

## HOW PT PERTAMINA AS AN INTEGRATED ENERGY COMPANY CAN SUPPORT THE CARBON MARKET

### I. INTRODUCTION

Carbon market has gaining traction since COP26, and the role of carbon market will be much more important in the future especially for hard-to-abate sectors such as energy intensive industries (integrated energy companies, oil & gas companies, cement & steel companies, etc). Carbon Market allow carbon emitters to offset their emission by purchasing carbon credit. Carbon offset credit are transferable and tradable instrument certified by governments and independent certification bodies. Based on UN Environment Programme, carbon offset defined as **“a reduction in emissions of carbon dioxide or greenhouse gasses made in order to compensate for or to offset an emission made elsewhere.”** Under the commitment to reach carbon neutrality, energy intensive companies use carbon offsets for their hard to abate emissions, such as LNG transport in oil & gas sector. However, there are potentials for energy intensive companies to not only become a buyer in the carbon market.

Energy companies could leverage their capabilities and competencies to develop carbon offset projects which could be categorized as sequestration projects (reducing emissions) and avoidance projects (avoiding emissions). For sequestration projects, energy companies can develop natural carbon sequestration such as NBS (Nature Based Solutions) or artificial sequestration such as Carbon Capture & Storage (CCS). While there are many avoidance projects that could be developed by energy companies such as developing solar panels, wind turbine, increasing energy efficiency, or providing biofuel for the transportation sector.

In this context, Pertamina as an Integrated Energy Company is currently also developing sequestration and avoidance projects by leveraging Indonesia comparative advantage such as, the 2nd largest tropical forest in the world, the home of 40% of world geothermal resources, one of global top producers of CPO (Crude Palm Oil), and one of global exporter of UCO (Used Cooking Oil). In addition, Pertamina also unlocking potential CCS/CCUS field in Indonesia. These projects not only can optimize economic value for Indonesia and increasing energy security for the nation, but also reduce emission and provide a better future for the world.

## II. CCS/CCUS

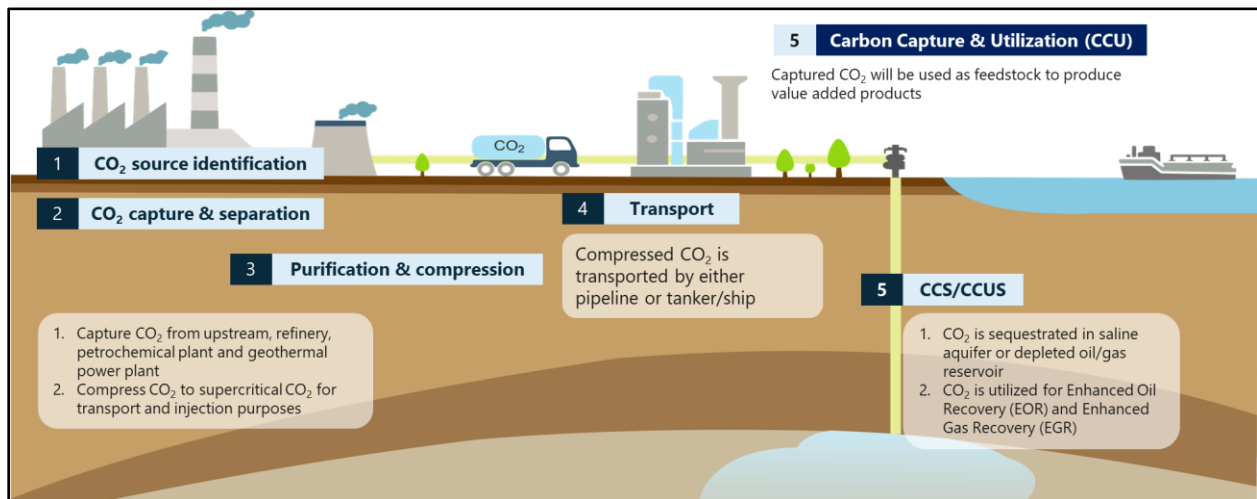
### II A. Value Chain

Global market for CCS/CCUS grows rapidly and requires advanced research, technologies & capacity building. Annual investment in South East Asia for CCUS reach approximately USD 1 billion, and there are many opportunities for CCUS in this region<sup>1</sup>.

CCUS has wide range of value chain as follows:

1. CO<sub>2</sub> source identification, including the concentration of CO<sub>2</sub> from flue gas;
2. CO<sub>2</sub> capture and separation, which identify the technology for capturing CO<sub>2</sub> and separation from upstream, refinery, petrochemical plant and geothermal power plant;
3. CO<sub>2</sub> compression to supercritical CO<sub>2</sub> for transport and injection purposes;
4. CO<sub>2</sub> Transport either by pipeline, tanker or ship;
5. And finally: CO<sub>2</sub> sequestration in saline aquifer or depleted oil/gas reservoir and CO<sub>2</sub> is utilized for Enhanced Oil Recovery (EOR) and Enhanced Gas Recovery (EGR)

The CCUS value chain illustrated as follows

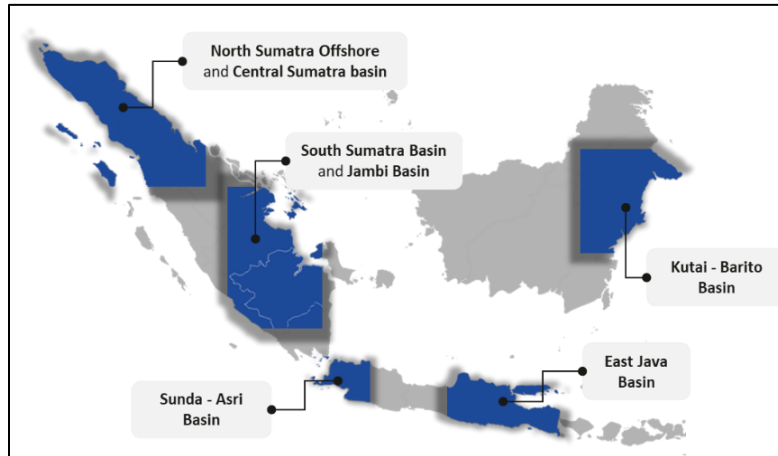


### II B. INDONESIAN CCS/CCUS POTENTIAL

Pertamina continues to make efforts in screening and selecting fields that can be used as CO<sub>2</sub> injection sites and collaborating with companies in feasibility studies as the first step in the real implementation of the CCUS project.

<sup>1</sup> Based on IEA Report: Carbon Capture, Utilisation and Storage: The Opportunity in Southeast Asia (2021)

## Indonesia Potential Field Identified:



Pertamina has also been developed Joint Study Agreement with several entities with the coverage of:

- a. Study and research to obtain suitable technology in order to store the CO<sub>2</sub> in subsurface formation
- b. Determination of CO<sub>2</sub> emission source along with mapping storage location
- c. Study of CO<sub>2</sub> capture and purification
- d. Location mapping and calculation of CO<sub>2</sub> storage capacity or utilization
- e. Study of CO<sub>2</sub> transportation via pipelines, trucking and shipping from industry to the location of CO<sub>2</sub> storage or utilization
- f. Mapping interconnection of CO<sub>2</sub> emission sources and locations (development of CCS/CCUS hubs & clusters)
- g. Development of CCS/CCUS hubs & clusters business scheme in one or more selected areas in Indonesia

## Our project staging are as follows:

### 2022-2023: Feasibility Study

- Subsurface and surface facility evaluation
- Transport study mechanism
- Commercial and business model planning

### 2023-2024: Front-End Engineering Design (FEED)

### 2024-2025: Permitting and Final Investment Decision (FID)

- Submit plans and financial responsibility for permit application

### 2025-2026: Engineering, Procurement and Construction (EPC)

- Construction of surface facilities, injector well, monitoring system

### 2027: Start Injection

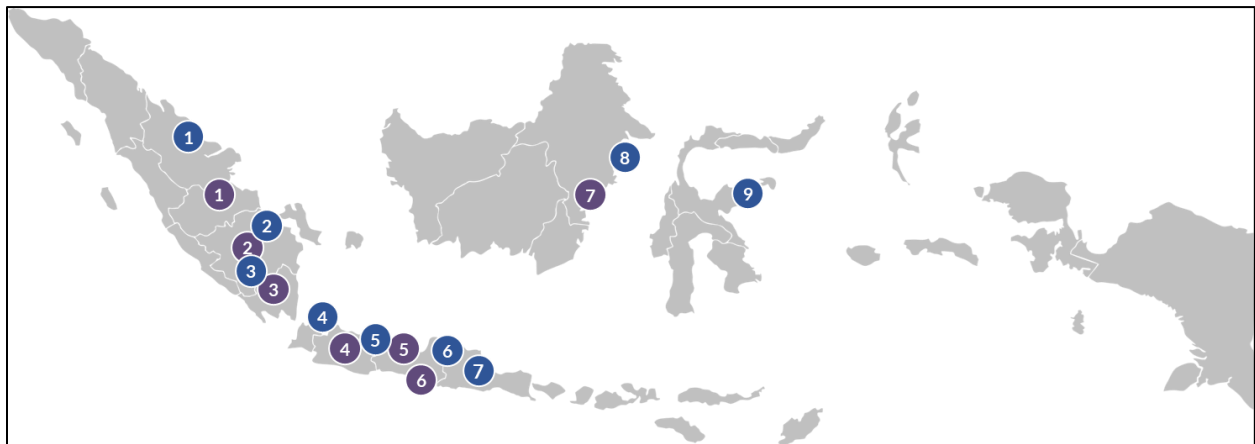
- Begin injection of captured CO<sub>2</sub>
- Well and surface monitoring

## II C. PERTAMINA CCS/CCUS INITIATIVES

Pertamina cooperates in the development of CCU (Carbon Capture & Utilization) with global partners, local universities, and research institution. CCU, is the process of capturing carbon dioxide (CO<sub>2</sub>) to be used later for a specific use, can be a key player in reducing climate change issues since it can positively impact the total levels of greenhouse gases.

Pertamina also cooperates in the development of CCS/CCUS with global partners, local universities and research institution. CCUS business is conducted via bilateral agreements between individual players in each area. As the scale of CCUS expands, we will see larger integration of CCUS business. Below is our CCS/CCUS Initiatives.

Below is the map of our CCU Initiatives (in purple) and CCS/CCUS Initiatives (in blue).



No	Project	Partner	No	Project	Partner
<b>CCU Initiatives in Pertamina</b>			<b>CCS/CCUS Initiatives in Pertamina</b>		
1	Study of utilization of stranded field with high CO <sub>2</sub> content	Japan engineering company with CO <sub>2</sub> reforming tech	1	CCS Hubs Central Sumatra	Japan trading and oil company
2	Basic research of methanol production via electrolysis with MEA	Sriwijaya University	2	CCUS/ CO <sub>2</sub> EOR Ramba	Japan oil and gas company
3	Study of the utilization of CO <sub>2</sub> into green methanol in the geothermal field	USA chemical industry and Local engineering company	3	CCS for Coal to DME Plant in Tj. Enim (South Sumatra)	Japan engineering company
4	PCC Production from CO <sub>2</sub> in natural gas processing (SP) Subang	Institut Teknologi Bandung and Pertamina EP	4	CCS Hubs Sunda-Asri basin	American multinational oil and gas corporation
5	CO <sub>2</sub> fixation with microalgae	Diponegoro University and local microbiological industry company	5	CCUS CO <sub>2</sub> -EOR Jatibarang	Pertamina EP
6	Catalyst development for CO <sub>2</sub> reforming and DME synthesis	Sebelas Maret University	6	CCUS/EGR Gundih	Institut Teknologi Bandung and Japan Consortium
7	CCU study at the Balikpapan refinery unit	Multinational industrial gases and engineering company	7	CCUS CO <sub>2</sub> -EOR Sukowati	Lemigas and Japan oil and exploration company
			8	CCS Hubs Kutai basin	American multinational oil and gas corporation
			9	CCS in Donggi-Matindok Blok (Central Sulawesi)	Institut Teknologi Bandung and Japan oil and gas company

### III. NATURE-BASED SOLUTION

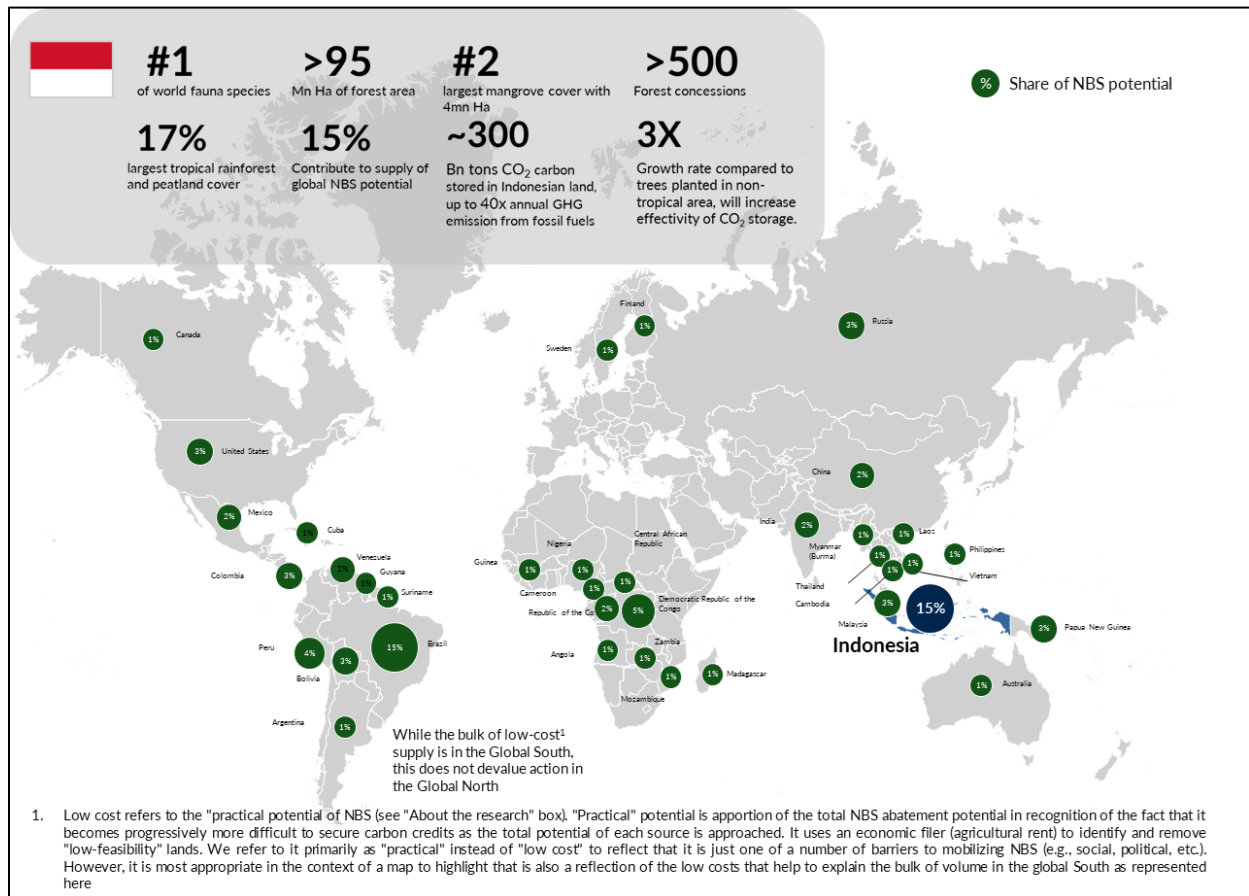
#### III A. OPTIMIZING 2<sup>nd</sup> LARGEST TROPICAL FOREST IN THE WORLD

Pertamina through its subholding PNRE optimize 2<sup>nd</sup> largest tropical forest in the world for low cost NBS through strategic cooperation; accelerating climate investment for decarbonization and creating tangible impact for biodiversity and community development. NBS is a potential voluntary solutions to combat climate change and providing significant impact to sustainability.

There are 3 natural carbon sinks available, reducing emission from atmosphere and managing emissions stored in other forms are critical:

- Atmosphere – where around 45% or 18.6 GTons of CO2 emission due to fossil fuels and industrialization are stored
- Biosphere/Forests – around 30% or 12.4 GTons of CO2 are reabsorbed by trees and soils. However, deforestation activities will release the carbon emission back to atmosphere
- Oceans – around 25% or 10.2 GTons of CO2 are reabsorbed through plankton, coral, fish, algae and others.

Indonesia has the 2nd largest global low cost NBS potential which will significantly contribute to achievement of 1.5°C pathway.



### III B. PROVIDING BENEFIT TO THE COMMUNITY AND BIODIVERSITY

Implementing the NBS initiatives will provide tangible benefit for climate, community, biodiversity and ensuring livelihood of native people. There is NBS initiatives that provide jobs and food security for Dayak Lundayah Tribe in Kalimantan. At Semamu concession, there are several critically endangered and endangered vegetations that could be protected such as Meranti Majau and Resak.



NBS also has potential to protect more than 20 species of mammals and more than 40 species of birds which are critically endangered. Below are the examples from Semamu concession.

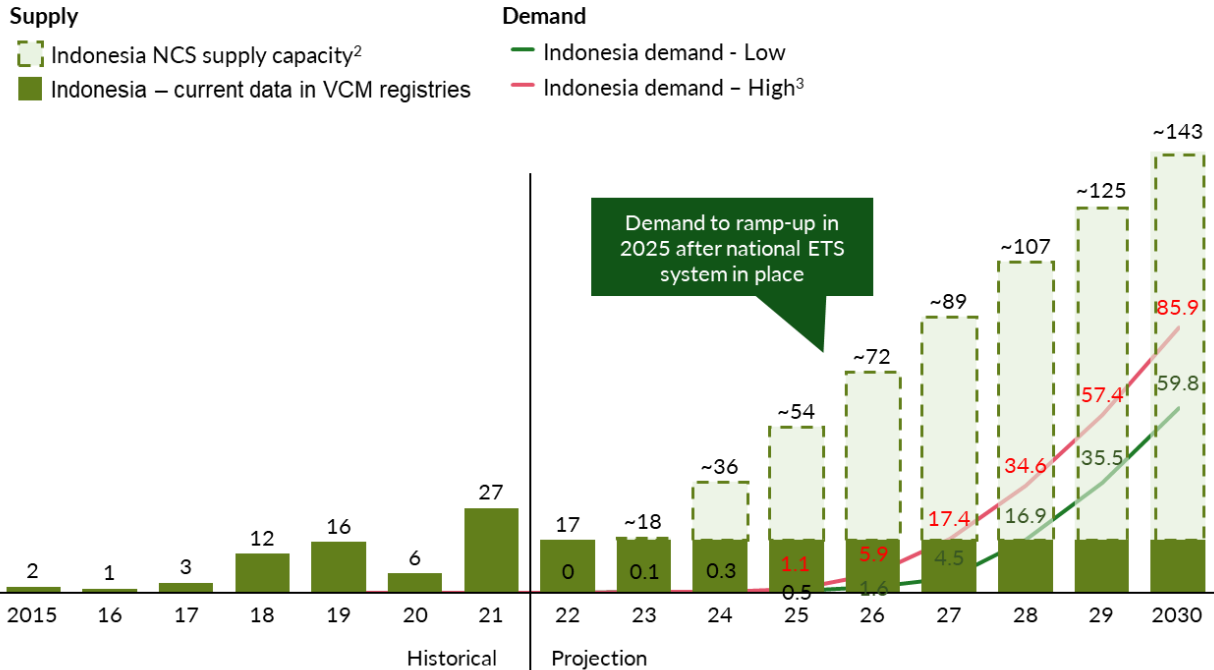


### III C. NBS CARBON CREDIT POTENTIALS

Indonesia’s carbon credit supply expected to exceed NDC-driven demand by ~60-80 Mn Tons in 2030 – with mostly coming from NBS Projects. Based on our pre-eliminary calculation, more than 50% fo NBS carbon credit volume will supply Indonesia NDC target in 2030, and more than 60 Mn Tons CO<sub>2</sub>e NBS carbon credit exceeding Indonesia’s demand which unlocks potential for export market.

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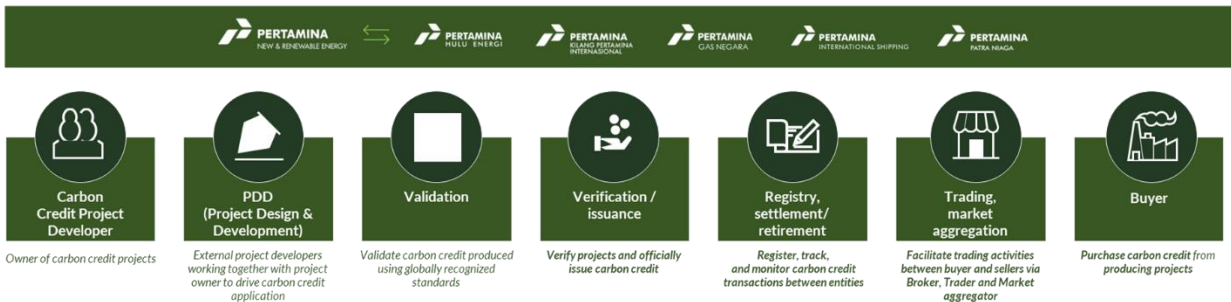
## Indonesia carbon credit demand & supply capacity million - tCO<sub>2</sub>e/year (preliminary calculation)



1. Carbon tax is in place by 2025 & CC will be used to offset < 30% un-abatable emission within each sector; FOLU is expected to be a sector with surplus mitigation capacity
2. Linear projection from present-day carbon credits to highly feasible NCS potential in 2050 excluding avoided deforestation, predicted by McKinsey Nature Analytics. Model takes conservative estimate by assuming NCS is predominant Indonesian credit type in 2050 and only includes highly feasible NCS.
3. Assuming 5% inefficiency of pilot SOEs and unknown companies in meeting target emission reductions.

### III D. PERTAMINA INITIATIVES

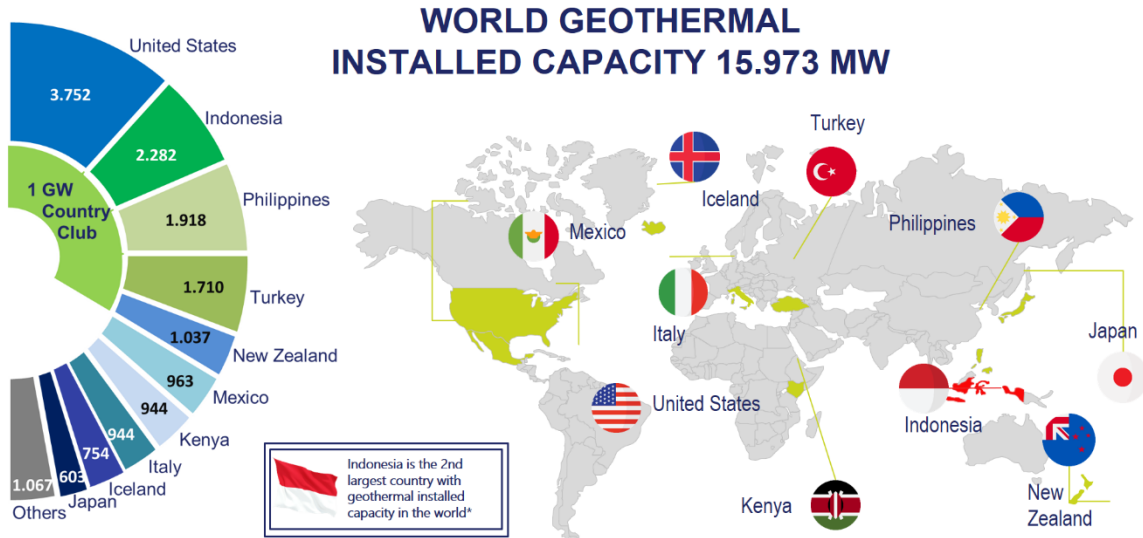
Pertamina through subholding PNRE has started to drive green investment through NBS cooperation with one of the largest forestry concession holder in Indonesia, Perhutani. This cooperation will develop 9 concessions as NBS projects. PNRE initiative will contribute to and actively involve in building Indonesian SOEs VCM ecosystem. PNRE also will be a market-aggregator for carbon trading and NBS project developer within Pertamina Group.



## IV. GEOTHERMAL

### IV A. UNLOCKING 40% OF GLOBAL GEOTHERMAL RESOURCES

Currently, Indonesia is the second largest country with geothermal installed capacity in the world, with geothermal resource potential in Indonesia up to ~24 Gigawatt. This potential becomes a pillar to achieve energy mix and carbon emission reduction plan. Compare to fossil fuel power generation, geothermal power generation emissions are very low and it becomes an advantage to leverage geothermal utilization potential in carbon credit sector.



### IV B. PERTAMINA CARBON CREDIT INITIATIVES

Pertamina through its subsidiary, PT Pertamina Geothermal Energy (PGE) is actively contributing and involved in Voluntary Carbon Market (VCM) ecosystem by managing several Carbon Credit Projects with total potential emission reduction ~2.6 Million ton CO<sub>2</sub>e/year. Since 2011, PGE has already registered its carbon credit project in the compliance market through Clean Development Mechanism under Protokol Kyoto rules. Currently, there are 7 (seven) carbon credit projects at PT Pertamina Geothermal Energy in Voluntary Carbon Market and registered as Gold Standard and Verified Carbon Standard (VCS). Carbon credit with Gold Standard ensure that projects in carbon markets represent the highest levels of environmental integrity and deliver other verified benefits positively impact the economy, health, welfare and/or environment of the community and ecosystems where the project is located. Gold Standard concept is aligned with Sustainable Development Goals (SDG's) and support achieving Global SDG's target.

Below is the map of our Carbon Credit Project and total potential emission reduction of each project:



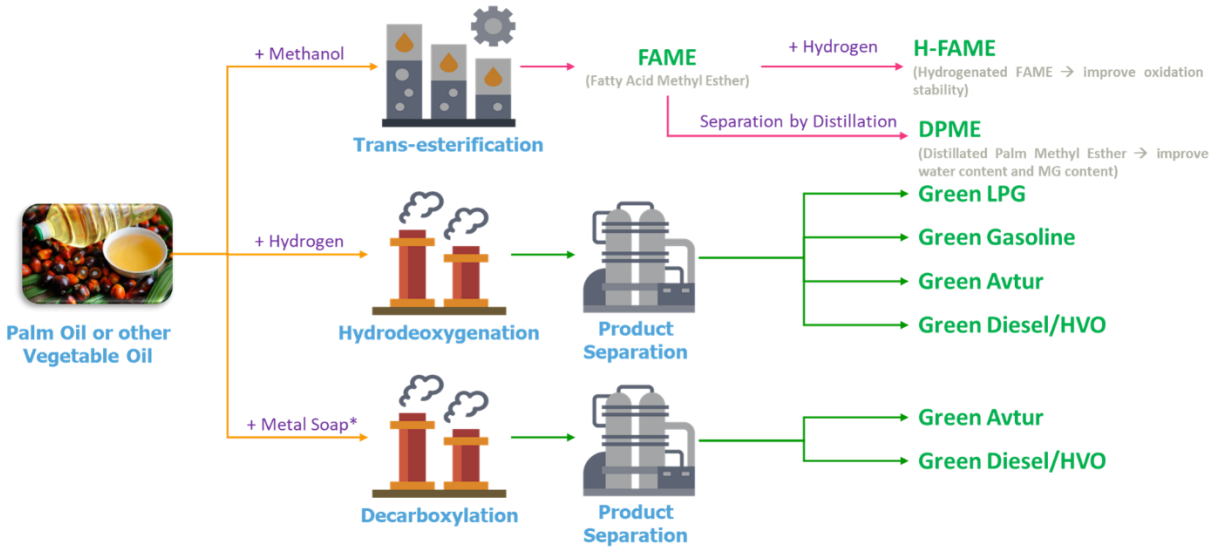


No	Project	Potential Emission Reduction (tCo2eq/year)
<b>Carbon Credit Project</b>		
1	Gold Standard Lumut Balai 1-2 Gold Standard Lumut Balai 3-4	581.784 581.784
2	Gold Standard Ulubelu 3-4	581.518
3	Gold Standard Kamojang 5 Carbon Credit Kamojang 4	156.669 402.780
4	Gold Standard Karaha 1	156.669
5	VCS Lahendong 5-6	181.030

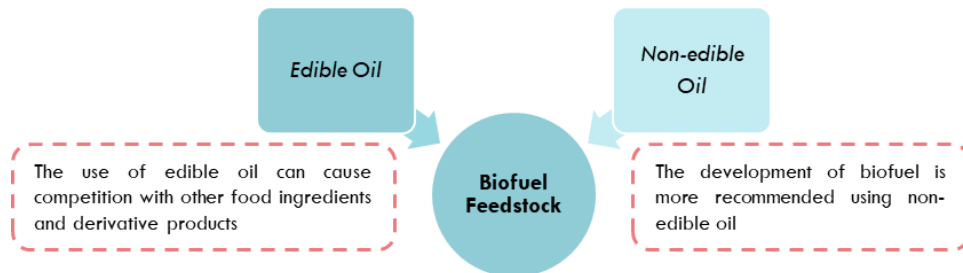
## V. BIOFUEL

### V A. PROVIDING CLEANER TRANSPORTATION FUEL

As the biggest producer of palm oil, Indonesia holds a massive potential for vegetable oil and lignocellulosic biomass utilization to decarbonize transportation fuels. Biofuel development can be utilized to reduce the impact of energy production and use on the global environment. Vegetable oil can be further processed into wide range of bio-based products to substitute conventional fossil fuel.



Utilization of non-edible oil could provide further lower emissions reduction. In 2018, only 9% of the biofuel production came from non-food feedstock. Almost 90% was made from non-edible oil and fat, and the rest made of lignocellulosic biomass. Hence, switching conventional transportation fuel with biofuel from non-food feedstock from waste (Used Cooking Oil) or lignocellulosic is seen more attractive despite the higher production cost. To help price competitiveness, incentive in the form of carbon credit in the market could help balancing the cost and at the same time verify the sustainability of the feedstock and its impact to the environment.



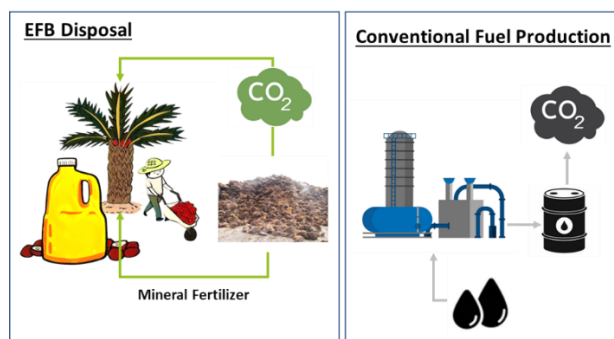
## V B. PERTAMINA BIOFUELS INITIATIVES

The background of the development of biofuels at Pertamina is to provide cleaner energy, to support government programs in reducing fuel imports, and to comply with government regulations on biofuels blending in the Minister of Energy and Mineral Resources Regulation No. 12/2015. Pertamina is currently implementing the blending of biodiesel into gasoil products with a portion of 30% (B30), where the volume has distributed in 2021 reached 7,59 juta kL. In addition to biodiesel blending, Pertamina also continues to develop other biofuels, including Sustainable Aviation Fuel (SAF), Green Diesel/Hydrogenated Vegetable Oil (HVO), and 2nd Generation Bioethanol.

Pertamina has been developing catalyst for SAF and HVO since 2015. Pertamina also has done several trials of coprocessing since 2014 and successfully produced co-processed green diesel & green jet fuel with the utilization of existing refinery. Green jet fuel 2.4% as one of coprocessing products has been used in flight test in October 2021. For HVO product, it also has been tested for utilization in passenger car, heavy equipments, and small ship. To continue to the commercial stage, Pertamina's SAF and HVO Project will be developed under PT Kilang Pertamina International (PT KPI). KPI currently has HVO production facility in Cilacap with capacity of 145.000 KL/year using RBDPO as a feedstock. Pertamina has launched "Pertamina RD" (Renewable Diesel) and provide the fuel for diesel generator in Formula E event in June 2022. Future phase 2 development is expected to be operated in 2026 to increase the capacity up to 348.000 KL/year and to be able to process more sustainable feedstock such as Used Cooking Oil (UCO). In addition, if the market is favorable, KPI has a plan to build standalone green refinery project with capacity of 1.16 million kL/year feedstock with the HVO and SAF mode.

For gasoline blending, Pertamina has been conducting study for 2nd Generation bioethanol. The bioethanol blending mandate has been issued by Minister of Energy & Mineral Resources (MEMR) since 2015. However, up to this point, the regulation has not been implemented yet. One of the challenges is the limitation of molasses as raw material for bioethanol. Meanwhile, Indonesia has enormous potential of Palm Oil Biomass, especially Empty Fruit Bunch (EFB), as feedstock alternatives. Therefore, Pertamina conducted Pre-Feasibility Study to build 2nd Generation Bioethanol Plant with capacity 50 kta (66 kLa) using EFB as feedstock. The plant is expected to be operated in 2027.

The construction of bioethanol production facilities from EFB can increase the company's Environmental, Sustainability, and Governance (ESG) value. This is related to the production of low-emission and environmentally friendly fuel from raw materials classified as waste. Biomass waste plays an important role towards the implementation of the Paris Agreement.



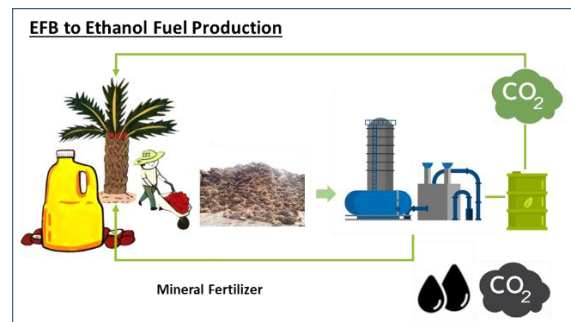
Picture 1. Current Conditions Related to Palm Oil Mill Work Cycle and Fossil Fuel Production

Current usage cycle conditions:

- EFB is stacked on plantations to get its mineral content as fertilizer.
- There is no valorization in the carbon content of OPEFB.
- Fuel oil is made from fossils so that it produces clean emissions.
- Fuel is processed in massive and centralized processing plants

So that a circular carbon economy scheme is needed for utilization, with quality improvements as follows:

- EFB will be processed in a biorefinery to produce ethanol fuel, valorizing its carbon content to create value-added products.
- The mineral residue will be concentrated in the by-product of vinasse which serves as an effective fertilizer
- By switching to ethanol fuel, the production of fossil fuels can be avoided, and carbon precursors will remain underground
- Bioethanol refinery will be built on small and distributed mode



Picture 2. Target Conditions Related to Palm Oil Mill Work Cycle and Fossil Fuel Production