
# Bothnia Nutrient Recycling

Biogas systems offer a range of benefits to society. Biogas production is currently prized for its climate benefits when replacing fossil fuels for the production of heat, electricity and vehicle gas, but at Bothnia Nutrient Recycling we have studied how to reuse the digestate, i.e. the residual product of production. We are working to improve profitability for biogas producers and develop a sustainable product from recycled nutrients, like phosphorus and nitrogen. Improving the use cases for digestate increases self-sufficiency in agriculture and contributes to a circular economy.

In the autumn of 2019, we began surveying the amount of digestate and existing knowledge in the Botnia-Atlantica region. We then investigated how to improve the efficiency of composting, the presence of microplastics and how quickly pharmaceuticals break down. Agricultural experiments in both Finland and Sweden have shown how well the different digestate products work as fertilizers for different crops. We can now also present assessments of recycling techniques and an initial marketing strategy for established and new products.

The project is being conducted in collaboration with our target groups: companies that produce biogas, entrepreneurs who can develop a commercialised digestate product, end customers and industry organisations. The work is taking place through project meetings, workshops, reference meetings and steering group meetings. We have also disseminated the results to the public, decision-makers and funding organisations. All work has been interdisciplinary, and we have improved project quality through inclusiveness to ensure gender equality.

## SUMMARY OF THE RESULTS

### Fewer pharmaceutical residues through anaerobic digestion

Novia UAS studied how twelve common pharmaceuticals break down during anaerobic digestion at 55 °C. The removal rate varied greatly between different pharmaceuticals. For example, paracetamol and the antibiotic trimethoprim degraded completely during anaerobic digestion. For diclofenac, which is for example used in the pain relief gel Voltaren, only a 30% reduction of the drug was measured at 30 days and a 23% reduction after 45 days. The hormone 17α-ethynylestradiol, which is used in many contraceptive pills, decreased on average by 72% after 30 days and 52% after 45 days. Reduced reduction after prolonged digestion may be due to several causes, for example the pharmaceutical degradation products are regenerated back to the parent drug

This study and several previous studies show that anaerobic digestion is not an effective method for removing pharmaceutical residues from sewage sludge, which means we need to develop additional post-treatment for reducing pharmaceutical residues to avoid spreading these in the environment.

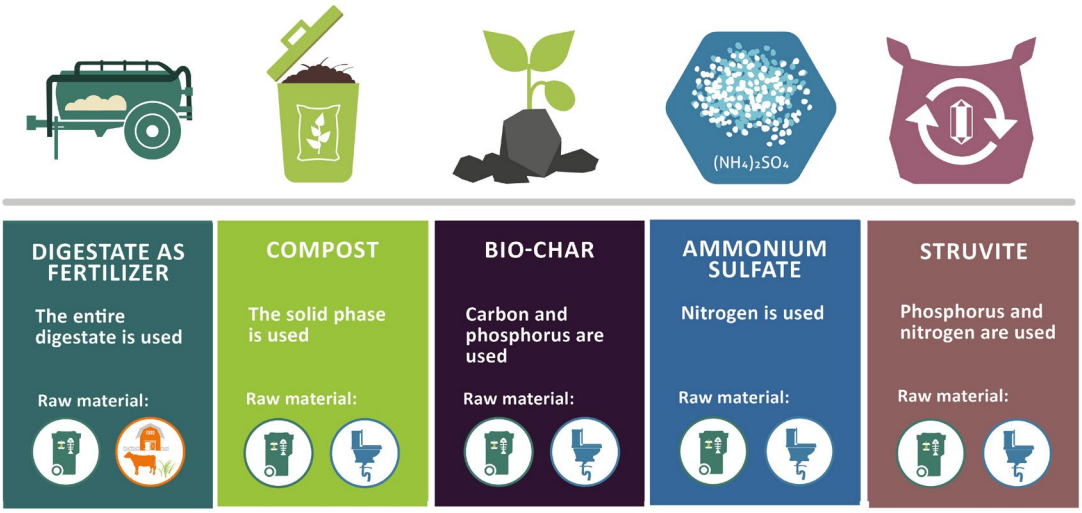
### Visible plastics

We have developed a method for determining visible plastic contaminants. This was done to demonstrate the occurrence of the visible plastic throughout the biogas plant and where measures could best be implemented to reduce the plastic in the process. This simplified method allows biogas plants to analyse the amount of plastic in digestate relatively easily and quickly and to compare these measurements against standard values

## Methods for determining microplastics

The presence of microplastics in digestate and reject water has been studied. Pre-treatment methods of digestate samples have been tested at Novia UAS but did not achieve satisfactory results. Additional improvements to methods are needed to remove unwanted organic material in the samples before microscopy and visual examination. The commercial laboratory ALS Scandinavia had the best success in determining the presence of microplastics in digestate and reject water samples and can be recommended to other biogas plants wanting to study the presence of microplastics.

During the project microplastics were studied in digestate and reject water from a biowaste reactor on three occasions and from a sewage sludge reactor twice. Microplastics were found in all samples, and the number of particles and plastic types varied greatly between sampling occasions.




## Demonstration experiments with digestate as fertilizer

The Swedish University of Agricultural Sciences (SLU) has conducted agricultural field tests in collaboration with agricultural high schools in Finland and Sweden. It may be possible to replace cattle slurry with compost when growing maize despite the low levels of nitrogen available to plants in the compost. When growing barley, NPK fertilizers gave the highest yield. Digestate from HEMAB and sludge biochar supplemented with recycled ammonium sulphate gave a slightly smaller yield and unfertilised gave the least yield. This digestate is better suited to barley than to grass because the viscous fertilizer did not penetrate the grass.

## Method for optimised composting processes

Ab Stormossen Oy has tested a more reliable method for measuring temperatures when composting digestate from biogas plants. It concluded this new method allows for better monitoring, adjusting and following up of the composting process. It provides a clearer picture of the process temperatures, saves time and facilitates compliance.

## Struvite

There have been attempts to extract struvite (magnesium ammonium phosphate) from iron-rich digestate. Conditions in the digestate have been changed by modifying the gas phase to obtain either struvite or vivianite (iron phosphate) as a dominant precipitate. Optimal conditions for vivianite are relatively easy to achieve (because sewage sludge contains iron from the purification processes), while struvite requires more reduction and sufficiently high sulphur content.

## Recycling technologies

Technically, pyrolysis (heating in an anaerobic environment) of sludge is a commercial solution that would solve many problems with contaminants in the digestate but at a high cost. Studies are needed on where sludge biochar can be used. Sludge biochar works like a phosphorus fertilizer, but phosphorus is relatively tightly bound due to the iron-based regent. On the positive side, pyrolysis of sludge has been introduced into European Biochar's methodology, which opens up an opportunity to sell carbon offset credits and provide an additional income source.

Using ammonium stripping for the manufacture of the nitrogen fertilizer ammonium sulphate is technically possible and is a commercially available and tested technique. A pilot-scale is recommended to test this technology. Crystallised ammonium sulphate can more easily be stored and sold during the growing season or transported long distances to a bulk buyer than liquid ammonium sulphate.

## Market introduction

Products need to be easy to use and affordable. In a broader perspective, a fertilizer's purity and quality should determine how it is used or processed and not the origin of the digestate. Industrial applications can be expected to be more stable and more competitive in terms of price than used in agriculture but with more limited demand.

Pricing for recycled end products has been estimated based on fossil equivalents, and currently they are more expensive. External risks characterise the availability of both nitrogen and phosphorus fertilizers. By requiring the addition of recycled nitrogen and phosphorus, recycled digestate products would become competitive. The perspective of the end consumer should also be considered in any such decision.

### FACTS ABOUT THE BOTHNIA NUTRIENT RECYCLING PROJECT

The project is conducted by Stormossen in Finland and runs from 2019 to 2022. The funding of 933,681 euro comes from the Botnia-Atlantica programme, Region Västerbotten, Region Västernorrland, Ostrobothnia Regional Council, Härnösands Energi & Miljö and VAKIN. In Finland, the project's partners are Ab Stormossen Oy and Novia University of Applied Sciences, and in Sweden BioFuel Region and SLU.

More information about the project can be found on our website:: Bothnia Nutrient Recycling