Oksidan (O3)	0.000628	0.1818	0.000114189	0.00000211
4	Nitrogen Oksida (NO2)	0.013542	0.1818	0.002461936	0.0000455
5	Partikulat < 10 μm (PM10)	0.000603	0.1818	0.00010968	0.00000203
6	Debu	0.000599	0.1818	0.000108807	0.00336
7	Karbon Monoksida (CO)	0.001145	0.1818	0.000208161	0.00000385
8	Karbondioksida (CO2)	3.2	0.1818	0.58176	0.010752
	Total			0.6	0.014

Based on Table XXI & XXII, exhaust gas emissions for auxiliary engines on fishing vessels 30 and 10 GT are calculated based on emission factors and fuel consumption per day, fuel consumption (ton/day) each ship is multiple by emission factor (ton/liter).The total calculation results are 0.6 and 0.014 tons/day.

TABLE XXIII. GAS EMISSIONS AUXILIARY ENGINE OF FISHING VESSEL 30 & 10 GT PER YEAR

No	Air Quality Parameters	Operating duration per year (hours)	Operating duration per year (hours)	Emission of Auxiliary Engine 30 GT per Year (Tons)	Emission of Auxiliary Engine for 10 GT per Year (Tons)
1	Sulfur Dioksida (SO2)	3510	2106	0.382	0.004
2	Timbal Hitam (Pb)	3510	2106	0.045	0
3	Oksidan (O3)	3510	2106	0.401	0.004
4	Nitrogen Oksida (NO2)	3510	2106	8.641	0.096
5	Partikulat < 10 μm (PM10)	3510	2106	0.385	0.004
6	Debu	3510	2106	0.382	7.076
7	Karbon Monoksida (CO)	3510	2106	0.731	0.008
8	Karbondioksida (CO2)	3510	2106	2041.978	22.644
	Total			2052.944	29.84

Based on Table XXIII, annual exhaust emissions for auxiliary engines on 30 GT fishing vessels are calculated

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based on auxiliary engine exhaust emissions per day and multiplied by the operating duration of auxiliary engines for one year, the total results of these calculations are 2052,944 tons/year and for 10 Gt is 29,84

Highest Exhaust Gas Emissions are Nitrogen Oxide (NO2), air pollution by NO2 gas can cause Peroxy Acetyl Nitrates which is abbreviated as PAN. Peroxide Acetyl Nitrates causes irritation to the eyes which causes the eyes to feel sore and runny. Carbon dioxide (CO2), air pollution by carbon dioxide will perforate the ozone layer, the greenhouse effect, the sun's light & heat entering the earth cannot be released into space cosmically, increasing the earth's temperature globally by several degrees, melting polar ice so as to increase the water surface the sea. Carbon monoxide, the effect caused by excessive carbon monoxide is inhibiting the supply of oxygen to the body, disrupting nerve function, disrupting the function of the heart, if in large amounts it will cause poisoning, weakness, dizziness, and unconsciousness.

K. *Economic And Emission Analysis Of PLST With Auxillary Engines*

1. Comparison of Investment Value of PLTS with Auxiliary Engines

TABLE XXIV. COMPARISON OF INITIAL INVESTMENT VALUE FOR A YEAR

No	Type & Ship Capacity	Value of Investment in PLTS	Value of Auxiliary Engine Investment
1	Fishing Vessel 30 GT	Rp.209,575,000.00	Rp.343,055,770.00
2	Fishing Vessel 10 GT	Rp.63,125,000.00	Rp.9,827,744.00

In the Table XXIV above is a comparison of the value of PLTS investment with the investment value of auxiliary engine on fishing vessels. It can be seen that the value of the initial investment for a year for PLTS is indeed very large except for the traditional purse seine fishing vessel with a capacity of 30 GT, because the auxiliary engines and maintenance costs are indeed very large to meet the huge electricity needs also on the ship. But the value of long-term investments for 20 years, PLTS is better than auxiliary engines. Shown in Table below.

TABLE XXV. COMPARISON OF INITIAL INVESTMENT VALUE FOR A 20 YEAR

No	Type & Ship Capacity	Value of Investment in PLTS	Value of Auxiliary Engine Investment
1	Fishing Vessel 30 GT	Rp.234,600,000	Rp.11,393,466,345.55
2	Fishing Vessel 10 GT	Rp.93,120,000	Rp.328,963,732.03

Can be seen in Table XXV, The value of long-term investment for 20 years shows that the value of PLTS investment is more profiTable than the investment value of auxiliary engine. Factors that cause a very high increase in the value of investment in auxiliary engine are the effects of fuel use and maintenance and operation of auxiliary engines that continue to increase every year while the PLTS does not use BBM at all and maintenance on the PLTS is relatively sTable.

2. Comparison of PLTS Exhaust Emissions with Auxiliary Engines

TABLE XXVI. COMPARISON OF EXHAUST GAS EMISSIONS FOR 1 YEAR

No	Type & Ship Capacity	Exhaust PLTS Emission Gas Value (Ton)	Flue Gas Emission Value (Tons)
1	Fishing Vessel 30 GT	0	2,052,944
2	Fishing Vessel 10 GT	0	29,837

Based on Table XXVI, the value of exhaust gas in PLTS for 1 year is 0 tons or can be said to be nonexistent, while for exhaust gas emissions produced by auxiliary engines for 1 year with the highest value of 2052,944 tons produced by auxiliary engines diesel fuel owned by the traditional fishing vessel purse seine with a capacity of 30 GT. For auxiliary engines on a 10 GT pole in line traditional fishing vessel that has used gasoline, it still emits a considerable amount of exhaust gas, which is 29.84 tons per year. So it can be concluded that the analysis of exhaust emissions from the use of PLTS is very environmentally friendly because it does not emit exhaust emissions at all, it is very different from the use of auxiliary engines on ships with very high levels of exhaust emissions and can cause air pollution and damage to nature.

IV. CONCLUSION

From the results of the analysis conducted are as follows It can be concluded that the initial investment (capital) value for a year for PLTS is very large except for the traditional purse seine fishing vessel with a capacity of 30 GT, but the value of long-term investment over 20 years shows that the value of PLTS investment is more profiTable than the investment value of auxiliary engine on fishing vessels fish. For exhaust gas emissions, it can be concluded that the analysis of exhaust emissions from the use of PLTS is very environmentally friendly because it does not emit exhaust emissions at all, it is very different from the use of auxiliary engines on ships with very high levels of exhaust emissions and can cause air pollution and natural damage.

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