1. Executive Summary (for public)

Latvia is a forestry country. Latvia is covered to over 50% by forests and therefore has extensive resources of biomass available which could be used as the feedstock of the considered plants. Currently around 3 million t_{bd}/a[1] of wood representing around one third of Latvian's wood production is exported.

This study was carried out to identify a local outlet for the wood to improve the economic welfare and the Greenhouse gas balance of the country.

The original purpose of the study was to evaluate options for power production in Latvia based on CHOREN's Carbo-V 160/5 biomass gasifier. This 3-stage gasifier based on the entrained flow principle offers clean syngas with excellent properties not just for power production but especially for synthesis processes like Fischer Tropsch or methanation for large scale biomass facilities. A Carbo-V gasfier is operational in the world's first BTL demonstration facility in Freiberg/Germany and is foreseen for a couple of projects around the world.

In a first phase, 7 cases were investigated based on heat and mass balances and an economic model.

In this first phase, it was concluded that:

- For wood drying, a drum dryer offers slight economic advantages but some operation/reliability drawbacks compared to a belt dryer. It was decided to continue with the drum dryer option.
- External wood chipping can not be recommended due to storage, cost and flexibility reasons.
- Heat usage is advantageous.
- Based on the given assumptions, district heating gives even better project economics than steam.
- A site with steam and/or heat off-take opportunity is recommended.
- The integration of an Organic Ranking Cycle (ORC)-Process gives slightly better project efficiency and economics but also adds complexity.
- ORC with use of district heating gives best project economics.

Due to changes in the Latvian legal framework for large biomass power plants, no economical viable business case could be identified. The involved parties decided to add a 2nd evaluation phase comparing additional applications for biomass gasification. Starting from a complete spreadsheet of options, the purpose of a first step was to reduce the number of options by qualitative means. It was assumed that for SNG (Syntetic Natural Gas), it is especially the feedstock conditioning and gasification units which have the main impact on the investment cost. Those units have no considerable economies of scale (linear upscaling). Thus in the discussed size, the SNG case has only marginal economies of scale which will be more than compensated by the higher biomass cost for larger projects. BTL-plants are only economically viable for larger sizes as significant economies of scale can be seen for FT unit. Therefore, BTL shall be considered for larger capacities such as 2x and 4x160 MW. Concerning the potential sites it was agreed that for the smaller projects, the inland site shall be preferred due to the considerably lower biomass costs.

[1] t_{bd}/a = bone dry tons per year

As the biomass cost seems to be nearly similar for inland and Riga for the large BTL project, and as Riga offers some slight advantages in the other site criteria, the following cases were investigated:

Product/ Feedstock capacity	Electr./Heat (BTE)*	BTL (liquid transport fuel)	SNG (=methane)	H_2 (hydrogen)
1x160MW	x	-	x	x
2x160MW	-	x	-	-
4x160MW	-	x	-	-

From phase 2 it was concluded that:

- The best BTL-Option is the large plant size (4x160 MW). Even as the specific biomass costs are lower when placed at the inland site this does not compensate higher specific capital cost for the smaller plant.
- For gaseous products to replace natural gas by H2 or SNG, both options are similar and both need significant incentives for implementation. For replacing H_2 produced from natural gas via steam reforming, Bio H_2 is not far away from full competitiveness.

As there is currently no need for H_2 in Latvia and as the feed in conditions to the natural gas grid are not yet clarified, currently no viable business case could be identified for gaseous products. It was agreed to enter the 3rd phase of the study to work out a business case for BTL production with an intermediate power production phase.

Therefore the final study intents to present relevant aspects for an investment into a Biomass-to-Liquid-(BTL)-Plant in Latvia with a feedstock capacity of 640 MW. As this would be one of the earliest facilities in the respective capacity range, the study looks at a smaller-scale Biomass-to-Energy (BTE)-facility as an intermediate step first with a subsequent extension to a large-scale BTL-facility.

The study considers the CHOREN Carbo-V biomass gasification technology as the core equipment for the BTE and BTL-Plant. Biomass is used in the gasifier to produce a high-quality synthesis gas which can be used to generate electricity and heat (BTE-Plant) or to produce a liquid transportation fuel (BTL-Plant) consisting of a Diesel and a Naphtha fraction.

The Carbo-V gasification is based on the CHOREN-standard-size gasifier with a biomass input capacity of 160 MW_{th}. For the BTE-application one gasifier with this capacity is considered. The BTL-application requires a larger total plant capacity in order to be economically viable. This requires the installation of additional gasifiers of this capacity in order to reach a total capacity of 640 MW_{th}.

Details of the plants are given in Table 1.

	BTE (intermediate step)	BTL (final step)
Definition of feedstock	83% round wood and wood processing by-products 14% forest residues (B) 3% stumps	86% round wood and wood processing by-products 9% forest residues (B) 5% stumps
Drying of feedstock	yes/drum dryer	yes/drum dryer
Gasification	1 x 160 MW Carbo-V	4 x 160 MW Carbo-V
Gas conditioning	consisting of: wet gas cleaning	consisting of: wet gas cleaning CO-Shift gas separation
Final process	Heat and Power Generation	Fischer-Tropsch-Synthesis
Final Product(s)	Electricity, heat	BTL (Diesel&Naphtha)
By-Product(s)	Heat	heat

Table 1: Plant definition

Based on a mass and energy balance both a CAPEX estimate and the OPEX were analysed with a sophisticated economic model.

It could be proven that a world-scale BTL facility would increase Latvian's GDP by 1% and improve the Latvain trade balance by €300 m per year. More than 440 direct new jobs not including indirect jobs can be expected. Construction work with a value of €250 m executed by local companies over 3 years is envisaged. More than 650,000 t of CO-equivalent can be saved by using the product of the BTL-plant instead of fossil based fuels.

As a final result in can be concluded that,

- Latvia is ready for at least one world-scale (5,000 bbd) BTL facility.
- with the current technical concept, BTL production costs (before interest and taxes without investment subsidies) of ~ 0.81€/l can be expected.
- including a total project IRR of 9% and considering the current uncertainty in the field of BTL incentives in Europe, currently no viable business case for a BTL facility in Latvia could be identified.
- a BTE/CHP-plant as intermediate promises lower investment cost in the 1st step and lower risk related to innovative technology, but due to the current framework does not improve the project IRR.
- optimization potential was identified both in the technical (less costly Fischer-Tropsch, lower CAPEX along the learning curves related to increasing maturity of the technology) and the financing concept (direct subsidies, lower interest rate).

Thus it's worthwhile further watching the development of market opportunities for syngas applications like H2, SNG and 2nd generation biofuels and continue the active project development when the time has come.