GHD Advisory

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CTIF Canadian Trade and Investment Facility for Development

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Growing SAFs Across Southeast Asia

→ Techno-Economic Assessment Asia Clean Energy Forum 2025 Presentation

June 2025

Project Lead: GHD
Project Sponsor: CTIF
Beneficiary: ASEAN Secretariat
Knowledge Partner: Boeing

Introduction & Background

Countries

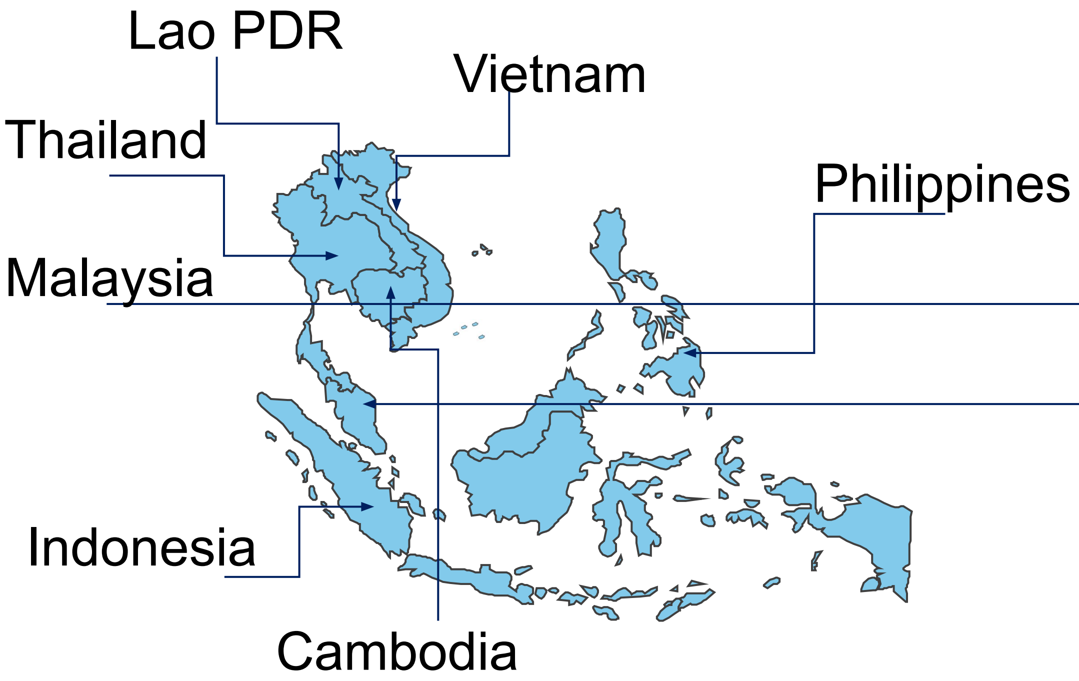


Figure 1: ASEAN Member States to be covered for the Mandate

Methodology

GHD's mandate focuses on **agricultural** and **forestry waste** feedstock sources for the following workstreams:

- Feedstock Assessment
- Technology Selection
- Carbon Intensity
- Feedstock and Product Logistics
- Environmental and Social Aspects
- Institutional Frameworks
- Financial Assessment

Feedstock Assessment

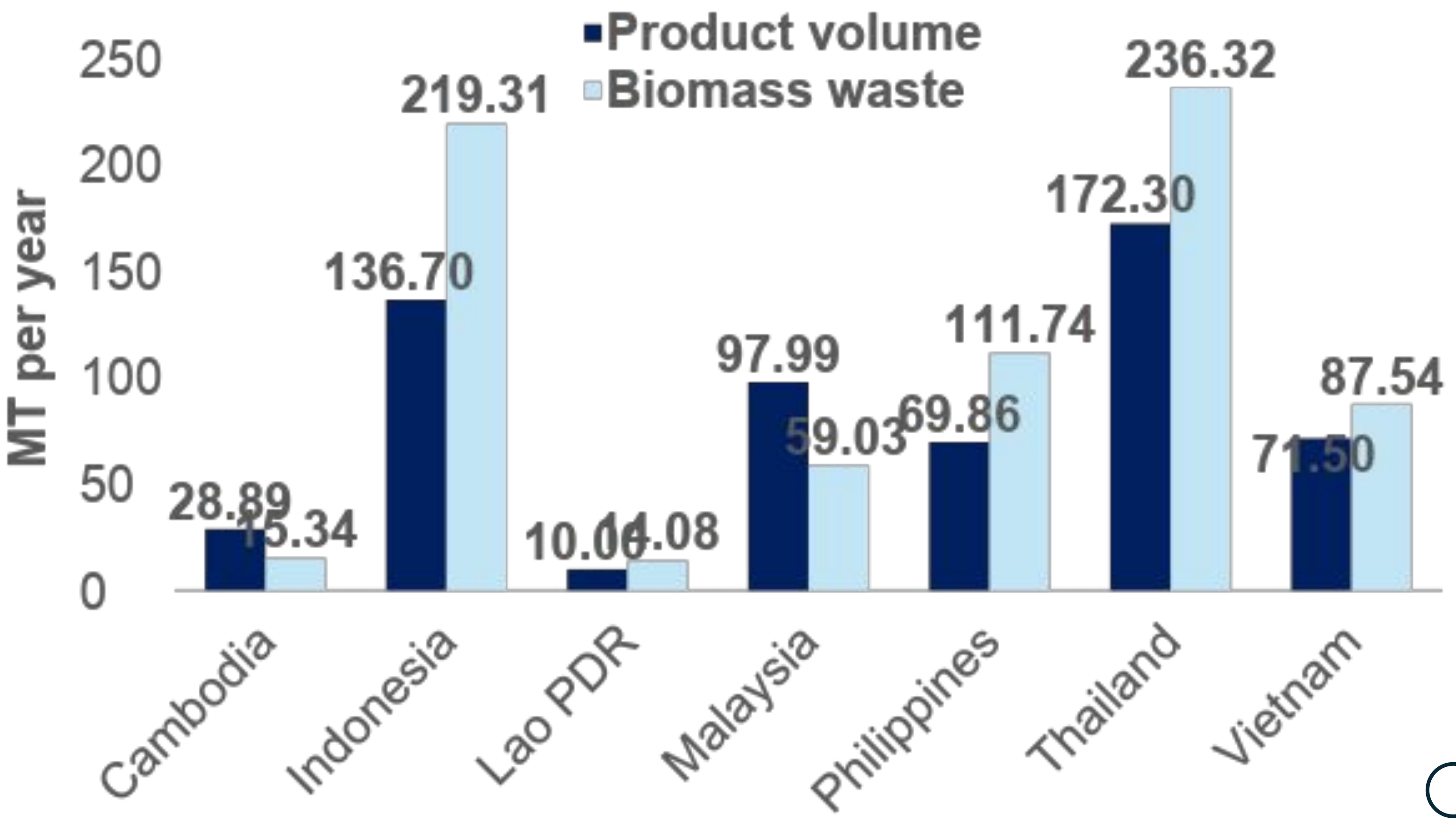


Figure 2: Product Volume and Biomass Waste per Country

*Sugarcane is not included in this chart because while sugarcane is typically the most prevalent crop, it is unlikely that sugarcane bagasse would be available for SAF production as it is used for energy generation

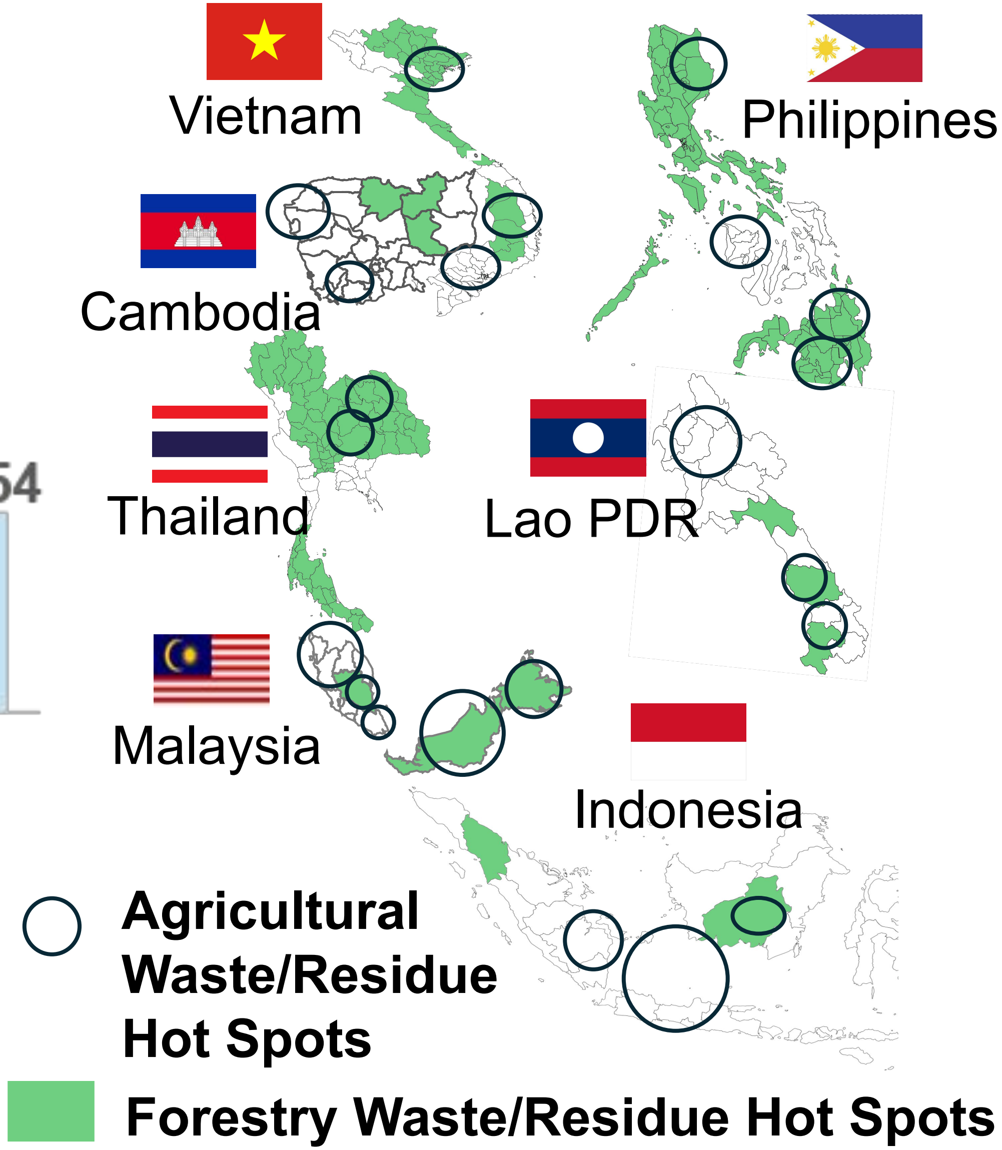


Figure 3: Overview of Agriculture and Forestry Waste/Residue Hot Spots in each Country

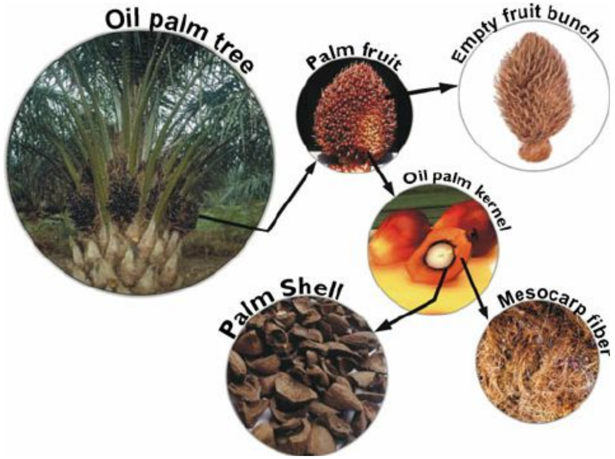
Feedstock Assessment

Available Feedstocks:

Rice husk & straw

Coconut husks

Non-standard Coconuts



Oil palm residues

Sugarcane bagasse

Cassava harvest

Corn

Forestry Waste

Pineapple

Technology Selection

Technology Pathways

Currently, drop-in biofuels are primarily produced via **Hydro-processed Esters and Fatty Acids (HEFA) from Hydrotreated Vegetable Oils (HVO)** or animal fats, but due to limited and expensive feedstocks, alternative pathways using more abundant and low-value feedstocks are being explored, despite higher investment costs.

Alternative Pathways:

- **Fischer-Tropsch (FT-SPK & FT-SPK/A):** Uses lignocellulosic feedstocks, requires drying and gasification.
- **Alcohol to Jet (AtJ-SPK):** Converts ethanol to jet fuel, involves biomass pre-treatment.
- **Hydrothermal Liquefaction (HTL):** No feedstock drying needed, high biocrude yield.
- **Gasification & Methanol Synthesis:** Produces methanol, which can be upgraded to jet fuel.

Technology Selection

- **HEFA:** Most mature SAF pathway with 100% blend capability, but requires significant hydrogen, raising costs and carbon intensity if non-renewable.

- **HTL:** High biocrude yield and feedstock flexibility, but complex with high CAPEX and unproven water treatment; ASTM approval may be challenged by biocrude variability.

- **ATJ:** ASTM-approved with saleable interim products, but complex and high CAPEX; offers flexible feedstock and potential for decentralized processing.

- **Gasification/FT:** ASTM-approved and self-sustaining, but costly and water-intensive; feedstock flexibility balanced by past tech failures impacting confidence.

- **Gasification/Methanol Synthesis:** Self-sustaining with saleable methanol, but highly complex with high CAPEX; lacks ASTM approval for SAF end product.

Carbon Intensity

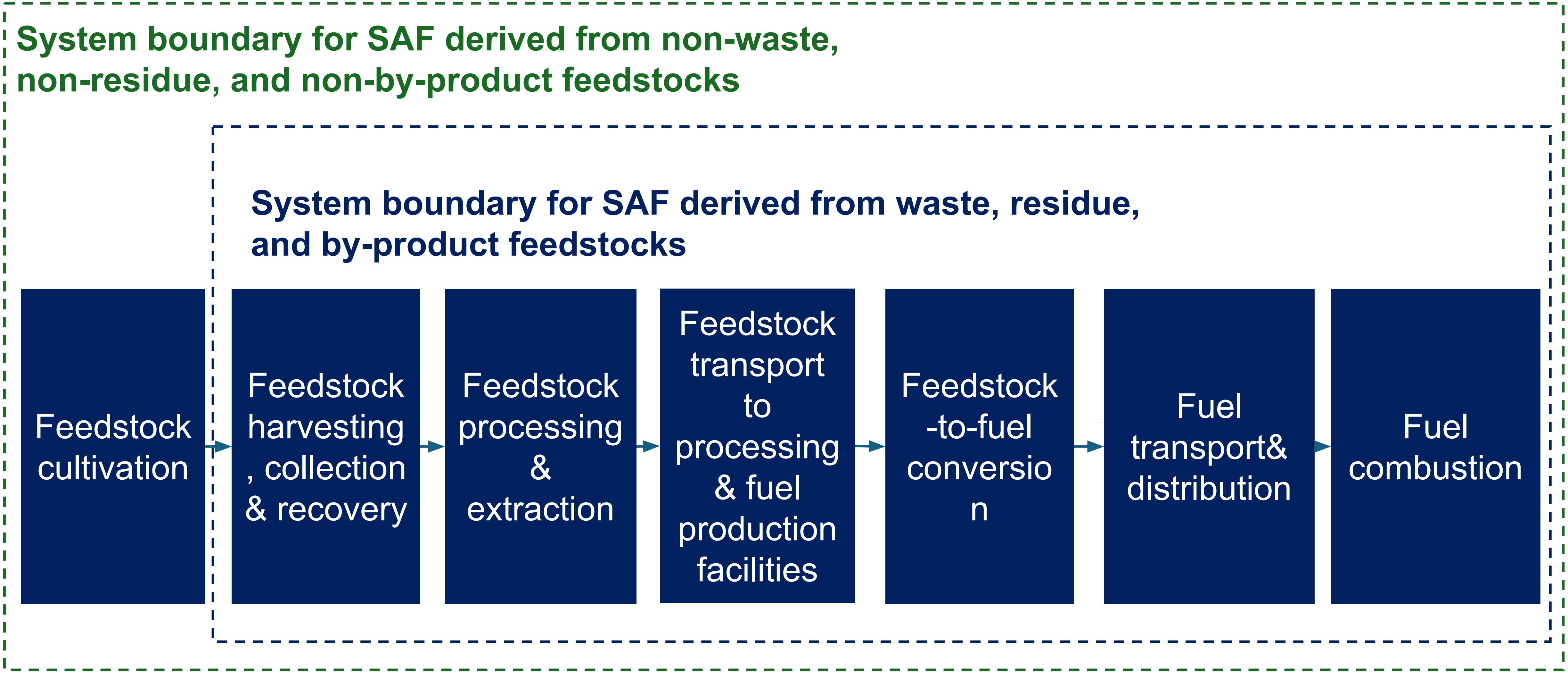


Figure 4: CORSIA SAF System Boundary Scenarios

Carbon Intensity

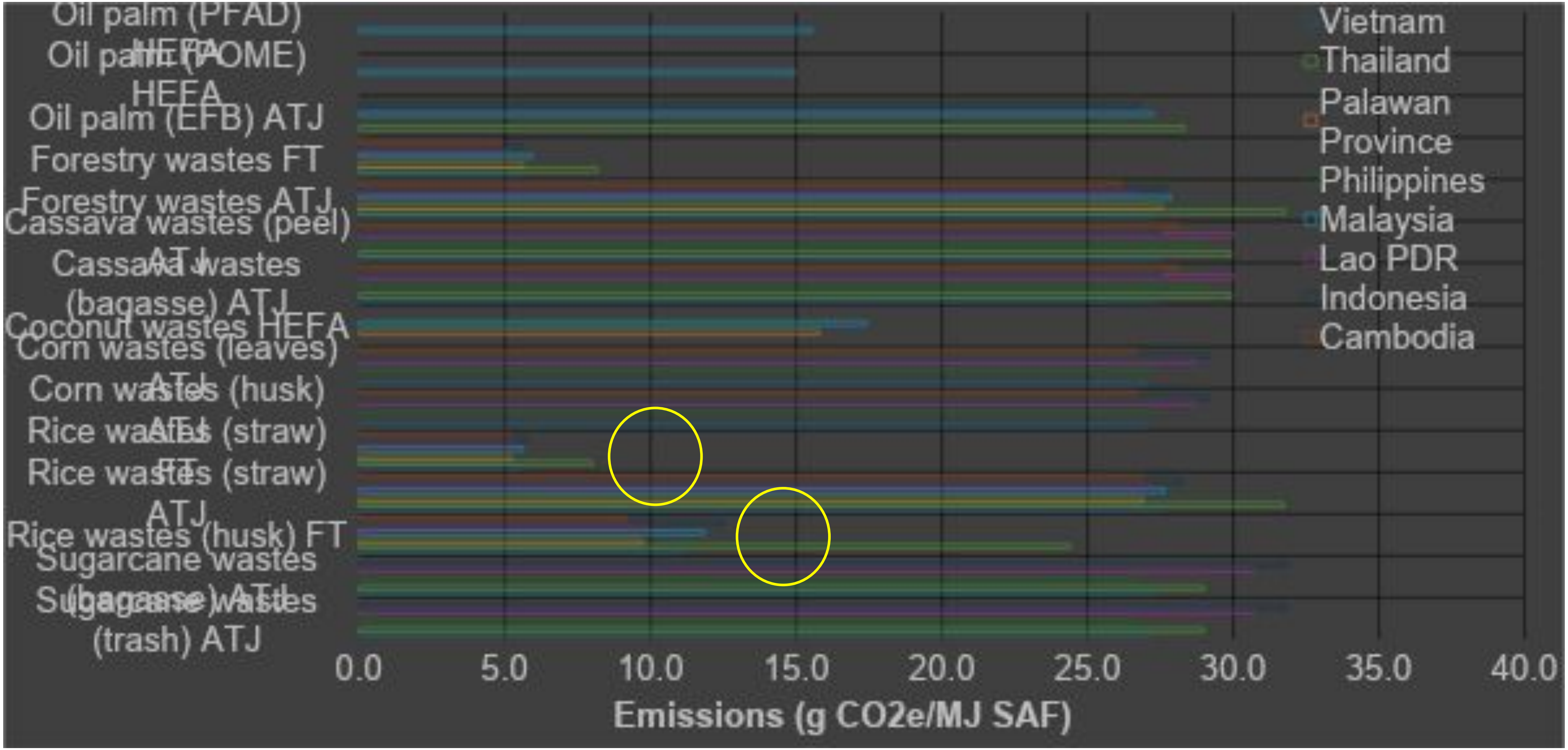


Figure 5: Estimated Carbon Intensities for Select Agriculture and Forestry Wastes

Feedstock and Product Logistics

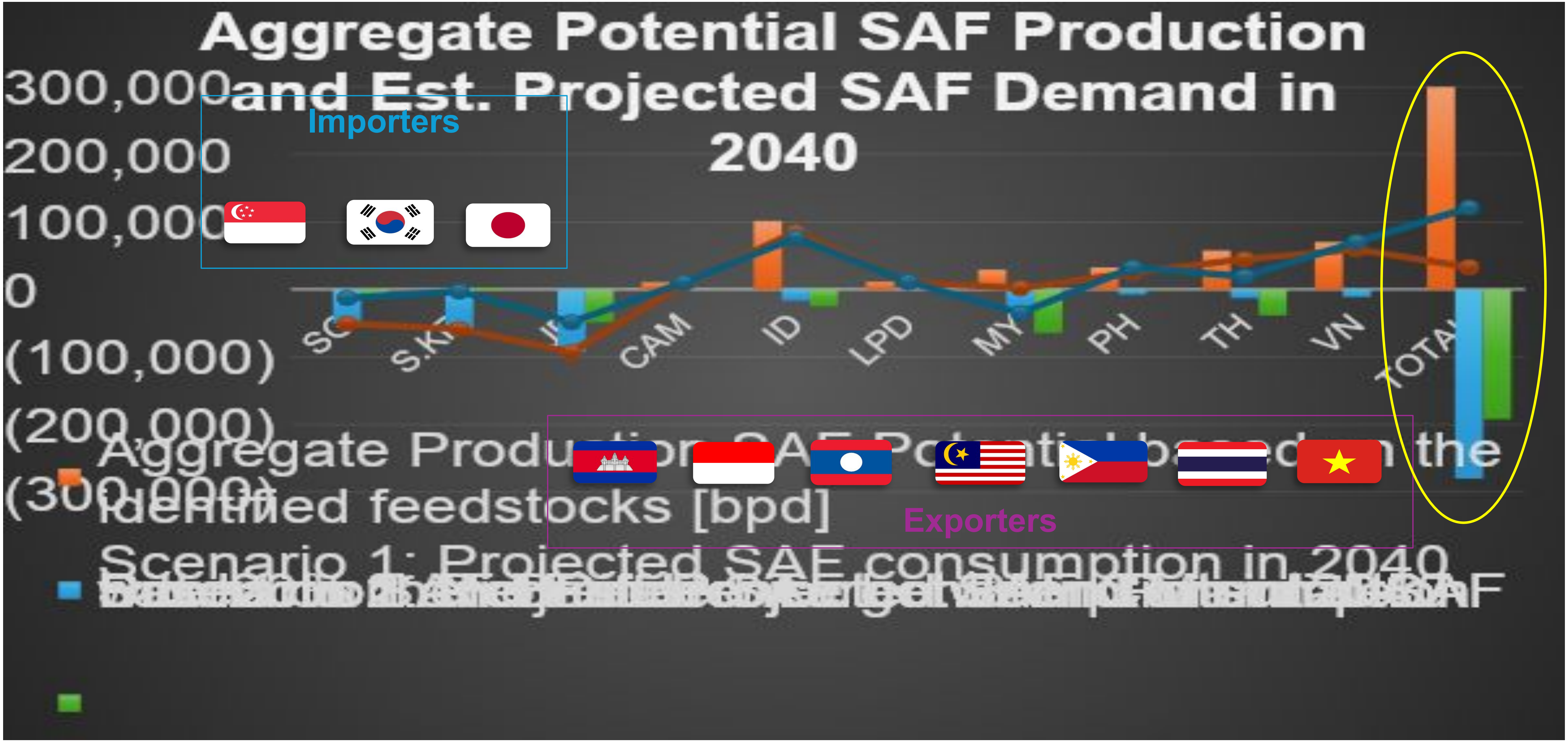


Figure 7: SAF Regional Supply – Demand Distribution

Institutional Frameworks

Global SAF Policy/Regulation Reference Points

- There is a SAF mandate which requires a minimum of 2% SAF at Union airports by 2025, with an obligation on fuel suppliers, progressively increasing to 70% by 2050.
- Aircraft operators that use SAF that comply with the sustainability criteria are able to reduce the number of ETS allowances they need to buy as an incentive by the European Union Emissions Trading System (EU ETS). However, free aviation emission allowances will be gradually phased out from 2024 to 2026, with up to 20 million allowances available based on the uptake of SAF on a first-come, first served basis.

- **Former**: The Blender's Tax Credit (BTC) was available to blenders that supply SAF with 50% or greater lifecycle emissions reductions. Fuels must have a lifecycle emission level of less than 50kg of CO_2eq per MMBTu.
- **2025 Shift**: A Producer's Tax Credit (PTC) will provide a credit to producers based on their fuel's carbon intensity (CI) score.
- The tax incentive is stackable with other Federal and state level credits and can be used to offset excise tax liability and lower selling price of the fuel.

Institutional Frameworks

Some examples of criteria and diagnostic questions that may be considered for policy developments are included below.

Lock-in and Policy Stability ("Stickiness")

Effective policy is thought to be effective in locking in and have difficulty in reversing. Various policies have different levels of lock-in and policy stability ("stickiness").

A key **diagnostic question** for this criteria is**:** **What can be done to create "stickiness" making reversibility immediately difficult?** An example includes contractual enablers that have the ability of establishing lock-in clauses and a duration for the contract.

Increasing Returns

Effective policy can also occur when the benefits increase over time.

The **diagnostic question** for this criteria is: **What can be done to entrench effectiveness over time?** A positive example may be establishments of Green Trade Lanes, which have the ability to provide long term benefits by accelerating the development and adoption of sustainable shipping technologies, promoting cleaner air quality in port cities, fostering economic growth through green innovation, and potentially contributing to reductions in greenhouse gas emission from international trade over time.

Institutional Frameworks

Some examples of criteria and diagnostic questions that may be considered for policy developments are included below.

Self Reinforcing

Similar to the concept of "stickiness" mentioned above, policies typically have greater success when they are self reinforcing and the costs of reversing rise over time.

The **diagnostic question** for this criteria is: **What can be done to self-reinforce and make reversibility immediately difficult**. Examples of this typically include government support for project developments that may influence technology readiness, production pathways and subsequent infrastructure developments. Once established, costs of reversing such infrastructure developments e.g. new or repurposes refineries, may increase over time.

Positive Feedback

In this case, the policy has the ability to achieve positive feedback and expand populators and reinforce original support.

The **diagnostic question** for this criteria is "**What can be done to expand the population that supports the policy**". In this case it is beneficial to consider both the US and EU policy approaches for SAF support. SAF adoption through production credits (e.g. US policy) may not be as effective as SAF Adoption Mandates at the End Use Location (e.g. EU policy) given adoption mandate appears to have greater ability to impact a greater number of populators.

Institutional Frameworks

Examples of Potential Levers (Government Support) for Project Developments that may be considered:

Based on the study completed, the following potential levers may be considered by government stakeholders to assist with the SAF project developments:

- Government to establish a biomass inventory register detailing biomass types, availability, utilization and major stakeholder groups.
- Government to establish land management outreach with farmers and the agricultural sector to promote involvement in SAF feedstock supply and sustainable attitudes to its production.
- Government to establish a centralised SAF development hub with general information to speed-up and facilitate developments including technology pathways with their costs, yields, utilities requirements, minimum scale, quantities of feedstock required.

Financial Assessment

The financial assessment included the scale of the plant, CAPEX, OPEX, the LCO SAF for technology pathways with the key findings documented and tabulated below.

Table 1: Scale, CAPEX and SAF price for each Technology Pathway

	Units	Gasification and FT	ATJ	HTL and Upgrading
Scale Minimum – 1,000 bpd	Feedstock Tpa*	490k	564k	210k
Ideal – 2,000 bpd	Feedstock Tpa*	980k	1,127k	420k
CAPEX 1,000 bpd	USD million	716	700	400
2,000 bpd	USD million	1,251	1,199	699
SAF price 1,000 bpd	USD / ton	9,223 - 10,200	9,154 – 10,150	5,048 – 5,600
2,000 bpd	USD / ton	8,159 – 9,050	7,970 – 8,850	4,454 – 4,940

**Biomass with 40% water content*

Concluding Remarks

Southeast Asia SAFs Hub

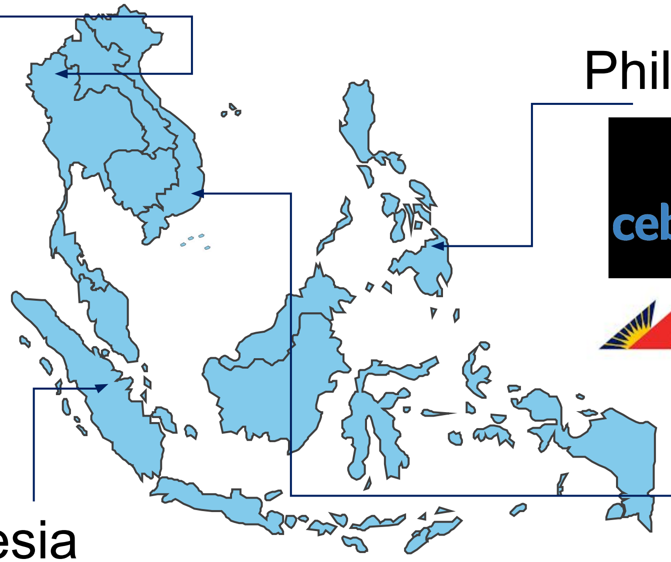
- Southeast Asia is strategically positioned to become a hub for SAF production due to its abundant feedstocks and proximity of high potential countries.
- SEA could produce 45.7 million MT of SAF annually by 2050 to meet 12% of global demand.
- Multiple initiatives and activities have already commenced including pilot SAF flights and SAF blending targets.

SAF Blending Target by Other Countries

- **Cambodia and Lao PDR**: *no official SAF mandates yet*
- **Malaysia**: **47% SAF Blending by 2050**
- **Singapore**: **3-5% SAF Blending by 2030**
- **South Korea**: **1% SAF Blending by 2027**
- **Japan**: **10% SAF Blending by 2030**

- SAF Targets by Thai Airways International: 2% to 60% SAF Blending from 2025 to 2050.

- Targets by PAL: min 1% SAF Blending by 2026



- Target: 5% SAF Blending by 2025, 10% SAF Blending by 2050.

- *No official SAF mandates yet.*

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*Thank You

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