Weyland BioEthanol

Public Summary:

Preliminary Feasibility Evaluation of Ethanol Production in Latvia Using Weyland Technology

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1 INTRODUCTION

1.1 Weyland AS

Weyland AS was established in Bergen, Norway in 2001 to commercialise technology for the production of fermentable sugar from cellulose materials for biofuel production. The technology is a result of research and development conducted in cooperation with the Bergen University College since 1987 and has been thoroughly documented through more than 1,000 laboratory tests and extensive tests in a bench-scale plant.

Currently, the technology is being demonstrated in an advanced pilot plant facility in Bergen, with a capacity of processing 75 kg/h of feedstock (with typical moisture content 10%). This pilot plant is capable of processing a wide variety of feedstocks and producing high yields of bioethanol and lignin. The Weyland process is based on concentrated acid hydrolysis of the cellulose, but differs from other proven technology in its unique method of removing and recycling 98.5% of the acid, thus enabling production of fermentable sugar at low cost and with significant environmental benefits. Feedstocks could typically be any cellulose containing organic materials such as forestry waste, timber, waste wood, bagasse, corn kernels, etc.

1.2 Contact information

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1.3 This document

The purpose of this document is to supply LVM with a summary of the main outcomes of a preliminary feasibility evaluation performed by Weyland for LVM. Whereas previous correspondence and reports were the subject of a non-disclosure agreement, the information contained in this summary document may be publically disclosed.

2 SUMMARY OF PRELIMINARY FEASIBILITY EVALUATION

2.1 Scope of Feasibility Evaluation

Weyland has performed a feedstock evaluation on samples provided by LVM. The samples, consisted of mixed wood chips, representing potential feedstocks in various price categories. The samples were tested in the laboratory to give information on composition and estimated achievable product yields (ethanol and lignin).

Following the feedstock evaluation a preliminary economic analysis was performed as a first order estimate of project economics under a given set of assumptions (“base case”). The sensitivity of these economics to the basic assumptions was also investigated.

2.2 Basic assumptions

Plant scope and scale: A full greenfield facility is assumed with a scale of 100 000 bdt/yr of raw material feed (softwood). The main products would be fuel grade ethanol and lignin pellets. This scope and scale are similar to a case previously studied by Weyland AS, thus enabling approximate estimation of capital and operating expenses. This would otherwise be quite difficult at this early stage in the feasibility evaluation.

Plant cost: 85 million Euros. A full greenfield facility is assumed – thus no benefits are realised from integration. All utilities, water treatment etc. must be included in the estimate. The total includes all equipment, buildings, engineering etc. Not included in the estimate are plot costs and connection of utilities to the plot boundary.

It should be noted that the cost of the “Weyland Core Technology” represents around 20% of the total capital cost. Therefore by far the major component of the capital cost will be unaffected by the choice of hydrolysis method. The costs outside of the Weyland scope are also those where there is most uncertainty – and local engineering partners may be able to give more realistic price estimates for Latvian conditions.

Financing: Full equity financing is assumed. No consideration is given to possible grants and subsidies. A depreciation period of 15 years is also assumed. No NPV effects are considered and no working capital is included in the capital costs.

Ethanol yield: 250 litres ethanol/bdt feedstock. This is somewhat lower than the yields typically achieved by the Weyland process for softwoods but it is somewhat higher than the yields attained in the feedstock evaluation of the LVM mixed samples. Indications are that the hydrolysis methods can be optimised further to increase yield.

Feedstock cost: 93 Euro/bdt. This is the price estimate provided by LVM. In comparison with most other case studies Weyland has seen – this is a high feedstock cost and is undoubtedly one of the biggest challenges to the economics evaluated here.

Energy costs: One of the advantages of Weyland technology is that it can be mostly driven by low grade energy (hot water and low pressure steam). This opens for opportunities for energy integration with other industries that produce waste heat. This would give lower operating costs to ethanol production and some income for waste heat for the partner process. However, in this case no such synergies have been identified and the base case considers market prices for energy.

- For steam (6 bar) a price of 53 Euro/MWh was provided.
- For hot water (100 degree supply – 80 degree return), a cost of 15 Euro/MWh was assumed.
- Electricity – the plant is assumed to be equipped with a biogas plant and engine. This would essentially mean that the plant is self-sufficient with respect to electricity. Thus electricity cost is not considered at this stage. Note though, that in the future there may be some potential for supplemental income from the production and export of electricity “green certificate”.

In addition to these parameters there are other cost estimates, which are not listed here – primarily for the various process chemicals, where typical market prices are used.

2.3 Base case result and sensitivity

We assume that an internal rate of return (IRR) of 10% or higher would need to be demonstrated in order for the project to be considered for further evaluation. Using the base case assumption set we do not achieve a positive IRR. Even by manipulating single variables in the ±20% range the project does not achieve an IRR of 10%.

It would be an extensive analysis to systematically consider simultaneous variation of more than one parameter. However, feedstock cost and energy cost are identified as the two major contributors to the operating cost. These are also the variables where we may have most potential to influence the values. Other variables – like ethanol selling price, for example, are harder to do anything about.

Sensitivity to simultaneous reduction in Feedstock and Energy cost was thus investigated:

> **Feedstock cost** – a price of 93 €/bdt was used as the base case. We expect that with some optimisation it will be possible to get reasonable yields from mixed sawmill wastes and thus use lower cost feedstock. Let's for the sake of this example assume that it would be possible to achieve a feedstock price of 68 €/bdt (20% reduction).
> **Energy cost** – in this case the non-feed operating costs are dominated by a low pressure steam cost of 53 €/MWh. This is about 4 times higher than the costs which have been considered relevant in other Weyland studies – where waste heat from a neighbouring industry would be purchased. Thus by energy integration with another industrial facility or power production facility there would be potential of reducing the utility costs even more than the 50% reduction considered here.

As an example then we simultaneously reduce feedstock costs by 20% (to 68 €/bdt) and energy cost by 50%. This gives an estimated **IRR of 10.3%.**

2.4 Concluding remarks

The economic analysis performed here is preliminary and based on fairly rough estimates – typical of this early stage in the project. However, the analysis does indicate a challenging business case on the basis of the assumed values. The analysis shows that particularly feedstock costs, energy costs, and to a slightly smaller extent, capital costs, are key to economic performance.

A potentially profitable scenario identified was the simultaneous reduction of feedstock cost by 20% and reduction in energy costs by 50%; giving an IRR of 10%.

In order to further develop a profitable scenario, the following areas of focus are highlighted.

Feedstock cost reduction:
- Identification of feedstock in the price region of 68€/bdt and below.
- Optimisation of hydrolysis processes to increase yield on low cost raw materials.

Energy cost reduction:
- Identification of best market price for hot water and 6 bar steam.
- Search for potential energy integration partners - industries which generate waste heat. The size of the ethanol plant could be sized according to the amount of energy available.
- Investigate economics of integrated CHP facility. If a CHP facility could be size matched to the ethanol facility it could potentially:
    a. Gain substantial income from "green electricity" export
    b. Utilise lignin bi-products locally and remove the need for pelletizing and transport – although it may be more economical to use the same feedstock as the ethanol process.
    c. Provide waste heat to drive the Weyland process.

Capital costs, although ranked lower than feedstock and energy, are still important. Here the following could be considered:
- Economy of scale – larger facilities would give a lower production cost per litre.
- Integration – costs of a full greenfield facility are high. If there were any possibilities for integration with other facilities (eg. pulp and paper mills or other chemical industry) might reduce costs for utilities, waste treatment, feedstock preparation etc. There may also be potential for centralised dehydration of the final alcohol (the final step which produces 99.8% alcohol).
- Uncertainty – as mentioned above the Weyland technology represents only about 20% of the total Capex. Outside of this scope there is more uncertainty in what the costs for equipment, engineering and construction would be – particularly in a Latvian context.