Aerospace Malaysia Innovation Centre

The Centre of Excellence on Biomass Valorisation for Aviation

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Medan, Indonesia

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The Challenge (i)

Air traffic will double in the next 15 years

Source: Airbus
The Challenge (ii)

Public pressure

- Third Heathrow runway could triple pollution deaths
- A third runway at Heathrow would triple the number of early deaths from pollution linked to the airport, a new study claims.
- Flight ban to protect baby walruses beached in Alaska
- European biofuel targets contributing to global hunger, says Oxfam

Climate change marches: hundreds of thousands demand action

Industry's Action
- Fuel Efficiency
- Reduction in CO2
- Reduction in Noise
- Reduction in NOx

More efficient engines
More efficient aircraft
Air traffic management (ATM)
Sustainable Fuels
The Movement

Source: Airbus
Airbus Global Sustainable Aviation Fuel Efforts
Largest Aeronautical R&T program in Malaysia
Industry driven consortium focused on applied R&T linked to local businesses needs
Research Profile

9 GOVERNMENT AGENCIES

12 UNIVERSITIES/RESEARCH INSTITUTES

14 RUNNING RESEARCH PROJECTS

14 INDUSTRY PLAYERS

13.7M MILLION OF PROJECT VALUES

“Fostering Research and Technology Capabilities for Malaysian Aerospace Industry”

www.amic.my

An initiative under:

AIRBUS

RIC
The “CoE” initiative, spearheaded by AMIC-Airbus, was officially kicked-off in January 27th, 2014 at MIGHT, Cyberjaya.

Marks an unprecedented collaboration, through the formation of a consortium consisting of industrial, academic and governmental players with relevant experience and capabilities.

The Consortium focuses on identifying sustainable biomass and/or waste biomass in Malaysia suitable for efficient conversion towards a green, sustainable and certifiable aviation jet fuel.
CoE – Investigation Overview

Today’s biomass residue is tomorrow’s potential by-products
Pillars of the CoE

Sustainable Biomass:
- Sustainability of feedstock(s), production and its value chain.
- Logistics
- Social, social-economics, social-political
- Life cycle assessment & environmental impact
- Policy and certifications

Conversion / Upgrading:
- Biomass to fuel conversion
- Process assessment & optimization
- Logistics & Operations
- Fuel testing
- Life cycle assessment & environmental impact
- Qualification and certification

R&T and Innovation

Business Development

Strategy & Policy
Biomass Conversion Pathways

“Conventional” AVTUR Pathways:
(crude oil, natural gas liquid condensates, heavy oil, oil shale, oil sands, ...)

Non-“Conventional” pathways to produce AVTUR

Lipid based fuels
(oils, greases, fats, ...)
camelina, algae, ...
lipids

Carbohydrate based fuels
(sugars, lignocellulosic fibres, ...)
sugar cane, ... lignocellulosic fibres...
saccharification

Non-petroleum fossil based fuels
(coal and natural gas)
gasification

Straight distillation

Hydroprocessing

HEFA (2011)
D7566 annex 2
Co-processed task force
CH task force

DSHC task force

ATJ task force
SK, SAK task force
HDCJ task force
FT-SKA task force
FT-SPK (2009)
D7566 annex 1

DEF STAN 91-91 Aviation Turbine Fuels & ASTM D1655 JET A1 (A) fully miscible and fungible

Source: Courtesy of Airbus Group
Malaysia Biomass – West Peninsular

Trees & permanent crops
- Rubber
- Oil Palm
- Coconut
- Cocoa
- Coffee
- Areca nut
- Rumbia
- Tea
- Orchard

Horticultural lands
- Mixed Horticulture
- Vegetables
- Herbs and Spices

Forest Land
- Log-pile/Exlog pile sites
- Forest land
- Secondary forest

Scrubland
- Scrub

Animal Husbandry areas
- Aquaculture
- Poultry, etc.

Short-term crops
- Banana
- Fiber crops
- Pineapple
- Paddy
- Grass nursery
- Tobacco
- Sugarcane

Agricultural residues: Empty fruit bunches (EFB), Palm kernel shells, Straw, Rice Husk, Sugarcane bagasse, Leaves and cane tops, Wood residues, Cocoa pods, Coconut fronds, Husks and shells, Logging residues, etc.
Oil Palm – By products potential

EFB : 48 - 55 Mton
Fibre : 22 - 28 Mton
Shell : 15 - 18 Mton

Total : 86 – 100 Mton
Paddy – By products potential

Husk: 4 – 5 Mton

Shells: 1 – 2 Mton

Total: 5 – 6 Mton
Rubber – By products potential

Total: 0.2 – 0.7 Mton
Tops: 0.2 Mton

Bagasse: 0.3 Mton

Total: 0.5 Mton

Sugarcane – By products potential
Coconut – By products potential

Husk:
0.5 - 0.6 Mton

Shells:
0.1 - 0.2 Mton

Total:
0.7 – 0.8 Mton
Forest & Wood – By products potential

Forest Residues: 9 – 10 Mton

Panel Residues: 2 – 3 Mton

Wood Industry: 2 – 3 Mton

Total: 14 – 16 Mton
By Product Potential

- Rubberwood total sector residues
- Sugarcane total sector residues
- Coconut total sector residues
- Paddy / rice total sector residues
- Forest & wood total sector residues

Potential of residues (Million tons of fresh matter per year)
# By-product (Residue) Overview

<table>
<thead>
<tr>
<th>CROP Residues</th>
<th>Land Area</th>
<th>Land Extension</th>
<th>Main Product Availability</th>
<th>Residues Availability</th>
<th>Government Incentives</th>
<th>Poverty Alleviation</th>
<th>Climate Mitigation</th>
<th>Logistics difficulties</th>
<th>Deforestation potential</th>
<th>Competition with food</th>
<th>International opinion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palm Oil</td>
<td>✓ ✓</td>
<td>-</td>
<td>-</td>
<td>✓ ✓</td>
<td>✓ ✓</td>
<td>✓</td>
<td>-</td>
<td>✓ ✓</td>
<td>✓ ✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Forest</td>
<td>✓ ✓</td>
<td>-</td>
<td>✓</td>
<td>✓ ✓</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
<td>✓ ✓</td>
<td>✓ ✓</td>
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</tr>
<tr>
<td>Paddy</td>
<td>✓</td>
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<td>-</td>
<td>✓ ✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Rubber</td>
<td>✓</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>✓ ✓</td>
<td>✓</td>
<td>-</td>
<td>✓ ✓</td>
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</tr>
<tr>
<td>Sugarcane</td>
<td>✓</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>✓</td>
<td>-</td>
<td>✓</td>
<td>✓ ✓</td>
<td>-</td>
<td>✓</td>
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</tr>
<tr>
<td>Coconut</td>
<td>✓</td>
<td>-</td>
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<td>-</td>
<td>✓</td>
<td>-</td>
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Biomass Conversion Pathways

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(crude oil, natural gas liquid condensates, heavy oil, oil shale, oil sands, ...)

Lipid based fuels
(oils, greases, fats, ...)

camelina, algae, ...

Straight distillation

Catalytic hydrothermolysis

Hydroprocessing

HEFA (2011) D7566 annex 2
Co-processed task force
CH task force

Non-“Conventional” pathways to produce AVTUR

Carbohydrate based fuels
(sugars, lignocellulosic fibres, ...)

sugar cane, ...

saccharification

Catalytic upgrading

DSHC task force
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FT-SPK (2009) D7566 annex 1

DEF STAN 91-91 Aviation Turbine Fuels & ASTM D1655 JET A1 (A) fully miscible and fungible

Source: Courtesy of Airbus Group
## Feed to Fuel (Preliminary)

<table>
<thead>
<tr>
<th>Feedstock By-product</th>
<th>Potential (Min/Max) in million tons</th>
<th>Dry Weight (mil tons)</th>
<th>Potential Sustainable Fuel (mil tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rubber</td>
<td>Min : 0</td>
<td>Min : 0</td>
<td>Min : 0</td>
</tr>
<tr>
<td></td>
<td>Max : 0.76</td>
<td>Max : 0.23</td>
<td>Max : 0.04</td>
</tr>
<tr>
<td>Sugarcane</td>
<td>Min : 0.23</td>
<td>Min : 0.14</td>
<td>Min : 0.02</td>
</tr>
<tr>
<td></td>
<td>Max : 0.5</td>
<td>Max : 0.30</td>
<td>Max : 0.05</td>
</tr>
<tr>
<td>Coconut</td>
<td>Min : 0.17</td>
<td>Min : 0.12</td>
<td>Min : 0.02</td>
</tr>
<tr>
<td></td>
<td>Max : 0.8</td>
<td>Max : 0.56</td>
<td>Max : 0.09</td>
</tr>
<tr>
<td>Paddy</td>
<td>Min : 1.27</td>
<td>Min : 0.64</td>
<td>Min : 0.10</td>
</tr>
<tr>
<td></td>
<td>Max : 6</td>
<td>Max : 3</td>
<td>Max : 0.49</td>
</tr>
<tr>
<td>Forest Residue</td>
<td>Min : 6.30</td>
<td>Min : 3.78</td>
<td>Min : 0.62</td>
</tr>
<tr>
<td></td>
<td>Max : 16</td>
<td>Max : 9.60</td>
<td>Max : 1.57</td>
</tr>
<tr>
<td>Oil Palm</td>
<td>Min : 35.28</td>
<td>Min : 10.58</td>
<td>Min : 1.76</td>
</tr>
<tr>
<td></td>
<td>Max : 99.47</td>
<td>Max : 29.84</td>
<td>Max : 4.89</td>
</tr>
</tbody>
</table>

Total Potential Bio-Kerosene Jet-A1

**All Biomass Feedstock:** 8,562,787 L
**Without Oil Palm Feedstock:** 2,692,326 L
**Only Paddy + Forest:** 2,478,688 L
In Context (Preliminary)

- Entire Malaysia consumes over 3 billion litres of Jet Fuel per year, or over 50 thousand barrels a day\(^1\).

- Considering passenger traffic from Malaysia to Europe\(^2\), and the amount of potential bio-fuel:
  - All biomass feedstock, it is possible to achieve up to 5 – 6% bio-fuel blend on all flights to Europe departing from Malaysia.
  - Excluding palm oil, it is possible to achieve up to 1.5 – 2% bio-fuel blend on all flights to Europe from Malaysia.
  - With only Paddy + Forest residue, it is possible to achieve up to 1.5 – 2% bio-fuel blend on all flights to Europe from Malaysia.

- Paddy and Forest residues looks promising; in terms of biomass availability, sustainability, ease of valorisation, and conversion potential.

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1. theglobaleconomy.com, Jet Fuel Consumption 2010
Future Perspective

- Continue to refine the biomass by-product potential with more in-depth analysis.
- To dive into the valorization of the conversion process, with focus on paddy and forest residue feedstocks.
- To expand the scope into a regional scenario, using the model and simulations already in place.
- To disseminate and analyse data obtained thus far with relevant organizations.
- To assess the potential industrial and business models, along with their viability for sustainable aviation fuels market in the region.
Indonesia Perspective
Indonesia Perspective

The specifics of Indonesia: lots of biomass and... and a lot of Haze!

Concept for an Indonesian action for sustainable jetfuel – while mitigating the Haze (a potential for avoiding million tones of CO2 emissions)
Haze: a global hazard

Gigatons of CO2 emissions

Source: Bapenas
Haze: 2014 fires in Sumatra (by districts)
Case of the wetlands
Case of the drylands
Up to 40% of the lignocellulosic biomass is wasted and could be valorised
Concept for an Indonesian action for sustainable jetfuel – while mitigating the Haze (a potential for avoiding million tones of Co2 emissions)
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Bio-jetfuel can give value to this biomass

Biomass without value

Bio-jetfuel economic engine helps poor people and agencies to prevent some fires
Jetfuel demand for biomass creates sustainable value for some wetland surface biomass

This value can trigger a marginal decrease of fire starts and a better landscape management (water table)
The leverage power of demand for biofuel blend from Sumatra
A decrease of 0.5% of Sumatran haze triggered by aviation demand for biofuel…

…will save as much CO2 as 5% of biofuel blend in all Thailand, Malaysia, Singapore, and Indonesia annual jetfuel consumption.
Thank you!

Center of Excellence on Biomass Valorization for Aviation

Credit to the COE Team:
Jean-Marc Roda, Maxime Goralski, Anthony Benoist, Kan-Ern Liew, Frederic Eychenne, Cyrille Schwob, Marcel Djama, Paridah Md Tahir, Anaphel Baptiste, Valentine Boudjema, Theodoros Galanos, Jean-Eudes Hevin, Simon Lavergne