



# The Chrisgas-project

## Summary

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One important way of reducing the transport sector's dependence on oil is to increase the use of vehicle fuels produced from renewables. This project will develop and optimise an energy-efficient and cost-efficient method to produce hydrogen-rich gas from biomass. This gas can then be upgraded to commercial quality hydrogen or to synthesis gas for further upgrading to liquid fuels.

The hub of the project will be the use of the existing and unique biomass-fuelled pressurised IGCC plant in Värnamo as a pilot facility. Within this project, new process equipment will be developed and tested and implemented in this pilot facility to produce clean hydrogen-rich gas. Such developments will be supported by an experimental-oriented research activity. Also included in the project are studies related to the large-scale use of such plants. The project will therefore provide the basis for, and enable the exploitation of the results in, future plants at commercial scale.

## Objective

The primary objective of this project is to demonstrate, at a scale of 20 MW thermal, the manufacture of a clean hydrogen rich gas on the basis of gasification of biomass, followed by gas upgrading by hot gas cleaning to remove particulates, and steam reforming of tar and light hydrocarbons to enhance the hydrogen yield.

The project consists of a number of tasks, the objectives of which are:

- conversion of a solid biofuel into a medium calorific value gas by gasification at elevated pressure using a steam and oxygen mixture
- cleaning the generated gas from particulates in a high temperature filter
- purification of the generated gas by catalytic auto-thermal steam reforming to generate a raw synthesis gas consisting mainly of carbon monoxide and hydrogen as energy carriers
- studies of the conditioning of the hydrogen-rich raw synthesis gas to the quality required for synthesis gas suitable for manufacture of bio-DME or other potential products

An R&D and process and system study programme will underpin the design basis of the individual process units re-designed or installed in the pilot facility. The R&D work will consider a variety of different fuels representative of various regions in Europe to expand the fuel basis for producing GTL (gas to liquid) fuels. The economy of production will be considered by optimisation studies and studies of economy of scale, which combined with the fuel sourcing studies will result in case studies representing realistic plants for various European regions.

## Work and Methodology

Planning of the reconstruction of the Värnamo pilot plant will be made and will be based partially on support from parts of the supporting R&D programme. The operational staff at Värnamo will be transferred in the latter part of 2005 from the present operator to this project. Plant construction will then begin and when the plant is ready for operation in 2008, test work shall commence.

In order to provide a sound technical background to the process to be installed at Värnamo, a supporting R&D programme on various technical aspects of the proposed process will be conducted. This programme encompasses studies and practical work on fuel drying, pelletisation and feeding against elevated pressure, as well as experimental studies of the gasification characteristics of a variety of biomass fuels, gas cleaning by state-of-the-art hot gas filters and by catalytic steam reforming of hydrocarbons, as well as innovative procedures using e.g. membranes. This supporting programme also includes studies of the optimisation of individual process steps, including the entire production chain from biomass to liquid fuel product, and an analysis by case studies of the feasibility for production of liquid fuels from biomass, as well as a study of the socio-economic aspects.

The R&D technical and experimental tasks in this project performed at sub-pilot scale run mostly in parallel to the pilot plant R&D and demonstration effort. Although some aspects addressed in these tasks will form part of the design basis for the rebuilding of the pilot plant, the majority of the tasks address supporting research or improved or innovative solutions that could be implemented in the plant, or elsewhere, in a mid- to long-term perspective. They will also assist in finding solutions to unforeseen problems encountered in the plant during the design and in the test runs.

## Expected Results

The results expected from the project represent a panoply of knowledge and experiences required to engage in the next, and likewise very challenging, stage of the development, that is to first demonstrate production of the motor

fuel, first in the Värnamo pilot plant, and then later at commercial scale at competitive costs throughout Europe. For this purpose, it is necessary to have a clear idea of the potential fuel basis in various locations as the associated average and marginal fuel costs must be known. Likewise, the process technology at various capacities must be known in order to allow estimation of the cost of production and investment, also taking into account interaction with the local communities. This know-how, representative for a variety of European conditions, will result from this project, supporting any plan for large-scale implementation.

The facilities and planned testing within this project will result in tangible results, e.g. improved cleaning and mechanical clamping systems for hot gas filters, use of state-of-the-art advanced ceramic materials, novel gas upgrading methods, actual data of catalytic steam reforming of biomass gas, investigation of different areas ranging from industrial use to development of new or improved catalysts, as well as an understanding of the catalyst behaviour and lifetime limiting factors down to a microscopic level. The results will also cover the interaction of the biomass varieties in terms of contaminants.