Jatropha World 2008

Jatropha as a Feedstock - The Consultants View

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Global Director Biotechnology

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Nexant ChemSystems

Agenda

- Climate Change Issues
- Nexant roles in the developing Biofuels industry
- Biofuel Industry Drivers and Perspectives
- Overview of Jatropha Development Activities
- Processing Economics
- Competition
- Areas for Improvement
- So What ?

Climate Change

The Challenge of Climate Change

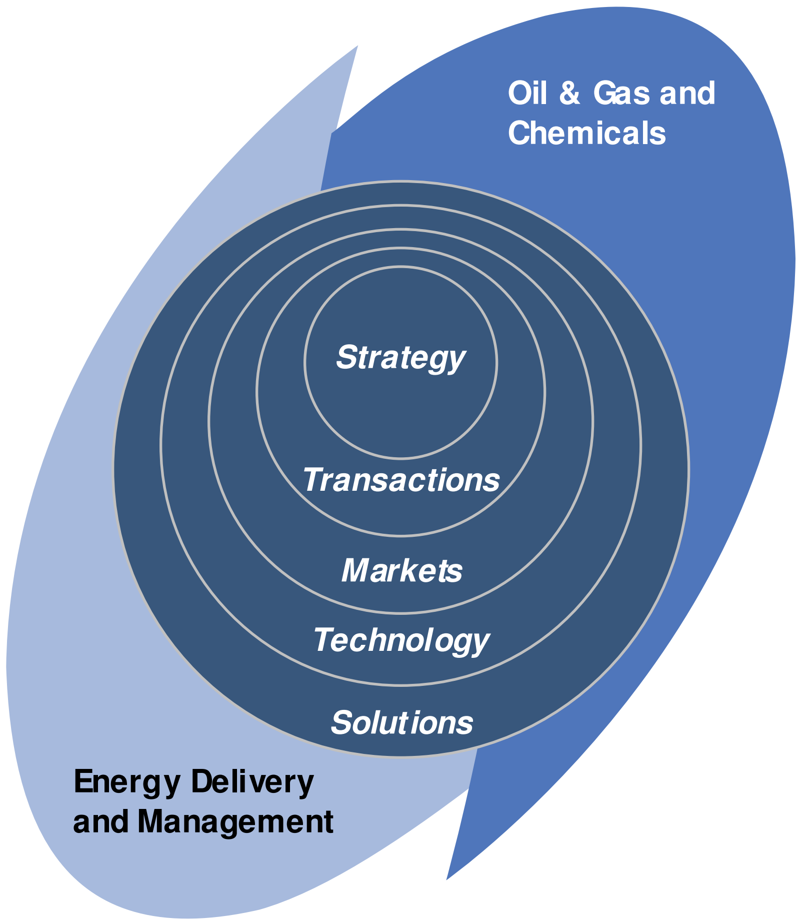
The Example of UK Climate Change Legislation

- Aim for a 60 percent reduction in per capita carbon consumption by 2050.
- Question: Is this aggressive enough? No it should be 90 percent by 2030.
- Airplanes and Shipping NOT included and yes they should be.
- Five year targets and planning schedule – Needs modification with annual monitoring and biannual targets
- Why ?
  - Need to avoid global temperature 2ºC increase by 2050
  - Many third world countries vulnerable to climate change
  - Potential for > 200 million environmental refuges.

Nexant Roles in Biofuels

Mission Statement

- ***Nexant's mission is to be the premier provider of consulting services and technology solutions to governments, utilities, energy producers, petroleum and chemical companies, and energy end-users worldwide***



Nexant has specific experience in acting as advisors to lenders as well as in biofuels

- **EMEA and East Asian Biofuels Teams**
  - **More focused on commercial transactions.**
  - **Currently supporting biofuel project sponsors and lenders on projects amounting to over Euro 2.0 billion.**
  - **Advising government organisations on second generation biofuel development strategies.**
  - **Advising development companies on how to enter the biofuels business and at what point in the value chain**
- **N. American Biofuels Team**
  - **More focused on evaluating and supporting second generation technology developments**
  - **Working with NREL, US DOE and related institutions**
  - **Provide multi-subscriber reports to communicate latest views on biofuel and biochemical technology, e.g. BIOBUTANOL**

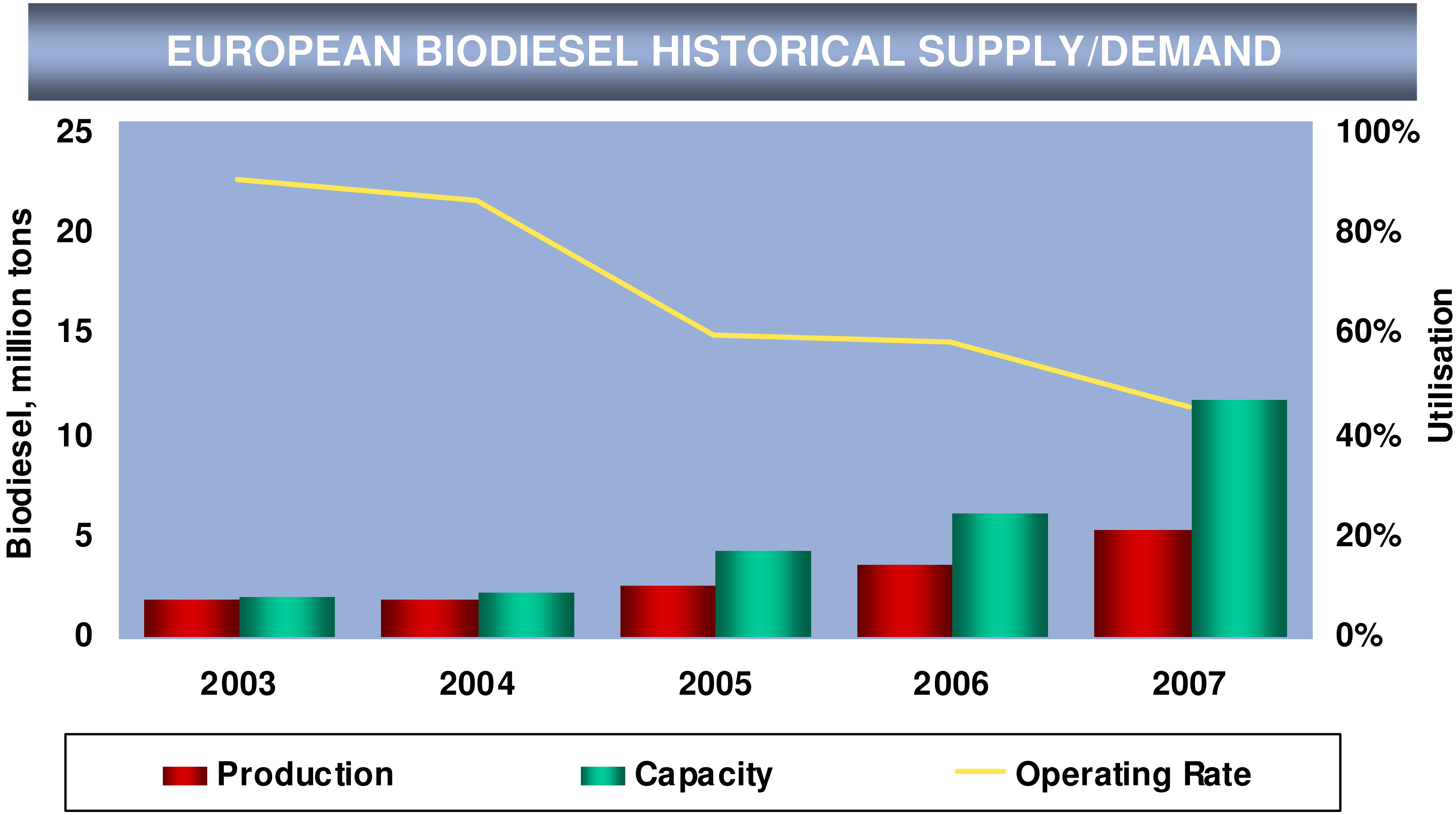
Industry Drivers

There are different regional drivers for biofuel industry developments ranging from energy security to agriculture

BIOFUELS MARKET DRIVERS	COMMENTS	W EUROPE	UNITED STATES	BRAZIL	CHINA	INDIA
Environment	- Reduce GHGs - Renewable	●	◑	◔	◑	◑
Energy Security	- Sourced domestically - Renewable	◕	●	◑	●	●
Agricultural Benefits	- Utilize spare land - Sourced Domestically	◑	●	◕	◔	◑
Protect Local Suppliers	- Maximize domestic supplies - Minimize import tariffs	◕	●		◑	?
Export Focus	- Flexible locations - Low cost of production			●		?

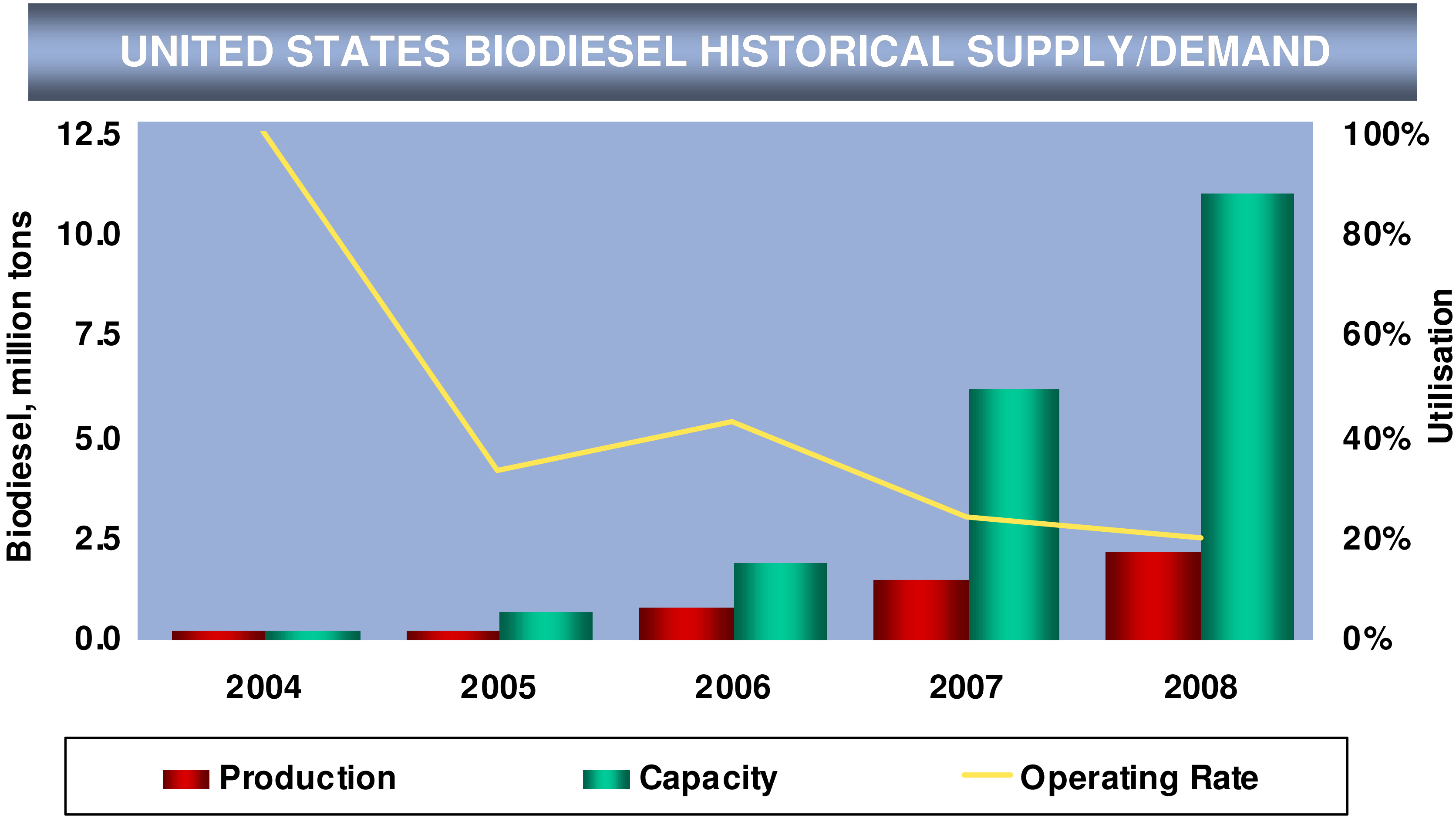
KEY:
High ● Medium ◑ Low ○

Several factors including low margins, legislation, etc, have caused great hardship in Europe



Source: Nexant

The situation in the United States is similar



Source: Nexant

Jatropha – The Panacea for All Biodiesel Ills?

Overview of Jatropha Developments

Jatropha – The Basics

- **Jatropha has high oil yield and quality for biodiesel and the potential to become a world-class agricultural product, if:**
  - **Mechanical harvesting equipment and procedures prove reliable and economic**
  - **Plantations are designed for mechanical harvesting**
  - **Mosaic virus disease is controlled**
- **Many of the issues and concerns raised over the crop in terms of agronomics, toxicity, seed harvesting, seed drying and oil extraction are well-understood and surmountable**
- **Many companies investing in seed origination and processing in a number of venues, including in the Americas, Africa, and Asia, where a balance can be struck between the substantial advantages of the plant and its oil, and the challenges in terms of soil, climate, and other indigenous conditions.**

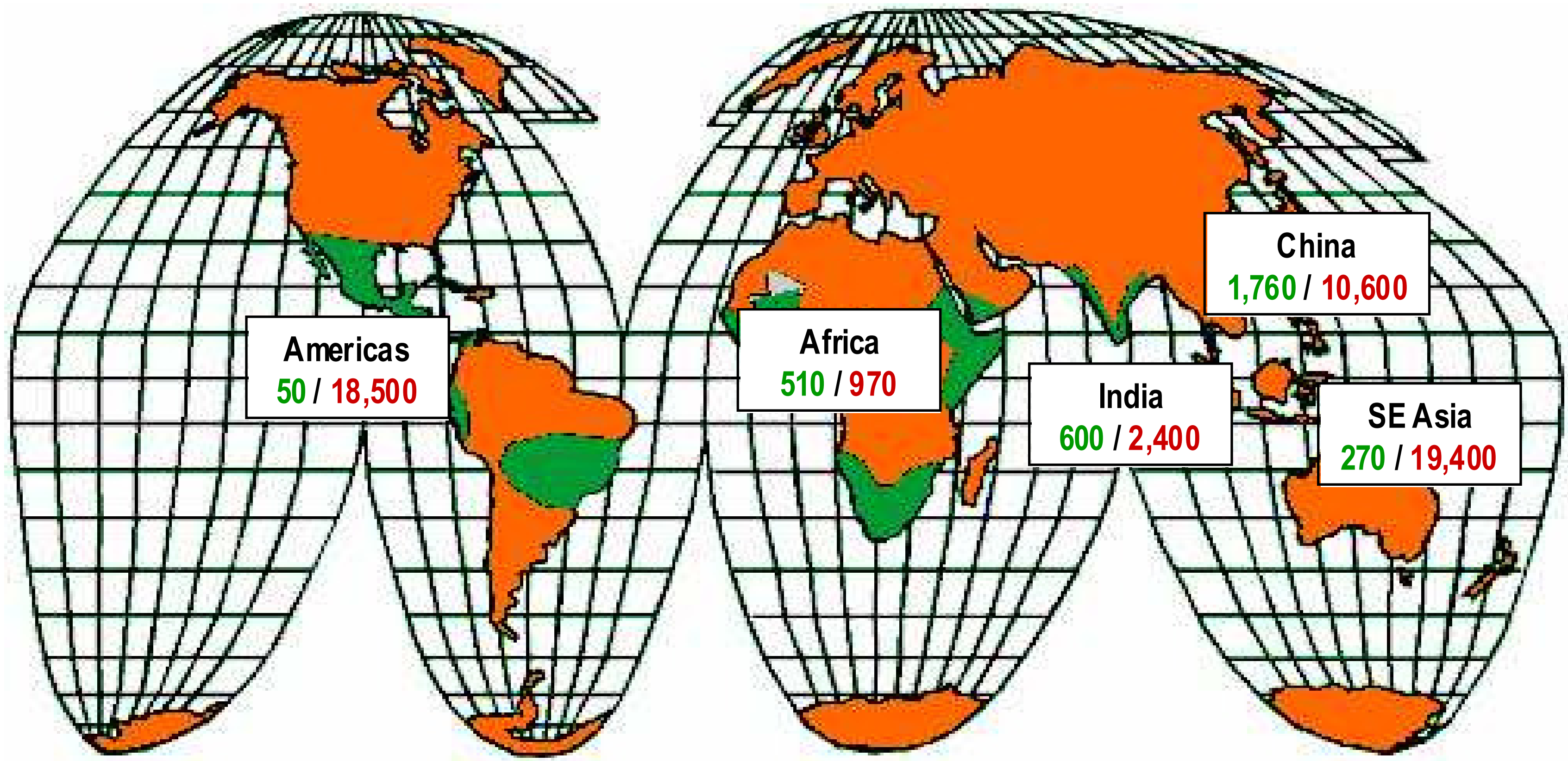
Jatropha – The Number of Developers continues to increase with several announcements

Players	Locations	Stake in Jatropha *
D1 Oils-BP-Agriom-KeyGene	World Wide – Mostly India, China, Africa	175,000 ha
PNOC-AFC	Philippines	700,000 ha
SINOPEC	China	40,000 ha
CNPC	China	150,000 ha
CNOOC	China	90,000 ha
Tamil Nadu University	India	Researcher
Bayer Crop Science	US	Pest/disease Control
(Agricultural Research Organization)	Israel	Promoter/technology developer
JatrophaTech	US	Clone/technology developer 350,000 ha

Forecast plantings suggest a biodiesel feedstock capacity approaching 17.5 million tons per year

Global Biodiesel Potential Production from Jatropha

Estimates on – currently planted / planned plantings – Units in million GPY biodiesel



Current estimated global non-jatropha biodiesel production / capacity = 1,840 / 6,130 MioGPY

World Total
28,130 / 51,870

However, as a plant it is best suited to tropical climates (so far)

Global Biodiesel Potential Production from Jatropha

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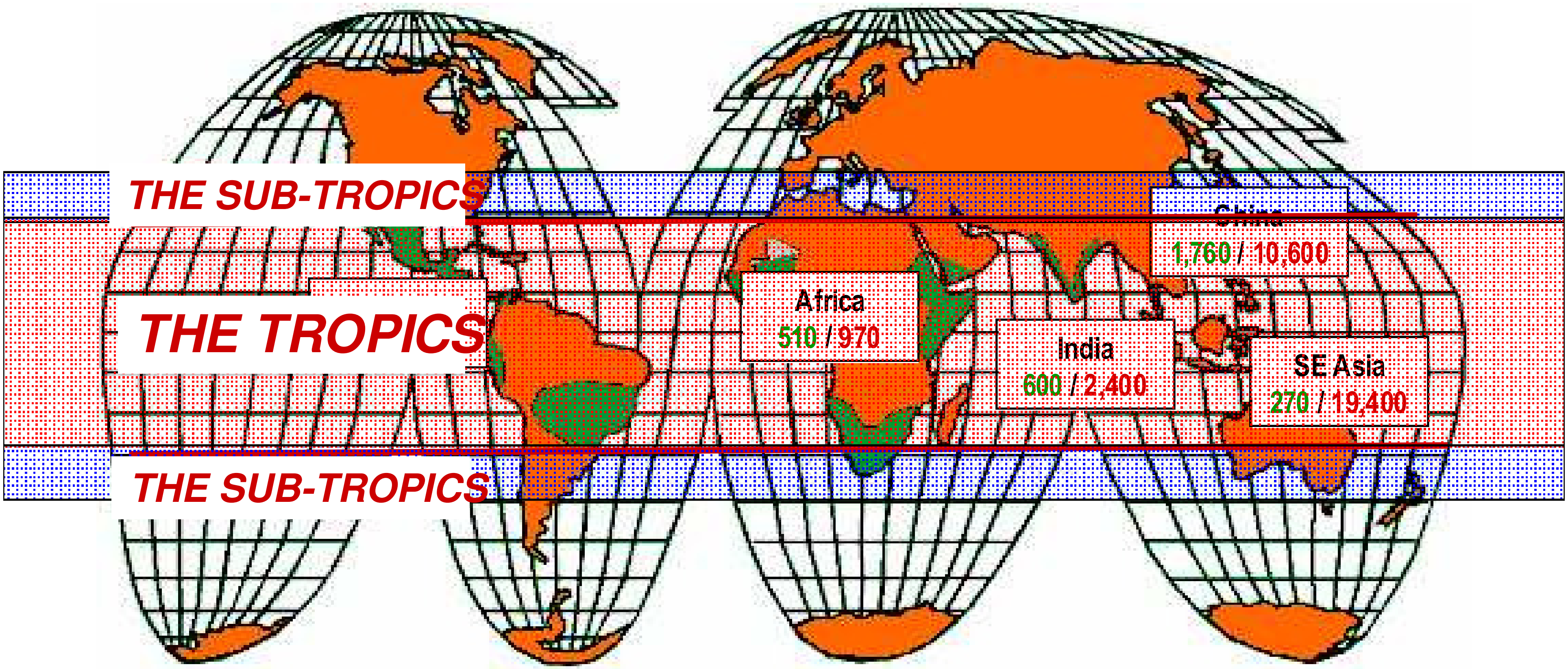

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When established over 50 000 kha of Jatropha plantations will be in operation

- **India (D1 Oils, BP, Government Projects, RIL)**
  - **Current 675 kha, Planned 2000 kha, 11000 kha earmarked**
- **Africa (D1 Oils, Anuanom, JatrophaTech, various**
  - **Current 575 kha, Planned 1100 kha**
- **China (Hunan, Hainan, Sichuan – Sinopec, CNOOC, CNPC, etc)**
  - **Planned 2000 kha**
- **Americas (Mainly Latin America, Caribbean, some US)**
  - **Total Planned 21000 kha**
- **East Asia – Topical Zones**
  - **Current 300 kha, Total Planned 22000 kha.**

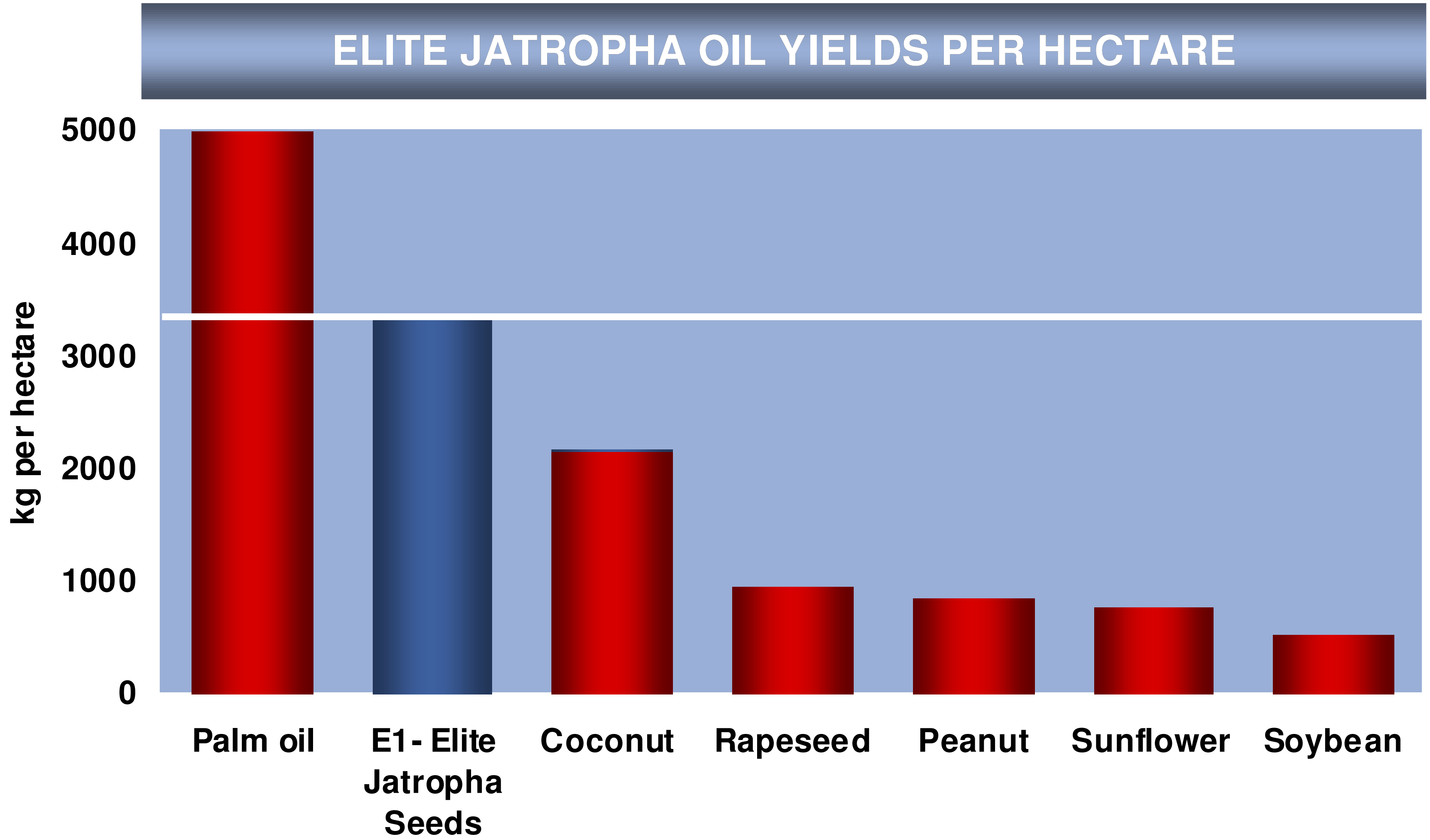
Developments continue to optimise yields and their sustainability

- **There is a need to optimize and enhance per hectare yields**
  - **Agronomics, e.g. Agriom/D1 Oils**
  - **Genetics**
  - **Husbandry – region/country dependent**
- **Pest and Disease Resistance (Toxicity ?)**
  - **Bayer Crop Science**
  - **Mosaic virus, Aphids, Bark Eater, Capsule Borer, Collar Rot**
- **Harvesting Techniques**
  - **Mainly Hand Cropped**
  - **Mechanical Systems under development (ARO-Israel)**
- **Biodiesel Suitability**
  - **Yield profile needs to improve to reach levels associated with palm oil to maximize plantation profitability**

Basic oil yields are low, but potential exists for substantial improvement

Crop	Kg oil/ha	Liters oil/ha	US gal/acre	Oil Content
Castor beans	1188	1413	151	50% - 55%
Coconut	2260	2689	287	70%
Corn (maize)	145	172	18	12%
Cotton	273	325	35	13% - 15%
Jatropha- non elite seeds	1590	1892	202	30% - 35%
Palm oil	5000	5950	635	35%
Peanuts	890	1059	113	36%
Rapeseed	1000	1190	127	37%
Soybean	375	446	48	15%
Sunflower	800	952	102	32%

Improved agronomy and husbandry can result in higher per hectare yields without GM



Processing Economics

Take Palm as a reference that has a different but complementary value chain

Fresh Fruit Bunches

Crude Palm Oil (CPO) → Refined Palm Oil (RPO) → Food and Biodiesel

Palm Kernel Oil (PKO) → Refined PKO → Food and Chemicals

As yet the Jatropha value chain is limited in comparison to palm

Jatropha Fruit

Crude Jatropha Oil

Refined Jatropha Oil

Biodiesel and soaps, etc

Seed Cake By-Product

Fertiliser Pyrolysis

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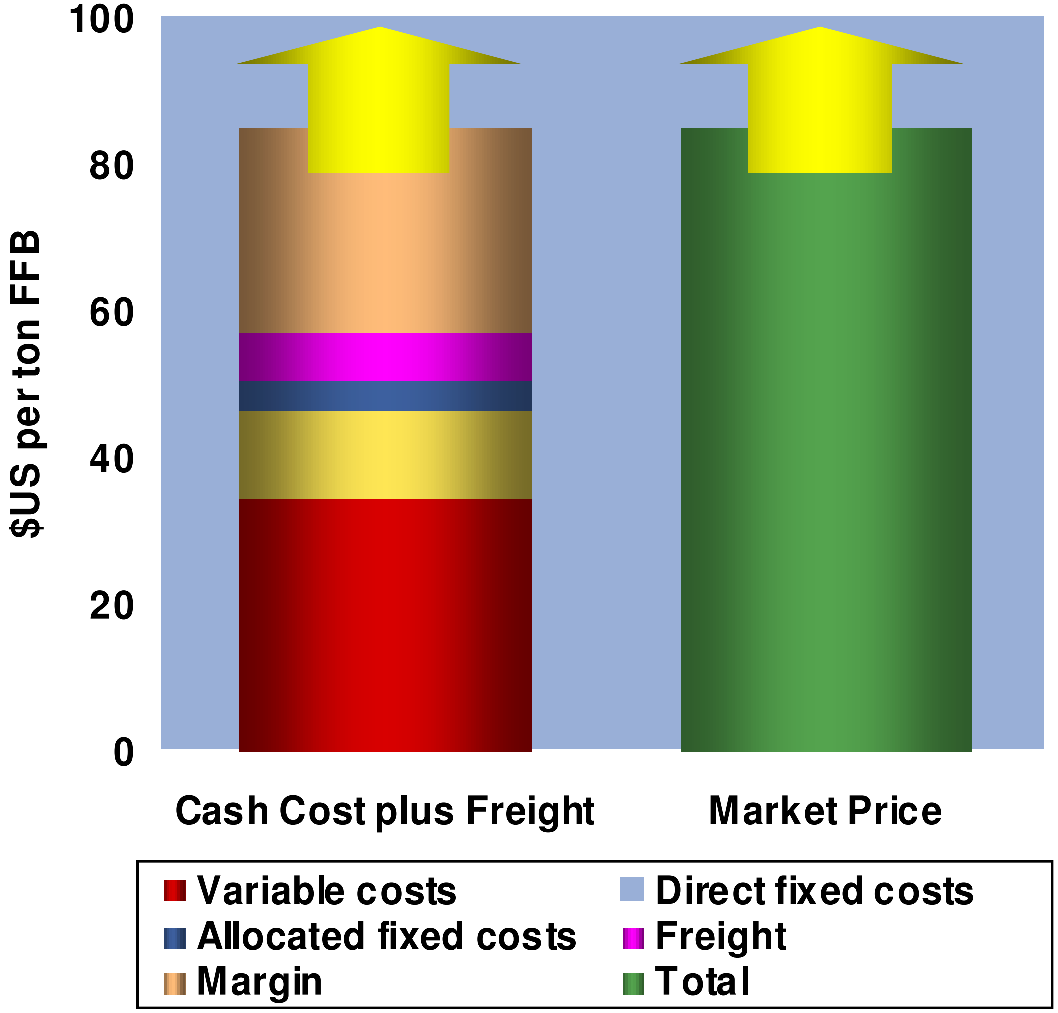
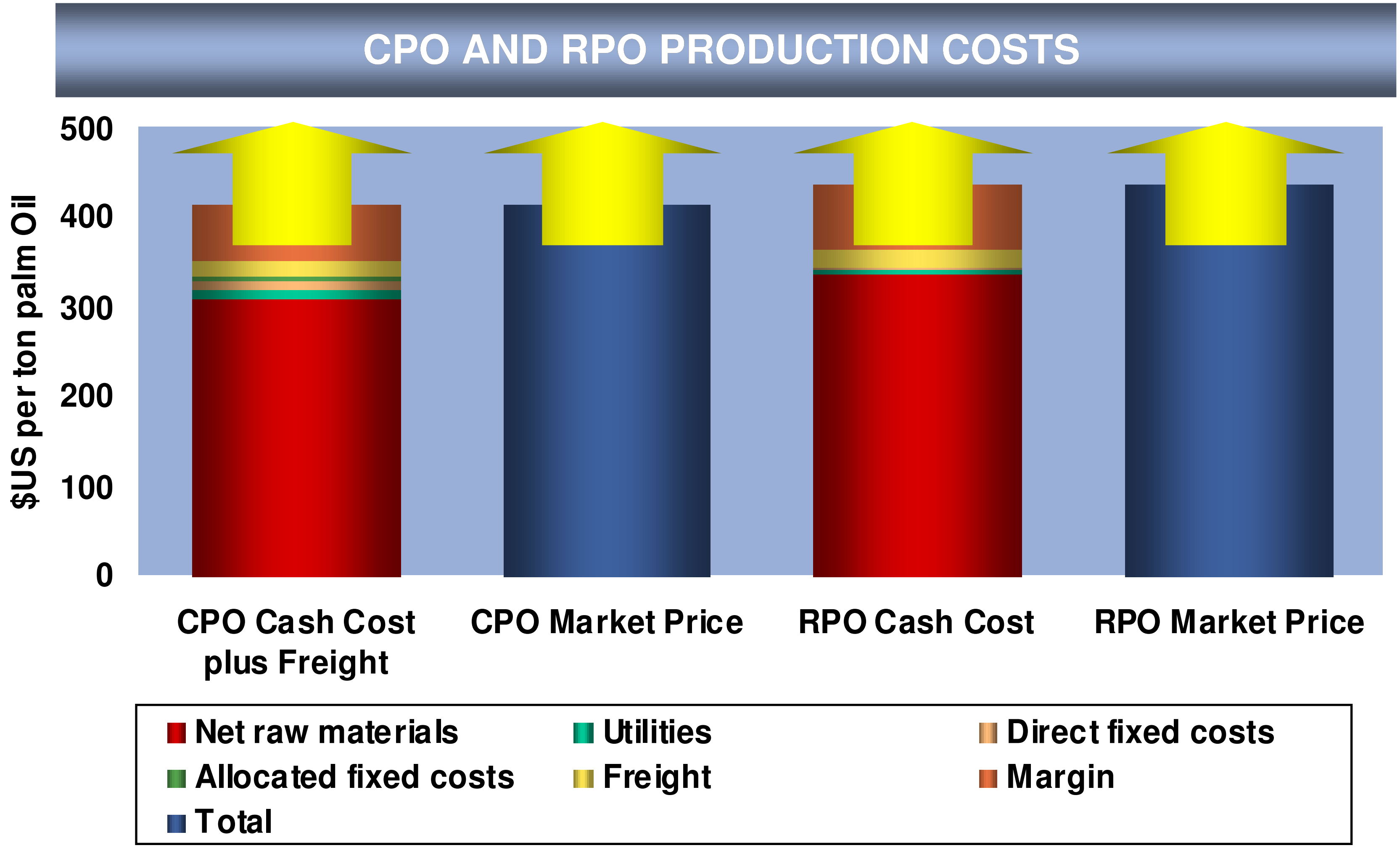
Nexant has modelled the production costs for an archetype palm plantation assuming all trees on an average basis. It is clear that on a prime plantation basis there is a considerable margin

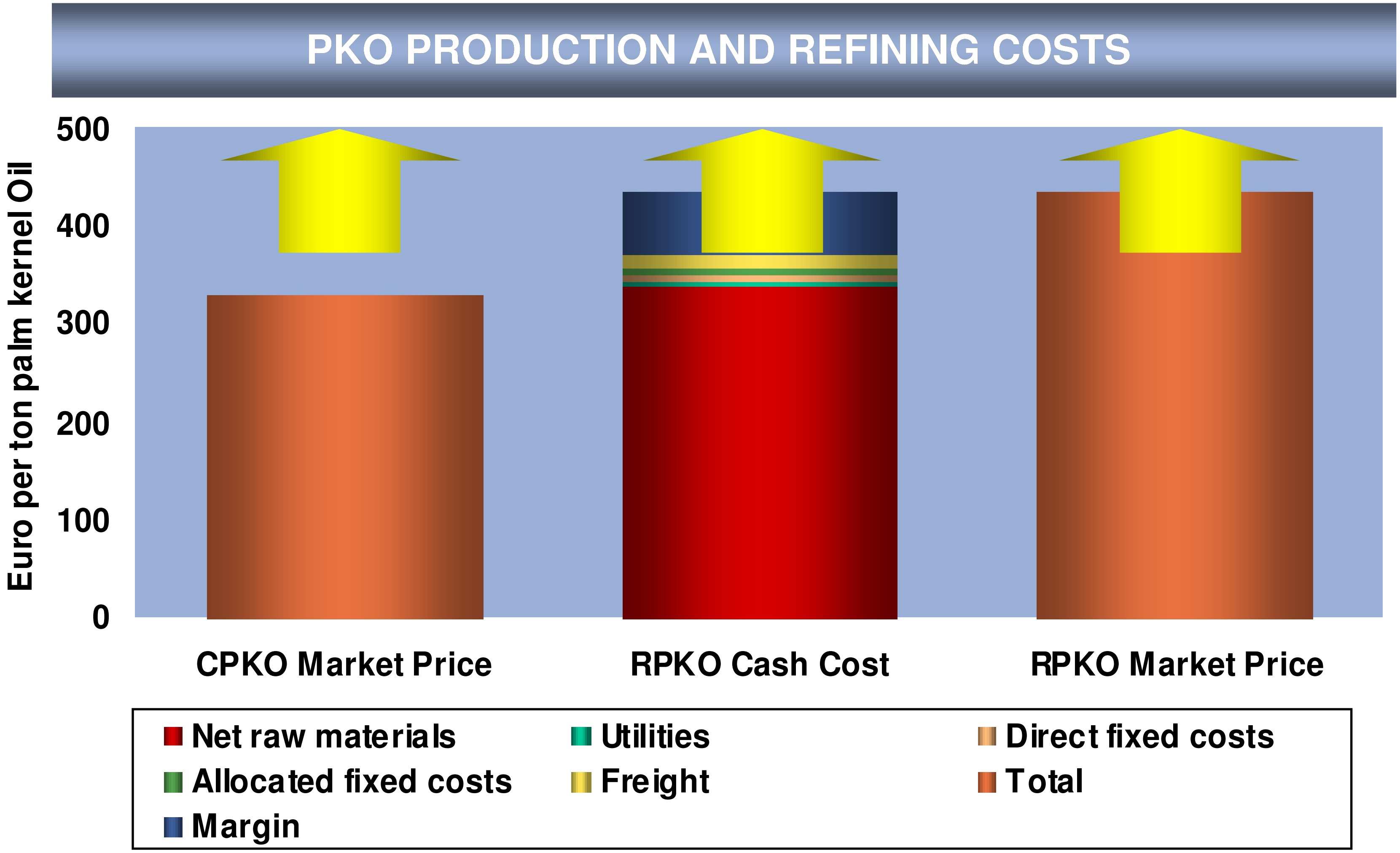


- Nexant has assumed a surface area of 2500 hectares reflect the specific case of typical Malaysian operations.
- Nexant assumes 24 tons FFB/ha or 5000kg oil/ha
- Nexant has formulated an ex-works FFB cash cost and considered road freight to the nearest crushing plant.
- In comparison Jatropha only provides circa 4 tons per ha of fruit.

Location for location Jatropha oil costs will be higher than palm at around $500 per ton but will a Jatropha oil market develop?



A product like palm can make further income from the palm kernel unlike Jatropha. Refined PKO margins are strong reflecting high pricing and strong demand



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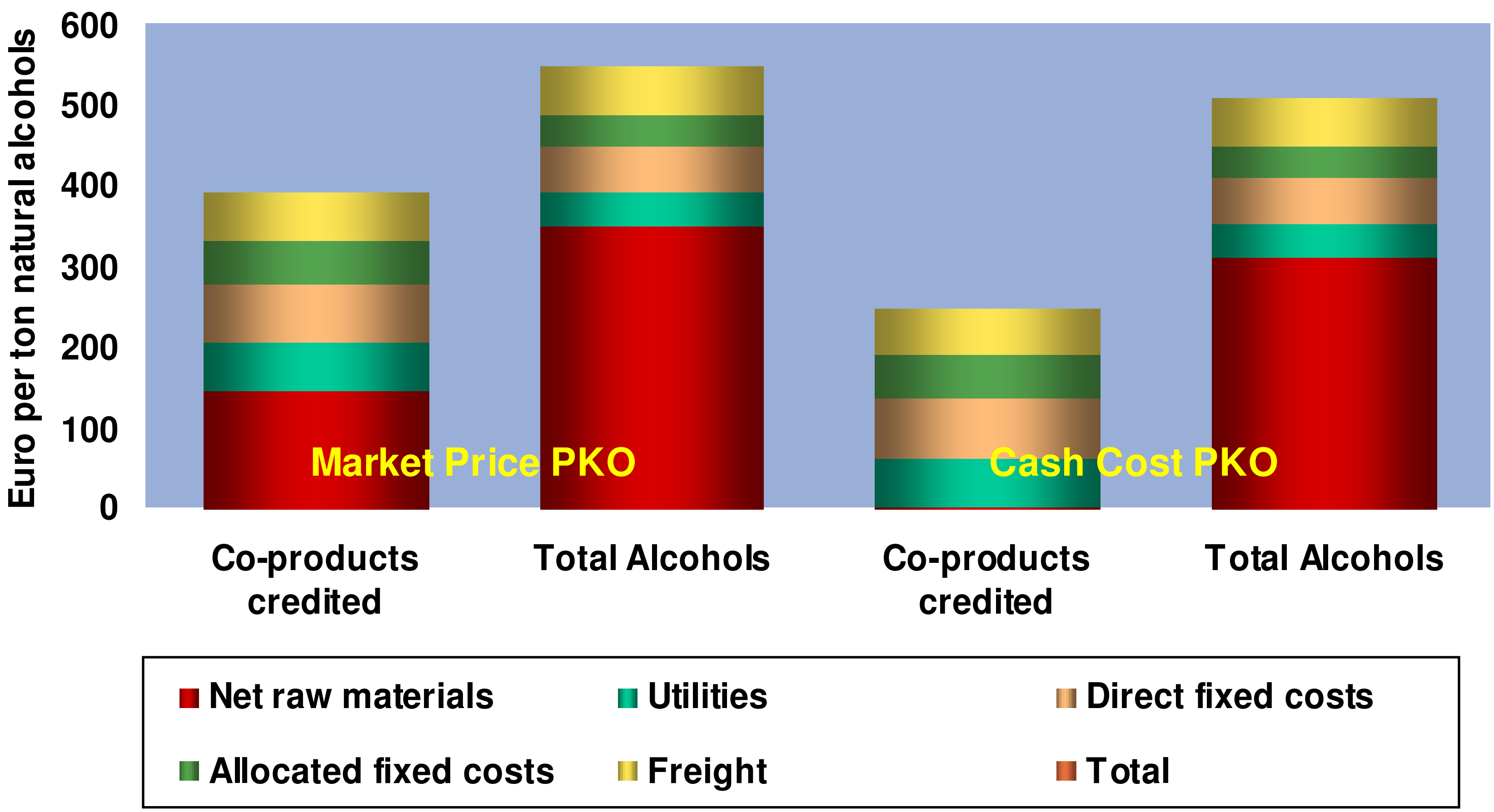
On an integrated basis PKO can be converted into detergent range alcohols. Can Jatropha in due course find alternative outlets to biodiesel through biotransformation alternatives ?

INTEGRATED NATURAL ALCOHOLS PRODUCTION COSTS



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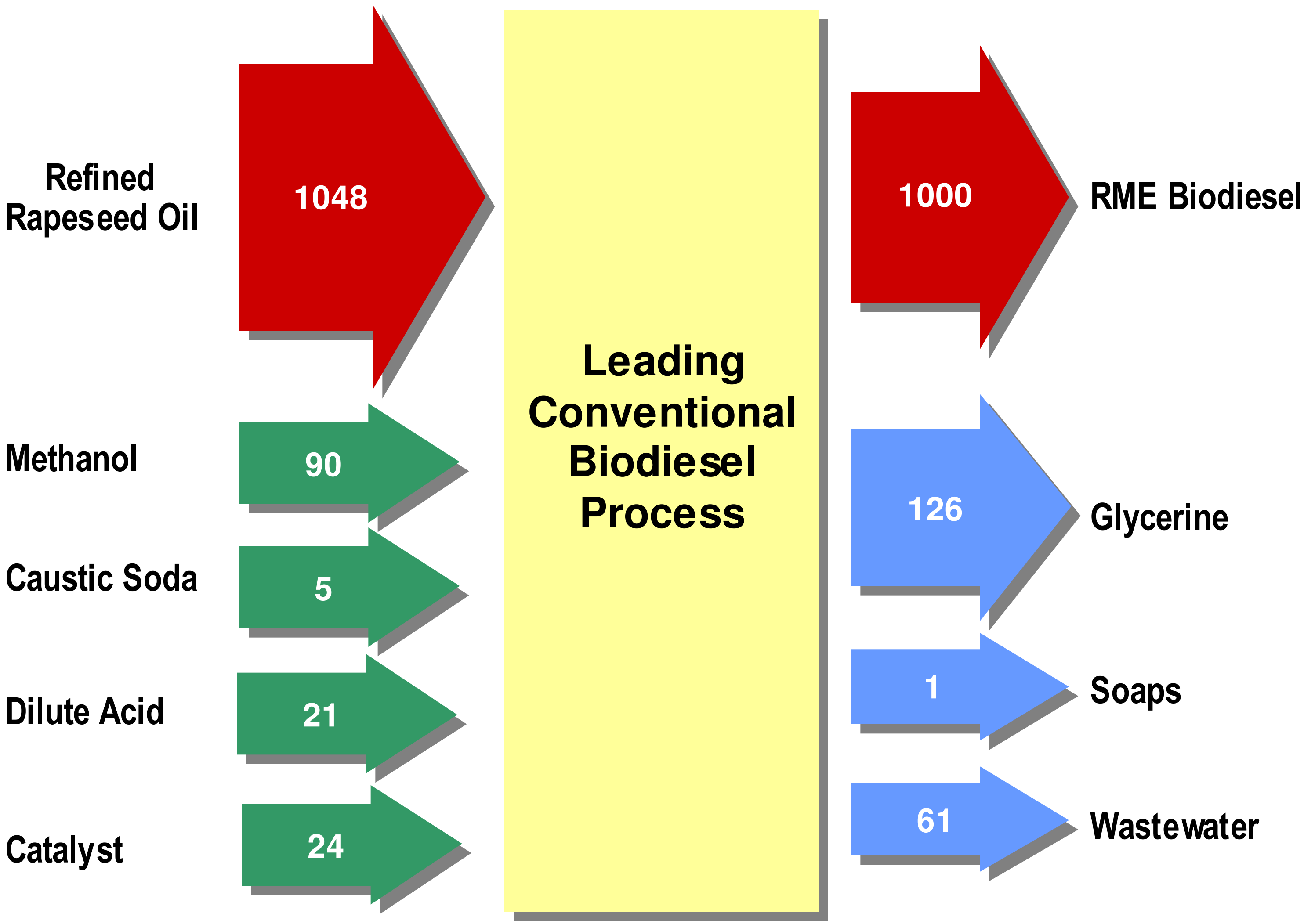
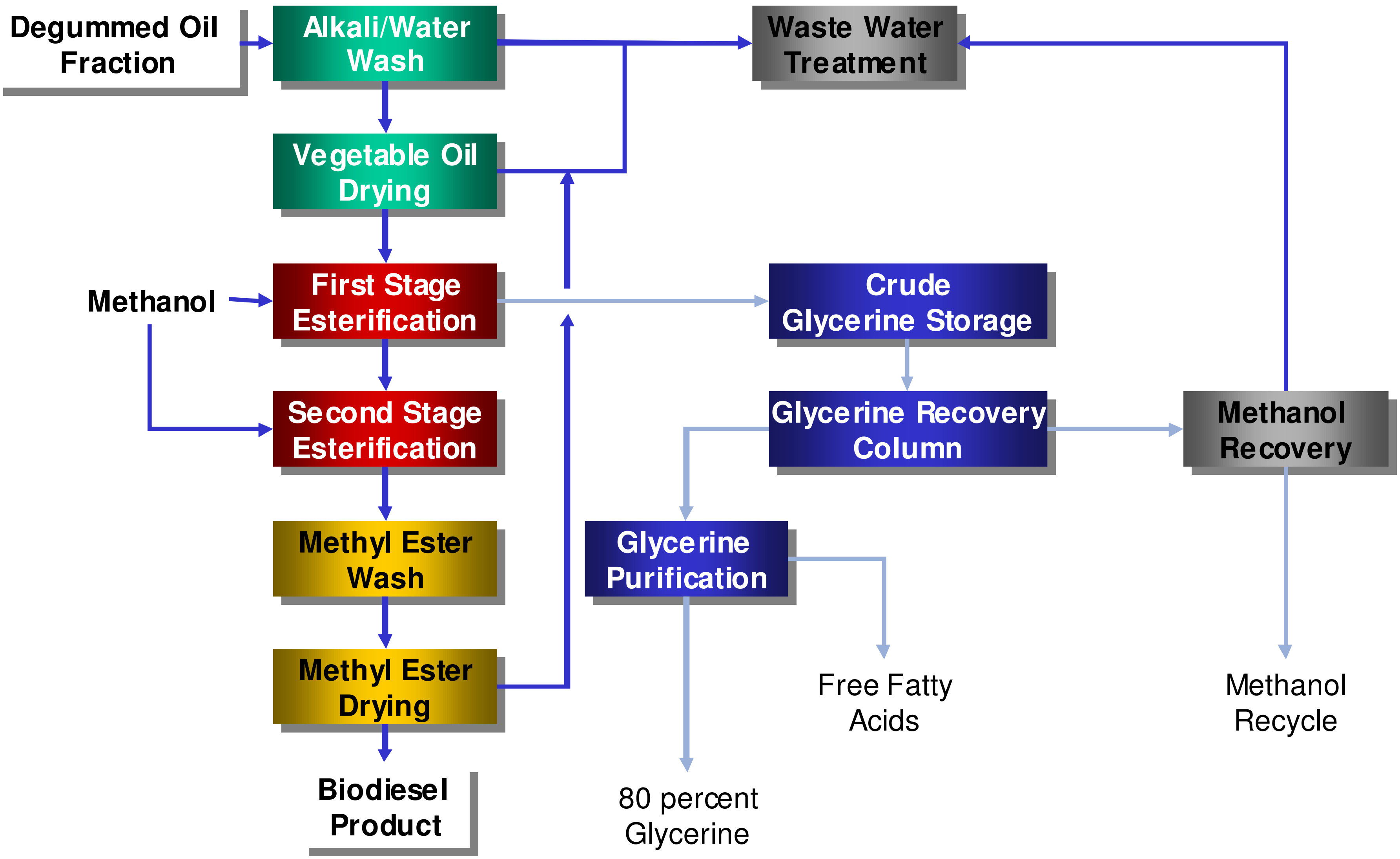
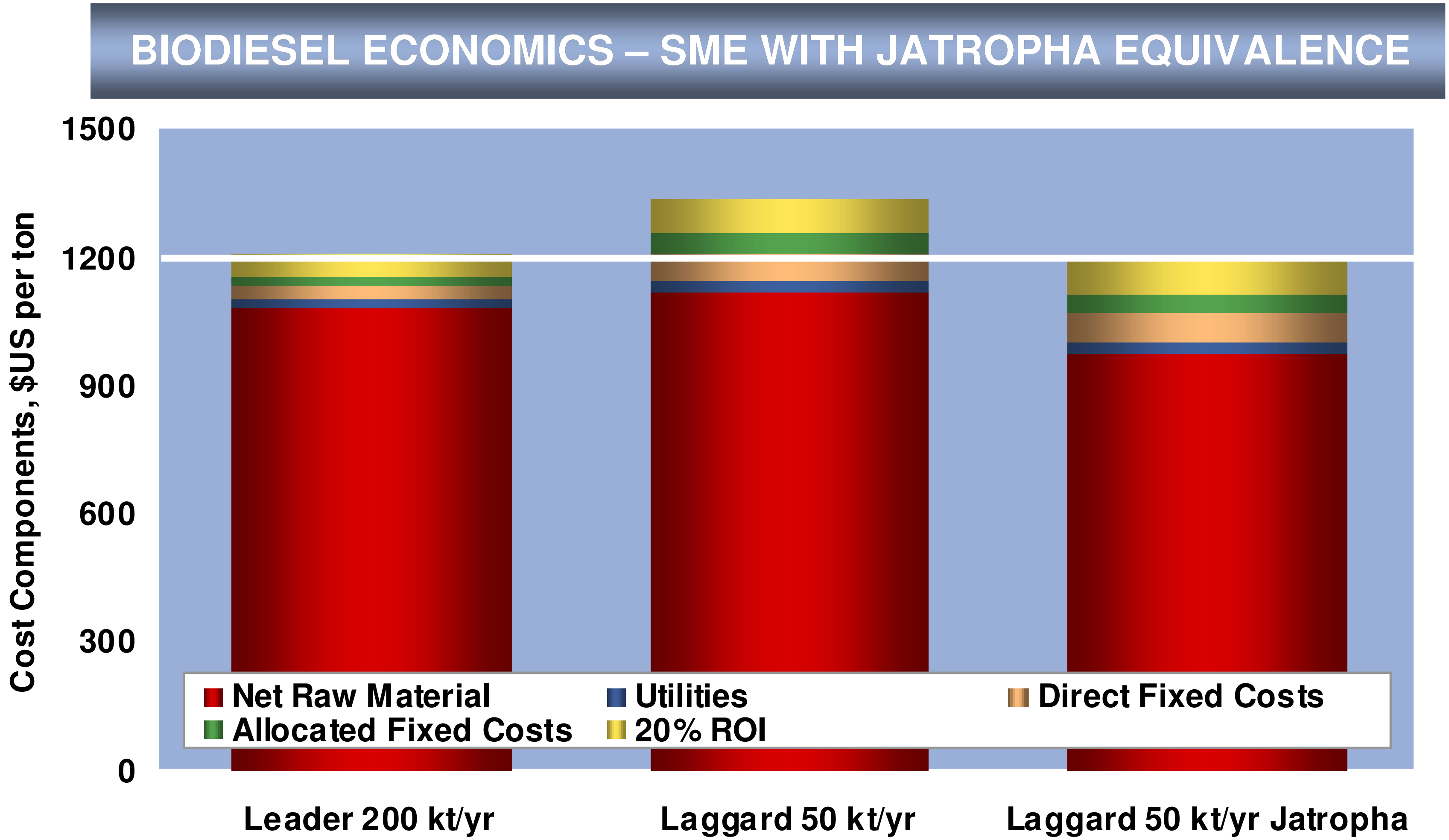
Simplified FAME Mass Balance



FAME biodiesel processes are very similar, following the same basic design concept

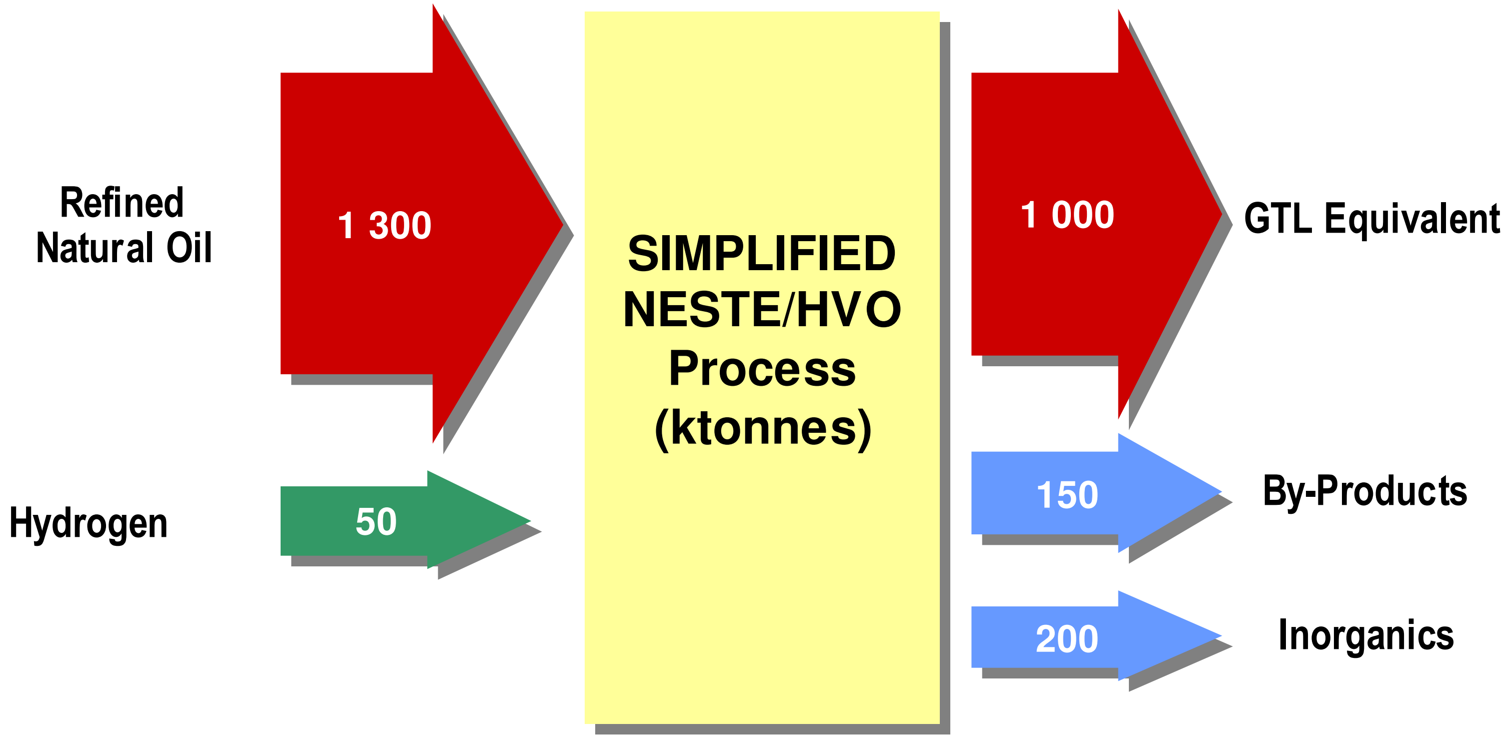


Jatropha pricing needs to be a least a 10 percent discount to Soybean Oil to allow the Laggard an Economic Return



Potential "Win:Win" Situation

HVO and like processes can also exploit Jatropha to make high performance ULSD, but probably a greater discount is needed because of higher feedstock use



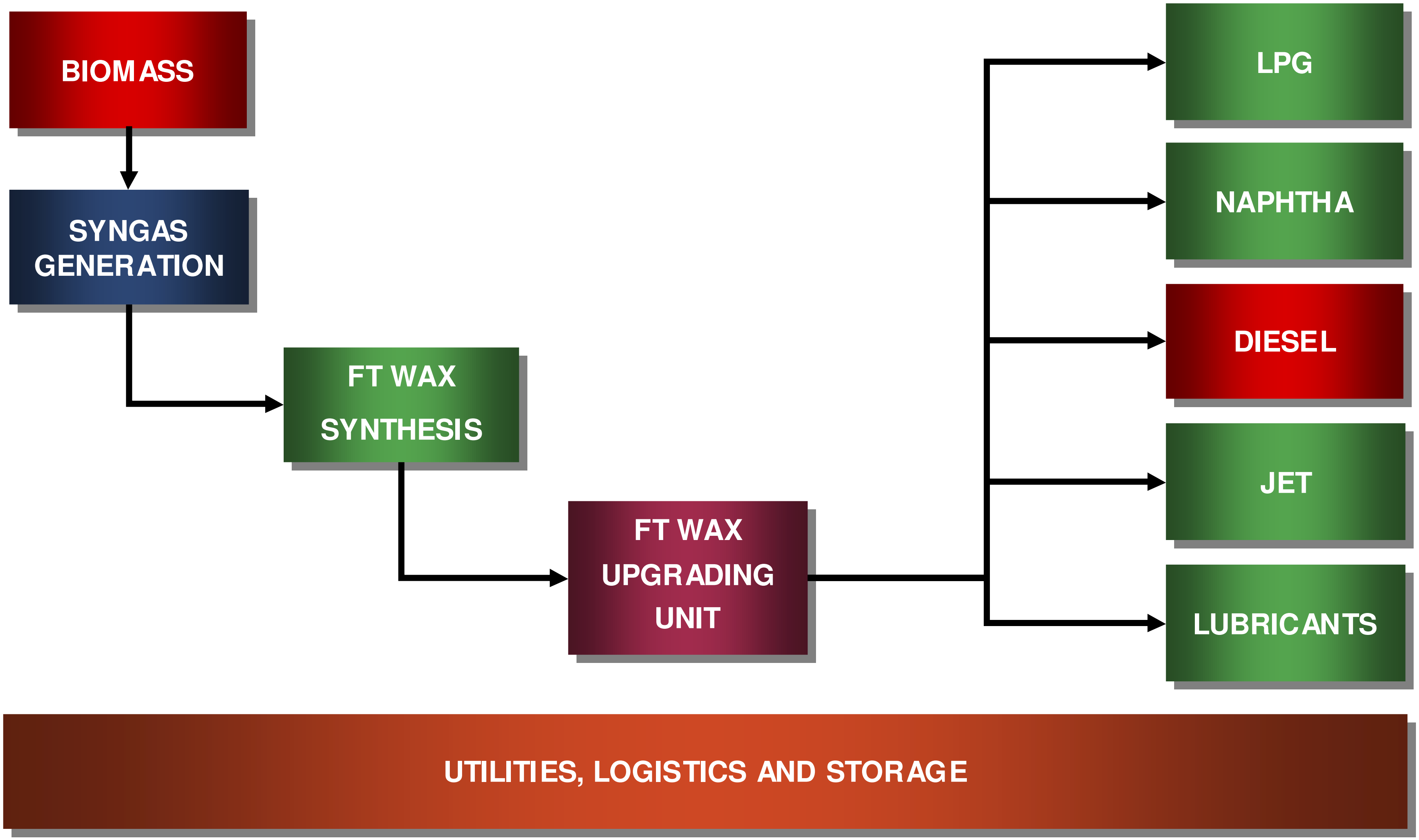
From a refiners perspective a better solution and no engine modification needed

The Competition

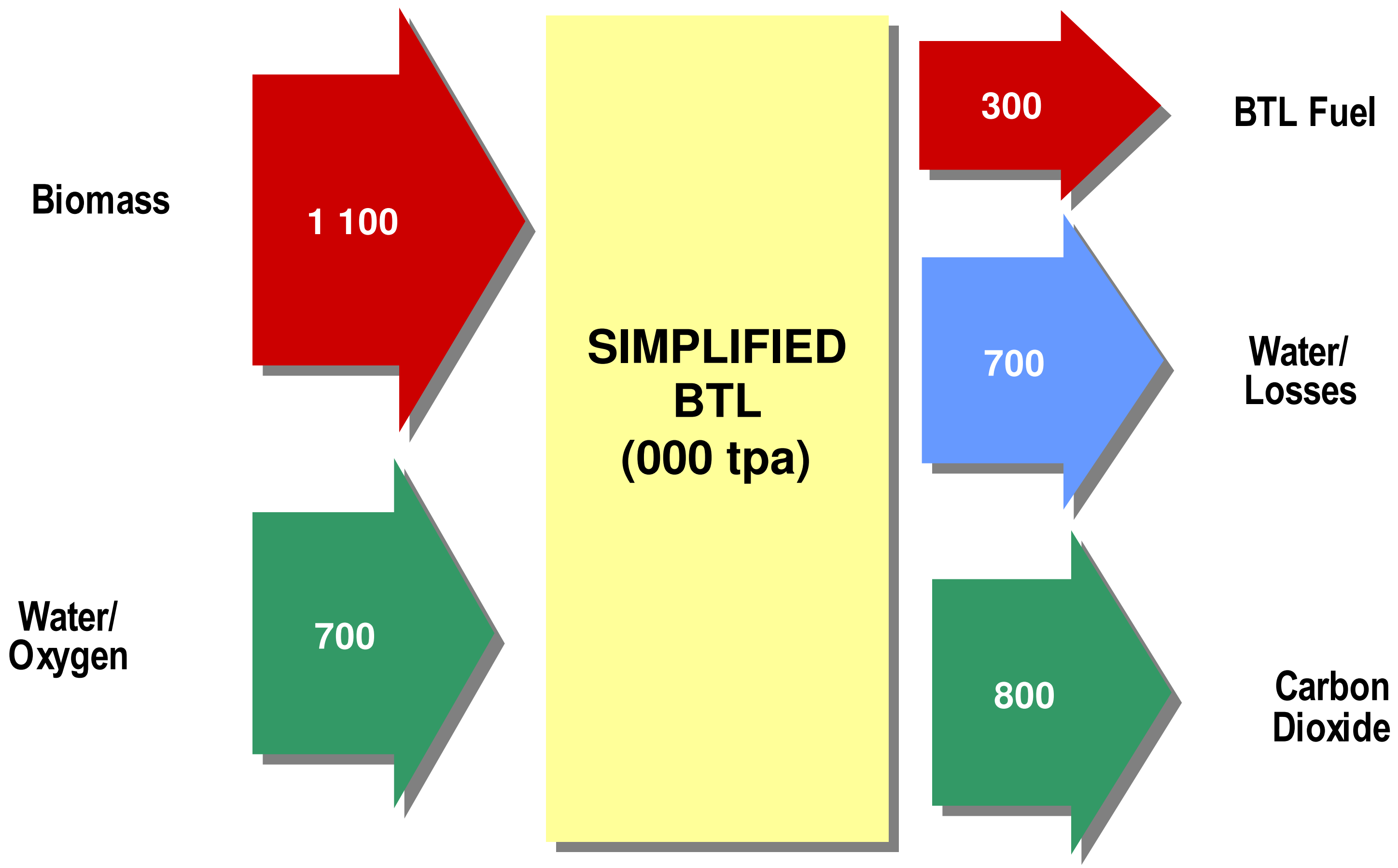
The CHOREN Beta plant to demonstrate the 2nd Generation "Biomass to Liquids" concept

Source: CHOREN GmbH, April 2007

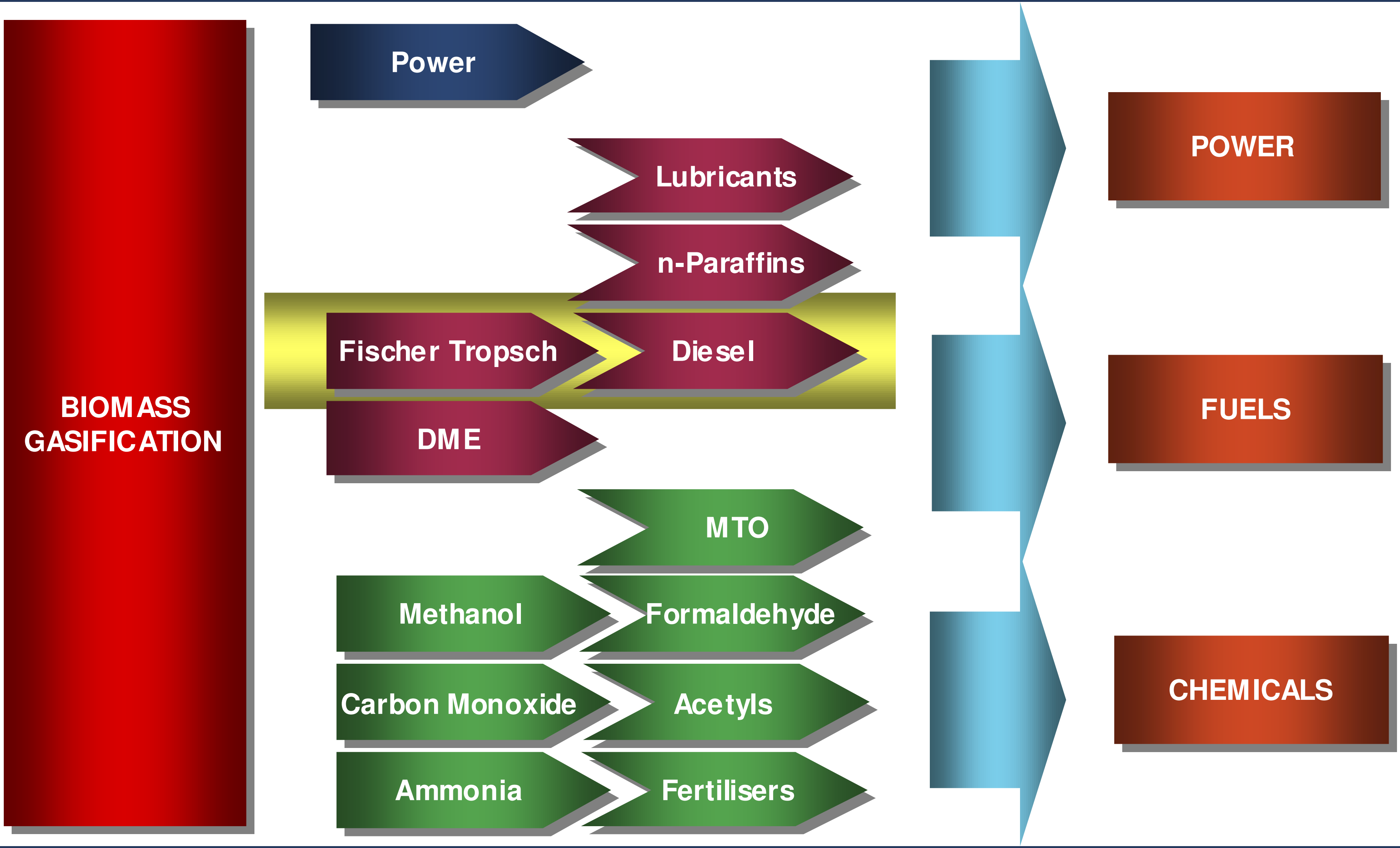
Simplified Second Generation Biodiesel Process – The "Biomass to Liquids" Concept



Second Generation technologies exploiting broad local biomass sources

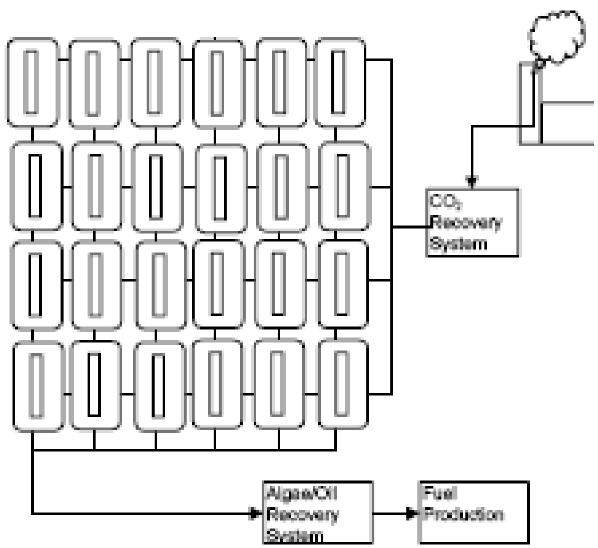


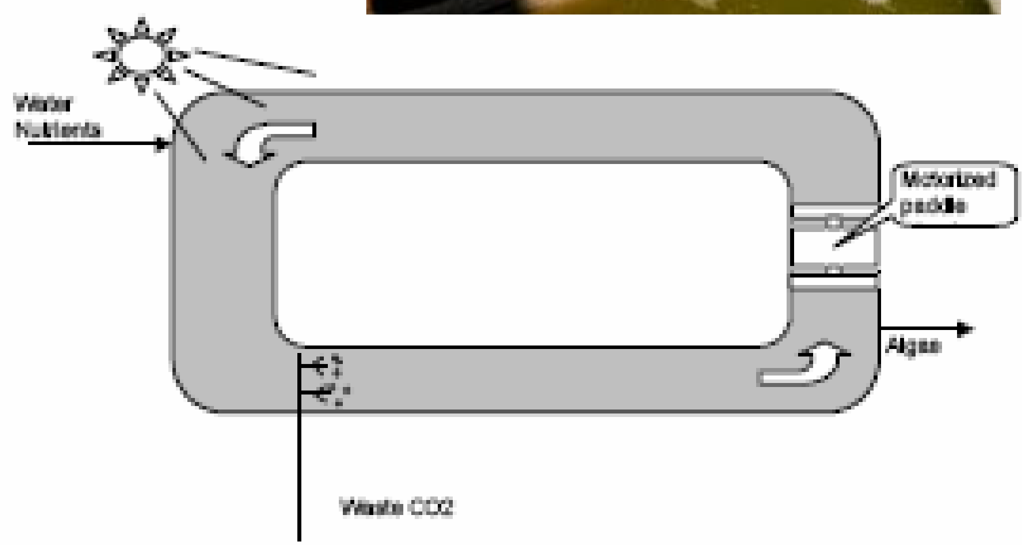
Gasification opens the way for a number of fuel, energy and chemical production options subject to feedstock availability



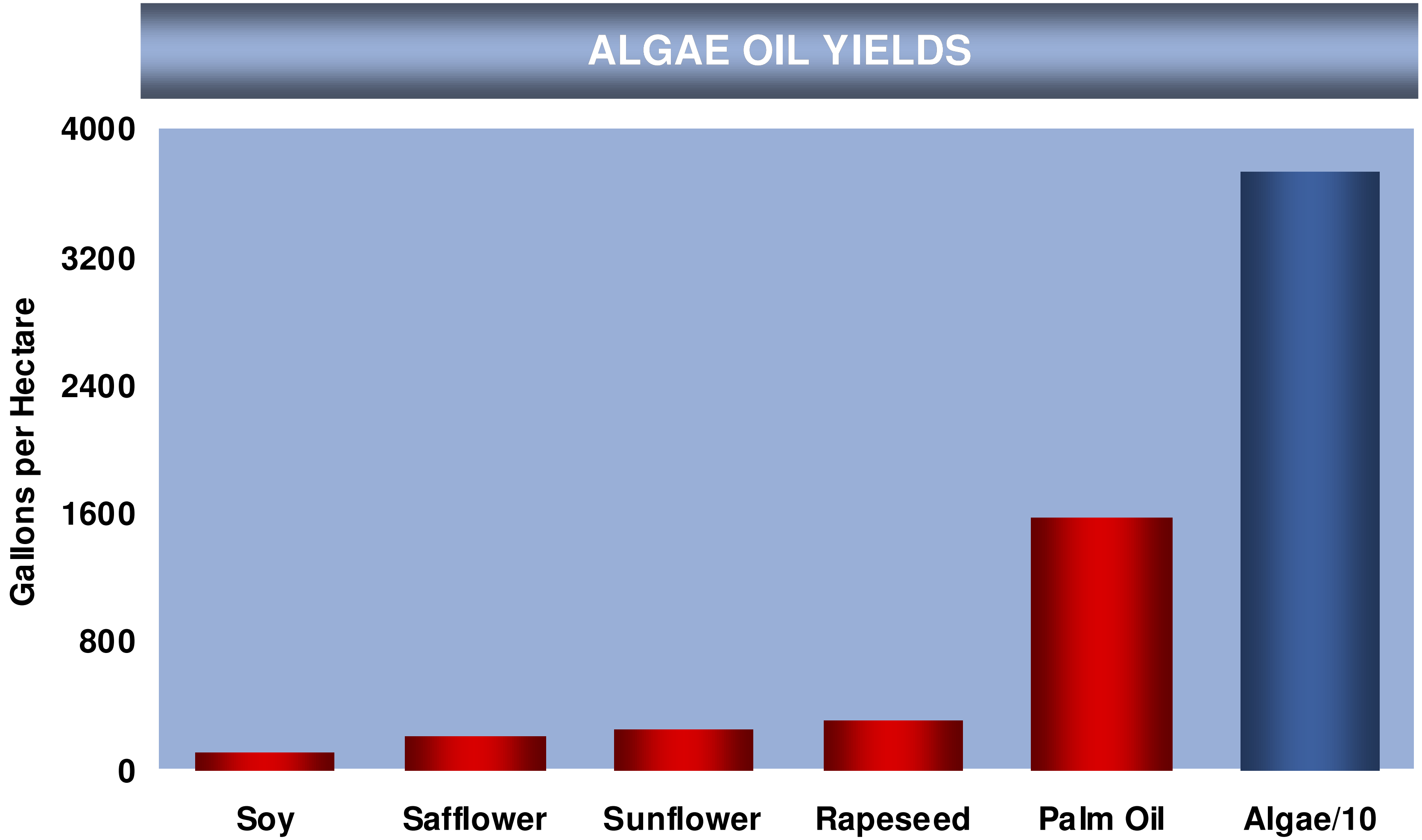
Closed pond, other closed systems are also being developed to grow algae for biodiesel

- **Closed systems investigated by DOE and private industry**
- **Industrial models readily available**





Algae are potentially a major step forward in per hectare oil yields



Key messages to take away today

- **Jatropha is emerging as the new biodiesel feedstock and will hopefully discourage a fuel vs fuel comparison, although the argument moves on to land for food versus fuel.**
- **Major developments ongoing to reach 50 000 kha in medium term. However, developments not in major markets, so could biodiesel production move out of these markets. – Do we solve energy security?**
- **Agronomic yields improving together with sustainability, but there is still room for further improvement to reach palm-like levels.**
- **Agriculture should prove economic as well as oil production, but there is uncertainty when a true Jatropha oil market emerges in terms of price. Indications are a substantial discount to conventional FAME feedstock needed.**
- **Jatropha offers "hope" and will continue to emerge as one of many biodiesel solutions.**

Thank You for Your Attention

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