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IMPROVING FISHERMEN'S WELFARE WITH FUEL-SAVING TECHNOLOGY

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ABSTRACT

The problem of energy for fishermen is indeed very complex. When fuel prices rise, it is very worrying that the poor in Indonesia will increase. The study aimed to find out the development of fishermen, as well as the benefits of using Brown's Gas Electrolyzer (BG-E) on a fishing boat in Indonesia. This type of data is secondary and sourced from second parties (Government Office and others). Analysis, synthesis methods, and alternative problem solving are prepared based on data, information, and observations to solve fisherman's problems based on research objectives. The application of BG-E technology can be applied to small-scale fishing boats, is Outboard Motorboats and 5-30 GT Motorboats. BG-E is made according to the ship's power requirements. The way it works through an electrolysis process to decompose compounds in the form of solutions melts, or ordinary liquids by the electric current flowing through the compound. From the results of the electrolysis process, it produces oxyhydrogen which will react with gasoline in the boat engine. This reaction will produce an explosion to move the piston on the ship's engine so that the engine can live. With the implementation of BG-E, it can save fuel oil consumption and improve the welfare of Indonesian fishermen. The originality of the research is related to the method used in the framework of estimating Fishermen fuel savings in Indonesia, so that the study will become novelty in the future.

Contribution/ Originality: The study aimed to find out the development of fishermen, as well as the benefits of using Brown's Gas Electrolyzer (BG-E) on a fishing boat in Indonesia.

1. INTRODUCTION

After falling in the first half of 2017, global commodity prices surged in the second half of 2017 and remained soaring into 2018. The World Bank's energy price index jumped in 2017 (Q4) of 23.6% (YoY), which largely driven by high coal prices and oil prices. Brent oil prices also rose sharply to reach 18.8% in December, due to tightening global supplies. This is partly due to the extension of the OPEC agreement to cut global oil production, as well as increasing political uncertainty in the Middle East. Meanwhile, the non-energy price index rose 5.2% in 2017, partly because the metal and mineral price index jumped by double digits [1].

The World Economic Review [2] reports that the transportation and industrial sectors are the biggest contributors to world oil needs with an average growth of 1.2% per year until 2030. And noteworthy is countries in the Asia-Pacific region and South Asia provides the largest portion, namely 58% of the total increase in world oil demand. This is considering that in the region there are developing countries with very large populations such as Indonesia, India, Vietnam, and developed countries like China (consumption of oil ranks third in the world).

Among the end-users, the industry is the biggest user. The industrial sector alone consumes 30% of total energy consumption in the end-user sector. Energy use in the industrial sector in 2012 reached 457 Mboe. This figure is slightly lower compared to the use of industrial energy in the previous period, which is 458 Mboe. Meanwhile, in the same year, transportation was the biggest oil user sector compared to other sectors. As in the previous period, the level of oil consumption in the transportation sector is still very dominant, almost reaching 100% of the total energy use in the transportation sector.

The existence of such delicate conditions, that the political economy of determining the price of energy that sets fuel as a commodity at a uniform national price is not appropriate for the different economic developments in Indonesia. The price of fuel that is made "cheap" with unwarranted subsidies brings a more negative side, rather than economic benefits [3].

The increase in fuel prices, on the other hand, has a domino effect, when the increase in fuel prices is only around 12.3%, the price increase of other basic needs is already above 20%, but if the fuel price is lowered because it uses a market mechanism, then it does not necessarily reduce the price of goods These basic needs become a dilemma from fluctuations in fuel prices on the market.

Limited world oil resources indirectly impact Indonesia, which is still dependent on world oil. Increasing the price of gasoline and diesel is unavoidable. The Energy Crisis greatly affected Indonesian people, one of which was Fishermen. Fishermen belonging to the poor population are very dependent on diesel fuel. When the price of diesel rises, there will be an extreme concern that Indonesia's poor will increase.

Indonesia is the largest archipelago country in the world which has the second-longest coastline after Canada and abundant fishery resource potential. According to Indonesian Geospatial Information Agency [4] the total length of Indonesia's coastline is around 99,093 Km. Therefore, the fisheries sector is the foundation for some people who depend on their lives on fishing (both fishing and aquaculture). Even so, the standard of living or the level of welfare of Indonesian fishermen and fish farmers continues to be in the spotlight. Small fishermen as the largest group of fishermen in Indonesia are still attached to poverty.

Based on BPS-Statistics [5] households in Indonesia who rely on their lives from fishing in public waters and the seas are 964,231 or around 1.5% of households in Indonesia. Of these, dominant is in the Province of East Java. Meanwhile, marine fishermen households that are classified as poor are 23.79%, fishermen in public waters are 24.98% and cultivation is 23.44%.

Households fishing business at sea has a greater per capita income compared to households fishing business in public waters, and fish farming business households. Per capita income of fishermen in public waters is Rp. 642,350 and sea fishermen Rp. 737,030. Fishermen's household income in public waters is Rp. 2,338,600 and marine fishermen Rp. 3,030,200. The number of poor people (residents with per capita expenditure per month below the Poverty Line) in Indonesia reaches 28.59 million people (11.22%). This number increased by 0.86 million people compared to the condition in September 2014 reaching 27.73 million people or 10.96% [6].

Fishermen have a very important role in the modernization of human life. They are among the most reactive parts of the environment. Its nature is more open when compared to other community groups. Their existence as an agent of development was not shown positively with their economic life. Fishermen are the most important social problem faced in coastal areas facing poverty problems.

Energy problems for fishermen are indeed very complex. The government has tried to overcome these solutions, including subsidizing fuel oil. The subsidy given by the government to fishermen has not been able to overcome the fishermen's energy problems, where the price of subsidized fuel that is given is still too little. This makes the fishermen think hard so that their catch can be sold according to the price of capital issued. Some parties involved in supporting fishermen have proposed an additional budget for fishermen fuel subsidies, but the response from the government is not good.

Various types of subsidies can contribute to the well-being of fishing communities. However, subsidies may contribute to capacity enhancement of fisheries sectors contribute to overcapacity and create the situation depletion of fishery stocks [7, 8]. Some peoples were concerned about sustainability of fishery resources, especially on the impacts of these subsidies on fishery stock. In their opinion, fishery subsidies that can be harmful to sustainable fishery such as fuel subsidy and construction of fishing boats should be banned. These groups against all types of harmful subsidies because they hope the fishery stocks will be remain healthy and effective management are being practiced. They said policy makers should practice good fishery management, which included count their fish stocks, doing science-based limits on capture and by catch, count their fishing boats, using licenses and fishing right to limit fishing capacity, and enforce the rules.

Though, resources remain the basis of economic activities, the setting up of the economy is become more linked with higher levels of material, information and cash flows of all categories. Parallel with this, resources, capital and even labour have shown increased levels of mobility [9].

Table-1. Transport investment policy development approach structure.

Levels	Validation	Purposes	Goals
Approaches	Theoretical framework Historical data Statistics	Investment Projects Analyses (Appraisal)	Setting innovative concepts/conclusions
Results	Knowledge gain: state-of the-art analysis	Identification of best practices	Development of Applied framework
Synthesis	Recommendations for developing countries (Indonesia):		
	1. Investment in transport infrastructure should remain the priority, but it should be address the demand for transport of goods and services, and it should be oriented in maintenance of transport infrastructure.		
	2. Efficiency of public investments in transport infrastructure should be improved.		
	3. Decision making process and accountability should be transparent and effective.		
	4. Investments in transport system should more address the social and environmental issues, not only the economic issue.		
	5. Transport pricing policy should be reengineered and empowered.		
	6. Transport projects appraisal policy should be strongly linked to strategic plan and should include the element of risk management. It should also use the cost and benefits analysis by including all related indicators and possibly using the method similar to the Indonesia Department for Transport method, but by taking into account the specifics of the country.		
	7. The other issues such energy, education and health should remain the states priorities, and there should not be tolerated shortage on investments (particularly this is important for Indonesia case).		

Source: Rodrigue [9].

Referring from Table 1, reduced transport costs mean that businesses can: (1) Connect with potential suppliers, enabling them to access higher-quality and/or lower-cost inputs; (2) Connect with potential customers, enabling them to supply markets further afield; and (3) Connect with a wider pool of talent in the labour market, allowing skills to be better matched to employment opportunities.

Total transport GDP related to final demand (this concept includes the expenditures by end users on goods and services for transport purposes). It includes the transport component of the four components of GDP: personal consumption expenditures, government expenditures and investment, business investment, and net exports. In essence, transport final demand measures the size of transport function in relation to GDP. Is transport system contribution to GDP decreasing or increasing in recent times?.

This paper is based on and is a development of research from Zainol and Yaakob [10]. This study describes a proposal to enable reductions in fuel consumption by introducing the combined use of a diesel engine and surface-piercing propeller (SPP). An analysis of fuel consumption reduction is presented, together with an economic feasibility study. Resulting data reveal that the use of the proposed modifications would save 23.31 liters of fuel per trip (40.75%) compared to outboard motors, equaling annual savings of RM 3962 per year. Meanwhile, a review by Zainol, et al. [11] describes a study to reduce fuel consumption by introducing a dual fuel diesel and CNG for Malaysian offshore fishing vessel. An analysis of fuel consumption reduction is presented, together with stability assessments. The results reveals that dual fuel diesel can provide noticeable lower fuel consumption compared to existing diesel engines and stability assessment signify that the conversion to dual fuel engine has no adverse effects to vessel stability.

Subsidies play two additional roles: To the degree that they stimulate fishing, they may also increase the national income of the nation. As long as the fishery is underdeveloped, i.e. as long as fishing is at a level less than that which can be safely sustained, then subsidies which encourage fishing may be useful.

Seeing the poor condition of the Indonesian economy from several complex economic problems, an additional policy is needed to improve the welfare of fishermen. In this case, an effective innovation is needed, so that the innovation can help fishermen in their efforts to save fuel and is expected to help improve the welfare of life.

With the increasing number of fishing vessels used by fishermen, the amount of fuel energy needs for ships is also getting bigger. However, with the increasing amount of fuel supply needed, it will make more wasteful of energy used for fishing boats and a world crisis that makes world oil prices unstable, making diesel fuel more expensive. Based on these thoughts, the author wants to make a solution that is by making fuel-saving devices through the process of electrolysis with water media as a saver for fishing boats. The objective to be achieved in making this final project is to estimate the fuel savings of fishing boats in Indonesia using diesel fuel through Brown's Gas Electrolyzer (BG-E) and the percentage of fuel savings from the tool.

2. MATERIAL AND METHODS

2.1. Research Design

The approach used is qualitative-descriptive based. Descriptive approach is a research approach that seeks to describe a phenomenon, event, event that occurs at present. This is following the purpose of descriptive research that is to describe what the existence of a variable, symptom, or condition, and not to test the hypothesis. Put forward a qualitative method as a research procedure that produces descriptive data in the form of written or oral words from people and observable behavior. In writing an article, a qualitative research report contains excerpts from data / facts revealed in the field to provide a complete illustration and to provide support for what is presented.

Qualitative and descriptive research methods have been very common procedures for conducting research in many disciplines, including education, psychology, and social sciences. These types of research have also begun to be increasingly used in the field of second language teaching and learning. The interest in such methods, particularly in qualitative research [12].

2.2. Research Scope

The scope of the research was chosen based on consideration of the research object, objectives to be achieved, ease of data collection, time and cost efficiency factors. Therefore, the research idea is only limited to fuel-saving technology on boat engines, namely Brown's Gas Electrolyzer (BG-E) based on Oxyhydrogen (HHO) in the context of improving the welfare of fishermen in Indonesia. The study was conducted for 3 months (October - December 2019) using secondary data.

2.3. Data Types and Sources

The type of data in this study is quantitative data and the source of the data used is secondary data. Using secondary data in research has proved itself a valuable approach to finding suitable data for one's needs [13]. Another definition of secondary data is data that has been collected by data collection agencies and published to the data user community.

Government Agencies or International Institutions collecting data from this study include: (1) BPS-Statistics on several publications; (2) Ministry of Energy and Mineral Resources of the Republic of Indonesia; (3) The Ministry of Maritime Affairs and Fisheries of the Republic of Indonesia; (4) The World Bank; and (5) Literature, as well as related information related to research topics to obtain secondary data for 5 years (2015-2019).

2.4. Data Collection Technique

Data collection is the most strategic step in research because the main purpose of the research is to obtain data. Therefore, researchers used library research-based data collection techniques.

Research library leaders from different parts of the globe with real-world experience navigating transformational change discuss key aspects of the evolving future of research libraries, academic librarianship, research collections, scholarly communication, and the changing nature of global scholarship [14].

2.5. Analysis Model

Data analysis from the research is carried out continuously during data collection until the end of the study or concluding. Qualitative analysts are justifiably wary of creating an unduly reductionistic or mechanistic picture of an undeniably complex, iterative set of processes. Nonetheless, evaluators have identified a few basic commonalities in the process of making sense of qualitative data.

In this chapter we have adopted the framework developed by Miles and Huberman [15] to describe the major phases of data analysis: data reduction, data display, and conclusion drawing and verification. Conclusions are sought for the components presented, noting patterns, regularity, clarity, possible configurations, causal pathways, and propositions in research.

3. RESULTS AND DISCUSSION

3.1. Brown's Gas Electrolyzer (BG-E)

Brown's Gas was discovered by Yull Brown (originally from Hungary) in 1974, and now it has become part of alternative energy in the world, especially in Europe, America, and Australia. Brown's Gas consists of 2 "H atoms" and 1 "O atom". Another name for Brown's Gas is Oxyhydrogen, and this gas is very flammable. Brown Gas (HHO) can release substantial energy when handled under the right conditions. To get Brown's Gas, through 3 basic processes that occur, including: (1) The basic substance for making Brown's Gas is water. The required water is placed in a container (small tank) and placed under the hood of a car; (2) Next, what is needed is electrical energy. Electrical energy in a car can be obtained from batteries (batteries) that exist in the car. The battery is connected to positive and negative electrodes that have been positioned in such a way in the container filled with water; and (3) When electricity flows through a cable (conductor) to the container, an electrolysis process of water occurs and a Brown's Gas is formed. Then, Brown's Gas can be used in the combustion chamber.

Efforts inefficient use of energy by adding the HHO system to motor vehicles. Brown's Gas is a water electrolysis system that is added with a catalyst that can produce pure hydrogen and oxygen which has high heating and octane values.

In addition, the combustion results from mixing with HHO gas can reduce pollution levels [16]. If the gas is added to a diesel or gasoline engine, it will improve the quality of combustion caused by the octane value of the fuel.

The process of increasing the value of octane and water vapor that is formed is able to make the engine cooler than combustion (using only gasoline or diesel fuel).

The use of Brown's Gas can increase the optimization of energy use because it can be proven from several studies that have been done. Among others, Goldwitz [17] optimized the ignition engine ignition conditions by adding hydrogen as a fuel supplement, resulting in an efficiency of more than 25%.

Another study which has compared hydrogen injection in spark-ignition engines with carburetors and engines with injection systems. A conclusion was made, that the fuel injection engine with the addition of hydrogen has greater power and a smaller risk of damage [18]. From these studies, it was concluded that hydrogen can be a fuel supplement to improve combustion quality, thereby increasing engine performance see Figure 1.

Figure-1. Transport investment policy development approach structure.
Source: Eagle-Research Energy Solutions [19].

In another study, it was mentioned that the injection of water into the fuel mixture supply inlet can also increase engine performance. As conducted by the Indonesian Institute of Sciences in 2008. The results were obtained that with water injection in a 225 CC vehicle test, spark ignition resulted in a reduction in CO and HC gas emissions. In addition, by Chadwell and Dingle [20] from his research it was found that in diesel engines, water injection can reduce NOx emissions by 82% and the torque increases.

Water injection helped in reducing the energy losses resulting from the transfer of heat to the walls and exhaust gases [21]. So, Brown's Gas has 3 main functions, is: (1) Save fuel, and increase mileage per liter; (2) Minimize emissions which are the main cause of the greenhouse effect; and (3) Improve engine performance and strength. Based on the main function of Brown's Gas, it is considered very appropriate as an innovation in the use of technology for the community, especially fishermen.

On one hand, electrolysis is the decomposition of compounds in the form of solutions, melts, or ordinary liquids by an electric current that flows through these compounds [22]. Electrolysis is a chemical process that converts electrical energy into chemical energy. The most important components of this electrolysis process are the electrodes and electrolytes. Table 2 shows that electrodes used in the electrolysis process can be classified into two indicators, namely: (1) Inert electrodes, such as calcium (Ca), potassium, graphite (C), Platinum (Pt), and gold (Au); and (2) Active electrodes, such as zinc (Zn), copper (Cu), and silver (Ag).

Table-2. Electrolysis reactions.

No.	Reaction on the Cathode	Reaction on the Anode
1.	The active metal ions (groups IA, IIA, Al, and Mn) which are reduced are water: 2H2O + 2e → 2OH- + H2	Ions that contain atoms with maximum oxidation numbers, for example, SO42- or NO3- which are oxidized are water: 2H2O → 4H + + 4e + O2
2.	Another reduced cation is the cation itself: Lx + (aq) + ne → L (s)	Halide ions (X -), oxidized to halogen (X2): 2X- → X2 + 2e
3.	H + ions from acids are reduced to hydrogen gas (H2): 2H + + 2e → H2	The OH- ion from the base is oxidized to oxygen gas (O2): 4OH- → 2H2O + 4e + O2
4.	If the electrolyte is liquid without liquid, the deposited metal will be obtained on the surface of the cathode (reaction at point 2).	In the metal plating and refining process, what is used as an anode is a metal (open Pt, C, Au), so that the anode (metal) undergoes oxidation and dissolves.

Source: Rasiawan [22].

The electrolyte can be a solution in the form of acid, base or salt, or in the form of fused halide salts, and fused oxides. The combination of electrolytes and electrodes produces 3 important categories of electrolysis, is: (1) Electrolysis of solutions with inert electrodes; (2) Electrolysis of the solution with active electrodes, and (3) Fused electrolysis with inert electrodes.

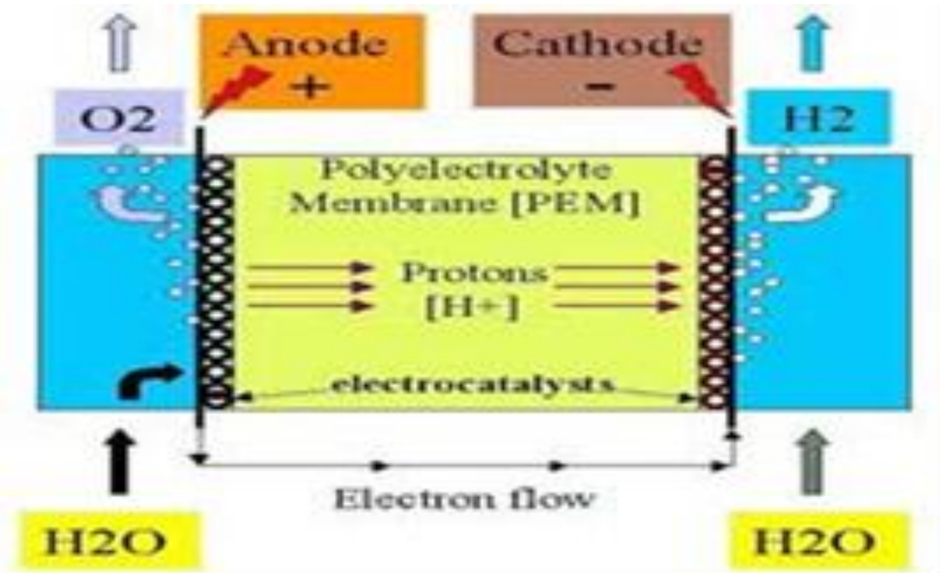

Figure-2. Illustration of electrolysis process.
Source: Eagle-Research Energy Solutions [19].

In electrolysis, the cathode is a negative pole and the anode is a positive pole. At the cathode, there will be a reduction reaction and the anode will have an oxidation reaction. Like that electrolyte solution can conduct electricity. Electric conductivity through a solution accompanied by a reaction is called electrolysis. Electrolysis reactions are classified as non-spontaneous redox reactions. The reaction can take place because of the influence of electrical energy. The electrolysis of electrical energy changes into chemical energy [22].

Electrons (electricity) enter the solution through the negative pole (cathode). Certain species in solution absorb electrons from the cathode and are reduced. Meanwhile, other species release electrons in the anode and undergo oxidation. So, just like a voltaic cell, the reaction at the cathode is a reduction, whereas the reaction at the anode is oxidation. However, the electrode charge is different. In voltaic cells, the cathode is positive and the anode is negatively charged. From the electrolyzed cell the cathode is negatively charged, while the anode is positively charged see Figure 2.

3.2. Development of Indonesian Oil

Table 3 shows the production of crude oil and condensate in Indonesia in 5 years experiencing a fluctuating trend. This is proven if the total production of the two types in 2015 reached 859.00 barrels per day and for the last period, namely 2019, it was 831.06 barrels per day (a decrease of 27.94 barrels). If examined closely, crude oil production is higher than condensate. Nevertheless, crude oil has decreased from year to year, wherein 2015 it was 763.00 barrels per day and in 2015 it was only at 690.08 barrels per day. Meanwhile, condensate (natural gas or earth) tends to fluctuate. Production in this type is still far below the Government's expectations, seen for 2015 only around 96.00 barrels per day and had dropped 4.53 points in 2017 (91.47 barrels per day).

Table-3. Indonesian crude oil and condensate production, 2015-2019 (thousand barrels / day).

Year	Crude Oil	Condensat	Total
2015	763.00	96.00	859.00
2016	728.00	97.00	825.00
2017	697.30	91.47	788.77
2018	690.08	95.71	785.79
2019	736.65	94.41	831.06

Source: Directorate General of Oil and Gas, Ministry of Energy and Mineral Resources, 2020.

Indonesia currently has a population of around 240 million people, carrying around 4 billion barrels of oil reserves (1 barrel = around 150 liters). Estimates per head of household (population) of Indonesia has a wealth of oil reserves of around 16 barrels or around 2,400 liters.

3.3. Development of Indonesian Fishermen

The Ministry of Maritime Affairs and Fisheries of the Republic of Indonesia through the Directorate General of Capture Fisheries estimates that within 5 years, the number of Motorized Boat without fishing has experienced ups and downs. In 2019 there were 239,237 units (down 2-fold) compared to 2015, which was around 413,690 units. Proven from the data period, it was noted that Motorized Boat in public waters was smaller than the sea. This is because the number of sea fishermen is far greater than general fishermen. Can be seen in 2019, the number of Boat without Motor sea waters as many as 172,907 units and the general is 66,330 units (this figure is much lower than other years).

Broadly speaking, from year to year national fish production has increased. During 2015, fish produced by capture fisheries (sea and general) reached 5,829,194 tons and increased by around 15% to 6,831,330 tons in 2019. When detailed based on its scope, catch production in the sea is indeed far dominant from public waters. Similar to the previous explanation, sea fish production in the same year was 6,351,480 tons, while the scope of public waters was 479,850 tons. That is, the increasing number of boats, has an impact on increasing fish production see Table 4.

Table-4. Number of fishing boat without motor and fish production produced in Indonesia, 2015-2019.

Details	Year	Catch Fisheries		
		Sea	River	Sub (Total)
Number of Boat without Motor (Unit)	2015	249,955	163,735	413,690
	2016	118,519	92,624	211,143
	2017	212,003	95,004	307,007
	2018	193,798	148,233	342,031
	2019	172,907	66,330	239,237
Production (Ton)	2015	5,435,633	393,561	5,829,194
	2016	5,707,013	408,364	6,115,377
	2017	6,037,654	446,692	6,484,346
	2018	6,204,668	473,134	6,677,802
	2019	6,351,480	479,850	6,831,330

Source: Directorate General of Capture Fisheries, Ministry of Maritime Affairs and Fisheries Republic of Indonesia, 2020a.

Fishermen are an important part of the wheel of Indonesia's economy, because this country is largely marine. The waters cover 2/3 of the total area of Indonesia. It is beyond expectations if it becomes public knowledge, if the welfare of the people who make a living at sea (as fishermen) is still classified as poor for decades since the proclamation of 1945. Reporting from Rong-Fang, et al. [23] Indonesian fishermen are included in the group of poor people in Indonesia in 2016 it almost touched 31.3 million. Meanwhile, World Bank data for 2017, mentioned a greater number of 108.78 million people. The average amount of fishing income (including fishing laborers) per day is only Rp. 80,499. Nominal is smaller when compared to building coolies wages of Rp. 98,301 a day. For every need for fishing, fishermen need 80 liters of diesel on average, whereas for the last year's diesel price (in September 2018) around Rp. 5,150.

3.4. Fishing Vessels Used by Indonesian Fishermen

Most fishermen in Indonesia (83%) still live in poverty and try the traditional way, using a fishing fleet that is very simple. Thus, the catch is only enough to meet daily needs. If viewed from the ownership of the ship that is owned like a pyramid, shows very wide below. On average, non-motorized vessels are 64%, outboard motorized vessels are 21%, while motor boats are only around 15% during 2015-2019. Fishermen income using boat without motor around Rp. 1,885,000 per year (70% of fishing).

Examining in Table 5, it can also be seen that the outboard fisherman income is Rp. 2,180,000 per year (73% of fish yield), as well as fishermen by motor boat have an income of Rp. 2,918,000 per year (78% of fish business). Other sources of income averaged over 5 years came from: farming, wages as laborers, processing and trading businesses, goods and other transportation services such as: services delivering anglers on charts, estuaries, ponds, rivers and rumpons. It can be seen that some fishermen are still dominant in using Motorless Boat or some kind of canoe. However, this causes income in aggregate (on average for 5 periods) per year, widened far from outboard motorized vessels or motorized types. To increase their income, there needs to be a transition from Boat without a Motor to an outboard motorized boat or motor boat, so that, it is expected to be able to improve the welfare of fishermen.

Table-5. Average types of ships and fishermen revenues in indonesia, 2015-2019.

No.	Ship Type	Total (%)	Income per Year (Rp)	Source of Income (%)
1.	Motorless Boat	64	1,885,000	70% from fish yields, 30% from other sources
2.	Outboard Motorized Boat	21	2,180,000	73% of fish yields, 27% of other sources
3.	Motor Boat	15	2,918,000	78% of fish business, 22% of other sources

Source: BPS-Statistics [24].

Based on Table 6, it is known that fishermen nationally are still operating on a small scale and the dominant use of vessels is the Outboard Motor Boat type. Besides, there was also an increase in the average number of ships (465,216 units), as well as fuel consumption (2,532,240 kilo liters) over the past 5 years. The increase in fuel needs of fishing vessels is quite evenly distributed on a small or large scale. In the small classification, outboard motorboat sizes are 217,140 units and large-scale motorcycles have sizes of 30 to 50 GT with a total of 7,776 units. There is a difference in total needs in Indonesia, fishermen who use Motor Boat sizes of 50 to 100 GT turn out to be far using more fuel oil (435,089 kilo liters) and on a small scale are outboard motorboats (435,089 kilo liters). This figure is far below the average number of needs of large or small scale vessels.

Table-6. Average estimated need for total fuel oil per ship size, 2015-2019.

Classification	Ship Size	Number of Ships (Units)	Total Needs (Kilo Liter)
Small Scale	Outboard Motorboats	217,140	435,089
	Motor Boat <5 GT	133,886	351,990
	Motorboats of 5 - 10 GT	77,076	179,965
	Motor Boat 10 - 20 GT	11,133	128,502
	Motor Boat 20 - 30 GT	5,675	112,621
Big Scale	Motor Boat 30-50 GT	7,776	229,885
	Motorboats 50 - 100 GT	7,131	436,245
	Motorboats 100 - 200 GT	4,260	328,976
	Motorboats> 200 GT	1,139	328,967
Total		465,216	2,532,240

Source: Directorate General of Capture Fisheries, Ministry of Maritime Affairs and Fisheries Republic of Indonesia, 2020b.

Fuel oil is the main requirement of fishermen in fishing activities in the sea and public waters. The increase in fuel oil and the removal of subsidies by the government at this time, can affect the welfare, especially small-scale fishermen. This can be seen from a survey conducted by the Indonesian Institute of Sciences in 2019 Table 7.

Table-7. The impact of the increase in fuel prices on the income and activities of small and medium scale fishermen in indonesia, 2019.

No.	Ship Size	Impact of Rising Fuel Prices		Total
		Yes	No	
1.	0 - 5 GT	26	18	44
2.	5 - 10 GT	8	2	10
3.	10 - 20 GT	2	8	10
Total		36	28	64

Source: Indonesian Institute of Sciences, 2019.

General description of the effect of the increase in fuel oil on income and activities of Indonesian fishermen, through the collection of random sampling data. From each region (34 provinces), 64 speakers or fishermen were represented. Broadly speaking, an average of 36 respondents or 56.25% mentioned the influence of the increase in fuel prices. On the other hand, there was no significant effect of the increase in fuel oil experienced by small and medium category fishermen, namely 43.75% (28 respondents).

Table-8. Average adjustment to sea activities and changes in income of small scale fishermen due to the increase in fuel oil, 2015-2019.

No.	Sea Activities	After	Before	Change (%)
1.	Sea Frequency (days / months)	27	24	-11
2.	Number of Crew (people)	3 - 4	3 - 4	0
3.	Fuel Consumption (liters)	25.7	13.6	-47
4.	Monthly Income (Rp)	1,922,959	1,663,720	-13

Source: Indonesian Institute of Sciences, 2019.

Table 8 shows the average change in fishermen's income due to rising fuel prices during 2015-2019 is presented in Table 8. Changes in the average income of small-scale fishermen due to the increase of fuel oil in the 5 years before and after the gap. If the frequency of fishing (day/month) experiences a fairly fluctuating change of up to -11%, with no change in the number of crews (0). Then for fuel consumption, it also experienced a significant change from 25.7 liters to 13.6 liters (change of -47%) and there was a decrease in income, with a value of Rp. 1,922,959 to Rp. 1,663,720 or changed dramatically (down -13%).

3.5. BG-E: Cheaper, Easier, and Super

Assuming the average speed of the boat is 60 km/hr at the level of fuel consumption per sea around 80 liters. With a savings of 37.5%, then from 80 liters is 62.5 liters of fuel. Price conditions for fuel oil (diesel type) Rp. 5,150 of 12 September 2018, the amount of money spent on 80 liters of fuel oil before using BBG technology is Rp.

412,000. Thus, the fuel savings of 37.5 liters are converted in nominal terms, namely Rp. 257,500. This value is very meaningful for fishermen because the majority are still classified as poor [25].

Table-9. Average prediction of savings needs and expenditures for small-scale fishermen fuel oil expenditure in indonesia, 2015-2019.

Ship Size	Fuel Needs (Kilo Liter) per Year			Expenses (Rp. Million) per Year		
	Aftrer	Before	Change	After	Before	Change
Outboard Motorboats	435,089	271,930.6	163,158.4	2,240.7	1,400.4	840.2
Motorboat <5 GT	351,990	219,993.8	131,996.3	1,812.7	1,132.9	679.7
Motorboat 5 -10 GT	179,965	112,478.1	67,486.9	926.8	579.2	347.5
Motorboats 10 - 20 GT	128,502	80,313.8	48,188.3	661.7	413.6	248.1
Motorboat 20 - 30 GT	112,621	70,388.1	42,232.9	579.9	362.4	217.4
Total	1,208,167	755,104.4	453,062.6	6,222.0	3,888.7	2,333.2

Source: Lianda, et al. [26].

In Table 9, is a prediction of savings that will be obtained by national fishermen if they use BG-E technology on boat engines. The estimated average for 5 years, the use of fuel oil to catch fish with BG-E technology can save 37.5%. In aggregate, the fuel needs of Indonesian small-scale fishermen reach an average of 1,208,167 liters per year. The assumption is that it can save 453,062 liters per year (only uses 271,930 liters per year). In terms of costs, the estimate for 2015-2019 is Rp 6,222.0 million and after the use of BG-E, fishermen's expenditure is expected to be Rp. 3,888.7 million or able to save Rp 2,333.2 million or 37.49%.

Fishermen with the size of an outboard boat that initially consumed an average of 435,089 liters of fuel oil, is estimated after the existence of this technology, only 271,930 liters (can save Rp. 840.2 million). Similar to other types, motorized vessels with less than 5 GT savings reach 131,996.3 liters or in the nominal form of Rp. 679.7 million. Researchers' projections for 5 to 10 GT Motor Ships in Indonesia could cut 67,486.3 liters (Rp. 347.5 million). Fuel consumption needs before using BG-E taken from Table 6.

3.6. The Advantages of BG-E on Fishing Boats

Brown's Gas Electrolyzer (BG-E) can be made easily, even by ordinary people. By making training for fishermen, it is hoped that they can produce their own BG-E. The ingredients needed are also easy to obtain. For water storage tubes made from bottles or used cake containers from plastic materials. The electrolyzer is made of stainless steel and adds cable as a link to the battery.

The materials used to make BG-E are quite cheap because they are very easy and affordable in the market. Fishermen can utilize used goods to make water containers in BG-E, hoses, and others.

By using BG-E, fishermen are estimated to save up to 37.5% in consuming fuel every day (especially diesel type). Besides, this technology can remove scale on the engine, because the combustion of the engine is more perfect with the addition of HHO gas. The use of BG-E does not reduce the quality of engine power. Also, BG-E carries environmentally friendly energy, because it can reduce motor vehicle exhaust gas emissions.

3.7. BG-E Work Process on Fishing Boats

BG-E technology can be applied to small scale vessels, namely Outboard Motorboats and Motorized Boat size of 5-20 GT. This is because the level of welfare of small scale fishermen is still lacking and needs to be improved with a fuel-saving device through the BG-E. The following is one of the fishing businesses besides catching fish, such as services to deliver fishing along with the size of the boat and the boat used.

Figure-3. Fishing activity researchers use outboard motorboats at saliki estuary.

As shown in Figure 3, fishermen in Muara Saliki, Muara Badak Area (Kutai Kartanegara Regency) are still dominated by using outboard boat boats. In this region, it is commonly referred to as "Ketinting" (passengers and crew are 3-4 people). In general, fishermen in these waters look for sources of income with fishing services with estuary spots (spots) on weekends (Saturday and Sunday), as well as other days. The price offered is also relatively cheap, which is around Rp. 250,000 – Rp. 350,000 per trip.

Figure-4. Fishing researcher activities using km 10 - 20 gt in karang and ataka (bontang).

Similar to the previous activity, income in the medium interval such as in the Bontang sea and surrounding areas. For example, many sea fishermen already have 10 - 20 GT motorized boats. Income is not only from fishing but transportation services, as well as fishing businesses. With a large engine capacity, fishermen can reach the Makassar Strait (average depth of 80- 200 meters). Therefore, fishing trips to the intended destination are very promising and can generate substantial profits. Rent motorboats with engines of 10 to 20 GT (Rp. 1,200,000 - Rp. 2,000,000) and can carry large numbers of passengers, 8-10 people, including fishermen and ship laborers see Figure 4.

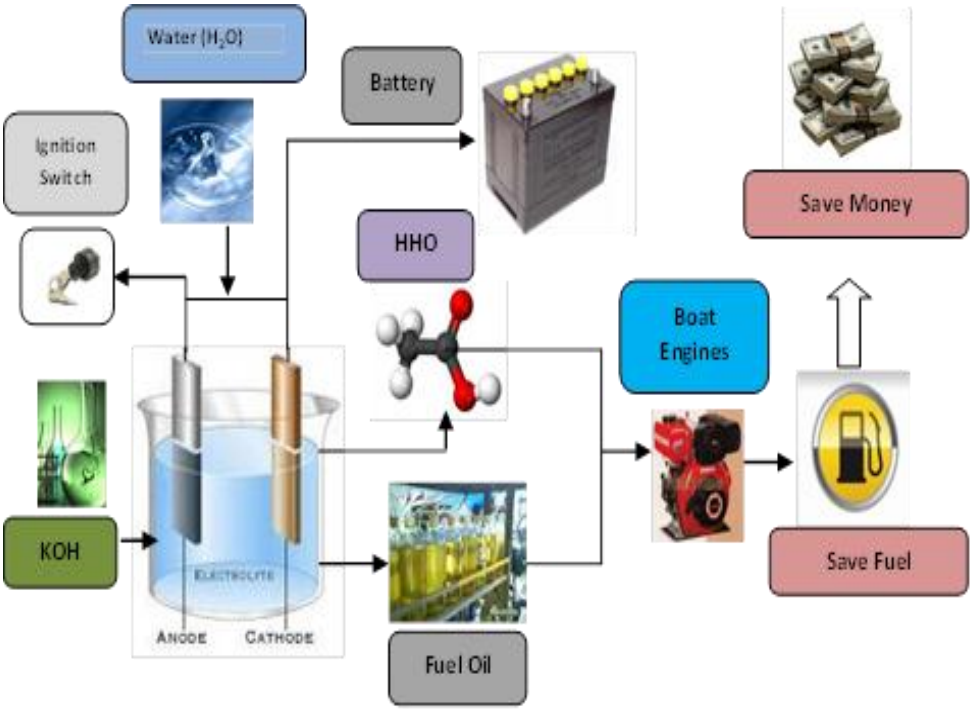

Figure-5. Scheme of bho-e based hho process on boat engines.
Source: Hakim and Guntur [27].

Fish boat engines will be modified on HHO-based BG-E technology, to be able to save on fuel consumption. BG-E is made according to the ship's power requirements. Following is the work process of BG-E by modifying the fishing boat fishing machine summarized in Figure 5. How it works on this BG-E with the electrolysis process where what happens in this process is the decomposition of compounds in the form of solutions, melts, or ordinary liquids by an electric current flowing through these compounds. In electrolysis, the cathode is a negative pole and the anode is a positive pole. At the cathode, there will be a reduction reaction which results (H2), while at the anode an oxidation reaction will result (O2).

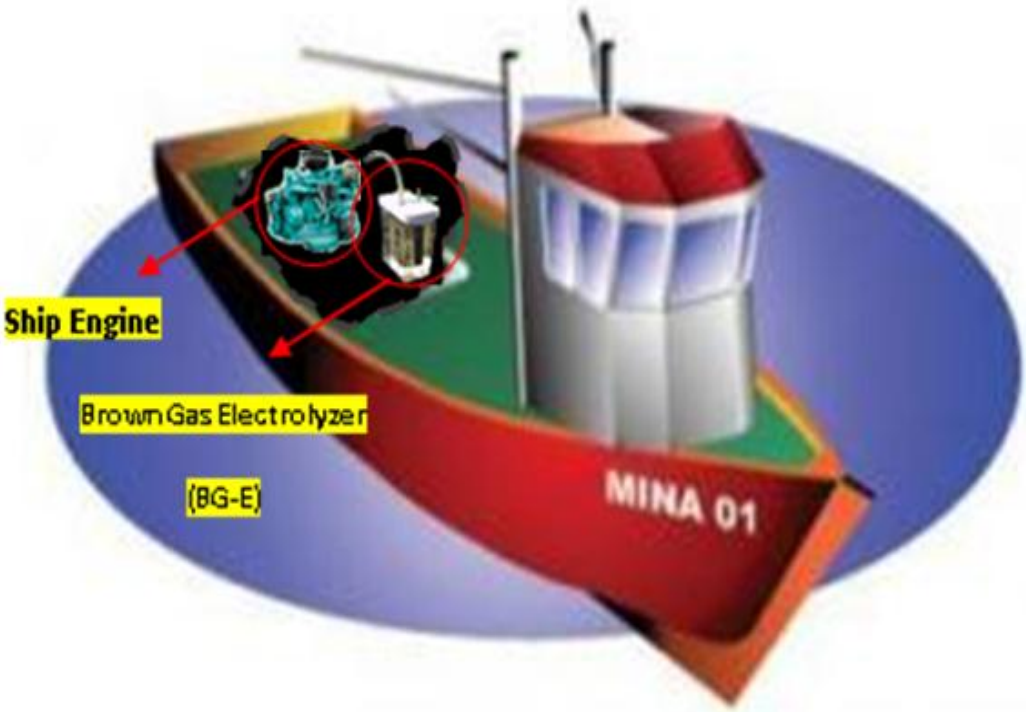

Figure-6. Modification of fish boat machine design using bg-e.
Source: Hakim and Guntur [27].

From the results of the electrolysis process, it produces oxyhydrogen which will react with gasoline in a fishing boat engine. The reaction between oxyhydrogen and gasoline fuel is able to produce an explosion that moves the piston on the ship's engine so that the engine can start as shown in Figure 6. Thus, the application of BG-E technology can save fuel consumption of boat and boat engines to improve the welfare of fishermen's lives.

3.8. BG-E: Offering to Indonesian Fishermen

Various supporting data that have been presented previously, shows the need for support for the community, especially fishermen (regarding fuel savings). Therefore, there needs to be appropriate technological innovation, namely the use of BG-E. This innovation is expected to save fuel consumption on the boat so that it can help improve the welfare of fishermen's lives, especially small and medium scale. For ideas to be implemented well, it is necessary to take strategic steps to respond to them as follows: (1) Recording the number of fishermen in Indonesia, along with the types of boats used for fishing; (2) Coordinate with the House of Representatives of the Republic of Indonesia regarding ideas and innovations, then make additional policies aimed at making the ideas implemented, appropriate and targeted; (3) Taking a gradual approach to the fishing community, so that one day they can accept this idea and apply it; and (4) Provide supplies to the fishing community about BG-E, how to use it, and maintain it.

4. CONCLUSION

Based on the facts and discussions observed, there are several conclusions in this study, including: (1) The use of BG-E can be applied to various types of Outboard Motor Boat and Motor Boat engines; and (2) HHO-based BG-E technology can save fuel consumption up to 37.5% and can improve the welfare of the fishing community's lives because operational expenses can be reduced.

World energy consumption has grown exponentially over the past few years. The degree of integration of energy consumption to other sectors of the economy such as transportation, aviation, and shipping among others underscores its role in facilitating economic activity [28].

The novelty of this research puts on the use of fuel-saving devices (BG-E) which are usually used in the transportation of motor vehicles and cars, this time the researchers conducted experiments on fishing boats in Indonesia. The study output is very interesting if in the future it is applied by various groups, especially fishermen.

The suggestions or recommendations that can be conveyed through this scientific idea are: (1) The fishing community can find information about BG-E so that it can apply to the boat engine, and (2) It is hoped that the government will pay more attention to research on all new innovations carried out by various domestic researchers, and be able to protect the copyright of products or ideas and market widely.

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