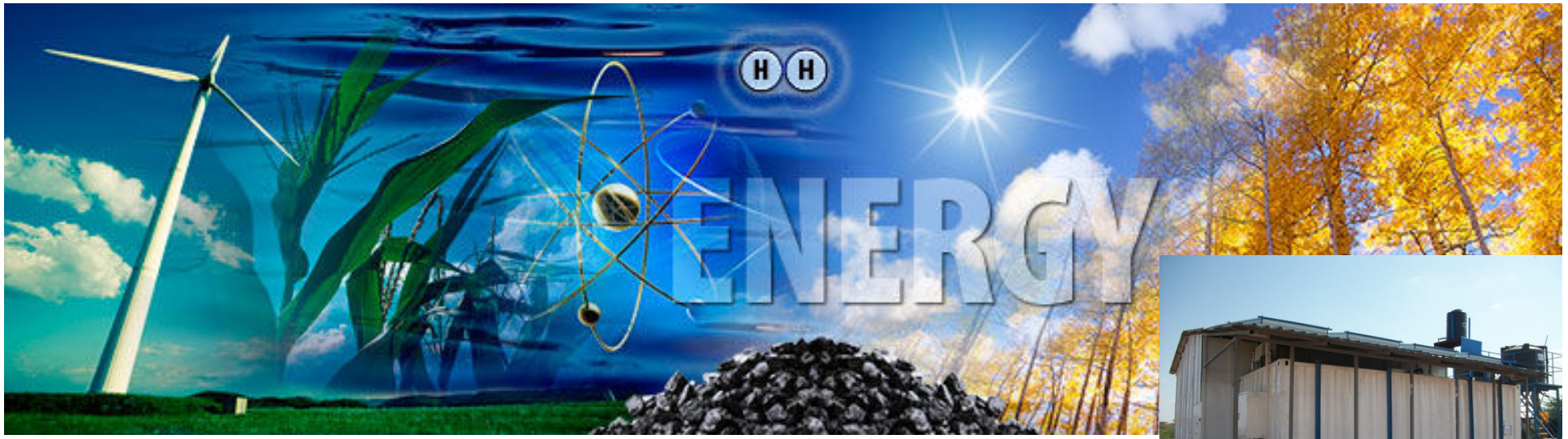

Renewable Energy

Waste To Energy

Energy Efficiency

International Workshop on Advances in Biofuel

27th September 2012

Kota Kinabalu

The Advent of the 2nd Generation of a MINI BIOGAS POWER PLANT

PROFESSOR DR. KARL WAGNER
Email: profwagnerkarl@gmail.com

Structure

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Rural Development Concept with Biogas all Sizes … and “MINI”

1. View on Palm Oil Mills for Biogas

2. Biogas Tech-nology

3. MBPP for Rural Development

Established Palm Oil Mill -> Organic Output

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Focus: CPO

New Focus: By-Products

Palm Oil Mill - Challenges

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- MAJOR CHALLENGE:
  - **Everything that influences the production of CPO and therefore the revenue and profitability of the core business !**

- **Environmental Regulation**
- **Cost Structure, e.g. Fertilizer**
- **Market Price and Behaviour**
- **Market Restrictions / Regulations**
- **Sustainability**

Palm Oil Mill - Organic By-Products

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Organic By-Products

- Use as fuel for boiler : Low efficiency but sufficient enough
- Use for Mulching and Composting : Energy consuming, mainly for solids

* … a word in favor for …

OPTION: Anaerobe Process for liquid and solid, energy producing, 1st treatment Step to reach BOD 20 compliant discharge after final Waste Water Treatment Plan (WWTP).

Palm Oil Mill
-> Sober REALITY

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The POM & Plantation needs …
(beside FFB's)

- **Water**
- **Steam**
- **Electricity**
- **Fertilizer (Plantation)**
- **to comply with Environmental Regulations**
- **Sustainability**

Palm Oil Mill - Scale of Economy

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ECONOMY of Scale for BIOGAS Application with Palm Oil Mills

The variation of capacity and size of the Palm Oil Mills in Malaysia have a huge variety (appr.):

- 1/3 rd are large
  … > 400 000 t FFB /a
- 1/3 rd are medium size
  … 200 000 – 400 000 t FFB /a
- 1/3 rd are considered small
  … < 200 000 t FFB/a

Especially 120 000 t down to 80 000 t FFB /a Mills encounter a huge challenge according to scale of economy.
-> by-product ?

Smaller Palm Oil Mill -> Rule of THUMB

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… and depending on local conditions …

Based on 100,000 t FFB processing per annum and average organic waste production, the efficiency of the anaerobe biogas process can range from:

- **0.4-0.7 MWh** … with POME only and standard 1 stage process and depending on technology

This would create a challenge in the feasibility for small Palm Oil Mills !

- **1.8 – 2.0 MWh** … with POME, EFB and Fiber included in the anaerobe process and applying high tech 2 stage processes

This efficiency would make BIOGAS feasible even for small Palm Oil Mills around 100 000 t FFB / a processing.

Palm Oil Mill - Organic Mass Use & Replace

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Challenges in discussion with Mill Owner and Operator:

- FIBER: Used as FUEL, … need to be diverted to AD Process
- PKS: Used as FUEL, … NOT suitable for AD Process
- EFB: Used as FUEL, … need to be diverted to AD Process
- POME: FREE for use and it is liquid base for the AD

AD process = Anaerobic Digester Process

… in exchange, the AD Process provides:

- FUEL (Biogas)
- FUEL (Dry Lignin Fiber / Pellets)*
- Organic Sludge
  - … as base for Composting
  - … and Organic Fertilizer
- Discharge for WWTP with stable COD to reach BOD 20
- CER's (Carbon Project)

* (2 Stage AD Process)

Palm Oil Mill - Challenges

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1) Get the trust needed to implement the technology and improvements

2) Get the organic by-products … offer replacement of their value

3) Deliver base for success and improvements in:
   a) Reach BOD 20 in discharge effluents
   b) Optimize Boiler Efficiency with use of PKS, Lignin and Biogas
   c) Deliver high quality Organic Sludge as base for
      - Organic Fertilizer
      - Local Composting Process

* … a word in favour of …

A word in favour of COMPOSTING …

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COMPOSTING – YES … BUT BEST after HARVESTING GREEN ENERGY

Comparison between COMPOSTING and ANAEROBE Processing		
Fact	**Composting**	**Biogas (Methanogenesis)**
Process	Aerobe Process	Anaerobe Procsess
POME	partial (10-20%)	ALL
EFB	YES	YES (2 stage process)
FIBER	YES	YES (2 stage process)
Oxygen	NEED Oxygen	NO Oxygen
Light	YES	NO Light
Energy	NEED ENERGY	PRODUCES ENERGY
Final Product(s)	Compost	Biogas (50-70% CH4)
		Fertilizer Sludge
Further Process	NONE	COMPOSTING
		Upgrade to Org. Fertilizer
Energy Balance	NEGATIVE	POSITIVE
Investment	Low	Medium - High
Cost/Profit Balance	Low Profit	High Profit
ROI / IRR	???	> 12% up to 25%
Support BOD20	NO	YES - 1st stage
Recommendation	… take as 2nd step !	Use as 1st Step !

=> There is NO competition between composting and anaerobe process – BUT it shall be complementary !

Rural Development Concept with Biogas all Sizes … and "MINI"

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LifeCycle of NATURE & Palm Oil

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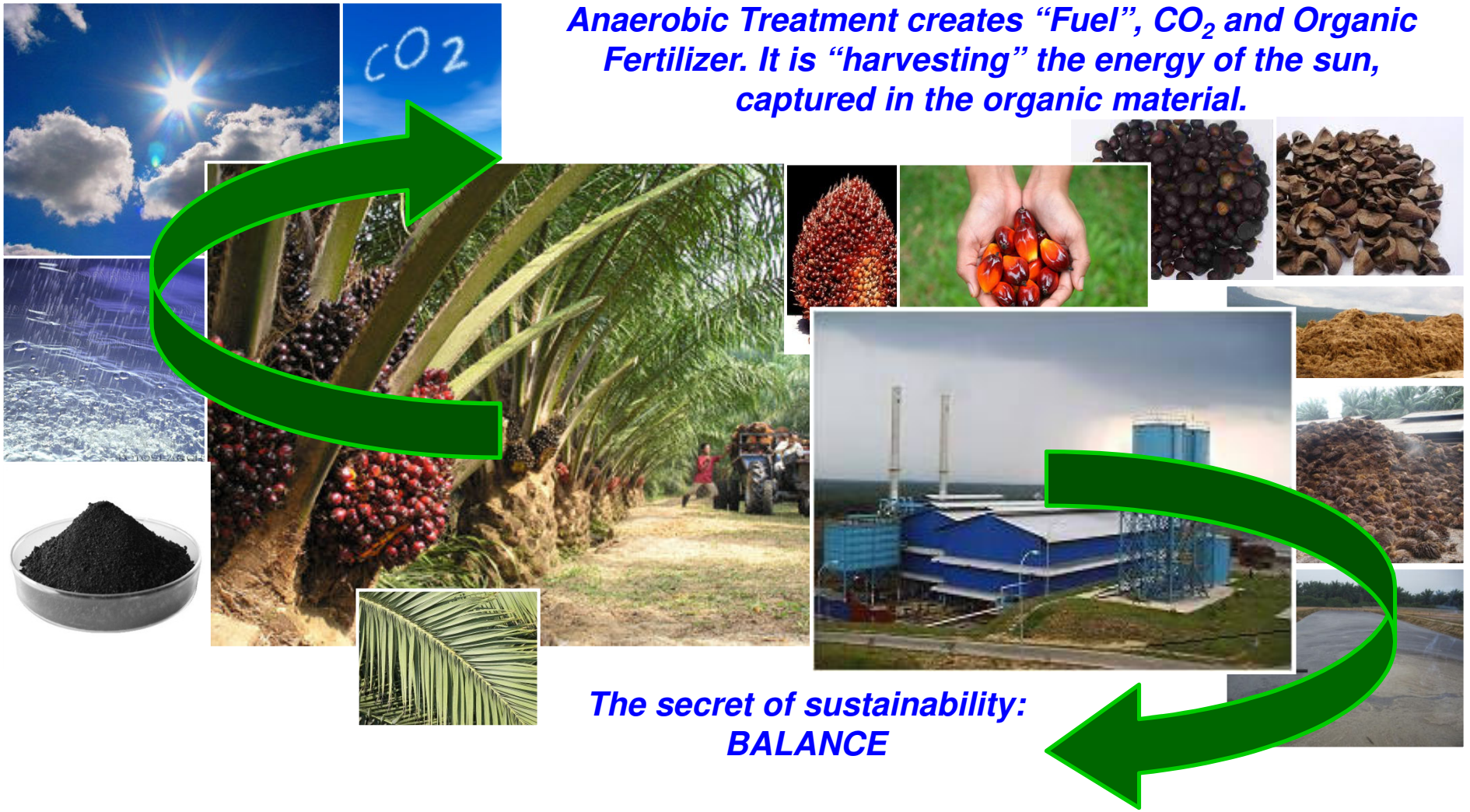
Palm Oil is made out of Sun-Energy, CO_2, Water and Fertilizing Minerals …

Anaerobic Treatment creates "Fuel", CO_2 and Organic Fertilizer. It is "harvesting" the energy of the sun, captured in the organic material.



The secret of sustainability: BALANCE

Biogas Process - Bio Chemistry in 2 Steps and 4 Reactions

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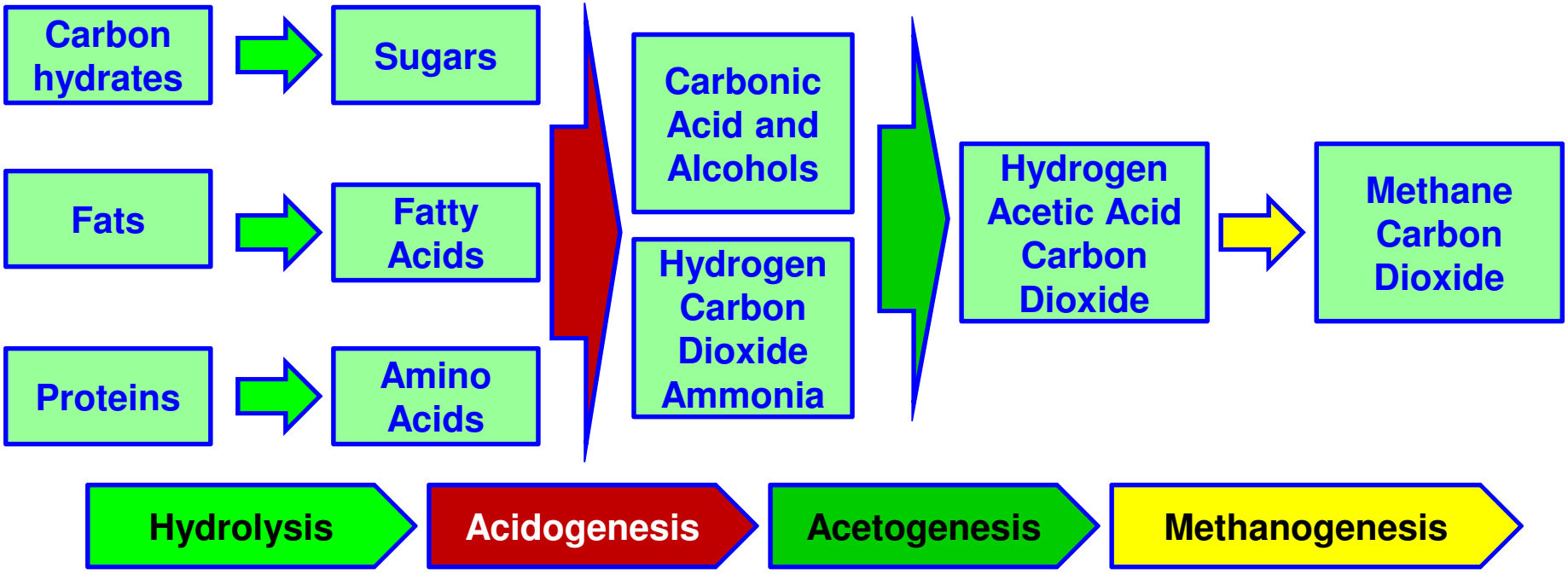

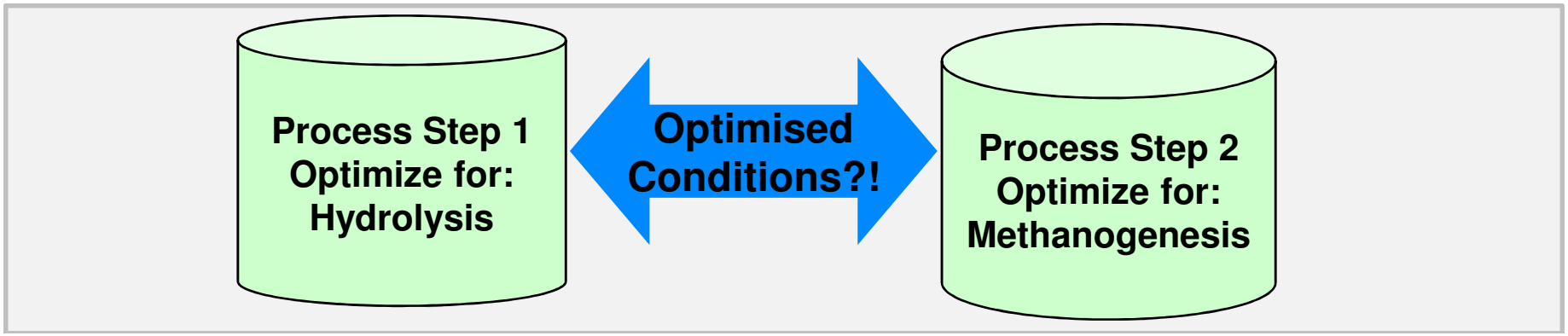

Biogas Process - Bio Chemistry

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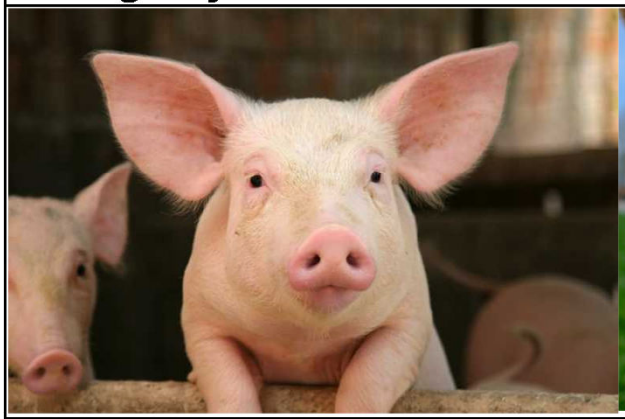
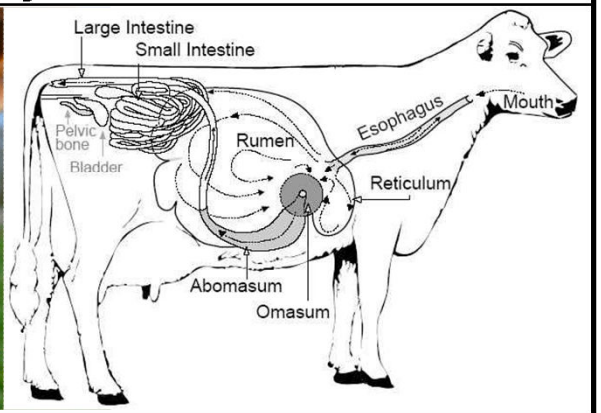
Don't feed a pig like a cow !	
Biogas Plant **1-Stage System**	**High Performance Biogas Plant** **Multi-Stage System**
 	
Pigs need easy digestable fodder	Cows are able to digest cellulosic material as fodder due to the 4 chabered stomach
All 4 steps of the methane production take place in one tank (stomach): Hydrolysis, Acidogenesis, Acetogenesis, Methanogenesis	Two steps in one tank, two steps in a second tank: 1st tank : Hydrolysis and Acidogenesis 2nd tank: Acetogenesis and Methanogenesis
1-Stage System: Standard yield … but ...	+ 30% higher yield from same feedstock

1 stage Anaerobe Process Technology 2stageThermophyllic Process

Process Selection: High Efficiency = High Return 2nd.. 3rd Generation

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1 stage Anaerobe Process Technology

DESCRIPTION	1ST GENERATION (Pond with membrane)	2ND GENERATION (Mesophilic Process)
Retention Time	More than 20 days	20 days
Digester Capacity Requirement	Big	Big
Desludging	Required	Not required (depends on process)
Homogenisation	None	By pump
Gas Production	Slow	Slow
Degradability	Low	Low
Fungi & Vira Contamination	Growth present	Growth present
Unwanted Microbiology	Present	Present
Alternative Organic Waste (to increase gas production)	Impossible	Troublesome
CDM Certification	o.k.	o.k.
Future CDM Certification (adjustment to stricter methodologies)	Doubtful	o.k.
Investment Cost	Low	Very high

2 stage Anaerobe Process Technology*

- Based on Thermophilic Process
- Optimizes process condition for Hydrolysis and Methanogenesis
- **Add solid Feedstock, e.g. EFB, Fiber to enhance gas production**
- Optimizes process automation for feeding and process control

POOR ⇨ GOOD ⇨ BETTER ⇨ The BEST

RÖTTALER MODELL

** patented*

Advanced Biogas Process: Feedstock

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Due to the capability to break down Cellulose, the 2 stage process is able to use solid feedstock in addition.

By-Product:
Lignin Fiber, useful as “Wood Pellets” or direct for wood burner.

2 Stage Biogas Power Pla

RÖTTALER MODELL

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Optimum environme	rolysis bacteria and methane bacteria	
	Hydrolysis bacteria	Methan bacteria
Time of reproduction	30 minutes to three days quick biological reaction	5 – 14 days slow biological reaction
Optimum of temperature	30 to 65 °C variable	37 °C or 55 °C constant
Optimum of pH value	down to 4,5	7 – 8
Vitality	robust, can easily cope with interruptions and variations of temperature and pH, quick change of feedstock is possible	very sensitive to any kind of disturbance in temperature and pH, change of feedstock is critical
Aerobic sensitivity	oxygen improves the hydrolysis process	strictly no oxygen
Biogas yield	low, methane content 0 – 30 %	high

HIGH Performance AD-Process

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Benefit:
- Fertilizer (optional)
- Sales of PKS, Fiber
- Sustainability
- BOD …

Fiber

EFB

POME

AD Process

Example: 100 000 t FFB/a Capacity

POME + EFB + Fiber = 2.0 MWh el. (500m3 CH4/h)

By Product: + Organic Sludge

By Product: + Lignin Fiber / Pellets

Revenue Streams:
- Gas / el. Power
- Fertilizer
- Lignin Pellets
- CER's

SLUDGE: Further COMPOSTING / Upgrading > Organic Fertilizer
Waste Water: With COD <500 further WWTP to reach > BOD 20

BIOGAS Opportunities & Local Solutions

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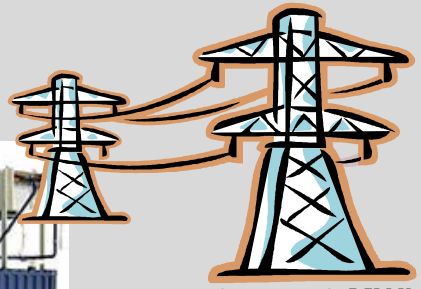
… for small Palm Oil Mills

FIT: 0.34 RM/kWh
= 1.36 RM / Nm³ CH_4



0.5 – 4.0 MWh

BioGas

Electricity + HEAT Recovery System

COOKING GAS

FUEL

+ Liquid CO_2 Gas Sales

BioGas

BioMethane

FUEL

125 – 1000 Nm³ / h CH_4 = 89 kg – 717 kg / h

BioMethane: 1.5 RM / Nm³ CH_4

Rural Development Concept with Biogas all Sizes … and "MINI"

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Sabah & Sarawak Remote Areas Outside the Reach of the Grid

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MBPP : Mini Biogas Power Plants
… small decentralized solutions?

Remote Areas e.g. in **Sabah - Sarawak**

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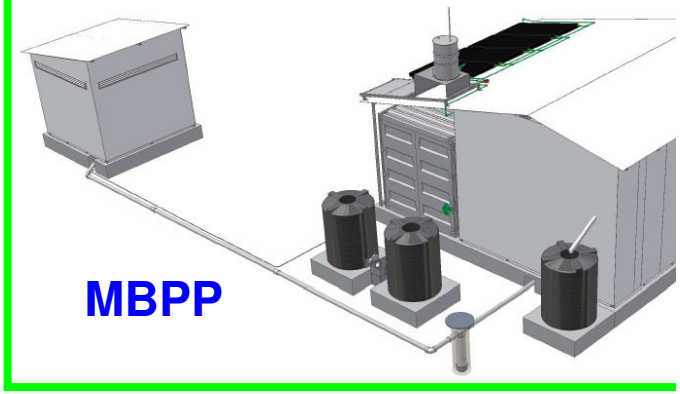
- **appr. 360 Rural Schools have NO grid Connection in Sarawak (MoE)**

- **Communities & Kampungs : Use of Generators and expensive supply of Diesel or Gasoline**

- **Remote areas are served by AIR or BOAT: 1 Liter Diesel = up to 6 RM**

- **Priorities:**
  - **A)Reliability / Availability of Power**
  - **B)Supply**
  - **C)Cost Savings**
  - **D)Carbon Footprint**



Mini Biogas Plant fulfills Priorities - at a Glance:

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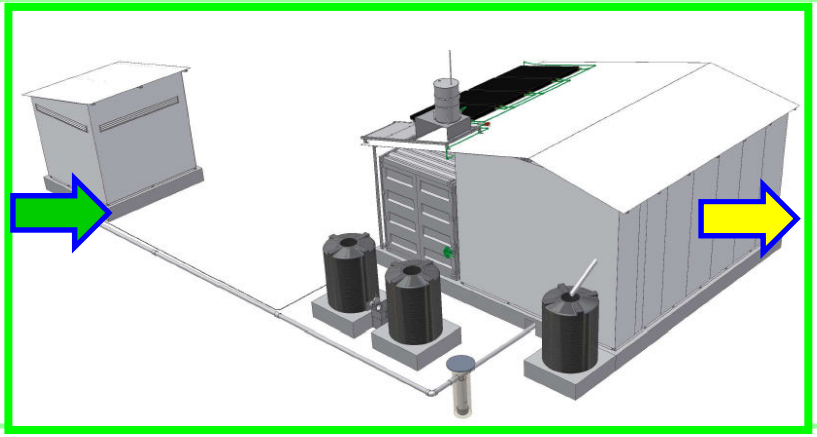
Farm: **Organic Waste** → **1. Gas & Electric Power** **2. Organic Fertilizers** → **Farm:** **Organic Fertilizers**

Household: **Organic Waste** → **1. Gas & Electric Power** **2. Organic Fertilizers** → **Farm:** **Organic Fertilizers**

Employment:
- **Operator**
- **Technician**
- **Collector**



Community Benefits:
- **Gas & El. Power**
- **Additional Income**
- **Waste Management**
- **Save Fossil Fuel**
- **Education**

General National Benefits:
- **GDP: Services & Products**
- **Employment**
- **Living Quality**

Feedstock: Huge Variety for the Biogas Plant

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Grass


Maize / Sunflower


Sorghum


Straw


Dry grass


Stems (banana i.e.)


Stems (cutted)


Leaves


Vegetable


Organic waste


vegetable waste


fish waste


market waste


grass

Basic Application & Target Group

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BASIC APPLICATION CONDITIONS:

- Organic Waste: 200kg / day … 1700kg / day … (open)
- Organic Waste Type: ALL (except wood, bones, paper)
- Space Required: 10x10m (min 8x8m) + delivery/pick up space
- Operation: Manual by trained local staff
- El. Power demand: **5 kWh … 35kWh …** **(250kWh … 2 MWh or bigger)**
- REMOTE : – Replacement of expensive Fossil Fuel for GenSet
- Costs: 1.2-1.5 Mio. RM

TARGET APPLICATION GROUP for Rural Development:

- **Communities & Wet Markets**
- **Farmer (small / mid size) with Live Stock and/or Plantation**
- **Process Industry with Organic Waste Output (e.g. FOOD, FRUITS, …)**
- **Hotel & Resorts**
- **Islands**
- **Universities & Campus, Colleges**
- **REMOTE**
  - **Schools**
  - **Airports**
  - **Telecommunication**

MBPP – Technology Outline in Detail

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- Mini Biogas Power Plant - Life Time: 20+ Years (references in operation for appr. 10 years already !)
  - Product Quality is similar to Industrial Biogas Plants
  - Monitoring (local & remote) ensure trend analysis and continuous maintenance and repair to keep the system high performing operational

- Process
  - Anaerobe Process – high efficient (patented), therefore space and cost optimized
  - **Multivariable** feedstock for organic waste, mix and changes easy possible
  - Semi automated and remote monitored process
  - State of the art small Generator with Battery Buffer to produce el. Power

- Safety
  - Safety and security provided due to fenced area
  - Germany Safety Standards applied for the process

- Mini Biogas Power Plant (capacity with food waste & green cuts)
  - min 200 kg/d = **5 kWh** el. power possible (12%)
  - … 1000 kg/d = **25 kWh** el. power possible (60%)
  - max 1700 kg/d = **45 kWh** el. power possible (100%)
  - Substrate: Food Waste and/or Green Cuts

- Operation Plan : Target continuously 24h-360d, 5 days service / a
  - Operation depends mainly on delivery of organic feedstock

- Local Partner: provide Site Area, Civil Works, Organic Waste and Utilities *
- MBPP: provide Operation**, Gas, El. Power and Fertilizer *

* Depending on each location and possibilities
** by German Main Contractor based inMalaysia or locals with training

Mini Biogas Power Plant … OUTPUT

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Feedstock - Organic Active							
Substrate	Dry Matter	Volatile Solids	Ratio to Feed	CH4 /VS and /Feedstock			
	%	%	kg VS / 1kg FS	m3CH4/kg VS	m3 CH4/kg FS	m3 CH4/t FS	kWh/t FS
Cattle Manure (Liquid)	8%	80%	0.064	0.55	0.035	35.20	4.84
Cattle Manure (solid)	25%	80%	0.200	0.55	0.110	110.00	15.13
Grass (fresh)	21%	91%	0.192	0.40	0.077	76.80	10.56
Market Waste (mixed)	25%	90%	0.225	0.40	0.090	90.00	12.38
Vegetable Waste	25%	90%	0.225	0.40	0.090	90.00	12.38
Fish Processing Waste	30%	90%	0.270	0.50	0.135	135.00	18.56
Food Waste (Canteen/Kitchen)	40%	98%	0.392	0.50	0.196	196.00	26.95
Park & Garden Waste (fresh)	42%	97%	0.407	0.50	0.204	203.70	28.01
Organic Waste (municipal)	75%	90%	0.675	0.60	0.405	405.00	55.69
Oil Seed Residue (pressed)	92%	97%	0.892	0.62	0.553	553.29	76.08

conservative rounded down = 180m3 / 1000kg per day

SIMPLIFIED as a rule of the thumb for **Food Waste** and **Green Cuts**:

(ATTENTION : Feeding per day – el. Power per hour !)

✓ 200 kg = 5 kWh el. Power … this 200kg are equivalent to green cut =

✓ 40 kg = 1 kWh el. Power 20g / m^2 on 1 hectare

✓ 1000 kg = 25 kWh el. Power or 50g / m^2 on 1 acre

Costs of Electricity

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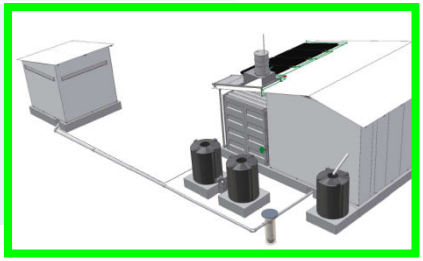
Source	Price KWh
Grid	0.30 RM (WM)
Gen Set (boat, air)	< 6 RM
MBPP	1.30 RM



0.30 1.30 6.

1 km powerline will cost RM 23 Mio

Case Study
San Andres Islands

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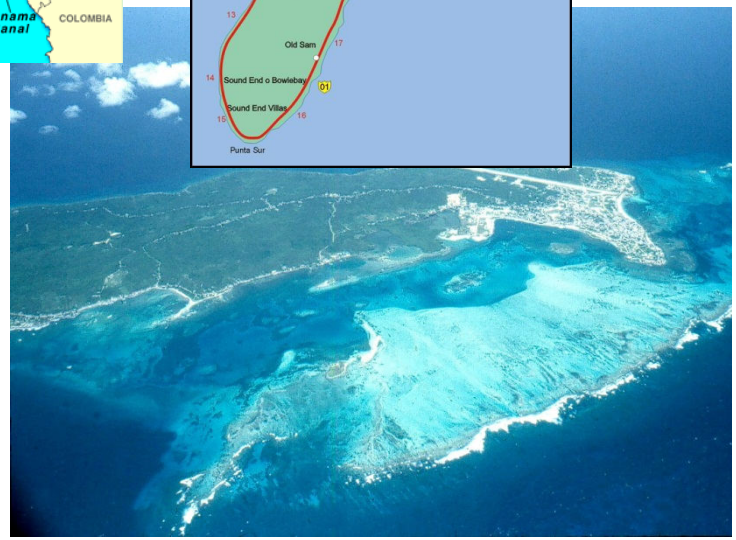
45 km²
Population 75,000

Tourism
Main Income Source

Fully dependent
on GenSets



German Know-How – Assembled in MALAYSIA

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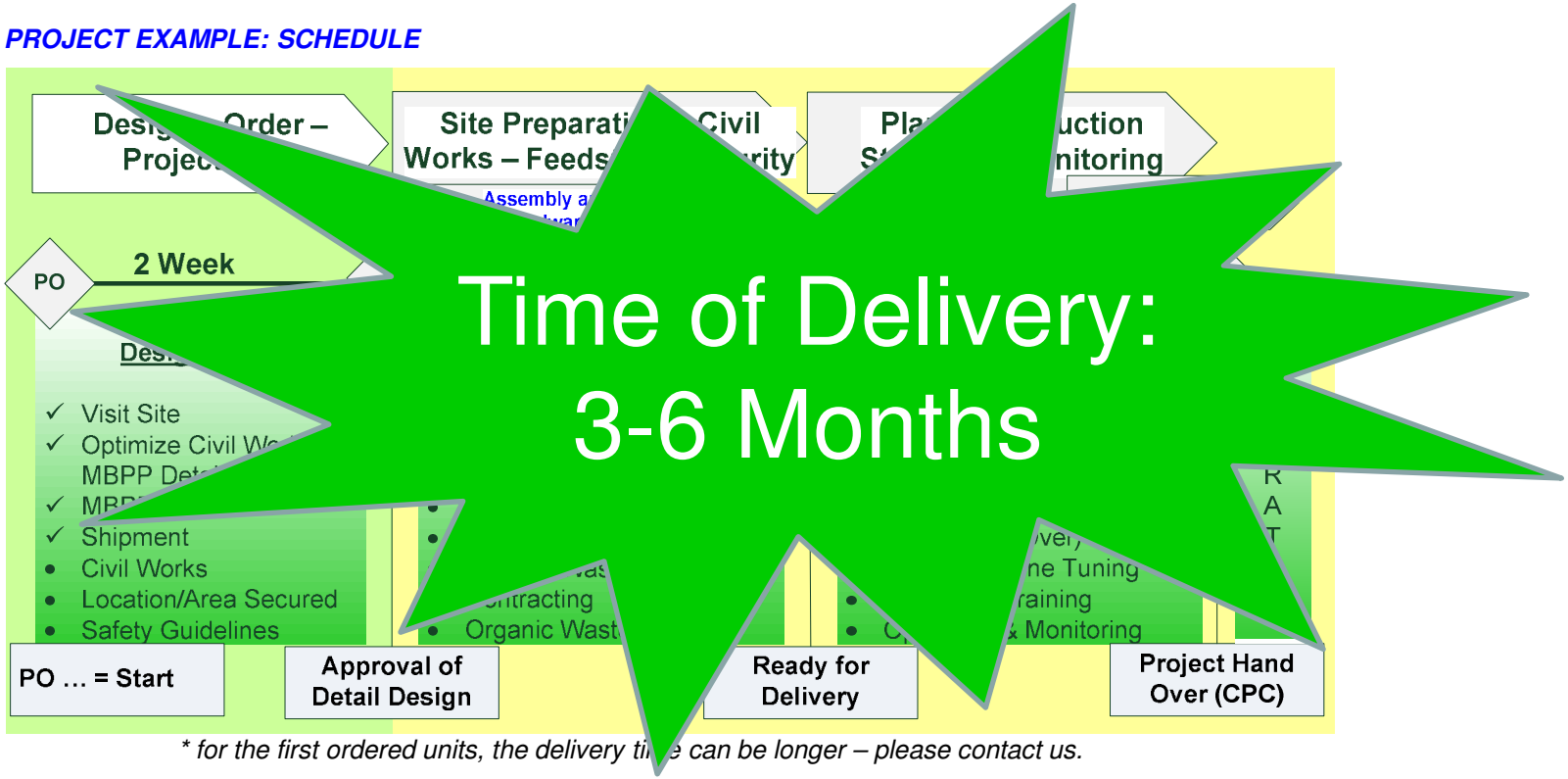
The MBPP will be produced in Malaysia according to GERMAN Engineering, Design & Know-How, Standards and Quality (ISO 9001, 14001, 18001).

Application Engineering will be done in MALAYSIA.

PROJECT EXAMPLE: SCHEDULE



** for the first ordered units, the delivery time can be longer – please contact us.*

Mini Biogas Plant – REFERENCES

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Partner companies from Germany are experienced in High Efficient Mini Biogas Power Plants – with 12 References in tropical AFRICA !

Example / References

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In a Nutshell: Benefits of a Mini Biogas Plant

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- **Feasibility**
- **Depending on Diesel Gasoline Price …**
- **Pay Back: 4-7 years – BEST case 3 years, WORST case 8 years !**
- **Substantial Cost Savings:**
- **Reduced Gasoline & Electricity Cost**
- **Reduced Disposal Cost for Canteen and Green Cut Waste**
- **Organic Waste Management for Rural Communities**

Benefits and ADDED Value out of using Mini Biogas Power Plants

Reduction / Replacement of Fossil Fuel	**COST Savings**
Reduction of Organic Waste	**COST Savings**
Creation of new Jobs	**WEALTH/SKILLS**
Production of Organic Fertilizer	**INCOME**
Education in Environmental Aspects	**INTELLIGENCE**
	GREEN

… all in all … everybody will benefit from these added values !!!

Vision 2030

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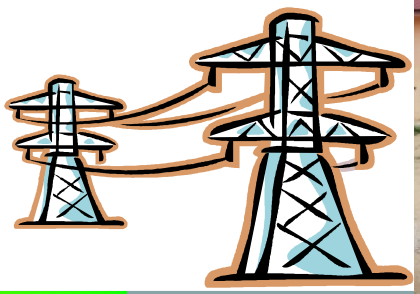
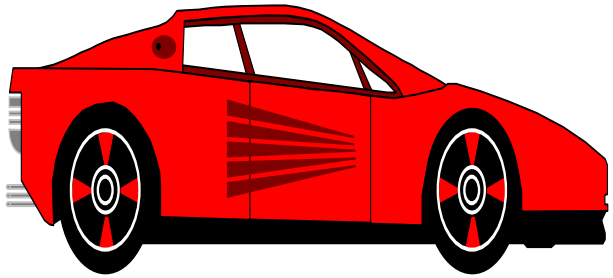


FUEL… -> BIOFUEL

ELECTRICAL



Thank you …

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Malaysia is rich in organic mass, a big value and a great asset for a bright future

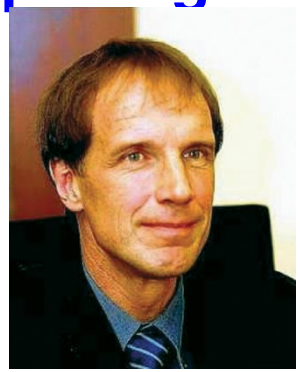
... with decentralized Mini-Small-Medium and Large Size Biogas Power Plants

YOU are WELCOME to VISIT the first Mini-Biogas Plant at USM:

Launch November / December 2012

MBPP Demonstrator Operation Opening

PROFESSOR DR. KARL WAGNER
Email: profwagnerkarl@gmail.com



Proceedings

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2. Bas Melssen
Agensi Inovasi MY
www.innovation.my

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National Biomass Strategy 2020

Task force under the Government

Objectives:
Align stakeholders
Attract downstream companies
Keep value creation in Malaysia -> create jobs

Right now, only chapter 1 of biomass strategy Malaysia is being written
Must be interesting for industry!
Policy can then facilitate
Look at the innovation side rather than at the technological side.

If we work together, 20 bio. Turnover from biomass and creation of 66,000 jobs

3. Choo Yuen Ney
Bio-Diesel

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- ~~Go into biodiesel~~
- Macro-view
- Govt.
- Problem: petrol prices cheaper than biodiesel
- 4 tons per ha/a
- Already 2006 Policy: 5 strategic thrusts:
- Not as rosy as we had planned earlier on.
- 1985: first biodiesel plant in the world
- Germany: tests. 3 plants in MY, biggest in Johor.
- Programme NOT SO ENCOURAGING, esp. For exports. Dropped to 50,000 t.

LOCAL B5 programme (Feb 2009)

5% biodiesel, 95% petrol.

1100 stations in central peninsula have to supply the hybrid

By 2014 nation-wide B5 => 500,000 t /a

1.5 billion tons less CO2

Issues/ challenges:

High costs of feedstock (unlike Indonesia, taxation different, can export 1 mio tons incl. EU

Biodiesel price higher, subsidies required.

Move from B5 – B10?

- Shell and fibre already used
- EFB to produce electricity supply grids

- Solid: pelletising brickets
- Liquids: bio oil

- No theme, no storyline

4. Choo Yuen May

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- Feedstock is an issue (Sabah is the place to be)
- EU 6 presenters
- Technology is not the constraint: Problem is lack of interest of buyers
- Focus on commercial applicability
- Tremendous potential in Sabah – not enough electricity. Still power shortage when power plants are completed
- 80%
- Focus on small power plants in rural areas
- Without need of policy making
- 1/3 of el could come from RE.


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