Opportunities for the pulp and paper industry to recovery energy from residues: industrial symbiosis with biogas as the hub

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Mission:

Scandinavian Biogas mission is to contribute to and facilitate the transition from fossil fuel to renewable energy
Scandinavian Biogas in brief

• Founded in December 2005
• Former Prime Minister of Sweden Göran Persson as Chairman of the Board
• Globally leading ability to prove and optimize concepts in both laboratory, pilot- and full scale.

• Head office in Stockholm
• Waste management and Biogas production in Sweden, Norway and Korea
• R&D and Process Department at Linköping University
• 70+ employees – specialists in biogas processes and technology
## Current plants in SBF portfolio

<table>
<thead>
<tr>
<th>Projects running</th>
<th>Client / Partner</th>
<th>Substrate</th>
<th>Production GWh/y (est.)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Henriksdal</td>
<td>Stockholm Vatten: SE</td>
<td>Sewage sludge, EOM</td>
<td>100 – (200)</td>
<td>Well functioning plant with proven technology. Extended 2015-16 with 3rd up-grading line and EOM dosing</td>
</tr>
<tr>
<td>Södertörn</td>
<td>SRV: Stockholm, SE</td>
<td>Food waste</td>
<td>75 – (85)</td>
<td>Launched in Aug 2015. Top of the line process solutions with off-the-shelf hardware. HOLD concept based</td>
</tr>
<tr>
<td>Ulsan</td>
<td>City of Ulsan: Korea</td>
<td>Sludge and food waste</td>
<td>61 (60)</td>
<td>Well functioning plant. Appointed to be the best food waste based biogas plant in Korea.</td>
</tr>
<tr>
<td>Trondheim</td>
<td>Skogn: Trondheim, NO</td>
<td>Fish waste, slaughter waste, paper mill sludge</td>
<td>95 (125)</td>
<td>Project have CSTR for fish farming waste and ECSB for pulp and paper process water. Liquefied methane for sale. HOLD concept based</td>
</tr>
</tbody>
</table>
Scandinavian Biogas - 2019 Group performance

352 GWh
Group sales 2019

198 ktonnes
Organic waste handled 2019

95 ktonnes
CO₂ reduction 2019
Industrial symbiosis engages diverse organisations in a network to foster eco-innovation and long-term culture change.

Lombardi and Laybourn, 2012
Possible opportunities for symbiosis with a mill

- Biogas up-grading
- Process heat

Biogas substrates
- $\text{H}_2$ and CO (syngas)
- Fed directly to digesters

Dewatering

Steam (6 bar)
Hot water 60-80°C
Bark and fibers

Process water
Bio-sludge
Methanol
Fibers

Heating other industries
District heating
CHP
Pellets to sell
Soil improver
Biodiesel
Possible connections

- Biogas
- Liquid digestate
  - Centrifuge accept (cake)
  - Nutritious rejected water

Vehicle fuel
- Process water treatment
  - Electricity consumption
  - Need for Nitrogen and Phosphorous

Internal substrates possible for biogas production on a generic mill are currently not big enough for industrial scale biogas production – 20-40 GWh.

However – the addition of such biogas to another biogas plant can be synergetic!
Biogas production at PPI – End users

**Internal:**
- Heat and power production
  - Boilers with environmental restrictions
- Replacement of fossil fuel
  - IR-drying of coating
- Vehicle fuel
  - Used for own vehicles

**External:**
- Vehicle fuel
  - Up-graded and sold on the market
  - Raw gas sales to gas company for upgrading to vehicle fuel
- Green gas
  - Up-graded and injected to gas grid as green gas
Traditional treatment of process water streams at PPI

Process water from factory → Pre-sedimentation → Waste activated sludge → Recipient

Pre-sedimentation → Sludge tank → Bio sludge

Fiber sludge → Sludge dewatering → Sludge cake to incineration or compost

Rejected water → Sludge dewatering
Possible treatment of process water streams at PPI

Example 1

- Process water from factory
- Pre-sedimentation
- Fiber sludge
- Sludge tank
- Sludge dewatering
- Sludge cake to Incineration or compost
- Biogas
  - UASB
  - CSTR
- Waste activated sludge
- Bio sludge
- CSTR
- Internal substrates: Methanol, Fibers
- Recipient

Rejected water
Possible treatment of process water streams at PPI

Example 2

Process water from factory → Pre-sedimentation → UASB or CSTR → Waste activated sludge → Recipient

- Fiber sludge
  - Sludge tank
    - Sludge dewatering
      - Rejected water
      - Biogas
        - Internal substrates: Methanol, Fibers
        - External substrates: Cow manure, Food waste, Ley crops, Fish waste etc.

- Bio sludge
  - Sludge tank
  - CSTR
  - Biogas

- Liquid digestate to fertilizer
- Sludge cake to fertilizer

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An example of industrial symbiosis between biogas production and pulp and paper industry
Skogn site - Norway

June 2014

Pulp and Paper mill area

AD plant for LBG

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2011
Project started with agreements and lab scale reactors

2015
Ground work started

2016-2017
Engineering work
2018

June
Inoculation CSTRs

July
Start-up operation

September
First delivery of LBG

November
Start-up of ECSB
NS AEROBIC BASIN
(33 000 m³)
(Activated Sludge Treatment)

NS SECONDARY sedimentation

ECSB units
(4 000 m³)
treating effluents from first sedimentation

CSTR digesters
(13 000 m³)
treating WAS and fish waste

LBG storage
(350 m³)
and gas upgrading

SECONDARY digester + GAS HOLDER

STORAGE TANKS (6X)
for fish silage and substrate

EVAPORATION
for part of the rejected water

NS SECONDARY sedimentation
Original idea of integration of Biokraft at the Skogn site

- Pre-sedimentation
- ECSB
- Aeration
- Post-sedimentation
- Recipient
- Biokraft
- Substrate containers
- Digesters
- Gas-upgrading
- Liquid methane (LBG)
- Bioslam
- Biogass
- N-rikt filtrat
- Solid biofertilizer
- Liquid biofertilizer
Treated volume of fish waste
\( \sim 41\,000\) ton per year
LBG is transported from the site to final users

About 9000 tons (12 million Nm\(^3\)) of methane per year:
2-3 trucks per day (appr. 18 ton load).
Mill’s WWTP – Today (mass balance)

20 000 m$^3$/d

Nitrogen and Phosphorous

1 ton/d as Urea
120 kg/d as Phosphoric acid

40 ton/d as sCOD

45-50 MWh/d for the WWTP (ca. 60% from aeration)

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Mill’s WWT – EffiSludge (mass balance)

- **Wastewater paper mill**: 20 000 m³/d
- **Primary clarifier**
- **Neutralization basin**: Reduced Nitrogen and Phosphorous
- **AD (UASB)**: (50% sCOD reduced) 0 ton/d as Urea, 95 kg/d as Phosphoric acid
- **Secondary clarifier**: RAS WAS
- **Gas upgrading**: 50 000 Nm³/d as Biogas
- **AD (CSTR)**: 25 ton/d as sCOD
- **Evaporation**: 150 m³/d Rejected water (N) 50 ton/d
- **Dewatering**
- **Sludge tank**
- **Incineration**: 28 MWh/d for the WWTP
- **Fertilizer**: 0 ton/d as Urea, 95 kg/d as Phosphoric acid
- **Dewatering Fertilizer**: 280 m³/d (3-4 %TS)
- **Evaporation**: 115 m³/d (30-35% TS) FISH WASTE
Urea dosing (m³/day)

80-90% saving!
Ongoing project linked to the Skogn site

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A cooperation between

Scandinavian biogas
BIOKRAFT
Norske Skog

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Thanks for the attention!

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