European Bio-refineries
Growing Opportunities for US companies

ABLC – Washington DC
April 4, 2012
Petrochemistry and biofuels in Europe
P Petrochemicals and polymers account for about 50% of EU chemicals sales

- Output from the EU chemicals industry covers three wide ranges of products:
  - base chemicals
  - specialty chemicals
  - consumer chemicals

- Eight countries account for 90% of EU chemicals production

- Germany remains the largest chemicals producer in Europe, followed by France, Italy and the Netherlands. Together, these four countries generated in 2010, 64% of EU chemicals sales, valued at €315 billion.

- Green chemistry is expected to double in France total chemistry:
  - From 8% to 15% shares in the 7 years to come: +3 B€ (French National Environment Agency)
A big market for transportation fuels

- In 2010: 169 B Gallons in EU (vs. 226 B Gallons in USA)

Source: European Environment Agency
The EU climate and energy package

- The CARE* package "20-20" targets for 2020 (Leg. June 2009):
  - 20% less GHG emissions
  - 20% more efficiency
  - 20% energy consumption to come from renewable resources

- NREAP*: each member state has different targets regarding (Dir. 2009/28/EC)
  - energy mix and best opportunities for renewables in this country
  - existing renewable energies shares

- EU biofuels policy is based on 2 Directives:
  - 2003 Biofuels Directive
  - 2009 Renewable Energy Directive (RED)

- Goal: 10% in total EU fuel consumption in 2020

2010 = only 4.7% of biofuels in total fuel consumption
The future for biofuel activities within Europe remains bright.

* CARE: Climate Action and Renewable Energy
NREAP: National Renewable Energy Action Plan
The biofuels place in EU

- EU consumption in 2010:
  - All fuels: 294 M toe
  - Biofuels: 14 M toe

Breakdown by type of biofuel (2010)

Source: Eurostat 2011 and EurObserv'ER 2011
Biodiesel has been produced on an industrial scale since 1992, largely in response to positive signals from the EU institutions.

- 10.7 Mtoe in 2010
- 254 facilities

- 2 leading countries: France and Germany for ca 50%

- Players: Diester, ADM, Infinita, Ineos, Cargill…

Source: EBB, European Biodiesel Board
The EU ethanol production

- Ethanol production capacity has significantly increased in recent years since the launch of the EU biofuels program.

- 2.9 Mtoe in 2010
- 70 facilities

- 3 leading countries: France, Germany and Spain for ca 66%

- Players: Abengoa, Tereos, Verbio, Crop Energies, Cristanol…

Source: ePure
Biofuels sales in **2010**: 13.8 B€ turnover (11.5 B€ in 2009) for 14 Mtoe

- Up to now, the 2003 Biofuels Directive led to approx. good results.
- NREAP gives better outlooks at each country level

In **2020**, 1st and 2G expected to exceed NREAP:

- 7.3 Mtoe bioethanol
- 21.7 Mtoe biodiesel

X2 in 10 years

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**Biofuel consumption trends (ktoe)**  
Source: EurObserv'ER 2011
The French biofuels market

- France = 19% of EU biofuels market in 2010
- 2.6 M toe of biofuels (80% biodiesel)
- 20 facilities
- 6.3% of fuels consumption

- 2020 target: 15% (NREAP).

- 2009 Renewable Energy Directive (RED) sets targets for minimum levels of CO\textsubscript{2} emission reduction and the sustainability of feedstock:
  - = positive signal for advanced biofuels production
  - French market **needs 3.6 M toe more biofuels for 2020**

- Players:
  Diester, Cristanol, Tereos, Ineos…
Biorefining in Western Europe

Data from Biorefuture 2009, Star Colibri studies and FAO statistics
Feedstock availability for sugar/grains biorefineries

- Wheat production

- Sugarbeet production
10 crop/grains + 12 wet biomass biorefineries
Lignocellulosic feedstock availability

- Wood residues
- Agriculture residues
11 lignocellulosic biorefineries
8 oilseed biorefineries (integrated)
Actual refineries and projects
The 22 leading European biorefineries

<table>
<thead>
<tr>
<th>Country</th>
<th>Location</th>
<th>Companies</th>
<th>Feedstock</th>
<th>Start</th>
<th>Inv. M€</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>Lenzing</td>
<td>Lenzing AG</td>
<td>Wood</td>
<td>2010</td>
<td>30</td>
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<tr>
<td>Austria</td>
<td>Lenzing</td>
<td>Danisco</td>
<td>Waste from pulp paper</td>
<td>2006</td>
<td>23</td>
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<tr>
<td>Belgium</td>
<td>Port of Ghent</td>
<td>Oleon, Alco Bio Fuel, Bioro</td>
<td>Soya, Rapeseed, Wheat</td>
<td>2008</td>
<td>+100</td>
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<tr>
<td>Belgium</td>
<td>Wanze</td>
<td>BioWanze</td>
<td>Wheat, Sugar Beet</td>
<td>2009</td>
<td>250</td>
</tr>
<tr>
<td>Belgium</td>
<td>Aalst</td>
<td>Syral</td>
<td>Wheat</td>
<td>2008</td>
<td>20</td>
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<tr>
<td>Denmark</td>
<td>Kalundborg</td>
<td>Inbicon</td>
<td>Straw</td>
<td>2011</td>
<td>54</td>
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<tr>
<td>France</td>
<td>Lestrem</td>
<td>Roquette, DSM</td>
<td>Wheat, corn, potatoes</td>
<td>2012</td>
<td>na</td>
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<tr>
<td>France</td>
<td>Compiègne</td>
<td>Diester, Novance</td>
<td>Rapeseed, Sunflower</td>
<td>2006</td>
<td>180</td>
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<tr>
<td>France</td>
<td>Bordeaux</td>
<td>DRT</td>
<td>Paper, wood residues</td>
<td>2010</td>
<td>+55</td>
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<tr>
<td>France</td>
<td>Reims</td>
<td>Bioamber, Cristanol, Procethol 2G</td>
<td>Sugar Beer, Wheat, Lignocellulosics</td>
<td>2006</td>
<td>350</td>
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<tr>
<td>Germany</td>
<td>Arneburg</td>
<td>Zellstoff Stendal</td>
<td>Wood</td>
<td>2006</td>
<td>1000</td>
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<tr>
<td>Germany</td>
<td>Schwedt</td>
<td>Verbio</td>
<td>Wheat, corn, straw</td>
<td>2006</td>
<td>na</td>
</tr>
</tbody>
</table>

Sources: Starcolibri study; BiofuelsDigest
The 22 leading European biorefineries (continuing)

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<td>Italy</td>
<td>Terni</td>
<td>Novamont</td>
<td>Corn, sunflower</td>
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<tr>
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<td>Le Calorie</td>
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<td>Netherlands</td>
<td>Sas van Ghent</td>
<td>Oleon, Royal Nedalco</td>
<td>Wheat and corn</td>
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<td>Netherlands</td>
<td>Amsterdam</td>
<td>Rotie, Noba, Organworld</td>
<td>Organic waste, used vegetable oils</td>
<td>2010</td>
<td>50</td>
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<td>Netherlands</td>
<td>Groningen</td>
<td>Bio-MCN</td>
<td>Glycerol, lignocellulosic biomass</td>
<td>2009</td>
<td>50</td>
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<td>Sweden</td>
<td>Pitea</td>
<td>Smurfit Kappa, Chemrec, Supine</td>
<td>Wood and recycled paper, black liquor, tall oil</td>
<td>2005</td>
<td>+150</td>
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<tr>
<td>Sweden</td>
<td>Örnsköldsvik</td>
<td>Domsjö, Sekab, Cherec</td>
<td>Wood, black liquors</td>
<td>2004</td>
<td>+300</td>
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<tr>
<td>UK</td>
<td>Manchester</td>
<td>Cargill, Royal Nedalco</td>
<td>Wheat</td>
<td>2008</td>
<td>+100</td>
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<tr>
<td>UK</td>
<td>Wissington</td>
<td>British Sugar</td>
<td>Sugar beet</td>
<td>2007</td>
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<tr>
<td>UK</td>
<td>London</td>
<td>BP</td>
<td>na</td>
<td>2012</td>
<td>na</td>
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Sources: Starcolibri study; BiofuelsDigest
Denmark: Inbicon

- Location: Kalundborg
- Demo plant
- Start: 2011
- In: 30 kt wheat straw
- Out:
  - 4.3 kt ethanol
  - 13 kt lignins
  - 11 kt C5 molasses
- Invest: 400 million DKK (54 M€)
- Jobs: 30

Photo credit: Inbicon
Germany: Verbio

Location: Schwedt

Bioethanol:
- In: wheat
- Out: 200 kt

Biodiesel
- In: vegetable oil
- Out: 250 kt

Biogas
- In: DDGS
- Out: energy and fertilisers

Photo credit: Verbio
Belgium: Ghent Bio-energy Valley

- **Alco Bio Fuel:**
  - In: wheat
  - Out: 280 kt ethanol
    150 kt DDGS

- **Bioro: (JV Cargill-Biodiesel Holding NV)**
  - In: rapeseed
  - Out: 250 kt biodiesel
    livestock feeding

- **Oleon:**
  - In: rapeseed + recycled vegetable oil
  - Out: 100 kt biodiesel

- **CHP 180 MWh**

- **Invest: 220 M€**
- **Jobs: 160**

Photo credit: Ghent Bio-Energy Valley
Does the ideal integrated biorefinery exist in Europe?
Reims, les Sohettes: a big Biorefinery

- 2 Mt/y sugarbeet
- 1 Mt/y wheat

- 400+ kt/y starch & sugars
- 280 kt/y ethanol
- 350+ kt/y livestock feeding
  + liquid fertilizers
  + green chemicals

- Invest: 350 M€
- Jobs: 600+200
Les Sohettes: a real **integrated** Biorefinery

**SUGAR COOPERATIVE BAZAUMCOURT**
Sugar production
Employee: 737
Shareholders: Coop Union (100 %)

**C.R.I.S.T.A.N.O.L.**
Distillery
Employee: 178
Shareholders: C.R.I.S.T.A.N.O.L. (45 %), M.B. (55 %)

**CHAMPAGNE CÉRÉALES / BLETANOL**
Wheat storage site, 951 MWh/year

**BIODEMO**
Biotechnological demonstration plant with the support of EDF
Employee: 24

**E.C.O.L.E. CÉNTRALE PARIS**
Research & Development in innovative biotechnological processes

**COGENERATION BIOMASS PROJECT**
Biomass (from wood, waste...)
Employee: 15

**CHAMTOR (CHAMPAGNE CÉRÉALES GROUP)**
Wheat and bioethanol production
Employee: 113

**RAW MATERIALS: SUGAR BEEF**

**RAW MATERIALS: SUGAR BEETS, CEREAL**

**RAW MATERIALS: WHEAT, SUGAR BEET**

**RAW MATERIALS: WHEAT**

**RAW MATERIALS: SUGAR BEEF, CEREAL, ALFALFA, BIOMASS**

**RAW MATERIALS: BIOMASS**

**LEGEND**
ROADS
RAILWAY
SYNERGY

Photo credit: Chamtor
Conclusion
Large opportunities for US companies

- 22 existing biorefineries
- + 45 R&D, pilot and demo projects

- The large biomass feedstock available gives huge opportunities for implementing additional biorefineries

- In Champagne-Ardenne with:
  - over 1 million metric tons/year available now for your projects
  - an actual biorefinery
  - a dedicated cluster with committed industrial players, farmers and researchers

This new growing industry, gives unique opportunities for US companies to enter European growing bioeconomy and find the best partnerships
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