

Upgrading of Malaysian Biomass for Cofiring with Coal

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Presentation Outline

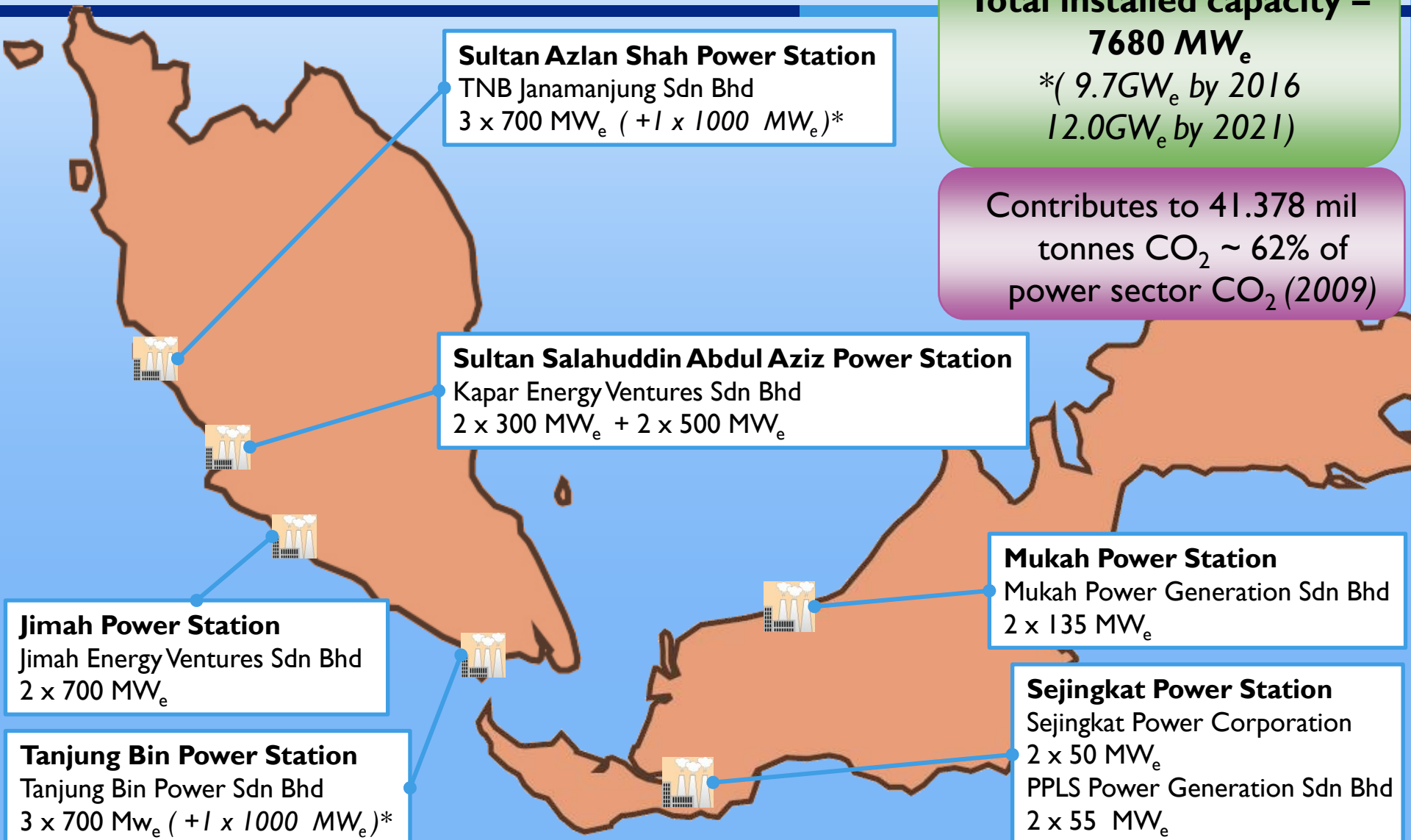
1. Introduction
2. Malaysian Biomass Resources
3. Biomass Briquetting
4. Biomass Torrefaction
5. Cofiring Research at CRE
6. Conclusions

Malaysia

- Location: $3^{\circ} 10' 0''$ N, $101^{\circ} 42' 0''$ E (Kuala Lumpur)
- Land area: 126,853 mi² / 328,549 km²
- Population : 28,722,597



Malaysia's Coal Power Generation



**Total installed capacity =
7680 MW_e**

***(9.7GW_e by 2016
12.0GW_e by 2021)**

**Contributes to 41.378 mil
tonnes CO₂ ~ 62% of
power sector CO₂ (2009)**

Cofiring Experience

Jimah Power Station

- 700 MW_e opposed fired boiler
- 1% - 3% wt pelletised EFB for 1 week
- storage issues and increased slagging



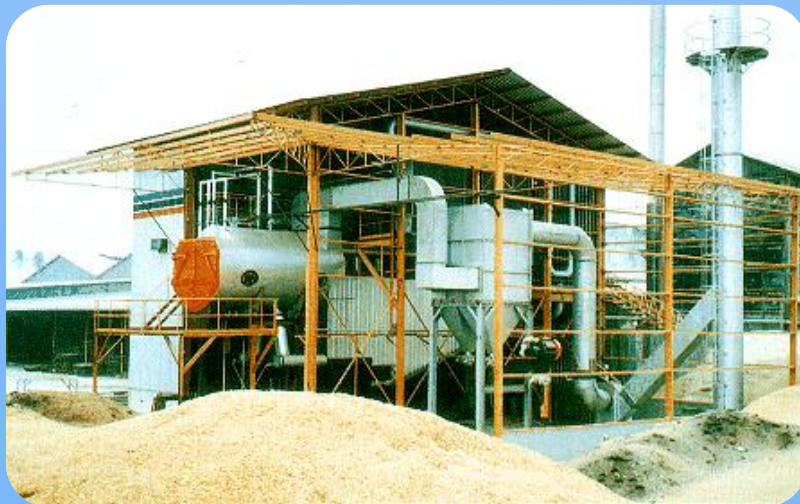
Biomass Resources

- Agricultural residues

- Centralised
- Air dried
- Surplus?



Palm Oil Mill



Rice Mill



Rubberwood Mill

Agricultural Residues ...I

▣ Palm oil mill



Residue (2011)	Amount / tonne	CV / MJ/kg	Energy Potential / MW _{th}	30% η / MW _e
Empty fruit bunch	24,493,248	14.6	10,432	3,130
Mesocarp fibre	14,891,894	14.8	5,977	1,793
Palm kernel shell	6,074,325	19.0	3,660	1,098

Agricultural Residues ...2

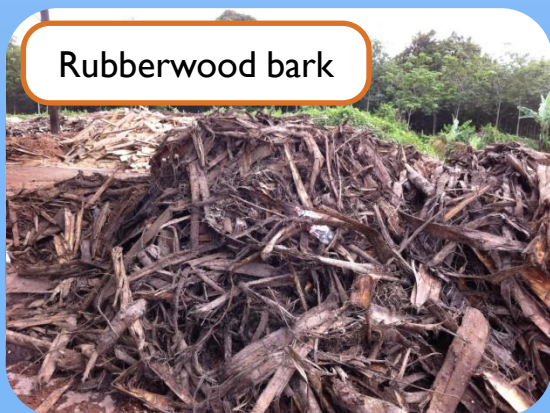
▣ Rice mill



Residue (2010)	Amount / tonne	CV / MJ/kg	Energy Potential / MW _{th}	30% η / MW _e
Rice husk	560,560	15.97	284	85

Total palm & rice biomass potential
= 6,106 MW_e

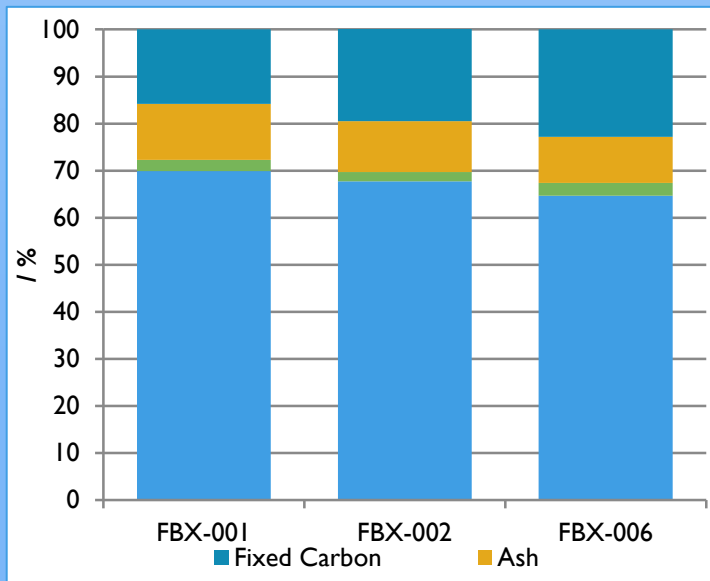
▣ Rubberwood mill



Residue	Amount / tonne	CV / MJ/kg
Bark	24,493,248	16.6
Sawdust	14,891,894	11.6

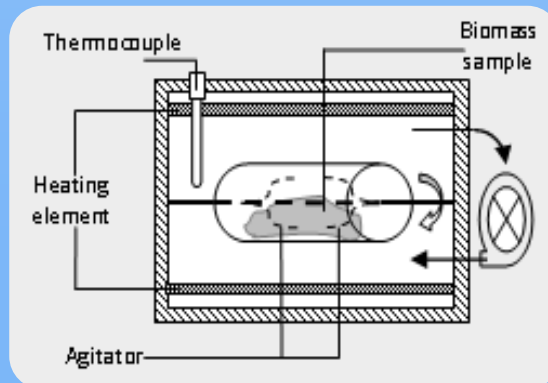
Biomass Briquetting

Formulation No.	Briquette raw materials	Source Palm Oil Mill
FBX-001	EFB (100%)	Mill A: Southwest Perak, with 2% residual oil in EFB
FBX-002	EFB (80%) and Mesocarp Fibre (20%)	Mill A
FBX-006	EFB (100%)	Mill B: Southwest Perak, with 5% residual oil in EFB



Torrefaction ...I

- Bench top batch torrefier
- Sealed vessel heated at 250 °C for 60 mins
- Future improvements
 - Absence of O₂
 - Temperature control



Torrefaction ...2

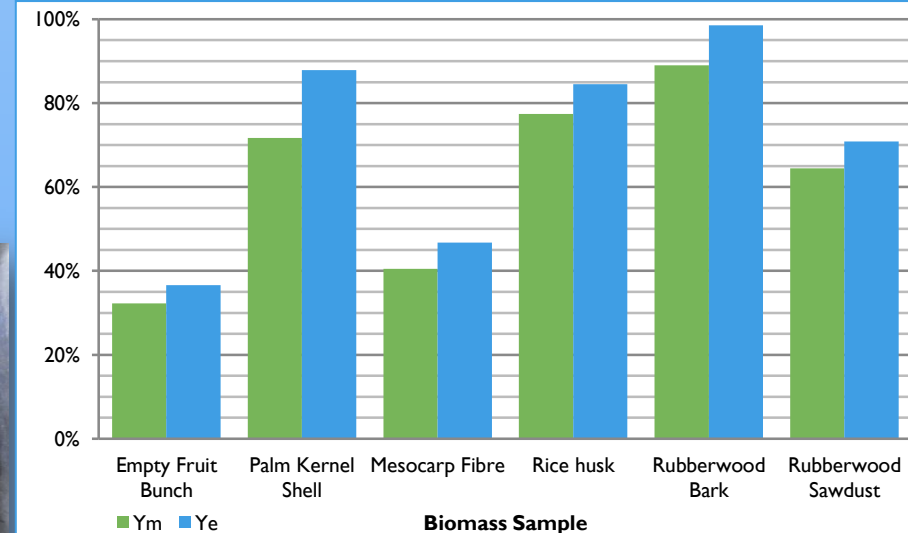
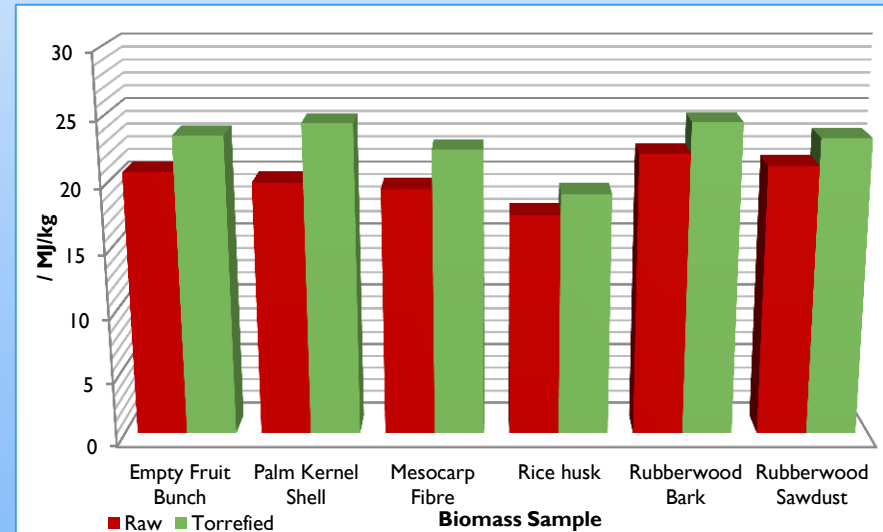
■ Calorific Value

■ Mass Yield, Y_m

$$Y_m = \frac{M_{torr.}}{M_{raw}} \times 100\%$$

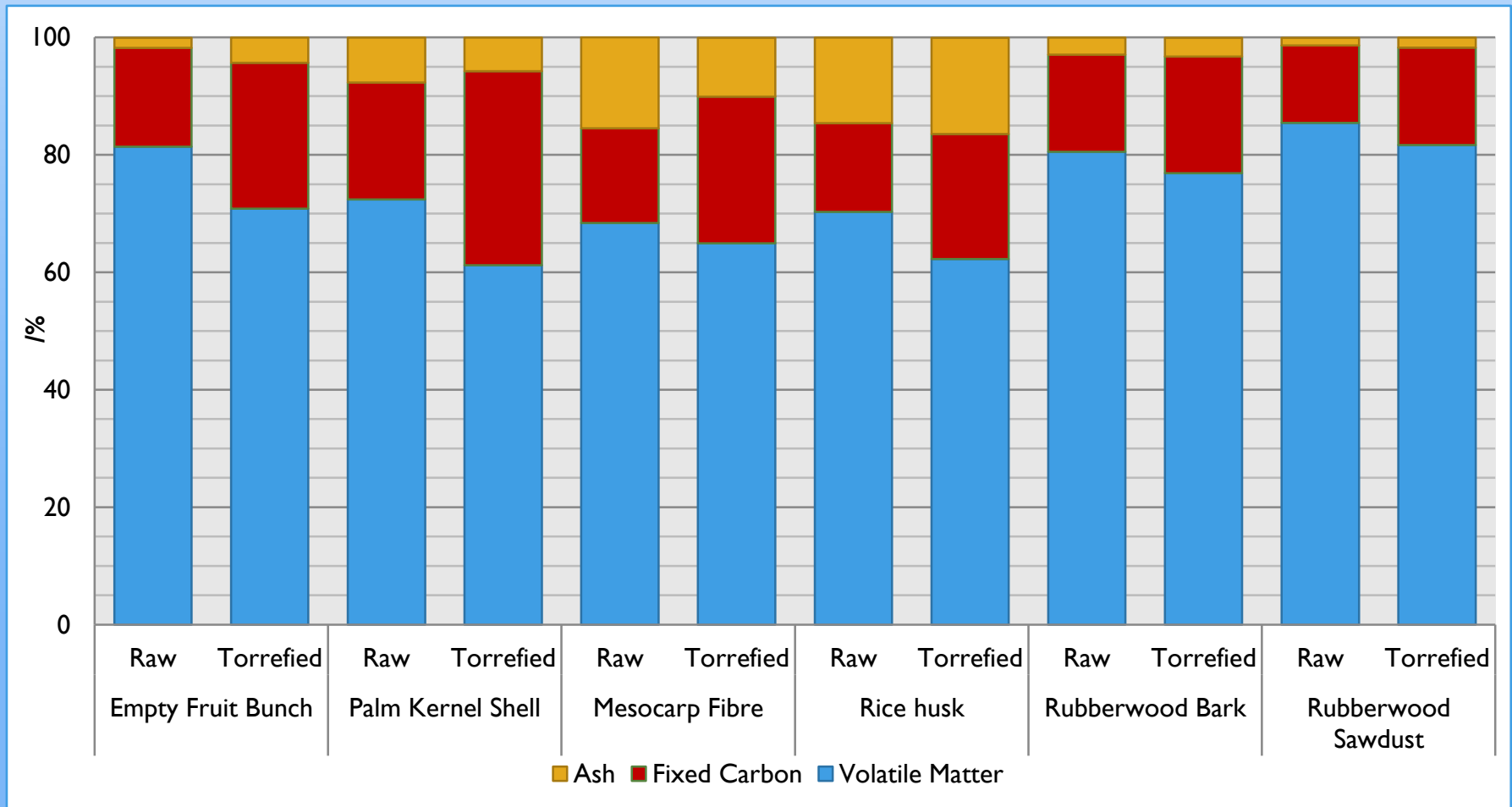
■ Energy Yield, Y_e

$$Y_e = \frac{CV_{torr.}}{CV_{raw}} \times Y_m$$



Torrefaction ...3

Proximate Analysis



Torrefaction of Pelletised Biomass

- Difficulty in binding
→ torrefying after pelletising



Biomass pelletising facility



Rice Husk



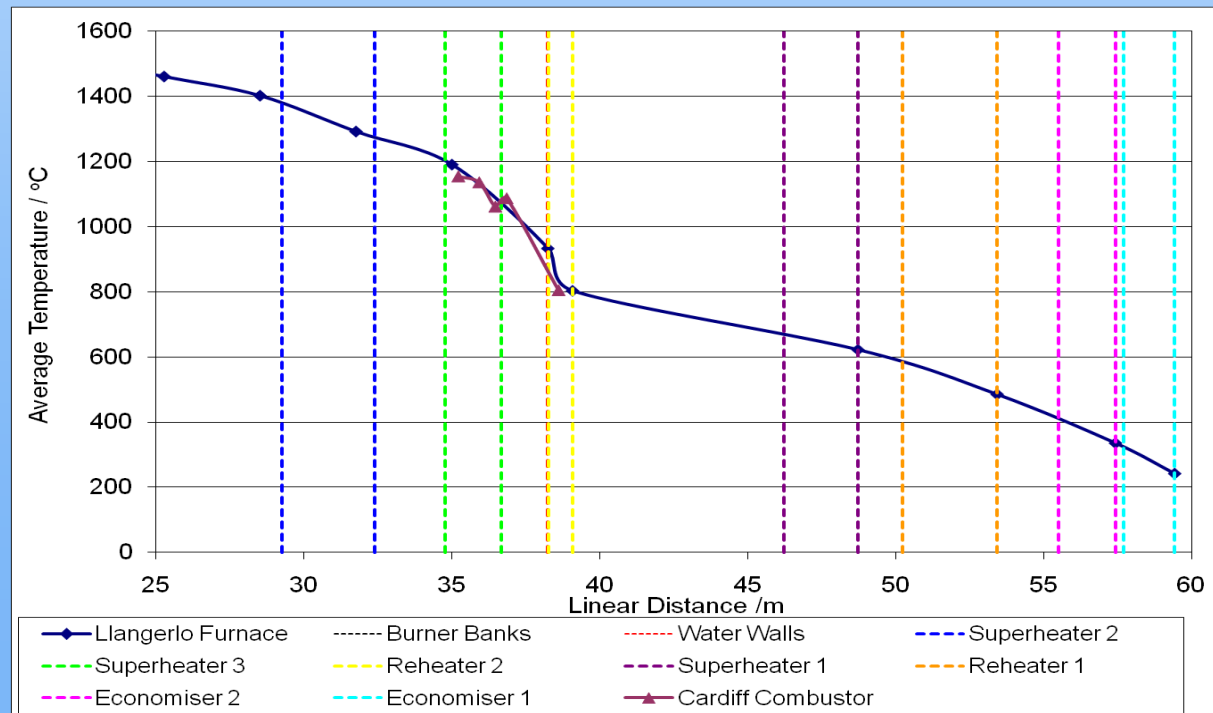
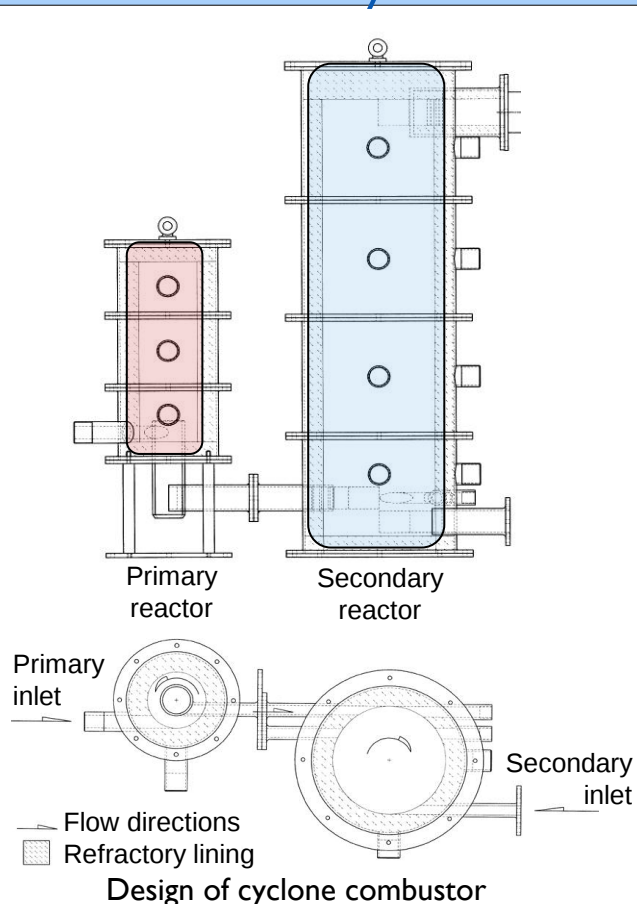
Empty Fruit Bunch



Cofiring Research at CRE

Two Stage Cyclone Combustor ...I

- Cyclonic combustion to provide suspension firing conditions
- **Primary reactor** mimics near burner region (reducing atmosphere)
- **Secondary reactor** mimics complete combustion regions



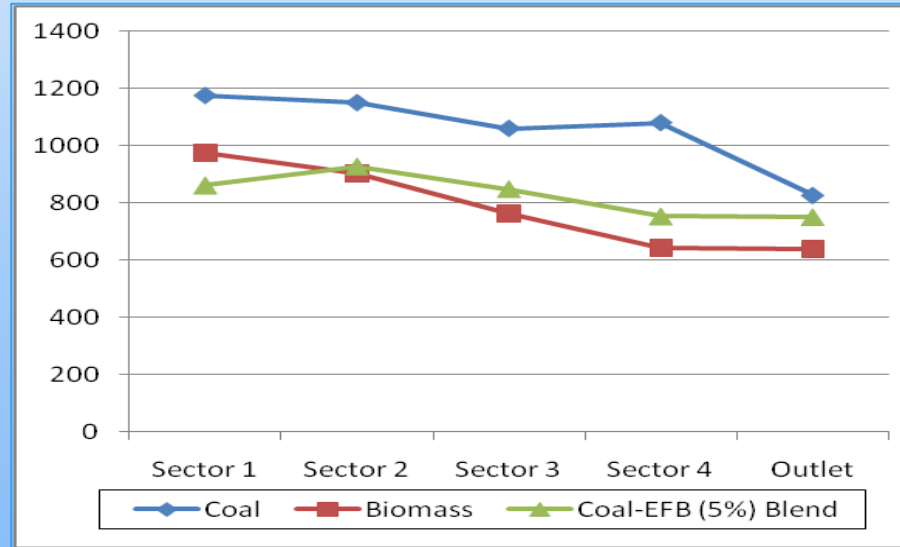
Temperature profiles of two-stage combustor against a real pulverised coal boiler
(Source : Cardiff University 2006)

Cofiring Research at CRE

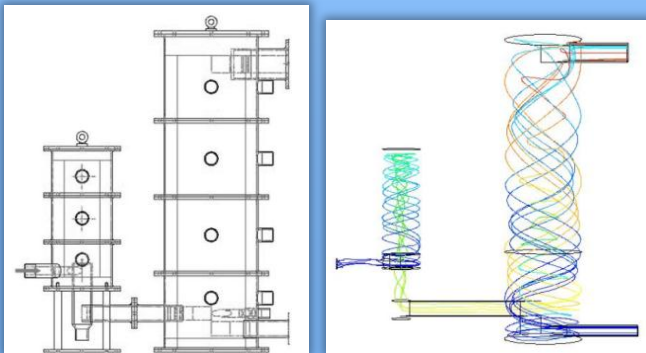
Two Stage Cyclone Combustor ...2



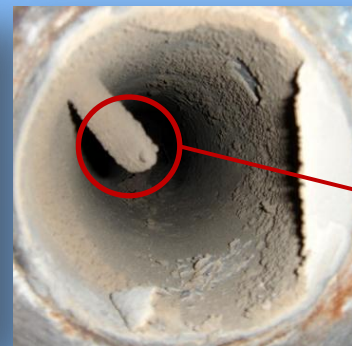
Two-stage combustor to simulate real boiler



Temperature profiles when firing various fuel blends in the secondary reactor



Computational fluid modeling used to complement actual combustion trials

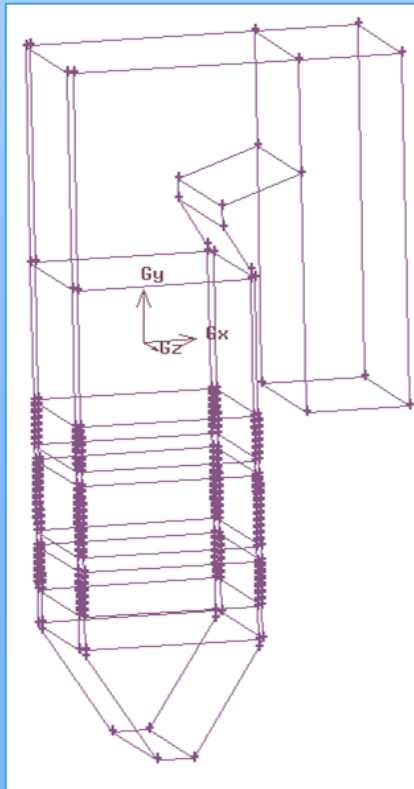


Slagging and fouling deposition

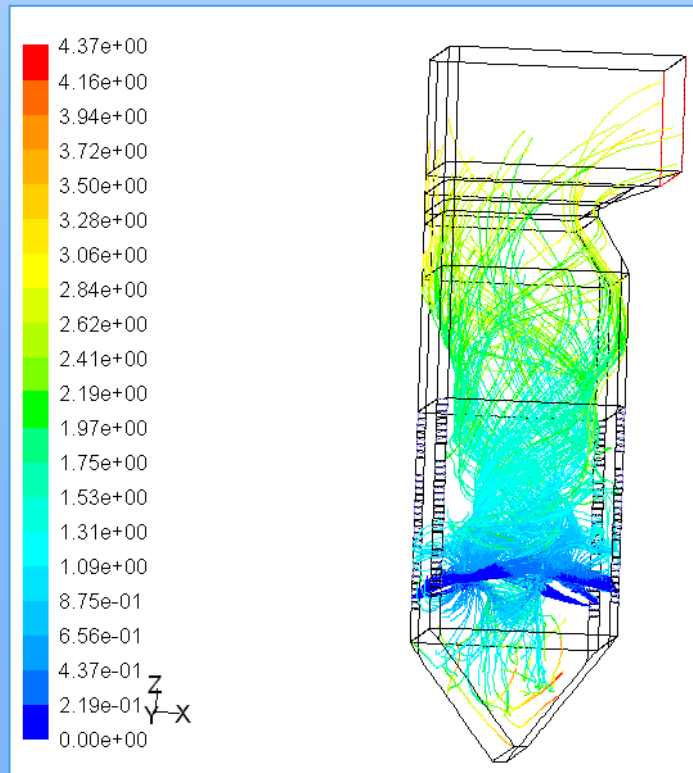
Cofiring Research at CRE

CFD Simulation of Real Boiler

- Modeling of a tangential fired 700 MW_e unit from Sultan Azlan Shah Power Station, Manjung



Model of furnace



Simulation of particle residence time



Cofiring Research at CRE

Blending Calculator for Malaysian Biomass Database

- Comprehensive database of properties
- Calculates fuel feed rates from $\%_{th}$.
- Calculates slagging and fouling indices.

MALAYSIA BIOMASS DATABASE

Comparing Fuel

Calorific Value

Energy Type	CV (MJ/Kg)	CV Dry (MJ/Kg)	CV Daf (MJ/Kg)
Palm Shell	19.47	20.85	21.34
EFB	17.63	19.38	21.11
Adaro	24.65	27.03	28.63

Proximate Analyses

Energy Type	Moisture (MJ/Kg)	Volatiles (MJ/Kg)	Carbon (MJ/Kg)	Ash (MJ/Kg)
Palm Shell	6.65	69.85	21.35	2.15
EFB	9.03	66.9	16.63	7.45
Adaro	8.82	48.06	38.04	5.08

Ultimate Analyses

Energy Type	C (MJ/Kg)	H (MJ/Kg)	N (MJ/Kg)	S (MJ/Kg)	O2 (MJ/Kg)
Palm Shell	56.05	6.3	0.46	0.03	35.02
EFB	49.25	6.6	1.22	0.09	35.39
Adaro	67.05	6.44	0.9	0.12	20.41

MALAYSIA BIOMASS DATABASE

Palm Shell [Biomass]



Descriptions: Malaysia and Indonesia are the largest producers of palm oil product. The palm oil industry has contributed the biggest income to the countries for many years. Moreover, palm oils has emerged as one of the most important oils in the world's oils and the market of fats. About 90% of palm oil is used as food related products worldwide and the other 10% is used for basic raw material for soap.

Origin : Global Green Synergy, Bidor, Perak



MALAYSIA BIOMASS DATABASE



Conclusions

- Coal will be the major fuel source for Malaysia.
- Interest in cofiring exists.
- Agricultural residues is a good source of biomass feedstock.
- Biomass requires upgrading for utilisation.
- Torrefaction can be the solution but further research still needed.
- CRE active in cofiring research in Malaysia.

Q & A



Thank You !



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