Biodiesel Markets in the World
Trends & Future Developments

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Rosario, Argentina – 13 de Julio, 2007
• Biodiesel Markets
• Drivers, Opportunities & Threats
• Trends & Future Development
• Conclusions
Global Biodiesel development

- EU in driving seat
- US following fast
- Many other countries join the production and commercialization route: Malaysia & Indonesia; Argentina & Brazil; China; India; ...

- Total production capacity:
  - Today: 7-8 MMT
  - 2009: 16 MMT expected
  - 2020: > 25 MMT?
Snapshot view of the World Biodiesel Market

USA – SLOW START (Incentives since 2005)
CAPACITY: ~1.7MMT growing to 3.6MMT by 2008
80% based on Soybean Oil; consolidation and bigger projects

EUROPE – LARGEST
BIODIESEL PRODUCER & USER
Capacity will double from 2005 to 2008
Based on Rapeseed Oil and growing use of Soybean Oil and (some) Palm oil

MALAYSIA & INDONESIA – AMBITIOUS PROGRAMS based on Palm oil
MALAYSIA (5MMT capacity end of 2007); INDONESIA (1.55MMT by 2008)
BRAZIL, ARGENTINA based on Soy and Sunflower seed oil (3 MMT in 2008)
CHINA, INDIA, KOREA, THAILAND, COLUMBIA, TURKEY, …
The Biodiesel Opportunity

**Technical Advantages:**
- Lubricity in Ultra Low Sulfur Diesel
- Reduced Emissions

**Renewable Fuel Standards:**
- EN 14214
- ASTM D 6751
- Testing

**Tax incentive compensating for cost difference with fossil diesel**

**High fossil petrol price**
Biodiesel in the EU

  – The promotion of the use of biofuels or other renewable fuels for transport

• Target:
  – 5.75% of transport energy is bio-based in 2010
  – Mandatory 10% in 2020 (in preparation)

• Objectives:
  – Promoting biofuels to replace diesel or petrol for transport
  – Meeting climate change commitments
  – Environmentally friendly
  – Security of supply
  – Promoting renewable energy sources
EU: Detaxation and Energy Premiums for Oilseed Crops

• Detaxation: taxes on diesel fuel in Europe are on average about $450/m³ (€326 to 417 per MT)

⇒ pump price of diesel ≈ the same level as the biodiesel price without tax

• Energy crop premiums for direct use in energy generation

• Creating extra income for farmers
  – Originally coupled to the production of vegetable oil on set-aside land
  – Today also with Energy premiums supporting production
  – Growing world demand creates interesting business opportunities
Towards an EU Energy Policy
EC proposals – January 10, 2007

• “Road Map on Renewable Energies”
  – Mandatory target of 20% of all energy for 2020
  – 10% Market share of biofuels by 2020
  – Sustainable production of biofuels
  – New EU legislation on heating & cooling energy sources
  – National Action Plans on how to achieve the targets

• Revision of Directive 98/70 on Fuel Quality
  – Reduction of 1%/yr of CO\(_2\) emissions from fuels (2010-2020)
  – In practice: 1.5%-1.7% biodiesel consumption decrease per year

• Revision of Directive 2003/30 (biofuels)
  – Umbrella Directive on renewable energies (summer 07)
  – Main issues: support policies, policy mix, assessment of CO\(_2\) impact

• Biofuels are the cornerstone of the EU proposed Common Energy Policy
Impact of Proposals and Road Map

• 10% target for transport fuel = 25-28 MMT in 2020
• End of national detaxation schemes?
• Revision of the Directive on Fuel Quality: strengthens the impact
• Positive conclusions of the European Council
  – Rapid implementation should follow
  – Policies and standards to be adapted in the next months
• Increase B5 to B10 for common transport use
  – Without extra labelling
  – Without creating a separate biodiesel market!
  – How will car and fuel manufacturers react?
Biodiesel in the EU: Supply vs. Demand

- Assuming there are no feedstock limitations
- Overcapacity in the short/medium term
- Scenario A (biodiesel/bioethanol 50:50)
  - Ongoing excess capacity
  - After 2010: biodiesel demand-capacity gap decreases
- Scenario B (biodiesel/bioethanol 70:30)
  - From 2007: biodiesel demand-capacity balanced
  - After 2010: further capacity needed
- *Problem?: present cap on 5% blend in EN590 spec*

<table>
<thead>
<tr>
<th>Year</th>
<th>Scenario (A) kT</th>
<th>Scenario (B) kT</th>
<th>Plant Capacity (kT)</th>
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<tbody>
<tr>
<td>2005</td>
<td>2.90</td>
<td>2.90</td>
<td>3.80</td>
</tr>
<tr>
<td>2006</td>
<td>4.90</td>
<td>4.90</td>
<td>7.20</td>
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<tr>
<td>2007</td>
<td>6.60</td>
<td>9.24</td>
<td>10.10</td>
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<tr>
<td>2008</td>
<td>8.20</td>
<td>11.48</td>
<td>12.10</td>
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<tr>
<td>2009</td>
<td>9.70</td>
<td>13.58</td>
<td>15.50</td>
</tr>
<tr>
<td>2010</td>
<td>11.60</td>
<td>16.24</td>
<td><strong>17.00</strong></td>
</tr>
<tr>
<td>2011</td>
<td>14.00</td>
<td>19.60</td>
<td><strong>19.00</strong></td>
</tr>
<tr>
<td>2012</td>
<td>16.00</td>
<td>22.40</td>
<td><strong>21.00</strong></td>
</tr>
</tbody>
</table>

Targets by Directive (%)

- 2005: 2.00
- 2006: 2.75
- 2007: 3.50
- 2008: 4.25
- 2009: 5.00
- 2010: 5.75
- 2011: 7.00
- 2012: 9.00
The European Dilemma

2005

– Total O&F in Europe: 22.2 MMT \([\text{O&F balance: deficit} = 28\%]\)
  15.9 MMT own production
  6.3 MMT [O&F as such or as oilseed: imports (7.6 MMT) – exports (1.3 MMT)]
– Biodiesel 3.2 MMT
– Total Diesel 133.5 MMT (transport only; growing!)
– Biodiesel > 2%

2010 (at the same food and diesel consumption level)

– Biodiesel target 2010: 5.75%, or 10-12 MMT
– DIFFERENCE = 7-8 MMT, equivalent with
  • > 5 million ha extra rapeseed production?
  • More imports of O&F for Food or Technical?

\[\Rightarrow\text{EU-27 O&F balance: deficit will quickly grow to MORE THAN 47\%}\]
Available Options

- **Initially: a to f**
  - Depends on price and availability of rapeseed/rapeseed oil on the world market
  - (a) limited potential; (f) difficult for other users (food, feed, tech)

- **Today: g & h**
  - Other oils could easily be used in blends
  - This requires more research (incl. engine tests)
  - Recycled oils don’t fit well on the mass fuel market
  - More feasible at high RSO price
  - This requires investments in biodiesel plants in other countries

- a. Produce more rapeseed
- b. Import more rapeseed
- c. Export less rapeseed
- d. Import more RSO
- e. Export less RSO
- f. Less RSO for other applications
- g. Increase % biodiesel produced from soybean, sunflower seed, palm oil, and recycled O&F
- h. Import biodiesel
European O&F Market

Source: Oil World Statistics, Hamburg
U.S. Biodiesel Incentives

• Energy act of 2005: $1 per gallon or $294 per MT for biodiesel made from virgin oils and fats
  – Tax incentive for biodiesel made from inedible animal fats and used vegetable oils is $0.50 per gallon

• This is equal to $42 per barrel (159.2 liters)
Biodiesel in the U.S.: Opportunity for Vegetable Oils & Fats

2006/07: Total O&F in U.S.A.: 16.9 MMT

= 15.4 MMT own production + 1.5 MMT [O&F: imports (2.7 MMT) – exports (1.2 MMT)]

And additionally: - 5.8 MMT O&F equivalent [oilseeds: exports as 28 MMT SB and other oilseeds]

Of which:

Only 1-1.2 MMT Biodiesel

Consolidated O&F Balance for the US is down to 25% surplus (from more than 45% just two year ago)
Biodiesel in Oil Supply Side Countries

Malaysia & Indonesia

- Huge investments in capacity ongoing (>6 MMT in 2008!)
- Based on palm oil methyl esters with limited use in colder climate
- Creates new outlets for local oil products
- Very competitive price at current oil price level

Brazil & Argentina

- More diverse investments in capacity ongoing (> 3 MMT in 2008!)
- Based on soybean oil and some sunflower seed oil methyl esters
- Creates new outlets for local oil products
- Competitive price at current oil price level

Export directed production surfing on tax incentives in importing countries (DETs on export side!)

Strong growth will take away more O&F from the World Market
Global ENDING STOCKS to USE 
(Ratio for Soybean Oil)

Lowest ratio forecasted for 2006/07 since 1974/75

Source: John C. Baize and Associates
World Oil Prices: a new Paradigm

- Since summer 2005 Palm Oil (and Rapeseed Oil) price are directly linked to mineral oil price (in EU); Soybean Oil linked since summer 2006 (EU & US)
- Since Spring 2007, all major oil listed at real energy price corrected for tax incentives
- Mandatory mixing of biodiesel makes vegetable oil prices less susceptible to the volatility of energy prices
<table>
<thead>
<tr>
<th>Product</th>
<th>31 May 2007</th>
<th>Oct-Apr 06/07</th>
<th>Oct/Sep 05/06</th>
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</thead>
<tbody>
<tr>
<td>Palm oil crude cif N.W. Europe</td>
<td>825</td>
<td>596</td>
<td>452</td>
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<tr>
<td>Palm oil RBD Malaysia fob</td>
<td>830</td>
<td>561</td>
<td>416</td>
</tr>
<tr>
<td>Palm oil crude Indonesia fob</td>
<td>790</td>
<td>394</td>
<td>543</td>
</tr>
<tr>
<td>Palm olein RBD Malaysia fob</td>
<td>835</td>
<td>569</td>
<td>422</td>
</tr>
<tr>
<td><strong>Palm olein RBD Malaysia cif Rotterdam</strong></td>
<td>905</td>
<td>631</td>
<td>489</td>
</tr>
<tr>
<td>Palm stearin RBD Malaysia fob</td>
<td>805</td>
<td>523</td>
<td>393</td>
</tr>
<tr>
<td><strong>Palm stearin RBD Malaysia cif Rotterdam</strong></td>
<td>875</td>
<td>586</td>
<td>460</td>
</tr>
<tr>
<td>Soybean oil Dutch fob ex-mill</td>
<td>817</td>
<td>697</td>
<td>573</td>
</tr>
<tr>
<td>Soybean oil Brazil fob</td>
<td>761</td>
<td>625</td>
<td>475</td>
</tr>
<tr>
<td>Soybean oil Argentina fob</td>
<td>740</td>
<td>620</td>
<td>469</td>
</tr>
<tr>
<td><strong>Rape oil Dutch fob ex-mill</strong></td>
<td>840</td>
<td>802</td>
<td>770</td>
</tr>
<tr>
<td><strong>Rape oil Hamburg fob ex-mill</strong></td>
<td>840</td>
<td>805</td>
<td>771</td>
</tr>
<tr>
<td>Sunoil EU fob N.W. European ports</td>
<td>870</td>
<td>716</td>
<td>635</td>
</tr>
<tr>
<td>Sunoil Argentina fob</td>
<td>786</td>
<td>634</td>
<td>544</td>
</tr>
<tr>
<td>Sunoil fob Black Sea</td>
<td>790</td>
<td>637</td>
<td>549</td>
</tr>
<tr>
<td>Cotton oil US PBSY fob Gulf</td>
<td>909</td>
<td>710</td>
<td>669</td>
</tr>
<tr>
<td>Corn oil US fob Midwest</td>
<td>728</td>
<td>614</td>
<td>555</td>
</tr>
<tr>
<td>Corn oil US fob Gulf</td>
<td>810</td>
<td>694</td>
<td>638</td>
</tr>
</tbody>
</table>

Source: ISTA Mielke GmbH, Weekly price update, © Copyright 2007
"Growing use of cereals, sugar, oilseeds and vegetable oils to satisfy the needs of a rapidly increasing biofuel industry is one of the main drivers [for the growing demand for agriculture products]" (Joint report by the OECD & FAO)

⇒ FOOD or FUEL debate is heating
Global Oils & Fats supply & demand

- MY 05/06: Oils & Fats supply 145 MMT (includes 35 MMT palm, 35 MMT soy, 15 MMT rape, other 20 MMT + 30+ MMT animal O&F)
- Food consumption grows at 1-2% per year (2 MMT)
- Global O&F production is rising
  - Malaysia & Indonesia continue to increment palm oil production.
  - Large export of soybean oil from US, Argentina and Brazil reduced in near future due to sharp domestic demand.
  - EU25 domestic vegoil production cannot keep pace with the increasing demand but will increase by replacing some grain and acreage (or just the opposite? See Bioethanol planning)
- Short term shortage ⇒ price increase ⇒ decrease demand ⇒ equilibrium.
- Midterm: more optimistic; but corn and soy compete for acres in the US

Another key factor: meal consumption (strongly disturbed supply & demand)
Future Biodiesel scenario

• **Political support: must remain strong to keep momentum**
  – Energy security
  – Environmental (Kyoto ….)
  – Agricultural diversification

• **Legislation**
  – Biofuel target from 5.75% up to 10% in Europe and other regions
  – Mandatory blending a major driving force
  – B10 specs needed on World Wide Fuel charter level

• **Diesel demand**
  – Increasing “dieselization” in Europe and many other regions ⇒ local diesel shortage
  – Good acceptance as biofuel
  – Move to next generation biofuels

• **Pricing**
  – Ongoing high petroleum prices (above 60 $ barrel)
Future Developments (1): Changing Oils & Fats Supply

- Raw material selection for biofuels expands
- Blending to make best fit at lowest cost is growing
- Biofuel industry competes for same raw materials with the food sector ⇒ food sector suffers, especially in developing countries
- Cost efficiency wins with decreasing incentives
- Quality & specification requirements get more restrictive: need to comply with increasing environmental and performance requirements
Rapeseed and Sunflower Seed Benefit from Biodiesel

• More oil per hectare
  – Soybeans: only 19% oil (500 kg per hectare or less)
  – Rapeseed, sunflower seed: 40-50% oil (1.2-1.6 MT per ha)
• Rising vegoil prices cause greater price benefit to rapeseed and sunflower seed than to soybeans
• Lower additional meal output less disturbing for animal feed market
• Competition with corn for ethanol further shrinks growth potential for soybean oil in US, Brazil and Argentina

➢ Many countries might grow more soft seeds
➢ Countries with superior logistics will win, even with soybean oil
Palm Oil
another Mid-Term Winner

Pro
• More than 4 MT oil per hectare
• Unbeatable low production cost

Contra
• Slow production increase leads to instability in the world market for Oils & Fats
• More suitable for direct energy production; limited use in biodiesel blends
• Questions about sustainability and environmental damage
Food vs. Fuel: alternative oils for fuel

- Recycled O&F and paper mill Tall oil valorization
- Mamona: seed with 40 to 60% oil; production around 1.5 MMT per year; leading producing areas are India, China and Brazil.
- Algae: experiments confirm a crude oil content of about 35%.
- Jatropha: used as a fuel oil, high attention in India, Malaysia, the Philippines and Egypt, up to 40% oil content, inedible

- Intensive R&D needed to optimize the supply chain, logistics, crushing, and use of products and by-products
Future developments (2):

Standards for international biodiesel trade

• Solid base = fair trade base
  Based on solid international standards

• The European biodiesel industry is threatened by US B99.9 unfair export subsidies to Europe

• B99.9 exports also threaten the worldwide development of biodiesel
  – Price distorting effect has a strong negative effect on European as well as world biodiesel market prices
  – Paid by US government (temporarily?)

• Argentinean and Malaysian DETs are a potential additional threat
Future Developments (3):
Level of FAME must go up

<table>
<thead>
<tr>
<th></th>
<th>Diesel type I</th>
<th>Diesel type II</th>
<th>Diesel type III</th>
<th>Diesel type IV</th>
</tr>
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<tbody>
<tr>
<td>Cetane Number (Cetane Index)</td>
<td>48</td>
<td>51</td>
<td>53</td>
<td>55</td>
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<tr>
<td>Density kg/m³</td>
<td>820</td>
<td>860</td>
<td>820</td>
<td>850</td>
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<tr>
<td>Viscosity mm²/s</td>
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<td>4.5</td>
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<td>4</td>
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<tr>
<td>Sulfur content ppm</td>
<td>2000</td>
<td>300</td>
<td>50</td>
<td>10</td>
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<tr>
<td>Total aromatics %m/m</td>
<td>25</td>
<td>5</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Polyaromatics %m/m</td>
<td>5</td>
<td>2</td>
<td>2</td>
<td>2</td>
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<tr>
<td>T95 °C</td>
<td>370</td>
<td>355</td>
<td>340</td>
<td>340</td>
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<tr>
<td>Flash point °C</td>
<td>55</td>
<td>55</td>
<td>55</td>
<td>55</td>
</tr>
<tr>
<td>Carbon residue %m/m</td>
<td>0.3</td>
<td>0.3</td>
<td>0.2</td>
<td>0.2</td>
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<tr>
<td>CFPP °C</td>
<td>Max. ≤ the lowest expected ambient temperature</td>
<td>Max. ≤ the lowest expected ambient temperature</td>
<td>Max. ≤ the lowest expected ambient temperature</td>
<td>Max. ≤ the lowest expected ambient temperature</td>
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<tr>
<td>Water content ppm</td>
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<td>200</td>
<td>200</td>
<td>200</td>
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<tr>
<td>Oxidation stability g/m³</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
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<tr>
<td>FAME content %v/v</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>None</td>
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<tr>
<td>Total Acid Number mg KOH/g</td>
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<td>0.08</td>
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</table>

FAME = ASTM 6751 or EN 14214
# Biodiesel Standards

<table>
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<tr>
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<tbody>
<tr>
<td>Applies to</td>
<td>FAME</td>
<td>FAAE</td>
<td>Diesel</td>
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<tr>
<td>Density 15°C</td>
<td>0.86-0.90</td>
<td></td>
<td>0.82-0.845</td>
</tr>
<tr>
<td>Viscosity 40°C</td>
<td>3.5-5.0</td>
<td>1.9-6.0</td>
<td>2.0-4.5</td>
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<tr>
<td>CFPP / Cloud Point</td>
<td>CFPP:</td>
<td>Cloud point:</td>
<td>CFPP:</td>
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<td>country/season</td>
<td>report</td>
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<tr>
<td></td>
<td>specific</td>
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<td>specific</td>
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<tr>
<td>Oxidation stability</td>
<td>6 hours min</td>
<td>3 hours min</td>
<td>N/A (25 g/m³)</td>
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<tr>
<td>Cetane number</td>
<td>51 min</td>
<td>47 min</td>
<td>51 min</td>
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<tr>
<td>Iodine value</td>
<td>120 max</td>
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<tr>
<td>Linolenic acid ME</td>
<td>12 max</td>
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<td></td>
</tr>
<tr>
<td>C(x:4) &amp; greater unsaturated esters</td>
<td>1 max</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Only major technical specifications are displayed*
Biodiesel Cost Optimizer ®

Least Cost Biodiesel Composition Calculation

Biodiesel Cost Optimizer model

A biodiesel blend cost optimization tool

This program is a stand-alone license to IDB.

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Biodiesel Cost Optimizer

• Biodiesel based on raw material blends can be much more economic than pure RME or pure SME and still comply with EN14214 or ASTM 6751
• In summer conditions almost any raw material can be used for FAME production
• Oxidation stability of the final product will affect raw material choice (corrected with antioxidants!)
• In winter, CFPP constraints will limit raw material choice, but B5 or B10 allows plenty of flexibility
• Always: lowest cost blend of the day
Future developments (4): Glycerine needs new markets

- Increasing crude glycerine supply ⇒ oversupply leads to low market prices ⇒ new market opportunities and new activities.
- Traditional usage (pharmaceutical, food, cosmetics) is only growing at 2 to 3% per year
- New chemical use, e.g.
  - Glycerin as feedstock to produce renewable propylene glycol
  - Producing epichlorydrin
  - Use as antifreeze
- Feed: R&D succeeded in finding optional nutritional ratios in animal feed (blend with molasses)
- Energy:
  - Use as fermenting agent ⇒ biogas
  - Burn in high efficiency steam/turbine ⇒ green electricity
World glycerine market
(source HB International)

Glycerine Production Estimates

- Others
- Synthetic
- Fatty Alcohol
- Biodiesel
- Fatty Acids
- Soaps

(000's MT/a)

Future developments (5): The sustainability debate

• Most biofuels bring environmental benefits
  – More Life Cycle Analysis (LCA) data needed
  – Many studies exist, often contradictory

• Tackle problems like:
  – Deforestation (Round Table for Sustainable PO/SBO)
  – High-GHG production techniques (palm oil)
  – FOOD or FUEL debate
Future developments (6): The Next Generation Biofuels

• Move to second-generation biofuels
  – Bio-alkanes with higher technical performance, and better cost efficiency
  – Thermal cracking of blended oils or fats with petroleum before refining has started; it may be a more long-term solution
  – Fischer Tropsch synthesis of linear and branched alkanes
  – BTL & GTL technology

• Pro:
  – Longer-term sustainability

• Contra:
  – Surplus refinery and transesterification capacity will need new use, e.g. supply RBD market for O&F
Biomass, Biogas and BTL/GTL

• Increasing investment in the development of by-product valorization in the energy sector:
  – Direct energy generation: e.g. glycerol; O&F by-products, but also DDG, straw and cellulosic fractions
  – Via intermediate processes such as fermentation to biogas (methane) or to ethanol

• BTL/GTL: Transforming biomass or biogas to liquid fuels with high performance characteristics (e.g. using Fischer Tropsch transformation to alkanes)

• Synthetic high-quality “designer” fuels based on lignocellulose and other Agriculture & Food Industry byproducts
Conclusions (1)

- Massive investments in production capacity underway doubling world capacity to 16 MMT in 2009 and highly probably above 25 MMT by 2012
- Vegetable oil supply will go through ups and downs but midterm markets will find equilibrium
- Non-food new feed stocks are a long-term strategic option
- Glycerin oversupply was pushed to look for alternative usage; some are very promising
- Strong government support and mandatory targets support further development
Conclusions (2)

• Legislation and Standardization needs harmonization and efficient and effective support mechanisms
• Biodiesel may change into more synthetic fuels based on Oils & Fats or other feedstocks
• Sustainability is driver for next generation fuels
• Current investments may lead to a new market paradigm for crude and RBD oils after the biodiesel era
Muchas Gracias

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