Upscaling of New Processes
- Challenges and Opportunities

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Driving Forces Towards a Biobased Economy

- Fossil independence - security of supply
- Climate change
- Increased competitiveness and earnings in the forest industry
- Legal requirements, e.g. on biofuel
Vision
SP shall be a uniting force and a central resource contributing with knowledge, research resources, test facilities and coordination of bioeconomy initiatives in Sweden.
Examples Forest Based Products and Suggested Maturity

Legend
- Cellulose Based
- Lignin Based
- Extractive Based

Technical Maturity
- Viscose
- Pulp and Paper
- Lignosulfonate
- Vanillin
- Tall Oil Diesel
- Tall Oil Resin
- Sulphite Ethanol

Commercial Maturity
- Cellulosic Ethanol
- Lactic Acid
- Diesel & Petrol
- Aromatics
- Furan Derivatives
- Cellulosic Butanol (ABE)
- Single Cell Protein
- Citric Acid
- Lipids from Fermentation
- DME
- Succinic Acid
Upscaling - who should pay?

Source: Sustainable Technology Development Canada
International Benchmark on Upscaling

International benchmark on the share of basic, applied and development activities

Örnsköldsvik: 2G Ethanol Demo Plant ➔ SP Biorefinery Demo

Past
• Operated since 2004 - 8 years experience
• Fully integrated 2G EtOH demo
• Operated by a company

Present
• Using accumulated experience for customers
• Multi-feedstock, multi-product demonstrator
• New business model: Open research environment operated by a neutral, independent institute
• Increased customer base, industry, SME, universities, institutes – national and international
• Demonstration and production
• Reinforced by acquisition of Processum
• Economy in balance
Feedstock and End Product Flexibility

Examples of raw materials:
- Wood chips
- Spruce
- Pine
- Poplar
- Tops and branches
- Pulp fibres
- Wheat
- Straw
- Energy crops
- Algae

Examples of products:
- Biogas
- Ethanol
- Butanol
- Lactic acid
- Succinic acid
- Citric acid
- SCP
- Yeast
- Amino acids
- Enzymes
- Lignin
- Hemicellulose
Company Overview

• Two sophisticated refineries (Lyseki and Gothenburg) with total capacity of 18 million m3 per year
• Focus on producing high quality value-added “green” transportation fuels
• Biggest refiner in the Nordic region with 30% of total refining capacity and 80% in Sweden
• In Sweden we supply energy and fuel equivalent to 15% of the country's total energy consumption
• About 50% of all refined products sold in Sweden are produced by Preem
• Two thirds of the production are exported - Preem is one of Sweden's largest exporters
• Highly regarded shipping regulations

• Preem has about 1300 employees
• About 3400 are working within the Preem brand
Reflections on Renewable fuels

Who will use it?

More expensive than fossil

Limited availability

Housekeeping with resources

Mandatory inblending

Tax Incentives

Spectra of Solutions needed

Still need of fossil transportation fuel?

Focus on Feedstocks, Waste and Byproducts

Focus on Energy efficiency

Focus on Productivity
Tall Oil to Diesel

• **Reason for using CTO:**
  – Demand for increased production of renewable fuels not involved in the — food versus fuel debate.
  – Local origin of raw material
  – Extrem high GHG reduction and energy efficiency
  – Infrastructure in an ordinary oil-refinery can be used.

• Cooperation between academy and industry
• Research and development in new environmental technologies including export of knowledge and products
• Moore renewable production in the refinery sector (license to operate)
• Increased cooperation for different sectors involved in road transport
Production of second generation biofuels

Talloil Diesel Process Steps

- **SunPine** - Production of Raw Talloil Diesel RTD from crude Talloil. Preem one of four part owners.

- **GHT** - Hydrogenation of crude talloil diesel to renewable hydrogenated biodiesel in Preem refinery Gothenburg

  - Investment 290 MSEK in PRG in stage 1
  - Throughput 100 000 m3/year in stage 1

Was in operation May 2010
CTO is a residue extracted from black liquor in a pulp mill.
SunPine refines CTO to a fatty acid called crude talloil diesel
In the rebuilt Preem refinery in Gothenborg Sulphur, Oxygen and Aromatics are removed, creating a renewable diesel structure identical as if based on fossil crude oil.
Production of Evolution MK1 Diesel

Campaign 1

RTD

LLGO ex CDU

GHT
HDS, HDN, HDO

GHT product
MK3

Campaign 2

Synsat
HDS, HDA

LLGO ex CDU

Evolution MK1
New Biofuels from Lignin

- Next: Finding new production pathways and new renewable base material for an increased production of renewable gasoline and diesel
- Possible new pathway might be based on lignin extracted from black liquor in a pulp mill
- Advantage: available in enough quantities for Sweden, with the same advantages as CTO – however lignin is not used today for other purpose than creating heat and electricity in a boiler at the pulp mill – i.e. low value
- Production costs for this process is estimated to be low compared to other processes based on black liquor for making fuels
Pyrolysis Oil

- Pyrolysis oil can be used in a refinery if – new production processes for pyrolysis oil is developed
- The molecule structure makes pyrolysis oil not suitable for ordinary hydro treating plants, pyrolysis oil has to be processed in a hydrocracker or FCC unit.
- Advantage: low cost raw material – GROT and the same advantage as for CTO and lignin
- Disadvantage: high processing cost for converting the oil into standard fuels
New Opportunities for Financing of Fuel Plants from Pulp and Forest Industry ds

- A new proposition for financing will be communicated within the FFF investigation - making it possible to both finance the investment as well as the production of renewables, based on special interest raw material
- The idea is to find a process making it possible to avoid state aid discussions
The future is Identical Gasoline and Diesel molecules, as if based upon fossil crude oil, produced from accepted renewable feedstock's
Convergence of Industries