Development of Biogas Projects in FGV:

Reflections & Way Forward and Opportunities for Value Creation in Palm Oil Based Biogas – Bio CNG and Biogas for Offgrid Power

19th International Oil Palm Conference, 26th - 28th September 2018

D. Mohd Reza

Felda Palm Industries Sdn. Bhd.

Milestones

1956

The Land Development Ordinance 1956 came into force on 1 July and FELDA was established with a starting capital of RM10 million.

A total of
112,635 SETTLERS
were taken in between
1957 – 1990.

1995

FELDA HOLDINGS SDN BHD
(now Felda Holdings Bhd or FHB)
was set up as
FELDA's commercial arm.

ALL FELDA COMPANIES AND CORPORATIONS BECAME SUBSIDIARIES UNDER FHB.

2007

FELDA incorporated **Felda Global Ventures Holdings Sdn Bhd (FGV)** to operate as a commercial arm for FELDA's overseas investments in upstream and downstream palm oil businesses as well as other agri-business.

2010

The Felda Group became the world's first smallholder organisation to attain the Roundtable on Sustainable Palm Oil (RSPO) Certification.

RSPO

1st IN THE WORLD

2011

MSM Malaysia Holdings Berhad, a subsidiary of FGV, was listed on the Main Market of Bursa Malaysia Securities Bhd. The exercise raised

RM796 million

It was the first company within the Felda Group to go public in Malaysia.

2012

On 28 June, FGV was listed on Bursa Malaysia. The initial public offering, which was the world's third largest in 2012, raised RM10.4 billion.

MAIN BOARD OF BURSA MALAYSIA

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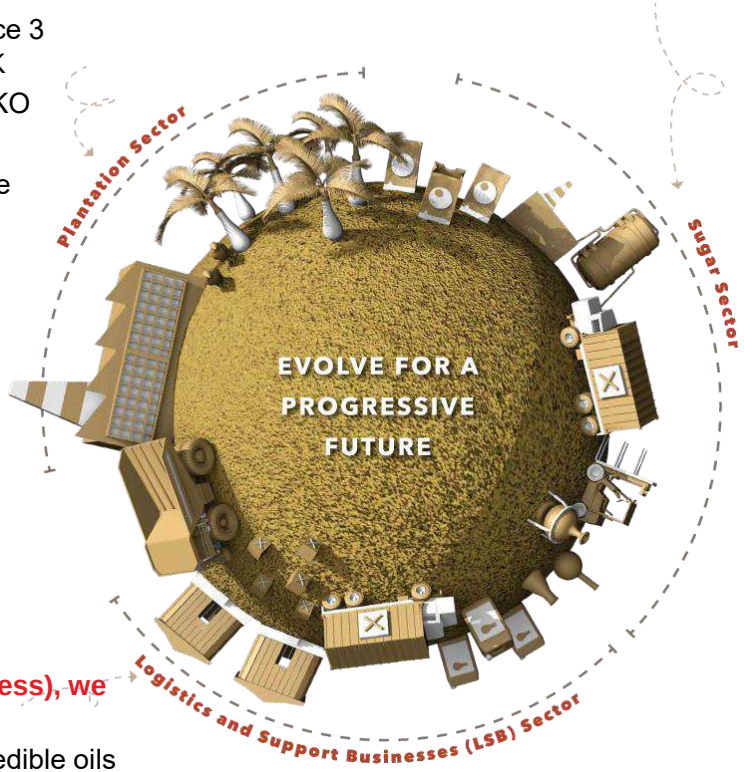
Our Business Activities That Create Values

On an Annual Basis:

- We process 15 million MT of FFB to produce 3 million MT of CPO and 0.80 million MT of PK
- We produce around 0.35 million MT of CPKO
- We sell 61% of our CPO to the market
- We refine 39% of CPO internally to produce palm olein, industrial and specialty fats for industrial usage and consumer consumption

In 2017, we increased our Stock Keeping Units to 143 items for domestic



Through MSM:

- We produce more than 1 million MT refined sugar annually for domestic and export markets
- We export 14% of our sugar to countries like Singapore, Papua New Guinea, Hong Kong, New Zealand and South Korea
- We produce seven types of products from sugar for the domestic market

Under LSB (Logistics and Support Business), we manage:

- Over 0.95 million MT storage capacity for edible oils
- 433 liquid and cargo tankers
- 3 warehouses and 2 jetty operations

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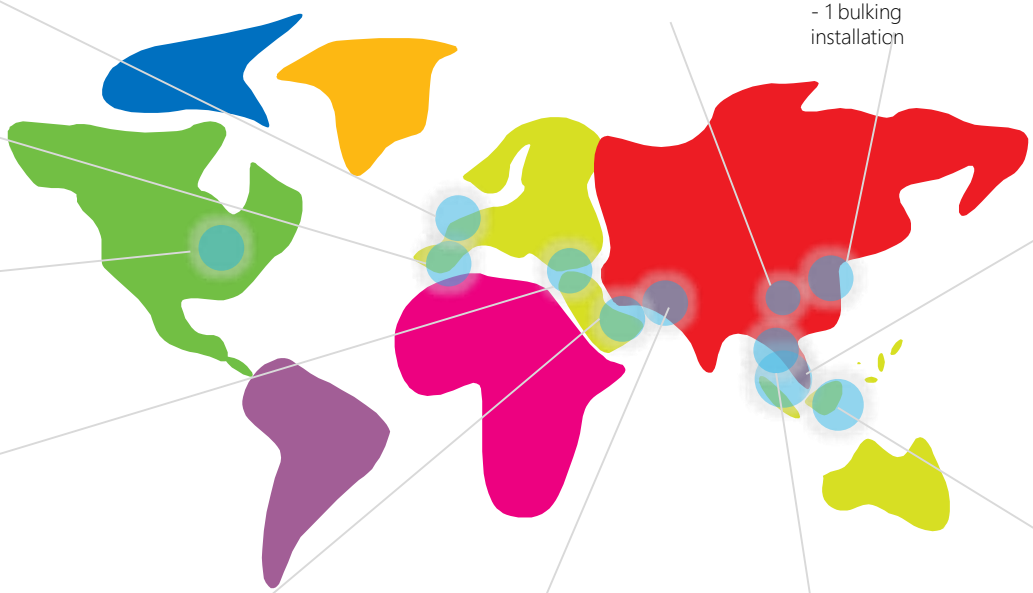
Our Global Presence



France
- 1 trading office*

Spain
- 1 trading office*

USA
- 1 oleochemical plant

Turkey
- 1 trading office

Cambodia
- 1 rubber processing facility*

China
- 1 oil palm refinery
- 1 bulking installation

Malaysia
-415,000 Ha of planted oil palm estates
- 12,519 Ha of planted rubber estates
- 66 mills
- 4 rubber processing facilities
- 6 oil palm refineries (2 are JVs)
- 4 kernel crushing plants
- 1 biodiesel plant
- 1 oleochemical plant*
- 3 R&D centres
- 2 sugar refineries
- 6 bulking installations (12 terminals)
- 3 warehouses
- 12 transport hubs
- 433 liquid and cargo tankers
- 1 jetty operation

Indonesia
- 35,000 Ha of planted oil palm estates^#
- 1 oil palm refinery*
- 1 rubber processing facility*
- 1 bulking installation
- 1 trading office

UAE
- 1 trading office

Pakistan
- 1 oil palm refinery*
- 1 bulking installation
- 1 jetty operation
- 1 oil seed crushing plant*

Thailand
- 1 rubber processing facility*

** Joint Ventures*
^ Excluding oil palm estates held under joint ventures
 # Inclusive of plasma

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Introduction of Felda Palm Industries Sdn Bhd (FPISB)

- **Felda Palm Industries Sdn Bhd (FPISB**) is a subsidiary of FGV. It was incorporated on the 14th September 1995.

Snapshot of our business..

- **415,000 ha of plantation estates**
- **12,519 ha of rubber plantations**

- **FPISB**
- **66 palm oil mills**
  - **Milling capacity – 3041 MT of FFB per hour**
  - **15 million MT of FFB per year**
  - **CPO production 2.5 – 3.5 million /year**

- 2 palm oil refineries through joint ventures
- 5 palm oil refineries through our associates
- 3.3 MM MT capacity (including JVs and associates)

- 7 bulking installations
  - – > 400 storage tanks with 752,250 MT capacity
- 2 warehouses
  - – 88,000 MT storage capacity
- 7 distribution depots

- Production of 99,000 MT of packed goods for consumers and food services industry
- Production of 1.6 MM MT of RBD products

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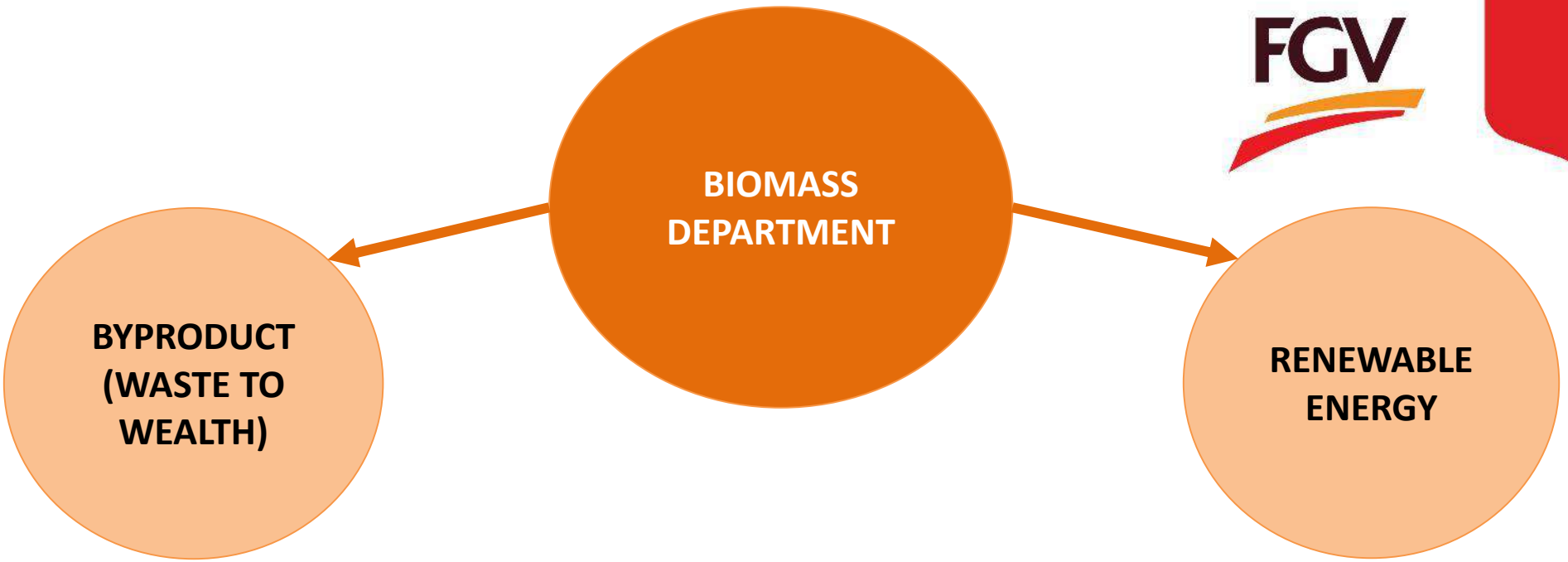
FPISB – BIOMASS DEPARTMENT



Byproducts

- Palm kernel shells
- Sludge oil
- EFB (empty fruit bunches)
- Organic compost
- Shredded EFB
- POME
- Decanter cake
- Black Soil
- Scum
- Scrap iron
- Kernel Oil
- DLF (Dried Long Fiber)
- Mesocarp fiber

25 Biogas plants

- 1 BioCNG Plant
- 9 Biogas Plants to national grid
- 4 Biogas Plants to boilers
- 1 Biogas Plant for rural electrification

6 Composting Plants

12.5 MW EFB Power Plant for national grid

7.5 MW EFB Power Plant

- electricity and steam to refinery
- electricity to kernel crushing plant
- electricity for a township

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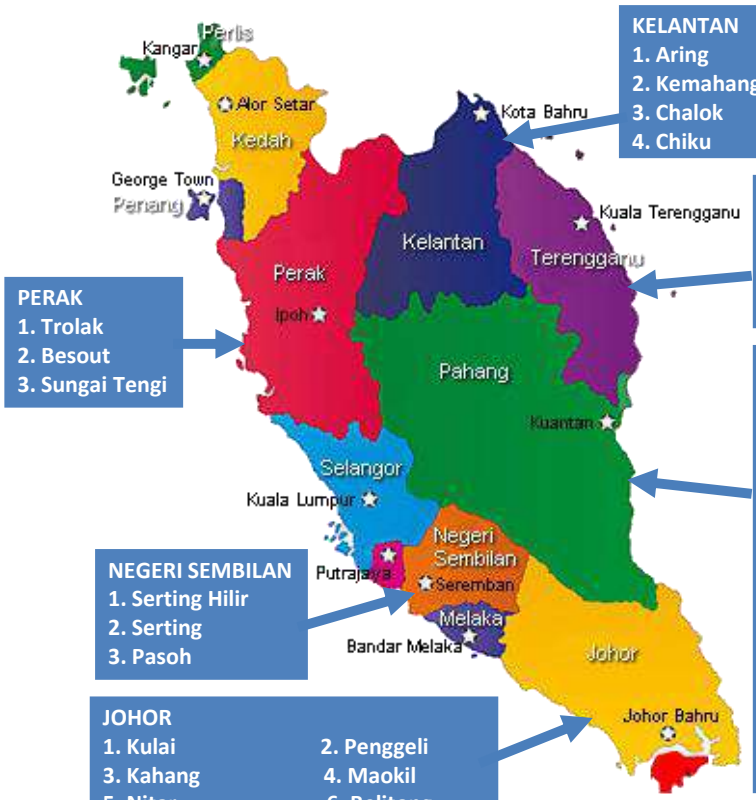
FPISB Palm Oil Mills (Peninsular Malaysia)



KELANTAN
1. Aring
2. Kemahang
3. Chalok
4. Chiku

TERENGGANU
1. Neram
2. Jerangau Barat
3. Jerangau Baru
4. Kerteh

PERAK
1. Trolak
2. Besout
3. Sungai Tengi

PAHANG

1. Lepar Hilir	2. Bukit Sagu
3. Panching	4. Kota Gelanggi
5. Seroja	6. Lepar Utara 6
7. Jengka 8	8. Jengka 3
9. Jengka 21	10. Padang Piol
11. Tersang	12. Kechau B
13. Chini 3	14. Chini 2
15. Selendang	16. Bukit Mendi
17. Bukit Kepayang	18. Tementi
19. Kemasul	20. Triang
21. Selancar 2A	22. Selancar 2B
23. Keratong 2	24. Keratong 3
25. Keratong 9	26. Krau
27. Mempaga	

NEGERI SEMBILAN
1. Serting Hilir
2. Serting
3. Pasoh

JOHOR

1. Kulai	2. Penggeli
3. Kahang	4. Maokil
5. Nitar	6. Belitong
7. Palong Timur	8. Air Tawar
9. Semenchu	10. Lok Heng
11. Adela	12. Tenggaroh 4
13. Tenggaroh Timur	14. Waha
15. Palong Timur	

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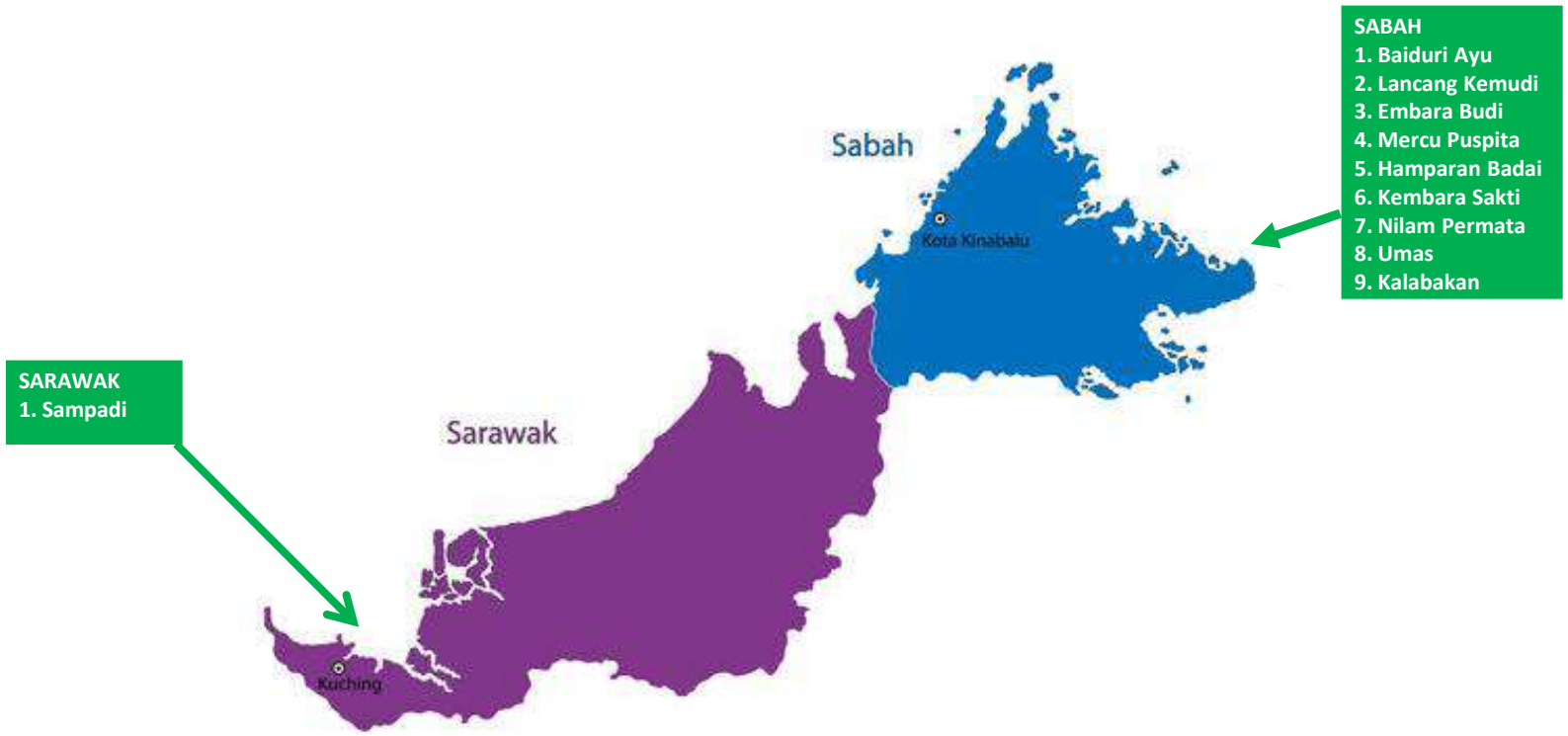
FPISB Palm Oil Mills (Sabah & Sarawak)



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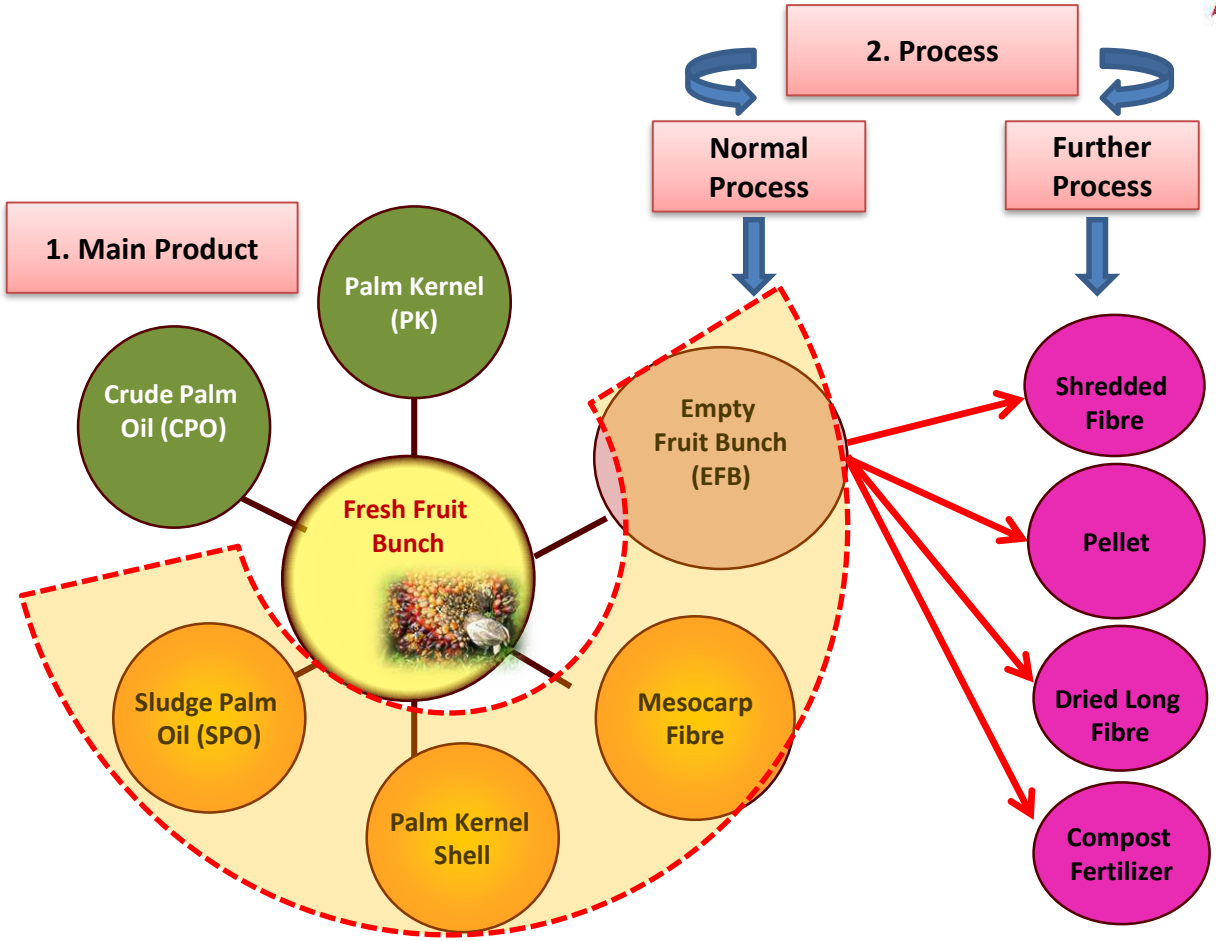
Biomass from the milling process



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Presentation Outline

1. Status of biogas plant development & utilization under EPP5

2. Development of Bio-CNG in Malaysia – A case study in Sungai Tengi Palm Oil Mill

3. Biogas to off-grid power – Felda Umas Palm Oil Mill, Sabah

4. Issues and Challenges

5. Way Forward

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Palm Oil Mill Effluent (POME) and Biogas Production in Malaysia (2015)*

Material	Quantity
FFB	97.57 million tonnes
Effluent	63.42 million tonnes = 63.42 million m^3
Treatment type	Ponding system : 91.3% Open digester : 8.7%
Biogas	1775.8 million m^3
Potential Electricity, MW	548 MW
GHG emission	17 – 20 million tonnes of CO_2 eq

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*Source MPOB

EPP5: Building Biogas Facilities at Palm Oil Mills*

Objectives

- All palm oil mills to install biogas facilities (or methane avoidance) by 2020
- To encourage use as energy source for internal use and to supply to national electricity grid
- GNI – RM2.9 billion (~ USD 0.65 billion)

Economic Benefits

- Biogas as fuel for in-house use and grid connection

Environmental Benefits

- To reduce carbon footprint of CPO production (GHG saving 17 – 20 mill. Tonnes of CO_2 eq / year)
- Upgrading of waste water treatment plant
- Enhance market acceptance & sustainability of M'sian Palm Oil Products

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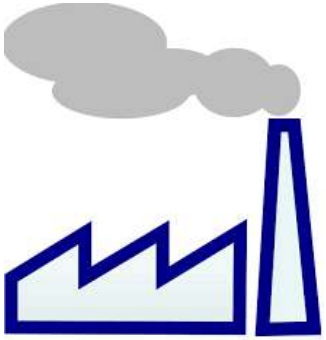
*Source MPOB

Status of Development EPP5 (as of July 2016)*



445 mills

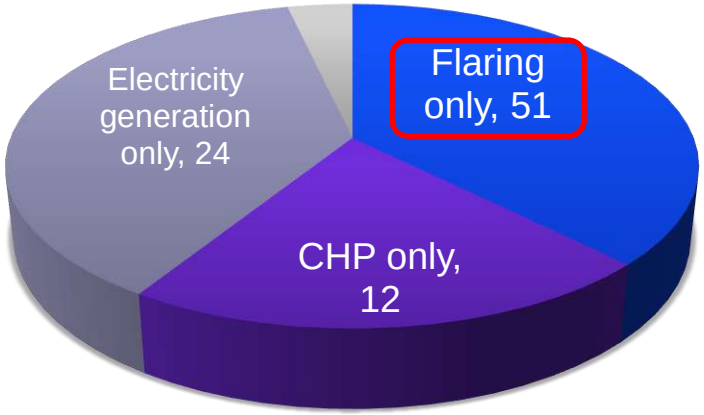
Status	
Completed Biogas Plants	89
Under Construction	5
Under Planning	145

Technology used of 89 completed biogas plants

Covered / engineered lagoon digesters : 38 units

Tank Digesters : 51 units

Utilization of the biogas plants



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*Et al MPOB

Introduction to Felda Palm Industries Sdn. Bhd.

- ✓ One of subsidiary of Felda Global Ventures (FGV)
- ✓ Felda Palm Industries Sdn Bhd - incorporated 1995
- ✓ No of Mills - 66 (as of 2018)
- ✓ No of Employees - +/- 6000
- ✓ FPISB is one of the largest producer of CPO & PK globally
- ✓ FPISB had embarked on progressive, consistent biogas initiatives since 2000

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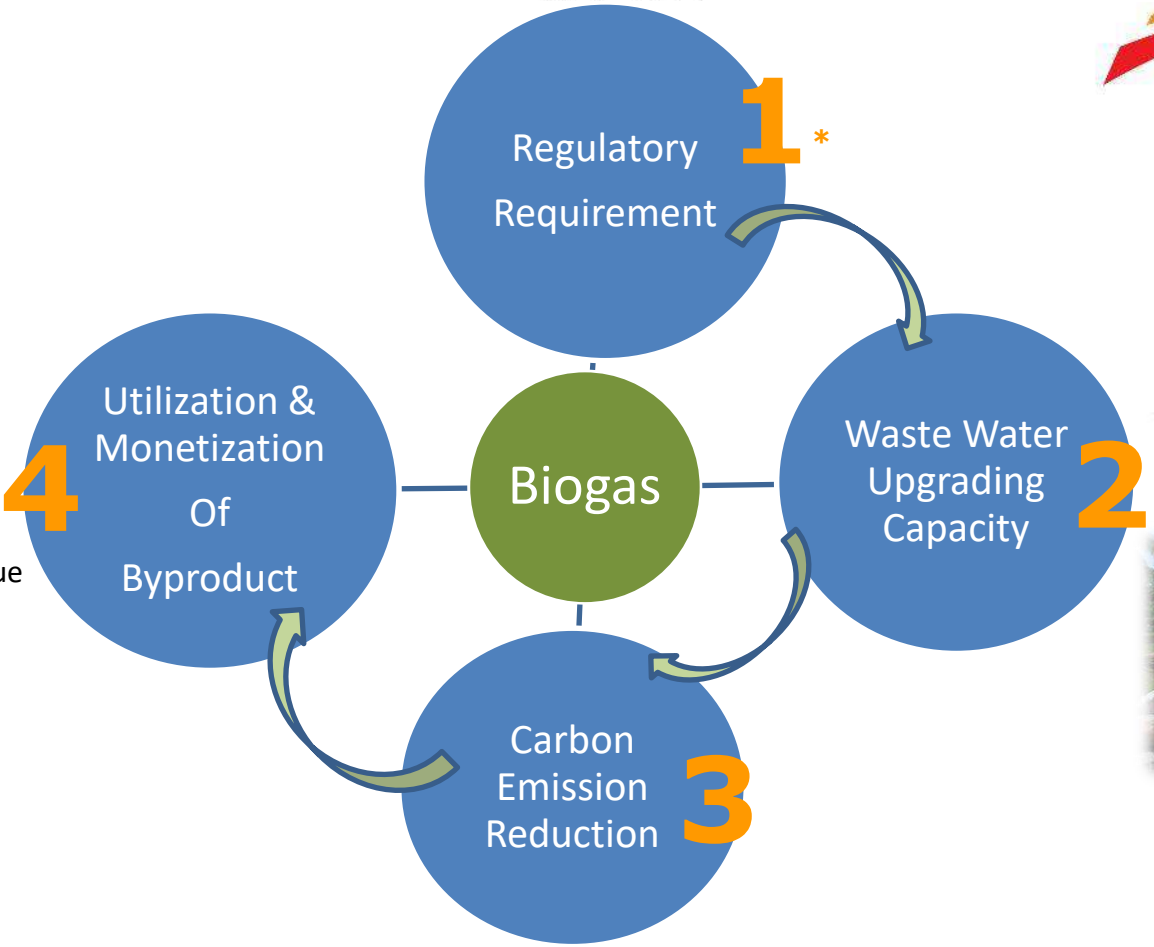
Why do we build biogas plant ?

* Number indicates priority 1>x>4

MPOB directives for upgraded/new mill



Biogas reactor reduces >95% COD

Additional revenue stream for mill

FGV achieves more than 90,000 mt CO2 eq CER/year (largest emission reduction by a plantation company

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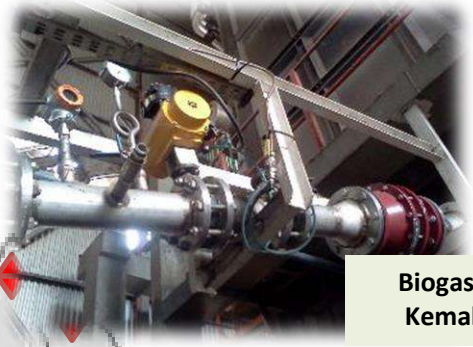
FELDA PALM INDUSTRIES - BIOGAS PROJECT LOCATION - MALAYSIA



Biogas to boiler – Kemahang POM

Biogas to Grid – Nitar POM

Rural Electrification – Umas POM

Nitar Gas Engine 1.6 MW

25 biogas plant nationwide (2018)

'Single Plantation Company in Malaysia & Indonesia having the most biogas plants'

- **Biogas Project**
- **Biogas with Power Generation**
- **Biogas with Gas Compression**

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BIOGAS PLANT
KALABAKAN PALM OIL MILL, TAWAU, SABAH

TECHNICAL DATA SUMMARY

Mill Capacity :
54 mt/hr
Biogas Capacity :
38,000 mt of POME
Biogas Flowrate :
700 – 800 m3/hr
Date commissioned **:**
February 2016

Successfully recorded first 1 million meter cube of biogas burned early May 2016
Consistent reduction of COD at 98.5 – 99 %
Integrated with Composting Plant (supply to nearby FGV plantation)
Outflow of biogas further treated with bio-polishing plant with consistent BOD of below 50 ppm

Bio-polishing Plant

Fully integrated mill with biogas, biopolishing plant and composting plant to reduce GHG emission

Flaring system

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BIOGAS PLANT IN TRIANG & KERATONG 9 PALM OIL MILL

TECHNICAL SUMMARY KERATONG 9 MILL

Mill Capacity :
40 mt/hr
Biogas Capacity :
60,000 mt of POME
Biogas Flowrate :
> 1000 m3/hr
Date commissioned **:**
April 2016

Latest addition of FGV biogas plant successfully commissioned - April 2016
Biggest POME holding capacity
(60,000 mt) to date

Triang & Keratong 9 Mill Biogas Planned Utilization :
Grid connection of 2 MW / each

TECHNICAL SUMMARY TRIANG MILL

Mill Capacity :
54 mt/hr
Biogas Capacity :
60,000 mt of POME
Biogas Flowrate :
> 1000 m3/hr
Date commissioned **:**
April 2016

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BIOGAS UTILIZATION : PALM OIL MILLING CONTEXT

Fresh Fruit Bunches

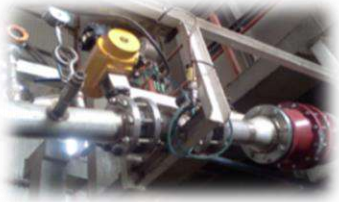
Palm Oil Mill Processing

POME : 60 – 70% of FFB

Anaerobic Digestion & Gas Capturing Facility

- **Power**
- BioCNG
- NGV
- Boiler
- Flaring

Powerup Mill and Steam used for Sterilisation and Heating



*BioCNG main application as industrial heating

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BIOGAS UTILIZATION : CONSIDERATIONS

Options for Biogas Capture

- **Basic Biogas Facilities**
  - **Flaring**
    - Basic facility
    - Flaring has no revenue generation
    - Energy cost savings for mills using boiler
    - No load at the area based on Power System Study by TNB
    - Interconnection Point, too far from mill (>5 km)
  - **Mill Use – Boiler or Engine**
    - Biogas Engine for internal use (diesel fuel displacement)
- **Connection to Grid**
  - **National Grid through FiT**
    - Requires FiT quota for National Grid
    - Revenue generation
    - Relative high CAPEX
  - **Direct Sale of Energy and Rural Electrification**
- **Other Options**
  - **Bio-Compressed Natural Gas (CNG)**
    - 1st commercial pilot plant in Sg. Tengi POM
    - Natural gas & revenue generation
    - Compressed gas sold to industrial customer
    - Vehicle conversion

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WORLD'S FIRST COMMERCIAL SCALE PALM BASED BIO-COMPRESSED NATURAL GAS

- Back in 2013, MPOB, FPISB & SDOE agreed to jointly collaborate on development of bio-compressed natural gas (BioCNG) from palm oil mill effluent (POME).

- **OBJECTIVE :**
  - **a) demonstrate operational & technical feasibility in bioCNG plant** (no other reference plant in the world) and **product quality acceptance to the market/customers**
  - **b) developing new value chain from biogas generation to bioCNG utilization** and **validate business case** for the plant against expected financial target

- Project has launched successfully on 28th October 2015 by Minister of Plantation Industries & Commodities, Malaysia

- Project showcase strong and fruitful collaboration between government & industry player (palm oil & technology provider)

- MPOB extensive support for project includes R&D, joint feasibility study & policy advisor

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Collaboration Approach

FGV

To provide fund ,space, manpower, utilities and biogas facilities for the development and operation of Bio-CNG plant

MPOB

To provide grant (mainly for the plant) and R&D expertise for the development, help government approvals

Sime Darby Energy & Utilities

Turnkey Contractor / Technology provider & Product Distributor

Commissioning and performance assessment Field trial / Utilization trial of the product

Commercial operation of the plant and commercialization of the Bio-CNG by FPISB

Selling and distribution of Bio-CNG to Industrial users

JV Co. for Marketing and Offtake/ Distribution of the Product

Sime Darby Energy & Utilities

GAS MALAYSIA

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February 2013 - MPOB identified Bio-CNG as a potential use of biogas

July 2013 – Industrial collaborators identified for project development – FPI and SDOE

October 2013 - Steering Committee of NKEA has approved project

February 2014 – Ground work at Sg. Tengi Palm Oil Mill

August 2014 - Installation of Bio-CNG Plant at Sg Tengi POM

December 2014 – Completion of installation work

February 2015 – Full commissioning of the plant

October 2015 – Launching of the plant

Hon. Minister MPIC

April – May 2016 – Production trials

May 2016 – Gas Purchase/Sales Agreement finalised

July 2016 – Commercial production of the Bio-CNG plant

Project Approach & Milestones

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Development of Bio-CNG Plant at Sg Tengi Palm Oil Mill

February 2014

June 2014

August 2014

May 2016

February 2015

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Media Coverage on Launching Event

MENTERI Perusahaan Perladangan dan Komoditi, Datuk Douglas Uggah Embas (kanan), bersama Presiden Kumpulan Felda, Tan Sri Mohd Isa Abdul Samad, melintasi Loji Pengeluaran ketika Majlis Perasmian Projek Usahasama Loji Pengeluaran Komersial " Bio - Compressed Natural Gal (BIO-CNG) ", pertama didunia menggunakan sumber biogas sawit di kilang Sawit Sungai Tengi, Kuala Kubu Baru, Selangor.- Foto Mohamad Shahril Badri Saali

SERENDAH, Selangor: Kerajaan mengenal pasti 113 kilang sawit di negara ini berpotensi untuk penjanaan elektrik daripada sumber biogas kelapa sawit.

Menteri Perusahaan Perladangan dan Komoditi, Datuk Amar Douglas Uggah Embas, berkata langkah itu bagi membolehkan kilang sawit yang terletak berdekatan dengan

Plantation Industries and Commodities Minister ***Datuk Amar Douglas Uggah Embas*** *flagging off the trailer transporting bio-CNG at the* ***launch of a bio-CNG plant*** *yesterday.*

Palm oil millers leading green way

ECO-FRIENDLY: 79 palm oil mills across the country have installed biogas plants to capture greenhouse gas

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PALM oil millers in Malaysia are leading the way in "greening" the palm oil supply chain by capturing dirty greenhouse gas before it enters the atmosphere and turning it into clean energy.

"A total of 79 palm oil mills across Malaysia have installed biogas plants to capture greenhouse gas," said Plantation Industries and Commodities Minister Datuk Amar Douglas Uggah Embas.

"If all mills capture and use this biogas, up to 20 million tonnes of carbon dioxide equivalent of greenhouse gas emissions can be mitigated per year," he said.

This, in terms of carbon dioxide emissions, is equivalent to about removing four million cars off the road," he said after launching a bio-Compressed Natural Gas (bio-CNG) plant, the first in the world to source from oil palm waste, here, yesterday.

These waste-to-energy plants help lower greenhouse gas emissions. Planters get to reduce reliance on fossil fuels, too.

Uggah said the government mandates eco-friendly projects by the palm oil industry in championing Malaysia's commitments to reduce carbon emissions by 40 per cent in 2020.

The bio-CNG commercial plant, located at Felda Sg Tengi estate, is a joint project with Malaysian Palm Oil Board, Felda Palm Industries Sdn Bhd and Sime Darby Offshore Engineering Sdn Bhd.

The plant is able to process 600 cu m of raw biogas generated from palm oil mill effluent lagoons.

These are then channelled into closed biogas digesters to produce bio-CNG as an alternative to fossil-based fuels such as liquefied petroleum gas and medium fuel oil.

It must be highlighted that bio-CNG is not able to substitute piped natural gas which is currently sold at an average subsidised rate of RM21.80 per British thermal units parts per million (mmBtu).

Felda Global Ventures Holdings Bhd chairman Tan Sri Mohd Isa Abdul Samad said the group has, so far, set up 25 biogas plants throughout its estates in Malaysia.

"By 2020, we aim to push this figure to 51. As the world's largest crude palm oil producer, we're committed to reducing our carbon footprint and improving our environmental friendly practices for the benefit of our community," Isa added.

Sime Darby Bhd is partnering Gas Malaysia Bhd on a 51:49 basis to distribute bio-CNG, a new and growing business. This initiative to supply bio-CNG to new customers will be driven by Sime Darby Offshore Engineering Sdn Bhd.

Scope of the Project

FPISB Biogas and utility	MPOB, FPI & SIME DARBY - upgrading and compression	SIME DARBY, Gas Malaysian & MISC - Distribution and marketing - Trailer / prime mover	Industrial customer

MPOB to monitor the project progress – R&D and commercial basis & Bio-CNG value/supply Chain

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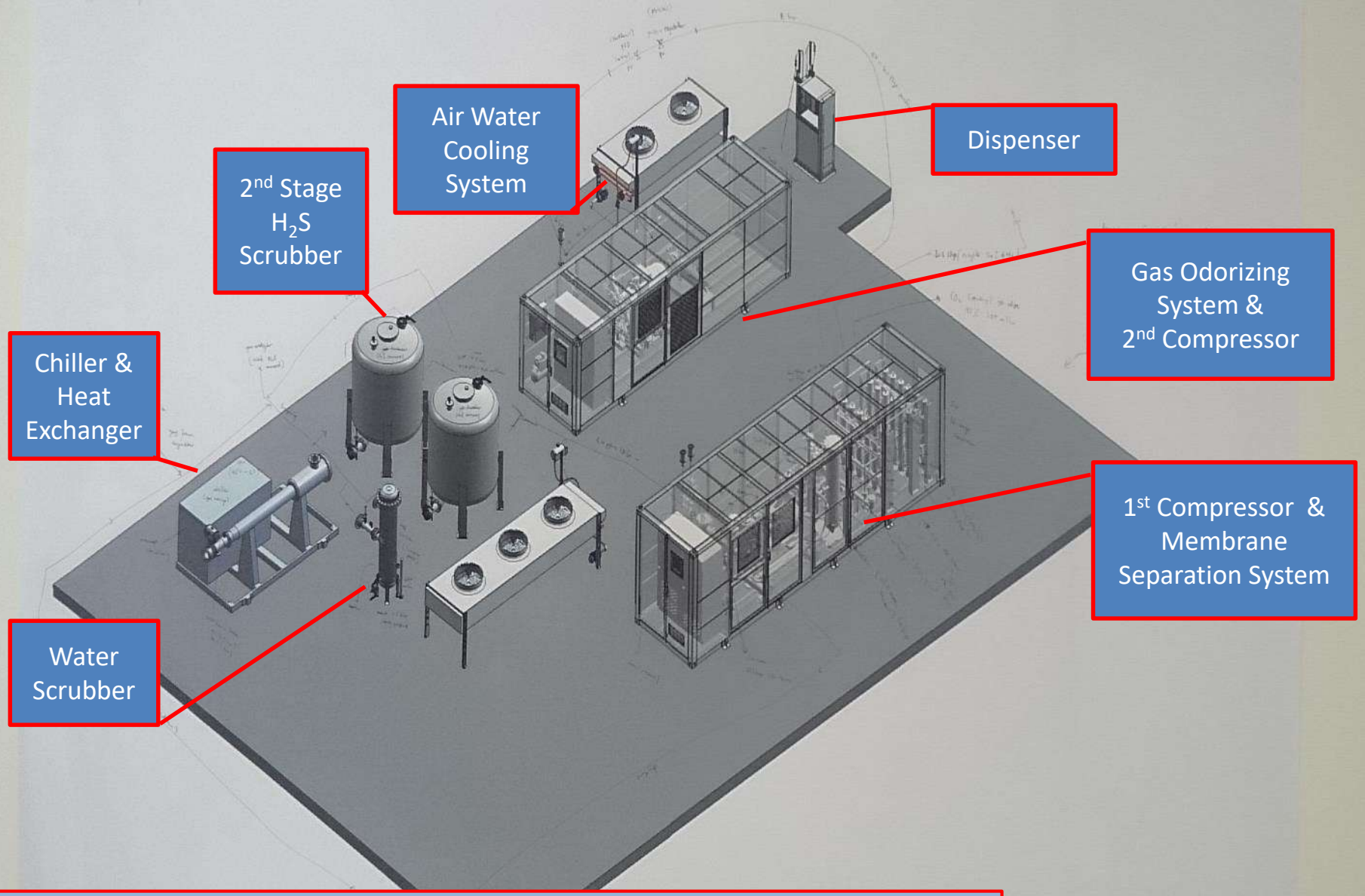
BioCNG PROJECT – MACHINERY DESCRIPTION & TECHNICAL DATA*



Inlet raw biogas – 660m3/hr (65% CH4 , 35% CO2 ,< 400 ppm H2S ex-first stage)
Outlet biogas, BioCNG – 400m3/hr (97% CH4 , 3% CO2 , ≤ 10ppm H2S)

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BIO-CNG AS RENEWABLE ENERGY - QUALITY

Raw Biogas - POME

60 – 65% Methane
30-35% CO2
2500 ppm H2S

Pre-treatment to gas compression

Natural Gas Specification

> 94 % Methane
4% CO2
< 10 ppm H2S
250 barG

Transport

Potential Customers

GAS MALAYSIA

PETRONAS

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SUCCESSFUL TRIAL WITH PETRONAS

- Successfully undergoing product trial with Petronas Dagangan Berhad (PDB)
- 3 trailers (up to 3,900 kg of bio-CNG supplied to Petronas NGV Stations & consumed by customers (16 – 18 May 2016) - no complain reported
- Extending to second trial on 4th week May 2016

Filling of bio-CNG to customer

PRU System installed at customer's site

Filling of trailer at site

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CURRENT STATUS FOR BIO CNG PRODUCTION

The commercial delivery of bioCNG achieved officially on 5th July 2016 as the date signed on Buyer's Notification (Fourth Schedule), committing 30,000 MMBTU/year (first phase) to OMI Alloys Sdn. Bhd. in Serendah, Selangor

Plant operating July to September 2016, producing nearly 3,000 MMBTU to customer as per contract. Plant undergo temporarily shut down in October 2016 for bioscrubber complete rectification, installation of new additional blower and realignment of bioscrubber piping, targeted to complete by end December 2016. OMI to upgrade 2 more lines, increasing product offtake more than 70,000 MMBTU/year. Production to resume early March 2017.

Trailer filling at OMI Sdn. Bhd.
PRU system
(11 July 2016)

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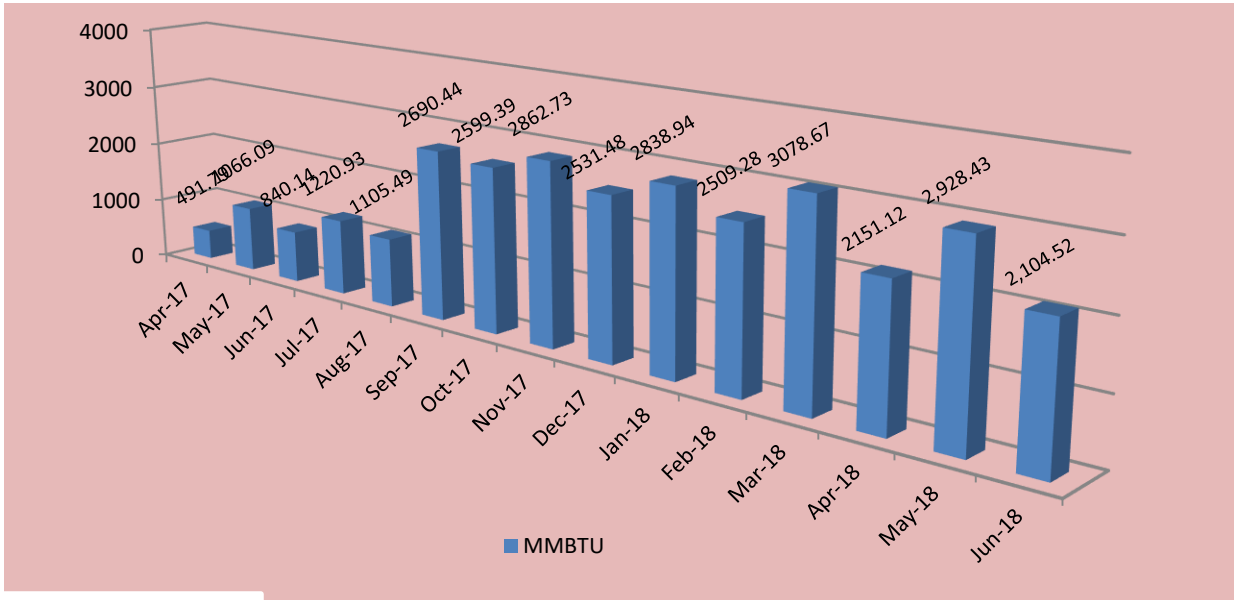
Production MMBTU April 2017 to June 2018*



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BIOGAS FOR OFFGRID POWER – FELDA UMAS

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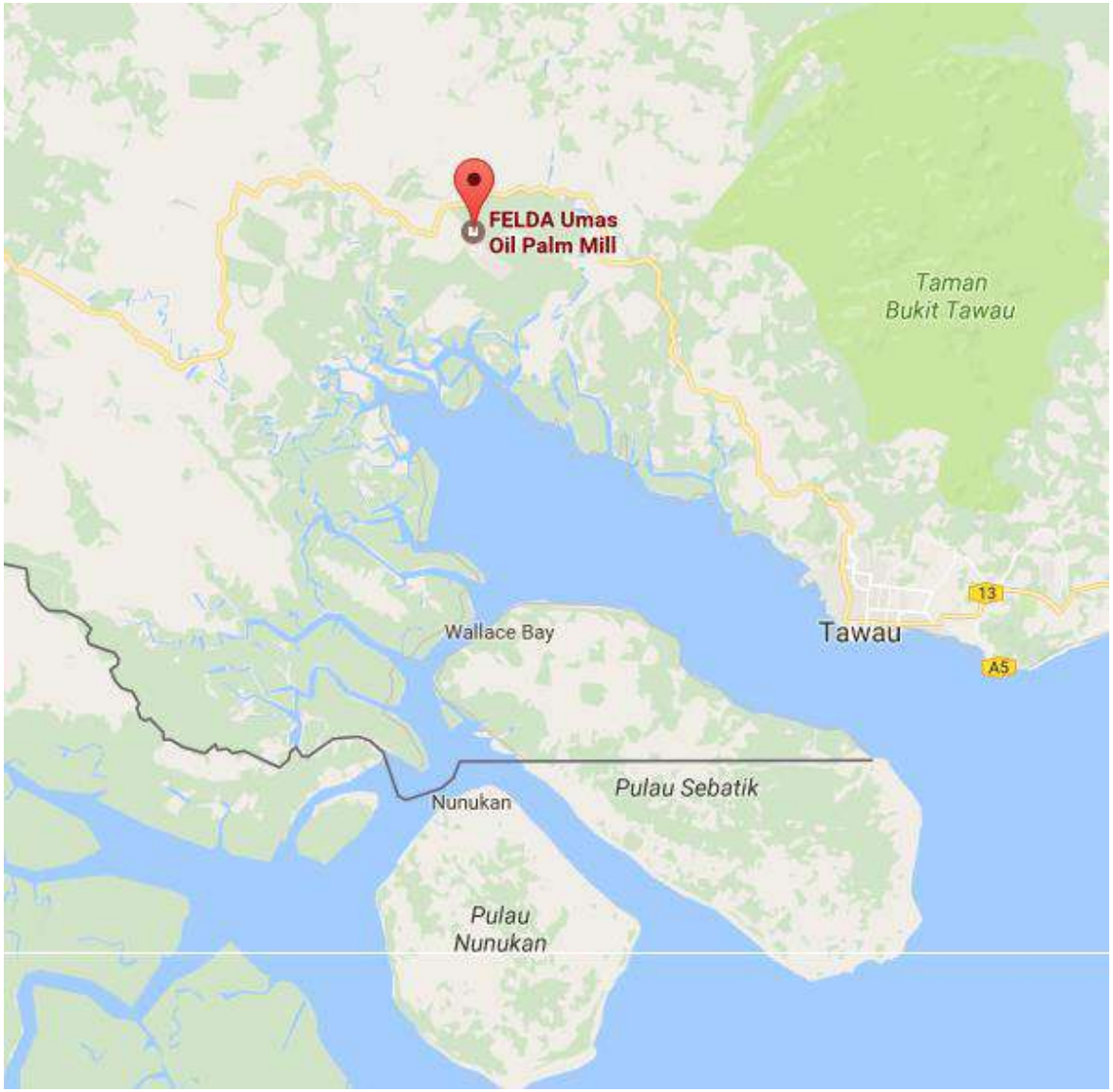
BIOGAS FOR OFFGRID POWER – FELDA UMAS



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BIOGAS FOR OFFGRID POWER – FELDA UMAS

- Project Background & Impact: Electricity generation from biogas engine (1,200 kW capacity) using biogas produced from biogas plant utilised as fuel source and diesel displacement in Felda cluster Umas, Tawau, Sabah. (Rural Electrification)
- Total project cost (Biogas Plant, Gas Engine & Electrical Connection): RM 14.0 million (Approx. USD 3M)
- Starting of Operation : 2012
- Biogas Reactor Capacity : 46,000m^3 (Palm Oil Mill Effluent)
- Biogas Generation rate from Biogas Pond Reactor : 1,000 m^3 / hour
- Electrical generation capacity from gas engine : 1,200kW (1 unit gas engine)
- Electric Distribution Area : Felda Umas Cluster, Tawau, Sabah. (3,000 houses, estimated 15,000 settlers, Felda staff & family)

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BIOGAS FOR OFFGRID POWER – FELDA UMAS

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BIOGAS FOR OFFGRID POWER – FELDA UMAS

Engineered lagoon AD

Felda Umas settlers

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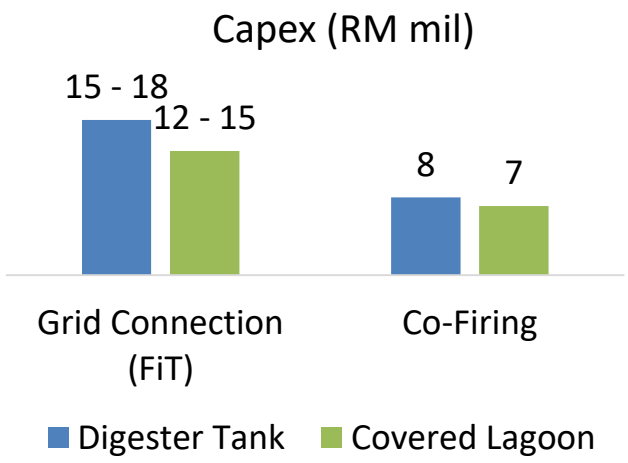
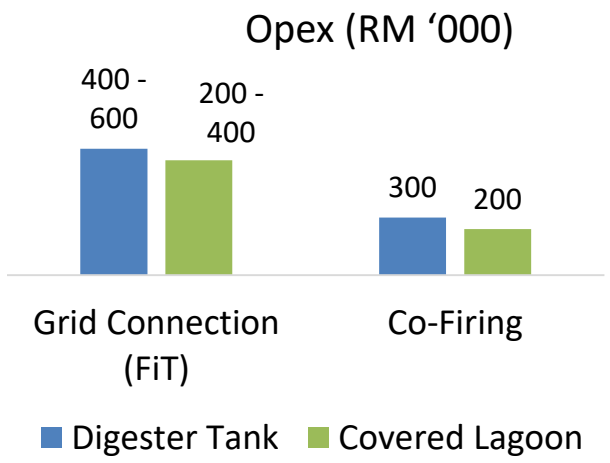
ISSUES AND CHALLENGES – BIO-CNG

- Inconsistency of biogas as feedstock – effect to product delivery.
- Location of palm oil mills to the industrial areas – high transportation cost, road quality etc
- Bio based fuel vs fossil fuel – competitive pricing due to highly subsidized fossil fuel in Malaysia
- Product acceptance by industry players - perception and additional technical modification of their existing burner etc
- Product classification – difficulties in getting incentives (either for producers/ users)





Source: MPOB, Pemandu Biogas Workstream NKEA Lab February – March 2015

ISSUES AND CHALLENGES – OFFGRID POWER

- Biogas generation depends on FFB process, wastewater quality and effluent generation: the right feasibility study to get the best consistent power output.
- Selection of the right AD technology: few proven in the SEA market with regards to handling POME.
- Copied AD design without full knowledge and understanding: unethical and project owner could face legal suit, loss of investment and junk in backyard.
- Selection of the right biogas engines, scrubbers, blowers, chillers: consistency and less downtime.
- Working culture, experience, training: understands the importance / critical to supply power to grid. New business / experience for a plantation company.
- Increase of electrical equipment in household.

WAY FORWARD – BIO CNG

Policy and Incentives

- To work closely with the Ministries and Government agencies in promoting and providing incentives/supports for Bio-CNG producers/users i.e tax exemptions, funds for new technology, mandate (blending)

Diversify the uses and distribution methods of Bio-CNG

- Mobile pipeline – to use trailers for mobilizing product to end users (industry)
- Injection to existing natural gas pipelines in Malaysia – mapping of mills to the nearest Gas Malaysia's pipelines
- Bio-CNG for plantation vehicles and internal uses (superior quality fuel for gas engine/ palm oil mill complex)

Good, reliable utilization technology

- Reasonable CAPEX (consistent biogas production, robust technology/machines, low waiting time for parts, low operation cost)

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WAY FORWARD – OFFGRID POWER

Technology and equipment

- Ensure the right AD technology for POME treatment
- Proven biogas engines, good electrical efficiency and for off-grid purpose.
- Good service after sales on critical items: biogas engines, scrubbers, blowers, chillers, gas analyzer, flowmeters, instrumentation.

People

- Trained team and ready for power generation: independent power producing (IPP) culture and mindset

Weather

- Good offgrid network in housing areas: falling trees and branches (rain, thunderstorm)

Upgrades

- Electrical network and system should be allocated / ready incase increase of power / demand. AD system should also be ready for CO-DIGESTION to increase biogas / electrical output

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