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Palm Kernel Shell (PKS) is More Than Biomass for Alternative Fuel After 2005.

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1: ABSTRACT

Palm Kernel Shell was partially a waste in 90s and early 2000 considering more than 350,000 tons were available for sale. The PKS had been a little known then for its potential usage in large scale. When the policy on environment for Green House Gases (GHG) emission reduction was little known in Malaysia Lafarge Malayan Cement Bhd (LMCB) has seriously embarked on the alternative fuel to partially replace fossil fuels (mainly coal) in its cement manufacturing.

The PKS is required to be pulverized if it were to be efficiently burnt in cement kiln as compared to coal burning efficiency. LMCB had a breakthrough in designing an impact crusher which has an output capacity of 10 TPH pulverized PKS and was installed at Rawang Plant, Selangor in late 2000. The 2nd crusher was designed for throughput capacity of 20 TPH being the largest PKS crusher in the world to-date was installed at Kanthan Plant, Perak in mid 2001

Malaysia was eligible to claim its carbon credit based on an approved methodology ACM 003 for partial replacement of fossil fuel by biomass palm kernel shell. The CDM project was finally completed after it was registered with UNFCCC – CDM Board in 2005 and approved and issued its Certified Emission Reductions (CERs) for 366,260 tons of CO_2 in 2006 (UNFCCC-0000 0247).

This paper discussed on the evolution of PKS market in Malaysia, development of palm kernel shell crusher and utilization of pulverized PKS as alternative biomass fuel as partial replacement of fossil fuel for CDM project .The successful submission and registration of the CDM project with UNFCCC- CDM Board has resulted in the issuances of CERs to the 1st world largest CDM biomass project on biomass fuel for partial replacement of fossil fuel in cement kiln.

Lafarge Malayan Cement Bhd - Malaysia

2 INTRODUCTION.

Palm Kernel Shell was partially a waste in 90s and early 2000 considering more than 350,000 tons were available for sale. The PKS had been a little known then for its potential usage in large scale. When the policy on environment for Green House Gases (GHG) emission reduction is little known in Malaysia Lafarge Malayan Cement Bhd (LMCB) has seriously embarked on the alternative fuel to partially replace fossil fuels (mainly coal) in its cement manufacturing. Ample supply and low demand of PKS in year 2000 had prompted Lafarge to carry out research on its viability for alternative fuel being a neutral carbon fuel. The excess quantity of PKS was about 350,000 tons per year with an assumption that 50% of PKS production was used within the palm oil industry and 25% by other industries and 25% was available for sale.

The PKS is required to be pulverized if it were to be efficiently used in cement kiln as compared to coal burning efficiency. While the burning of PKS in palm oil mill boiler is traditionally the most primitive and inefficient utilization of fuel. Lafarge had a breakthrough in designing an impact crusher which has an output capacity of 10 TPH pulverized PKS and was installed at Rawang Plant (RP), Selangor in late 2000. The 2nd crusher was designed for throughput capacity of 20 TPH being the largest PKS crusher in the world to-date was installed at Kanthan Plant (KP), Perak in mid 2001. The average monthly PKS consumption as alternative fuel for a period between 2000 and 2005 was 8000 tons per month or 8% fuel replacement for both the Plants.

When UNFCCC and Kyoto Protocol was ratified in September 2005 by 189 countries and 151 countries respectively , Clean Development Mechanism (CDM) was established to ensure those industrialized countries (Annex 1 countries) are legally bound and committed to reduce GHG emission according to the level that had been committed. Malaysia being one of Kyoto Protocol signatories for Annex 2 country was eligible to claim its carbon credit based on an approved methodology ACM 003 for partial replacement of fossil fuel by biomass palm kernel shell. The CDM project was finally completed after it was registered with UNFCCC – CDM Board in 2005 and approved and issued its Certified Emission Reductions (CERs) for 366,260 tons of CO2 in 2006 (*UNFCCC-0000 0247*).

3: PALM KERNEL SHELL (PKS) MARKET STUDAY in WEST MALAYSIA

The supply of palm kernel shells (PKS) to both RP and KP had been erratic and inadequate to meet the replacement need of fossil fuel by PKS for 2005. This market study was done based on the current supply behavior of PKS traders and the ability of palm oil mill operators to supply PKS.

PKS production is assumed at 6% by weight of the tonnages of fresh fruit bunches (FFB) produced. The Malaysia Palm Oil Board (MPOB) publishes the FFB figures on a monthly basis. For year 2004 the total FFB production and processed amount was 42.1 M tons for West Malaysia giving a PKS production of 2.52 M tons. Of this volume, it is estimated that 50% of the PKS was consumed by palm oil mill boilers as its primary fuel, 20% is inaccessible due to logistics, 20% is supplied to other heat consuming industries and only 10%, or 252,000 tons are available for LMCB. RP and KP annual PKS requirement is about 90,000 tons (inclusive of 8,000 tons for stock) for its fuel replacement needs of 8% and 5% respectively. This requirement is about 3.56% of the total PKS production by the oil palm industry.

In 2004 the supply of PKS to both RP and KP was 36,200 tons against the requirement of 143,000 tons for fuel replacement of 12 %. In 2002 and 2003 the delivery of PKS was 70,500 tons and 86,000 tons respectively. As fuel oil and diesel prices continued to escalate the other heat consuming industries are increasingly using PKS as their alternative fuels.

In 2004, the traditional PKS suppliers to RP & KP found the new market was, and still is, very attractive with PKS (delivered) price above RM 80 per ton while RP and KP prices were still maintained at about RM 60 per ton. The reluctance of suppliers to enter into short term supply contract with LMCB resulted in uncertainty of PKS supply to both the Plants. When the price of PKS offered to current suppliers was increased from between RM65 to RM 70 per ton the supply to RP showed some improvement. The total PKS delivered for 2005 was 33,520 tons and 7, 595 tons by the 6 and 2 PKS suppliers to RP and KP respectively.

As price is the only success factor for adequate supply of PKS to the Plants it is critical to establish well coordinated purchasing by Procurement. This coordinated purchase was achieved with great success in 2001 and 2002 with the delivery of PKS to the plants exceeding 100,000 tons. With good PKS management and with aggressive purchasing strategy an annual PKS delivery of about 90,000 tons is achievable and deliverable.

3.1 Market Overview

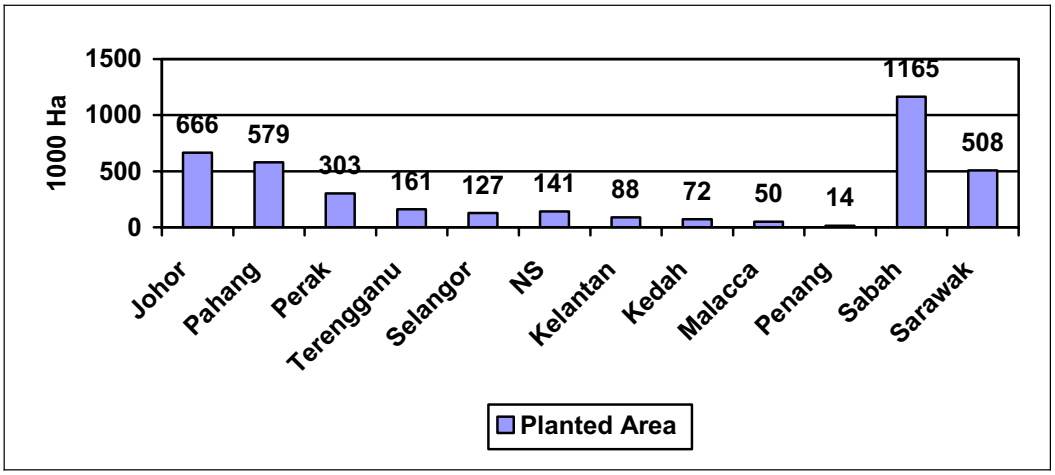
Oil palm has over the years become the dominant crop replacing rubber as the cornerstone of plantation sector. The waste products from the milling process are empty fruit bunch (EFB), fruit fibers, palm kernel shell (PKS) and palm oil mill effluent (POME). Lately EFB, PKS and fibers are increasingly being sold as a commodity as their usages find markets outside the industry itself. The renewable source of the biomass within this industry has attracted numerous research and development to find other usage than the traditional power generation. Key players in the oil palm industry i.e. Felda, Sime Derby Bhd, Golden Hope Bhd and Guithrie Bhd have made PKS as their new source of additional revenue.

3.2 Overview of Oil Palm Industry

3.2.0 Planted Area

The total planted area in Malaysia has increased by 73,287 ha in 2003 to 3.875 million ha in 2004. However, the increase was only in East Malaysia i.e. Sabah (43,535 ha) and Sarawak (43,535 ha). Peninsular Malaysia recorded a slight decrease of 560 ha mainly due to conversion of planted land into commercial and residential developments by plantation giants such as Guthrie Bhd, Golden Hope Bhd, IOI Bhd and I&P Bhd.

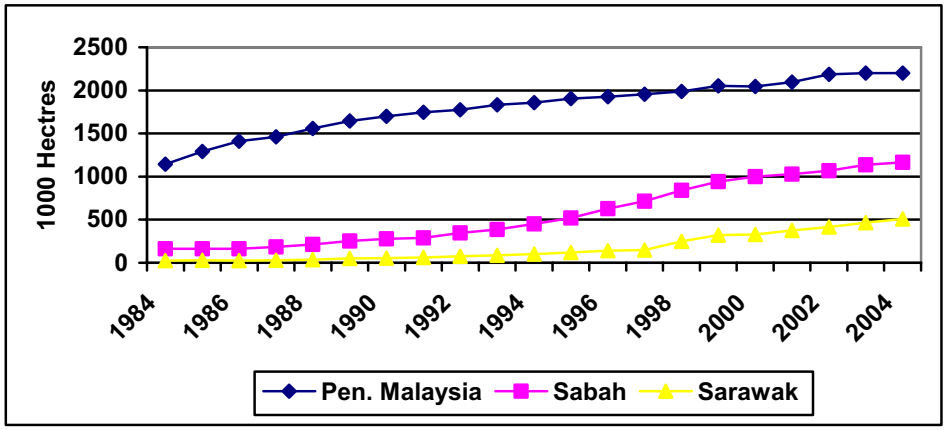
Figure 1: Oil Palm Acreage Planted in Malaysia



3.2.1 Planting Trend

The oil palm planted area in Peninsular Malaysia has reached a plateau level at about 2.2 million ha of oil palm. As the trend of the current annual production of FFB of about 42 million tons remains stagnant in the last two years, it is envisaged that the future production of PKS would be about 2.52 million tons in Peninsular Malaysia and would not significantly increase. The oil palm planted area in Sabah is growing rapidly from 12% in 1984 to 30 % in 2004 of the total planted area. The expansion of planted area is almost entirely focused in East Malaysia. The total FFB production in Malaysia for 2004 was 69.77 million tons.

Figure 2: Growth of Oil Palm Acreage Planted in Malaysia



3.2.2 Yearly Season

On average the yearly peak season typically occurs between **May to November**, whereas the low season is between **December to April**.

3.23 Palm Oil Mils In Peninsular Malaysia

The number of palm oil mills (POM) in Peninsular Malaysia is currently 252 mills; accounting for approximately two third of the mills in Malaysia.

Figure 3: Distribution of Palm Oil Mills in West Malaysia

	State	**Mills**
1	Johor	69
2	Pahang	69
3	Perak	45
4	Selangor	26
5	NS	14
6	Terengganu	12
7	Kelantan	9
8	Kedah	3
9	Penang	3
10	Malacca	2
	Total	**252**

3.24 Ownership of Palm Oil Mills In Pen. Malaysia

FELDA as the biggest plantation company in Malaysia is the natural leader in terms of POM ownership.

Figure 4: Major Palm Oil Mill Operators

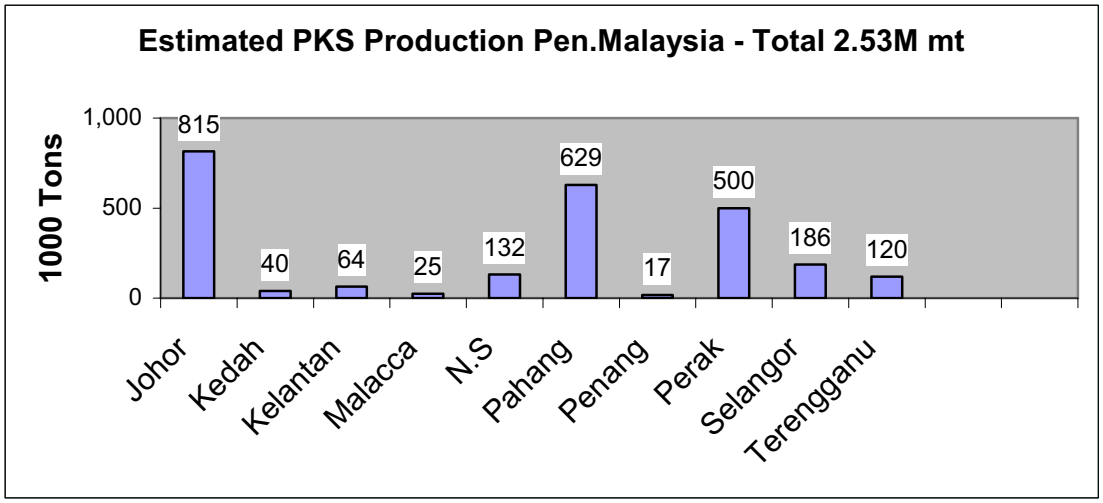
	Owner	**Mills**
1	FELDA	62
2	Guthrie	13
3	Golden Hope	11
4	KL Kepong	8
5	FELCRA	6
6	United Plantation	5
7	Others	147
	Total	**252**

3.3.0 Production of PKS and PKS Market in Peninsular Malaysia

3.3.1 Production of PKS

The production of PKS is based on the **six percent** content by weight of the shell in relation to fresh fruit bunch (FFB) received at the palm oil mills.

Figure 5: PKS Production in Peninsula Malaysia (By State) For 2004

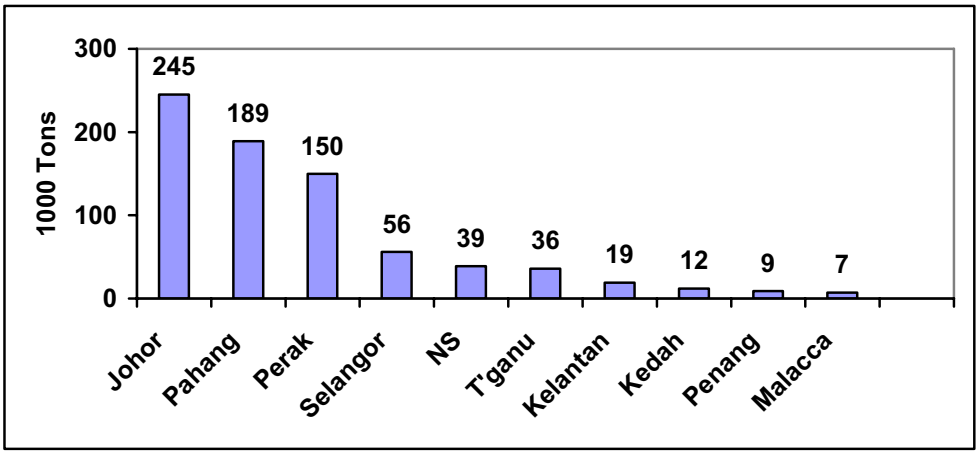


The bulk of the PKS supplied to APMC comes from four major States i.e. Johore, Pahang, and Perak while Negeri Sembilan and Terengganu support less than 10%. Johore, Pahang and Perak produce more than 77% of the total PKS production However, most of the PKS from Selangor is for the mills' own consumption and not readily available for sale.

3.3.2 Estimated Current Market of PKS in Peninsula Malaysia

The mills burn at least 50% of the PKS produced as its primary fuel, and another 20% is estimated to be lost due to spillages, losses in production, poor quality, logistics and inaccessibility to palm oil mills, full consumption by some mills and etc. The remaining 30% is assumed to be available in the market. The estimated current PKS volume based on the above assumptions is shown in Fig 6.

Figure 6: PKS Availability for Sales



Nevertheless there is no study ever conducted to confirm how much PKS is actually available in the market. Such study will entail extensive market research on the consumption of PKS by other consumers**.**

3.40 PKS SUPPLY TO RP and KP For 2000 – 2005

3.41 PKS Received & Consumed At Works

Figure 7: PKS Received and Consumed for 2000- 2005

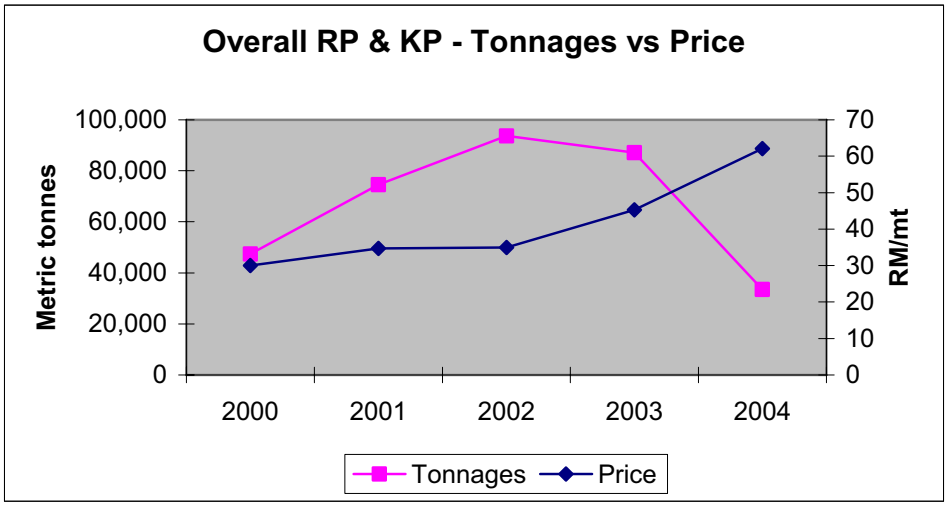
Year	Received Rawang	Consumed Rawang	Received Kanthan	Consumed Kanthan
2000	63,174	26,558	37,415	20,842
2001	24,519	41,700	31,466	32,896
2002	32,524	42,195	38,026	51,526
2003	42,154	42,470	43,813	44,618
2004	26,116	25,713	10,471	7,772
2005	33,520	36,443	7, 595	7,455
TOTAL	**222,007**	**215,079**	**161,191**	**165,109**

The above Figure 7 indicated that both Plants were consuming about 80,000 tons annually from 2001-2003. However, the supply had reduced significantly in 2004 and improved marginally in 2005 for RP only as the suppliers were unable to meet the uncertainty of quantity required by LMCB. At the same time, other heat consuming industries (such as clay bricks, rubber glove and ceramic) offered higher prices of PKS as diesel and fuel oil prices escalated.

3.4.2 Tonnages vs Price

The graph in Fig 8 shows the correlation between the tonnages and price of PKS, during which time the surge in demand for PKS by other consumers pushed up the price that the LMCB could not respond to high PKS price increase to secure the tonnages

Figure 8: PKS Tonnage Vs Price



3.4.3. PKS Market for APMC

The supply of PKS to RP generally comes from the Central and Southern States of Peninsular Malaysia whereas for KP the supply generally comes from Northern States (mostly from Perak) and Eastern States (mostly from Pahang and Terengganu). However, some tonnages of PKS from Southern State (Johore) was diverted to KP and drastically reduced due to market competition by other heat consuming industries.

3.4.4 Purchases

Purchases nowadays are done on spot basis to obtain the best possible price at any given time in view of fluctuation in monthly supply according to season. No suppliers are willing to enter into Supply Contract either short or long term as the PKS available quantity is outside suppliers' control.

4.0 PKS SUPPLIERS & RELATED ISSUES.

4.1 Past & Current Suppliers

From 2000 to 2005, there are about 24 different suppliers throughout this period, but of the remaining 10 current suppliers only 4 are considered long term suppliers while 3 suppliers are fairly new.

4.2 Problems Faced By Suppliers

i. Inconsistent supply of PKS from palm oil mills and this has affected the PKS supply delivery daily rate.
ii. PKS suppliers have a contractual obligation to Palm Oil Mills to off-take PKS as payment has been made prior to delivery.
iii. RP & KP were unable to receive PKS after working hours and on Public Holidays and Sunday.
iv. Unable to optimize receiving of PKS by the Plants during peak PKS production i.e. May to November.
v. Plants deferred the delivery PKS when there was major Plant Shutdown for more than 3 weeks during peak months of PKS season..

After going through these predicaments and difficulties many of these suppliers found that other industries have also offered extremely attractive price .

4.3 OPPORTUNITY, THREATS & RISKS

PKS, along with other palm based biomass, being a renewable biomass has great application potentials in many industries. Numerous R&D have been carried out to develop different applications of palm based biomass by Malaysian Palm Oil Board (MPOB), SIRIM, Forest Research Institute of Malaysia (FRIM) and private companies. Among the areas of application that have been established are as alternative fuels, stock material for activated carbon manufacturing and etc.

5.0 Other User of PKS

i. Clay Brick Manufacturers

Increasingly more bricks manufacturers are relying on PKS as their main fuels to generate heat in the bricks manufacturing; replacing diesel, MFO and charcoal.

ii. Rubber Gloves Factories

These factories are amongst the major users of PKS; replacing diesel and MFO whose prices are quite high nowadays. This was very attractive market as PKS price was breaching RM80 per ton delivered to factories in Perak in early 2005.

iii. Kernel Crusher Factories

Several Palm Kernal Crushing Plants are reported to be using PKS as their fuels to generate power for their plants and steam for oil palm fruits processing..

iv. Activated Carbon Manufacturers

Traditional coconut shell is the starting raw material for making charcoal which are then turned into activated carbon. PKS is now becoming a replacement material to coconut shell, however the volume is small.

v. Power Generation

Several companies have carried out several studies to ascertain the viability of using palm based biomass fuels. This development will further push towards higher demand for PKS but not likely to happen in the next 5 years.

5.0 Evolution of PKS Crusher

Research on pulverizing PKS started as early as year 2000. After various trials on different design of impact crushers the blade impact crusher was found to be the most economical. LMCB had designed the biggest PKS impact crusher ever manufactured in the world with 100% local components. With pulverized PKS with -3mm more than 80% and <5mm was 20% the burning of PKS at precalciner was successfully achieved. Since 2001, both Rawang and Kanthan Plants have using blade impact crusher. In 2002 more than 90,000 tons of pulverized PKS were used as biomass fuel to replace about 11% fosil fuel.

6.0 Clean Development Mechanism (CDM) Project on PKS as Biomass Fuel.

Having successfully burnt pulverized PKS as neutral carbon fuel , LMCB had started working on CDM methodology on its own. In 2003, UNFCCC Meth Penal had accepted LMCB's methodology (*ACM 0003 – UNFCCC 2004*) and the Project Design Document (PDD) had been submitted which was entitled " Partial Replacement of Fossil Fuel with Palm Kernel Shell in Cement Manufacturing" and was registered on April 21, 2006. Verification of the project was carried out and certified emission reduction (CERs) was

issued for 369, 200 units or equivalent of 369,200 tons of CO2. The PKS CDM project had been the first world largest biomass ever submitted to UNFCCC and approved. The CERs are yet to be traded on the open CO2 market or European Union Trading Scheme (EUTS) by Lafarge Group- France as the buyer of Annex 1 country.

Figure 8 : Verified CERs for RP& KP for 2000-2005

Year	RP CERs	KP CERs	RP+KP Total CERs	Non Biomass CO2	RP+KP Net CERs
2000	25,632	16,555	42,185	0	42,185
2001	37,139	32,539	69,678	0	69,678
2002	38,884	53,852	92,736	0	92,736
2003	41,477	48,981	90,458	298	90,160
2004	25,865	7,540	33,405	312	33,093
2005	31,687	7,040	38,727	319	38,408
	200,684	166,507	367,189	929	366,260

Lafarge Malayan Cement Bhd (LMCB) has exclusively developed the technology and skills to substitute a significant percentage of the coal used at its Kanthan and Rawang plants with Palm Kernel Shell (PKS) Biomass from the Oil Palm Industry.

The manufacture of cement is a highly energy intensive activity. The vast majority of this energy is required to heat the raw materials to a level that brings about the necessary chemical change to create cement clinker. A complete description of the cement manufacturing process is given in Annex 6. In Malaysia, the heating process is predominantly achieved through the firing of coal although some plants have in recent years also started consuming other fossil fuels such as e.g. pet coke.

The substitution of biomass for fossil fuels in the cement manufacturing process in Malaysia has a significant contribution to make to the country's sustainable development plans. LMCB currently sources all of its coal supplies from outside of Malaysia. The substitution of a locally arising biomass product for imported fossil fuels not only reduces Malaysia's dependence on imports, but also gives rise to environmental benefits from preserving fossil fuels and utilising a waste biomass stream, which would otherwise be stockpiled and left to biodegrade, open to saturation by tropical rains and ultimately of no current use to any industry.

The decision to substitute fossil fuel with biomass is a positive action to reduce CO_2 emissions from the cement manufacturing process. It's a direct result of the commitments given, originally, by Blue Circle Industries of the UK in its "Environmental Report 1999" and more recently by Lafarge S.A. of France (parent company of LMCB following its acquisition of Blue Circle Industries in 2001) as set out in its first sustainable

development report, "Building a Sustainable World" (relevant extracts also at Annex 7). This action is also consistent with Lafarge's global target to reduce CO_2 emissions by 20% over the period 1990 to 2010. As stated in its 1999 Environmental Report, Blue Circle committed to support the development of demonstration projects in relation to flexible mechanisms such as CDM under the Kyoto Protocol.

The technology to process and use PKS has been developed in a partnership with Blue Circle Industries' Technical Centre in Europe based on their experiences of combustion of alternative fuels. Knowledge and expertise have been actively transferred in the development of the project by design work in Europe and European expert deployment in Malaysia during design, construction and subsequent follow up adjustments and performance monitoring.

7.0 **Impact of PKS as Biomass Fuel on GHG Reduction and Oil Palm and Palm Oil Industries**.

It has been recognized that LMCB is the first company in the world to use PKS as biomass fuel in large scale as alternative fuel to partially replaced fossil fuel in the cement manufacturing. This CDM project has demonstrated that oil palm industry is environmentally sustainable in reducing GHG and not otherwise as it has been labeled by some anti palm oil groups in Europe and USA. This project also has placed Malaysia as one of Lafarge group operating Integrated Plants that contribute to its target to reduce CO2 reduction by 20% globally.

While PKS is also used by other industries in Malaysia, there is a huge loss to the country as the burning of the PKS is not noticeable and recorded as a source of CO2 reduction. As Malaysia is approaching to become industrialized country it is more critical for the MPOB to ensure that the PKS is made available to those industry which could further elevate good image of the oil palm and palm oil industries respectively through this noble CDM project. MPOB must make full use of the success of the CDM projects fullest to the industry benefits as it could also be used to counter the anti palm oil groups in USA and Europe.

8.0 **Conclusion**

The reduction of 0.94 tons CO2 for every ton of PKS usage in the cement manufacturing is very significant in GHG reduction for Lafarge Group. The success of the CDM project in using PKS as partial replacement of fuel in cement manufacturing and it has been certified by UNFCCC – CDM Board through its issuance of CERs should be considered by the oil palm and palm oil industry as a significant tool to counter the anti palm oil group in USA and Europe. LMCB can consume more than 100,000 tons per year for its cement plant in Malaysia. This consumption of PKS would also help reduce the importation of coal from overseas, thus contribute to Malaysia savings of its foreign exchange .