ANDRITZ PULP & PAPER – focus on biomass
Market drivers, technologies, and products
ANDRITZ Capital Market Days 2009

Contents

- ANDRITZ PULP & PAPER – overview
  - Biomass and market drivers
  - ANDRITZ’s products in biomass
  - Summary and conclusions
# Full line supplier

**ANDRITZ PULP & PAPER business lines**

<table>
<thead>
<tr>
<th>Customers</th>
<th>Main products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulp mills</td>
<td>Complete lines for chemical, mechanical, and recycled fiber production.</td>
</tr>
<tr>
<td>Paper mills</td>
<td>- Complete lines for tissue and board.</td>
</tr>
<tr>
<td></td>
<td>- Stock preparation and approach flow.</td>
</tr>
<tr>
<td>Power generating industry</td>
<td>- Bubbling fluidized bed boilers for bio-fuels.</td>
</tr>
<tr>
<td></td>
<td>- Biomass gasifiers</td>
</tr>
</tbody>
</table>
Processes and equipment
Full line capability

Chemical pulp
- Cooking
- Washing
- Screening
- Bleaching
- Dewatering
- Drying
- Baling
- Palletizing

Market pulp

Wood yard

Chemical recovery

Mechanical pulp
- Refining
- Bleaching
- Dewatering
- Drying

Market pulp

Palletizing

Recycled fibers
- Pulping
- Deinking
- Screening/Cleaning
- Washing/Bleaching
- Dewatering
- Drying
- Baling
- Palletizing

Market DIP

Service
incl. engineered wear products, upgrades, modernizations, maintenance packages, automation solutions, etc.

processes offered by ANDRITZ
**Strong growth through organic expansion and acquisitions**

Focus: complementary products, technologies, and businesses

<table>
<thead>
<tr>
<th>Acquisitions</th>
<th>Sales ANDRITZ PULP &amp; PAPER (MEUR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990 Sprout-Bauer</td>
<td>329</td>
</tr>
<tr>
<td>1992 Durametal</td>
<td>719</td>
</tr>
<tr>
<td>1994 Kone Wood</td>
<td>883</td>
</tr>
<tr>
<td>1998 Kvaerner Hymac</td>
<td>672</td>
</tr>
<tr>
<td>1999 Winberg</td>
<td>810</td>
</tr>
<tr>
<td>2000 Ahlstrom Machinery</td>
<td>885</td>
</tr>
<tr>
<td>2000 Lamb Baling Line</td>
<td>1,033</td>
</tr>
<tr>
<td>2000 Voith Andritz Tissue LLC (JV)</td>
<td>1,304</td>
</tr>
<tr>
<td>2002 ABB Drying</td>
<td>1,462</td>
</tr>
<tr>
<td>2002 IDEAS Simulation</td>
<td>1,327</td>
</tr>
<tr>
<td>2003 Acutest Oy</td>
<td></td>
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<tr>
<td>2003 Fiedler</td>
<td></td>
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<tr>
<td>2004 EMS (JV)</td>
<td></td>
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<tr>
<td>2005 Cybermetrics</td>
<td></td>
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<tr>
<td>2005 Universal Dynamics Group</td>
<td></td>
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<tr>
<td>2006 Küsters</td>
<td></td>
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<td>2006 Pilão</td>
<td></td>
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<tr>
<td>2007 Bachofen + Meier</td>
<td></td>
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<tr>
<td>2007 Sindus</td>
<td></td>
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<tr>
<td>2008 Kufferath</td>
<td></td>
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<tr>
<td>2009 Rollteck</td>
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</tr>
</tbody>
</table>
Long-term development of profitability

Decline in profitability from 2004 to 2008 mainly due to:

- decline of service sales as % of total business area’s sales – resulting from the strong growth of the capital business and
- investments in expansion of product scope (board machine, biomass power boiler, etc.).

Average EBITA margin 1999-2003: 5.6%
Average EBITA margin 2004-2008: 6.1%

* excluding restructuring
Global presence of ANDRITZ PULP & PAPER

Sales by region 2008

- Europe: 41%
- Asia: 20%
- South America: 17%
- North America: 13%
- Others: 8%

Employees by region 2008 (5,102 employees as of end of 2008)

- Europe: 61%
- North America: 18%
- South America: 12%
- Asia: 9%
Important ANDRITZ PULP & PAPER references at a glance

ANDRITZ is also engaged in the maintenance of most of these mills.
VCP – Votorantim Celulose e Papel, Brazil
World’s largest single-line pulp mill (1.3 mill. t/a pulp production)

- Start-up in March 2009.
- Complete fiberline from digester to finished bales.
- Complete white liquor production plant.
Hunan Tiger Forest & Paper Group Co., Ltd., China
400,000 t/a pulp production

- Start-up August 2008.
- Softwood pulp production.
- Andritz’s scope of supply comprises:
  - wood handling
  - cooking
  - washing
  - screening and bleaching
  - pulp drying and bale handling
  - chemical recovery boiler and evaporation,
  - lime kiln and recausticizing.
Chenming Zhanjiang, China
700,000 t/a pulp production

- Start-up 2011.
- Hardwood pulp production.
- Andritz’s scope of supply comprises:
  - wood handling
  - cooking
  - washing
  - screening and bleaching
  - pulp drying and bale handling
  - chemical recovery boiler and evaporation
  - lime kiln and recausticizing.
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Biomass – what is it?

Woody/tree crops
- Wood chips, HW and SW-residual (birch, poplar, eucalyptus, etc.).
- Engineered high efficiency wood-crops (hybrid poplar, shrub willow, etc.).

Cereals
- Corn stover/stalks, cobs and corn fiber.
- Wheat and barely straws.

Sugar crop residual
- Sugar cane and energy cane bagasse.
- Sweet sorghum residual.

Forages & grasses
- Switch grass (panicum virgatum) and other prairie grasses.
- Alfalfa.
- Jose tall wheat grass, wild rye, bermuda grass (cynodon dactylon), bahia grass (paspalum notatum), napier grass (pennisetum purpureum).
- Miscanthus, arundo donax (giant reed) and other high yielding grasses.
Ways of converting biomass into heat/electricity and fuels

Solid biomass
- Thermo-chemical conversion
  - Pelletising
  - Gasification
- Bio-chemical conversion
  - Pyrolysis
  - Fermentation of starch based Biomass
  - Pretreatment fermentation of cellulosic Biomass
- Mechanical-chemical conversion
  - Pressing of oil out of seeds and oil rich plant + conversion

- Power boiler
- Heating warm water
- Integrated gasification combined cycle
- Synthetic natural gas
- Bio-Diesel
- Pretreatment fermentation of cellulosic Biomass
- Dimethylether
- Pyrolysis oil
- Power boiler
- Biofuel
- Fischer-Tropsch
- Bio-Diesel 1st generation
- Bio-Ethanol 1st generation
- Bio-Ethanol 2nd generation
- Bio-Diesel 1st generation
- Biofuel

Process offered by ANDRITZ

Market expectations
Driving forces for increased use of biomass

- Fast growing energy demand worldwide.
- Biomass is highly competitive.
- The need for renewable carbon sources in the chemical and metal industry will be in addition to the huge need for renewable energy.
- The costs for CO₂ emissions (and other emissions) will be high.
- Growing environmental regulations and implementation of support mechanisms.
- Future supply and costs for fossil carbon sources (biomass the only viable alternative).
- Technology for biomass conversion show a fast development and biomass productivity is also possible to increase considerably, this will bring the costs down drastically for biomass based products.
- The reserves of coal and biomass are in more political “secure areas”.

Drivers for production of renewable fuels out of biomass

- **Climate change:** need for reduction of greenhouse gases.

- **US Energy Independence and Security Act of 2007:**
  Increase production of renewable fuels from 4.0 billion gallons to 36.0 billion gallons by 2022; thereof, 21 billion gallons to be derived from non corn starch products → this would mean approximately 350 plants for 2nd generation ethanol production (each plant: 200,000 m³ ethanol/y).

- **EU target by 2020:**
  - 20% renewable out of total energy consumption.
  - 10% renewable for transport fuel out of total fuel consumption.
Ambitious targets of the European Union

Final energy consumption EU-25, 2020, TWh
100% = 15,000 TWh

Source: Renewable energy road map, Commission of the European Communities, 2007
Fuel tax credits in the USA and Canada

Government backed incentive programs to stimulate investments

- **Canada: “Green transformation program”**
  - 0.16 CAD/liter black liquor fired – max. 1 billion USD.
  - Funds must be spent during next three years for energy efficiency improvements, upgrades, and new equipment for energy.
  - 24 mills are eligible for funding.

- **USA: Black Liquor Credit expires at the end of 2009**
  - 0.13 USD/liter of alternative fuel used in producing an alternative fuel mixture.
  - As a result, US companies receive ~175 USD/t of pulp or paper produced, representing ~50% of manufacturing cash costs.
  - Total spending: 6-7 bn. USD/a.

- **BCAP credit: will start January 1, 2010**
  - Biomass Crop Assistance Program allows to get subsidy for biomass being used in energy production; pulp and paper industry can take benefits out of that.
  - Program pays suppliers of biomass to approved facilities 45 USD per ton of dried material.
  - RISI has calculated that this tax credit is around 50 USD per ton of pulp:
    - for kraft pulp mills annual subsidy 2.4 billion USD
    - for non-kraft mills 140 million USD
    - for lumber mills 1.3 billion USD
    - other wood industry 200 million USD
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  - 2\textsuperscript{nd} generation biofuels
  - Gasification
  - Pelletizing
- Summary and conclusions
Pulp mill – biomass conversion into pulp and energy

The process
Example
Recovery island

Recovery island incl. biomass boiler for pulp mill with capacity of 1 mill. t/a:
- Recovery efficiency of chemicals: 98%.
- Green electricity produced: 160 MW.
- Excess power generation: up to 80 MW recovery boiler.
- Investment in recovery boiler: ~150 MEUR.
- Investment power boiler: ~50 MEUR.
ANDRITZ biomass boilers
New business with technology for green electricity markets

- Driver: high feed in tariffs in different countries depending on local legislation.
- Market outlook very good for Europe and US.
Growing reference base for green energy production
First boilers in operation

Total order intake of the following orders more than 140 MEUR:

Ence Navia, Spain, start-up 2008:
- steam flow 120 t/h
- power output 30 MWe

Ence Huelva, Spain, start-up 2010:
- steam flow 195 t/h
- power output 50 MWe

Portucel Cacia, Portugal, start-up 2009:
- steam flow 58 t/h
- power output 15 MWe

Portucel Setubal, Portugal, start-up 2009:
- steam flow 58 t/h
- power output 15 MWe

CHP plant in Estonia, start-up 2010:
- steam flow 94 t/h
- power output 18 MWe
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Why ANDRITZ focuses on 2nd generation biofuels?

- Only 2nd generation biofuels fulfill the ultimate goal to cut green house gas emissions substantially:
  - availability of raw material,
  - CO₂-efficiency,
  - no competition with food.

- Strong believe only in processes with highest efficiency and lowest investment cost supported by clear demand for those final products.

- Deep insight knowledge of entire process chain – from raw material handling up to the final product.

- Able to build large scale equipment and processes to achieve economies of scale.
Ethanol production
Comparison 1\textsuperscript{st} and 2\textsuperscript{nd} generation

New challenges producing cellulosic ethanol vs. corn ethanol:
Cellulosic ethanol vs. corn ethanol

Positive Energy Balance

Corn Ethanol: 1.5 Units of Energy
Cellulosic Ethanol: 5.5 Units of Energy

95% less GHG Emissions

Gasoline: 24.6
Corn Ethanol: 12.3
Cellulosic Ethanol: 1.2

Pounds of CO₂ Equivalent


From biomass to ethanol

Biomass
- Wood chips
- Grasses
- Agrarian residuals

Hydrolysis
- Pre-hydro (Dil. Acid)
- SteamEx PreTreatment
  (some hemi’s dissolved)

CO₂

Ethanol

Lignin
ANDRITZ’s expertise in 2\textsuperscript{nd} generation fuels

Patents, pilot plants, and test laboratory

- Development of pretreatment system ready and several patents filed:
  - Sold six pilot plants based on ANDRITZ patents to leaders in the industry.

- Own test laboratory in full operation:
  - 1,900 m\textsuperscript{2} laboratory facility opened in 1991.
  - Offering “contract” lab services to customers.
  - Pulping and biofuel R&D, fiberline process and product engineers.

- Offering semi and full scale plants to major players in ethanol industry.
ANDRITZ bio-ethanol process

- Feedstock handling
  - Pre-hydrolysis
    - Washing
      - Steam explosion
        - C6
        - Enzymatic hydrolysis
          - Fermentation
            - Distillation
              - Separation
                - Lignin
                  - Dehydration
                    - Ethanol
                      - Power boiler
                        - Power

- C5
  - Enzymatic hydrolysis
  - Fermentation
  - Distillation
  - Separation
    - Evaporation?
  - Power boiler
    - Power

ANDRITZ core competence
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- Summary and conclusions
## Biomass gasification

### Technology alternatives

<table>
<thead>
<tr>
<th>Fixed bed</th>
<th>Bubbling fluidized bed</th>
<th>Circulating fluidized bed</th>
</tr>
</thead>
</table>

![Fixed bed diagram](image1.png)

![Bubbling fluidized bed diagram](image2.png)

![Circulating fluidized bed diagram](image3.png)
### Biomass gasifier applications

<table>
<thead>
<tr>
<th>Fuel gas for kilns</th>
<th>Co-generation (gas engine)</th>
<th>(Co-)firing (boiler)</th>
<th>IGCC (gas turbine)</th>
<th>Syngas production</th>
</tr>
</thead>
<tbody>
<tr>
<td>• 10-60 MWth.</td>
<td>• 10-50 MWth.</td>
<td>• 20-150 MWth.</td>
<td>• 10-50MWth.</td>
<td>• 150 MWth.</td>
</tr>
<tr>
<td>• Atmospheric CFB (BFB could be used as well).</td>
<td>• Low pressure BFB.</td>
<td>• Atmospheric CFB.</td>
<td>• Pressurized BFB or CFB.</td>
<td></td>
</tr>
<tr>
<td>• Electricity by gas engine units.</td>
<td></td>
<td></td>
<td></td>
<td>• Development phase.</td>
</tr>
</tbody>
</table>

- **Pulp and paper and cement industries**
- **Municipal utilities**
- **Utilities and all industries with large fossil fuel fired boilers**
- **Utilities and industries who aim for new mid-size power plant with max power**
- **BTL producers (P&P & others) and utilities**

**Green power**
UPM – Biofuel To Liquid (BTL) project

- UPM-Kymmene is one of the leading global forestry companies.
- UPM announced in October 2006 that it prepares to become a significant producer of renewable biofuels, like biodiesel.
- UPM, ANDRITZ and Carbona cooperate on the development of the technology for biomass gasification and synthesis gas cleanup for bio-liquids production.
- The pilot plant of the Gas Technology Institute in Chicago is used for oxygen gasification/gas cleanup testing and development.
- Gasification of different forest biomass types and related gas yield and quality has been verified.
- Design data for scale-up and process integration has been accomplished.
- Operation parameters for the full scale plant have been generated.
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  - Gasification
  - **Pelletizing**

- Summary and conclusions
Development of global wood pellet market

Strong growth expected

- 18% growth p.a.
- 25% growth after 2010

Other projections (2020):
- Essent 142 mill. t/a
- Rotterdam Port 130 mill. t/a
- AEBIOM 150 mill. t/a

Source: ProPellets analysis 2008 + presentations by Essent, Rotterdam Port & AEBIOM
Drivers for growth of pellet consumption

The current pellets are excellent feedstock for co-firing with coal, dedicated biomass powered plants, and residential heating.

**Opportunities for ANDRITZ:**
- Clear trend to large scale pelletizing plants (500,000-1,000,000 t/a).
- ANDRITZ only company worldwide who is able to offer complete turnkey plants based on own technology.
Well proven technologies
ANDRITZ – global market leader in wood pelleting plants

- Global installed base is about 440 wood based pellet production plants.

- ANDRITZ has supplied equipment to more than 250 of these wood pelleting plants.

- Half of the global production of wood pellets is produced by ANDRITZ machines.
Example: pellet mill, confidential customer

Capacity of 1,000,000 t/a

Woodroom
- 2,400,000 m³ wood/a
- debarking 2 x 190 m³/h

Pellet production
- 125 t/h
- 36 pellet machines

Drying
- 4 x 31 t/h

Bark pile

Chip silo 10,000 m³

Complete ANDRITZ pellet plant with clear responsibilities
Preparation of raw material for drying/pelleting

- Cleaning
- Debarking
- Chipping
- Screening
- Storing
- Mixing and dozing to drying

Wood infeed (softwood & hardwood)

Excellent “pellet chip” quality is produced by the HHQ-Chipper™
Drying
Preparation/refining of biomass for further usage

- 35-50% dry solids.
- Low heating value.
- Biological active.

Drying systems

- >60-97% dry solids.
- Free flowing.
- Increased heating value.
- Biological stable.
- Reduced bulk density.

Dry product
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- Summary and conclusions
Summary and conclusions

**Biomass market**

- Strong market growth to continue due to growing stringent environmental regulations and support mechanisms from various governments.

- Fast growth of technology for biomass conversion will increase competitiveness of biomass based products.

- Growing project activity for biomass and recovery boiler expected during the next few years.

**ANDRITZ strategy**

- Expand product portfolio for bio-boiler markets.

- Further expand and grow new markets (gasification, complete pelletizing plants).

- Develop full line competence in 2nd generation biofuels.
Disclaimer

Certain statements contained in this presentation constitute ‘forward-looking statements.’ These statements, which contain the words 'believe', 'intend', 'expect’ and words of similar meaning, reflect management’s beliefs and expectations and are subject to risks and uncertainties that may cause actual results to differ materially.

As a result, readers are cautioned not to place undue reliance on such forward-looking statements. The Company disclaims any obligation to publicly announce the result of any revisions to the forward-looking statements made herein, except where it would be required to do so under applicable law.

Note: 2008 figures restated.