

VärmlandsMetanol Ltd founded in 2001



The bioMethanol plant, with Hagfors in the background strategically located in the forest rich county of Värmland

Photo: Lars Nilsson Photomontage: Structor, Örebro

Methanol from wood - an excellent fossil free motor fuel!

An urgent, sustainable industrial project

VärmlandsMetanol Ltd intends to build and operate the **world's first commercial biomass-to-methanol plant** in Hagfors, Sweden.

VärmlandsMetanol will gasify forest biomass residues and produce syngas into fuel grade methanol — a sustainable motor fuel with excellent fuel properties, which can be blended into gasoline and used in all gasoline engines.

ThyssenKrupp Industrial Solutions, (TKIS, former Uhde) has been selected as a technology and EPC contractor for the entire plant.

Annual production **130 000 m³** fuel grade methanol.

Forest residues — a sustainable "Swedish oil-well" that won't run dry

www.varmlandsmetanol.se

VärmlandsMetanol Ltd, Postbox 61, SE-683 22 Hagfors, Sweden

VärmlandsMetanol Ltd is a public company - shareholders are registered by Euroclear.

History

VärmlandsMetanol Ltd was founded in 2001 by Dr Björn O. Gillberg and the Miljöcentrum Foundation. The initial purpose was to build and operate a pilot plant (20 MWth) producing methanol, district heating and electricity from forest biomass using gasification technology. The objective was to demonstrate the great potential of gasification technology and to create a research and development centre for large-scale bioMethanol production.

Based on research and two pre-feasibility studies the company decided in 2006 to build a full-scale commercial plant of 111 MWth that would have a production capacity of 130 000 m³/year fuel grade methanol.

In 2007 VärmlandsMetanol Ltd became a public company. It is today owned by the Miljöcentrum Foundation, the Municipality of Hagfors, the Swedish Federation of Farmers, TRB (an umbrella organization for the 12 largest haulage contractors in Sweden), 1 800 private persons and 60 small companies.

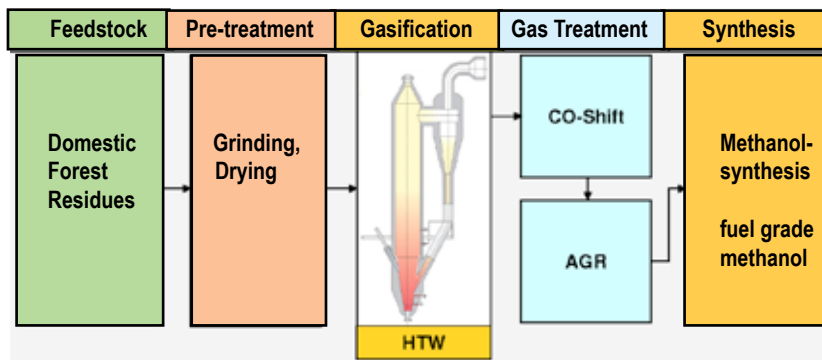
ThyssenKrupp Industrial Solutions (TKIS), a world leading engineering contractor, has been selected as technology

supplier and engineering partner for the project. An Engineering, Procurement and Construction (EPC) contract will be applied with a cost, time, quality and performance guarantee. TKIS' list of references includes over 100 gasifiers worldwide based on different gasification technologies covering a variety of feedstock.

The business plan is to produce and sell bioMethanol as low blend admixture in 95-octane unleaded petrol. Present day gasoline engines and distribution systems can handle a mixture of this kind without modifications, or additional costs for distribution. A primary business objective is to develop a "turnkey" concept and build additional plants (for the production of bioMethanol) in Sweden and also export the concept to other forest rich countries.

As part of this plan, VärmlandsMetanol together with E.ON Gasification Development AB, PEAB, SAKAB AB and the Municipality of Kumla and have completed a pre-feasibility concept study for a biorefinery, output 250 MW bioMethane and bioMethanol as well as 50 MW district heating.

Integrated Process Chain for the Production of Bio-Methanol



Facts about the plant

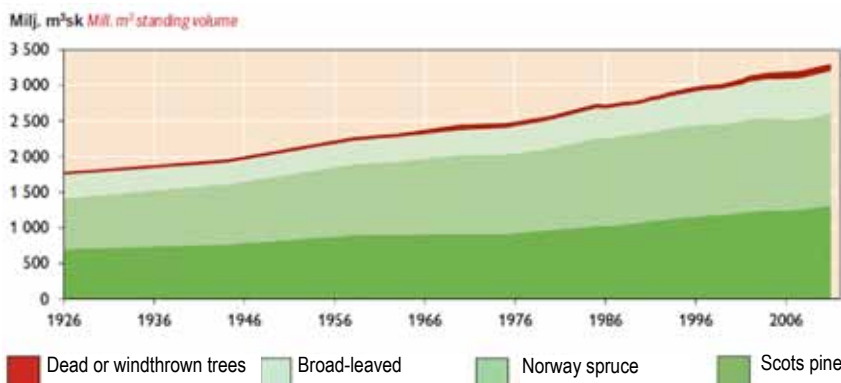
- Required capital - € 350 million
- Raised 50/50 private placements and bank loans
- ThyssenKrupp Industrial Solutions engaged on EPC-base
- Three years construction time
- Input 1 100 tonnes forest residues /day (35 trucks /day)
- Output 375 000 litres methanol /day (12 trucks /day)
- About 700 jobs during three years construction
- About 50 permanent jobs at the plant
- About 50 permanent jobs in connection

The process is "fed" with sustainable forest residues that is chipped, dried and processed to wood pellets. The wood pellets are converted to raw gas in the gasifier. In the next step the raw gas is purified and adjusted to the correct relation carbon dioxide/hydrogen used for the synthesis of fuel grade bio-Methanol. The gasification takes place at high temperature, high pressure and reduced oxygen feeding. The integrated process generates waste heat that is used for drying the feedstock. The only by-products are wood ash and slightly polluted waste water.

The mineral rich wood ash will be returned to forest land where it belongs. The slightly polluted waste water can/will be treated in the local sewage treatment works.

The gasification technology can be used for production of methanol, ethanol or gasoline from wood. The highest energy efficiency at the lowest cost is achieved producing methanol. About fifty plants of VärmlandsMetanols size will cover Swedens future need of motorfuels. In addition without interfering with the needs of the conventional forest industry.

Standing volume since 1920-ties, 5-year averages



- Annual increment has exceeded gross felling with 20% since the 1920's
- During 80 years the standing volume has doubled
- Several official reports has concluded that bio-Methanol from forest residue is the way to get fossil freedom:

- The Governments Official Investigations, SOU 1996:184 - *Improved Climate Environment and Health with Alternative Fuels*
- The Commission against Oil Dependence 2006
- The Royal Swedish Academy of Sciences's report 2013, *Biofuels now and in the future*

Excluding protected areas, mountains and inhabited areas.

Source: Swedish University of Agricultural Science. Swedish National Forest Inventory 2014. Swedish Forest Agency.

Another alternative motor fuel is methanol, which commonly is referred to as wood alcohol. Just as ethanol it is excellent to use as a low admixture in ordinary petrol. Another advantage is that it is cheap to produce from wood biomass. It is difficult to find disadvantages with using methanol. There is a surplus of biomass feedstock and the infrastructure – the gas stations – already exist.

Source: Swedish oil company Preem, the Energy Challenge 2010

What is Methanol?

- ♦ The simplest form of alcohols, wood alcohol, (CH₃OH)
- ♦ An excellent high octane (105 octane) motor fuel
- ♦ Low blends in gasoline will increase engine efficiency and reduce fuel consumption
- ♦ Ranks as one of the top 4 globally used chemicals
- ♦ So far mainly produced from fossil natural gas
- ♦ Also produced through gasification of coal at approximately 100 plants globally (including China)
- ♦ Can also be produced through gasification of wood
- ♦ Was used by the German army to keep their vehicles running during World War II
- ♦ Was used in Sweden during the 1940's as admixture in gasoline
- ♦ Introduced as a motor fuel by the Swedish company Nynäs in the 1980's as M15 (produced from fossil natural gas)

What about ethanol?

- ♦ The energy efficiency for biomass-to-methanol conversion through gasification is about 70 % as opposed to 20-25 % for wheat, other crops or wood-to-ethanol through fermentation
- ♦ Low profitability, land use efficiency is poor and greenhouse gas savings are limited
- ♦ Arable land is limited (in Sweden and globally) which only allows for a marginal production of agro-based ethanol
- ♦ Unethical to use agro-crops for producing ethanol in a starving world, with an alarming demographic development

Is Methanol dangerous?

- ♦ No, only if you drink it. (gasoline is also unhealthy to drink)
- ♦ No, contrary to gasoline and diesel it is not mutagenic or carcinogenic and degrades rapidly in soil and water.
- ♦ Burning methanol is extinguished with ordinary water

Market for bioMethanol?

- ♦ Directive 2209/28/EG stipulates that 10 % of all motor fuels in the EU shall be renewable by 2020
- ♦ The EU Directive is an important market driver as it, based on default values for greenhouse gas savings, defines the phasing out of the 1st generation agro-based ethanol (2016-2020) and prescribes the use of 2nd generation biofuels such as bioMethanol. Contribution of biofuels produced from food crops is by 2020 capped at 7 %.
- ♦ In order to meet the 10 % target by 2020, approximately 500 000 m³ gasoline and 500 000 m³ diesel must annually be replaced by biofuels in Sweden
- ♦ BioMethanol used as low-blend (up to 25 %) requires no adaptation of gasoline engines or infrastructure, moreover flexi-fuel cars (E85) run equally well on M85

- ♦ BioMethanol is an excellent fuel for the electric cars of tomorrow, powered by direct methanol fuel cells (DMFC)
- ♦ Fossil methanol is a basic building block for hundreds of chemical products. Growing consumer demand will force the chemical industry to widen its feedstock base, particularly by broader use of bio-based renewable raw material such as bioMethanol. The shipping company Stena Line is now replacing fuel oil with fossil methanol to reduce SO₂-emissions and thus opening up for using bioMethanol in the future.

Do we have the feedstock?

- ♦ Yes, in Sweden we have about 23 million hectares of forestland. Annual increment has exceeded gross felling with 20-30 % since the 1920's. Currently the annual increment, not harvested, is 30 million forest cubic meters (m³f). VärmlandsMetanol will not compete with saw mills and pulp industry regarding the supply of sustainable feedstock.
- ♦ Supply of sustainable forest residues have been secured through agreements with leading producers of forest feedstock

Project execution - status

- ♦ An industrial site (20 ha) has been acquired for the plant
- ♦ An office building at Uddeholm has been acquired
- ♦ Three conceptual studies have been concluded
- ♦ VM has selected TKIS as EPC contractor
- ♦ A detailed development plan for the site has been approved by the Municipality of Hagfors in January 2010
- ♦ Supply of feedstock/forest residue has been secured
- ♦ A pre-Basic Engineering Package (pre-BEP) has been delivered by TKIS (in August 2011)
- ♦ License agreements with different technology providers have been negotiated and finalized in January 2012
- ♦ Design Basis Document was finalized in 2012
- ♦ Several issues of new shares has been carried out
- ♦ An Environmental Impact Assessment (EIA) and a Risk Assessment have been completed
- ♦ The project has been delayed due to unexpected CO₂- and energy taxes on biofuels in Sweden since 2013.
- ♦ The plant can, according to the project execution plan, be ready for startup 36 months after the investment decision.

In progress

- ♦ Finish the legal procedure for obtaining the industrial environmental permit from the Environmental Court
- ♦ Securing off-take agreements
- ♦ Securing capital

Strategy

- ♦ The lead time for this kind of project is approximately ten years of which seven years have been carried through in the Hagfors project.
- ♦ Enormous amount of engineering and development efforts of all technical and commercial information from the Hagfors project is proprietary to VärmlandsMetanol and TKIS.
- ♦ VärmlandsMetanol and TKIS are as business partners committed to apply the wealth of existing engineering work for fast-track project realization of bioMethanol plants world wide.



Björn Gillberg:

”BioMethanol is a superior, sustainable drop in motor fuel!”

- ✓ Gasoline cars run excellent on low blends of methanol (25 %) without any modification
- ✓ Ethanol cars run equally well on methanol
- ✓ Methanol is an excellent fuel for electric cars of tomorrow, powered by fuelcells
- ✓ Perfect raw material for any chemical industry to reduce their carbon footprints
- ✓ BioMethanol is a profitable investment which does not compromise with the future of our children

VärmlandsMetanol Ltd - Board of directors

Chairman:

Wollmar Hintze, Ph.D. in chemical engineering (The Lund institute of technology), former Environmental Director at the Citytunnel project in Malmö and adviser to TetraPak on environmental issues relating to process technology.

Member and CEO:

Björn O Gillberg, Ph.D. and Ph.D. h.c., founder of Värmlands-Metanol, chairman of the Miljöcentrum Foundation and Miljöcentrum Ltd and former Environmental Controller to the Citytunnel project and the Öresund bridge in Sweden.

Other members:

Sture Sonebrink, co-founder of VärmlandsMetanol, entrepreneur and owner of one of the largest private forest holdings in Sweden.

Torbjörn Lindskog is a graduate from Handelshögskolan in Gothenburg, School of Business, Economics and Law. During the 1970- and 80-ties he worked as export manager at Edsbyns Industri AB, Haglund&Söner and TVAB. CEO at the manufacturer of high precision ammunition, Norma Precision AB in Åmotsfors until he retired 2013.

Margareta Thyselius possesses an advanced education in economy and management and is a former CFO at Miljöcentrum 1974-1998 and Akademikonferens, Swedish University of Agricultural Sciences 1998-2008. During 2009-2015 she was CFO at VärmlandsMetanol.

Auditor:

Stefan Lidén, PwC, Karlstad.

BioMethanol right in time!

The time is more than ripe for bioMethanol. In a Swedish context a large-scale investment in gasification technology for the production of biofuels from forest biomass is a feasible, cost and energy efficient way to reach the EU ten percent target for renewable motor fuels by 2020. Especially considering that the EU has decided that agrobased biofuels shall be limited to seven energy percent.

The choice of methanol produced through gasification of cellulosic biomass, as a substitute for gasoline, is from a process and technological perspective, self-evident. The energy efficiency is higher than for any other liquid biofuel. Sweden has a significant and increasing surplus of forest biomass. In addition, methanol used as a low admixture in gasoline does not require new infrastructure, which paves the way for a cost-efficient, immediate and major reduction of CO₂ emissions from the existing and future automobile fleet.

VärmlandsMetanol’s industrial partner, ThyssenKrupp Industrial Solutions, one of the very few global actors, who have the competence and the financial “muscles” needed to guarantee a successful implementation of the project.

Björn O. Gillberg, CEO

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