POTENTIALS OF DIFFERENT BIOMASS-TO-LIQUID (BTL) FUEL OPTIONS

Study by

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Summary

Within the framework of the FURORE project, AVL List GmbH commissioned this study for analysing the potentials of different Biomass-to-Liquid (BTL) fuel options.

The technical potential is defined as the potential that can be reached with existing technologies and respecting the material balances. It can be calculated from such input data as available area, typical yield, wood harvesting statistics or waste amount per inhabitant. There is no information about economic circumstances included. In fact, depending on the cost of the necessary processes and on the market conditions, only a varying share of the technical potential will be made accessible. This share varies in time and in space, so it can differ from one country or region to another considering the local circumstances. Another share of the technical potential is already used for other (concurring) purposes, such as heat or material use.

In a first step, the technical potentials of biomass residues and of energy plantations are estimated for 30 European countries (energy content of raw materials, primary energy).

- The technical potential of all residual biomass in EU 30 is estimated at 5 700 PJ per year (3 700 PJ per year in EU 15). About 2/3 of this technical potential comes from logging residues and thinning residues, the rest is mainly based on straw, industrial wood residues and used wood. Used cooking oils can be neglected compared with this. Raw materials that can be used for the production of biogas by fermentation are not included because biogas is not included within the framework of this study.

For energy plantations, it is assumed that 17 % of the arable land of each country can be used for such plantations and that the necessary crop rotation includes not only a fixed share of the arable land. The crop rotation leads to the use of each arable land for energy plants in average once in six years (perennial wood plantations excepted).

- The technical potential resulting from energy plantations depends on the chosen energy plant and on the chosen biofuel to gain. If all available areas are used for one plant, the highest potentials can be found for Miscanthus (primary energy potential: 3 849 PJ for EU 30), sugar beet is following (potential for ethanol and biogas together: 3 359 PJ in EU 30).

In general, there is a higher technical potential in residues than in cultivated energy plants.

In the next step, the potential after conversion for the main conversion technologies is calculated (final energy potential). This technical potential for each biofuel considers only the ratio between final energy within the biofuel and primary energy within the biomass. The necessary energy for conversion and transportation as well as the importance of by-products is not taken into account, for this an complete LCA would be necessary. The technical potentials of biofuels can so be calculated from the primary energy potentials, but they exclude each other (because all raw materials can only once be used).

- Assuming the decision for one kind of biofuel to introduce, the yearly technical potential for all 30 countries in consideration can be 830 PJ for biodiesel (FAME), about 2 700 PJ for ethanol, between 3 000 and 5 900 PJ for methanol, between 3 000 and 6 100 PJ for FT-Diesel or between 4 800 and 6 100 for biogene hydrogen.

Data for biodiesel and ethanol can be clearer estimated, because experiences about the ratio between primary energy and final energy exist. However, methanol, FT-Diesel and bio-hydrogen are produced in thermo-chemical processes existing mostly only in a R&D stage. Here, different technologies and different sizes of the transformation plants have a high influence on the real efficiency. For this reason, large bandwidths have been indicated. One short chapter gives a short description of the supposed conversion technologies within the described scenarios as well as of some other possible technologies for producing liquid biofuels.

The plantation of different energy plants leads to different final energy potentials in each considered country, so four scenarios are defined, where the maximum reachable potential is calculated depending on different defined framework conditions:

- The first scenario tries to achieve the maximum fuel potential for each country, so the assumed 17 % of the arable land are used to cultivate sugar beets in most countries, Miscanthus or wood in others. Ethanol is produced from sugar beet. All straw, all woody residues and all harvested wood are transformed with high efficient technologies into hydrogen (scenario 1a) or in FT-Diesel (scenario 1b). So this scenario shows that from the point of view “maximum utilisation of European inland biofuels potentials” the bio-hydrogen and the FT-Diesel are equal. The technical potential in EU 30 (6 400 PJ) corresponds to the half of the estimated road transport energy demand in 2020.
- In scenario 2, the maximum potential for such fuels is calculated that can be used in today’s motors. Ethanol is only used for a 5-%-blend with petrol, FT-Diesel is dominating the rest. The calculated technical potential is 6 100 PJ yearly in EU 30.
- In scenario 3, the use of biofuels is depending on its ranking within the GHG-balance. Straw and all woody residues are transformed into methanol, woody energy plants are used to produce hydrogen. The yearly technical potential for EU 30 is 5 900 PJ of biofuels.
- In scenario 4, those biofuels are preferred that can be produced at lowest prices. This leads to using arable surface for oil plants and producing biodiesel (FAME), for converting existing woody residues and straw, FT-Diesel is preferred. As the biofuel

yield from oil seeds is lower than from all other options, the technical potential in this scenario corresponds only to 4 200 PJ yearly.

In the next chapter, some ideas about higher or lower investment cost within the fuel provision and using chain are given for each scenario, the most important factors for the implementing timetables are indicated also.

- All scenarios lead to higher prices for biofuels than for conventional fuels, but the highest investment cost are found in those scenarios (especially 1a and 3) where all filling stations and car fleets must be exchanged for using the new fuels. Table 21 gives an idea about the corresponding timetables: Important changes in agriculture, high R&D demand and the necessary exchange of filling stations and cars will lead to longer transition periods than introducing biofuels for existing vehicles.
- In all scenarios, synthetic fuels are important and the timetable of R&D in this sector is often the most important retarding factor, so more R&D activities in this field are recommended.