# Renewable energy Opportunities from Palm Oil Milling

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Universiti Kebangsaan Malaysia
The National University of Malaysia

Sime Darby
YAYASAN

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- Zero Waste Technology Research program
- Biogas from POME
- Biohydrogen &  Methane from POME
- Biohydrogen-Methane-Algal Oil from POME
- Challenges

# Palm Oil Sustainable Research at Universiti Kebangsaan Malaysia




Sustainable Development: Zero Waste Technology

Climate Change

Sustainable Economy

# ZERO WASTE TECHNOLOGY


Universiti Malaysia PAHANG

Sime Darby

Universiti Malaysia Terengganu

สถาบันวิจัยวิทยาศาสตร์และเทคโนโลยีแห่งประเทศไทย
Thailand Institute of Scientific and Technological Research
กระทรวงวิทยาศาสตร์และเทคโนโลยี
วว. TISTR

The University of Nottingham
UNITED KINGDOM · CHINA · MALAYSIA

Universiti Malaysia Sabah

LIPI
LEMBAGA ILMU PENGETAHUAN INDONESIA
INDONESIAN INSTITUTE OF SCIENCES

AGROTECHNOLOGY & FOOD SCIENCES GROUP
WAGENINGEN UR

Feng Chia University

## 5 UKM-YSD Chair for Sustainable Development: Zero Waste Technology for the Palm Oil Industry

**RM15 million**

**10 years**

2010 – 2020

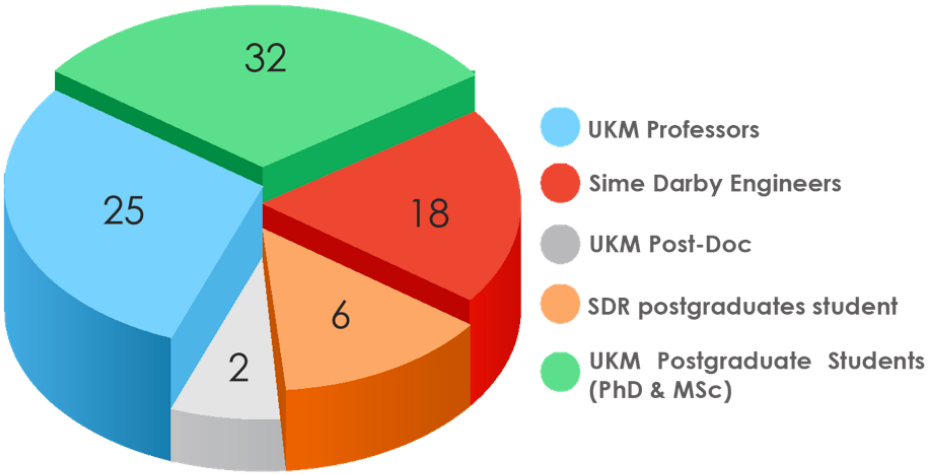
As part of Sime Darby's initiative to lead researches relevant to the palm oil industry, in January 2010, SDE formed a partnership

+ 14 scholarships worth

**RM1.68 million**

**4 years**

2014 – 2018




**TOTAL: 83**

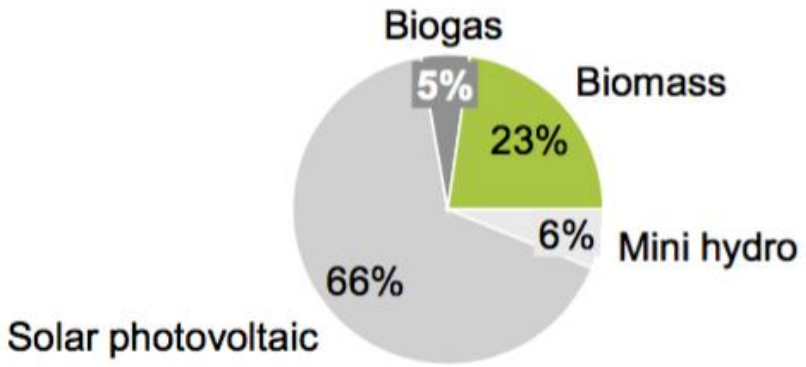
'Sustainable Development' scholarships have been allocated to Sime Darby employees and UKM research assistants pursuing Masters degrees and PhDs for a period of four years until 2018.

# RE Installed vs. Planned

**2014**

**Total Installed Capacity**
%

243 MW

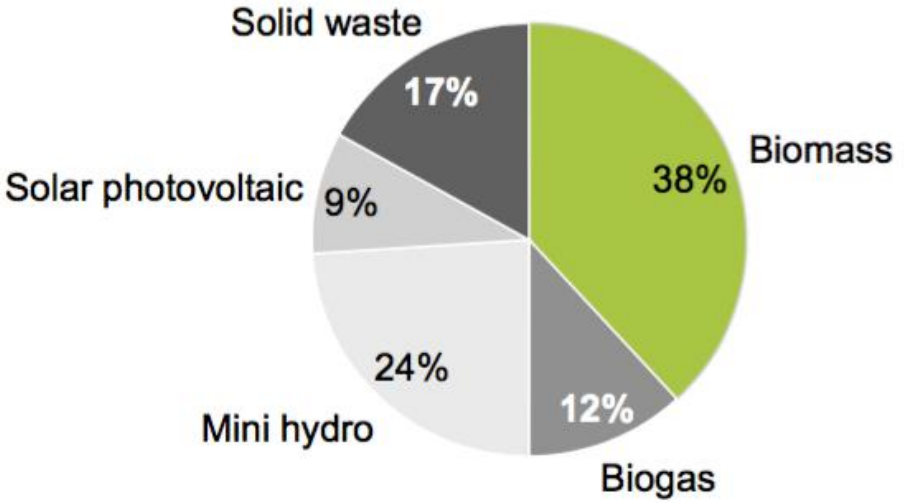



**ELEVENTH MALAYSIA PLAN**
**2016-2020**
ANCHORING GROWTH ON PEOPLE

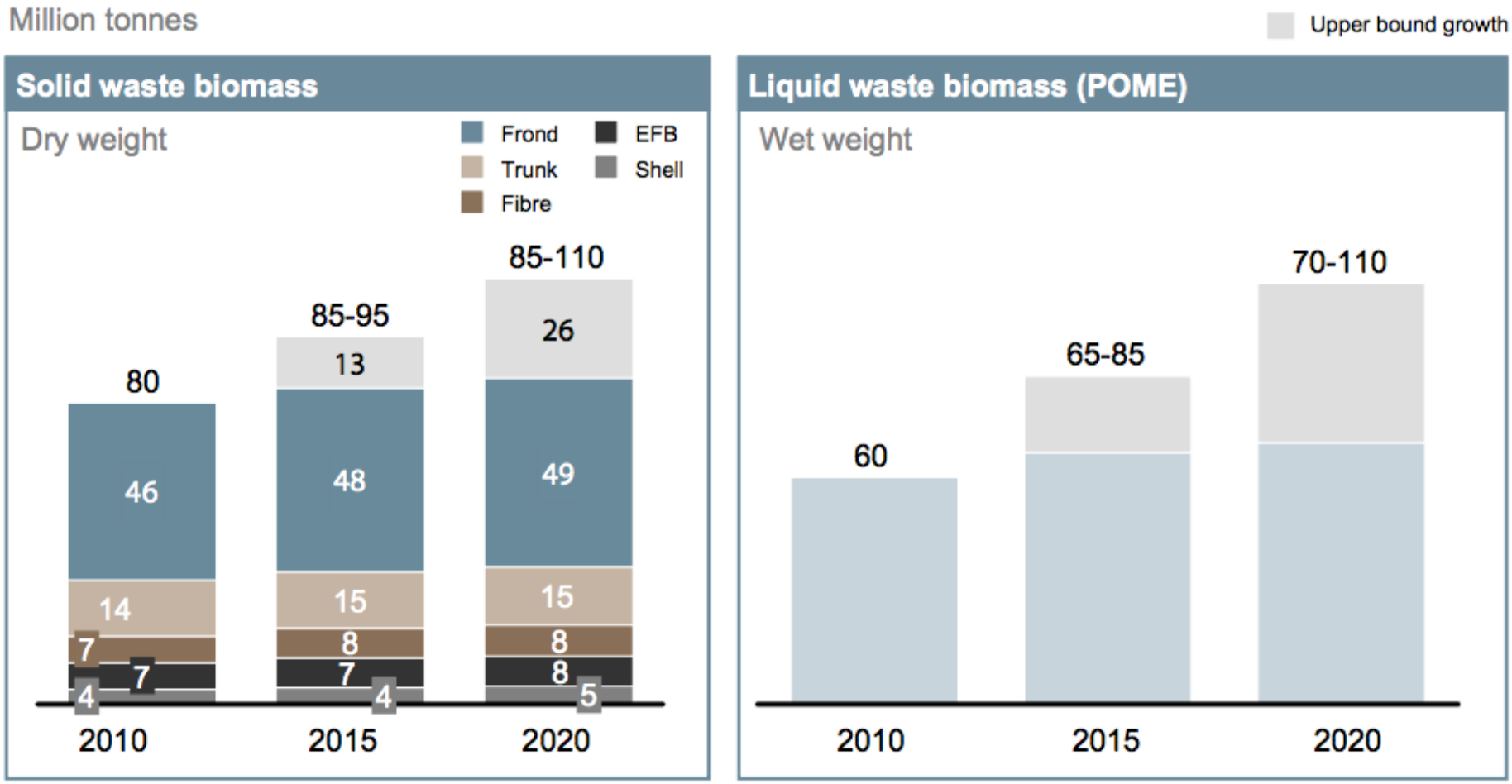
**2020**

**Total Installed Capacity**
%

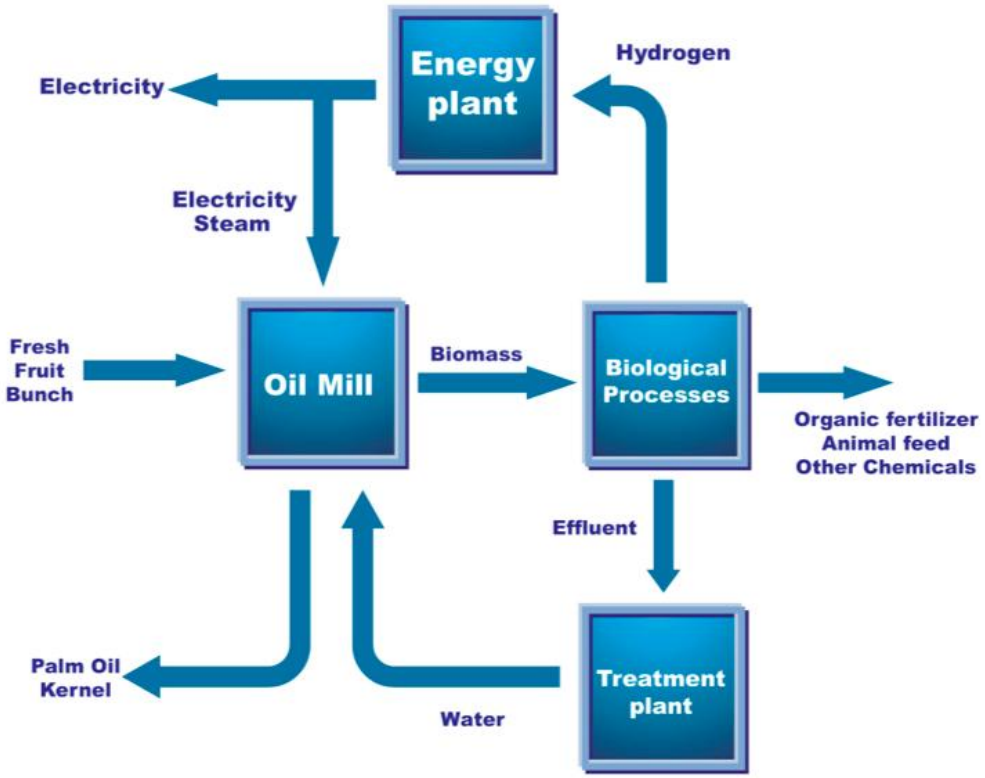
2,080 MW



# Palm Biomass Resources

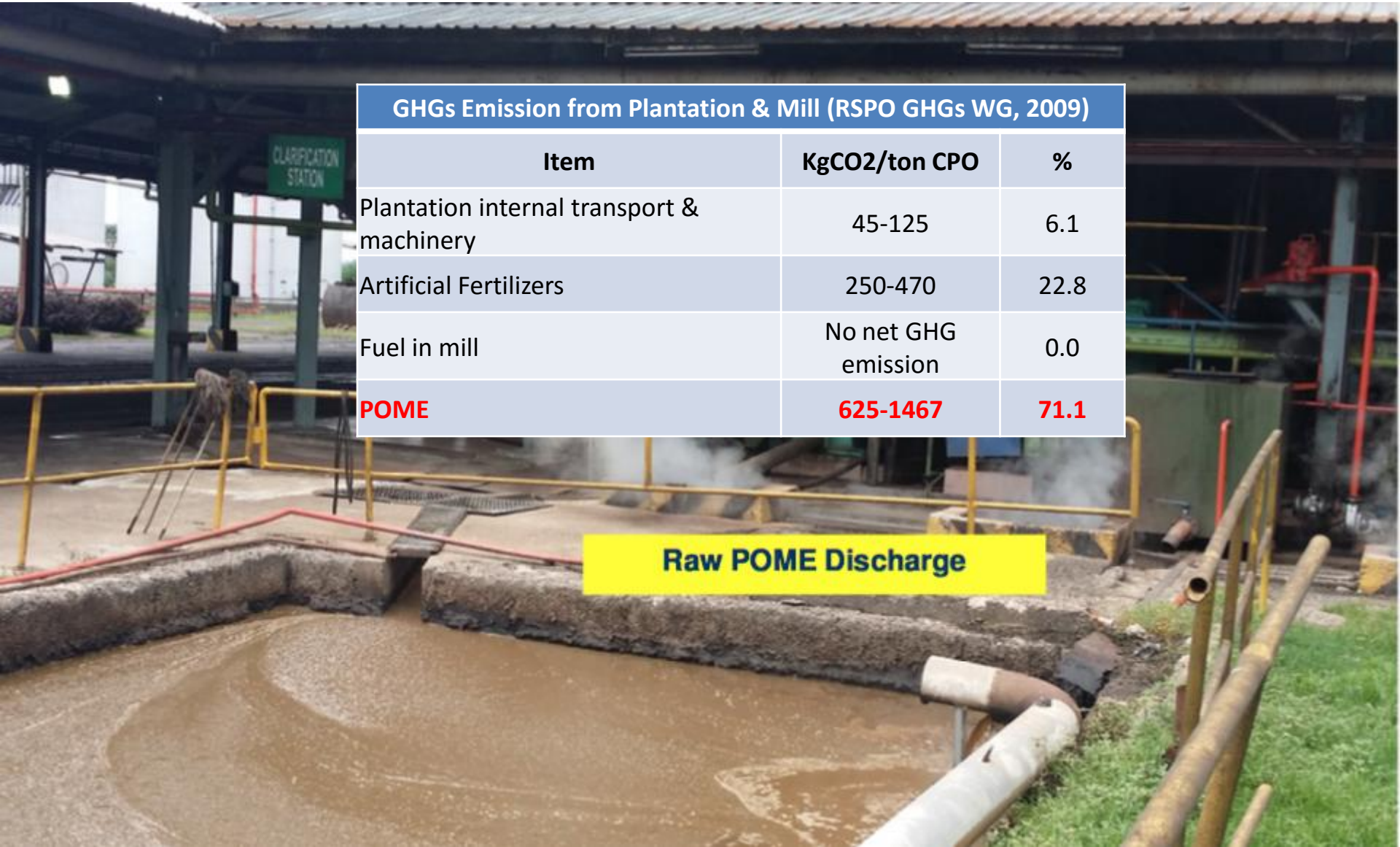


# Zero Waste Technology




- Biohydrogen & Biogas Production
- Hydrogen Purification, Storage & Power Generation
- Biomass Conversion
- Algae $CO_2$ capture & Effluent Treatment
- Bioconversion of Biomass to organic fertilizer
- Water Reuse & Recycle

# Palm Oil Mill Effluent (POME)

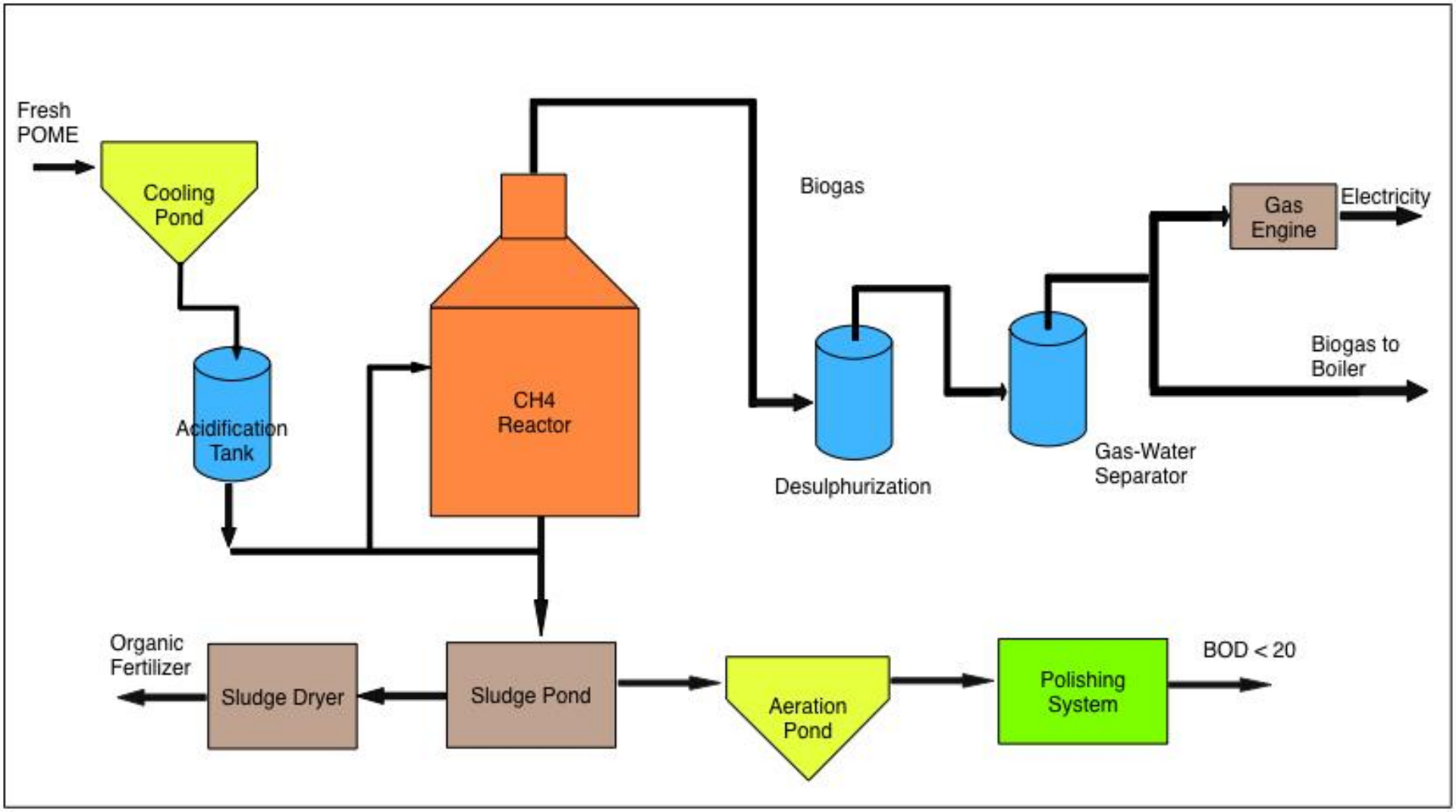



| GHGs Emission from Plantation & Mill (RSPO GHGs WG, 2009) | | |
|---|---|---|
| **Item** | **KgCO2/ton CPO** | **%** |
| Plantation internal transport & machinery | 45-125 | 6.1 |
| Artificial Fertilizers | 250-470 | 22.8 |
| Fuel in mill | No net GHG emission | 0.0 |
| **POME** | **625-1467** | **71.1** |

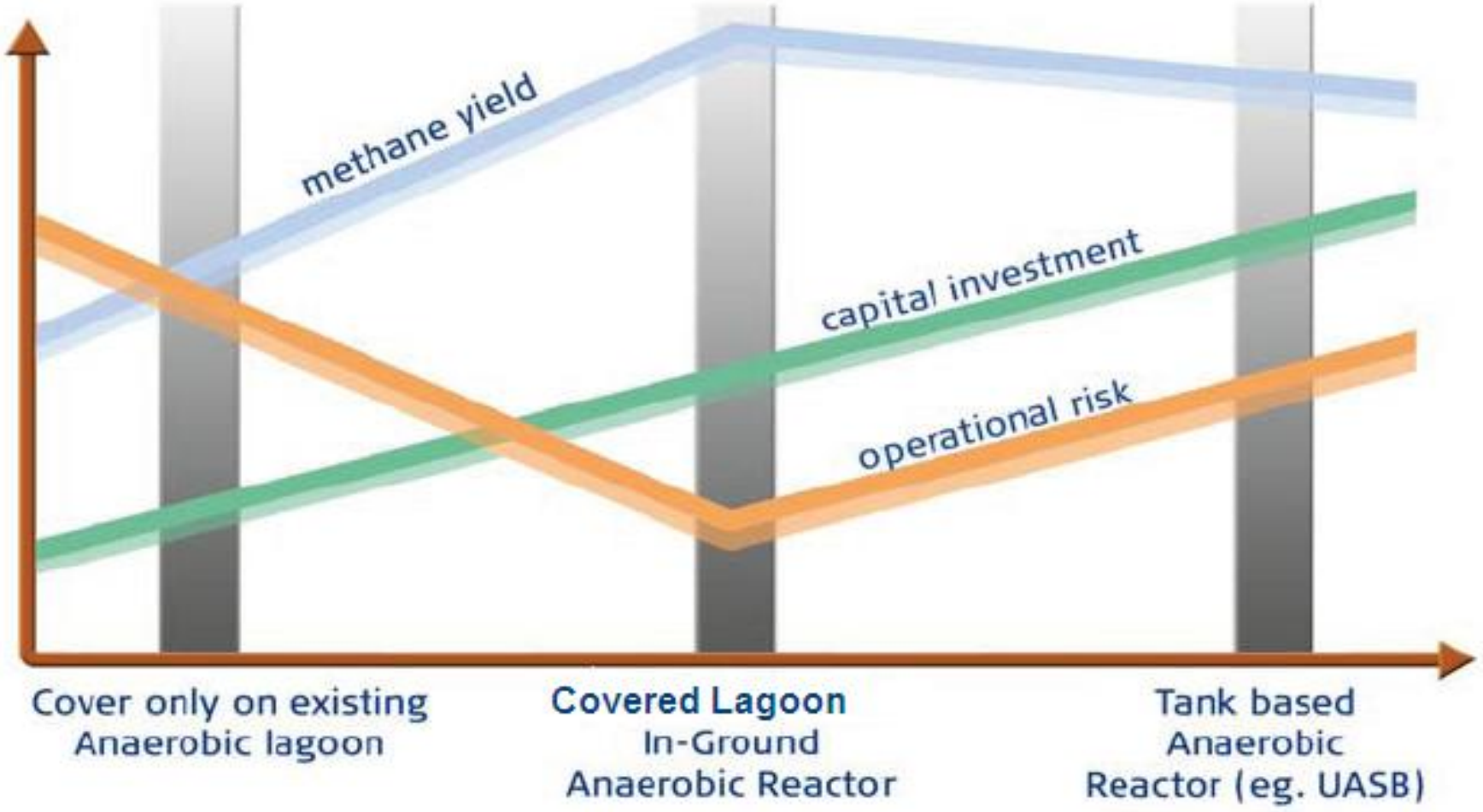
# Biogas from POME

| Parameter | Performance characteristics |
|---|---|
| Raw effluent | |
| COD (ppm) | 44 000-83 000 |
| BOD (ppm) | 14 000-34 000 |
| Final discharge | |
| COD (ppm) | 1400-2500 |
| BOD (ppm) | 50-270 |
| Composition of biogas | |
| Methane (%) | 56-64 |
| Carbon dioxide (%) | 35-41 |
| Hydrogen sulphide (ppm) | 217-1418 |
| Volume of biogas ($m^3$ biogas $m^{-3}$ POME) | 26.6-30.0 |

# Biogas from POME



# Typical Anaerobic Digester Comparative Pointers



# Sime Darby's Existing Projects & Future Potential

| Perak | Crop | |
|---|---|---|
| **Flemington** | *236* | **FIT** |
| Seri Intan | *216* | **FIT** \| **CNG** \| **NEW** |
| Elphil | *129* | **CoF** |
| Chersonese | *186* | TDC |
| Selaba | *144* | TDC |

| Kedah | Crop | |
|---|---|---|
| Sg. Dingin | *320* | **CNG** |

| Sarawak | Crop | |
|---|---|---|
| Rajawali | *218* | **CNG** |
| Lavang | *200* | **CNG** |
| Derawan | *165* | LP |
| Pekaka | *190* | TDC |

| Sabah | Crop | |
|---|---|---|
| **Merotai** | *303* | **CNG** |
| **Sandakan Bay** | *198* | **CaP** |
| **Binuang** | *195* | **CaP** |
| **Giram** | *175* | **CaP** |
| Melalap | *82* | LP |

| Selangor | Crop | |
|---|---|---|
| **Tennamaram** | *253* | **FIT** |
| **West** | *211* | **CNG** |
| East | *128* | **CaP** |
| Bkt Kerayong | *139* | TDC |

| Pahang | Crop | |
|---|---|---|
| Kerdau* | *231* | **FIT** \| **CNG** |
| Jabor | *74* | LP |
| Bkt Puteri | *55* | LP |

| Indonesia | Crop | |
|---|---|---|
| **Rantau** | *229* | **CaP** |
| **Pemantang** | *218* | **CaP** |

| N. Sembilan | Crop | |
|---|---|---|
| Sua Betong | *245* | **FIT** |
| Tanah Merah | *148* | **CoF** |
| Kok Foh | *172* | **CoF** |
| Labu** | *133* | LP |

| Melaka | Crop | |
|---|---|---|
| Kempas | *288* | **FIT** |
| Diamond Jubilee | *113* | TDC |

| Johor | Crop | |
|---|---|---|
| **Hadapan** | *231* | **FIT** |
| Gunung Mas | *263* | **FIT** \| **CNG** \| **NEW** |
| Ulu Remis | *247* | **FIT** \| **CNG** \| **NEW** |
| Pagoh | *167* | **CoF** |
| Chaah | *120* | **CoF** |
| Bkt Benut | *99* | TDC |

***Legend***
***On-Going Projects***
*Future Potential*

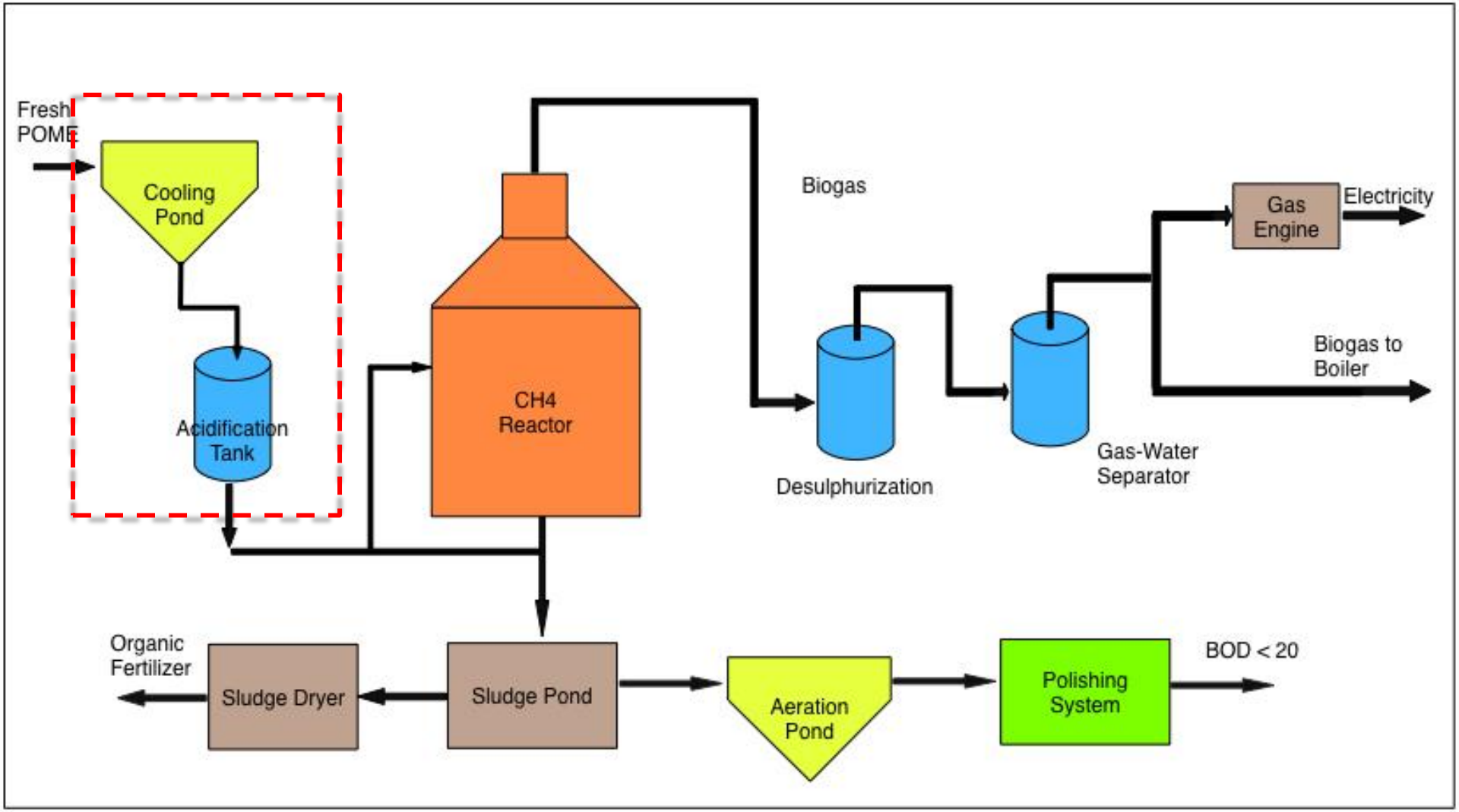
***Abbreviations***
***FIT*** *– Feed-in-Tariff*
***CNG*** *– Compressed Natural Gas*
***CaP*** *– Captive Power*
***CoF*** *– Co-Firing*
***NEW*** *– New Technology*
*TDC – To be decommissioned*
*LP – Limited potential*

***Note***
*Crop – 5-year avg. (FY11-FY15), kMT p.a*
*To reconsider – geographically isolated
** Earmarked for property development

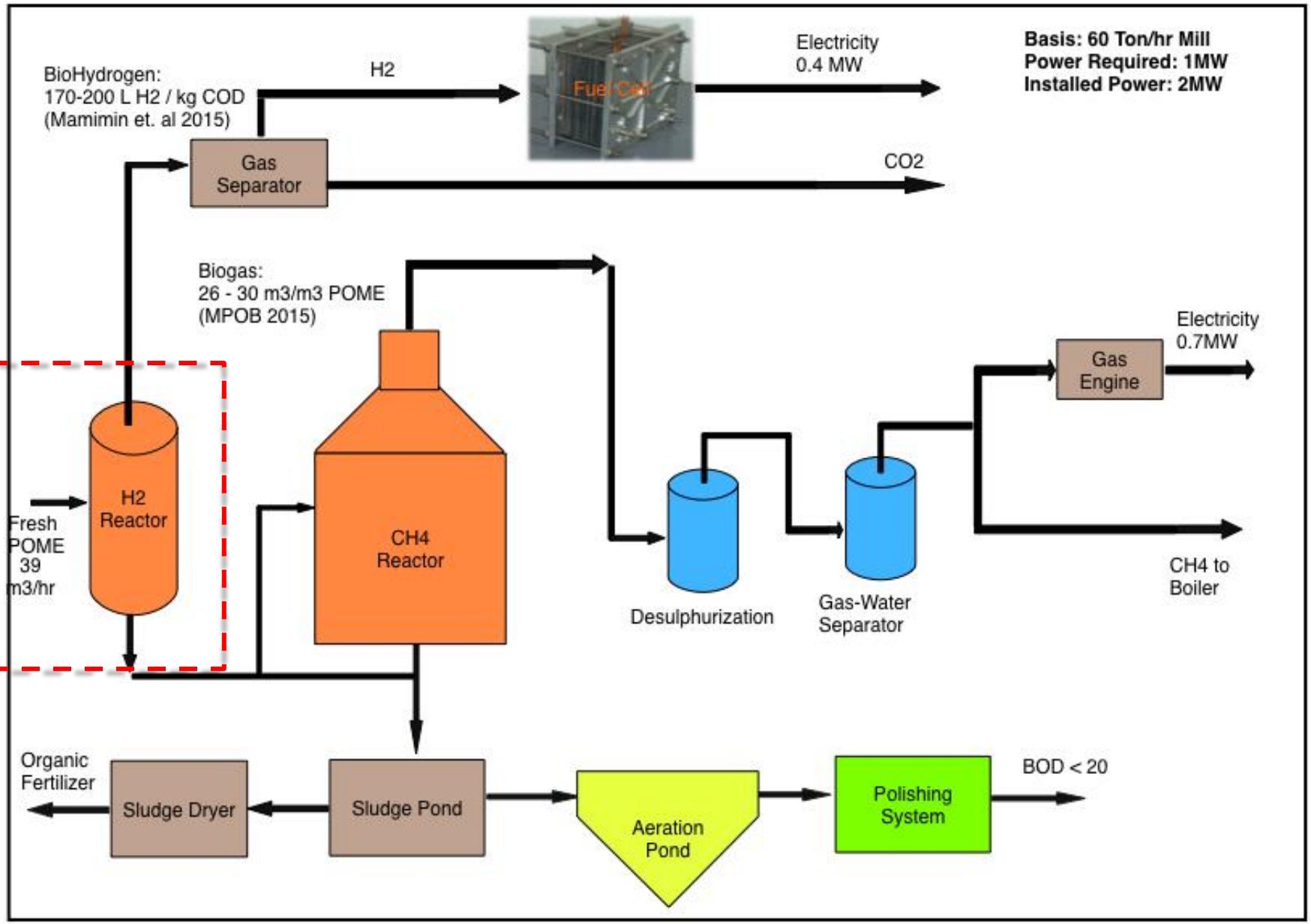
| Project Summary | FIT | CNG | FIT OR CNG | FIT OR CNG OR NEW | CaP | CoF | Total | TDC OR LP |
|---|---|---|---|---|---|---|---|---|
| On-Going | 3 | 2 | - | - | 5 | - | 10 | 11 |
| Future Potential | 2 | 3 | 1 | 3 | 1 | 5 | 15 | |
| Total | 5 | 5 | 1 | 3 | 6 | 5 | **25** | 11 |

# Typical Biogas Digester

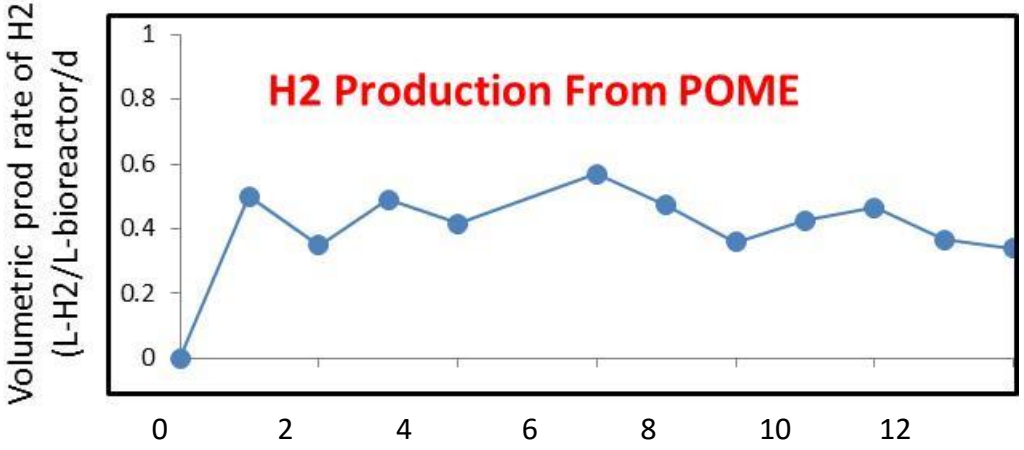
# Biohydrogen & Methane from POME



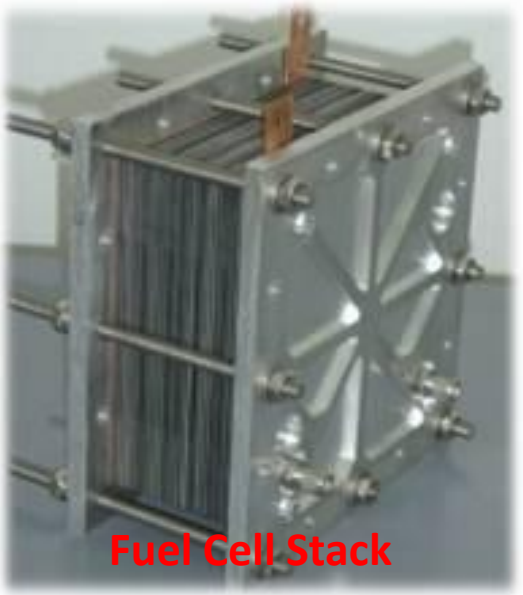
# Biohydrogen & Methane from POME



# Bioydrogen From POME





# Tenaga mesra alam

## Teknologi sel fuel sebagai ganti sumber tenaga fosil

OLEH LAUPA JUNUS LAUPA.JUNUS@UTUSAN.COM.MY | 27 Oktober 2014 12:02 PM

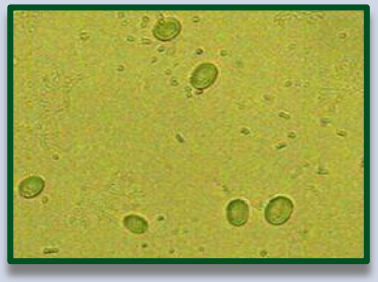
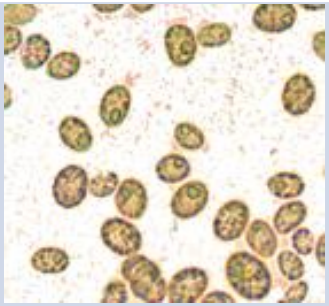
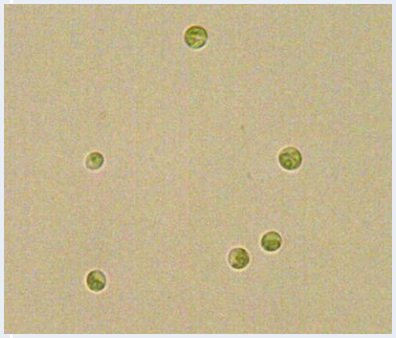
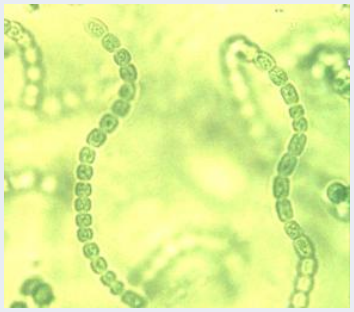
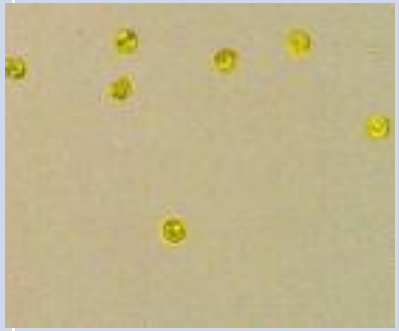
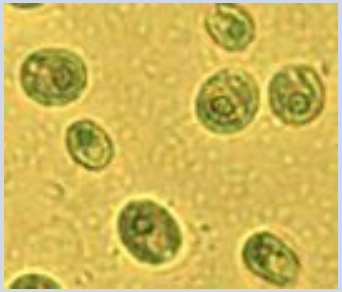


Wawancara Pengarah Sel Fuel, Prof. Dr. Abu Bakar Mohamed di Institut Sel Fuel, UKM Bangi, disini hari ini. Gambar: JEFFRI IRAN. Pemberita: LAUPA JUNUS (S & T).

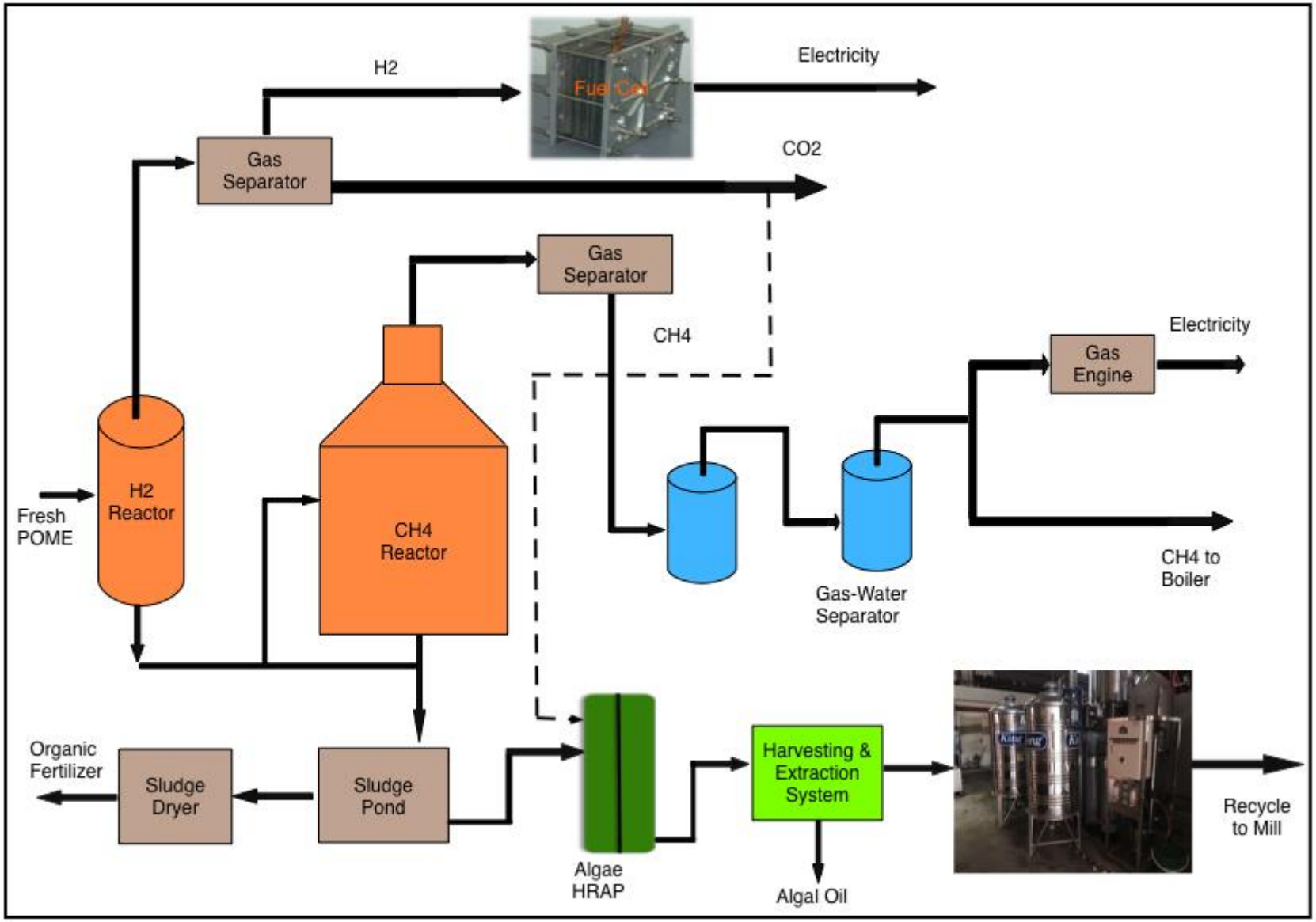
# Biohydrogen-biogas-Algal Oil

| Characteristics | Anaerobic Digester Effluent | BBM Medium | BG-11 medium | Unit |
|---|---|---|---|---|
| **$NH_4^+$-N** | 260.5 | - | - | mg $L^{-1}$ |
| **$NO_3^-$-N** | 1.6 | 41.2 | 247.1 | mg $L^{-1}$ |
| **TN** | 520 | 41.2 | 247.1 | mg $L^{-1}$ |
| **TP** | 84.4 | 53.4 | 7.1 | mg $L^{-1}$ |
| **COD** | 3175 | - | - | mg $L^{-1}$ |
| **$BOD_3$** | 1735 | - | - | mg $L^{-1}$ |
| **pH** | 8.09 | 7.0 | 7.0 | - |
| **Turbidity** | 451 | - | - | NTU |

# Isolated Strains from POME

| Strain | Morphology | NCBI Registration | |
|---|---|---|---|
| Characium sp. UKM1<br>**NCBI Registration:**<br>**GenBank: KJ143753** |  | Coelastrella sp UKM4 .<br>**NCBI Registration:**<br>**Genbank: KP691597** |  |
| Chlorella Sorokiniana UKM2<br>**NCBI Registration:**<br>**GenBank: KP262476** |  | *Anabaena sp UKM5*<br>**NCBI Registration:**<br>**Genbank: KP691598** |  |
| Chlorella Sorokina UKM 3<br>**NCBI Registration:**<br>**GenBank: KP262477** |  | *Chlamydomonas sp UKM 6*<br>**NCBI Registration:**<br>**GenBank: KP898730** |  |

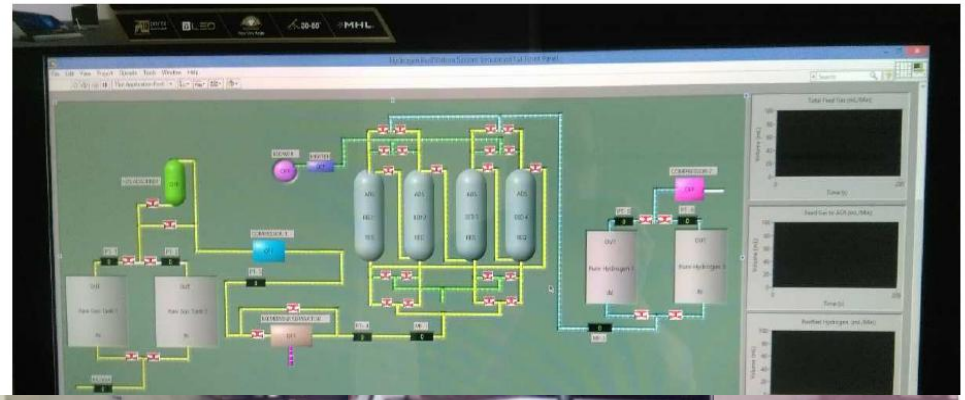
# Biohydrogen-Methane-Algae Oil

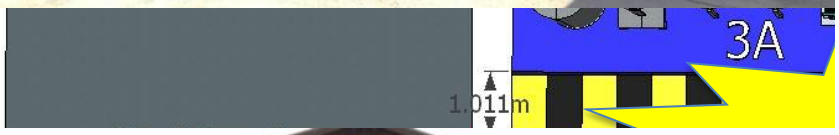


# Potential Algal Oil from POME

| Item | Units | Existing Pond | Based on Volume | References / assumption |
|---|---|---|---|---|
| POME Production in 2014 (tones) | Tons | 70,320,136 | | - |
| Total area available (Ha) | Ha | 4390 | | - |
| Algae biomass yield (g/sq m day) | g/sq m .day | 40 | | Chisti 2007 |
| Oil content (Botryococcus brauni) | % | 25-75 | | Chisti 2007 |
| Oil Content (Chlorella sp.) | % | 28-32 | | Chisti 2007 |
| Algae Biomass Production ton per yr | Tons/yr | 460,950 | 1,212,416 | 300 working days |
| Oil Production per yr (Botryococcus ) | Tons/yr | 263,400 | 606,208 | 50% oil content |
| Oil Production per yr (Chlorella ) | Tons/yr | 158,400 | 363,725 | 30% oil content |


Sime Darby
Plantati
KILANG KELAPA SAWIT
TENNAMARAM

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1.011m

# Challenges

- How to convince the “big players” in the palm oil industry
  - Not their core business
  - Decision making process
- Absence of performance base rewards for renewable energy development. Main KPI
  - Incerase Oil extraction rate
  - Reduce cost of production

# Acknowledgement


- Sime Darby Foundation
- Sime Darby Plantation
- Sime Darby Research


# Thank You

http://www.ukm.my/ukm-ysd.susdev/

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