Factsheet
SYSTEMIC Demonstration Plant

Groot Zevert Vergisting (Beltrum, NL)

A short introduction to GZV

Groot Zevert Vergisting (GZV) is located in Beltrum, in the eastern province of Gelderland (the Netherlands). The Demonstration plant operates from 2004 and employs 40 full time equivalent (Table 1). It is a fast-growing company whose treatment capacity is 102 kt per year, making it one of the largest anaerobic digestion (AD) plant in the Netherlands. GZV has the ambition to become the first "Green Mineral Mining" Centre in the Netherlands.

Table 1. Technical information of the biogas plant.

Characteristics	
Date of construction	2004
Size	6.5 MWe
Volume	15 000 m^3
Digester type	Mesophilic digestion

Drivers for Nutrient Recycling

Intensive livestock farming has led to over-fertilization of agricultural land resulting in environmental problems due to phosphate (P) and nitrogen (N) leaching to ground- and surface waters. To prevent further accumulation of P in soils, the Dutch government has set application limits for P based on equilibrium fertilization. As a consequence, approximately 25% of the P produced by livestock farming cannot be applied within the Netherlands and therefore should be exported to neighbouring countries against high costs. Furthermore, in line with the Nitrates Directive, the yearly application of N from animal manure is limited up to 170 kg N per hectare (ha) or 250 kg N per hectare (derogation). This has led to a paradoxical situation in which farmers pay to get rid of their manure and meanwhile purchase mineral N-fertilizers to comply with crop nutrient demands. According to GZV, there is an existing demand in the region for each individual nutrient recovered from digestate except for P-rich fertilisers which need to be exported. Though the region hosts far more cows than pigs, the majority of the manure treated at GZV comes from pig farms. This is because arable farmers prefer dairy manure over pig manure due to its lower P content. Disposal costs of pig manure can be as high as 20-25 €/m^3.

Feedstocks

In 2018 the co-digestion GVZ plant will increase its treatment capacity from 102 to 135 kt substrate (Table 2).
Animal manure will be the major substrate (more than 70% of total feedstock), and pig manure will be collected from about 55 pig farms.

Table 2. Origin of GZV feedstock (2017 and 2018).

Type	Origin	Mass (2017)	Mass (2018)
Manure	Pig manure	65 kt	80 kt
	Dairy manure	2 kt	5 kt
	Slaughterhouse manure	12 kt	15 kt
Co-products	Waste dairy industry	12 kt	15 kt
	Waste feed industry	8 kt	15 kt
	Glycerin	3 kt	5 kt
Total		**102 kt**	**135 kt**

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Biogas production

The biogas produced every year is around 10 Mm^3 (Table 3). About 80% of the produced biogas is transported through a 5 km-long pipeline towards a milk factory (Friesland-Campina). About 20% of the produced biogas is converted to electric power and used at the site.

Table 3. Yearly biogas production and average composition before purification.

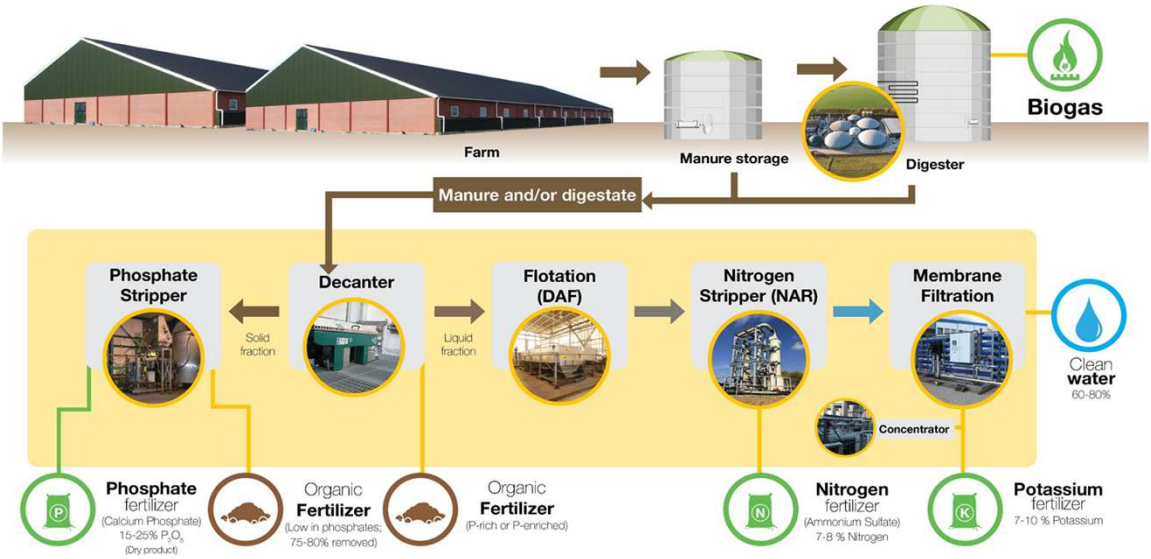
Component	
CH_4 (%)	58
CO_2 (%)	40
H_2S (ppm)	2000-3000
O_2 (%)	0.2
Total biogas production (Mm^3)	10
Biogas per tonne of feedstock (m^3/t)	75

Nutrient Recovery and Reuse (NRR) Technologies

Currently, the digestate is separated trough a screw press in a solid and liquid fraction. The liquid fraction is used as a N-fertilizer on agricultural land in the Netherlands. The solid fraction is, after a hygienization step (60 minutes at 70 °C), exported to neighbouring countries where it is used as an organic P-fertilizer. Part of the digestate is also applied directly on the field in Germany. In collaboration with Nijhuis and Wageningen UR, GZV will implement a system for NK recovery from the liquid fraction (GENIUS) and P recovery from the solid fraction (RePeat).

The GENIUS and RePeat processes

In phase 1 (GENIUS-NK) the digestate is separated into a solid and a liquid fraction by means of a decanter. The N-rich liquid fraction will be processed into a nitrogen-potassium (NK-) concentrate and clean water through a combination of DAF and membrane filtration (RO).
In phase 2 (GENIUS-Total) the system will be extended with an ammonium stripper (NAR) before the micro-filtration step. Finally, an evaporator will concentrate the output from the RO step, increasing the amount of produced clean water. Final products will be ammonium sulphate (AS) and liquid K fertilizer (K-concentrate).
The P-rich solid fraction will be treated with a P-stripper called "Re-P-eat" through a process of acid (H_2SO_4) and base $Ca(OH_2)$ addition. The products of this process will be mineral calcium phosphate (CaP) and a P-poor organic soil conditioner.



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Products and market

In the GENIUS-Total process, N and K can be sold as separate products whereas GENUIS-NK produces a NK-concentrate. AS is free of organic matter, while K-fertilizer contains dissolved organics. The recovered water (50-60% of total volume in phase 1 and up to 80% in phase 2) meets stringent criteria for discharging to surface water. The recovered mineral phosphorus can be exported to regions with a demand for P-fertilizers (e.g. France) or used as a feedstock for the production of triple-superphosphate at ICL Fertilizer. The P-poor organic matter can be used a soil conditioner to increase carbon contents. Product characteristics are listed in table 4.

Table 4. Expected composition of the recovered products.

	Ingoing digestate	Recovered products				
		NK-fertilizer	Ammonium Sulphate	K-concentrate	Soil Conditioner	P-fertilizer
Dry matter (DM %)	5.8				32	82
Organic Matter (%)	65% of DM	1-3	<0,1	2-15	89% of DM	45% of DM
N-total (g/kg)	6	8-15 NH_4-N	75-85 NH_4-N	15-30 NH_4-N	5.0	20
P_2O_5-total (g/kg)	3.5	0.2-0.4	<0.1	1-2	3.2	140
K_2O-total (g/kg)	4	8-20	<0.1	60-80	0.2	5
Volume (%)	100	5-10	5-10	5-10	20	2

Economic benefits

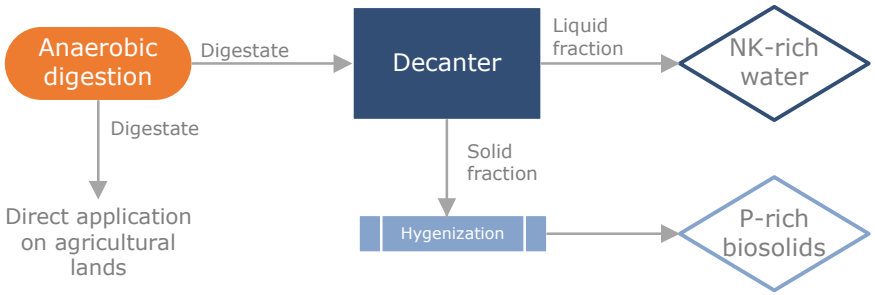
Digestate volume is reduced by 60-80%. Only small volumes of concentrated minerals need to be transported or applied on fields, leading to reduction of digestate transport cost over long distances. Nijhuis estimated that treatment costs will decrease to 13 € per cubic metre of manure processed.

Sustainability goals

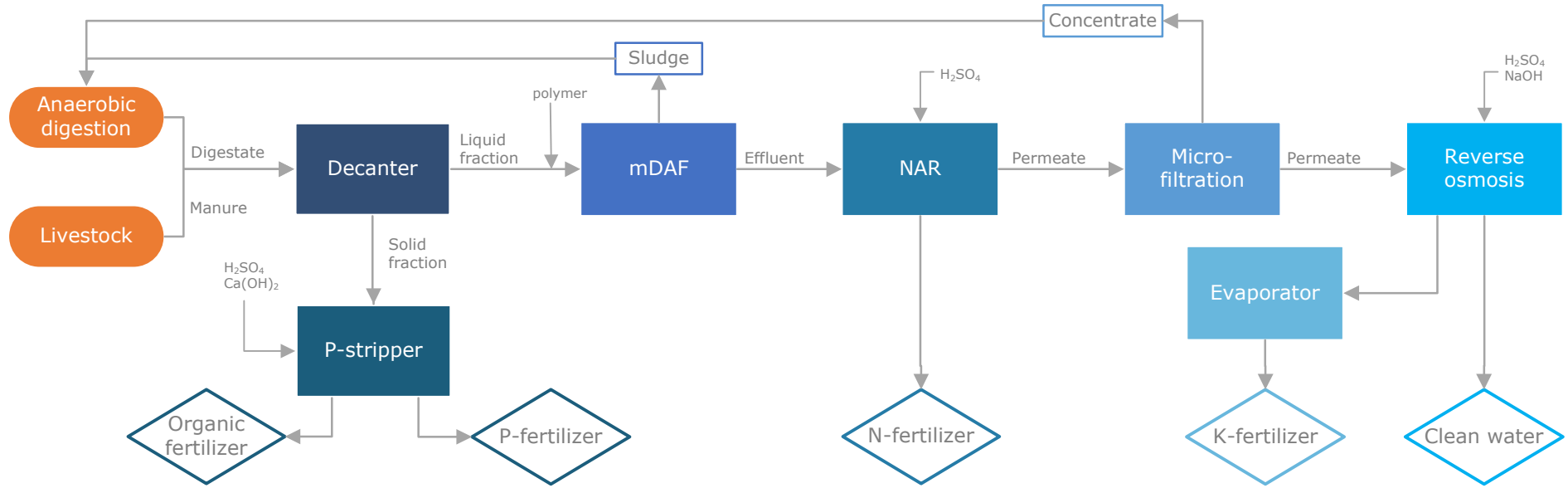
GZV is committed to reach to following targets:

- Reduce CO_2 emissions related to manure transport and the production of mineral N-fertilizer.
- Prevent losses of P, a non-renewable and potentially scarce mineral.
- Increase the carbon-content of soils: nutrient-poor digestate after treatment can be applied in the nearby region as a soil conditioner to improve soil quality for food production.

Annex 1: Groot Zevert Vergisting Demonstration installation – Beltrum (NL)



Current process



Envisaged process in phase 2 of GENIUS-Total

Technical specifications:

Current process

Name	Type	Treatment capacity (m^3/h)	Power consumption (kW)	Heat requirement (kW)
Decanter	Mechanical separation	16	24	-

Envisaged process

Name	Type	Treatment capacity (m^3/h)	Power consumption (kW)	Heat requirement (kW)
Decanter	Mechanical separation	28	36	-
DAF	Mechanical separation	32	17.6	-
Hygenisation	IR	3	48	320
P-stripper	Stripping	3	25-50*	-
NAR+CO_2 stripper	Stripping	25	56	500
Micro-filtration	Membrane filtration	25	225	-
Reverse Osmosis	Membrane filtration	20	62	-
Evaporator	Evaporation	5	85	900

*estimated data