IChemE ADVANCING CHEMICAL ENGINEERING WORLDWIDE

Introduction to the Palm Oil Industry

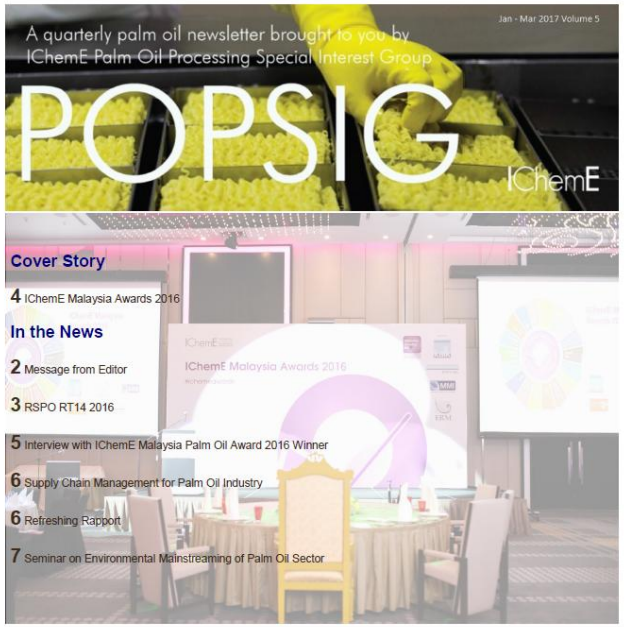
Palm Oil Processing Special Interest Group

Hong Wai Onn

POPSIG was formed on 3rd August 2015 in Kuala Lumpur, Malaysia to provide a forum for the exchange of ideas, the sharing of experiences and encouraging innovation in the palm oil processing industry.

It is not limited to traditional areas of milling, refining or oleochemicals. It includes new areas such as nutraceuticals, biogas and energy, biomass, biofuels and bio-based chemicals.

Processing in the palm oil industry encompasses all the four key challenges in *Chemical Engineering Matters* viz energy, food & drink, health & well being and water. The approach to improving the quality of life through the use palm oil has to be done safely and sustainably.



http://www.icheme.org/communities/special-interest-groups/palm-oil-processing/resources/newsletter.aspx

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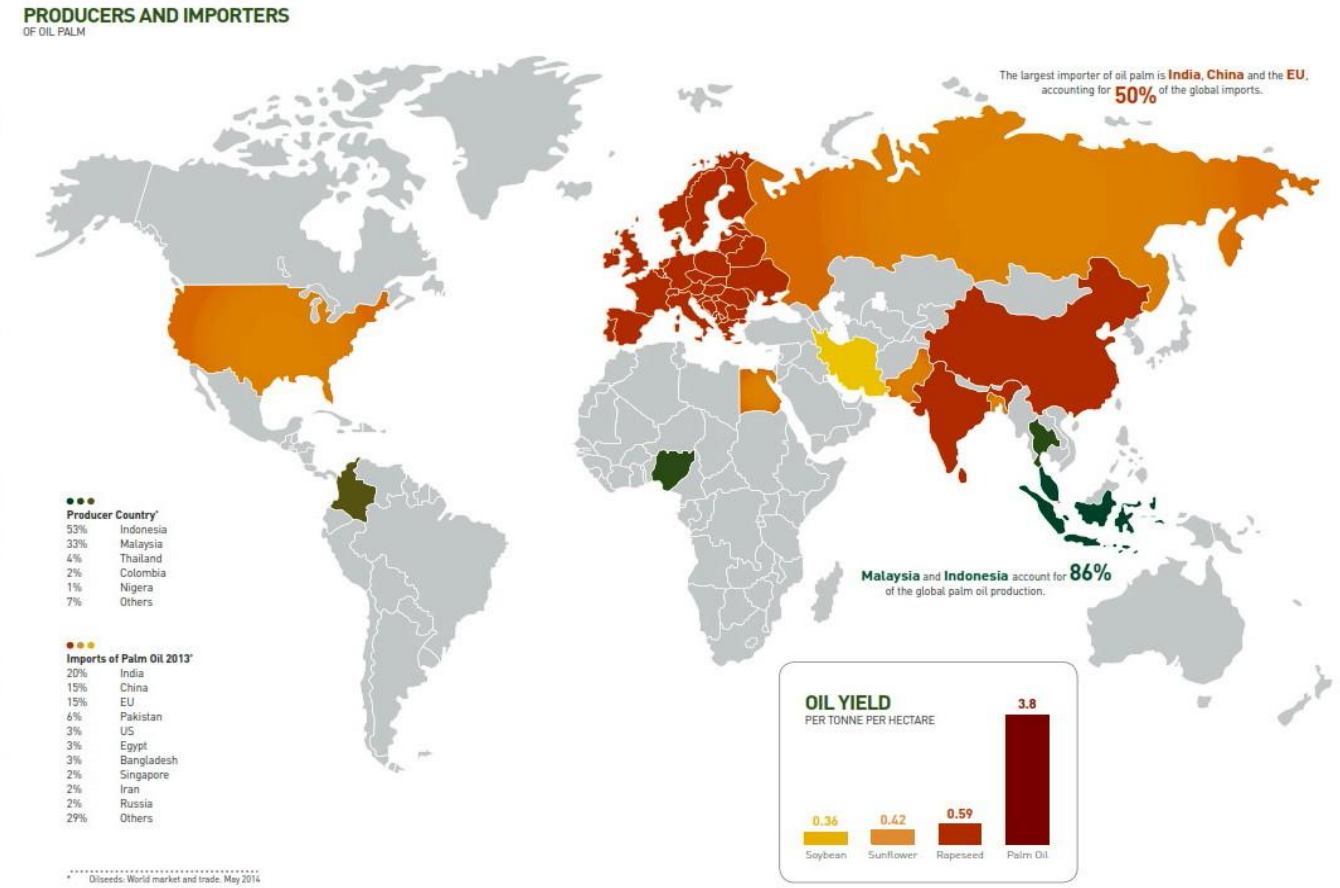
Introduction to the Palm Oil Industry

By

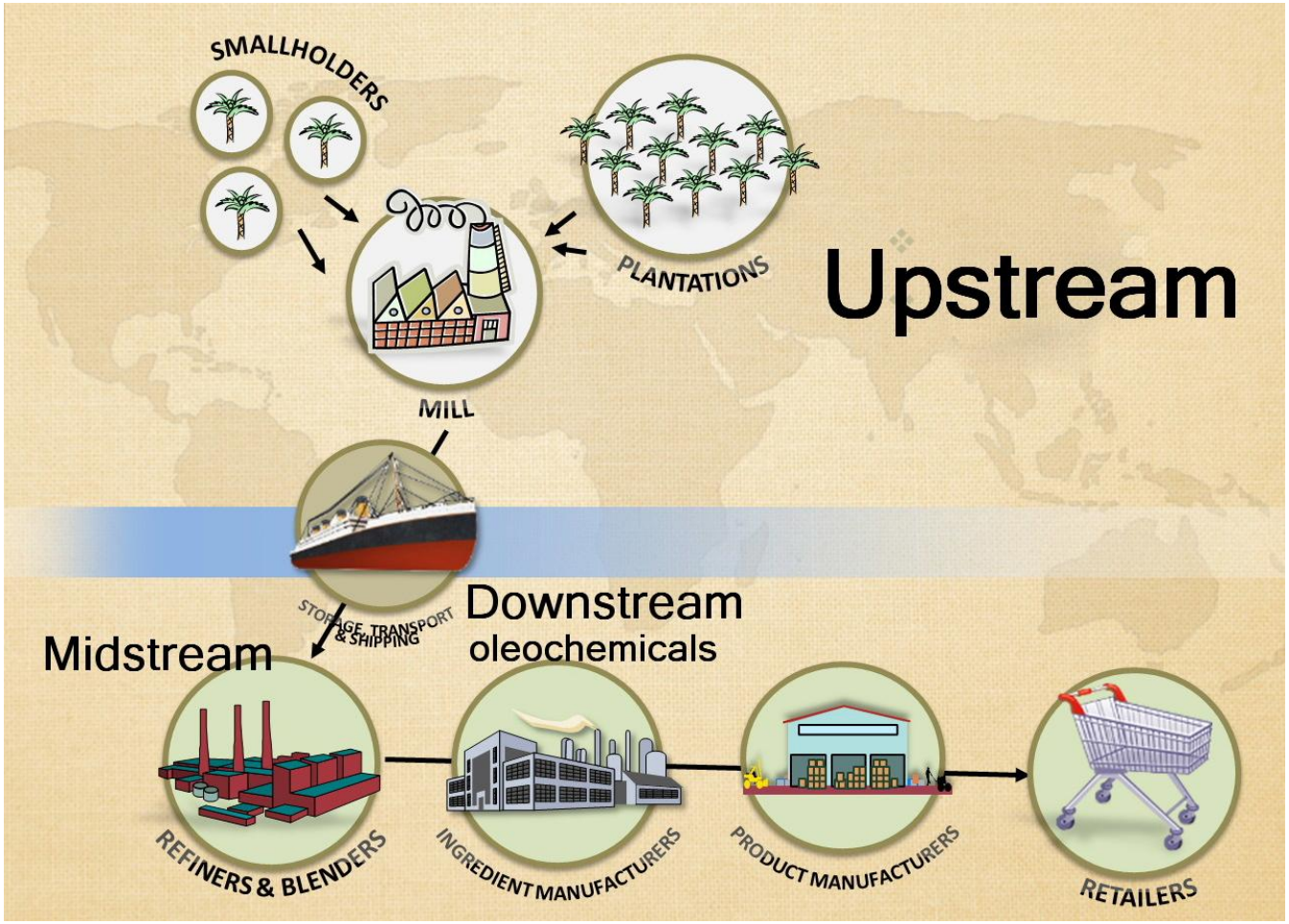
Hong Wai Onn CEng MIChemE

Palm Oil Processing Special Interest Group

Palm Oil at a Glance



The Palm Oil Supply Chain



What will be covered …

- The importance of palm oil
- Milling
- Refining
- Oleochemicals
- Bulking Installations
- Sources of information
- NKEA and the 8 EPPs in Malaysia
- The role of a chemical engineer
- Key players

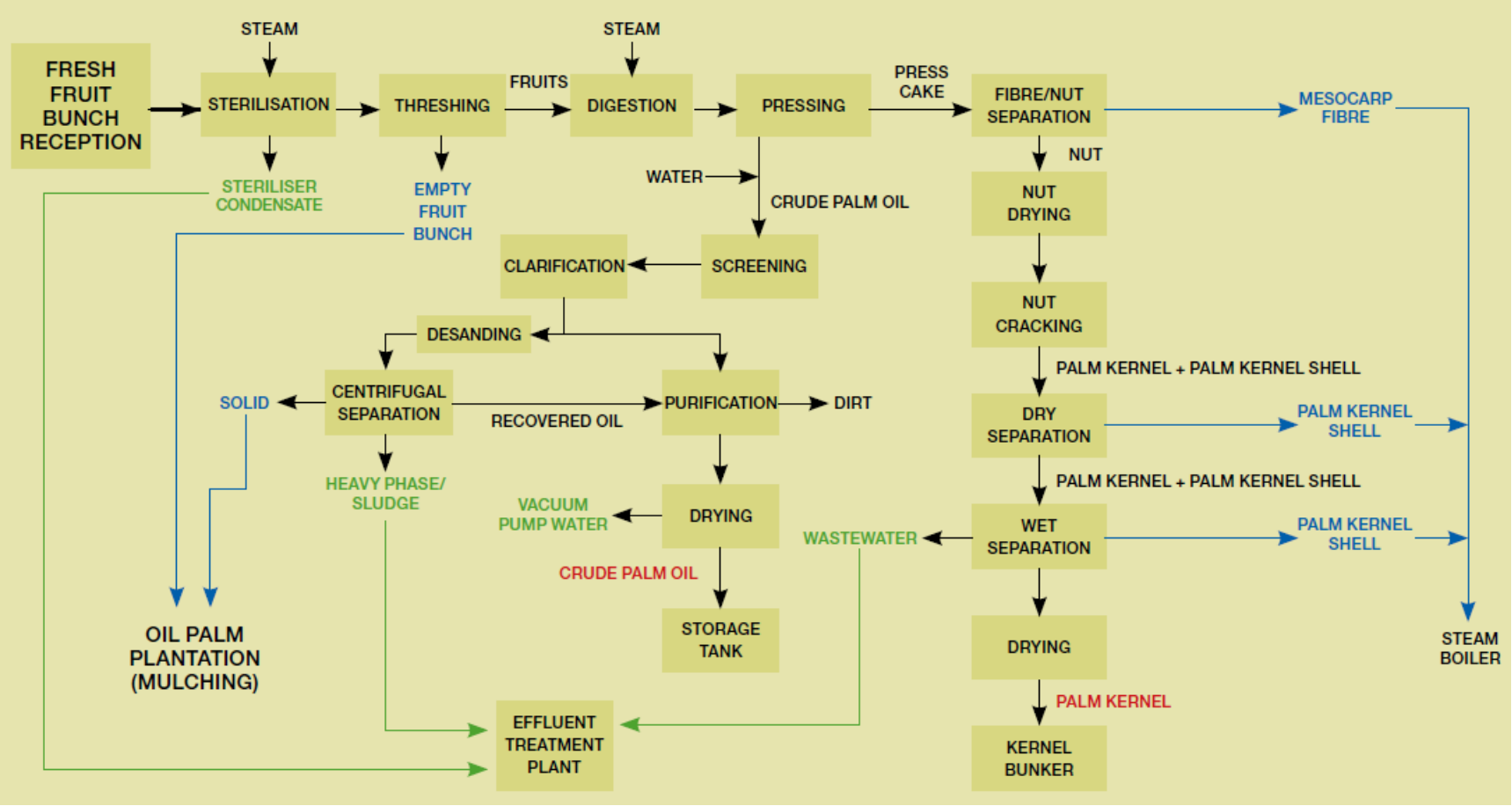
Malaysia is celebrating **100** years of palm oil this year, as the first oil palm was grown in 1917.

Some Key Numbers 2016 for Malaysia

- 5.7 million hectares of land (17% of land mass)
- 17 million tonnes of palm oil & 2 million tonnes of palm kernel oil
- 8% of world's oil & fat production
- Export revenue RM 41 billion (5.3%, #4)
- 600,000 people employed directly

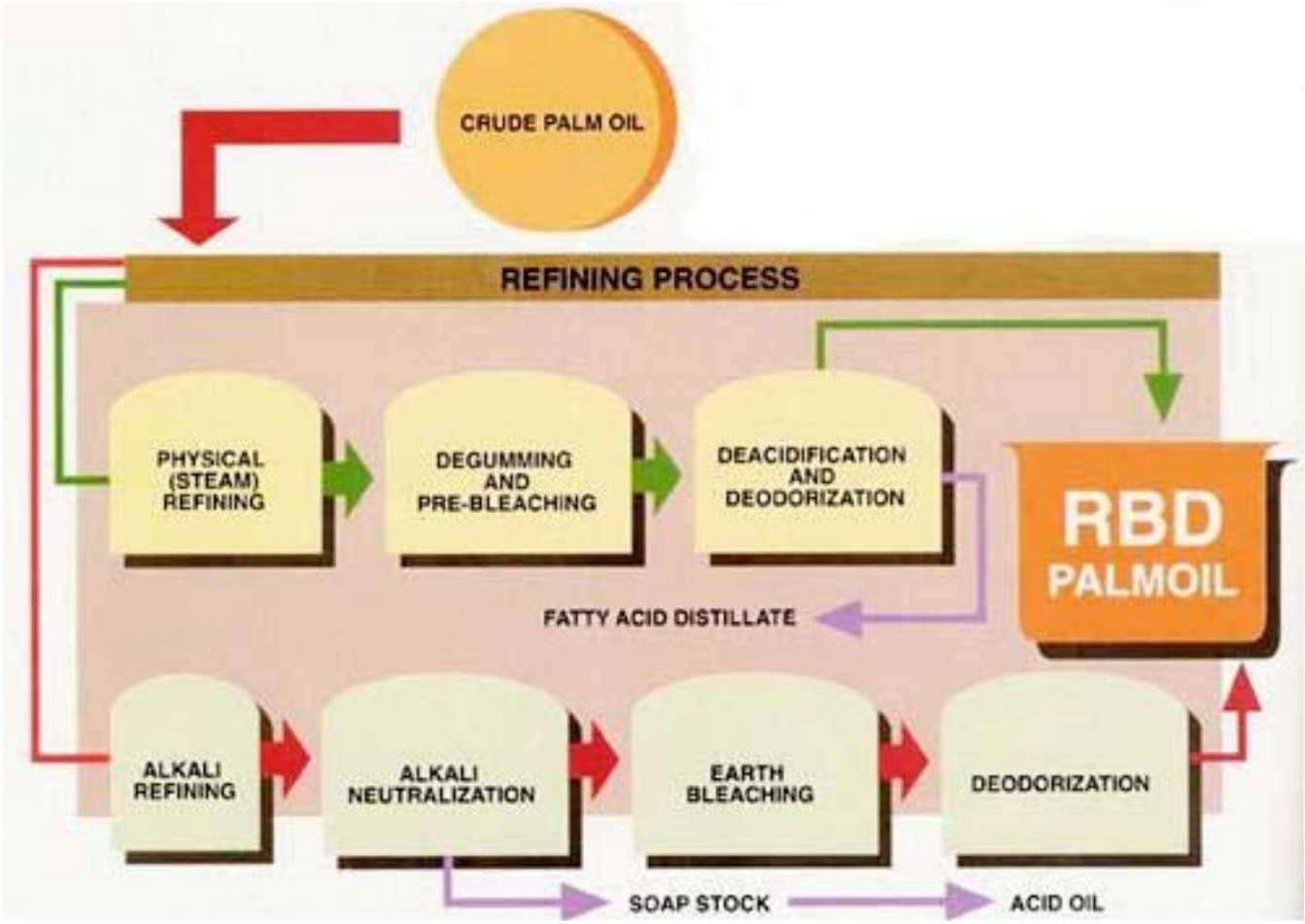
Oil Palm Plantation

Process Flow for Milling



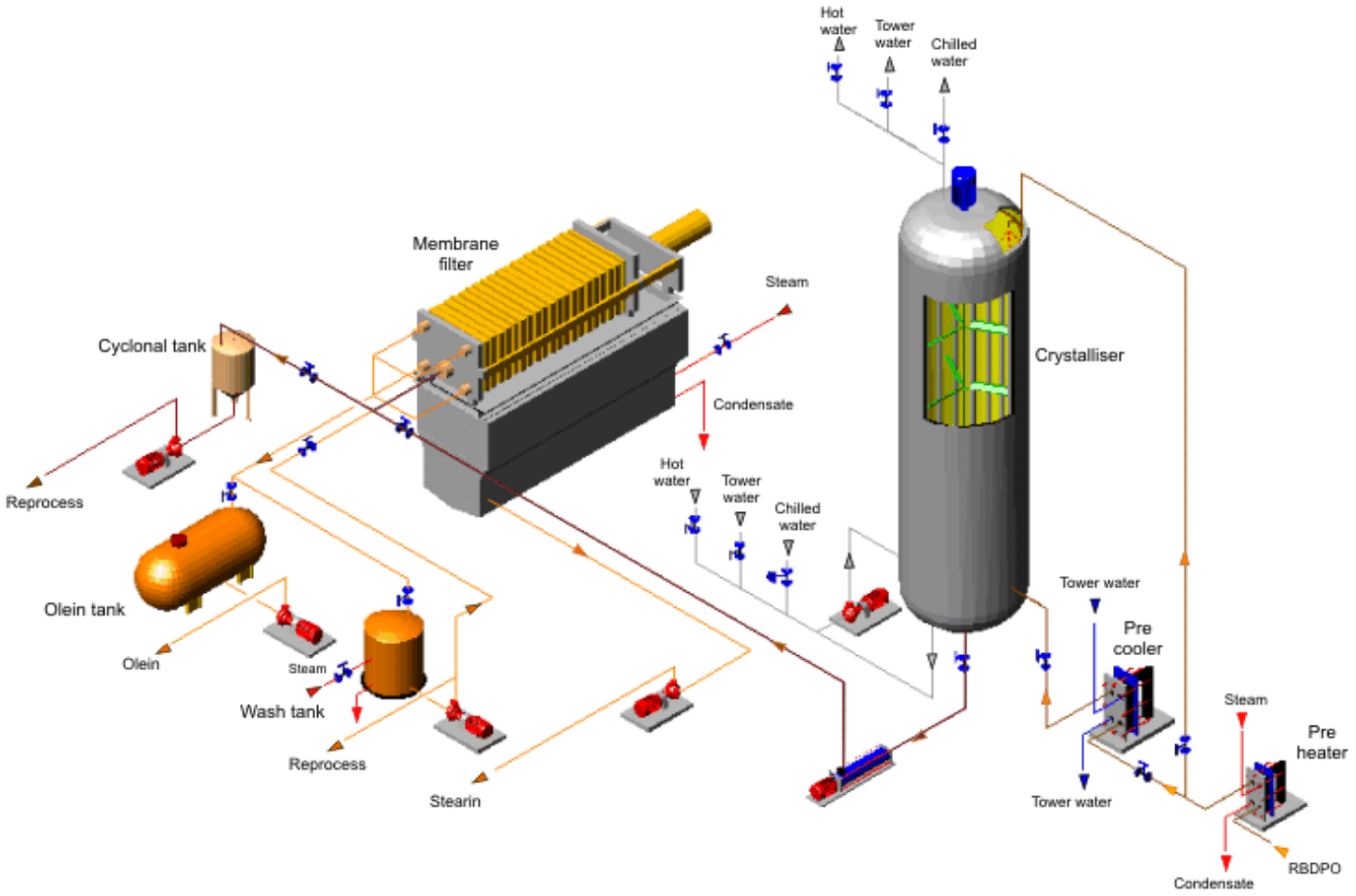
Palm Oil Mill

Process Flow for Refining

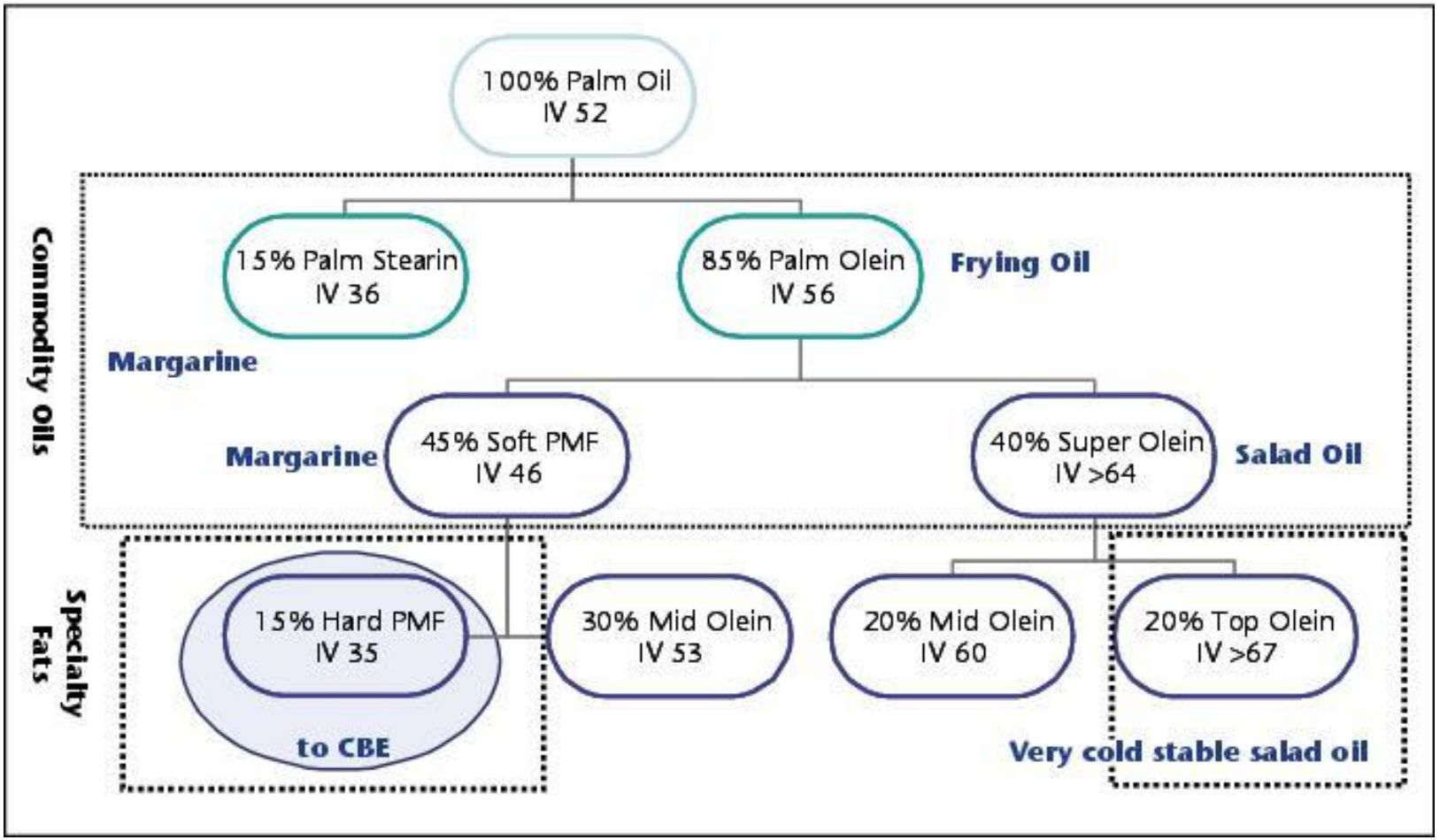


Palm Oil Refinery

Process Flow for Fractionation



Fractionated Palm Oil Products



Activity 1

2 minutes

Enter into the question section
some edible products
made from palm oil

Edible Palm Oil Products …

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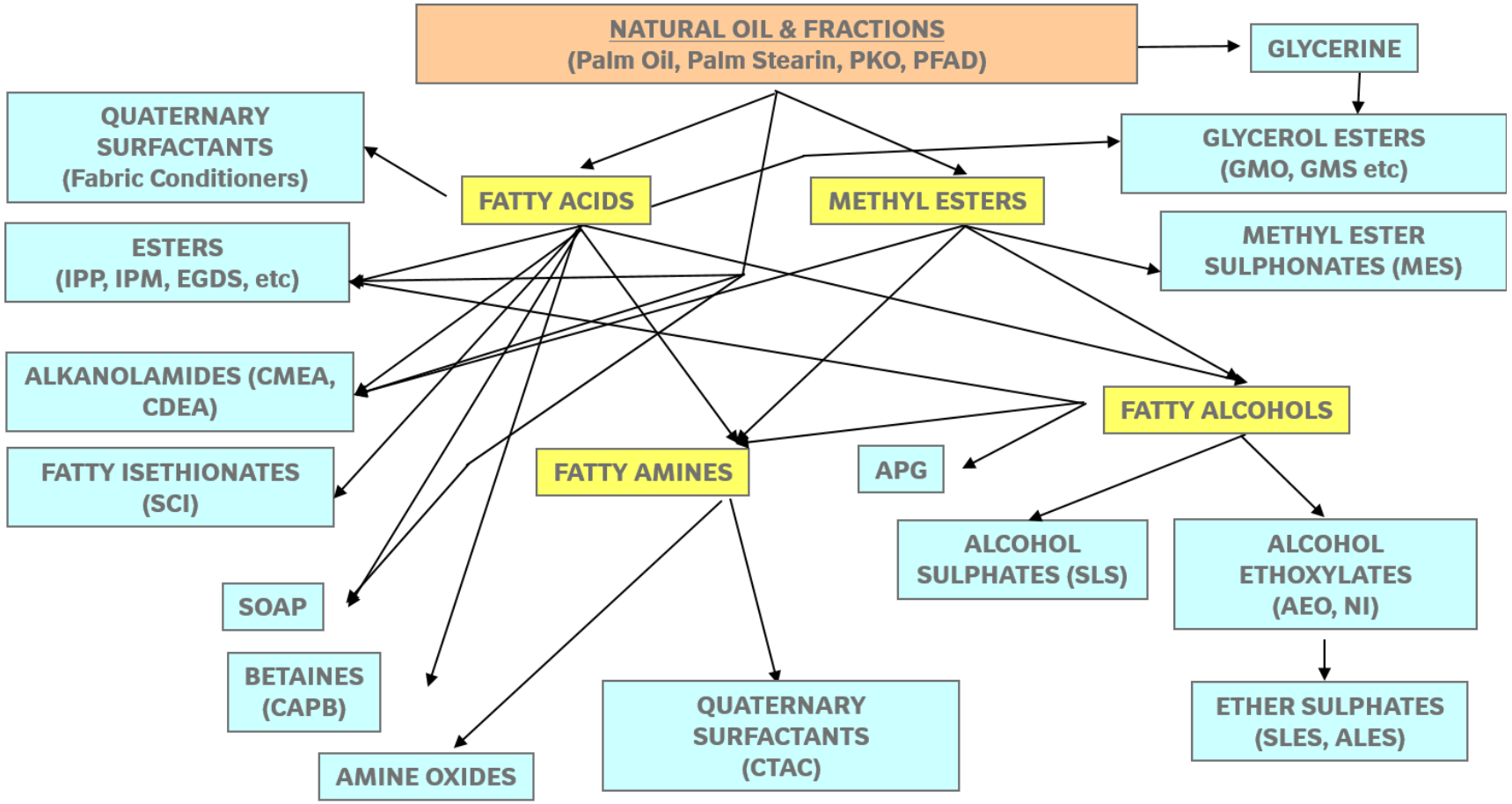
Palm Oil Derivatives Flowchart



Fatty Acids & Fatty Alcohol Plants

Activity 2

2 minutes

Enter into the question section

some end consumer products containing oleochemicals and their derivatives

End Consumer products …

 Soap noodles		 Sodium lauryl sulfate	 Stearic Acid	 Esters
 Glycerin, Isopropyl Myristate	 Methyl Ester Sulfonate	 Cetyl palmitate, isopropyl myristate, sorbitan monostearate, stearyl alcohol	 Amide as slip agent	 Tocotrienols

Bulking Installations – Key for Exports

Key Organizations

Name	Full name
MPOA	Malaysian Palm Oil Association (Growers)
MPOB	Malaysian Palm Oil Board (Licensing/R&D)
MPOC	Malaysian Palm Oil Council (Promotion)
PORAM	Palm Oil Refiners Association of Malaysia
AOMG	ASEAN Oleochemical Manufacturers Group
MEOMA	Malaysian Edible Oil Manufacturers Association
MBA	Malaysian Biodiesel Association
RSPO	Roundtable on Sustainable Palm Oil
MPOCC	Malaysian Palm Oil Certification Council
CPOPC	Council of Palm Oil Producing Countries

NKEA in Malaysia

National Key Economic Areas (NKEA)

2) Palm oil and related products

EPP in Malaysia

Entry Point Project (EPP)

Upstream productivity

- EPP 4: Increasing the oil extraction rate
- EPP 5: Developing biogas at palm oil mills

Downstream expansion and sustainability

- EPP 6: Developing oleo derivatives
- EPP 7: Commercializing second generation biofuels
- EPP 8: Expediting growth in food- and health-based downstream segments

List of companies under EPP 6 Q1 2014

List of companies/projects under EPP 6 (Commercialisation)

EPP 6 Product commercialisation projects

Companies/Projects – Products	Total investment	Total grant committed*
ICM Specialty – Surfactant & Glycerol Derivatives	134.40	19.01
IOI Esterchem – Glycerol Derivatives and Bio-lubricants	130.00	43.60
KLK – Palm Oleo Klang – Specialty Esters	16.40	5.25
KLK – Oleomas – Fatty Alcohols/Acids & MES Integrated Complex	480.10	107.90
Ancom – MSMA Herbicides Manufacturing Plant Expansion	9.77	0.09
Emery P1 – Plastic Additives and Bio-Lubricants	136.50	7.72
Emery P2 – Surfactant (Specialty Esters)	86.7	11.20
Emery P3 – Surfactant (Sulphates)	187.52	12.80
Emery P4 – Expansion of ME Fractionation & Tank Farms	69.89	3.89
Carotino – Expansion of MCT Plant	10.00	0.80
Unioleon – Oleo Derivatives for Food Application	91.85	11.21
Company A – Production of Methyl Ester, Glycerine, and crude Carotene	100.00	1.10
Company B – Short Path Distillation Extension for Glycerol Derivatives	17.00	5.59

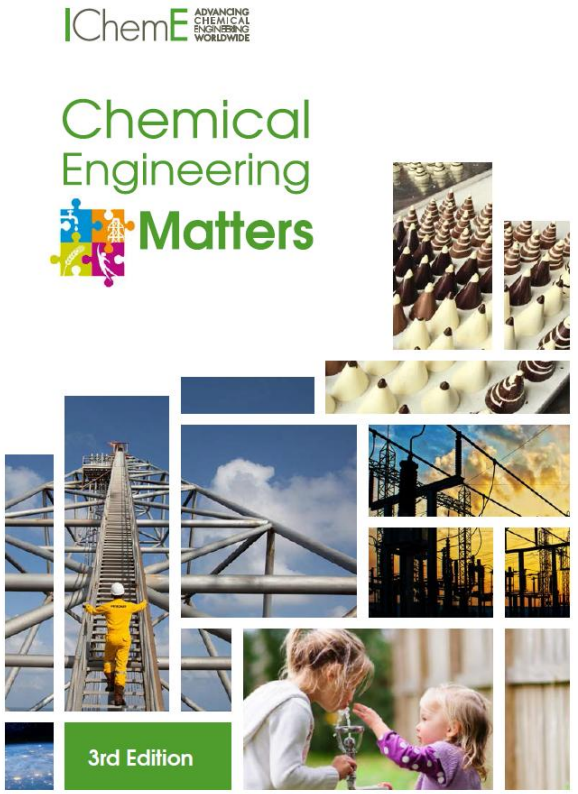
Source: PEMANDU

Chemical Engineering Matters

The role of chemical engineers
in the palm oil industry
and society

Chemical Engineering Matters

- Outlines the scope, application and implications for chemical engineering in activities across the four challenge areas (Water, Energy, Food and nutrition, and Health and wellbeing) where chemical engineers create, maintain and improve quality of life, now and in the future.



http://www.icheme.org/~/media/Documents/icheme/pdfs/ChemEngMatters3_web.pdf

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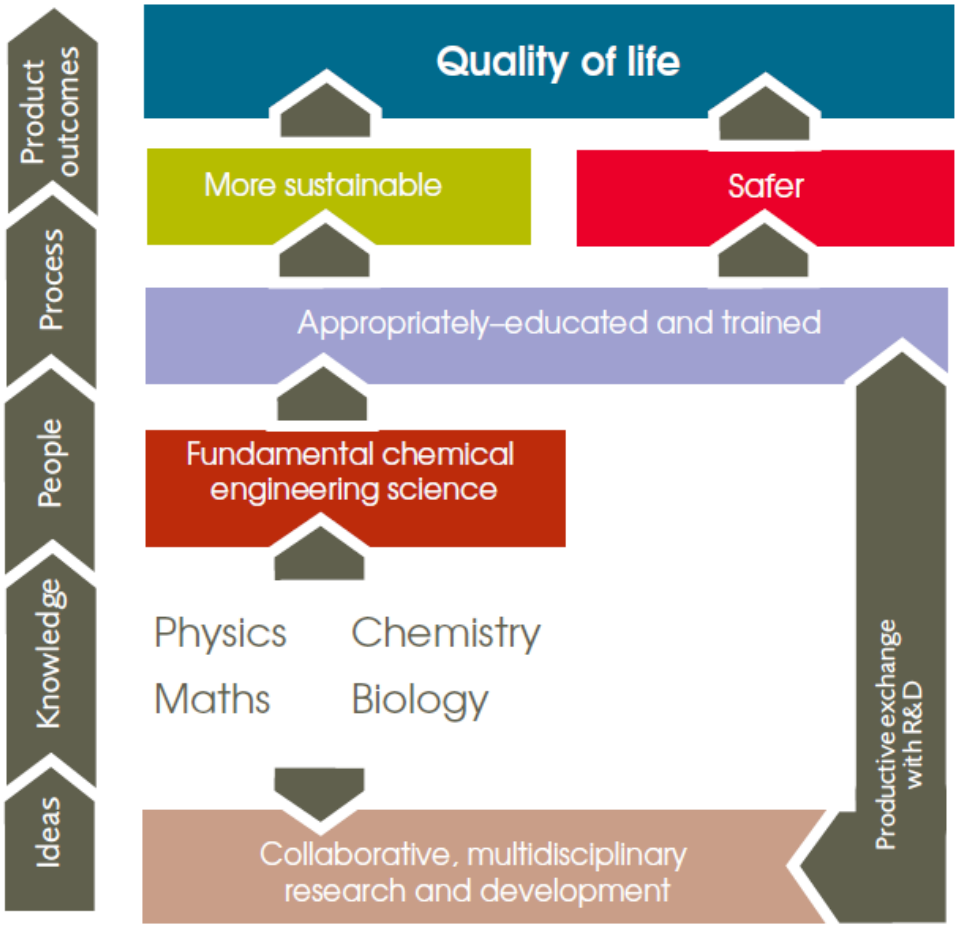
The Role of a Chemical Engineer



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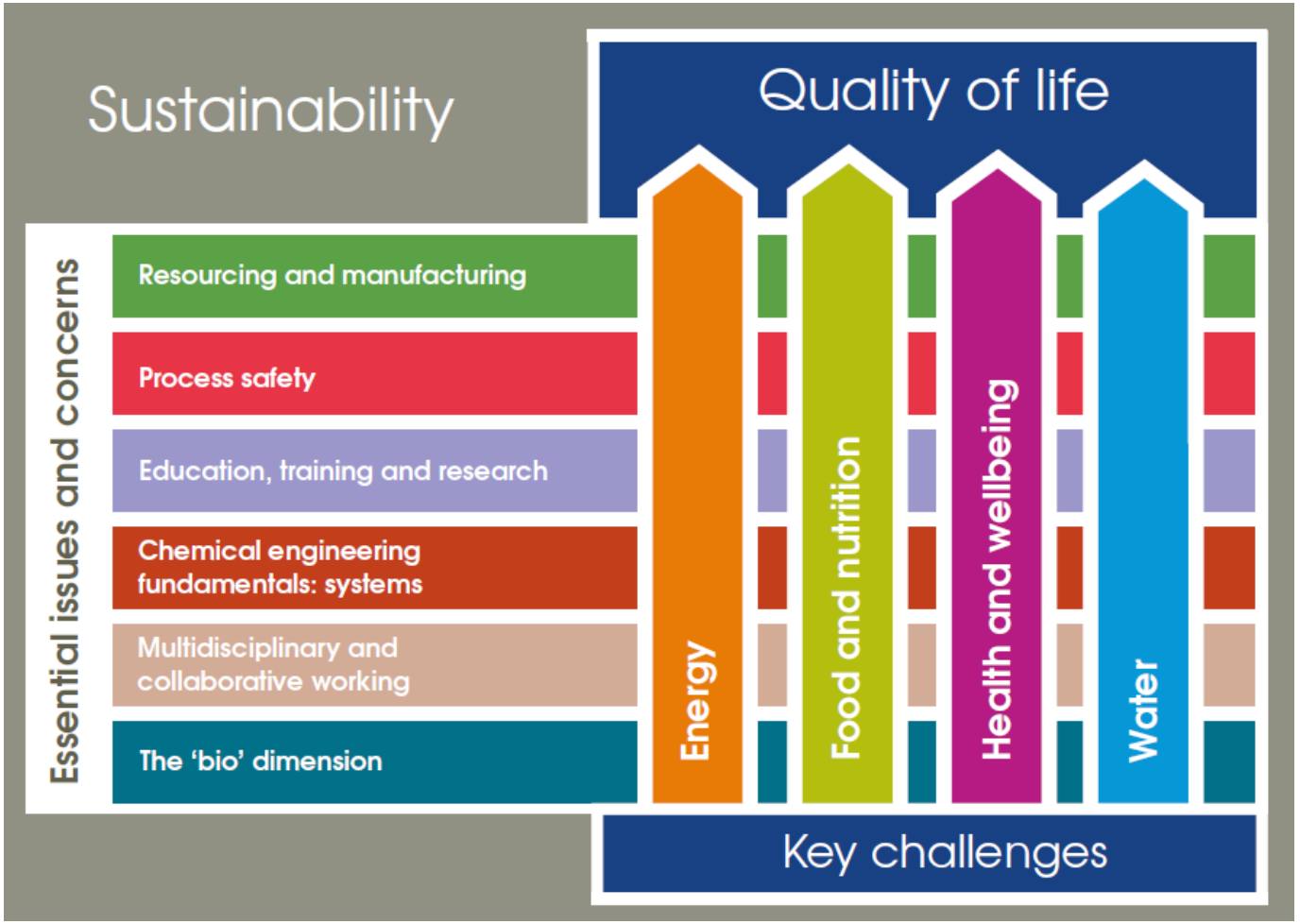
The Role of a Chemical Engineer



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The Role of a Chemical Engineer

Competence

- Application of knowledge
- Wider implications
- Transferable skills

Application of Knowledge

Item	Examples
Process technologies	Distillation, crystallisation, filtration
Safety systems	Management of change, HAZOP
Laws of conservation	Multiple effect evaporation
Mathematical modeling	Spray crystallisation, catalysed reactions
Underlying chemistry	Hydrolysis, esterification, hydrogenation
Systems analysis	Trouble shooting, control of processes
Chemical thermodynamics	Increasing splitting degree in a hydrolyzer
Economic evaluation	Plant debottlenecking, cost savings

Technical Areas

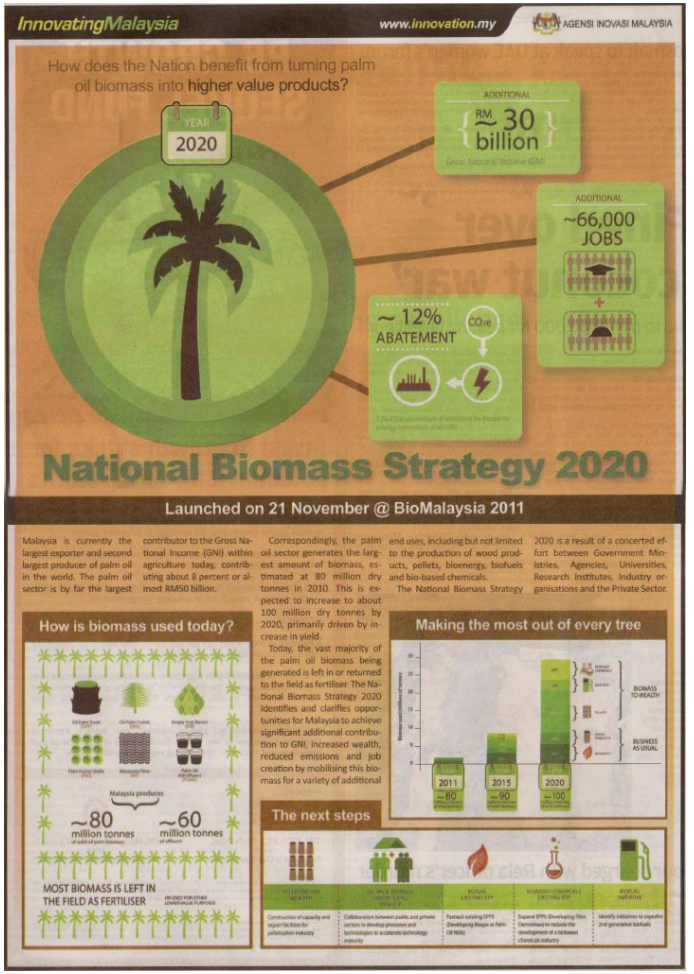
Process plant operation	Legislation, regulation
Computer application	Development of products, services
Project management, administration	Teaching, managing, training
Instrumentation & control	Quality & assurance
Technical / economic evaluation	R&D
Economic accountancy, cost estimation	Technical sales, marketing, contracts
Health, safety, risk aspects	Design of process, plant & equipment
Sustainability & environmental aspects	

Wider Implications

Item	Examples
Health, hazard and safety aspects	Opportunity to improve process safety
	Registration, **E**valuation, **A**uthorisation and Restriction of **Ch**emical substances (EU)
Sustainability aspects	Clean Development Mechanism (POME) & National Biomass Strategy 2020
	Roundtable on Sustainable Palm Oil (**RSPO**)
Commercial and economic aspects	Fluctuating palm oil & palm kernel prices
	NKEA : Palm Oil as a Growth Engine in the Tenth Malaysia Plan (2011-2021)

National Biomass Strategy

- It aims to assess how Malaysia can gain more revenue from its palm oil industry through utilisation of the associated biomass.



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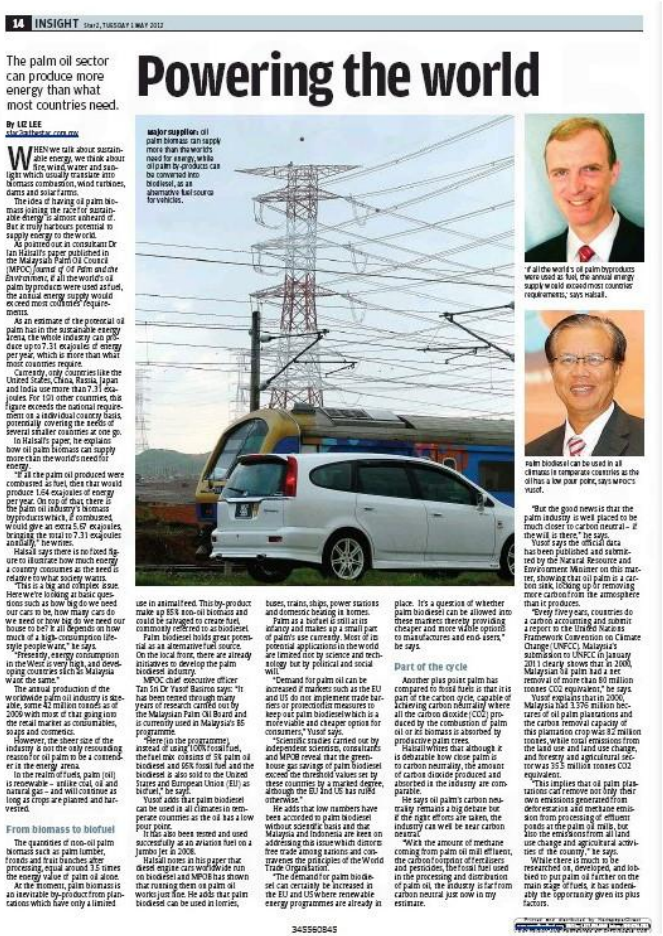
Palm oil can power the world



14 INSIGHT Star2, TUESDAY 1 MAY 2012

The palm oil sector can produce more energy than what most countries need.

Powering the world

By LIZ LEE
star2@thestar.com.my

WHEN we talk about sustainable energy, we think about fire, wind, water and sunlight which usually translate into biomass combustion, wind turbines, dams and solar farms.

The idea of having oil palm biomass joining the race for sustainable energy is almost ashamed of. But it truly harbours potential to supply energy to the world.

As pointed out in consultant Dr Ian Halsall's paper published in the Malaysian Palm Oil Council (MPOC) Journal of Oil Palm and the Environment, if all the world's oil palm by-products were used as fuel, the annual energy supply would exceed most countries' requirements.

As an estimate of the potential oil palm has in the sustainable energy arena, the whole industry can produce up to 7.31 exajoules of energy per year, which is more than what most countries require.

Currently, only countries like the United States, China, Russia, Japan and India use more than 7.31 exajoules. For 191 other countries, this figure exceeds the national requirement on a individual country basis, potentially covering the needs of several smaller countries at one go.

In Halsall's paper, he explains how oil palm biomass can supply more than the world's need for energy.

"If all the palm oil produced were combusted as fuel, then that would produce 1.64 exajoules of energy per year. On top of that, there is the palm oil industry's biomass by-products which, if combusted, would give an extra 5.67 exajoules, bringing the total to 7.31 exajoules annually," he writes.

Halsall says there is no fixed figure to illustrate how much energy a country consumes as the need is relative to what society wants.

"This is a big and complex issue. Here we're looking at basic questions such as how big do we need our cars to be, how many cars do we need or how big do we need our house to be? It all depends on how much of a high-consumption lifestyle people want," he says.

"Presently, energy consumption in the West is very high, and developing countries such as Malaysia want the same."

The annual production of the worldwide palm oil industry is sizeable, some 42 million tonnes as of 2009 with most of that going into the retail market as consumables, soaps and cosmetics.

However, the sheer size of the industry is not the only resounding reason for oil palm to be a contender in the energy arena.

In the realm of fuels, palm (oil) is renewable – unlike coal, oil and natural gas – and will continue as long as crops are planted and harvested.

From biomass to biofuel

The quantities of non-oil palm biomass such as palm lumber, fronds and fruit bunches after processing, equal around 3.5 times the energy value of palm oil alone.

At the moment, palm biomass is an inevitable by-product from plantations which have only a limited use in animal feed. This by-product make up 85% non-oil biomass and could be salvaged to create fuel, commonly referred to as biodiesel.

Palm biodiesel holds great potential as an alternative fuel source. On the local front, there are already initiatives to develop the palm biodiesel industry.

MPOC chief executive officer Tan Sri Dr Yusof Basiron says: "It has been tested through many years of research carried out by the Malaysian Palm Oil Board and is currently used in Malaysia's B5 programme.

"Here (in the programme), instead of using 100% fossil fuel, the fuel mix consists of 5% palm oil biodiesel and 95% fossil fuel and the biodiesel is also sold to the United States and European Union (EU) as biofuel," he says.

Yusof adds that palm biodiesel can be used in all climates in temperate countries as the oil has a low pour point.

It has also been tested and used successfully as an aviation fuel on a Jumbo Jet in 2008.

Halsall notes in his paper that diesel engine cars worldwide run on biodiesel and MPOB has shown that running them on palm oil works just fine. He adds that palm biodiesel can be used in lorries, buses, trains, ships, power stations and domestic heating in homes.

Palm as a biofuel is still at its infancy and makes up a small part of palm's use currently. Most of its potential applications in the world are limited not by science and technology but by political and social will.

"Demand for palm oil can be increased if markets such as the EU and US do not implement trade barriers or protectionist measures to keep out palm biodiesel which is a more viable and cheaper option for consumers," Yusof says.

"Scientific studies carried out by independent scientists, consultants and MPOB reveal that the greenhouse gas savings of palm biodiesel exceed the threshold values set by these countries by a marked degree, although the EU and US has ruled otherwise."

He adds that low numbers have been accorded to palm biodiesel without scientific basis and that Malaysia and Indonesia are keen on addressing this issue which distorts free trade among nations and contravenes the principles of the World Trade Organisation.

"The demand for palm biodiesel can certainly be increased in the EU and US where renewable energy programmes are already in place. It's a question of whether palm biodiesel can be allowed into these markets thereby providing cheaper and more viable options to manufacturers and end-users," he says.

Part of the cycle

Another plus point palm has compared to fossil fuels is that it is part of the carbon cycle, capable of achieving carbon neutrality where all the carbon dioxide (CO2) produced by the combustion of palm oil or its biomass is absorbed by productive palm trees.

Halsall writes that although it is debatable how close palm is to carbon neutrality, the amount of carbon dioxide produced and absorbed in the industry are comparable.

He says oil palm's carbon neutrality remains a big debate but if the right efforts are taken, the industry can well be near carbon neutral.

"With the amount of methane coming from palm oil mill effluent, the carbon footprint of fertilisers and pesticides, the fossil fuel used in the processing and distribution of palm oil, the industry is far from carbon neutral just now in my estimate.

"If all the world's oil palm by-products were used as fuel, the annual energy supply would exceed most countries' requirements," says Halsall.

palm biodiesel can be used in all climates in temperate countries as the oil has a low pour point, says MPOC's Yusof.

"But the good news is that the palm industry is well placed to be much closer to carbon neutral – if the will is there," he says.

Yusof says the official data has been published and submitted by the Natural Resource and Environment Minister on this matter, showing that oil palm is a carbon sink, ticking up by removing more carbon from the atmosphere than it produces.

"Every five years, countries do a carbon accounting and submit a report to the United Nations Framework Convention on Climate Change (UNFCC). Malaysia's submission to UNFCC in January 2011 clearly shows that in 2000, Malaysian Oil palm had a net removal of more than 60 million tonnes CO2 equivalent," he says.

Yusof explains that in 2006, Malaysia had 1.376 million hectares of oil palm plantations and the carbon removal capacity of this plantation crop was 82 million tonnes, while total emissions from the land use and land use change, and forestry and agricultural sectors was 39.5 million tonnes CO2 equivalent.

This implies that oil palm plantations can remove not only their own emissions generated from deforestation and methane emission from processing of effluent ponds at the palm oil mills, but also the emissions from all land use change and agricultural activities of the country," he says.

While there is much to be researched on, developed, and lobbied to put palm oil further on the main stage of fuels, it has undeniably the opportunity given its plus factors.

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An official publication of the Malaysian Palm Oil Council (MPOC)

Review | Open Access

Journal of Oil Palm & The Environment 2011, 2:8-14 doi:10.5366/jope.2011.01

Towards a Sustainable Energy Economy – The Role of Palm

Ian L. Halsall, PhD, Consultant

Abstract

This paper reviews the factors which affect the palm industry's role in the world energy economy. Currently palm's role as a renewable fuel is small, but if all the world's palm oil, and palm biomass by-product, were to be used as fuel, then the annual energy supply would be 7.31 exajoules - more than most country's requirements. Alternatives are evaluated, as are social issues.

Keywords

Palm, Renewable Fuel, Palm Biomass, Energy Economy, Sustainable Energy

JOPE 2011, 2:8-14

1. Introduction

Today the worldwide palm oil industry is sizeable, with an annual production of some 42 million tonnes (as of 2009). Most of this gets consumed in food uses, soaps and cosmetics, but in recent years palm oil has already entered the world's fuel market too.

To give an idea of the palm industry's potential for energy, these figures are sizeable also. If all the palm oil produced were combusted as a fuel then that would produce 1.64 exajoules (exa = 10^{18}) of energy per year. On top of that, there is the palm industry's biomass by-product (ie palm lumber, fronds, and fruit bunches after processing) which, if combusted, would give an extra 5.67 exajoules, bringing the total for palm to 7.31 exajoules annually.

To give these numbers some perspective: 42 million tonnes of oil per year equals 640,068 barrels per day. That is equivalent to 38% of the UK's current oil consumption of 1,710,000 barrels per day (crude oil and palm oil have comparable energy densities). An alternative perspective is that 640,068 barrels per day is more than the total daily oil consumption of Argentina. Also, 640,068 barrels per day is greater than the oil consumption of Malaysia, or for that matter The United Arab Emirates or, for that matter, 182 different countries (208 being the total number countries in the world)[1]

The above figures refer to palm oil production and fuel oil consumption. If we include the non-oil palm biomass too, then the potential increases considerably. This is because the quantities of energy from non-oil palm biomass equal around 3.5 times the energy value of palm oil alone. When we sum up both the palm oil and the non-oil biomass, we get the above mentioned figure of 7.31 exajoules per year. That means the palm industry could supply more than the total energy consumption of many countries. For example, if we focus on electricity consumption, then 7.31 exajoules of fuel value equates to 2.03 trillion kWh per year. Taking a typical power station efficiency of 30%, the figure for available electricity is then 609 billion kWh per year. For comparison, only a few countries consume more than this (such as: USA, China, Russia, Japan and India). But, there are another 191 countries in the world, where such a number would be more than the national requirement (on an individual country basis - in fact, it would be more than several smaller countries combined). All in all, the potential is large[1]. How much of this potential gets reached, depends on a number of factors:

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Waste is profit

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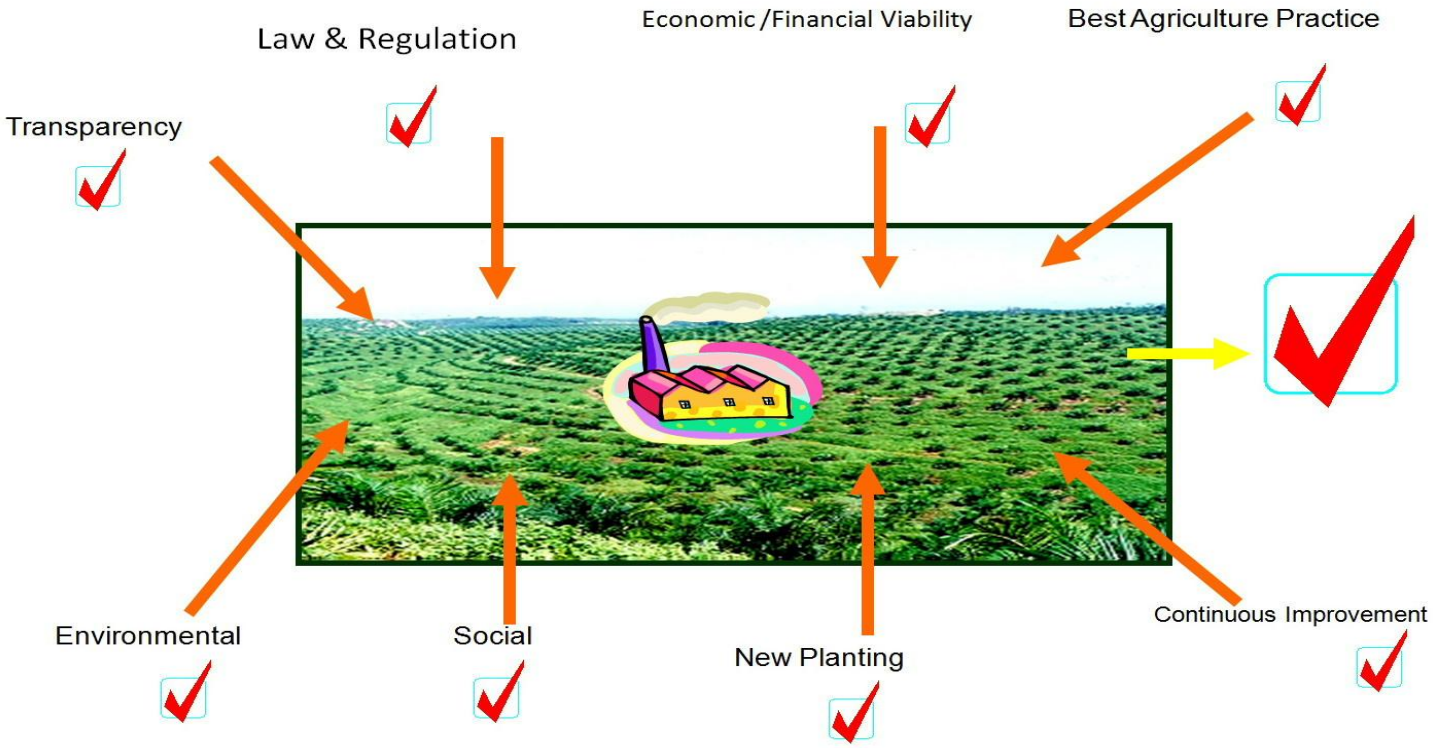
Wider Implications

Item	Examples
Health, hazard and safety aspects	Opportunity to improve process safety
	Registration, **E**valuation, **A**uthorisation and Restriction of **Ch**emical substances (EU)
Sustainability aspects	Clean Development Mechanism (POME) & National Biomass Strategy 2020
	Roundtable on Sustainable Palm Oil (**RSPO**)
Commercial and economic aspects	Fluctuating palm oil & palm kernel prices
	NKEA : Palm Oil as a Growth Engine in the Tenth Malaysia Plan (2011-2021)

Sustainable development

RSPO
Roundtable on Sustainable Palm Oil

RSPO P & C
8 principles, 39 criteria, 125 indicators



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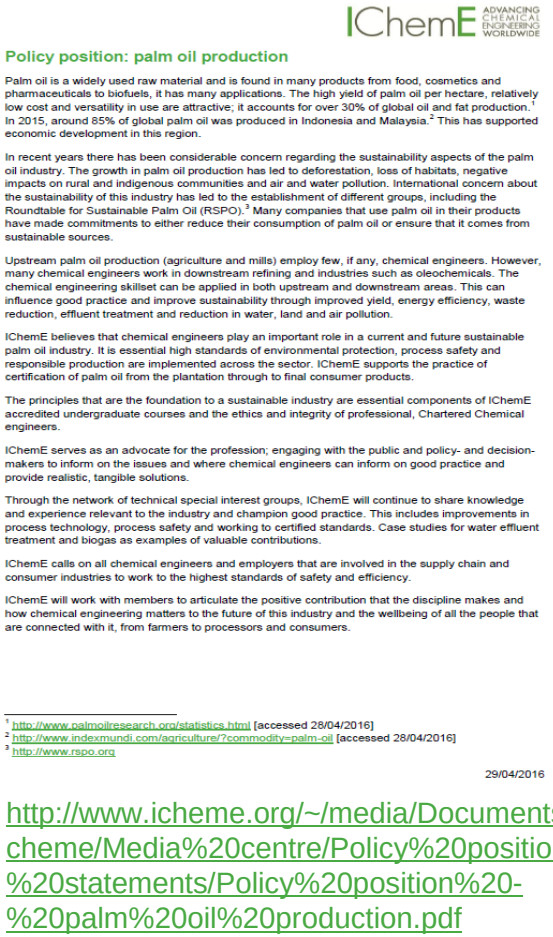
Stand on Palm Oil Production

- IChemE believes that chemical engineers play an important role in a current and future sustainable palm oil industry.

- IChemE supports the practice of certification of palm oil from the plantation through to final consumer products.



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Policy position: palm oil production

Palm oil is a widely used raw material and is found in many products from food, cosmetics and pharmaceuticals to biofuels, it has many applications. The high yield of palm oil per hectare, relatively low cost and versatility in use are attractive; it accounts for over 30% of global oil and fat production.[1] In 2015, around 85% of global palm oil was produced in Indonesia and Malaysia.[2] This has supported economic development in this region.

In recent years there has been considerable concern regarding the sustainability aspects of the palm oil industry. The growth in palm oil production has led to deforestation, loss of habitats, negative impacts on rural and indigenous communities and air and water pollution. International concern about the sustainability of this industry has led to the establishment of different groups, including the Roundtable for Sustainable Palm Oil (RSPO).[3] Many companies that use palm oil in their products have made commitments to either reduce their consumption of palm oil or ensure that it comes from sustainable sources.

Upstream palm oil production (agriculture and mills) employ few, if any, chemical engineers. However, many chemical engineers work in downstream refining and industries such as oleochemicals. The chemical engineering skillset can be applied in both upstream and downstream areas. This can influence good practice and improve sustainability through improved yield, energy efficiency, waste reduction, effluent treatment and reduction in water, land and air pollution.

IChemE believes that chemical engineers play an important role in a current and future sustainable palm oil industry. It is essential high standards of environmental protection, process safety and responsible production are implemented across the sector. IChemE supports the practice of certification of palm oil from the plantation through to final consumer products.

The principles that are the foundation to a sustainable industry are essential components of IChemE accredited undergraduate courses and the ethics and integrity of professional, Chartered Chemical engineers.

IChemE serves as an advocate for the profession; engaging with the public and policy- and decision-makers to inform on the issues and where chemical engineers can inform on good practice and provide realistic, tangible solutions.

Through the network of technical special interest groups, IChemE will continue to share knowledge and experience relevant to the industry and champion good practice. This includes improvements in process technology, process safety and working to certified standards. Case studies for water effluent treatment and biogas as examples of valuable contributions.

IChemE calls on all chemical engineers and employers that are involved in the supply chain and consumer industries to work to the highest standards of safety and efficiency.

IChemE will work with members to articulate the positive contribution that the discipline makes and how chemical engineering matters to the future of this industry and the wellbeing of all the people that are connected with it, from farmers to processors and consumers.

[1] http://www.palmoilresearch.org/statistics.html [accessed 28/04/2016]
[2] http://www.indexmundi.com/agriculture/?commodity=palm-oil [accessed 28/04/2016]
[3] http://www.rspo.org

29/04/2016

http://www.icheme.org/~/media/Documents/icheme/Media%20centre/Policy%20position%20statements/Policy%20position%20-%20palm%20oil%20production.pdf

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Palm oil for well being (tocotrienols)

A rising star

Tocotrienols, the lesser-known siblings of the vitamin E family, are fast emerging as a superior addition to the prevalent and more popularly used tocopherols. Together, they provide a full range of antioxidant properties that are vital for good health.

By FIONA HO

Not all equal

Looking to the future

... beauty and cosmetics market.

Transferable Skills

Item	Examples
Managing relationships	Developing supporting staff with low level of formal education
Leadership in a professional role	Lead peers from different backgrounds in project
Communicating ideas formally	Applying to be a Chartered Chemical Engineer

The Role of a Chemical Engineer

Commitment

Item	Example
Commitment to profession	Be active in IChemE & your trade/technical association
Continuing professional development.	Do regular gap analysis

Typical Numbers …

Item	Mill	Refinery	Oleochemical Plant
Investment, RM mil	55	85	125
Capacity, t/day	500	1000	400
No of employees	50	100	180
No. of Chemical Engineers	0.5	2	10

Activity 3

2 minutes

Enter into the question section

some key players in the palm oil industry:-
Suppliers, Manufacturers, and Customers

Key Players

Suppliers		Manufacturers		Customers	
Item	**Company**	**Item**	**Company**	**Item**	**Company**
Caustic Soda	CCM	Mill	Sime Darby	Soap noodles	J & J
Plant	Desmet Ballestra	Refinery	Cargill	Edible Oils	Unilever
Methanol	Petronas	Fatty Acids	IOI Oleo	Edible Oils	Kraft Heinz
Boiler	Boilermech	Fatty Alcohol	Emery Oleo	Fatty Acids	P & G
Mill	CBIP	Esters	Nat Oleo	Fatty Alcohol	BASF
Enzyme	Novozymes	Biodiesel	Carotino	Esters	L'Oreal
Biogas plant	Kubota	Biorefinery	Genting	Biodiesel	Shell

100 Years for Malaysian Palm Oil

- Can we continue to be the global technology leader in the processing of this Golden Crop?

- Big potential for us to transform the industry particularly in process engineering through science and innovation.

Conclusion

- Palm oil is the most widely-used vegetable oil in the world
- The oil palm tree is the most efficient oil crop in terms of land use
- Join the palm oil industry and be a leader
- Set your sights now on being a Chartered Chemical Engineer

Thank You

Next Evening Talk

Challenges in Biodiesel Business

on 10 April 2017

at Monash University Malaysia

by U.R. Unnithan, founder & CEO of SUMWIN Group