Power System Technology
ISSN:1000-3673

Received: 06-02-2026 *Revised: 15-03-2026* *Accepted: 10-04-2026*

Evaluation of Biodiesel B30 Consumption Among Traditional Fishermen in Coastal Areas: a Case Study of Central Java's North Coast

Amad Narto[1]*, Teguh Purnomo[2]

[1,2] *Politeknik Ilmu Pelayaran Semarang, Indonesia*

**Correponsdence Author:* amad_narto@pip-semarang.ac.id

Abstract: This study evaluates the acceptance of traditional fishermen toward the use of B30 biodiesel as a marine fuel in the coastal area of Tegal, Central Java. B30 biodiesel, a blend of 30% biodiesel and 70% diesel, is promoted as a renewable energy-based alternative fuel that aims to reduce emissions and support sustainable development. The B30 biodiesel available in the study area is a subsidised fuel intended for specific types of fishing vessels, namely those with a capacity of less than 30 gross tonnage. A quantitative approach was employed through laboratory analysis of three fuel samples and a perception survey among fishermen regarding the technical and administrative aspects of fuel distribution using a Likert scale method. Field observations of the subsidised fuel refuelling process were also conducted to assess the biodiesel B30 distribution system. The laboratory results showed that the fuel generally met national standards, although some samples exhibited low cetane numbers. On the other hand, fishermen's perceptions indicated a low level of trust in the fuel's quality and efficiency, particularly regarding engine performance and maintenance requirements. Many fishermen also expressed concerns about complex administrative procedures and called for quality assurance from fuel suppliers. These findings underscore the importance of enhancing distribution systems, streamlining regulations, and highlighting the benefits of biodiesel to foster trust and promote the adoption of B30 biodiesel among fishing communities, thereby supporting a clean energy transition in coastal regions that benefits local communities.

Keywords: *Biodiesel, B30, Coastal Area, Traditional Fisherman, Marine Environment*

1. Introduction

Green Coastal areas are regions that play a vital role and face various challenges, including social, economic, and environmental issues (Susman et al., 2021; Yola et al., 2022). These areas support local communities by providing livelihoods through fisheries and tourism, and the health of coastal ecosystems is closely linked to the well-being of these communities (Hidayati, 2021; Roisah et al., 2023; Warren & Steenbergen, 2021; Yamindago, 2015). One segment of the local community is fishermen, whose primary occupation is catching fish at sea. As their primary source of income and employment, fishermen heavily rely on fishing activities to enhance their earnings and improve their quality of life (Muringai et al., 2020;

Power System Technology
ISSN:1000-3673
Received: 06-02-2026 Revised: 15-03-2026 Accepted: 10-04-2026

Perret & Yuerlita, 2014; Wirajing & Nanfosso, 2025; Xu et al., 2023).

To support fishing activities, diesel-powered boats are among the means of transportation used by fishermen who rely on them for their livelihoods. However, the operation of diesel engines, which function through combustion to generate energy transmitted to the propeller for vessel movement, inevitably produces exhaust gases that contain toxic compounds such as sulphur oxides, nitrogen oxides, and carbon, which can pollute both the air and marine environments (Sagin et al., 2024; Victorovych Sagin & Andriiovych Kuropyatnyk, 2018). Several coastal areas in Indonesia have experienced pollution, which has significantly affected the livelihoods of fishermen and marine resources (Baum et al., 2016). Emission concentrations tend to accumulate in port areas and coastal regions. Fishermen living in coastal areas are vulnerable to health problems due to poor air quality caused by pollution (Haryanto, 2017). This situation not only raises health concerns but also poses potential threats to the sustainability of fishery resources, as well as impacts related to climate change and other long-term consequences. Pollution and climate change represent significant pressures faced in coastal areas, necessitating comprehensive management strategies (Mutaqin et al., 2020; Nursyirwan et al., 2018; Rahmania et al., 2021).

Studies have shown that particulate emissions from ships have significantly contributed to the decline in air quality in coastal and port areas (Corbett et al., 2007; Moldanová et al., 2013; Viana et al., 2014). Ship emissions have been associated with approximately 250,000 cases of premature morbidity and death globally by the year 2020 (Sofiev et al., 2018). The health threats posed by air pollution from ship emissions cannot be ignored. Even with the use of low-emission fuels, ship emissions continue to contribute to greenhouse gases and pose significant challenges to air quality (Shi et al., 2025; Sofiev et al., 2018). The majority of emissions from ships consist of fine particles, primarily in the form of sulphates, which adversely affect human health, cause acidification of seawater and coastal soils, eutrophication, and the formation of secondary sulphate aerosols and other harmful particles in the environment (Jalkanen et al., 2012; Jonson et al., 2015). Sulfate is a component of ship emissions formed through the oxidation of SO_2 (Ault et al., 2010). ulfur oxides (SOx) are pollutants emitted from ship power systems, released through exhaust stacks, and have significant impacts on human health, climate change, and premature morbidity (Liu et al., 2019; Sofiev et al., 2018). SOx serve as primary precursors in the formation of sulfuric acid (H_2SO_4), which contributes to atmospheric aerosols and acid rain (Yuan et al., 2024). Secondary pollutants, such as fine particulate matter and ozone, are formed from emissions containing nitrogen oxides (NOx) and sulphur oxides (SOx) through atmospheric chemical and physical processes (Vutukuru & Dabdub, 2008). Therefore, not only sulphur oxides (SOx) but also nitrogen oxides (NOx), delicate particulate matter (PM2.5 – particles with aerodynamic diameters ≤2.5 µm), and other pollutants are components of ship emissions that pose serious environmental and health hazards (Sofiev et al., 2018).

Power System Technology
ISSN:1000-3673
Received: 06-02-2026 Revised: 15-03-2026 Accepted: 10-04-2026

Nevertheless, diesel engines are commonly used as the central propulsion systems for fishing vessels. The fuel used by most of these vessels is high-sulfur fuel (Yang et al., 2022). Given the harmful impact of ship emissions, cleaner fuels have become a priority for reducing emissions from the combustion of fossil fuels, aligning with the Sustainable Development Goals and global efforts to mitigate climate change. In coastal regions of Indonesia, as an alternative to address this issue, the use of cleaner fuels such as biodiesel for fishing vessels can be considered. Biodiesel is promoted as an environmentally friendly fuel, with abundant raw material availability in Indonesia. The implementation of biofuel programs in Indonesia is driven by several factors, including energy security and resilience, poverty alleviation, and environmental quality improvement (Wirawan et al., 2024). Studies show that biodiesel, derived from renewable sources such as animal fat, algae, and vegetable oils, can serve as a sustainable alternative fuel that significantly reduces environmental pollution and pollutant emissions compared to traditional diesel fuel. For example, emissions can be reduced by 44% by switching from conventional diesel to biodiesel in fishing vessels. This emission reduction includes carbon dioxide (CO_2), particulate matter, and sulphur oxides, thus promoting biodiesel as an eco-friendly fuel derived from renewable energy sources (Damian et al., 2025; C.-Y. Lin & Huang, 2012; Noor et al., 2018; Sagin et al., 2025; van Wijnen et al., 2015).

In 2006, Indonesia officially began its biodiesel journey as a substitute for fossil fuels by promoting biofuel regulatory programs aimed at reducing emissions, enhancing energy security, and increasing palm oil consumption. Gradually, the development of biodiesel in Indonesia progressed, starting with a 2.5% blend in 2006. This was followed by incremental increases, reaching a 20% blend in 2016, known as Biodiesel 20 (B20). By 2020, the Indonesian government mandated a 30% biodiesel blend, making Indonesia the country with the highest level of biodiesel implementation in the world (Farobie & Hartulistiyoso, 2022; Febriansyah, Mulyono, et al., 2020; Febriansyah, Utomo, et al., 2020; Ramdhani & Setiawan, 2021; Silalahi et al., 2020; Widrian et al., 2022). However, the application of biodiesel in Indonesia’s coastal areas and for fishing vessels presents both opportunities and challenges. The implementation of biodiesel as a clean marine fuel remains very limited compared to its use on land. One of the primary obstacles to the successful development of biodiesel for marine use is its relatively higher cost compared to other marine fuels (C.-Y. Lin, 2013a, 2013b). Additionally, biodiesel faces significant challenges in distribution or logistics, particularly in integrating it into existing diesel infrastructure (Part, 2008), nevertheless, compared to fossil fuels, biodiesel offers an alternative fuel derived from sustainable energy sources (Purwanto & Lutfiana, 2023).

This study examines the content of biodiesel fuel marketed in one of Indonesia's coastal regions and the local community's acceptance of biodiesel as a marine fuel, offering a social perspective on the opportunities and marketing of biodiesel. The opportunities and challenges of implementing biodiesel fuel in coastal areas extend beyond the technical aspects of biodiesel fuel to other factors, such as the lack of awareness and acceptance among consumers

Power System Technology
ISSN:1000-3673
Received: 06-02-2026 Revised: 15-03-2026 Accepted: 10-04-2026

regarding biodiesel. Nevertheless, the social, economic, and environmental benefits for both communities and the nation, in terms of sustainable development, can be realised through the potential application of biodiesel. Therefore, raising public awareness about the benefits of biodiesel and the negative impacts of fossil fuel consumption is highly necessary (G.-E. Lee et al., 2017; Naimah & Morgunova, 2018; Sukkasi et al., 2010).

2. Related Works

2.1 Biodiesel Development in Indonesia

The Government of Indonesia has the responsibility to report its contribution to GHG emission reductions. As part of the national development agenda (Nawacita), which supports the long-term energy supply, the Government of Indonesia established an energy mix policy through Government Regulation Number 79 of 2014 on the National Energy Policy. This policy aims to increase the share of renewable energy to 23% by 2025 and 31% by 2050 as part of national resilience and the realisation of sustainable energy development in line with the Sustainable Development Goals (SDGs). Specifically for biodiesel, production is targeted to reach 13.9 million kiloliters by 2025 and 52.3 million kiloliters by 2050 (Kuntjoro et al., 2021; Setya Andani et al., 2021; Widrian et al., 2022).

Indonesia's energy policy was initiated by the government in 2006 to shift fuel consumption from fossil fuels to renewable energy sources, including biofuels. To achieve this, mandatory requirements were established for the implementation of biofuels, along with the provision of subsidies. The phased implementation of biodiesel began in 2008 with a compulsory blend of 2.5% biodiesel (Jupesta et al., 2011; Zafriana & Qurbani, 2021). This study examines the development of biodiesel, specifically the 30% biodiesel blend, commonly referred to as B30. The development journey of B30 in Indonesia is illustrated in Figure 1.

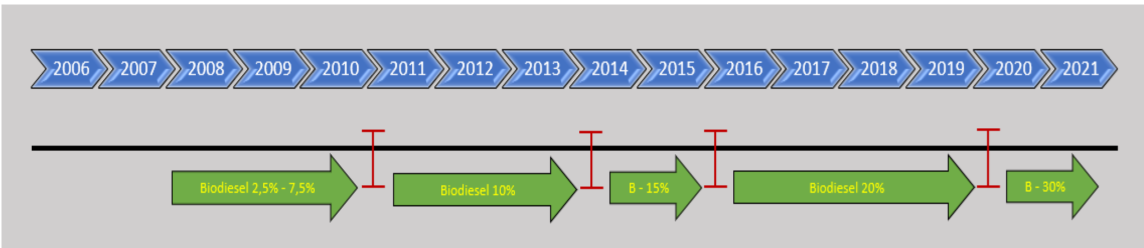


Figure 1. Development Biodiesel-B30 in Indonesia

The development of B30 biodiesel in Indonesia began in 2020. The Indonesian government continues to advance biodiesel blending efforts for the future. As part of efforts to achieve energy security amidst the decline in domestic oil extraction and to reduce dependence on fossil fuels, the use of biodiesel enables Indonesia to diversify its energy sources (Firdaus et al., 2019). The realization of domestic biodiesel utilization has continued to increase year by year, as shown in Table 1. (Kementerian ESDM, 2024).

Table 1. Progress in the Utilization of Biodiesel in the Domestic Sector

Power System Technology
ISSN:1000-3673
Received: 06-02-2026 Revised: 15-03-2026 Accepted: 10-04-2026

Realized Volume of Fuel	Year
9,29 Million kl	2021
10,45 Million kl	2022
12,29 Million kl	2023
13,16 Million kl	2024

The consumption of biodiesel in Indonesia has shown a consistent year-to-year increase in the implementation of the B30 biodiesel blend. Looking ahead, Indonesia aims to raise the blend ratio to 100%, referred to as B100. The progress and realization of biodiesel are closely linked to current regulatory policies. The elements of these policies for biodiesel development are outlined in Table 2.

Table 2. Mandatory Policy Document on the Implementation of Biodiesel Blending in Indonesia

Policy Document	Major Content	Year
Presidential Instruction No. 1	Provision and utilization of biofuel as another fuel	2006
Ministry of Energy and Mineral Resource Regulation No. 32	Mandatori provision, utilization and trade of biofuels as alternative fuel, Biodiesel (B2,5% – B7,5%)	2008
Ministry of Energy and Mineral Resource Regulation No. 25	Mandatory the biodiesel blend ratio has been oncreased from B7,5% to B10%	2013
Ministry of Energy and Mineral Resource Regulation No. 25	Mandatory the biodiesel blend ratio B15% and B20%	2014
Ministry of Energy and Mineral Resource Regulation No. 12	Mandatory the biodiesel blend ratio has been oncreased from B20% to B30%	2015

2.2 Biodiesel Blend-B30 Quality Parameters

Biodiesel fuel in Indonesia must meet specifications established by the Ministry of Energy and Mineral Resources. The quality standards for B30 biodiesel blend marketed in Indonesia are presented in the following table (Solikhah et al., 2020).

Table 3. Quality Standards and Specifications of Biodiesel Blend B30 Marketed in Indonesia

No	Characteristics	Unit	Category		Testing Method
			B30 HSD 48	B30 HSD 51	

Power System Technology
ISSN:1000-3673
Received: 06-02-2026 *Revised: 15-03-2026* *Accepted: 10-04-2026*

			Min	Max	Min	Max	
1	Cetane Number/ Cetane Index		48 45	- -	51 48	- -	ASTM D613 ASTM D4737
2	Specific Gravity at 15^{0}C	Kg/m^3	815	880	810	850	ASTM D4052/ ASTM D1298
3	Viscosity at 40^{0}C	mm^2/S	2,0	4.5	2,0	-	ASTM D 445
4	Sulfur Content	% m/m	-	0.25 0.2[1)] 0.05[2)] 0.005[3)]	-	0.05 0.005[1)]	ASTM D4294/ ASTM D 5453/ ASTM D 2622
5	Distilate : 90% Vol Evaporation	^{0}C	-	370	-	370	ASTM D 86
6	Flash Point	^{0}C	52	-	55	-	ASTM D 93
7	Cloud Point	^{0}C	-	18	-	18	ASTM D 2500/ ASTM D 5771/ ASTM D 5773/ ASTM D 7683
	Pour Point	^{0}C	-	18	-	18	ASTM D 97/ ASTM D 5949/ ASTM 5950/ ASTM D 6749
8	Carbon Residue	% m/m	-	0.1	-	0.1	ASTM D 189/ ASTM D 4530
9	Moisture Content	Mg/kg	-	425	-	280	ASTM D 6304/
10	FAME Content	% v/v	30[4)]				ASTM D 7371/ ASTM D 7806
11	Copper Strip Corrosion	Merit	-	Class 1	-	Class 1	ASTM D 130
12	Ash Content	% m/m	-	0.01	-	0.01	ASTM D 482/ ISO EN 6245
13	Sediment Content	% m/m	-	0.01	-	0.01	ASTM D 473
14	Strong Acid Number	Mg KOH/gr	0		0		ASTM D 664
15	Total Acid Number	Mg KOH/gr	-	0.6	-	0.3	ASTM D 664
16	Visual Apperance		Clear and Bright		Clear and Bright		Visual

Received: 06-02-2026 Revised: 15-03-2026 Accepted: 10-04-2026

17	Colour	No ASTM	-	3	-	1	ASTM D 1500
18	Lubrisitas (HFFR wear scar dia @60^{0}C	Mikron	-	460[5)]	-	460	ASTM D 6079
19	Oidation Stability	Hour Minute	35 45				EN 15751 ASTM D 7545/ EN 16091
20	Particulate Contamination	mg/l	Not regulated		-	10	ASTM D 6217/ ASTM D 7321

2.3 Properties and Characteristics Biodiesel

Biodiesel is an ideal renewable energy fuel characterized by being biodegradable, non-toxic, low-emission, and environmentally friendly. Its raw materials include vegetable oils such as palm oil, canola l, soybean oil, algae, agricultural waste, and animal fats. Biodiesel is commonly known as FAME, produced using ethanol or methanol as catalysts through a transesterification reaction (Y.-C. Lin et al., 2011; Srikumar et al., 2024; B. Wang et al., 2021).

Biodiesel has a higher viscosity and oxygen content compared to fossil fuels, with an oxygen content of 10%–15%, which allows for complete combustion (Chong et al., 2021; Knothe & Razon, 2017; Wirawan et al., 2024). Biodiesel blends exhibit lower fine particulate emissions compared to diesel fuel (Bakeas et al., 2011; Karavalakis et al., 2016; Na et al., 2015). However, biodiesel is prone to oxidation, which can lead to engine deposits. This issue can be mitigated through various measures, such as the use of antioxidants and proper fuel storage procedures (Haryono et al., 2024; Sugiarto et al., 2018, 2020). Long-term storage of biodiesel presents significant challenges related to oxidation, water stability, and microbial growth. For example, the oxygen content in biodiesel results in a higher flash point and more complete combustion in diesel engines. Additionally, the moisture saturation level in biodiesel is 15 to 25 times higher than that in petroleum diesel within the temperature range of 4 °C to 35°C. Consequently, the tendency to absorb moisture can lead to the formation of fatty acids due to the hydrolysis of biodiesel (Dunn, 2005; He et al., 2007; Jain & Sharma, 2010; Knothe, 2007; J. S. Lee et al., 2010; Ryu et al., 1996; Xin & Saka, 2010). Compared to fossil fuels, biodiesel offers better lubricating properties, which can extend engine life and reduce maintenance costs (Balat, 2006; Etim et al., 2022). Biodiesel, as a renewable energy source, is promoted for its ability to produce more efficient combustion due to its higher oxygen content, higher cetane number, and lower sulphur content. However, for diesel fuel blended with biodiesel known as biodiesel blends the higher the biodiesel content, the more the properties and characteristics resemble those of pure biodiesel. For example, the B30 biodiesel blend produces exhaust emissions that are 0.1–0.2 g/km, or 5–20% lower, than those of B20 (Solikhah et al., 2020).

Power System Technology
ISSN:1000-3673

Received: 06-02-2026 Revised: 15-03-2026 Accepted: 10-04-2026

3. Material And Method

3.1 Study Location

The study was conducted in the coastal area of North Tegal, Central Java Province, Indonesia (Figure 2.). This location was selected because biodiesel blends with B30 have been marketed there. The B30 biodiesel blend is a fuel composed of 30% vegetable oil-based biodiesel and 70% petroleum diesel. It is a renewable energy product that is biodegradable, non-toxic, hygroscopic, and corrosive and contains additives to reduce carbon monoxide, hydrocarbons, particulate matter, and harmful emissions from diesel engine combustion (Basha, 2014; Fardilah et al., 2022).

Figure 2. Map of Tegal City Region
Source: Central Agency of Tegal Region Statistic

3.2 Experimental

This study conducted statistical analysis using the SPSS software application and observed laboratory analysis results, supplemented with limited observational instruments, to assess the social impact of marketed biodiesel fuel on fishing communities. The parameters for statistical analysis were based on emerging issues within the local community regarding the marketing of fuel used for diesel engines on boats. Meanwhile, the laboratory analysis involved testing three samples with limited observations, based on compliance with the material data sheet standards concerning the quality of the marketed fuel. Although experimental methods were used as instruments in this study, further testing, analysis, and broader research beyond the scope described in this paper are necessary in the future to provide more comprehensive assessments and alternatives for biodiesel fuel, particularly B30 biodiesel blends, as a sustainable fuel option.

3.3 Scope of Study

This study examines the marketing mechanisms of biodiesel fuel promoted in coastal areas to fishing communities, the biodiesel fuel materials marketed, and the assessment by these communities of both the marketing mechanisms and the fuel products.

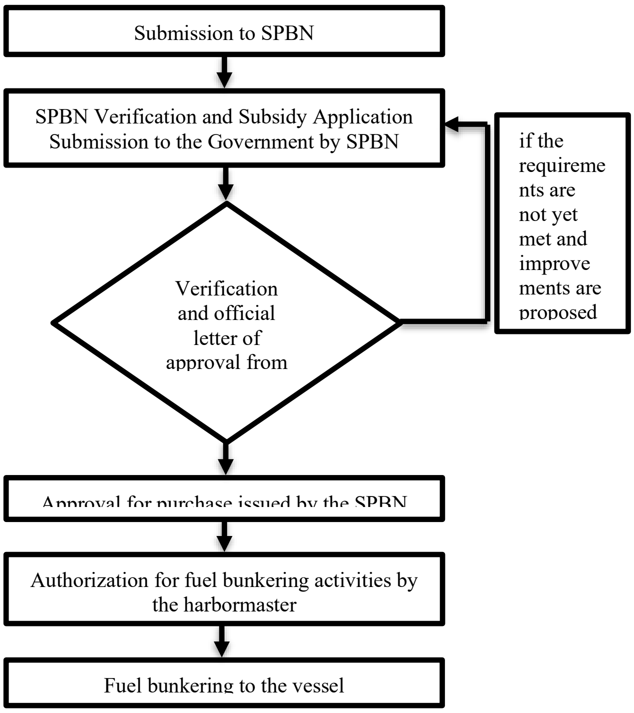
Power System Technology
ISSN:1000-3673
Received: 06-02-2026 *Revised: 15-03-2026* *Accepted: 10-04-2026*

4. Result and Discussion

4.1 Biodiesel Marketing Meschanism

The B30 biodiesel blend, marketed in the observation area, is a subsidised fuel provided by the government for fishing vessels of specific sizes and types. Fuel subsidies are allocated for ships with a gross tonnage ranging from 10 to 30 and powered by diesel engines. The SPBN is responsible for distributing the B30 biodiesel blend and accepts proposals for the purchase of subsidised fuel. Several mandatory supporting documents must be submitted to facilitate the purchase process, including the vessel's registration certificate, a fuel purchase request form, a crew list, and other relevant documents. Subsequently, the SPBN submits a request for subsidised fuel allocation to the local government, which verifies the compliance of the submitted documents before approving the purchase of the B30 biodiesel blend. Once the request is approved, the official approval letter will specify the volume of subsidised fuel permitted for purchase, measured in kiloliters. Following this, an application for fueling approval must be submitted to the harbour master's office to ensure that safety and security procedures are followed during the bunkering process from the SPBN to the vessel's fuel tank. The mechanism for acquiring the fuel is illustrated in Diagram 4.1

Diagram 4.1. Operational Protocol for the Submission and Approval of Subsidized Fuel Requests



Power System Technology
ISSN:1000-3673
Received: 06-02-2026 *Revised: 15-03-2026* *Accepted: 10-04-2026*

4.2 Analysis of Fuel Material Testing

The testing analysis was conducted by ASTM standards. ASTM standards are developed by the American Society for Testing and Materials to regulate and guide the testing, performance, usage, and safety of various chemicals, equipment, and products. These standards are applied in biodiesel testing to ensure that the fuel meets specific quality criteria, making its contents safe and effective for engine performance while maintaining the appropriate chemical composition. By adhering to ASTM standards, producers can ensure the quality of their products, meet market eligibility requirements, and build consumer trust (Fernado, 2005; McCormick & Westbrook, 2007).

This study collected fuel samples to examine the biodiesel content by the MSDS as marketed. The analysis focused on selected criteria relevant to basic performance in diesel engine combustion. The results of the testing are presented in the table below:

Table 4. Test Results of the Content Values of Three (3) Biodiesel (B30) Samples in the Study Area

			Name of The Test Sample			
No	**Characteristics**	**Unit**	**Sample A Value**	**Sample B Value**	**Sample C Value**	**Testing Method**
1	Cetane Number		31,1	30,8	Unidentified	ASTM D 613 ASTM D 4737
2	Specific Gravity at 15^{0}C	Kg/m^3	855,4	854,8	852,7	ASTM D 4052/ ASTM D1298
3	Viscosity at 40^{0}C	mm^2/S	4,2	3,953	4	ASTM D 445
4	Ash Content	% m/m	0.005	0.0027	0.0933	ASTM D 482/ ISO 6245
5	Colour		L = 28,31 a = 4.43 b = 1.14	L = 29,06 a = 4,70 b = 0,45	L = 31,74 a = 3,64 b = 2,83	Digital Colorimeter
6	Calorific Value	Cal/g	10421,4 or 43,6 mj/kg	10426,3 or 43,6 mj/kg	10162,6 or 42,5 mj/kg	Bomb Colorimeter
7	Fame Content/ Metil Metal Ester	%	62,58	59.96	59.03	GCMS
8	Metanol	%	Unidentified	Unidentified	Unidentified	GCMS
9	Visual Apperance		Clear and Bright	Slightly Turbid	Turbid	Visual

The B30 biodiesel blend sample, categorized as Sample A, was collected from the fishermen's

Received: 06-02-2026 ***Revised: 15-03-2026*** ***Accepted: 10-04-2026***

refuelling station via the distribution pipe at the dispensing machine, representing the initial stage of distribution. Sample B was obtained from the vessel's daily operational tank. At the same time, Sample C was collected from the sedimentation tank of the ship, where the fuel had been stored for an extended period.

The sampling criteria were selected to provide a basic assessment of key factors for achieving optimal combustion, and therefore, tests were conducted based on limited parameters. As shown in Table 4., the fuel content generally complies with the standard specifications for B30 biodiesel blends and aligns with the MSDS. However, there were discrepancies observed in the cetane number values across all three samples. Specifically, Samples A and B exhibited cetane numbers below the standard, while the cetane number for Sample C could not be identified. Further investigation is needed to evaluate these results. Additionally, in terms of visual appearance, Sample C appeared more turbid compared to Samples A and B, as observed directly through the sample testing bottles.

4.3 Community Statistical Assesment

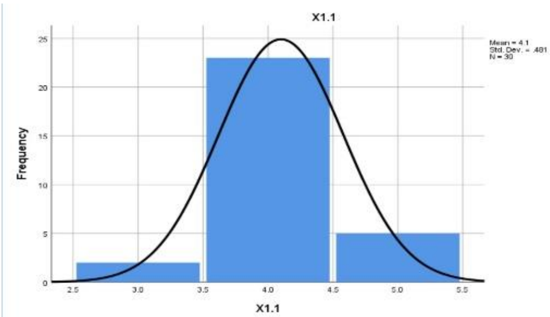
4.3.1 Service Quality Assesment

The assessment of biodiesel (B30) fuel sales to fishermen was evaluated based on key service aspects, namely price, time efficiency, and the administrative requirements necessary to obtain the fuel. The collected data were processed using the **SPSS** software and interpreted through the **descriptive frequency analysis method**. The results of the data processing, including tables and graphical representations of the service quality evaluation, are presented as follows:

Table 5. Assesment of Price Satisfaction in Relation to Production Costs

X1.1					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	RR	2	6.7	6.7	6.7
	S	23	76.7	76.7	83.3
	SS	5	16.7	16.7	100.0
	Total	30	100.0	100.0	

Diagram 4.2 Assesment of Price Satisfaction in Relation to Production Costs



Power System Technology
ISSN:1000-3673
Received: 06-02-2026 *Revised: 15-03-2026* *Accepted: 10-04-2026*

As shown in Table 5. and Diagram 4.2, 76.7% of respondents agreed that the current fuel price has contributed to reducing fisheries production costs. The majority of fishers also expressed intense satisfaction with the pricing, indicating its perceived role in minimizing operational costs in capture fisheries.

Table 6. Assesment of Satisfaction with the Fuel Acquisition Timeframe

X1.2					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	TS	12	40.0	40.0	40.0
	RR	1	3.3	3.3	43.3
	S	17	56.7	56.7	100.0
	Total	30	100.0	100.0	

Diagram 4.3 Assesment of Satisfaction with the Fuel Acquisition Timeframe

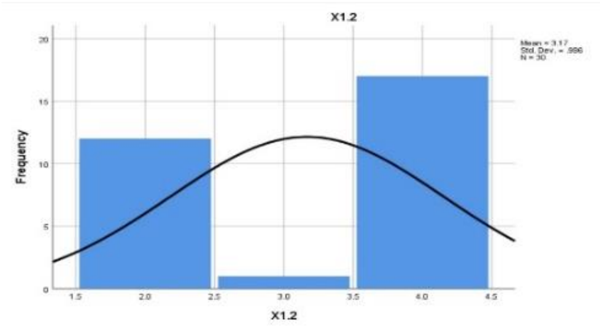


Table and diagram 4.3 illustrates that 56.7% of respondents agreed that fishermen find it easy to obtain the marketed biodiesel fuel. However, the data also reveal that 40% of surveyed fishermen disagreed with this statement. This divergence indicates the need for further consideration regarding fuel accessibility despite the statistically significant proportion of fishermen agreeing.

Table 7. Assesment of the Ease of Obtaining Fuel Requirements

X1.3					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	TS	13	43.3	43.3	43.3
	S	17	56.7	56.7	100.0
	Total	30	100.0	100.0	

Power System Technology
ISSN:1000-3673
Received: 06-02-2026 *Revised: 15-03-2026* *Accepted: 10-04-2026*

Diagram 4.4. Assesment of the Ease of Obtaining Fuel Requirements

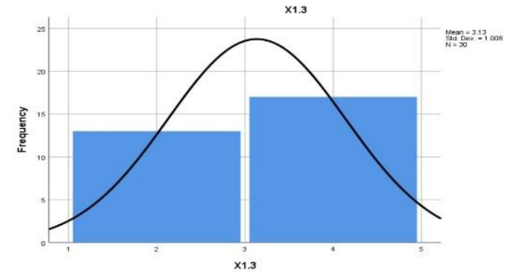


Table 7 and Diagram 4.4 show that 56.7% of the surveyed fishermen agree that the administrative requirements to obtain biodiesel fuel are relatively easy to meet. However, 43.3% of respondents expressed their disagreement with this statement, indicating concerns about administrative accessibility. Although the analysis results generally indicate a positive satisfaction level, these findings highlight the need for further attention to improve the administrative process and enhance fishermen's satisfaction in obtaining fuel.

Table 8. Assesment of Suitability Between Requirements and Fuel Recipients

X1.4					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	TS	5	16.7	16.7	16.7
	RR	19	63.3	63.3	80.0
	S	6	20.0	20	100.0
	Total	30	100.0	100.0	

Diagram 4.5. Assesment of Suitability Between Requirements and Fuel Recipients

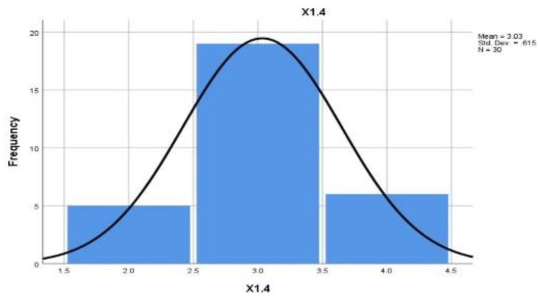


Table 8 and Diagram 4.5 present the results of the analysis which show that 63.3% of fishermen express doubts about the suitability between the established eligibility criteria and the actual recipients of subsidised fuel. The biodiesel used by fishermen is a type of fuel subsidised by the government, which requires meeting specific criteria, such as the vessel's gross tonnage, the kind of vessel, and other administrative requirements. However, based on observational data, more than 50% of fishermen doubt that the distribution of subsidised fuel has been targeted correctly.

Power System Technology
ISSN:1000-3673
Received: 06-02-2026 Revised: 15-03-2026 Accepted: 10-04-2026

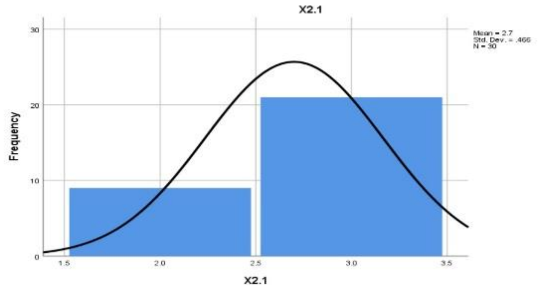
4.3.2 Product Assesment Analysis

Biodiesel B30 is a type of fuel allocated for the operational needs of fishing vessels. In the study area, various types of fuel are available to fishermen. However, Biodiesel B30 has become the primary choice due to government subsidies, making it more economically accessible. Nevertheless, fishermen still have expectations that the subsidies provided do not compromise the quality and performance of the fuel they consume. This study relies on survey data obtained from a sample of the local fishing population to evaluate their level of trust in the quality and operational performance of the subsidized Biodiesel B30 available in the region.

Table 9. Assesment of the Suitability of Fuel Content Based on MSDS

		X2.1			
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	TS	9	30.0	30.0	30.0
	RR	21	70.0	70.0	100.0
	Total	30	100.0	100.0	

Diagram 4.6. Assesment of the Suitability of Fuel Content Based on MSDS



Based on the data presented in Table 9 and Diagram 4.6, the survey results indicate that 70% of fishing respondents expressed doubts about the compliance of the subsidised fuel content with the specifications stated in the material data sheet or applicable technical standards for fuel. This level of doubt is influenced by numerous complaints from fishermen, who state that since using this type of fuel, the frequency of engine maintenance for their boats has increased. Nevertheless, to ensure a clear understanding of the relationship between fuel use and the increased intensity of engine maintenance, further studies are needed, including an analysis of fuel composition, engine operational hours, maintenance methods applied, and other technical variables.

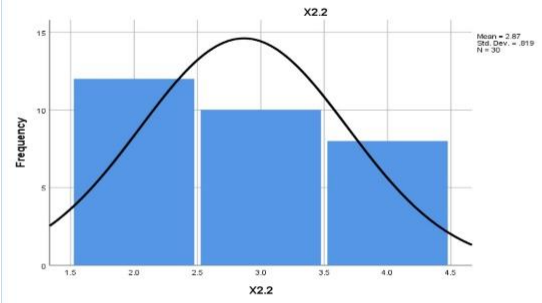
Table 10. Assesment of Fuel Efficiency Trust on Ship Engines

		X2.2			
		Frequency	Percent	Valid Percent	Cumulative Percent

Received: 06-02-2026 Revised: 15-03-2026 Accepted: 10-04-2026

Valid	TS	12	40.0	40.0	40.0
	RR	10	33.3	33.3	73.3
	S	8	26.7	26.7	100.0
	Total	30	100.0	100.0	

Diagram 3. Assesment of Fuel Efficiency Trust on Ship Engines

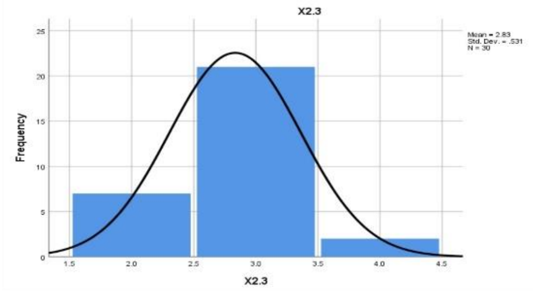


As shown in Table 10. and Figure 3., 40% of respondents disagreed with the statement that the type of fuel provides efficiency in fuel usage for ship engines, while another 33.3% expressed uncertainty. These findings indicate a relatively low level of confidence among fishermen regarding the fuel efficiency of reducing consumption. This perception also raises important questions about the basis of assessment used by the fishermen, particularly whether their evaluation is supported by documented operational data comparing the performance of this fuel with alternative fuels previously used.

Table 11. Assessment of Fuel Quality Trust on Ship Engine Performance

X2.3					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	TS	7	23.3	23.3	23.3
	RR	21	70.0	70.0	93.3
	S	2	6.7	6.7	100.0
	Total	30	100.0	100.0	

Diagram 4.8. Assessment of Fuel Quality Trust on Ship Engine Performance



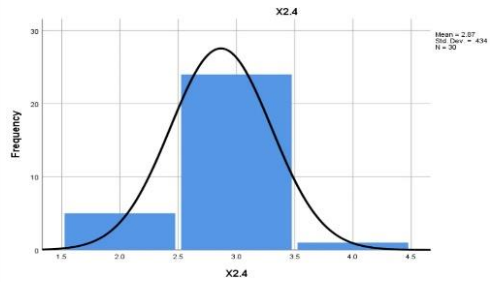
Power System Technology
ISSN:1000-3673
Received: 06-02-2026 *Revised: 15-03-2026* *Accepted: 10-04-2026*

Based on Table 11. and Diagram 4.8, 70% of respondents expressed doubts about the quality of B30 Biodiesel fuel. The fishermen questioned whether the fuel met the proper standards and whether it could positively impact the performance of boat engines. This level of doubt aligns with the findings in Table 2.5 and Diagram 2.5, where fishermen reported unsatisfactory experiences related to engine maintenance when using this type of fuel. Nevertheless, these doubts require further examination by considering various other factors that may influence the fishermen's perceptions of this fuel type.

Table 12. Assessment of the Impact of B30 Biodiesel on Ship Engine Maintenance

X2.4					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	TS	5	16.7	16.7	16.7
	RR	24	80.0	80.0	96.7
	S	1	3.3	3.3	100.0
	Total	30	100.0	100.0	

Diagram 4.9. Assessment of the Impact of B30 Biodiesel on Ship Engine Maintenance



Based on Table 12. and Diagram 4.9, the data show that similar to the findings in Table 2.7, as many as 70% of fishermen express doubts about the influence of fuel on the maintenance process of the diesel engine on their boats. This finding indicates that a portion of the respondents still doubts the correlation between the use of fuel and the performance and maintenance of their engines. However, the direct aspect of fuel's influence on performance and maintenance is not the focus of this study; therefore, it is recommended that this could be a topic for future research.

5. DISCUSSION

5.1 . Composition and Storage of Biodiesel Blends.

5.1.1 Testing Composition Parameters

A. Cetane Number

The cetane number is a crucial parameter for evaluating the ignition quality of fuel under compression. A high cetane number improves fuel efficiency, reduces exhaust gas emissions

Received: 06-02-2026 *Revised: 15-03-2026* *Accepted: 10-04-2026*

and engine noise, and enhances engine durability due to a better and measurable ignition quality—specifically, the ignition delay, which is the time between fuel injection into the combustion chamber and the top dead centre of combustion or the start of the combustion process (Bezaire et al., 2010; Ickes et al., 2009; Moser et al., 2009). Emissions of carbon monoxide (CO), nitrogen oxides (NOx), and hydrocarbons (HC) can be reduced by increasing the cetane number. However, an excessively high cetane number may also lead to increased emissions of CO and NOx (Li RuiNa et al., 2014; Z. Wang et al., 2012; Yu et al., 2011). Studies show that two cetane number samples in the B30 biodiesel blend testing met the marketed biodiesel quality standards, while one sample showed a cetane number below the standard. Nevertheless, further research on other influencing factors is necessary to assess the substandard cetane number result.

B. Specific Gravity

Biodiesel has a higher specific gravity than other fossil fuels, and it varies with temperature. Specific gravity is a property related to the molecular structure of biodiesel, increasing proportionally with the carbon chain length and being inversely proportional to the number of double bonds (Boudy & Seers, 2009; Fernandes et al., 2014). Studies show that all tested samples had values within the minimum and maximum range of standardized biodiesel quality. Therefore, the specific gravity content demonstrates that biodiesel is an efficient fuel, as particular gravity influences the efficiency of the combustion process.

C. Viscosity

Kinematic viscosity and density are two key properties of biodiesel directly related to the standard requirements for diesel engines (Giakoumis & Sarakatsanis, 2018; Özgür & Tosun, 2017). The viscosity of a liquid affects several key parameters, including fuel lubrication quality, engine emission deposits, spray characteristics, exhaust gas formation, and the injection of fuel into the combustion chamber. Therefore, fuel atomization with high viscosity can have negative impacts, as it may result in poor fuel spray, leading to incomplete combustion in diesel engines, which in turn can cause sediment deposits in the engine and changes in smoke and exhaust gas emissions (Dafsari et al., 2019; Jarrahian et al., 2015; Li et al., 2020; Xiong et al., 2021). Biodiesel's kinematic viscosity is relatively high and significantly influences the atomization effect, droplet size, engine operating conditions, jet stream penetration, and overall combustion quality (Xiao et al., 2023). Biodiesel is a complex mixture of esters, and its overall viscosity performance is affected by any changes in its components (X. Wang et al., 2022). Studies show that viscosity testing on all fuel samples indicated values within the standard range and close to the upper limit of quality standards. This suggests that the marketed fuel has a good viscosity level, which supports effective fuel spray during injection into the combustion chamber.

D. Ash Content

Ash content in biodiesel fuel refers to the residual solid matter that remains after the biodiesel sample is completely burned under controlled conditions. This ash consists of inorganic

Received: 06-02-2026 Revised: 15-03-2026 Accepted: 10-04-2026

materials such as metals, salts, or other non-organic compounds that do not combust along with the fuel.

E. Colour

The physical characteristics of colour in biodiesel fuel can provide initial information about its quality, purity, and the raw materials used in the production process. However, colour is not a primary parameter in biodiesel quality standards, as it can vary due to differences or issues in the production process. While colour can serve as a visual indicator, it still requires confirmation through laboratory tests, such as density, water content, glycerol, FAME, and ash content, among others.

F. Caloric value

The calorific value of biodiesel fuel is generally lower compared to other fossil fuels due to its higher oxygen content. The addition of ethanol to biodiesel blends can further reduce the calorific value (Madiwale et al., 2017). Calorific value is a crucial parameter in evaluating the energy content of a fuel, representing the amount of heat energy released during combustion under constant pressure, with all combustion products, except water, in a gaseous state. Fuels with higher calorific values typically produce more energy and have the potential to reduce fuel consumption and emissions (Bai et al., 2024; Bakar et al., 2024; Markowski et al., 2020). Therefore, calorific value is closely related to fuel efficiency and plays a significant role in minimizing the environmental impact of exhaust gas emissions.

G. Fame Content

Fatty Acid Methyl Ester (FAME) content is a key parameter used to distinguish biodiesel from petroleum diesel due to its environmentally friendly nature and renewable energy source (Wategave et al., 2021). FAME content is one of the essential criteria that biodiesel must meet to comply with specific quality standards, ensuring appropriate emissions and engine performance. FAME in biodiesel is biodegradable and environmentally friendly; however, the rate of biodegradation can vary depending on the specific composition of the FAME and environmental conditions (Thomas et al., 2017). Based on this study, the FAME content meets the standard, with a value above 30% by volume. Therefore, the B30 blend's FAME content, resulting from the transesterification process, has fulfilled the required quality standards.

H. Methanol

Methanol is one of the components used in biodiesel to improve the combustion process, addressing the adverse effects of high viscosity that can lead to poor atomization and reduced combustion efficiency (Chaichan, 2018; Xie et al., 2025). The addition of methanol to biodiesel enhances thermal efficiency and increases cylinder pressure under low-load conditions. It also results in a longer ignition delay during the combustion process when the methanol concentration is higher. Moreover, peak combustion pressure tends to decrease under light load but increases under medium and heavy load conditions (An et al., 2015; G. Lin et al., 2015; Yellapragada et al., 2019).

Power System Technology
ISSN:1000-3673
Received: 06-02-2026 Revised: 15-03-2026 Accepted: 10-04-2026

5.1.2 Biodiesel Storage

Storage media such as ship holds or tanks, ground storage tanks, and fuel tanks for vehicles, vessels, and generators can be used to store B30. Storing B30 requires careful attention to the storage media and material composition to ensure the fuel quality remains stable.

A. Ground Storage Tank

Referring to the guidelines for the handling and storage of biodiesel and B30 biodiesel blends issued by the Ministry of Energy and Mineral Resources, the storage of B30 biodiesel blends in underground tanks is not recommended for periods exceeding three months unless the tank is equipped with an air filter that is routinely inspected and maintained. This ensures that when the biodiesel blend is dispensed from the tank, the air entering the vapour space is free from microbial contamination. When storing biodiesel in underground tanks, several fuel parameters must be carefully monitored, including water content, acid number, cloud point, and oxidation stability. One of the biodiesel samples in this study was taken from an SPBN tank. SPBN is a station specifically designated for selling fuel to fishermen. SPBN is similar to SPBU but offers a more limited range of fuel types. SPBN stores its fuel in underground tanks. According to the guidelines, the storage of B30 in underground tanks requires specific conditions such as:

1) The tank temperature must never fall below the cloud point of biodiesel or must be stored in a location with a temperature above 20°C;
2) The tank must be free from water contamination;
3) The tank must be equipped with a draining facility;
4) The storage tank material and its accessories must be compatible with the properties and characteristics of biodiesel.

B. Ship Tank

Onboard a vessel, B30 can be stored in the hold or the fuel tank. According to the Guidelines for the Handling and Storage of Biodiesel and Biodiesel Blends issued by the Ministry of Energy and Mineral Resources, storing B30 in a ship's fuel tank that is not used regularly is not recommended unless periodic quality inspections are conducted and the results still meet the required specifications. Consumers, particularly fishermen need to have a clear understanding of the characteristics of B30 when storing it. Some of the key aspects they need to understand include:

1) Biodiesel tends to absorb water. If storage is intended to last more than three months, the fuel tank should be filled to prevent water vapour condensation in the tank space.;
2) Biodiesel has a slightly higher density compared to petroleum diesel, which may lead to fuel separation if stored for more than three months. Therefore, it is recommended to run the engine periodically, even if it is seldom used.
3) Biodiesel has solvent properties that can dissolve dirt and residues on tank walls and piping.
4) B30 is highly influenced by vessel activity; therefore, fuel quality monitoring should be conducted by sampling, sounding, and draining at least once a week.

Power System Technology
ISSN:1000-3673
Received: 06-02-2026 Revised: 15-03-2026 Accepted: 10-04-2026

5.1.3 Continuation of Biodiesel Implementation for Local Communities

Globally, from annual energy consumption of 40 million tons of fuel, fishing vessels produce approximately 100 million tons of CO_2 emissions, with around 75%–90% of fuel consumption used for propulsion power (Suryanto et al., 2025). n 2011, the capture fisheries sector was estimated to consume 40 billion litres of fuel, accounting for 1.2% of global oil consumption and generating approximately 179 million tons of CO_2-equivalent GHG emissions. Between 1990 and 2011, GHG emissions from global fisheries increased by 28%, with fishing vessels consuming the largest share of energy in the seafood value chain, resulting in significant emissions that are harmful (Basurko et al., 2016; Jafarzadeh et al., 2017; Parker et al., 2018). The fisheries sector, therefore, makes a considerable contribution to global carbon emissions (Hua & Wu, 2011). However, the implementation of mandatory biodiesel usage in local areas still faces numerous challenges, including regional-level regulations for biodiesel development and the actual fuel usage ratio among local communities (Widrian et al., 2022).

The continued implementation of biodiesel fuel for local communities requires consideration of several key aspects, including: (1) Carbon Tax Regulations: Increasing the price of fossil fuels to incentivize the use of cleaner energy sources is a regulatory design within carbon tax policies aimed at reducing greenhouse gas emissions. This approach encourages consumers to switch to cleaner fuels, optimize vessel operations, improve energy efficiency, and invest in more efficient technologies (Baranzini & Weber, 2023; Gao et al., 2023; Jinwen et al., 2010; Koričan et al., 2025; Litman, 2009; Núñez Sánchez, 2025). However, carbon taxes must be carefully designed with a detailed regulatory framework to ensure wise implementation—such as Indonesia's inclusion of carbon tax provisions under Law No. 7 of 2021 on the Harmonization of Tax Regulations. (2) Increasing the Biodiesel Blend Ratio for Fishing Vessel Diesel Engines: Fuel specifications with specific standards for marine biodiesel are essential to meet maritime industry requirements. ISO 8217 is considered the standard for marine fuel, although it primarily applies to commercial vessels (Galle et al., 2012). Nevertheless, in Indonesia, biodiesel blends marketed to local communities in coastal areas have adopted the B40 policy, which comprises 40% biodiesel and 60% fossil fuel. (3) Regulatory Simplification: Subsidies for biodiesel sales to local communities should promote a significant increase in consumption. High subsidies for energy development necessitate strategies for the effective use and optimization of that energy (Adiatma & Prasojo, 2021; Husada et al., 2023). This study shows that local communities require simplified regulations to access subsidized fuels, which could help reduce their operational time in capture fisheries production. (4) Outreach on Renewable Energy Sources: Not all local coastal communities are aware of the role of renewable energy sources, particularly biodiesel. Therefore, relevant stakeholders need to conduct technical and comprehensive outreach regarding renewable energy to local coastal communities. Such efforts could raise awareness and encourage a shift toward renewable energy sources, such as biodiesel.

Power System Technology
ISSN:1000-3673
Received: 06-02-2026 *Revised: 15-03-2026* *Accepted: 10-04-2026*

6. Conclusion and Recommendations

Introducing biodiesel blends into maritime transportation, including fishing vessels, presents additional challenges, such as the need for comprehensive field testing, the establishment of marine-standard specifications, and enhancing price competitiveness. Strategies to address these barriers include offering tax incentives, providing subsidies, and adopting fuel-compatible systems within existing fuel infrastructure [120]. The B30 biodiesel blend distributed to local communities in coastal regions has met the marketing standards for B30 biodiesel blends in Indonesia. However, the level of trust among local communities regarding the quality of the biodiesel blend remains low, primarily due to local concerns that the use of biodiesel may increase the frequency of maintenance and repairs of diesel engines onboard vessels.

The study indicates that trust in biodiesel blends among local communities would significantly improve if accompanied by protection or guarantees related to engine maintenance and repairs, especially in cases where the fuel content does not meet the MSDS specifications. This approach would not only promote biodiesel as an environmentally friendly and low-emission fuel but also ensure that consumers are protected against potential risks associated with the marketed product. Furthermore, more efficient or simplified biodiesel marketing and distribution strategies by policymakers could boost fuel distribution demand from local communities, considering their limited time for capture fishery production and operational activities at sea. Therefore, these comprehensive measures could significantly enhance biodiesel adoption among local communities, enabling their marine operations to contribute to government programs aimed at environmental protection and sustainable development in coastal regions.

Conflict of Interest

The authors declare that they have no known financial interests, personal relationships, or other conflicts of interest that could have appeared to influence the work reported in this paper.

Acknowledgment

The authors would like to thank the Merchant Marine Polytechnic Semarang for their generous financial support and LPDP of the Ministry of Finance for the doctoral program scholarship. The authors also thank all authors for realizing the current work.

Nomenclature

List of Abbreviations

MSDS	Materal Safety Data Sheet

Received: 06-02-2026 Revised: 15-03-2026 Accepted: 10-04-2026

GHG	Greenhouse Gas
FAME	Fatty Acid Methyl Esters
SPBN	The Fisherman's Fuel Filling Station

Author Contributions

All authors contributed to the completion of this observation. The first author was responsible for formulating the initial idea of the study, which the second author then guided through the development of the methodology. The third author contributed to the analysis of the observation results.

References

1. Adiatma, J. C., & Prasojo, H. (2021). *Critical review on the biofuel development policy in Indonesia*. IESR. https://iesr.or.id/wp-content/uploads/2021/05/Critical-review-on-biofuel_IESR040521.pdf
2. An, H., Yang, W. M., & Li, J. (2015). Numerical modeling on a diesel engine fueled by biodiesel–methanol blends. *Energy Conversion and Management*, *93*, 100–108.
3. Ault, A. P., Gaston, C. J., Wang, Y., Dominguez, G., Thiemens, M. H., & Prather, K. A. (2010). Characterization of the single particle mixing state of individual ship plume events measured at the port of Los Angeles. *Environmental Science & Technology*, *44*(6), 1954–1961.
4. Bai, Y., Sun, Y., Pan, H., Wang, S., Dong, Y., Chen, B., Qiu, J., & Jing, W. (2024). Combustion properties and pollutant analysis of coal-blended bio-heavy oil fuel. *RSC Advances*, *14*(7), 4362–4368.
5. Bakar, R. A., Kadirgama, K., Ramasamy, D., Yusaf, T., Kamarulzaman, M. K., Aslfattahi, N., Samylingam, L., & Alwayzy, S. H. (2024). Experimental analysis on the performance, combustion/emission characteristics of a DI diesel engine using hydrogen in dual fuel mode. *International Journal of Hydrogen Energy*, *52*, 843–860.
6. Bakeas, E., Karavalakis, G., Fontaras, G., & Stournas, S. (2011). An experimental study on the impact of biodiesel origin on the regulated and PAH emissions from a Euro 4 light-duty vehicle. *Fuel*, *90*(11), 3200–3208.
7. Balat, M. (2006). Fuel characteristics and the use of biodiesel as a transportation fuel. *Energy Sources, Part A*, *28*(9), 855–864.
8. Baranzini, A., & Weber, S. (2023). *Carbon taxes*. Edward Elgar Publishing Limited.
9. Basha, S. A. (2014). Biodiesel emissions and performance. *Sustainable Energy Solutions in Agriculture. CRC Press, Boca Raton, FL*, 323–334.
10. Basurko, O. C., Gabiña, G., & Quincoces, I. (2016). Fuel consumption monitoring in fishing vessels and its potential for different stakeholders. *Shipping in Changing Climates Conference*, 10–12.
11. Baum, G., Kusumanti, I., Breckwoldt, A., Ferse, S. C. A., Glaser, M., Adrianto, L., van

Power System Technology
ISSN:1000-3673
Received: 06-02-2026 Revised: 15-03-2026 Accepted: 10-04-2026

der Wulp, S., & Kunzmann, A. (2016). Under pressure: Investigating marine resource-based livelihoods in Jakarta Bay and the Thousand Islands. *Marine Pollution Bulletin*, *110*(2), 778–789.

12. Bezaire, N., Wadumesthrige, K., Ng, K. Y. S., & Salley, S. O. (2010). Limitations of the use of cetane index for alternative compression ignition engine fuels. *Fuel*, *89*(12), 3807–3813.
13. Boudy, F., & Seers, P. (2009). Impact of physical properties of biodiesel on the injection process in a common-rail direct injection system. *Energy Conversion and Management*, *50*(12), 2905–2912.
14. Chaichan, M. T. (2018). Combustion and emission characteristics of E85 and diesel blend in conventional diesel engine operating in PPCI mode. *Thermal Science and Engineering Progress*, *7*, 45–53.
15. Chong, C. T., Loe, T. Y., Wong, K. Y., Ashokkumar, V., Lam, S. S., Chong, W. T., Borrion, A., Tian, B., & Ng, J.-H. (2021). Biodiesel sustainability: The global impact of potential biodiesel production on the energy–water–food (EWF) nexus. *Environmental Technology & Innovation*, *22*, 101408.
16. Corbett, J. J., Winebrake, J. J., Green, E. H., Kasibhatla, P., Eyring, V., & Lauer, A. (2007). Mortality from ship emissions: a global assessment. *Environmental Science & Technology*, *41*(24), 8512–8518.
17. Dafsari, R. A., Lee, H. J., Han, J., Park, D.-C., & Lee, J. (2019). Viscosity effect on the pressure swirl atomization of an alternative aviation fuel. *Fuel*, *240*, 179–191.
18. Damian, C. S., Devarajan, Y., Jayabal, R., & Raja, T. (2025). Enhancing marine diesel engine compatibility with sustainable fuels: Key factors and adjustments. *Marine Pollution Bulletin*, *215*, 117836.
19. Dunn, R. O. (2005). Effect of antioxidants on the oxidative stability of methyl soyate (biodiesel). *Fuel Processing Technology*, *86*(10), 1071–1085.
20. Etim, A. O., Jisieike, C. F., Ibrahim, T. H., & Betiku, E. (2022). Biodiesel and its properties. In *Production of biodiesel from non-edible sources* (pp. 39–79). Elsevier.
21. Fardilah, V. A., Pusparizkita, Y. M., Aslan, C., Schmahl, W. W., Kaliwoda, M., Setiadi, T., Devianto, H., Harimawan, A., & Bayuseno, A. P. (2022). Assessment on the pitting-corrosion of 1037-mild carbon steel by bacteria in B30 biodiesel product. *Journal of Bio-and Tribo-Corrosion*, *8*(4), 92.
22. Farobie, O., & Hartulistiyoso, E. (2022). Palm oil biodiesel as a renewable energy resource in Indonesia: current status and challenges. *Bioenergy Research*, *15*(1), 93–111.
23. Febriansyah, H., Mulyono, A. B., Yayienda, N. F., & Isharyadi, F. (2020). Water Contents and Monoglycerides as Development Role of Biodiesel Standard in Indonesia for B30 Implementation. *Proceeding of the Electrical Engineering Computer Science and Informatics*, *7*(2).

Power System Technology
ISSN:1000-3673
Received: 06-02-2026 Revised: 15-03-2026 Accepted: 10-04-2026

24. Febriansyah, H., Utomo, F. B., & Suminto, S. (2020). The readiness of Indonesia to Implement blended biodiesel B30. *E3S Web of Conferences*, *190*, 13.
25. Fernado, S. D. (2005). Issues with biodiesel purity and the current US biodiesel standard. *The 2005 Annual Meeting*.
26. Fernandes, D. M., Santos, D. Q., Vieira, D. F., & Munoz, R. A. A. (2014). Development of an algorithm for correction of specific gravity of biodiesel. *Renewable Energy*, *63*, 507–510.
27. Firdaus, A., Machfud, M., Suryani, A., & Achsani, N. A. (2019). Measuring Indonesia's energy security level in the context of biodiesel agroindustry. *International Journal of Energy Economics and Policy*, *9*(6), 154–164.
28. Galle, J., Verhelst, S., Sierens, R., Goyos, L., Castaneda, R., Verhaege, M., Vervaeke, L., & Bastiaen, M. (2012). Failure of fuel injectors in a medium speed diesel engine operating on bio-oil. *Biomass and Bioenergy*, *40*, 27–35.
29. Gao, X., Zhu, A., & Yu, Q. (2023). Exploring the carbon abatement strategies in shipping using system dynamics approach. *Sustainability*, *15*(18), 13907.
30. Giakoumis, E. G., & Sarakatsanis, C. K. (2018). Estimation of biodiesel cetane number, density, kinematic viscosity and heating values from its fatty acid weight composition. *Fuel*, *222*, 574–585.
31. Haryanto, B. (2017). Climate change and urban air pollution health impacts in Indonesia. In *Climate change and air pollution: The impact on human health in developed and developing countries* (pp. 215–239). Springer.
32. Haryono, I., Ma'ruf, M., Setiapraja, H., Fajar, R., & Mansur, D. (2024). Characterization of Palm Biodiesel Deposit on The Locomotive Engine Fuel Filters: Composition, Physical, Chemical Properties. *International Journal of Technology*, *15*(6).
33. He, B. B., Thompson, J. C., Routt, D. W., & Van Gerpen, J. H. (2007). Moisture absorption in biodiesel and its petro-diesel blends. *Applied Engineering in Agriculture*, *23*(1), 71–76.
34. Hidayati, D. (2021). The influence of coastal and marine ecosystem conditions on fisheries and socio-economic activities of local fishermen. *IOP Conference Series: Earth and Environmental Science*, *695*(1), 12030.
35. Hua, J., & Wu, Y. (2011). Implications of energy use for fishing fleet—Taiwan example. *Energy Policy*, *39*(5), 2656–2668.
36. Husada, V. S., Fathurrahman, N. A., Wibowo, C. S., & Joesoef, I. E. (2023). Juridical review on the mandatory biodiesel program for maintaining national energy security in Indonesia. *IOP Conference Series: Earth and Environmental Science*, *1187*(1), 12036.
37. Ickes, A. M., Bohac, S. V, & Assanis, D. N. (2009). Effect of fuel cetane number on a premixed diesel combustion mode. *International Journal of Engine Research*, *10*(4), 251–263.

Received: 06-02-2026 *Revised: 15-03-2026* *Accepted: 10-04-2026*

38. Jafarzadeh, S., Paltrinieri, N., Utne, I. B., & Ellingsen, H. (2017). LNG-fuelled fishing vessels: A systems engineering approach. *Transportation Research Part D: Transport and Environment*, *50*, 202–222.
39. Jain, S., & Sharma, M. P. (2010). Stability of biodiesel and its blends: a review. *Renewable and Sustainable Energy Reviews*, *14*(2), 667–678.
40. Jalkanen, J.-P., Johansson, L., Kukkonen, J., Brink, A., Kalli, J., & Stipa, T. (2012). Extension of an assessment model of ship traffic exhaust emissions for particulate matter and carbon monoxide. *Atmospheric Chemistry and Physics*, *12*(5), 2641–2659.
41. Jarrahian, A., Aghel, B., & Heidaryan, E. (2015). On the viscosity of natural gas. *Fuel*, *150*, 609–618.
42. Jinwen, Z., Xiaoying, Z., & Guowen, S. (2010). The Conceit of Carbon Tax Designs Based on Tax System Innovation in China. *2010 3rd International Conference on Information Management, Innovation Management and Industrial Engineering*, *3*, 41–44.
43. Jonson, J. E., Jalkanen, J. P., Johansson, L., Gauss, M., & Denier Van Der Gon, H. A. C. (2015). Model calculations of the effects of present and future emissions of air pollutants from shipping in the Baltic Sea and the North Sea. *Atmospheric Chemistry and Physics*, *15*(2), 783–798.
44. Jupesta, J., Harayama, Y., & Parayil, G. (2011). Sustainable business model for biofuel industries in Indonesia. *Sustainability Accounting, Management and Policy Journal*, *2*(2), 231–247.
45. Karavalakis, G., Johnson, K. C., Hajbabaei, M., & Durbin, T. D. (2016). Application of low-level biodiesel blends on heavy-duty (diesel) engines: Feedstock implications on NOx and particulate emissions. *Fuel*, *181*, 259–268.
46. Kementerian ESDM. (2024). *Laporan Kinerja Kementerian ESDM Tahun 2024*. Kementerian ESDM. https://www.esdm.go.id/assets/media/content/content-laporan-kinerja-kementerian-esdm-tahun-2024.pdf
47. Knothe, G. (2007). Some aspects of biodiesel oxidative stability. *Fuel Processing Technology*, *88*(7), 669–677.
48. Knothe, G., & Razon, L. F. (2017). Biodiesel fuels. *Progress in Energy and Combustion Science*, *58*, 36–59.
49. Koričan, M., Fan, A., & Vladimir, N. (2025). Analysis of environmental-economic sustainability of fishing vessels and its improvement by alternative powering options in projected decarbonization scenarios. *Fisheries Research*, *285*, 107385.
50. Kuntjoro, Y., Khotimah, K., & Agustiani, R. (2021). Indonesia energy security concept to improve sustainability of new and renewable energy utilization in Indonesia with quintuple helix model: 4A+1S for national defense. *IOP Conference Series: Earth and Environmental Science*, *753*, 12045. https://doi.org/10.1088/1755-1315/753/1/012045
51. Lee, G.-E., Loveridge, S., & Joshi, S. (2017). Local acceptance and heterogeneous

Received: 06-02-2026 Revised: 15-03-2026 Accepted: 10-04-2026

externalities of biorefineries. *Energy Economics*, *67*, 328–336.

52. Lee, J. S., Ray, R. I., & Little, B. J. (2010). An assessment of alternative diesel fuels: microbiological contamination and corrosion under storage conditions. *Biofouling*, *26*(6), 623–635.
53. Li, H., Zhang, T., Tsang, D. C. W., & Li, G. (2020). Effects of external additives: Biochar, bentonite, phosphate, on co-composting for swine manure and corn straw. *Chemosphere*, *248*, 125927.
54. Li RuiNa, L. R., Wang Zhong, W. Z., Li MingDi, L. M., Zhao Yang, Z. Y., Ni PeiYong, N. P., & Liu Shuai, L. S. (2014). *Experimental study of cetane number on methanol/biodiesel emission of pollutant.*
55. Lin, C.-Y. (2013a). Effects of biodiesel blend on marine fuel characteristics for marine vessels. *Energies*, *6*(9), 4945–4955.
56. Lin, C.-Y. (2013b). Strategies for promoting biodiesel use in marine vessels. *Marine Policy*, *40*, 84–90.
57. Lin, C.-Y., & Huang, T.-H. (2012). Cost–benefit evaluation of using biodiesel as an alternative fuel for fishing boats in Taiwan. *Marine Policy*, *36*(1), 103–107.
58. Lin, G., Guo, Q., Song, P., & Song, J. (2015). Combustion and Emission Performances of Diesel Engine Fueled With Biodiesel-Methanol Blend Fuels. *The Open Fuels & Energy Science Journal*, *8*(1).
59. Lin, Y.-C., Hsu, K.-H., & Chen, C.-B. (2011). Experimental investigation of the performance and emissions of a heavy-duty diesel engine fueled with waste cooking oil biodiesel/ultra-low sulfur diesel blends. *Energy*, *36*(1), 241–248.
60. Litman, T. (2009). Evaluating carbon taxes as an energy conservation and emission reduction strategy. *Transportation Research Record*, *2139*(1), 125–132.
61. Liu, H., Meng, Z.-H., Lv, Z.-F., Wang, X.-T., Deng, F.-Y., Liu, Y., Zhang, Y.-N., Shi, M.-S., Zhang, Q., & He, K.-B. (2019). Emissions and health impacts from global shipping embodied in US–China bilateral trade. *Nature Sustainability*, *2*(11), 1027–1033.
62. Madiwale, S., Karthikeyan, A., Bhojwani, V., & Dombale, M. (2017). Improvement of palm oil biodiesel properties using ethanol as an additive and its effect on diesel engine performance, combustion and emissions. *ARPN Journal of Engineering and Applied Sciences*, *12*(13), 3987–3994.
63. Markowski, J., Imilkowski, P., Nowacki, M., Olejniczak, D., Madry, J., Netter, K., Jesionek, K., & Wieczorkiewicz, G. (2020). The concept of measurement of calorific value of gaseous fuels. *E3S Web of Conferences*, *207*, 1025.
64. McCormick, R. L., & Westbrook, S. R. (2007). Biodiesel and Biodiesel Blends. *ASTM Standardization News*, *35*(4), 28.
65. Moldanová, J., Fridell, E., Winnes, H., Holmin-Fridell, S., Boman, J., Jedynska, A., Tishkova, V., Demirdjian, B., Joulie, S., & Bladt, H. (2013). Physical and chemical

Received: 06-02-2026 *Revised: 15-03-2026* *Accepted: 10-04-2026*

characterisation of PM emissions from two ships operating in European Emission Control Areas. *Atmospheric Measurement Techniques*, *6*(12), 3577–3596.

66. Moser, B. R., Williams, A., Haas, M. J., & McCormick, R. L. (2009). Exhaust emissions and fuel properties of partially hydrogenated soybean oil methyl esters blended with ultra low sulfur diesel fuel. *Fuel Processing Technology*, *90*(9), 1122–1128.
67. Muringai, R. T., Naidoo, D., Mafongoya, P., & Lottering, S. (2020). The impacts of climate change on the livelihood and food security of small-scale fishers in Lake Kariba, Zimbabwe. *Journal of Asian and African Studies*, *55*(2), 298–313.
68. Mutaqin, B. W., Marfai, M. A., Helmi, M., Nurhadi, N., Umarella, M. R., & Munir, M. (2020). How important risk analysis of plastic pollution in coastal area? Case study in Masohi, Central Maluku. *E3S Web of Conferences*, *200*, 2014.
69. Na, K., Biswas, S., Robertson, W., Sahay, K., Okamoto, R., Mitchell, A., & Lemieux, S. (2015). Impact of biodiesel and renewable diesel on emissions of regulated pollutants and greenhouse gases on a 2000 heavy duty diesel truck. *Atmospheric Environment*, *107*, 307–314.
70. Naimah, D., & Morgunova, M. (2018). Analysis of palm-oil-based biodiesel in Indonesia using technological innovation system approach. *E3S Web of Conferences*, *43*, 1007.
71. Noor, C. W. M., Noor, M. M., & Mamat, R. (2018). Biodiesel as alternative fuel for marine diesel engine applications: A review. *Renewable and Sustainable Energy Reviews*, *94*, 127–142.
72. Núñez Sánchez, M. J. (2025). Decarbonisation of Fishing Vessels: Policy Challenges and Areas of Concern in View of Accident Investigation and Inspections. *Journal of Agromedicine*, *30*(2), 351–359.
73. Nursyirwan, I., Fitrah, B., L., B. C. R., & S, C. R. P. (2018). *Considering Ecosystem Valuation for Coastal Zone Management by Using Economic Valuation and Visitor Preferences on Tourism Aspect*. https://www.iahr.org/library/infor?pid=38969
74. Özgür, C., & Tosun, E. (2017). Prediction of density and kinematic viscosity of biodiesel by artificial neural networks. *Energy Sources, Part A: Recovery, Utilization, and Environmental Effects*, *39*(10), 985–991.
75. Parker, R. W. R., Blanchard, J. L., Gardner, C., Green, B. S., Hartmann, K., Tyedmers, P. H., & Watson, R. A. (2018). Fuel use and greenhouse gas emissions of world fisheries. *Nature Climate Change*, *8*(4), 333–337.
76. Part, O. (2008). The handbook of environmental chemistry. *Emerging Contaminants*, *5*, 2.
77. Perret, S. R., & Yuerlita, and. (2014). Adapting to declining fish resources: the differentiation of livelihood systems and fishing strategies in Singkarak Lake's fishing community, West Sumatra. *Regional Environmental Change*, *14*(3), 1203–1214.

Power System Technology
ISSN:1000-3673
Received: 06-02-2026 Revised: 15-03-2026 Accepted: 10-04-2026

78. Purwanto, A. J., & Lutfiana, D. (2023). Toward an optimized biofuel use pathway for Indonesia road transport. In *The Handbook of Energy Policy* (pp. 555–586). Springer.
79. Rahmania, R., Kusumaningrum, P. D., Chandra, H., Sianturi, D. S. A., Firdaus, Y., Akhwady, R., Sufyan, A., Hatori, C. A., Indriasari, V. Y., & Triwibowo, H. (2021). Overview of Existing Waste Processing Techniques in Small Islands of Pulo Aceh, Seribu, Karimunjawa and Wakatobi. *IOP Conference Series: Earth and Environmental Science*, *925*(1), 12023.
80. Ramdhani, A. Y., & Setiawan, A. D. (2021). A Conceptual System Dynamics Model of Enhancing Biodiesel Adoption in Indonesia. *Proceedings of the 4th Asia Pacific Conference on Research in Industrial and Systems Engineering*, 169–173.
81. Roisah, K., Rahayu, R., Yusliwidaka, A., Mubarok, Z., & Buditama, A. (2023). Legal Development in the Overcoming Overfishing in Indonesian Coastal Areas. *JILS*, *8*, 1065.
82. Ryu, D., Katta, S. K., Bullerman, L. B., Hanna, M. A., & Gennadios, A. (1996). Viability in methyl soyate of microbial contaminants from farm fuel storage tanks. *Transactions of the ASAE*, *39*(6), 2001–2004.
83. Sagin, S., Haichenia, O., Karianskyi, S., Kuropyatnyk, O., Razinkin, R., Sagin, A., & Volkov, O. (2025). Improving Green Shipping by Using Alternative Fuels in Ship Diesel Engines. *Journal of Marine Science and Engineering*, *13*(3), 589.
84. Sagin, S. V, Sagin, S. S., Fomin, O., Gaichenia, O., Zablotskyi, Y., Píštěk, V., & Kučera, P. (2024). Use of biofuels in marine diesel engines for sustainable and safe maritime transport. *Renewable Energy*, *224*, 120221.
85. Setya Andani, I. W., Sugiyono, A., Khotimah, K., & Siregar, B. (2021). Decarbonizing the electricity system in Sumatra region using nuclear and renewable energy based power generation. *IOP Conference Series: Earth and Environmental Science*, *753*, 12011. https://doi.org/10.1088/1755-1315/753/1/012011
86. Shi, J., Chen, J., Wan, Z., Zhou, S., Jun, Y., & Shu, Y. (2025). The impact of low-sulfur marine fuel policy on air pollution in global coastal cities. *Sustainable Horizons*, *14*, 100130.
87. Silalahi, F. T. R., Simatupang, T. M., & Siallagan, M. P. (2020). Biodiesel produced from palm oil in Indonesia: Current status and opportunities. *AIMS Energy*, *8*(1).
88. Sofiev, M., Winebrake, J. J., Johansson, L., Carr, E. W., Prank, M., Soares, J., Vira, J., Kouznetsov, R., Jalkanen, J.-P., & Corbett, J. J. (2018). Cleaner fuels for ships provide public health benefits with climate tradeoffs. *Nature Communications*, *9*(1), 406.
89. Solikhah, M., BARUS, B., Karuana, F., Wimada, A., & Amri, K. (2020). *Pedoman Penanganan dan Penyimpanan Biodiesel dan Campuran Biodiesel (B30)*.
90. Srikumar, K., Tan, Y. H., Kansedo, J., Tan, I. S., Mubarak, N. M., Ibrahim, M. L., Yek, P. N. Y., Foo, H. C. Y., Karri, R. R., & Khalid, M. (2024). A review on the environmental life cycle assessment of biodiesel production: Selection of catalyst and

Received: 06-02-2026 *Revised: 15-03-2026* *Accepted: 10-04-2026*

oil feedstock. *Biomass and Bioenergy*, *185*, 107239.
91. Sugiarto, B., Hidayat, J. A., Suryantoro, M. T., Setiapraja, H., Yubaidah, S., & Dani, R. C. (2020). Effect of biodiesel oxidation on deposit growth rate in the combustion chamber. *AIP Conference Proceedings*, *2255*(1), 30037.
92. Sugiarto, B., Suryantoro, M. T., Yubaidah, S., & Attharik, M. I. (2018). The effect of antioxidant additives on the growth of deposits on the use of biodiesel fuel (B100) at certain temperatures. *IOP Conference Series: Earth and Environmental Science*, *105*(1), 12075.
93. Sukkasi, S., Chollacoop, N., Ellis, W., Grimley, S., & Jai-In, S. (2010). Challenges and considerations for planning toward sustainable biodiesel development in developing countries: lessons from the Greater Mekong Subregion. *Renewable and Sustainable Energy Reviews*, *14*(9), 3100–3107.
94. Suryanto, S., Nugroho, D., Muawanah, U., Triharyuni, S., Oktaviani, D., Wibowo, S., Adi, N. S., & Adi, P. D. P. (2025). The potential contribution of Indonesian fishing vessels in reducing Green House gas emission. *Aquaculture and Fisheries*, *10*(3), 372–381.
95. Susman, R., Gütte, A. M., & Weith, T. (2021). Drivers of land use conflicts in infrastructural mega projects in coastal areas: A case study of patimban seaport, indonesia. *Land*, *10*(6), 615.
96. Thomas, A. O., Leahy, M. C., Smith, J. W. N., & Spence, M. J. (2017). Natural attenuation of fatty acid methyl esters (FAME) in soil and groundwater. *Quarterly Journal of Engineering Geology and Hydrogeology*, *50*(3), 301–317.
97. van Wijnen, J., Ivens, W. P. M. F., Kroeze, C., & Löhr, A. J. (2015). Coastal eutrophication in Europe caused by production of energy crops. *Science of the Total Environment*, *511*, 101–111.
98. Viana, M., Hammingh, P., Colette, A., Querol, X., Degraeuwe, B., de Vlieger, I., & Van Aardenne, J. (2014). Impact of maritime transport emissions on coastal air quality in Europe. *Atmospheric Environment*, *90*, 96–105.
99. Victorovych Sagin, S., & Andriiovych Kuropyatnyk, O. (2018). The use of exhaust gas recirculation for ensuring the environmental performance of marine diesel engines. *NAŠE MORE: Znanstveni Časopis Za More i Pomorstvo*, *65*(2), 78–86.
100. Vutukuru, S., & Dabdub, D. (2008). Modeling the effects of ship emissions on coastal air quality: A case study of southern California. *Atmospheric Environment*, *42*(16), 3751–3764.
101. Wang, B., Or, W.-H., Lee, S.-C., Leung, Y.-C., Organ, B., & Ho, K.-F. (2021). Characteristics of particle emissions from light duty diesel vehicle fueled with ultralow sulphur diesel and biodiesel blend. *Atmospheric Pollution Research*, *12*(9), 101169.
102. Wang, X., Ma, Y., Huo, J., Liu, J., Wang, S., Fang, L., & Zhao, Z. (2022). Viscosity measurement and correlation research of one biodiesel component (methyl octanoate)

Power System Technology
ISSN:1000-3673
Received: 06-02-2026 Revised: 15-03-2026 Accepted: 10-04-2026

with five 1-alcohols. *Fuel*, *324*, 124441.

103. Wang, Z., Qu, L., Li, M., & Chen, L. (2012). Effect of DTBP on biodiesel combustion and emission characteristics of diesel engine fuelled with bio-diesel. *Transactions of the Chinese Society of Agricultural Engineering*, *28*(23), 60–66.
104. Warren, C., & Steenbergen, D. J. (2021). Fisheries decline, local livelihoods and conflicted governance: An Indonesian case. *Ocean & Coastal Management*, *202*, 105498.
105. Wategave, S. P., Banapurmath, N. R., Sawant, M. S., Soudagar, M. E. M., Mujtaba, M. A., Afzal, A., Basha, J. S., Alazwari, M. A., Safaei, M. R., & Elfasakhany, A. (2021). Clean combustion and emissions strategy using reactivity controlled compression ignition (RCCI) mode engine powered with CNG-Karanja biodiesel. *Journal of the Taiwan Institute of Chemical Engineers*, *124*, 116–131.
106. Widrian, A. F., Arifianto, B. S., Nurbaiti, & Sasongko, N. A. (2022). Review of biodiesel policy in Indonesia. *IOP Conference Series: Earth and Environmental Science*, *1034*(1), 12062.
107. Wirajing, M. A. K., & Nanfosso, R. T. (2025). Households' resilience capacity in the Cameroon fishing communities: case of the internally displaced and Immigrants fishermen. *World Development Perspectives*, *38*, 100678.
108. Wirawan, S. S., Solikhah, M. D., Setiapraja, H., & Sugiyono, A. (2024). Biodiesel implementation in Indonesia: Experiences and future perspectives. *Renewable and Sustainable Energy Reviews*, *189*, 113911.
109. Xiao, H., Wang, W., Bao, H., Li, F., & Zhou, L. (2023). Biodiesel-diesel blend optimized via leave-one cross-validation based on kinematic viscosity, calorific value, and flash point. *Industrial Crops and Products*, *191*, 115914.
110. Xie, M., Wang, Y., & Zhang, K. (2025). Development and optimization of a realistic biodiesel-methanol mechanism based on genetic algorithm. *Renewable Energy*, *250*, 123301.
111. Xin, J., & Saka, S. (2010). Test methods for the determination of biodiesel stability. *Biofuels*, *1*(2), 275–289.
112. Xiong, Z., Xiao, N., Xu, F., Zhang, X., Xu, Q., Zhang, K., & Ye, C. (2021). An equivalent exchange based data forwarding incentive scheme for socially aware networks. *Journal of Signal Processing Systems*, *93*(2), 249–263.
113. Xu, Z., Qayum, M., Afzal, J., & Aslam, M. (2023). Availability and access to Livelihood capital assets for development of sustainable Livelihood strategies of fishermen: A case study of Manchar Lake Pakistan. *Heliyon*, *9*(12).
114. Yamindago, R.-I.-A. (2015). Restoring coastal ecosystems-a case study Malang and Gresik regency, Indonesia. *Journal of Coastal Conservation*, *19*(2), 119–130.
115. Yang, N., Deng, X., Liu, B., Li, L., Li, Y., Li, P., Tang, M., & Wu, L. (2022). Combustion performance and emission characteristics of marine engine burning with

Power System Technology
ISSN:1000-3673

Received: 06-02-2026 *Revised: 15-03-2026* *Accepted: 10-04-2026*

different biodiesel. *Energies*, *15*(14), 5177.

116. Yellapragada, D., Rao, B., & B.Ajit. (2019). Emission And Combustion Characterization of Palm Biodiesel- Methanol Blends with Variable Compression Ratios. *Indian Journal of Environmental Protection*, *39*, 894–901.
117. Yola, L., Ulfiasari, S., Nanditho, G. A., Daga, R., Hannase, M., & Fatwa, N. (2022). Marine Pollution Challenges in Jakarta Northern Coast Fishermen Settlement. In *Sustainable Development Approaches: Selected Papers of AUA and ICSGS 2021* (pp. 127–133). Springer.
118. Yu, W., Chen, G., & Zuohua, H. (2011). Influence of cetane number improver on performance and emissions of a common-rail diesel engine fueled with biodiesel-methanol blend. *Frontiers in Energy*, *5*(4), 412–418.
119. Yuan, D.-F., Liu, Y., Trabelsi, T., Zhang, Y.-R., Li, J., Francisco, J. S., Guo, H., & Wang, L.-S. (2024). Probing the dynamics and bottleneck of the key atmospheric SO2 oxidation reaction by the hydroxyl radical. *Proceedings of the National Academy of Sciences*, *121*(6), e2314819121.
120. Zafriana, L., & Qurbani, I. D. (2021). Determination of the palm based biodiesel policy integration model as a renewable energy commodity. *Decision Science Letters*, *10*(3), 263–276.