Grassification

O9.1 - Techno-Economic Assessment of Value Chains from Roadside Grass Clippings

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1 The GRASSIFICATION project

Processing roadside grass clippings is a challenge throughout the 2 Seas Programme area due to their high volume, high processing costs and legal status. The industrial sector, however, is interested in the possibility of using roadside grass clippings as an alternative resource (as opposed to fossil sources or dedicated agricultural produce, e.g. isolation material). The common challenges for applying roadside grass clippings as a renewable feedstock in industrial processes are currently threefold:

- the supply chains are not yet optimal, resulting in higher costs;
- a highly variable and heterogeneous quantity;
- an unsupportive institutional framework leading to legal and political challenges.

The overall objective of the Grassification project is to apply a multi-dimensional approach to roadside grass clippings refining to optimize it into a viable value chain for the biobased and circular economy. The project commits itself to optimize logistics and technical aspects of the grass clippings supply chain and processing, demonstrate its market potential as well as formulate policy and legal recommendations to create a more supportive framework for the recycling of this renewable resource. These actions will increase the volume of usable material, lower costs, and generate a higher added-value for this so-called ‘waste’ streams. In this way, the use of roadside grass clippings as a renewable resource for the production of biobased products and hence the circular economy will become more attractive.

2 Context of the document

In this report we specifically evaluate the techno-economic feasibility of the 3 most promising value chains to be developed with roadside grass clippings: agricultural co-digestion, industrial mono-digestion and production of biomaterials and biocomposites.

3 Agricultural co-digestion of grass clippings and pig manure

In Grassification we evaluated the potential of roadside grass digestion from an economic point of view. We compared a base case in which roadside grass is digested together with pig slurry and VeDoWS manure in a pocket digester, with two reference cases. The first reference case is a pocket digester of the same size that only processes manure and the second reference case is a large scale dry OMSW digester with roadside grass. The aim was to evaluate to what extent the addition of roadside grass in a digester is interesting from an economic point of view.

Based on the assessment we can conclude that the biogas potential of (roadside) grass is sufficiently large to make it interesting as a feedstock for digestion. However, due to the status of roadside grass as waste, strict post-treatment conditions have to be met that largely impact the processing costs. In both the base case and the second reference case, the processing costs per ton feedstock amount to ca. 100 euro per ton, compared to a cost of around 50 euro per ton in the first reference case. If we instead evaluate the biogas production cost across the three cases, we conclude that this is the same for the base case and first reference case at approximately 0.5 euro/m^3 compared to approximately 0.3 euro/m^3 in the second reference case. To calculate the biogas production cost, we do not allocate the cost for the digestate post-treatment. It can be concluded that, with the assumptions made, none of the cases is economically feasible without subsidies.

From these results it is clear that adding roadside grass to a pocket digester, together with manure, is not interesting for the farmer from an economic point of view due to the strict post-treatment conditions that have to be met. Furthermore, also technical challenges exist with the presence of sand and litter for which no good solutions are available at the moment. From an economic point of view it is therefore more interesting to process the roadside grass in a large scale OMSW digester compared to the pocket digester. One advantage is that the dry digester is not stirred and therefore the litter does not cause much harm in the reactor. Second, OMSW composting facilities already have pre- and post-treatment processes available that can also be used for roadside grass and/or the end-product. Third, the conditions for post-treatment of digestate from OMSW digestion are the same as for roadside grass, implying that OMSW digesters already have the correct post-treatment processes in place, as well as the needed permits.

In this study we compared pocket digestion, with and without roadside grass with a large scale dry digester that processes OMSW with roadside grass. We did not make a comparison with a large scale agricultural digester. Due to scale advantages, the costs might be reduced in a large scale agricultural digester compared to a pocket digester, however, the additional complexities that adding roadside grass with a waste status causes to a pocket digester, are also valid for a large scale agricultural digester. Therefore, it seems more straightforward to add roadside grass to a large scale OMSW digester.

If one wants to continue the pathway of mixing roadside grass and manure in a digester as a potential technical solution for processing roadside grass, one first needs to prove that pathogens and seed weeds are eliminated, i.e. that the hygienization requirements are met, with a cheaper treatment process than composting of the entire digestate fraction as is required now.

Another point of attention is the presence of litter that cannot be removed efficiently with the current available technologies. This presence of litter is not only a challenge for digestion, but also for other potential uses, like in the biocomposites case. If a technology can be developed to remove the litter efficiently, this would open up many opportunities. Considering the current situation, dry digestion or composting seem the most interesting options. Avoiding the amount of litter by having good agreements with the contractor or stimulating initiatives such as 'de mooimakers' where volunteers help to clean the roadsides can be alternative solutions. The latter is of course not possible at all roadsides.

4 Industrial mono-digestion of grass clippings

A techno-economic analysis was performed for the landfill digester case which is a mono-digestion of roadside grass. We evaluated the economic feasibility of two scenarios, i.e. one scenario in which the digestate is further processed at a composting installation and a second scenario where the digestate is dried and fractionated into three fractions. We have calculated the total production cost, as well as the NPV for these scenarios based on base case assumptions. Considering the high uncertainty of these assumptions, we have performed several sensitivity analysis to identify the impact of both technical and economic parameters on the economic feasibility.

From the assessments described in this report, it is clear that the economic feasibility of the landfill case is highly dependent on the exact location and the infrastructure that is available. Furthermore, the underlying assumptions, both technical and economic, are uncertain and need to be verified to increase their accuracy. Especially the parameters linked to the fibre quality are important and if an optimum needs to be found between the biogas production and fibre quality and amount, it is better to focus on the fibre quality. Based on the sensitivity analysis we already have a good insight on the effect of the technical and economic assumptions on the economic feasibility.

The most important question to be answered is the effect of digestion on the fibre quality and its applicability in the different markets. In case the effect is positive, the case can be further optimized also taking into account the requirements for the fibres to evaluate the economic feasibility with a higher accuracy. In case the effect of digestion on the fibre applicability is non-existing or negative, the landfill case will not be economically feasible and it is better to use the roadside grass as such in material applications.

5 Production of biocomposites from grass clippings

Biocomposites are receiving increased attention from industries due to growing concern for environmental impacts and reducing raw material costs. The reasons are the government directives on recycling, green marketing, social influence etc. Due to this, the demand for environmentally friendly products made from renewable sources is rapidly increasing.

To assess the feasibility of using roadside grass clippings as a feedstock for the production of biocomposites, two main products were considered, namely fibres and biocomposite granules. The fibres act as the reinforcement in the biocomposite granules. The granules are then used to produce final products using manufacturing processes such as extrusion, thermoforming and injection moulding. The fibres can be directly used in the manufacturing processes such as pressing for panels, insulation boards et., and needle punching for non-woven textiles. Moreover, a detailed estimate to the cost of mowing was included in the analysis.

For the fibres, the minimum selling price (MSP) could be €528 and €295 per ton of fibres with and without mowing costs. If the mowing costs are not included and considered to be social costs, then the MSP of grass fibres estimated is significantly lower than other natural fibres in the market. The MSP of granules (25% fibres, 60% polylactic acid and 15% filler) estimated in this study is €1073 and €1013 per ton of granules with and without mowing costs. The increased price is due to the cost of PLA, which is used as a matrix. If a cheaper synthetic matrix is used, then the MSP of granules can be reduced significantly. Furthermore, the MSP of granules also depends upon the composition of the material. The higher the grass ratio, the lower is the MSP of granules. Even with the high cost, the estimated MSP is lower in comparison to the price of products available in the market from the Stora Enso company.

The granules are the input raw material for the processes of extrusion, thermoforming and injection moulding. Therefore, the price of the final products from these processes also greatly depends on the price of the granules. The final products envisioned from pressing are medium density fibreboard and insulation boards. In the MDF, equal quantities of virgin grass fibres and digestate fibres were considered. The insulation board was assumed to consist of only virgin grass fibres (90%). The results indicated that the estimated MSP is significantly lower than the market prices available at Hubo company. For non-woven textiles, two different compositions are considered. The first consists of only virgin fibres and the second consist of an equal mix of virgin grass fibres and polypropylene fibres. The MSP of the non-woven textiles is also lower when compared to the market.

The results obtained in this report are promising and indicate that the usage of roadside grass to produce natural fibres has great potential. However, it all boils down to the quality of the envisioned products. In the Grassification project, the quality of these products was also tested and very promising results were obtained. The products with natural fibres are generally expected to have relatively lower qualities and lifetime than their synthetic counterparts. However, the fact that these products can be recycled or are biodegradable at the end of their life makes them more attractive.

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