Interreg
EUROPEAN UNION
2 Seas Mers Zeeën
European Regional Development Fund

GRASSIFICATION

Anaerobic co-digestion of grass clippings
Decentralized biogas production

The project

Roadside grass clippings are a problem fraction throughout the 2 Seas Programme area due to their high volume, subject to high processing costs. 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).

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 supply;
- 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 in order 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.

Why anaerobic digestion of grass clippings?

An important goal within the Grassification project is to use roadside cuttings as feedstock for material and energy. While material production is a higher-value application for the grass clippings, this value-chain still needs to be further developed.

On the other hand, anaerobic digestion is a well-developed process in the 2 Seas Programme Area and would be more easily adopted in the short term as a valorization route for roadside grass clippings.

Therefore, an exploratory digestion test on pilot-scale was conducted in the installation of Inagro to determine whether roadside grass can be digested (20 v/v %) in co-digestion with VeDoWS manure and pig slurry and whether this can lead to a stable digestion process.

The need for ensiling

Roadside grass is highly available approximately twice a year: June and September, when mowing of roadside verges is allowed. Given the peak of available grass for further processing, preservation steps are required before digestion to ensure continued availability of the feedstock, such as ensiling.

Substrates used in the co-digestion experiment

The used grass was mown in Harelbeke with a flail mower with an adapted head (Vandaele) developed in the Grassification project, which was shown to decrease the litter and sand fractions in the grass clippings.

No further pretreatment was done before ensiling, which was done in a trench silo without additive addition. The grass, with an initial dry matter content lower than 30%, was compacted and covered to create an anaerobic environment.

The faecal fraction from pigs (collected fresh by an adapted stable construction VeDoWS) was used in this trial, since the biogas potential of this fresh, faecal fraction is two times higher than pig slurry. However, conventional pig slurry was also added to adjust the viscosity to prevent possible operational difficulties with the installation due to the high dry matter content of the faecal fraction.

The final mix fed daily to the digester consisted of:

- 1000 kg of VeDoWS manure
- 1400 kg of pig slurry
- 600 kg silage verge grass (20 w/w% of the total mixture).

The installation used was a classic CSTR reactor (200 m^3 with a filled volume of approximately 150 m^3), with an electrical power of 31 kW, which is controlled by Inagro in the mesophilic temperature range (± 38 ° C). The biogas is burned in a combined heat and power unit (CHP) after water vapor and sulfur are removed via a condensation step and biological desulphurization.

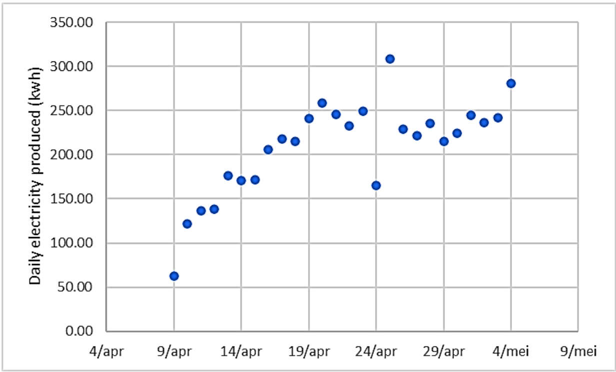
Why co-digestion?

Grass is a very fibrous material, resulting in mixing problems due to increased viscosity, floating layers and blockage of pipes and pumps if used as the sole substrate in a monodigestion process. At the same time, adding grass to pig manure in the digester can help maintaining an optimal pH for methanogens, decreasing ammonia/ammonium inhibition and providing a better carbon/nitrogen ratio (C/N).

Achieved results

Based on the biomethane potential tests, the biogas potential of VeDoWS manure was the highest (157.1 m³ biogas/ton). Pig slurry had the lowest biogas potential (33.2 m³ biogas/ton) while the potential of roadside grass was situated in between (107.9 m³ biogas/ton). The amount of carbohydrates has a direct link with the biogas potential, as these are easily degradable sugars. VeDoWS manure had the highest amount, 116 kg/ton, compared to 21.3 kg/ton and 87.4 kg/ton for pig slurry and roadside grass, respectively.

A biogas production between 7.5 to 9 m³/h was obtained during the 30 days of experiment. This was similar to the production obtained when only pig manure was fed to the digester, indicating that the addition of 20% grass did not cause any perturbations to the system. Once grass started to be fed to the reactor, the daily electricity production increased until a plateau was reached around 200-250 kwh/day.



The pH was stable during the digestion. The digestate had a FOS/TAC of 0.2, which is low. This low FOS/TAC indicates that the feeding of the digester could be increased. Indeed, the ideal organic loading rate is situated between 4 and 8 ODM/day.m³, while the organic loading rate in the experiment was calculated to be 2.83 ODM/day.m³. However, this mainly impacts costs and would not hamper the digestion process.

The digestate had a dry matter content between 14% and 9% and an average nitrogen content of 5 kg NH3-N/1000 kg FM, which is an appropriated concentration for mesophilic processes. Methane (CH4) is the energy rich component of biogas and the higher the CH4 content of the biogas, the more energy can be produced. Although grass had a lower CH4 potential than VeDoWS and pig slurry (±54% versus ± 58%), the addition of grass did not result in a decrease of methane content in the produced biogas, and a content around 58% was obtained once the process stabilized.

Conclusions

The retention time was too short to obtain constant values and thus an optimal digestion process. In the beginning, the digester was still in a transition phase, in which micro-organisms were still adapting to the new environment. Nevertheless, biogas production was successful and reached similar values as when the reactor was stably operating without the addition of grass.
The adapted mowing head used for harvesting the grass for this experiment might be better but litter was still present, which can cause clogging of the reactor. An additional bottleneck is the fibrousness of the grass clippings; fibres can get stuck and cause damage to the digester. However, in the present experiment with 20% of grass in the substrate, the fibres did not create blockages nor foaming.

Different legislations determine the possibility to co-digest roadside grass clippings. First, pathogens and weed seeds should be killed. Moreover, the digestate obtained after roadside grass digestion must undergo an integral additional treatment to reach required process conditions described on OVAM's website[1]. Finally, in this experiment, the roadside grass was co-digested with manure. Therefore the digestate is also subjected to the Manure Decree[2]. This means that digestate of this combination of input materials needs to be treated by a facility meeting the hygienisation requirements and with a permit for manure treatment. This further highlights the need for policy revision for increasing the amount of roadside grass clippings being valorized in a circular economy concept.

[1] https://www.ovam.be/voorwaarden-voor-het-vergisten-van-bermmaaisel

[2] https://www.biogas-e.be/kenniseninnovatie/wetgeving/digestaat

Additional information

To read the full report on the experiment of anaerobic digestion, please visit https://www.biorefine.eu/projects/grassification

To learn more about the anaerobic digestion of grass clippings, please visit https://www.youtube.com/watch?v=R6xkHiMZWZE (video in Dutch)

Project partners:

With the financial support of:

www.interreg2seas.eu/en/grassification