International Journal of Arts and Social Science **www.ijassjournal.com**
ISSN: 2581-7922,
Volume 5 Issue 1, January 2022

Indonesia's Readiness to Reduce Carbon Levels in the Maritime Area during the Covid-19 Pandemic

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ABSTRACT : The Covid-19 pandemic has had an impact on the decline in shipping mobility. This also has an impact on the environment and actors involved in maritime activities. With this incident, this has also made countries in the world pay more attention to the environment, especially the increase in carbon in maritime areas. As for Indonesia at this time, it will focus on implementing its commitment to reduce carbon emissions by up to 29 percent by 2030. Therefore, this article aims to discuss Indonesia's level of readiness in reducing carbon emissions, especially in water areas. The research method used in this research is evaluative research which refers to the concept of *Ocean Based Mitigation* as a result of the discussion of the *High Level Panel for a Sustainable Ocean Economy*, where this concept identifies water areas that have the potential to generate carbon. Based on the existing conclusions, Indonesia's level of readiness for decarbonization in marine areas has only reached 44%. This acquisition is still a process, so that in the future other areas also need to be improved, namely in the area of marine transportation, protection of marine ecosystems, fisheries and aquaculture, and carbon storage on the seabed.

KEYWORDS *- Carbon Emissions, Maritime, Covid-19 Pandemic*

I. INTRODUCTION

The recent corona virus (COVID-19) pandemic resulted in on of the worst global crises since World War II. Because, nearly 100 million people have been infected worldwide, and more than 2 million have died from the disease, where it affects not only humans but also the world trade system, which expected to fall between 13 until 32% in 2020 as the COVID-19 pandemic, and causes a decrease in the mobilization of shipping fleets. The reduction in global maritime mobility affects not only trade and the global economy, but also the environment, especially marine pollution and attacks by invasive species which are heavily affected by ship activity. In a recent International Maritime Organization (IMO) report that has been submitted to the Committee for the Protection Of the marine environment (MEPC), greenhouse gas (GHG) emissions from shipping –expressed in carbon dioxide equivalent (CO_2e)-increased 9,6% in 2007. 2018 with respect to 2012 and accounted for 2,89% of global anthropogenic emissions, with container and bulk shipments accounting for the majority of total emissions. This has also attracted great attention in the scientific community in linking COVID-19 with the aquatic environment (Millefiori, 2021).

Meanwhile, to ensure the reduction of carbon levels in the Covid-19 pandemic, there is a need for discussion in designing appropriate national and international governance frameworks for ocean-based carbon removal approaches which will later become an important prerequisite before being scaled up. International legal frameworks for the ocean, such as the *United Nations Conventions on The Law Of The Sea* and *The London Conventions and Protocol*, predate the concepts of ocean carbon dioxide removal. As a result, this framework is retroactively applied to ocean carbon removal approaches, leading to differing interpretations and a lack of clarity in some cases. Some legal expert have suggested amending existing legal instrument to more directly regulate ocean carbon removal, including carbon removal in ongoing negotiations for new international

treaties or shifting governance to another international body, where strong environmental safeguards, including transparent monitoring and reporting should also be in place. Finally, ocean carbon removal approaches should not move forward without first considering the impact on local communities and indigenous peoples. Public acceptance of potential trials and impacts on coastal communities must be also be prerequisites for moving forward on a large scale (Lebling,2020).

Meanwhile, on the national framework, especially Indonesia in reducing carbon emissions. Currently, Indonesia is focusing on implementing its commitment to reduce carbon emissions by up to 29 percent by 2030, both on land at sea. From the marine sector, this commitment will be carried out through the movement to implement *green* ports throughout Indonesia. The transitions to *green port* will be implemented as soon as possible. The commitment to reduce emissions was also conveyed by the President of the Republic of Indonesia, Joko Widodo while attending in *26th United Nations Climate Change Conference* (COP26) which took place in Glasgow. The promise made by Indonesia at COP21 which took place in Paris, France, in 2015, stated that the Government of Indonesia would reduce emissions by 29% with national support in the period 2020-2030 and or 41% with international support. Also, implementing an increase in unconditional commitments is greater than 26 percent compared to 2010 (Ambari,2021).

The issue of carbon reduction is an important issue for Indonesia, because the problem will not only affect Indonesia but also the whole world. In this paper, the author will describe the efforts that have been made domestically in reducing marine carbon emissions and Indonesia's level of readiness to reduce carbon in Indonesian waters. In general, the systematic discussion of this paper includes *Ocean Based Mitigation* approach. At the end, a general conclusions will be given regarding the level of readiness of Indonesia.

II. LITERATURE REVIEW

The research method used in this study is evaluative research. Evaluative research is a research activity that evaluates an activity/program that aims to measure the success of an activity/program and determine the success of a program and whether it is as expected (Kantun, 2017). To study further about reducing carbon emissions in waters, the author uses of the *Ocean Based Mitigation* approach which is an approach from the results of the *High Level Panel Discussions for a Sustainable Ocean Economy* which has been established since 2018. This *Ocean Based Mitigation* covers five areas to be reviewed, namely 1. *Ocean based renewable energy;* 2. *Ocean Based transport;* 3. *Coastal and Marine Ecosystems;* 4. *Fisheries, Aquaculture, and Dietary;* 5. *Carbon Storage in The Seabed.*

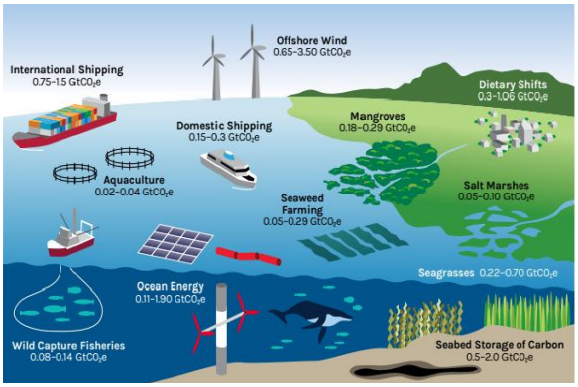

Figure 1. Areas in *Ocean Based Mitigations*
Sources : *Guldberg, H* (2019

Within each area, this report assesses a range of individual mitigations options that can be made, as technology and policy developments are needed to advance implementation. (Guldberg, 2019).
Based on the *Ocean Global Mitigation* approach, Indonesia also needs to meet existing requirements, so that significant reductions in carbon emissions can be take in the future. Indonesia efforts that have been committed

in terms of carbon reduction at the Climate Change Conference (COP26) have become an effort although their implementation still needs to be addressed. In the future, if this approach can be applied, it is hoped that Indonesia will also be able to contribute in reducing global carbon emissions.

Table 1. Mitigation Options in Five Ocean-Based Climate Action Areas

Action Area	Mitigation Option	Description
Ocean Based Renewable Energy	Increasing Offshore Wind Utilization	Fixed or floating offshore turbine installation
	Increasing Ocean Energy Utilization	Energy is absorbed from ocean waves, currents, tides, salinity and temperature differences. Solar energy wih floating *photovoltaic*.
Ocean Based Transport	Reducing emissions from Domestic Shipping	Following the IMO definition of shipping between ports within the country; including ferry
	Reducing emissions from international shipping	Following the IMO definition of shipping between ports between countries. International shipping does not include military, fishing vessels; including mass carriers, tankers and container ships.
Coastal and marine ecosystem	Restorations of mangroves, swaps and seagrass beds	The absorption potential is derived from the restoration of lost and degraded coastal ecosystem. Coastal wetland systems include mangrove, salt marshes, and seagrass beds, plus conservation and restoration of *adaject* islands, coral reefs and mudflats to slow coastal wetland erosion.
	Avoid anthropogenic loss and degradation of mangroves, salt marshes and seagrass beds	Prevents the release of sequesterd carbon in soil and costal wetlands vegetation by protecting the ecosystems and avoiding further degradation.
	Increase seaweed production by cultivation	Potential absoption through seaweed cultivation, especially through the cultivation of seaweed products that replace other products with a higher GHG footprint or new applications with no or minimal footprints
	Restoration and protections of seaweed habitat	Absorption potential from restoring degraded (and protecting) intact seaweed habitat
	End overexploitation of marine biomass to support biodiversity recovery and increase biomass	The role of marine mammals and fish stocks in the marine carbon cycle, including mortality and sinking to the ocean floor
Fisheries, Aquaculture, and dietary shifts	Reducing emissions from fishing vessels	Emissions from the use of gasoline for inland, coastal and deep sea fisheries
	Reducing emissions for cultivation	Life cycle emissions from aquaculture (new feed to replace fish meal)
	Increase the portion of sea-based protein	Switching emissions-intensive land-based protein sources (mainly beef and lamb) to low carbon marine based protein sources
Carbon storage in the Seabed	Carbon dioxide storage on the ocean floor	Offshore geological storage of captured carbon dioxide on the ocean floor..

Sumber : Guldberg (2019)

III. RESEARCH METHODS

In analyzing Indonesia's readiness to carry out decarbonization in water areas, the indicators also refers to Guldberg (2019). Which is listed in the following table:

Table 2. Indicator of The Impact of Marine Mitigation On Environmental Change

Area	Confidence Level		
	Low	**Medium**	**High**
Renewable Energy	Based Expansions of Renewable Marine energy has potential to promote gender equality	• Ocean-based renewable energy will have a positive impact on reducing water use compared to fossil fuel-based technologies • Replacing fossil fuels with marine-based renewable energy contributes to positive health outcomes	• Effective marine spatial planning, with the advent of combined marine energy technologies, will be effective in reducing the loss of biodiversity from the ocean • Expansion of marine based renewable energy leads to job creation and economic growth • Opportunities for innovation are expected to emerge by expanding clean ocean energy, promoting scientific research and resulting in increased technological capabilities
Water Transportation		• Reducing emissions from shipping vessels will help reduce ocean acidification • Reducing emissions from shipping has the potential to have a marginal impact on prices of internationally traded commodities	• Cleaner ocean shipping fuel will amplify positive human health outcomes • Mitigation options to reduce emissions from shipping can encourage innovation and upgrade the sector's technological capabilities
Coastal and Marine Ecosystem	• Seaweed production can create jobs, economic growth, and increase research. It has a potential role in providing affordable	• Integration of social and gender considerations into restoration policies for coastal habitat vegetation can promote	• Coastal and vegetated habitats (*Blue carbon ecosystems*) contribute to climate change adaptation by increasing coastal

	energy • Mitigation options for rebuilding marine biomass can contribute to poverty • Mitigation options to rebuild marine biomass can also negatively impact poverty alleviation and employment targets, and can limit food progress.	gender equality and educational opportunities • Seaweed cultivation and wetland restoration strengthen capacity to meet food security targets. Healthy mangroves have a positive impact on the health of coastal communities through the provision of food and medicine to local residents	resilience and reducing the impact of sea level rise. • Vegetated coastal habitats offer high biodiversity benefits for terrestrial and marine ecosystems, including fisheries • Restoring and protecting coastal habitat vegetation has the potential to create jobs, promote economic growth, and enhance research and engaging small-scale fishers and local stakeholders throughout the decision-making process is critical to ensuring the dissemination of positive and net social outcomes • Seaweed farming has a low level of environmental risk identified for small-scale aquaculture projects
Fisheries and Cultivation		• Increasing feed conversion ratios and using plant-based ingredients in aquaculture feed instead of animal by-products to meet the demands of the demands of the rapidly growing aquaculture sector could potentially reduce water use	• Aquaculture can present many community and environmental challenges. Unplanned aquaculture expansions in some areas has had a negative impact on other coastal and terrestrial ecosystems. • Reducing the height levels of meat consumptions among some populations and substituting for a balance of sea-based

		proteins has positive human health benefits. • Mitigation options related to marine protein-based enhancement in fisheries and aquaculture will result in job creation and savings for households, and encourage technological innovation
Carbon Storage on the Seabed	Offshore investment in seabed storage can lead to job creation, economic growth, and innovation	There is great uncertainty regarding the environmental implications of marine carbon storage options

Source : Guldberg (2019)

The data used in this study comes from online literature studies obtained from 2020 to 2021 related to renewable energy, marine transportation, marine and coastal ecosystems, fisheries and aquaculture, and carbon storage on the seabed according to *Ocean Based Mitigation* description. The assessment was developed to reflect the robustness of the linkage score. The level of confidence from high to low is determined based on the level of evidence (number of studies and other articles) and the level of agreement with the evidence presented in the literature. For each linkage score, a confidence rating was assigned, in which an increase in the level of evidence and level of agreement correlated with increasing trust (Guldberg,2019).

IV. RESULT AND DISCUSSION

4.1. Utilization of Marine-Based Renewable Energy in Indonesia

According to the Center For Research and Development of Electricity Technology, New Renewable Energy and Energy Conservation (2021), based on Government Regulation No. 79 of 2014 concerning National Energy Policy, the target for new and renewable energy mix in 2025 is at least 23% and 31% in 2050. The target capacity of PLT-Angin (Wind Power Plant) in 2025 is 255 MW. Meanwhile, until 2020, PLT-Angin has only been installed around 135 MW with details of 75 MW in the Sidrap area and 60 MW in Janeponto area. Thus, the development of wind energy in Indonesia is still a national challenge. Availability of energy potential maps accurate wind energy in all regions of Indonesia is very necessary as the first step in identifying and selecting wind energy project sites. The map provides information on wind characteristics in various areas such as average wind speed, maximum, and minimum speed which can be converted into power density maps and annual energy maps (in kWh/ or W/m^2). This information is very useful as a basis for determining the location and selection of the right turbine technology. The provision of offshore wind energy potential data has a higher level of difficulty. This is due to several reasons, ranging from difficulties in building a strong foundation structure, power supply installation, data transfer to difficult maintenance if there is damage. This difficult causes offshore wind measurements to be much more expensive than onshore, even though high resolution offshore wind measurement data is very useful for accurate estimation of wind potential. One of the efforts to accelerate the utilization of wind resources, the ESDM Research and Development Agency through

P3TKEBTKE has developed a method for calculating wind energy potential by making a map of Indonesia's wind energy potential with a resolution of 5 km in 2016. In 2020, the map was updated by extending the model input period and then calculating Indonesia's onshore and offshore wind energy potential. Furthermore, to describe Indonesia's wind energy potential, the modeling results are displayed in onshore and offshore wind speed distribution maps, seasonal wind speed distribution maps, Wind Power Density (WPD) distribution maps, and annual energy production distribution maps (Annual Energy). Production/AEP). Model verification was carried out on the measurement data of 111 stations of the Meteorology, Climatology and Geophysics Agency (BMKG) and 11 measurement locations of the Geological and Marine Development Research Center (P3GL-KESDM).

Next on the utilization of marine energy. According to National Energy Council Member Herman Daniel Ibrahim regarding marine-based renewable energy, current data is based on the results of the P3GL study, Ocean Thermal Energy Conversion (OTEC) marine thermal energy technology has the potential to be developed in North Bali waters. In addition, currently the Directorate General of EBTKE KEESDM has also collaborated with AFD (France) to study the potential for the development of a pilot project for a marine current power plant in 2018 in the Lombok Strait, Sape Strait, and Toyopakeh Strait. Based on the results of bathymetry measurements in the field, further measurements are needed (but funding is constrained). Herman Darnel closed by saying that there is a need to accelerate strategic programs to develop new and renewable energy in the future. Then the Director of ANEKA, Ministry of Energy and Mineral Resources Chrisnawan Anditya said the NRE mix in 2020 was 11.2% and was targeted for 2030 at 28%, besides that the contribution to reducing GHG emissions in 2020 was 64.36 million tons CO2e and in 2030 it was 314 million tons CO2e. Emission reductions are driven through the following actions, including: providing electricity through NRE plants, implementing energy efficiency, using Biofuels (BBN) and implementing biomass co-firing to reduce coal power plant consumption. Currently the development of marine energy in Indonesia is still in the research and development stage, one of which is a Feasibility study on ocean current technology in the Alas Strait (between Lombok and Sumbawa Island), Sape Strait (between Sumbawa and Komodo Island) and the Pantar Strait (between Pantar Island). and P. Alor) carried out by Balitbang ESDM. In addition, the current Government has also regulated the selling price of electricity from Marine Power Plants in the Minister of Energy and Mineral Resources Regulation Number 50 of 2017 (National Energy Council, 2021).

4.2. Regulation of Maritime Transport Emissions in Indonesia

In connection with the regulation of sea shipping emissions in Indonesia. Currently, according to the Coordinating Ministry for Maritime Affairs and Investment (2021), at the national level the regulation is stated in SE No. 35 of 2019 the Director General of Hubla of the Ministry of Transportation concerning the Obligation to Use Low Sulfur Fuel and the Prohibition of Transporting or Carrying Fuel that Does not Meet the Requirements and Waste Management. Exhaust Gas Recirculation From Ships. In SE Number 35 of 2019, it is stated that Indonesianflagged vessels and foreign-flagged vessels operating in Indonesian waters are required to use fuel with a sulfur content of a maximum value of 0.5% m/m. In addition to supporting Decarbonizing Shipping and Port, Deputy Basilio assessed that encouraging ships to use Low Sulfur Marine Fuel Oil (LS MFO) can also increase revenue for the country if Indonesia can sell LS MFO to passing ships. Regarding the readiness of Bunkering Low Sulfur Marine Fuel Oil in Indonesia, Pertamina has launched low sulfur MFO ship fuel and has signed a Memorandum of Understanding (MoU) between PT Krakatau Bandar Samudera (Krakatau International Port/KIP) and PT Patra Niaga Pertamina on August 4 2021. The first sale of *Bunkering Low Sulfur Marine Fuel Oil* (LS MFO) has also been carried out at KIP Cilegon Pier on 27 August 2021 to foreign vessels MV. Alona has a Cyprus flag amounting to 160 MT or the equivalent of 175,000 liters of LS MFO. Furthermore, the regulation of emissions on shipping vessels has been regulated in PP No. 31 of 2021 regarding shipping in article 132 in paragraph 1 which reads "Every ship is obliged to use fuel with a maximum sulfur content of 0.5% m/m", while for foreign ships it is regulated in paragraph 2 which reads "Foreign ships that still

use fuel with a sulfur content of more than 0.5% m/m must be equipped with an exhaust gas cleaning system approved by the government of the ship country".

4.3. Marine Ecosystem Management in Indonesia

Coastal ecosystems in Indonesia, especially mangroves, seagrass beds and brackish swamp areas have enormous potential for blue carbon reserves, namely as natural carbon sinks and stores whose capacity exceeds mainland tropical forests (Anugrah, 2021). Mangroves are distributed in tropical and subtropical parts of the earth. The total accumulated area of mangroves in the two climate areas is about 18 million hectares. Of this number, Indonesia ranks first as the country with the largest mangrove area, which is about 3.311 million hectares or about 25 percent of the world's total mangrove area, followed by Brazil at around 8 percent and Australia at 7 percent. In Indonesia, mangroves are not evenly distributed along 95,000 kilometers of coastline. The center of Indonesia's mangrove ecosystem is in Tanah Papua with Papua Province being the site of the largest mangrove forest, namely 1,634,041 hectares and West Papua Province 473,059 hectares (Putra, 2021). In restoring this mangrove, the government is committed to continuing to restore the mangrove area. From the critical land area of 637 thousand hectares (ha), an area of 17 thousand hectares has been restored last year. Meanwhile, Minister of Environment and Forestry Siti Nurbaya in the National Mangrove Management Coordination Meeting, Thursday (11/2/2021), explained the plan for mangrove rehabilitation in 2021 covering an area of 124 thousand ha (20%). It will be continued in 2022 covering an area of 155 thousand ha (25%), 2023 covering an area of 155 thousand ha (25%), and in 2024 an area of 187 thousand ha (30%). This big work, of course, requires big financial support. The mangrove rehabilitation fund from the 2021 State Budget only covers an area of 1,250 hectares. Therefore, it is necessary to expand the budget aspect through international cooperation such as foreign grants that are synergized across ministries and agencies. Then, currently there is support from the German Kreditanstalt für Wiederaufbau (KfW) cooperation and the Ministry of Environment and Forestry worth 20 million euros. There is also assistance from the World Bank through the Ministry of Maritime Affairs and Fisheries (KKP) which is still being discussed with Bappenas worth more than USD200 million.

Efforts to accelerate implementation have been carried out by the government, including the establishment *Badan Restorasi Gambut dan Mangrove* (BRGM). Mangrove rehabilitation will be focused on nine provinces covering an area of 600 thousand ha, namely North Sumatra, Riau, Riau Islands, Bangka Belitung, West Kalimantan, East Kalimantan, North Kalimantan, Papua and West Papua. Currently, the government continues to collaborate with universities, NGOs to carry out research and applied studies on mangroves. KLHK (Minister of Environment and Forestry) and KKP (Minister of Marine and Fisheries) have also pioneered the construction of modern nurseries and World Mangrove Centers in Java and Kalimantan. Furthermore, the government is reviewing mangrove seed nurseries through a coastal village labor-intensive program using the Village Fund. For one thing, Indonesia has also succeeded in getting financial support and cooperation in reducing greenhouse gas (GHG) emissions through the Reducing Emissions from Deforestation and Forest Degradation (REDD+) mechanism with several international parties. Indonesia has received a REDD+ Result Based Payment (RBP) funding commitment from Norway which is a payment for the performance of reducing GHG emissions from REDD+ activities for the 2016-2017 period of 11.23 million tons of CO_2eq (carbon equivalent), with a value of USD56 million.

Meanwhile, the *RBP Green Climate Fund* was awarded for the performance of reducing GHG emissions from REDD+ activities for the 2014-2016 period of 20.3 million tons of CO2eq with a value of USD103.8 million. Furthermore, the RBP from the World Bank 's Forest Carbon Partnership Facilities-Carbon Fund collaboration in East Kalimantan Province was given for the performance of reducing GHG emissions from REDD+ activities of 22 million tons of CO2eq with a value of USD110 million for three payment stages between 2021-2025. All funds from international cooperation commitments are managed by the Environmental Fund Management Agency (BPDLH). RBP funds from several international collaborations were directed at strengthening mitigation actions to reduce emissions in the field, such as for mangrove and peat restoration

(Wisnubroto, 2021). In addition to funding, the Indonesian government has sought to improve mangrove protection, for example by introducing spatial plans, a system for resolving land use conflicts and balancing environmental and economic considerations by establishing zones for special uses. The Government has also made substantial progress in expanding Marine Protected Areas to more than 23 million (worldbank, 2021), which is currently regulated in Law No. 26 of 2007 on Spatial Planning (UU PR). Therefore, the function of the mangrove forest area will later be included in the space allocation that has been determined in the Regional Spatial Plan (RTRW). The PR Law itself in its implementation separates the regulation of sea and air space in different laws. Based on these provisions, the Law on the Management of Coastal Areas and Small Islands (UU PWP3K) was formed . The scope of the regulation includes a transitional area between land and sea ecosystems that are affected by changes on land and sea, with a landward division that covers the sub-district administration area and a seaward as far as 12 nautical miles measured from the coastline. The regulation area of the PWP3K Law is a place for the growth and development of mangrove forests (Ervita, 2021).

Then, in terms of efforts to meet decarbonization other than mangroves, an important commodity that plays a very important role is seaweed. In its development, according to the Ministry of Maritime Affairs and Fisheries, Director General of Aquaculture, Tb Haeru Rahayu, the government will start building seaweed cultivation villages in Eastern Indonesia. This is done as an effort to develop one of the leading commodities of the aquaculture sub-sector. The government intervened by building new land in the form of seaweed villages which are projected to be built starting next year in Southeast Maluku and East Sumba. This breakthrough program includes the development of aquaculture for export supported by marine and fishery research as well as the development of freshwater, brackish and marine aquaculture villages based on local wisdom. Meanwhile, to achieve the target of seaweed production which is projected to increase from 9.78 million tons in 2019 to 12.3 million tons in 2024, KKP has designed a work plan through extensification and intensification of cultivated land, both by increasing productivity and opening new land. Tebe assessed that the collaboration that the Ministry had built with the Kalimajari Foundation by applying technological assistance to cultivators in NTT, Papua and West Papua had been able to encourage partnerships to increase research and production of seaweed seeds. This, he said, was a very important part as a form of participation in the development of Indonesian seaweed cultivation, especially in the eastern region (Prophecy, 2021). As for increasing the use of seaweed in Indonesia, the government has taken serious steps in developing the national seaweed industry through Presidential Decree 33/2019. Steps to strengthen the national seaweed industry are implemented in several programs, including research on the development of new types (species and/or varieties) cultivation, technological innovation of semifinished products and final products, as well as national and global seaweed product markets. Not only for food, currently seaweed has developed its use as a raw material for making capsule shells in the pharmaceutical sector (Directorate General of Strengthening and Competitiveness of Marine and Fishery Products, 2021). Finally, in terms of protection from the threat of overexploitation, starting January 2022, the Ministry of Maritime Affairs and Fisheries will implement a measured fishing policy. In the future, fishing will no longer be free, aka there is a quota arrangement. This policy will regulate a number of arrangements, including regulation of fishing areas, the number of fish caught, and the number of vessels that can make fishing. Quota-based scalable fishing is given to industry, traditional fishermen, and hobby or fishing tourism. For industry, use the open auction method at several investors per capture zone. The KKP also projects that if this policy is successfully implemented in a State Fisheries Management Area of the Republic of Indonesia (WPPNRI), it can generate hundreds of trillions of rupiah. For industrial quotas in this measured fishing policy, investors may apply for quotas that have been determined by the KKP based on the analysis results from the study of the National Commission for the Study of Fish Resources (Komnas Kajiskan) (Jelita, 2021)

4.4. Capture and Aquaculture Emission Management in Indonesia

In terms of reducing emissions from capture fisheries in Indonesia, several ideas are currently being developed from the government. For example, replacing fishing vessels based on fossil energy to be replaced

with electric power. The Minister of Maritime Affairs and Fisheries, Sakti Wahyu Trenggono, is exploring the potential of using electric boat innovations for capture fisheries to support the blue economy principle. This was revealed by Minister Trenggono when he tested the Ellen ferry which served the crossing route from Sonderborg to Aeroskobing, Denmark and saw the ship's battery recharging facility, accompanied by the Ambassador of the Republic of Indonesia to the Kingdom of Denmark and the Republic of Lithuania Dewi Savitri Wahab, Thursday (28/10/ 2021). The ship on board applies the principles of being environmentally friendly and energy efficient with electric power (Ariesta, 2021). Then efforts to reduce carbon emissions in the aquaculture sector, things that need to be considered are the need for replacement of fish feed that does not use fish meal or fish oil. This also has an impact because these components are supporters that can contribute to increasing emissions. Therefore, it is necessary to make efforts to change materials and policies so that the output is more tangible. Currently, several efforts are being made by Indonesia to reduce dependence on fish meal or oil among the use of natural feeds, including using maggot. According to the explanation from the Directorate General of Cultivation of the Ministry of Maritime Affairs and Fisheries at the IPB webinar (16/03/2021), the government's support in cultivating maggot as a substitute for fish meal is government assistance with 1 pilot package of maggot cultivation in the community with a capacity for processing organic waste of 2.5 tons per year. days, development of 1 package for industrial scale maggot cultivation at the UPT Directorate General of Aquaculture in 2020 and 1 package in Mandiangin, South Kalimantan in 2021, Development of integrated maggot cultivation system with fish cultivators, preparation of technical guidelines for maggot cultivation for fish cultivation, location setting and development of maggot cultivation areas with a cluster system, and policies that are integrated with the main related parties of the environmental service and the ministry of LHK and related stakeholders in the utilization of organic waste (Directorate General of Aquaculture, 2021). Furthermore, in terms of cultivation development, the Indonesian government for the next 5 years will build a pond area through cluster models. The principle of the shrimp cultivation cluster itself is the management of shrimp cultivation in one area with technical management and jointly managed businesses with the aim of minimizing failure and increasing productivity, while remaining friendly to the environment. In the future this shrimp pond area can be integrated with the silvofishery concept. With silvofishery in the future, it is possible to develop aquaculture using controlled traditional polyculture methods, namely polyculture with white snapper, saline tilapia and seaweed strengthen the existence of mangroves as a barrier that maintains the environment so that it can be sustainable (Directorate General of Aquaculture, 2020).

4.5. Management of Carbon Gas Storage on The Seabed

The Ministry of Energy and Mineral Resources (ESDM) re-emphasizes the commitment of the Indonesian government to optimize the contribution of fuel use in reducing CO_2 emissions by up to 29% by 2030. This effort will be immediately taken, one of which is by implementing Carbon Capture, Utilization, and Storage (CCUS) in oil and gas sector. Currently, the Government is formulating regulations related to carbon pricing. The draft regulation is currently in the finalization stage at the State Secretariat. Not only that, the Government is also continuing the process of drafting regulations related to CCS/CCUS which was previously initiated by the Center of Excellence CCS/CCUS and supported by the Asian Development Bank (ADB). In addition, there are several studies related to CCUS being carried out in Indonesia, namely the CCUS Gundih project which was originally a CCS project and has been carried out since 2012. Then, other CCUS projects and studies are Tangguh EGR in West Papua, Sukowati in East Java, Limau Niru in South Sumatra and so on. In fact, CCUS studies connected to downstream industries will soon begin, such as how to separate CO_2 from an ammonia plant in Central Sulawesi (Endarwati, 2021). In addition, in terms of implementing CCUS in the future, SKK Migas has approved the Plan Of Development (POD) launched by BP and its tough partners for the development of the next stage of the Tangguh LNG project, namely the Ubadari Field and Vorwata Carbon Capture Utlization and Storage (CCUS) in West Papua, Indonesia. The development of the Ubadari field is an accelerated step after going through a successful appraisal program and will be produced through an unmanned installation connected by an offshore pipeline to the Tangguh LNG facility, which in the future is estimated to

add 1.3 trillion cubic feet of gas potential. Meanwhile, the Vorwata CCUS development will re-inject around 25 million tons of CO_2 into the Vorwata reservoir to reduce most of the carbon emissions and provide additional gas production through Enhanced Gas Recovery (EGR). This is because the CO2 injection will reduce up to 90% of CO2 from the reservoir which is currently released into the air, or almost half of Tangguh LNG's emissions. The Tangguh Expansion Project, including the construction of Train 3 has been mentioned as one of the National Strategic Projects by the Government of Indonesia (Alkalis, 2021).

4.6. Analysis of Indonesia's Readiness in Efforts to Decarbonize Waters Area

When referring to the Guldberg indicator, some of Indonesia's previous efforts which were in the description, were analyzed and scored which are presented in the form of a table as follows:

Table 3. Matrix of readiness for decarbonization of water areas in Indonesia

Area	Confidence Level		
	Low	**Medium**	**High**
Renewable Energy			The development of marine energy in Indonesia is still in the research and development stage, one of which is a feasibility study on ocean currents technology in the Alas Strait (between Lombok and Sumbawa Island), Sape Strait (between Sumbawa and Komodo Island) and the Pantar Strait (between Pantar Island and North Sumatra). . Alor) conducted by Balitbang ESDM
Water Transportation		Emission regulation on shipping vessels has been regulated in PP Number 31 of 2021 regarding shipping in article 132 in paragraph 1 which reads "Every ship is required to use fuel with a maximum sulfur content of 0.5% m/m.	
Coastal and Marine Ecosystem	The government intervened by building new land in the form of seaweed villages which are projected to be built starting next year in Southeast Maluku and		The Indonesian government in protecting coastal habitats has implemented it through the establishment "*Badan Restorasi Gambut dan Mangrove"* (BRGM).

	East Sumba. This breakthrough program includes the development of aquaculture for export supported by marine and fishery research as well as the development of freshwater, brackish and marine aquaculture villages based on local wisdom.		Mangrove rehabilitation will be focused on nine provinces covering an area of 600 thousand ha, namely North Sumatra, Riau, Riau Islands, Bangka Belitung, West Kalimantan, East Kalimantan, North Kalimantan, Papua and West Papua. Currently, the government continues to collaborate with universities, NGOs to carry out research and applied studies on mangroves. In addition to funding, the Indonesian government has sought to improve mangrove protection, for example by introducing spatial plans, a system for resolving land use conflicts and balancing environmental and economic considerations by establishing zones for special uses.
Fisheries and Cultivation		Efforts made by Indonesia in reducing dependence on fish meal or oil among the use of natural feed, including using maggot	Development of an integrated maggot cultivation system with fish cultivators, preparation of technical guidelines for maggot cultivation for fish cultivation, location regulation and development of maggot cultivation areas with a cluster system, and policies that are integrated with the main relevant parties, the environmental service and the Ministry of Environment and Forestry and related stakeholders in the

			utilization of waste waste. organic. The Indonesian government in the next 5 years will build a silvofishery system in pond areas that will incorporate fish cultivation and strengthen the existence of mangroves as coastal resilience.
Carbon Storage on seabed	*SKK Migas* has approved the Plan Of Development (POD) launched by BP and its tough partners for the development of the next phase of the Tangguh LNG project, namely the Ubadari Field and Vorwata Carbon Capture Utlization and Storage (CCUS) in West Papua, Indonesia. The development of the Ubadari field is an accelerated step after going through a successful appraisal program and will be produced through an unmanned installation connected to an offshore pipeline to the Tangguh LNG facility, which in the future is estimated to add 1.3 trillion cubic feet of gas potential.		
Amount	**2**	**2**	**3**
Percentage(%)	**28%**	**28%**	**44%**

Source : Data Analysis

4.7. Discussion

From the results obtained, in the area of renewable energy Indonesia's efforts get a high score, because the Indonesian government has started to develop research and development for feasibility studies of ocean currents technology in the Alas Strait (between Lombok and Sumbawa Island), Sape Strait (between Sumbawa and Komodo Island)) and the Pantar Strait (between Pantar Island and Alor Island) which have been carried out by the ESDM Balitbang. This has also been included in Guldberg's high indicators, namely opportunities for innovation are expected to arise by expanding clean ocean energy, promoting scientific research and resulting in increased technological capabilities.

Then in the sea transportation area, the Indonesian government's efforts get a moderate score, because Indonesia is currently still focusing on fuel regulation, namely by regulating the use of 0.5% sulfur content in marine transportation fuel. If Indonesia wants to get a high score, in the future Indonesia also needs to make new innovations for environmentally friendly technologies, especially fuel for sea transportation. This medium category also refers to the Guldberg indicator that reducing emissions from shipping vessels will help reduce ocean acidification and also to the indicator that reducing emissions from shipping has the potential to have a marginal impact on the prices of internationally traded commodities, which means that the Indonesian government is still focused on regulating fossil fuels. without any policy efforts to change policies to environmentally friendly fuels, it is estimated that this will also affect world commodity prices because shipping companies have to bear the cost of fuel in accordance with government regulations.

Furthermore, in the marine ecosystem area, Indonesia gets two values, namely low and high values. The low value is due to the fact that currently Indonesia is still starting to develop seaweed commodities as raw material for export and economic development for coastal communities. This is also included in the Guldberg indicator, namely seaweed production can create jobs, economic growth, and increase research and has a potential role in providing affordable energy. So that in the future, if Indonesia wants to be ready to face decarbonization, based on the Guldberg indicator, the environment for seaweed cultivation commodities needs to be sterilized from risks such as exploitation activities so that this seaweed can function optimally for carbon sequestration. On the other hand, Indonesia's efforts have also received high marks, namely by carrying out activities to restore mangroves on the coast. The implementation is by establishing a Peat and Mangrove Restoration Agency which in the future the protection process will involve universities, NGOs and fishermen. In addition to funding, the Indonesian government has made efforts to improve mangrove protection, for example by introducing spatial plans, a system to resolve land use conflicts and balance environmental and economic considerations by establishing zones for special uses. This is also included in the Guldberg indicator, namely restoration efforts that seek to increase coastal resilience and also the impact of rising sea levels and strengthen the economy of communities in coastal areas.

Then in the area of fisheries and aquaculture, Indonesia currently, based on the Guldberg indicator, gets two values, namely medium and high values. In the medium value, because Indonesia is currently using maggot in an effort to convert from fish meal and fish oil to fish culture feed. Therefore, if Indonesia seeks to increase readiness in this sector, then Indonesia also needs to look for alternatives other than the use of animals, according to Guldberg, feed substitution can use seaweed because it has a more positive impact on using less water. In addition to getting a medium score, Indonesia's efforts got a high score because Indonesia has attempted to integrate aquaculture ponds with mangroves to increase coastal resilience with a cluster model. In addition, integration efforts were carried out, especially with the environmental service and the Ministry of Environment and Forestry as well as related stakeholders. So that this is also included in the high category of Guldberg, namely the unplanned expansion of aquaculture in several areas has had a negative impact on coastal and other terrestrial ecosystems, because Indonesia has integrated into the pond area, it is expected to have a positive impact on the coastal ecosystem of the pond area.

Finally, on carbon storage on the seabed, Indonesia is currently in the low category because Indonesia is more intensive in investing in carbon storage on an ongoing basis. This is also included in the Guldberg indicator, namely offshore investment in seabed storage can lead to job creation, economic growth, and innovation. But in Guldberg's explanation, carbon storage in the sea is not too significant in reducing carbon, because even though carbon has been entered into the seabed, this carbon can still come out and can pollute marine ecosystems. So this activity needs to be closely monitored so that the negative effects can still be controlled.

V. CONCLUSION

In this assessment, the highest indicator is a determinant that the country is ready to face decarbonization. From the amount obtained, Indonesia's readiness has only reached 44% for decarbonization in water areas. This acquisition is still a process, so that in the future other areas need improvement, namely in the

area of marine transportation, protection of marine ecosystems, fisheries and aquaculture, and carbon storage on the seabed.

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