“ SAF Development Programme in Indonesia “

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Sustainable Aviation Fuel (SAF) - ICAO

- 1.Sustainability Criteria

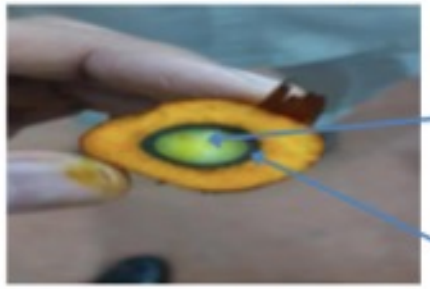
- 2. LCA values and Treshold (Core LCA + ILUC)
- (max 80 gram CO2/MJ)

- 3.Technology Pathways

Fresh Fruit Bunch

Palm Fruit

Palm Tree



Palm Kernel

Shell

Cross Section Palm Fruit

Crude Palm Oil (CPO)

Palm Kernel Oil (PKO)

Palm Fatty Acid Distilate (PFAD)

DEFAULT LCA EMISSIONS VALUES FOR SAF (01/02)

DIRECT SUGAR

HEFA

No	Fuel Conversion Process	Fuel Feedstock	Default Core LCA Value (in gCO2e/MJ)	ILUC LCA Value
12	Synthesized isoparaffins (SIP)	Sugarcane	32.8	14.0
13	Hydroprocessed esters and fatty acids (HEFA)	Camelina	42.0	0.0
14		Corn oil	17.2	0.0
15		Palm Fatty Acid Distillate (PFAD)	20.7	0.0
16		Palm oil - closed pond	37.4	35-55
17		Palm oil - open pond	60.0	35-55
18		Rapeseed	47.4	21-45
19		Soybean	40.4	23-100 (Brazil)
20		Soybean	40.4	20-51 (US)
21		Tallow	22.5	0.0
22		Used cooking oil	13.9	0.0

GHG Saving according to ICAO CORSIA

Jenis Feedstock	Open Effluent or With Methane Capture	LCA (g CO2e/MJ)			GHG SAVING (% to Fossil Fuel 89 g CO2e/MJ)
		Core LCA	ILUC (Malaysia & Indonesia)	Total LCA	
Palm Oil Hydrotreated (HEFA)	Open Effluent	60.0	39.1	99.1	- minus 10 - (minus 11%)
	With Methane Capture	37.4	39.1	76.5	12.5 (14%)
Palm Fatty Acid Distillate (PFAD)	-	20.7	0.0	20.7	68.3 (76%)

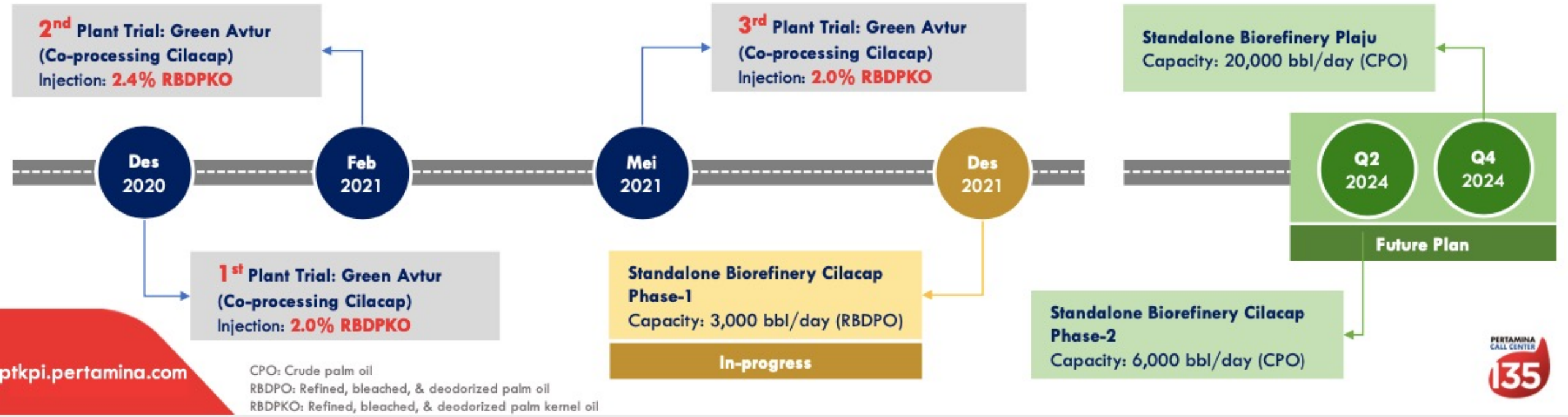
GHG Saving according to Annex V, EU Renewable Directive II

Jenis Feedstock	Open Effluent or With Methane Capture	GHG SAVING (terhadap Fossil Fuel 94 g CO2e/MJ)	
		Typical Value	Default Value
Palm Oil Bio-diesel	Open Effluent	32%	19%
	With Methane Capture	51%	45%
Palm Oil Hydrotreated	Open Effluent	34%	22%
	With Methane Capture	53%	49%
Palm Pure Vegetable Oil	Open Effluent	40%	30%
	With Methane Capture	59%	57%

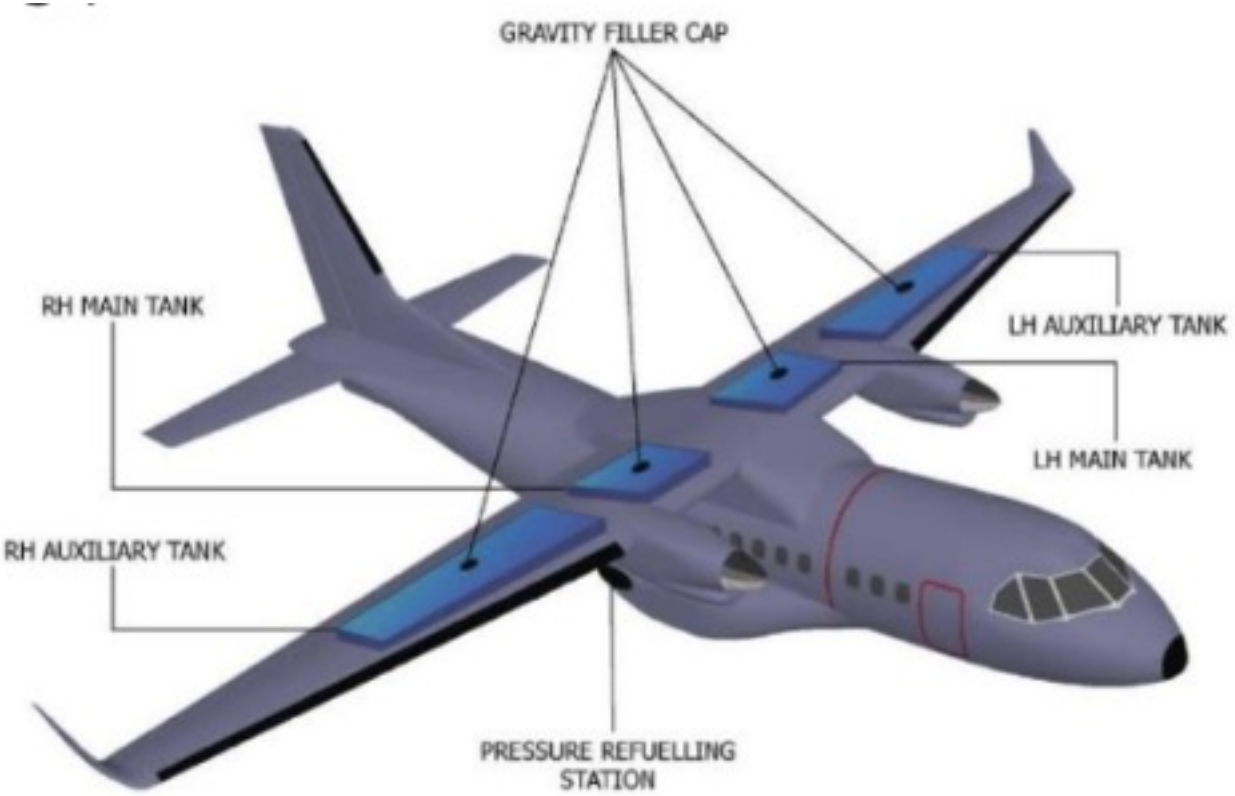
Methane Capture (Covered Anaerobic Pond / Closed Pond)

Methane Capture (Covered Anaerobic Pond / Closed Pond)

Road-map Bio-Avtur Production
Source : PERTAMINA



Test Flight CN-235
Using Bio-avtur J 2.4 , produced by Co-processing
(Source : Bioavtur Test Team Bandung Institute of Technology – ITB)



Fuel Capacity

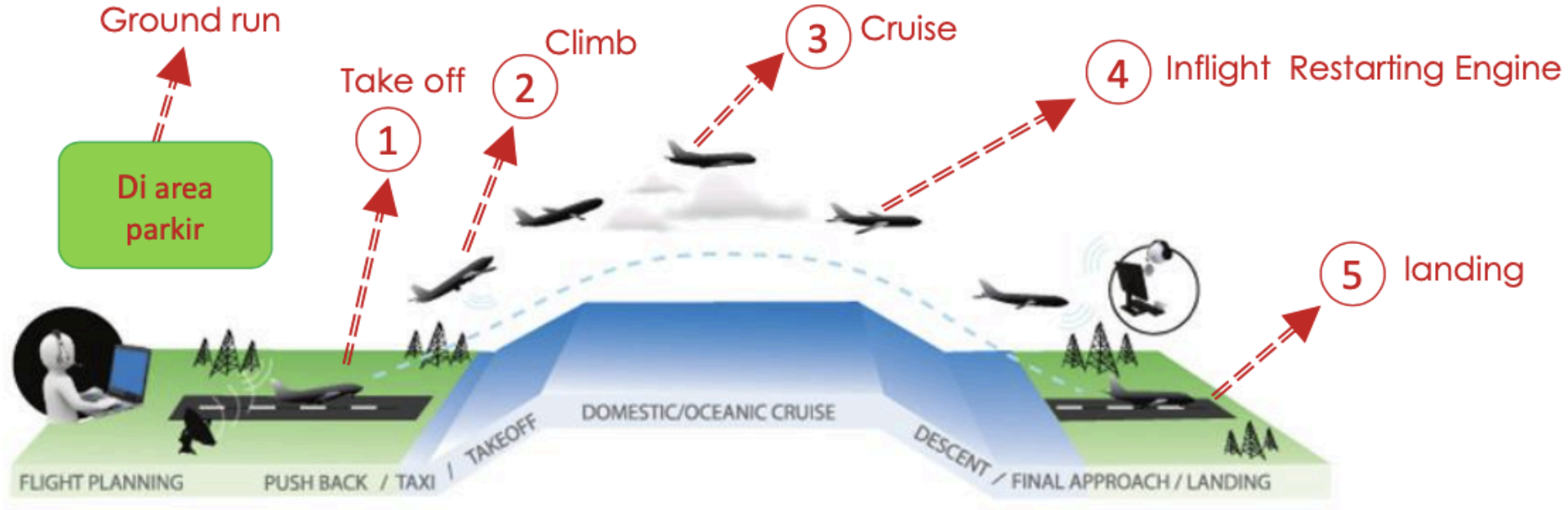
	liter	kg(*)	lb(*)
RH Main Tank	1020	820	1800
RH Aux Tank	1590	1276	2813
LH Main Tank	1020	820	1800
LH Aux Tank	1590	1276	2813
Total	5220	4192	9240

(*) Dihitung menggunakan berat spesifik 0.803 kg/liter

Left Tank filled by Jet A1,

Right Tank filled by Bio-Avtur J 2.4

In-flight re-starting engine using Bioavtur J2.4 was done at altitude 10,000 ft, to see how the engine responding when started in thin air condition



Source : Bioavtur Test Team - ITB

Summary :

1. **Test flight aircraft CN -235 has been carried out successfully using Mix Fuel of Jet A1 and Bioavtur J2.4**
2. **Bioavtur J2.4 comply with ASTM 1655**
3. **No respons found between Right Engine using J2.4 and Left Engine using Jet A1**

Source : Bioavtur Test Team - ITB

Challenges :

- 1. Sustainability Criteria
- 2. LCA Treshold
- 3. Feedstock Price
- 4.Technology
- 5. Investment Cost
- 6.Off-taker uncertainty, no SAF mandatory
- 7.Competing with Fossil fuel

ICAO CORSIA offset mechanism

Offset emission by purchasing “Carbon Unit”

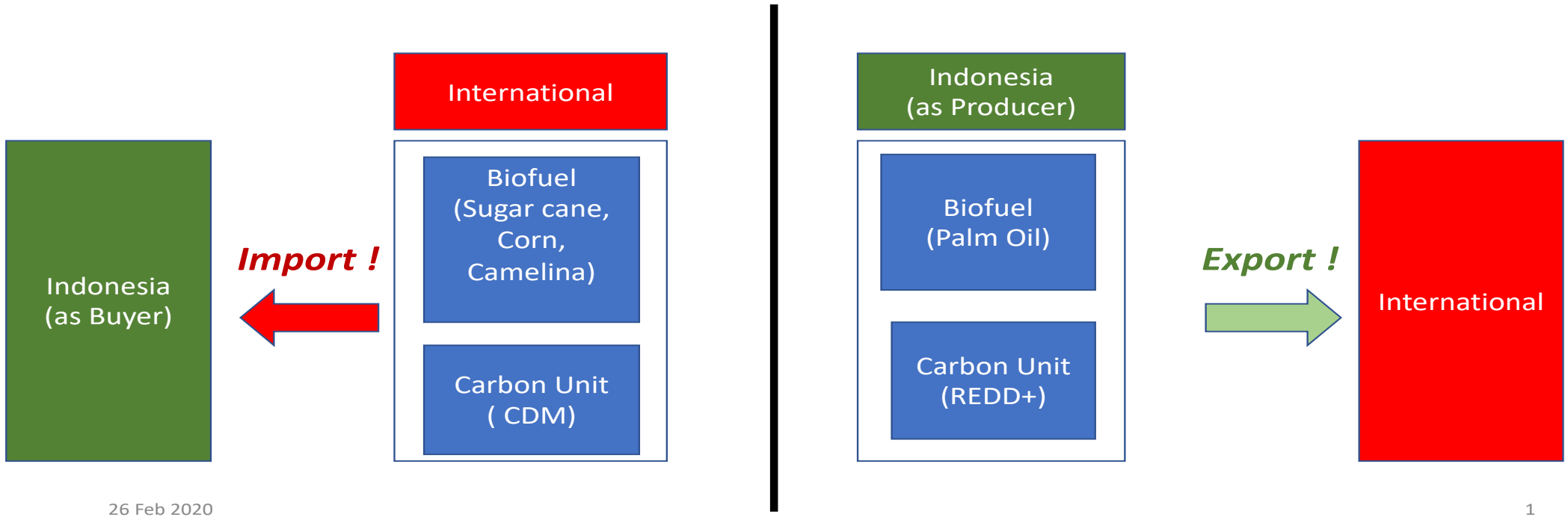
Reduce emission by using biofuel

Buy “Carbon Unit”

Buy /Use “Sustainable Biofuel”

as " Burden / Cost "

as " Opportunity"



26 Feb 2020

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Terimakasih

Thank you