

Technological Initiatives for Carbon Management and Energy Security

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Ensuring Energy Transition while Enabling Energy Security

Pertamina is committed to support Indonesia government commitment to achieve Net Zero by 2060 or sooner by developing roadmap of asset decarbonization and green business building

Pertamina Green Business Initiatives

Estimated 2060 capacity¹ and cumulative capex² up to 2060



Biofuels
200+ kbps capacity for HVO and HEFA

±\$10 bn



Renewables
60 GW to fulfil 15% market share

\$50-55 bn



CCS/CCUS
~60 MTPA capacity of E2E CCS/CCUS business

\$20-25 bn



Battery and EV
80 GWh battery production capacity
~800,000/yr E2W production
~1.5 TWh charging stations

\$3-5 bn



Hydrogen
3 MTPA for transport, industry

\$45-50 bn



Carbon business
20+ mn tCO₂ carbon credits generated by 2030

1. Before equity adjusted
2. Equity adjusted, cumulative from 2022-2060
3. Based on 2022 emission data

GOALS

Aspiration:
Scope 1 & 2: Net Zero Emission by 2060

STRATEGIC INITIATIVES

Decarbonization of business

- Energy efficiency
- Green power generation
- Loss reduction (e.g., flare, methane)
- Fleet electrification
- Static equipment electrification
- Carbon capture and storage (own use)
- Low/ zero carbon fuel for fleets

New business building

- Renewables
- EV Charging and Swapping
- Blue/Green Hydrogen (manufacturing, transport)
- Nature-based solutions
- Battery and EV
- Biofuels
- Integrated CCS/ CCUS service (domestic/ regional carbon sink)
- Carbon market business

ENABLERS

Reporting (carbon accounting), performance management and Pertamina Internal Carbon Price

Sustainability organization, capabilities

Stakeholder engagement

~25-30 Mn

Tonnes CO₂ abated (Scope 1 & 2) in 2060

~30-40 Bn

Revenue per year from new green businesses

~2%

Contribution to Indonesia's Net-Zero aspirations (Scope 1 & 2)³

Several Pillars of Energy Transition

To Support Net-Zero Aspirations and the Decarbonization Agenda



Circular Carbon Economy

Pertamina plan to apply Circular Carbon Economy in several area:
Recycle : Biomass, Biogas
Reduce : Solar PV, EV, LNG Bunkering, CCS
Reuse : CCUS for EOR/EGR and CCU to PCC and methanol



Hydrogen

Pertamina has started the initiatives for utilization of green hydrogen in Indonesia which will use electricity from geothermal field



Bio Energy

Biomethane from Biogas, blending of FAME with gasoil, bioethanol from waste biomass



Green Refinery

Development of Green refinery in Cilacap and Plaju



EV Battery & Energy Storage System

Participate in Indonesia Battery Company Joint Venture. Develop EV battery ecosystem including swapping & charging business



Fuel Switching

Methanol Plant construction for fuel switching, Plan to on stream in 2025



New Renewable Energy

Power generator capacity enhancement in 2020 – 2026:

- Solar PV
- Wind
- Hydro



Geothermal

Capacity enhancement from 672 MW in 2020 to 1128 MW in 2026

Initiatives on Carbon Capture, Utilization and Storage in Pertamina

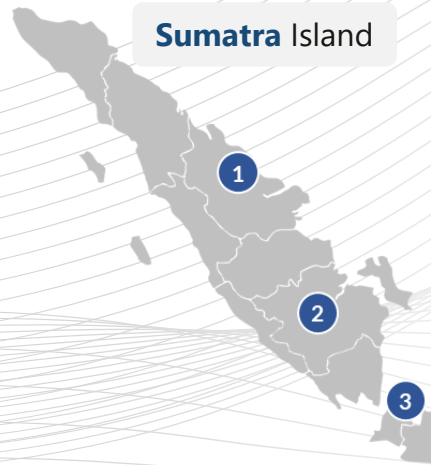
Collaborations in developing CCS/CCUS Project with Global Partners

No	Project
Study CCS/CCUS	
1	CCS/CCUS Hubs Central Sumatra
2	CCS Coal to DME Plant Tanjung Enim (South Sumatra)
3	CCS/CCUS Hubs in Kutai and Sunda-Asri basin
4	CO ₂ Huff and Puff Jatibarang Field
5	CCUS CO ₂ -EGR Gundih Field
6	CCUS CO ₂ -EOR Sukowati Field
7	CCS in Donggi-Matindok (Central Sulawesi)
CO₂ Utilization Study / Study CCU	
8	Utilization stranded field with high CO ₂ content
9	Methanol production from green hydrogen
10	Utilization of CO ₂ into green methanol in the geothermal field
11	PCC Production from CO ₂ in natural gas plant (SP) Subang
12	CO ₂ fixation with microalgae
13	CO ₂ reforming for chemical production
14	CCU study at the Balikpapan refinery unit



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**

CCS/CCUS Initiatives in Sumatera and Java



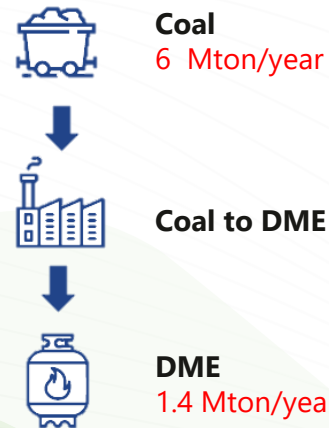
1 CCS Hubs Central Sumatra

Basin	Central Sumatra
Source	CO2 from refinery, power plant and other industry near Central Sumatra
Status	<ul style="list-style-type: none"> • Feasibility Study (FS) 2022 - 2024 • FID, FEED, EPC – 2027 • Implementation - 2028

Central Sumatra Basin



Production scheme



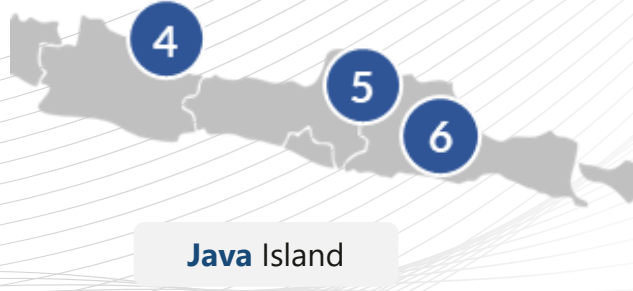
3 CCS Hubs Sunda-Asri basin

Basin	Sunda – Asri
Source	CO2 from refinery, power plant and other industry near Cilegon and South Sumatra
Status	<ul style="list-style-type: none"> • FS – 2024 • FID, FEED, EPC – 2028 • Implementation – 2029

2 CCS for Coal to DME Plant in Tj. Enim (South Sumatra)

Basin	South Sumatra
Source	CO2 from coal gasification plant to DME
Status	<ul style="list-style-type: none"> • Feasibility Study (FS) 2023 • Implementation – 2027

CCS Initiatives in Java and Central Sulawesi



4 CCUS CO2 EOR Jatibarang

Field	Jatibarang, West Java
Source	CO2 from natural gas processing Subang
Potential reduction	14.6 thousand ton CO2/year
Status	<ul style="list-style-type: none"> • Feasibility study – 2022 • Pilot CO₂ Injection – 2026 • EPC – 2029 • Implementation 2031

5 CCUS/EGR Gundih



Field	Gundih, Central Java
Source	CO2 from natural gas processing / CPP Gundih
Potential reduction	3 Million ton CO2 in 10 years
Status	<ul style="list-style-type: none"> • FS – Feb 2022 • FEED – 2025 • EPC – 2027 • Implementation - 2027

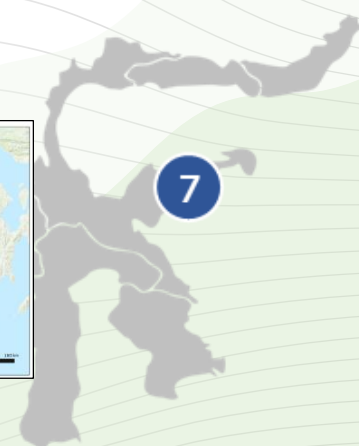
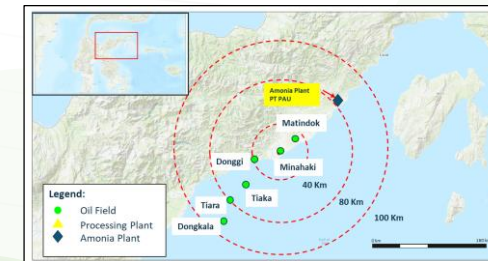
6 CCUS CO2-EOR Sukowati



Field	Sukowati, East Java
Source	CO2 from natural gas processing JTB gas plant
Potential reduction	14.2 Million ton CO2 in 25 years
Status	<ul style="list-style-type: none"> • FS & FEED – 2023 • EPC Pilot – 2025 • Pilot test – 2027 • EPCI – 2028 • Implementation 2030

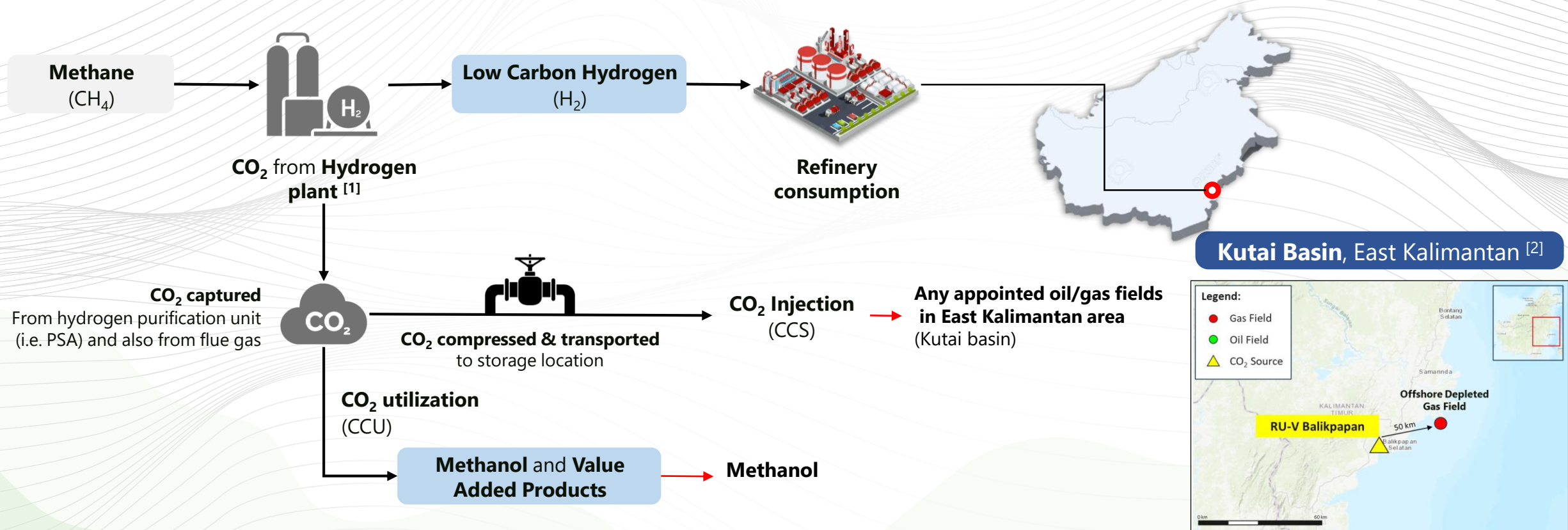
7 CCS in Donggi-Matindok Blok (Central Sulawesi)

Field	Central Sulawesi basin
Source	CO2 from ammonia plant
Status	<ul style="list-style-type: none"> • Feasibility study - 2023



Low Carbon Hydrogen Production combined with CCS/CCUS

Collaborative development on low carbon hydrogen in Balikpapan Refinery



[1] **RU V Balikpapan** (RDMP phase 1): around 120,000 Nm³/hr
 [2] Kutai basin, East Kalimantan is one of the basins with the largest CO₂ storage capacity

Notes
 Distance to injection location: ± 50 km
 *need more detailed subsurface study and characterization

CO₂ Utilization to Methanol in Pertamina Field

Geothermal field



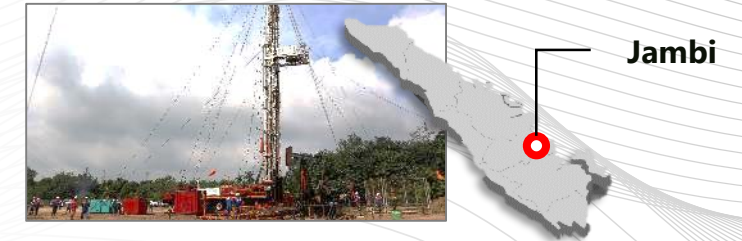
Project	Green Methanol
CO₂ utilized	CO ₂ from non-condensable gas

Refinery unit

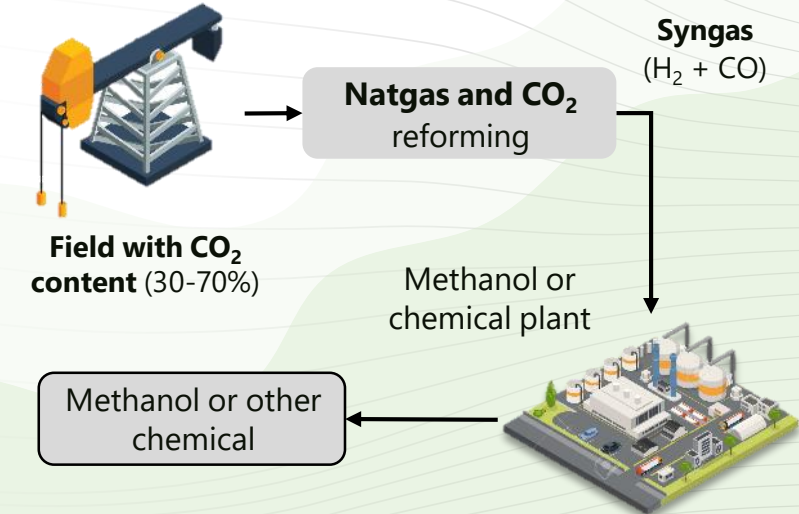
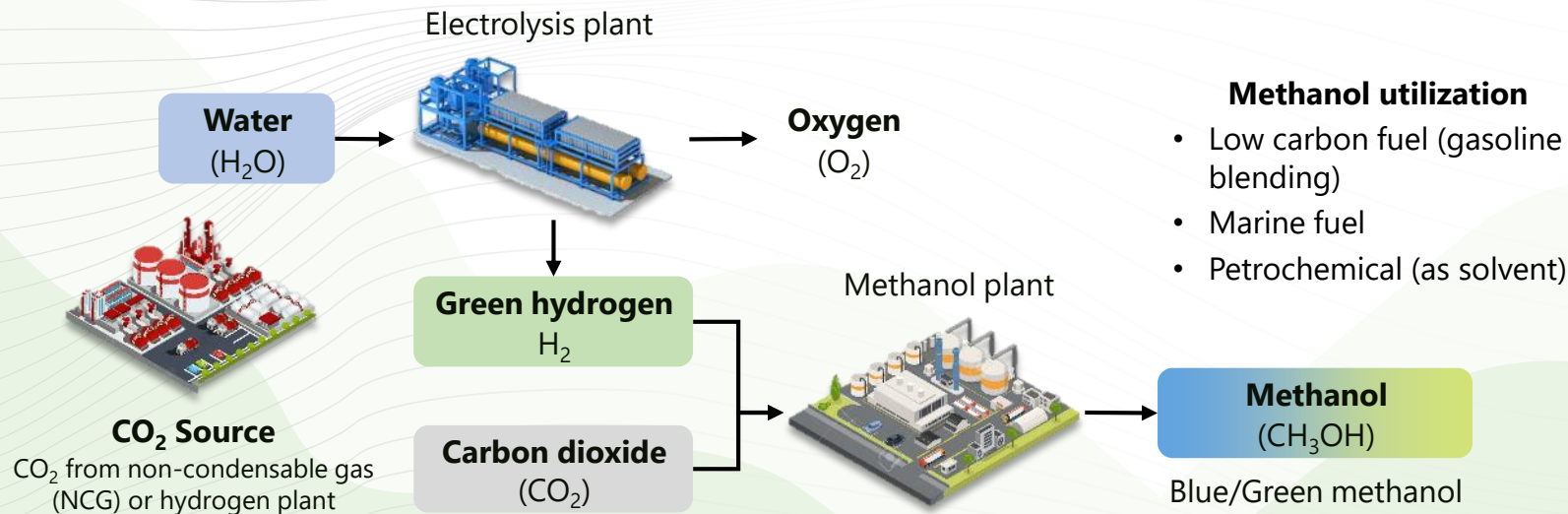


Project	Low Carbon "Blue" Methanol
CO₂ utilized	CO ₂ from hydrogen plant

Upstream/Stranded field



Project	Methanol or other chemicals (DME, MMA or oxo-alcohol)
Resource	Natural gas with high CO ₂ content



Renewable Diesel & Sustainable Aviation Fuel (SAF)

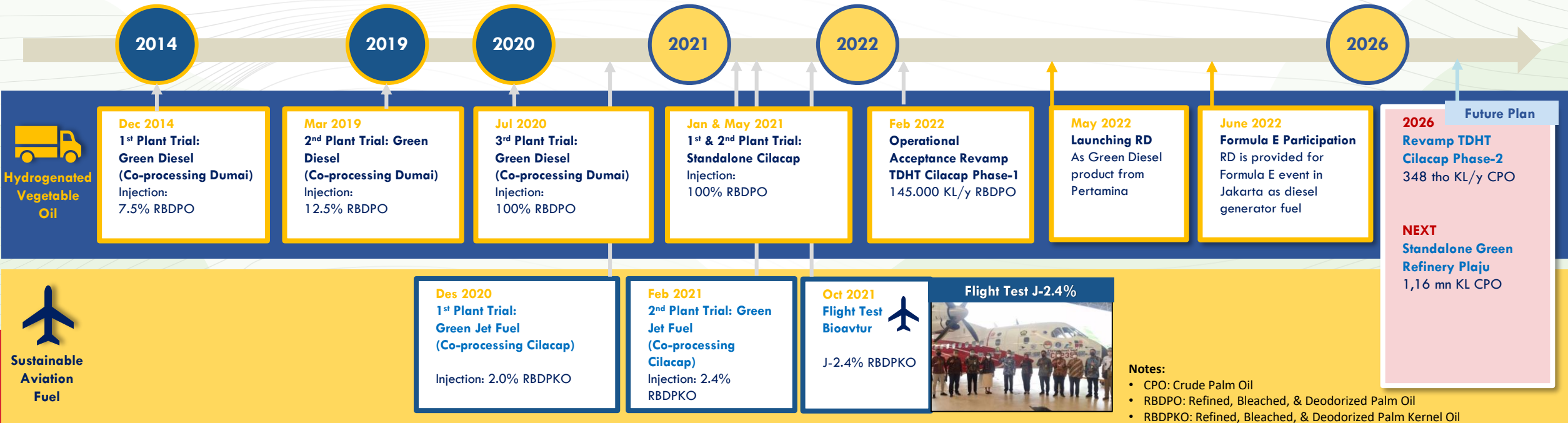


PT KPI's Renewable Energy Production Implementation

- 1 Renewable Feedstocks**
 UCO, POME Oil, RBDPO and non edible oil
- 2 Conversion**
 Vegetable feedstock is processed with hydrogenation and isomerization

1: Co-Processing

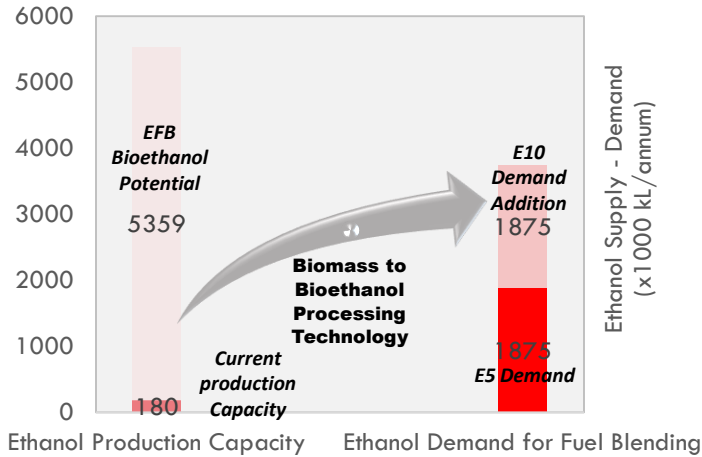
2: Conversion



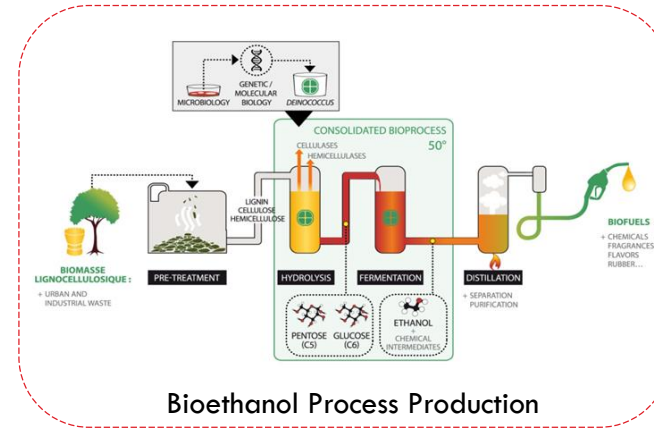
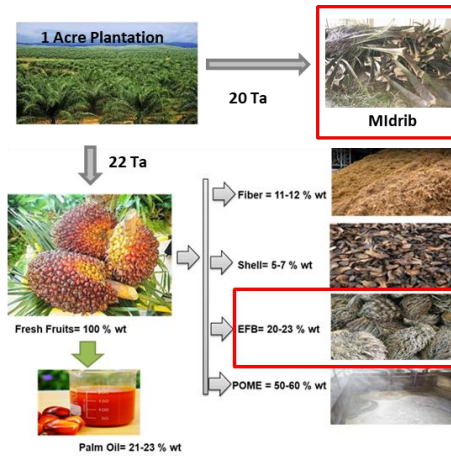
- Notes:**
- CPO: Crude Palm Oil
 - RBDPO: Refined, Bleached, & Deodorized Palm Oil
 - RBDPKO: Refined, Bleached, & Deodorized Palm Kernel Oil

Waste Biomass to BioEthanol

Indonesian Ethanol Supply and Demand for Fuel Blending



Pertamina has a plan to build 2nd Generation Bioethanol Plant with capacity 50 kta (66.000 kLa) using EFB as feedstock in KEK Sei Mangkei or other locations



Properties	ASTM standard	
	Petrol	Ethanol
Density (kg/m ³)	747.4	794
Vapour pressure (kPa)	36	10
Octane number	RON	91
	MON	85
Flash point (°C)	-65.0	13.0
Heating value (MJ/kg)	44.4	30.0
Auto ignition temperature (K)	519	635
Distillation temperature (°C)	30-190	75-80
Stoichiometric air/fuel ratio	14.7	8.96

1. Current Ethanol production capacity is merely 180.000 kLa, mostly from molasses.
2. Ethanol demand for E5 is 1.875.000 kLa, and will be doubled for E10.
3. Indonesia has huge potential biomass supply to be converted to ethanol. Palm Oil EFB potentially produced 5.359.000 kLa ethanol.

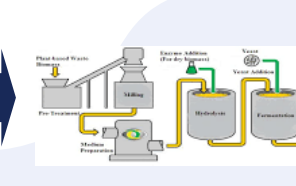
Other Potential Feedstock – Sorghum



Indonesia has plan to increasing Sorghum Plantation Area in 17 Province with total capacity 30.000 Ha¹ in 2023



Molasses from Sorghum Stem



1st G Bioethanol Processing Plant

Bioethanol 70.000 kL/year²

Source: ¹BPS. ²Prasad, 2007

- Many CCU, CCS and CCUS initiatives are developed by Pertamina with numerous partners which require advanced technological development for decarbonization.
- There are a number of potential projects on Blue Hydrogen (with CCUS) and Green Hydrogen from Geothermal power generation
- Biofuel development is very strategic for Sustainability and Energy Security
- Different sources of renewable feedstocks are studied for Renewable Diesel production including POME oil, non edible oil and used cooking oil.
- Bioethanol from waste biomass has potential to reduce Scope 3 emission and create circular economy in plantation.