Production of advanced biofuels

Dina Bacovský, Bioenergy 2020+

Vienna, 29.9.2016
Database and interactive map

http://demoplants.bioenergy2020.eu
### Cellulosic ethanol facilities

<table>
<thead>
<tr>
<th>Company</th>
<th>Country</th>
<th>Capacity [t/y]</th>
<th>Start-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Du Pont</td>
<td>Nevada, Iowa, USA</td>
<td>83.000</td>
<td>2016</td>
</tr>
<tr>
<td>(Abengoa)</td>
<td>Hugoton, Kansas, USA</td>
<td>75.000</td>
<td>2014</td>
</tr>
<tr>
<td>POET-DSM Advanced Biofuels</td>
<td>Emmetsburg, Iowa, USA</td>
<td>75.000</td>
<td>2014</td>
</tr>
<tr>
<td>GranBio</td>
<td>Sao Miguel, Alagoas, Brazil</td>
<td>65.000</td>
<td>2014</td>
</tr>
<tr>
<td>Longlive Biotechnology</td>
<td>Yucheng, Shandong, China</td>
<td>60.000</td>
<td>2012</td>
</tr>
<tr>
<td>Beta Renewables</td>
<td>Crescentino, Piedmont, Italy</td>
<td>40.000</td>
<td>2013</td>
</tr>
<tr>
<td>Cane Technology Center (CTC)</td>
<td>Piracicaba, Sao Paulo, Brazil</td>
<td>40.000</td>
<td>2012</td>
</tr>
<tr>
<td>Raizen Energia</td>
<td>Piracicaba, Sao Paulo, Brazil</td>
<td>30.000</td>
<td>2015</td>
</tr>
<tr>
<td>Henan Tianguan Group</td>
<td>Zhenping, Henan, China</td>
<td>30.000</td>
<td>2011</td>
</tr>
<tr>
<td>Borregaard Industries AS</td>
<td>Sarpsborg, Norway</td>
<td>15.800</td>
<td>1938</td>
</tr>
</tbody>
</table>
### Facilities for gasification and pyrolysis

<table>
<thead>
<tr>
<th>Company</th>
<th>Country</th>
<th>Capacity [t/y]</th>
<th>Start-up year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fortum</td>
<td>Joensuu, Finland</td>
<td>50.000</td>
<td>2013</td>
</tr>
<tr>
<td>pyrolysis oil for use in CHP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enerkem</td>
<td>Edmonton, Alberta, Canada</td>
<td>30.000</td>
<td>2014</td>
</tr>
<tr>
<td>methanol / ethanol from MSW</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Goteborg Energi</td>
<td>Gothenburg, Sweden</td>
<td>11.200</td>
<td>2014</td>
</tr>
<tr>
<td>SNG from forest residues</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Plans announced or facilities under construction with a range of thermochemical technologies by:
- BioMCN
- Sundrop Biofuels
- Akwawit
- Gulf Coast Energy
- Virent
- Clearfuels
- Solena
- Clearfuels
- CORE Biofuel
- Fulcrum
- Cool Planet
- Vanerco (Enerkem & Greenfield Ethanol)
- Enerkem Mississippi Biofuels
- ORG

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Commercial facility in Emmetsburg, Iowa, USA

Fermentation of agricultural residues (corn stover) fermentation to ethanol, integrated into conventional corn ethanol facility

Capacity 500 000 t/y ethanol, of which 75 000 t/y cellulosic ethanol;

Started up in 2014
Total investment 250 mio USD

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Slide 5
DuPont

- Commercial facility in Nevada, Iowa, USA
- Fermentation of corn stover to ethanol
- Capacity 83,000 t/y
- Started up in 2016
Abengoa

- Facilities:
  - Pilot: York, USA; 75 t/y; since 2007
  - Demo: Babilafuente, Spain; 4,000 t/y; since 2010
  - Commercial: Hugoton, USA; 75,000 t/a; started up in 2014; Funding was 76 mio USD

- Fermentation of corn stover, wheat straw and switch grass to ethanol
  - Steam explosion
  - Enzymatic hydrolysis
  - C5 and C6 Co-Fermentation
  - Heat and power provided from biomass
Beta Renewables

- Commercial facility in Crescentino, Italy, capacity 40,000 t/year ethanol from fermentation of wheat straw, rice straw, arundo donax, poplar, started up in 2013

- Technology is also realized in the GranBio project in Brazil with a capacity of 65,000 t/year ethanol production
GoBiGas

- Gothenburg, Sweden
  - Phase 1: 11,200 t/y (20 MW), started up in 2014
  - Phase 2: 80-100 MW - cancelled
- Gasification of wood chips, methanation to produce biomethane, used for heat and electricity production
- Gasification technology developed in Austria (Repotec, Güssing)

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Folie 9
Enerkem

- Commercial facility in Edmonton, Canada
- Gasification of organic residues and waste streams with subsequent catalytic synthesis to produce methanol and/or ethanol
- Capacity 30,000 t/y
- Started up in 2014
What happened to…?

- Choren
- Range Fuels
- KiOR
- RenTech
- Lignol
- Pacific Ethanol
- New page
- Flambeau River
- Gevo
- Coskata
- …
USDOE Integrated Biorefinery Program

http://www.energy.gov/eere/bioenergy/integrated-biorefineries

Major DOE Biofuels Project Locations
Geographic, Feedstock, and Technology Diversity

Current Status of the IBR Portfolio (as of July 2013)
A total of 33 IBR projects have been awarded to date:

- 5 Complete (two still compiling final report)
- 19 Active
- 4 New Awards Under Negotiation
- 5 Mutually Terminated
- 16 produce Cellulosic Ethanol
- 12 produce Renewable Hydrocarbons
- 3 produce Algae Oil
- 2 produce Bioproducts
# NER 300 Projects
first call announcements Dec 2012

<table>
<thead>
<tr>
<th>Project</th>
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<tr>
<td>BEST</td>
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<td>28</td>
<td></td>
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<tr>
<td>CEG Plant Goswinowice</td>
<td>SEKAB</td>
<td>Poland</td>
<td>31</td>
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<tr>
<td>VERBIO Straw</td>
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<td>Ajos BTL</td>
<td>Vapo Oy</td>
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<td>UPM Stracel BTL UPM</td>
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<td>Woodspirit</td>
<td>BioMCN</td>
<td>Netherlands</td>
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<td>SEKAB</td>
<td>Poland</td>
<td>31</td>
<td>Investment decision pending</td>
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<td>Ajos BTL</td>
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<td>freezed in Feb 2014</td>
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Biofuels Policy Drivers

- Energy supply security
- Rural income
- GHG emission reduction
Biofuels Policy Drivers

- Energy supply security
  - low fossil oil prices reduce concerns over supply security and make biofuels even less competitive

- Rural income
  - food versus fuel debate: high prices for agricultural products drive food prices

- GHG emission reduction
  - sustainability debate: if not done right, biofuels may produce more GHG emissions than fossil fuels
EU Policy

  - 5.75% biofuels by 2010
- RED (2009):
  - 10% of transport fuels from RES by 2020
  - Sustainability criteria, incl. min. GHG reduction of 35% / 50% from 2017 on
- RED Amendment (2015):
  - Cap of 7% for conventional biofuels
  - Suggested 0.5% target for advanced biofuels
  - No transport specific post 2020 targets
Renewable Fuel Standard mandates volumes to be sold

Increasing from 13 billion gallons in 2010 to 36 billion gallons in 2022

Minimum GHG emission reduction is 20%
50% for advanced fuels
60% for cellulosic fuels

But:

- Development of cellulosic fuels lagging behind schedule
- Mandated volumes waived every year
USA: RFS2 mandated volumes

RFS2 volumes as mandated Feb 2010

billion gallons

- other advanced biofuel
- biomass-based diesel
- cellulosic biofuel
- unspecified biofuels

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Slide 19
USA: RFS2 revised mandated volumes

RFS2 volumes as mandated Nov 2015

- unspecified biofuels
- cellulosic biofuel
- biomass-based diesel
- other advanced biofuel
- total renewable fuel as originally published in 2010
Political Support in EU and USA has decreased

...consequently

- plans for advanced biofuel production sites move to Brazil and China
- targeted products move from biofuels to biochemicals

As to get advanced biofuels down the learning curve a stable policy environment up to 2030 is needed as to guarantee a market for biofuels and trigger the necessary investments.
Advanced biofuels learning curve

Thanks for your attention!

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