UPM BIOFUELS
Biofuels from wood-based raw materials

European Technology Platform
Biofuels for Low Carbon Transport & Energy Security
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Sari Mannonen, UPM Biofuels
UPM – The Biofore Company

UPM leads the integration of bio and forest industries into a new, sustainable and innovation-driven future

- 21,000 employees
- Sales exceeds 10 billion euros in 2013
  - Production in 17 countries
  - Worldwide sales network
  - Listed in the NASDAQ OMX Helsinki stock exchange
- UPM Biofuels is a strategic business unit of UPM Biorefining
Biofuels a key step on pulp and paper industry's transformation path towards biorefining industry

Pulp and paper industry today:
Relatively low value-adding products mostly from primary raw materials

Biorefining industry of tomorrow:
High value-adding products with all materials, including residues, processed

Woody biomass
• Logs
• Pulpwood
• Energy wood
• Recycled fibre
• Saw dust
• By-products

Sawn timber
Plywood
Pulpwood and recycled fibre
Pulp
Wood residues

End users

Energy

Labels
Hygiene products
End users

Biofuels
Biochemicals
Biocomposites
End users

Current focus areas
Future growth avenues
Wood raw material is the basis of many different businesses at UPM.
Sustainability is in the core of our operations

- Wood is a renewable and recyclable raw material
- Sustainable forest management
- Good forest management practices
- Environmentally and ecologically sound harvesting
  - State-of-the-art techniques
  - Qualified personnel
  - According to PEFC or FSC standard
  - All UPM owned forests are certified
- Certified fibre to highest possible degree and promote a global increase in the use of certified wood
- Origin of all wood is known, legal and not from high conservation value forests
- All wood supplies covered by a third-party verified chain of custody
UPM Biofuels and latest sustainability recognitions

UPM renewed its position as the industry leader in Dow Jones Sustainability Indexes for 2014-2015

Award for Breakthrough Innovation in Technology in 2013

Shortlisted in Sustainability Product Innovation category in 2013

Winner in Travelling category 2014 awarded by European Commission

Finalist in Sustainable Innovation category in the Leading Technology Award 2014
UPM Biofuels strategy

<table>
<thead>
<tr>
<th>Advanced biofuels</th>
<th>Wood-based raw materials</th>
<th>Sustainable operations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drop-in fuels fully compatible with current vehicle engines</td>
<td>Renewable wood-based raw materials not suitable for food production</td>
<td>Significantly, even 80%, less greenhouse gas emissions</td>
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UPM will be a big player in advanced biofuels market
Revenue targeting > 1 billion €/a
First step: UPM Lappeenranta Biorefinery
Key facts:
• Product: Renewable diesel
• UPM investment: 150 M€
• Capacity: 100,000 tonnes/a
• UPM Patents & Applications: 150
• Commissioning: Summer 2014
• Employment: 200 persons
• Contributes approximately 25% of Finland’s biofuel target
Raw material: Crude Tall Oil (CTO)

- Contains natural extractives of wood
- Yield 20–50 kg CTO/t pulp
- Global production > 2 000 000 t/a
  - CTO supply potential above demand globally and increasing
  - Significant share burned for energy
  - Production potential 2 600 000 t/a
- UPM tapping into underutilized lower grade CTO streams
- UPM biorefinery minor addition to total demand, no effect on demand-supply balance

Residue of pulping process

No increase in harvesting or land use

Outside food value chain

Source: Ecofys, Low ILUC assessment CTO, Pöyry
Crude Tall Oil (CTO) – a residue of pulp making process
UPM renewable diesel process

CRUDE TALL OIL
A residue of chemical pulping process containing natural extractive components of wood.

PRETREATMENT
Crude Tall Oil is purified: salts, impurities, solid particles and water are removed.

HYDROTREATMENT
Pretreated Crude Tall Oil is fed together with make-up and recycled hydrogen to the reactor where the chemical structure is modified. Reaction water is separated and directed to waste water treatment.

FRACTIONATION
Remaining hydrogen sulfide and uncondensable gases are removed. The remaining liquid is distilled to separate renewable diesel.

RENEWABLE DIESEL
High quality advanced biofuel suitable for all diesel engines.
Capturing synergies by full integration into UPM Kaukas mill site in Lappeenranta, Finland
UPM Lappeenranta biorefinery, Finland
UPM BioVerno – Renewable drop-in diesel suitable for all diesel engines

- **RENEWABLE RAW MATERIAL**: 100%
- **CO2 EMISSIONS (VS. FOSSIL FUEL)**: -80%
- **HYDROCARBON FUEL, COMPATIBLE WITH DIESEL STANDARD EN590**: 100%
Long term fleet tests completed with VTT

- Fleet testing with 20% UPM BioVerno renewable diesel with 4 Volkswagen cars
- 20,000 km/car
- Summer and winter conditions, various distances
- Independent testing by experienced test drivers of Technical Research Centre of Finland (VTT)
- Investigating fuel functionality in engine, emissions and fuel consumption
  - Functions as fossil diesel
- Phase 2: heavy duty vehicles test (busses)
UPM Biofuels
Growth Strategy and
Competitive Edge
UPM Biofuels growth strategy

**ENTERING BUSINESS**
- HYDROTREATMENT
  - Tall oil → UPM Lappeenranta Biorefinery start-up 2014

**EXPANDING BUSINESS**
- THERMAL CONVERSION
  - Solid wood materials → Gasification (BtL) /Pyrolysis

**GROWTH OF BUSINESS**
- FUTURE DEVELOPMENT
  - New technologies, processes & raw materials
  - R&D activities & co-operation with strategic partners

Products are drop-in hydrocarbons – Ready components for commercial blends
UPM is in an excellent competitive position to integrate processes for new bioproducts

Three areas of competence bring UPM in the position to become the frontrunner in new biomass based innovations

1) Access, management and sourcing of biomass

2) Processes of biomass conversion

3) Run sustainably large industrial processes

**Biomass handling**
- Debarking
- Saw mills
- Mechanical pulping

**Chemical processes**
- Kraft pulping
- Renewable diesel production

**Bioenergy & Infrastructure**
- Biomass boilers
- CHP
- Water treatment

Core competences of chemical companies
UPM's competitive edge in biofuels

<table>
<thead>
<tr>
<th>Competitive raw-material</th>
<th>Efficient process</th>
<th>High quality product</th>
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| • Part of the UPM ecosystem  
  • Optimise wood fractions to right products  
  • Steady supply  
  • Outside food value chain  
  • No indirect land-use change  
  • Meets sustainability criteria | • Technology based on UPM and partner’s innovations & know-how  
  • Efficient use of raw material  
  • Integrate synergies  
    • Industrial infrastructure  
    • Energy | • 2nd generation hydrocarbons  
  • Compatible with current fleet and standards  
  • 80% reduction in greenhouse gas emissions  
  • High energy content  
  • No blend wall limitations |
Driver’s seat in advanced biofuels