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Research Article

Mangrove Cultivation Method in Rembang Powerplant as an ABCDE (Abrasion, Biodiversity, Carbon Stock, Deforestation and Emissions) Solution

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Abstract: PT PLN Nusantara UP Rembang is a powerplant produces Greenhouse Gas (GHG) emissions, seeking to increase the amount of CO2 absorbtion by increasing the Open Green Space Area. GeHa Apung (Green House Float) is an anti-failure method of mangrove cultivation that is specifically made in the sea by utilizing the tides of seawater so that water needs are met and seeds are more adaptive. The roof of GeHa Apung uses a top cover that is placed in the middle zone because the paranet regulates the level of sunlight so as to reduce pest attacks and protect the seedlings from garbage. The GeHa Apung foundation uses rigid and hollow tetrapod by utilizing fly ash and bottom ash waste. The frame uses wood and bamboo waste so that it is safe from waves. With the innovation of GeHa apung, the planting success rate produced is 60-80%. GeHa Apung has succeeded in cultivating mangrove seedlings with a planting success rate of 77.9%, reducing the level of coastal abrasion at the Rembang coal-fired power plant by 1 cm from 2022 to 2023, increasing the biodiversity index (H') from 1,66 (in 2022) to 1.68 (in 2023), mangrove carbon stock/blue carbon by 2,308. 31 ton of CO2, mangrove growth rate of about 7 cm within 5 years can be known to have carbon absorption in 2033 of 2.66% of total coal-fired power plant emissions Rembang in 2023, increasing green Open Space Area in the Rembang PLTU Area through mangrove afforestation by 1.1%, successfully absorbing CO2 of 623.44 tons of CO2 or 0.015% of the GHG emissions generation of PLTU Rembang in 2023 and supporting the acquisition of Gold PROPER points for PT PLN Nusantara Power UP Rembang in terms of biodiversity by 1.54% and contribution to NZE Moonshot or Growth Moonshot.

Keywords: powerplant; mangrove; carbon stock; emissions; tetrapod; biodiversity; abrasion; deforestation

1. Introduction

PT PLN Nusantara Power UP Rembang is a power plant unit enganged in the field of Steam Power Plant with coal fuel with a capacity of 2 X 315 MW. The burning of coal in the electricity production process at the Rembang coal-fired power plant produces emissions. This fuel burning process is a source of immobile emissions, namely the Chimney Boiler Unit 10 and Unit 20 which emit GHG (Grenhouse Gas) gases in the form of CO2, CH4 and N2O. Efforts to reduce the concentration of GHGs in the atmosphere, namely the amount of CO2 released into the air, must be controlled by increasing the amount of CO2 absorbtion such as

increasing open green space areas, so as to reduce CO2 emissions as low as possible. The reduction of GHG emissions is mainly supported by the forestry sector as a net sink carbon storage (Presidential Decree No. 90 Th 2021 Article 3 paraghraph 4) . [2]

During the 2021 – 2030 period, Indonesia is projected to experince an average of 359 thousand hectares/year of deforestation. In this regard, based on the Minister of Industry of the Republic of Indonesia No. 40 of 2016, industrial estates must have a green open space of at least 10% of the total area. The increase in green open space is in line with the increase in the company's biodiversity index. The problem at the Rembang PLTU from 2021 to 2022, the biodiversity index did not increase, which was 1.66. This is partly due to limited land on land and limited water for watering. Based on Master Plan for biodiversity conservation at PLTU Rembang, there is an area that has the potential for development, namely mangrove planting in the coastal area of PLTU Rembang.

Mangrove planting can also function as an abrasion barried in the Rembang PLTU area. Based on abrasion data on the coast of Rembang using satellite image data from Lansat 8 (2017 – 2023), abrasion data was obtained in the coastal area of Rembang of 0.85 meters/year. Meanwhile, from the results of the 2022 Rembang PLTU RKL RPL Monitoring Report, coastal abrasion data of the Rembang PLTU was obtained by 1 cm/year.

However, in the process of mangrove cultivation there are various problems related to cultivation methods. Several methods of cultivating mangroves on land and planting mangroves conventionally have been carried out at PLTU Rembang and have failed. Climate change conditions, abrasion and other environmental factors also affect the failure of mangrove planting at the Rembang Power Plant. The manufacture of breakwater from bamboo is considered less effective in anticipating these conditions. Therefore, it is necessary to innovate optimal cultivation methods so that the survival of mangrove plants can be maintained and remain sustainable to reduce the level of abrasion, increase the biodiversity index, mangrove carbon stock/blue carbon, afforestation through the increase of Green Open Space (RTH) and support the absorption of CO2 emissions.

2. Materials and methods

GeHa Apung is a mangrove cultivation method in Rembang powerplant as an ABCDE (abrasion, biodiversity, carbon stock, deforestation, emissions) solution. The caracteristics of mangrove plants are that they cannot be sumerged in water as a whole and cannot live without waterlogging [1]. According to Brown (1996), the carbon content in tree biomass is almost 40%. The capacity or saturation point of mangroves as carbin depletion can vary depending on a number of factors, such as the type of mangrove, environmental conditions, productivity levels, mangroves and their geographical location. Estimates of the carbon sequestration capacity of mangroves vary according to various studies and assessments. According to FAO (2007), the carbon sequestration capacity of mangroves is estimated to be 3 to 4 times more than terrestrial tropical forests per unit area. UNEP (United Nations Environment Programme) also states that mangroves are able to store significant amounts of carbin between 50 – 1000 tons of carbin per hectare according to their location and environmental conditions [4]. In this study, we conducted an analysis and suitability assessment of the mangrove to be planted at the Rembang coal-fired power plant, as shown in Fig 1.

Figure 1. Analysis of the suitablility of mangrove Seedlings at PLTU Rembang

GeHa Apung is a Green House that specialized in adjusting the charactgeristics of mangrove plants. Green houses are usually made on land, but this floating green house is in the sea using the tides of sea water so that water needs are met and seeds are more adaptive. Seedling is carried out in the same location as planting so that the seedlings are more adaptive and the planting succes rate is 60 – 80%. Ge Ha Apung is equipped with a paranet and placed in the middle zone because the paranet will regulate the level of heat/sunlight so that it can reduce pest attacks and be protected from garbage and sufficient water fulfillment as shown in Fig. 2 Design and implementation of GeHa Apung.

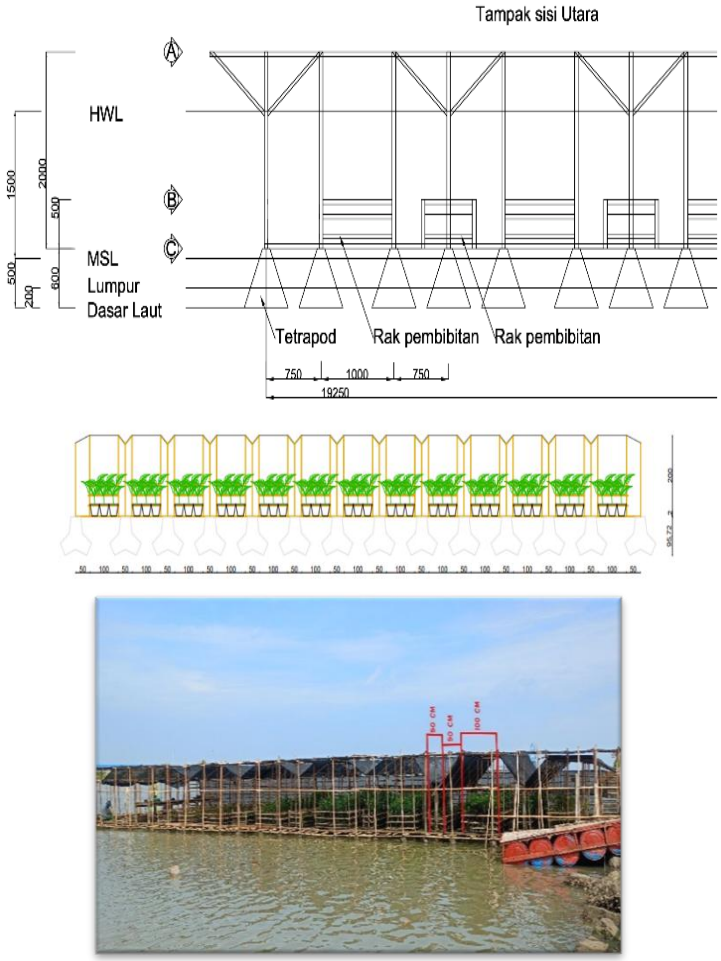


Figure 2. Design and implementation of GEHA Apung

The fondation of GeHa Apung uses tigid tetrapods and is given holes from the use of Fly Ash Ash waste, and wood from the use of wood waste so that it is safe from waves. A tetrapod with a special design is shown in Fig 3.

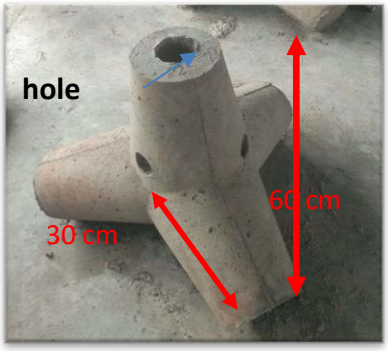


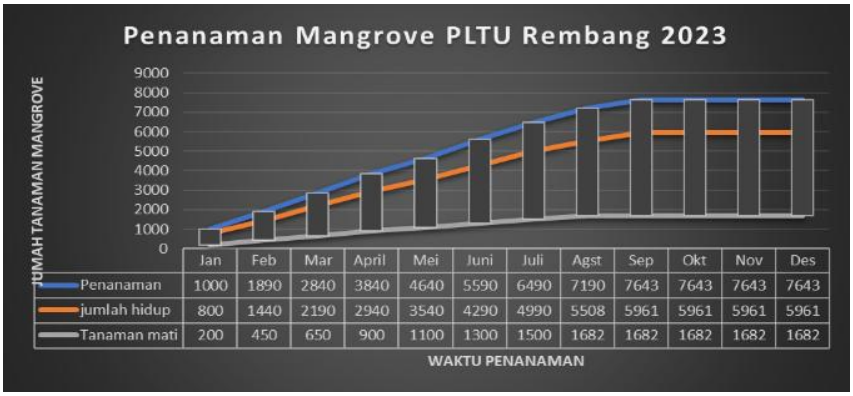
Figure 3. Tetrapods as the foundation of GEHA Apung

3. Results and discussion

GEHA Apung will be implemented in 2023 and provides benefits including :

3.1. Succes of Mangrove Cultivation

The mangrove plant seedlings that were successfully cultivated in GeHa Apung in 2023 amounted to 9,601 seedlings and 136 dead seedlings. In 2023, 7,643 seedlings were planted with a planting success rate of 77.9% or 5,961 seedlings successfully living in the waters of PLTU Rembang (The planting area is 0.6 Ha or equivalent to 1.1% of the total RTH area). The number of mangrove nurseries is influenced by the availability of mangrove seedlings in the mangrove forest area of the coal-fired power plant.



	Jan	Feb	Mar	April	Mei	Juni	Juli	Agst	Sep	Okt	Nov	Des
Penanaman	1000	1890	2840	3840	4640	5590	6490	7190	7643	7643	7643	7643
jumlah hidup	800	1440	2190	2940	3540	4290	4990	5508	5961	5961	5961	5961
Tanaman mati	200	450	650	900	1100	1300	1500	1682	1682	1682	1682	1682

Figure 4. Mangrove planting chart of Rembang Powerplant in 2023

Figure 4 is a graph of monitoring planting and the success rate of mangrove planting. In September – December was no planting due to extreme weather so it was not safe for personnel to plant. For dead plant seedlings to be planted, embroidery is carried out every month.

3.2. Abrasion

Based on the Monitoring Report RKL RPL PLTU Rembang, the abrasion data decreased from 2022 to 2023 by 1 cm/year. [3]

3.3. Mangrove Biodiversity Inventory

Based on inventory data conducted by the biodiversity research team, the mangroves of PLTU Rembang are dominated by Rhizopora mucronata, Rhizopora stylosa, Rhyzopora apiculata, Avicennia Marina, dan Sonneratia alba. Based on Table I below, the mangrove biodiversity index at the medium category, but the index value increased from 1.66 to 1.68.

Table 1. Mangrove Biodiversity of Rembang Powerplant

No	Mangrove Biodiversity	Pi	(-Pi. Lnpi)
1	Rhyzopora stylosa	0,20644	0,32571
2	Rhizopora mucronata	0,32630	0,36544
3	Rhizopora apiculata	0,11876	0,25303
4	Avicennia marina	0,15760	0,29120
5	Sonneratia alba	0,15538	0,28930
6	Bruguiera gymnorrhiza	0,02442	0,09065
7	Lumnitzera racemosa	0,00666	0,03337
8	Excoecaria agallocha	0,00222	0,01356
9	Ficus callosa	0,00222	0,01356
Species diversity index (H')			1.68
Species equality index (E)			0.76
Type wealth index (R)			1.18

3.4. Mangrove Carbon Stock/Blue Carbon

The method of measuring mangrove carbon stock/blue carbon uses the interpretation of landline image 8 and refers to SNI 7724:2011 and the Blue Carbon Initiative [4]. The spectrum of colors shown by mangroves is infrared light, this red color trends to be more intense than the red color shown by plants on land [5]. From the results of the analysis, it was obtained that Mangrove Carbon Stock/Blue Carbon amounted to 2,308.31 Tons of CO2 as shown in Fig.5

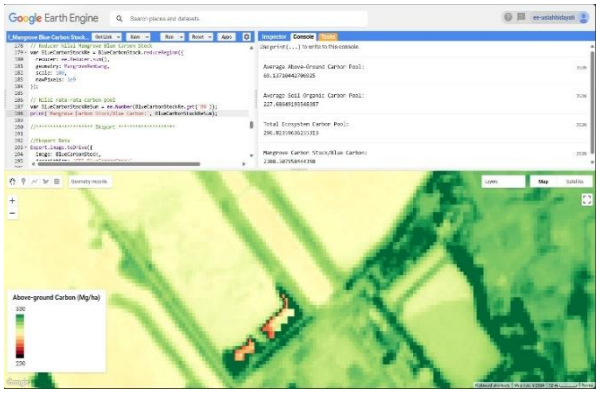


Figure 5. Analysis of Mangrove carbon stock/blue carbon PLTU Rembang

3.5. Mangrove Growth Rate

The diameter of mangroves with current conditions will increase by about 7 cm within 5 years. Fig. 6 below shows that when the mangrove has a diameter of 23.22 cm, the mangrove area of PT PLN Nusantara Power UP Rembang with its current condition is able to absorb 114,811.61 tons of CO2. This means that the mangrove area can absorb around 2.66% of the total carbon

dioxide (CO2) emissions in 2023 in 2033 when the mangrove reaches a diameter of 23.33 cm. The current absorption of mangroves compared to the absorption capacity of mangroves when the diameter reaches 23.33 cm has increased by 2.65%.

Figure 6. Projected graph of increased carbon sequestration

3.6. Aforestation through Increasing Green Open Space Area

Increasing Green Open Space in the Rembang PLTU area through mangrove afforestation of 0.6 Ha or equivalent to 1,1% of the total area powerplant (54Ha)

3.7. CO2 Emission Absorption

Based on the calculations of the Laboratory at the Rembang Power Plant from mangrove samples at the Rembang Power Plant, the total absorption of CO2 Emissions in the Mangrove Area of the Rembang Power Plant is 623,44 Ton CO2 as shown in Fig. 7

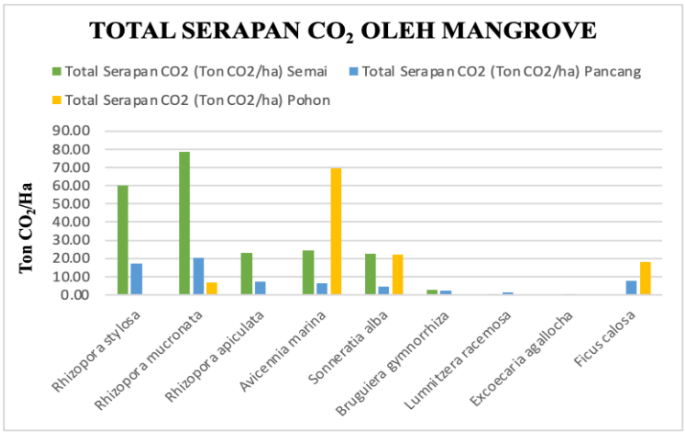


Figure 7. Total CO2 absorption by mangroves in the Rembang PLTU

4. Discussion

This GeHa apung can be disseminated in public area as an ABCDE (Abrasion, Biodiversity, Carbon Stock, Deforestation, Emission) solution as well as can be developed for ecotourism/ecoeducation of the community in general. Mangrove processed products can also be used to improve the community's economy. GeHa Apung so that it can be replicated in other PLN units because it has the potential to become a program beyond kWh, which is a new tourism potential. In addition, it is necessary to measure the index. In addition, the measurement of the biodiversity index in the GeHa Apung area is carried out, because it is not only a place for

mangrove cultivation, but also a new ecosystem for fauna around the waters of the Rembang power plant. It is better to prepare a master plan for mangrove areas by further improving the readiness of security and circulation routes if it is be developed into a tourist location in the GeHa Apung.

5. Conclusion

GeHa Apung has succeeded in cultivating 7643 mangrove seedlings in 2023 with a planting success rate of 77.9% or 5961 seedlings. Geha Apung has reduced the level of coastal abrasion at PLTU rembang from 2022 to 2023 by 1 cm/year. Geha Apung helped increase the biodiversity index (H') from 1.66 (year 2022) to 1.68 (year 2023). The potential for carbon and mangrove forest area of PLTU Rembang is 2,308.31 tons of CO2. The growth rate of mangrove is around 7 cm within 5 years so that it can be known that CO2 absorption in 2030 will be 2.66%.

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