



Cover Delivery Report

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Construction-, monitoring-, or demonstration-activities at demonstration plants (year 2)



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Summary

The following report refers to D1.19 of Systemic project: "Construction-, monitoring-, or demonstration-activities at demonstration plants (year 2)".

The report, compiled in collaboration with the 5 demonstration plants, includes a descriptive chapter for each of them.

In regard to Groot Zevert Vergisting, the status of planning and construction is described for both RePEat and GENIUS processes. Moreover, the demonstration activities organized in the past year and foreseen for the next year are also outlined.

For AM-Power, Acqua & Sole and RIKA Biofuels, the planning of engineering and construction is described, including an explanation for the delay. BENAS demo is currently the only demo plant that is fully operational with NRR system.

Results obtained from the monitoring of the demo plants are extensively reported in D1.3 '*Second annual updated report on mass and energy balances, product composition and quality and overall technical performance of the demonstration plants*' and D1.11 '*Document on product characteristics, lab results and field trials*'.

1 Groot Zevert Vergisting

1.1 Status and planning of construction

GENIUS process for treatment of the liquid fraction of digestate

The GENIUS installation was constructed in 2018 and commissioned in January 2019 and has been in operation since that moment. The installation consist of multiple separation and treatment units including two decanter centrifuges, a hygienisation unit, a dissolved air flotation (DAF), a microfiltration, and a reverse osmosis and ionic exchange installation (Figure 1.1). The investment in the GENIUS installation is not part of GZV's SYSTEMIC budget but monitoring of the GENIUS installation and products thereof are part of the SYSTEMIC project.



Figure 1.1 Photo's of the new GENIUS installation for the production of solid fraction, NK concentrate and clean water from digestate

RePeat process for treatment of the solid fraction of digestate

GZV invested in a full scale installation for the separation of P-rich solid fraction of digestate into a P fertiliser and a low-P soil improver. The full scale installation will have capacity of 15.000 ton y⁻¹ which equals the production of solid fraction from 130.000 ton digestate.

At the time of writing, construction was still in process. Several units were already installed including all mixing and storage tanks, a storage facility for the solid fraction, a settler for removal of fine particulate matter and screw presses for dewatering. The delays in the construction were in part caused by difficulties in purchasing the precipitation reactor. The precipitation reactor is a conus-shaped tank with a volume of about 70m³ and equipped with a rotator and aerator as well as sensors and dosing points for chemicals. Delivery time on this large and special reactor was longer than expected. The struvite reactor has now been delivered (Figure 1.2) and will be installed on site in October. Thereafter, instalment of piping, cables and electronics will start. Commissioning is now scheduled for the third week of November.



Acidification tank

Plateau with screw presses

Storage tanks and phosphate dewatering

Figure 1.2 Photos of the new RePeat installation at GZV

1.2 Monitoring activities

Monitoring of the biogas plant prior to implementation of NRR (reference situation)

In 2018, prior to the commission of the nutrient recovery installations, mass- and energy balances of the biogas plant were monitored in order to establish the reference situation for GZD.

The monitoring included:

- Monthly analysis of NPK in the digestate
- Collection of data on the use of additives in the biogas plant including additives used for gas desulphurisation.
- Biogas and electricity production
- Consumption of electricity and heat subdivided into the major units including the biogas plant, desulphurisation unit and the hygienisation unit

Monitoring of the GENIUS installation

Monitoring of the GENIUS installation started in April after commission and optimisation of the installation.

The following aspects are included in the standard monitoring programme of the GENIUS installation:

- Sampling of the ingoing digestate, intermediate flows and end products occurs every two weeks. The position of sampling points is given in Figure .3. Samples are send to a commercial lab and analysed on:
 - Dry matter
 - Organic matter
 - N, P, K, S
 - Ca, Mg, Fe
 - pH
- Measurement of the in- and outgoing and intermediate flows. The position of the six flow meters (Figure) enables setting up a mass balance of in- and outgoing flows. The flow rates are automatically recorded and daily-averaged numbers are send to Wageningen Environmental Research for further data processing
- Consumption rates of chemicals including sulphuric acid, polymer, magnesium chloride and flocculant are collected on a monthly basis or more frequent.
- Electricity consumption of the overall installation is monitored on a monthly basis. The electricity consumption per separation unit is estimated from the machines wattage.
- Gas consumption of the infrared hygienisation unit is monitored on a monthly basis.

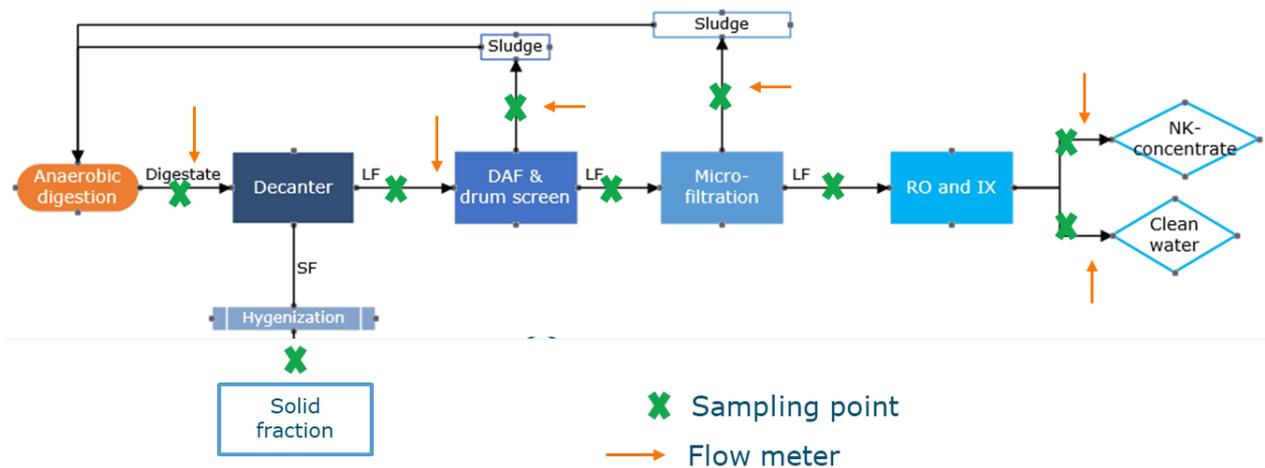


Figure 1.3 Simplified process scheme of the GENIUS installation at GZD including sampling points and position of flow meters

Monitoring of the RePeat installation

Monitoring of the RePeat installation has started in August 2019.

The monitoring programme includes:

- Monitoring of mass and flow rates; The RePeat installation is equipped with 8 flow meters and a weighing belt for the ingoing solid fraction. Data are recorded automatically and daily averages are used for construction of the mass balance. Weight of the end products being the big bags with struvite and trucks with soil improver, are recorded manually per batch leaving the plant.
- Analysis of samples. The sampling campaign includes the ingoing and outgoing flows as well as most of the intermediate flows (Figure 1.4). The sampling positions have been chosen as such that a mass balance can be constructed for each separation unit. Samples will be taken every two weeks and analysed on;
 - Dry matter
 - Organic matter
 - N, P, K, S
 - Ca, Mg, Fe
 - pH
- Electricity consumption of the whole installation and per separation unit (3 units) are recorded automatically
- Chemical consumption rate (sulphuric acid and magnesium hydroxide) is recorded automatically

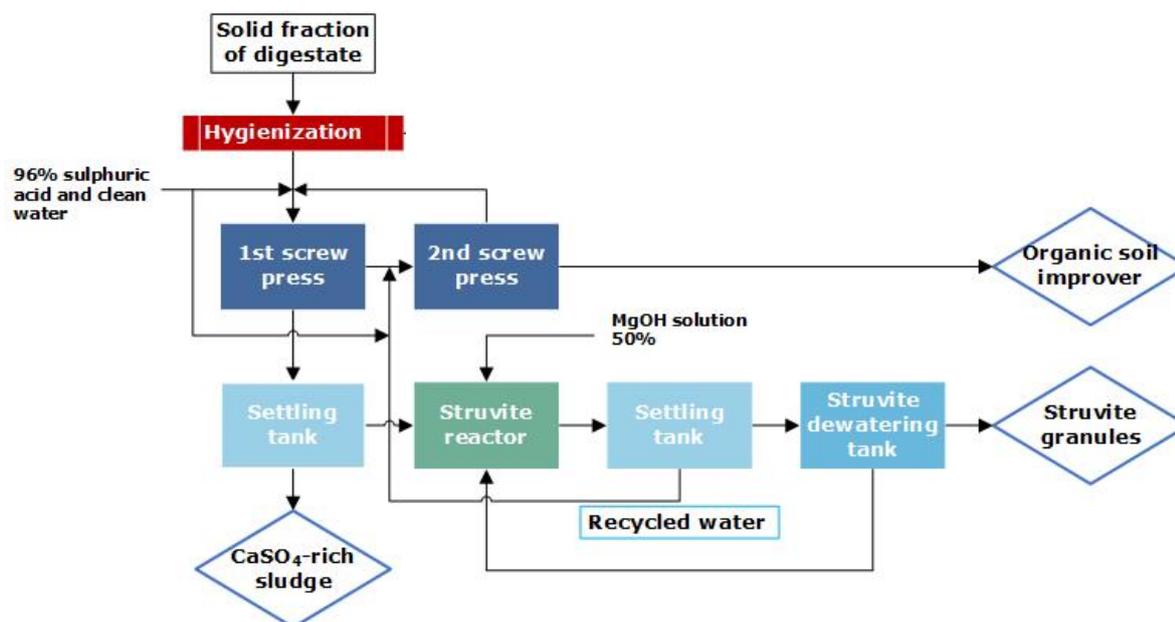


Figure 1.4 Process scheme of the RePeat installation including sampling points and position of flow meters

1.3 Demonstration activities

Since the start of the SYSTEMIC project, there have been over 30 plant visits of smaller and larger groups. A full list of dissemination activities is available in SYSTEMIC's report on dissemination activities. Here, a selection of key events is given.

Key demonstration activities are:

- 4 September 2019: The Green Mineral Mining Centre of GZV was officially opened by her majesty Queen Máxima of the Netherlands. About 200 invited visitors attended the official opening ceremony. [Read the news item here \(English\)](#).
- 16 May 2019. Plant visit to Groot Zevert Vergisting organised by VCM and BiogasE as part of WP3 of SYSTEMIC. The 40 visitors were mostly representatives from private companies including biogas plants, fertiliser trading companies and engineering companies.
- 11 September 2019. Online release of a [plant movie](#) for the general public (In Dutch).
- 29 May 2019. Online release of a plant video for farmers and engineers in [Dutch](#) (4500 views) and [English](#) (350 views) .

2 AM-Power

2.1 Status and planning of construction

The installation of the vacuum evaporator consists of 2 identical units, each with an evaporation capacity of $150 \text{ m}^3 \text{ d}^{-1}$. The first vacuum evaporator was delivered in January 2019 and connected to the decanter centrifuge in April 2019. The second vacuum evaporator was delivered in April and installed in June 2019 (Figure 2.1).



Figure 2.1. The new evaporator units installed at AM-Power.

The start-up and the initial tests on water, as a treated medium, were successful. Further preliminary tests have been conducted on the liquid fraction of digestate and results were encouraging. After evaporation, the DM content of evaporated liquid fraction of digestate reached 22%. If we compare this to DM content of initial digestate before mechanical separation, we can observe a potential increase of DM content up to 4-5 times due to the evaporation process.

Currently, AM-Power is investigating the optimal polymer dosage required for the best performance of the evaporator. The evaporator manufacturer is finalizing some technical aspects of the unit and implementing the software for the remote control of the system. According to the plant owner entire installation should be fully operational by December 2019/January 2020. Figure 2.2 gives an overview of the whole process scheme of the NRR scheme.

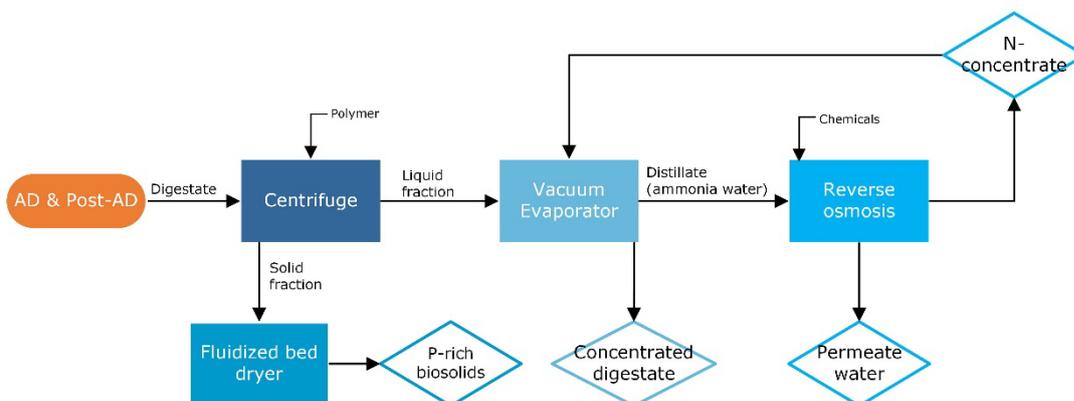


Figure 2.2. Final process scheme of demonstration plant AM-Power.

2.2 Monitoring activities

A short sampling campaign was conducted by UGent, which included the sampling of intermediate and final streams generated at AM-Power during the period of September-October 2018. The results will be used as baseline scenario to compare the performance of the new NRR system which is currently under construction.

In the past months, AM-Power has installed flow meters to monitor ingoing and outgoing streams of different unit steps. A new sampling campaign of the nutrient recovery plant will be carried out by UGent as soon as the system is fully operational and stable, which is provisionally expected to occur in December 2019/January 2020. This will include monitoring of the mass- and energy balances, consumption of additives and assessment of product quality.

Flow meters have been installed at the following sampling points:

- Decanter centrifuge: ingoing raw digestate, added polymers, outgoing liquid fraction
- Vacuum evaporator: ingoing liquid fraction digestate, incoming tap water for evaporator cleaning, outgoing concentrated digestate, outgoing condensate
- Reverse Osmosis: ingoing condensate, outgoing permeate water, outgoing centrate.

2.3 Demonstration activities

As part of the Systemic workshop, a guided visit to AM-Power took place on September 18 2019 with around 45 visitors. A second visit is planned on September 27 2019 under the guidance of Stefania Rocca (H2020 Systemic advisor) and Erik Meers (H2020 Systemic WP1 leader) with a delegation of EC representatives.

3 Acqua & Sole

3.1 Status and planning of construction

On the 19th of April 2019, Acqua & Sole obtained the authorization for the construction of the new absorption section (Figure 3.1).



Figure 3.1. The new absorber unit installed at Acqua & Sole.

The start-up of the plant was scheduled for the end of July 2019, but the supply of recirculation ammonium sulphate pipes (made of alloy 825) was delayed of 6 weeks and Acqua & Sole is still waiting for a declaration of the supplier about this issue. As a result, the construction phase has been delayed. Since the startup of the new absorption unit has to be coordinated by switching off the existing unit (this transitional period should be as short as possible in order to avoid ammonia inhibition in the digestion process), the startup of the new unit has been rescheduled for the end of September/first week of October 2019. Figure 3.2 gives an overview of the whole process scheme of the NRR scheme.

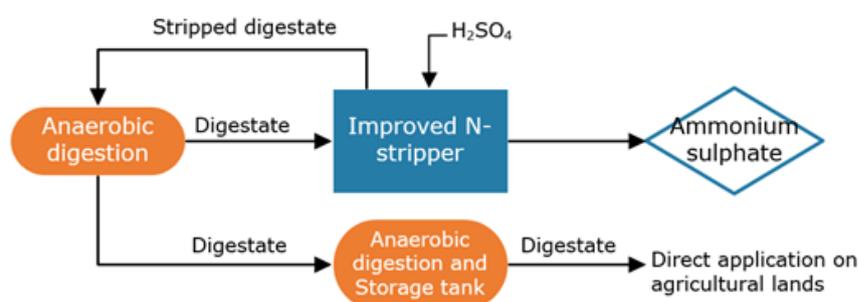


Figure 3.2. Final process scheme of demonstration plant Acqua & Sole.

3.2 Monitoring activities

The monitoring activities in the second year were significantly expanded. Information on the mass of feedstock input, biogas and methane production, power generation and consumption, digestate and ammonium sulphate production was gathered once a month. Starting from January 2019, University of Milan has been performing the chemical characterization of produced ammonium sulphate and digestate. This monitoring has resulted in a more detailed mass balance and product quality assessment, which are

reported in D1.3 '*Second annual updated report on mass and energy balances, product composition and quality and overall technical performance of the demonstration plants*' and D1.11 '*Document on product characteristics, lab results and field trials*'.

3.3 Demonstration activities

As every year, Acqua & Sole organized an open day at their biogas plant. A total of 15 visits were organized during 2018. Visits organized for specific groups (such as farmers, public institutions) included on average 10-20 people; while events organized in collaborations with schools reached groups of 80 students.

4 RIKA Biofuels

4.1 Status and planning of construction

The reason for the delay in the construction of the biogas plant is that the Environmental Agency demanded detailed design at a very late stage in the planning application. RIKA Biofuels completed the design work and successfully attained planning permission for the project. However, in September 2016, changes in renewable energy policy occurred and Feed-In Tariff (RIKA's renewable subsidy) for projects with an output over 500 kW electricity (kWe) has been effectively removed. Other potential uses of the gas (biomethane injection and liquid biomethane as a transport fuel) were explored, but the business case could not sustain without the CHP Feed-In Tariff.

Fortunately, RIKA Biofuels has another site under development at Fridays Eggs in Kent which will substitute Oaklands demonstration installation. This project is identical to Oaklands as it will rely on DVO technology to process at least 57 500 tonnes per annum of poultry manure. This is a gas to grid project and as such does not rely on the Feed-in Tariff over 500 kWe like Oaklands. The project has a planning permission, a grid connection and funding. After a delay of more than a year, the UK Government finally introduced new renewable heat tariffs in May 2018 for which RIKA applied. Subsequently, construction of the Fridays project started in December 2018 with the commissioning targeted to take place in November 2019. Figure 4.1 gives an overview of the whole process scheme of the NRR scheme.

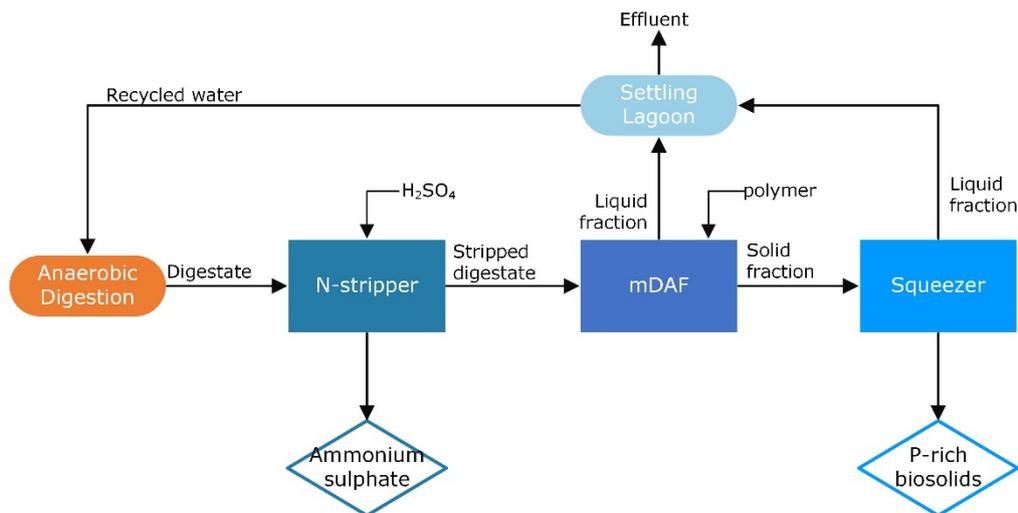


Figure 4.1. Final process scheme of demonstration plant RIKA Biofuels.

4.2 Monitoring activities

Due to a fire accident at the biogas plant located in the USA, which served as a replacement of the UK plant, no monitoring activities were conducted during the second year of SYSTEMIC project.

4.3 Demonstration activities

Since the plant has not been built yet, demonstration activities have not taken place.

5 BENAS

5.1 Status and planning of construction

In order to make the electricity production more flexible, BENAS has completed the construction of an additional storage tank. Two additional CHPs have been installed and all digesters have been improved with new roofs (Figure 5.1).



Figure 5.1. Aerial view of demonstration plant BENAS.

From January 2019 the biogas plant is operating with high flexible power generation. For grid stabilization, the cogeneration installation is sometimes completely disconnected from the grid for a few hours. During this periods, the produced biogas is collected in the gas reservoirs and no power and heat are produced. Since the FiberPlus system relies on waste heat from the CHP, it turns into a "sleep mode" during these shutdown phases. Currently, the biogas plant and the NRR system operate successfully in a fluctuating mode, as demonstrated during the monitoring campaign performed by Ghent University between January and April 2019 (results reported in D1.3).

In order to achieve the production of high quality biogas fibers for the market, different experimental trials have been executed, generating in total almost 1 kt DM y^{-1} . Biogas fibers have been tested as an input material in wood, paper and non-woven industry: and new business models for different applications are in preparation. BENAS plans to increase the fiber production to about 6 kt DM y^{-1} in 2020/2021.

In regards to the possibility of recuperating P, BENAS has characterized their LFs digestate for total-P, water-soluble P and calcium acetate/calcium lactate (CAL)-soluble P content. Measurements were executed on two different intermediate streams of BENAS NRR system (Figure 5.2):

- LF raw digestate after screw press 1
- LF stripped digestate after screw press 2

Results showed that 88% of P contained in LF raw digestate and 95% of P in LF stripped digestate are plant-available. In order to segregate a higher amount of P in SF digestate, BENAS has conducted a separation trial including the addition of iron salt and natural starch polymer to the stripped digestate prior separation via screw press 2. Results have shown that the amount of plant-available P in the SF stripped digestate was higher than 95%. Further separation trials on screw press 1, including limited amounts of flocculants, were carried out as well. Results have shown that 50% of total-P in LF stripped digestate (containing 60-80% of plant-available P) was successfully removed, allowing the system to generate high-P press cake.

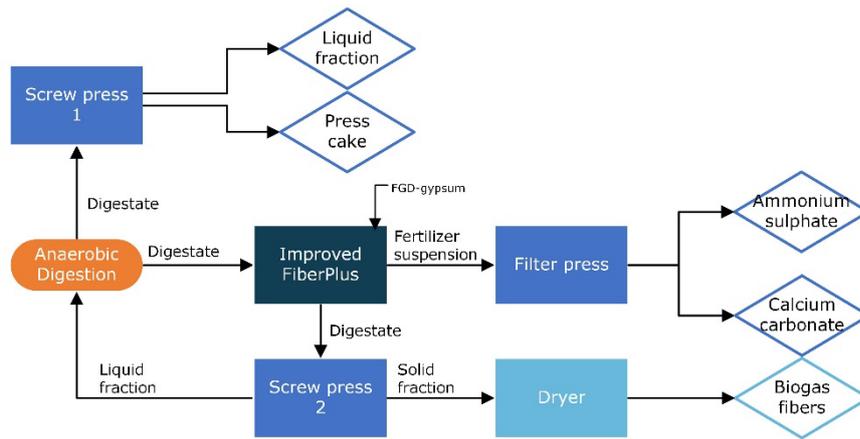


Figure 5.2. Final process scheme of demonstration plant BENAS.

5.2 Monitoring activities

The monitoring activities in the second year were significantly expanded. The online data from the plant control SPS of the FiberPlus stripping plant (capture: 1 value/sec) was collected and processed by GNS on a monthly basis. Monthly averages and daily means were compiled. Additional data from the biogas plant have been collected (e.g. mass of feedstock input, biogas and methane production, power generation and consumption, digestate and biobased fertilizers production). Gypsum consumption and calcium carbonate production were calculated by GNS and Ghent University. From January till April 2019, Ghent University has been collaborating on the monitoring activities of BENAS by performing the chemical characterization of all generated intermediate and final products. This monitoring has resulted in a more detailed mass balance and product quality assessment, which are reported in D1.3 'Second annual updated report on mass and energy balances, product composition and quality and overall technical performance of the demonstration plants' and D1.11 'Document on product characteristics, lab results and field trials'.

5.3 Demonstration activities

Since the start of the Systemic project, there have been over 25 demonstration activities for various target audiences. A full list of dissemination activities is available in the report on dissemination activities. This can be summarized as follows:

- 9 poster presentation, flyer dissemination, short statements and lecture at conferences, workshops and exhibitions in Germany (1 time in Brussels)
- 2 popularized publications in German biogas magazines and series
- 7 publication campaigns in online media (newsletters, websites)
- 8 meetings, consulting with interested applicators of NRR technologies
- presentation of the SYSTEMIC project in numerous technical discussions with users, policy makers and researchers
- "Open House Day" at the BENAS plant on the 13th of July 2019 with about 500 participants: the EU-project SYSTEMIC in Germany was symbolized with EU-flags and German-flags in the presentation hall, the visitors could read information at posters and papers about SYSTEMIC in German and English

New activities in progress include:

- two press releases in German about the SYSTEMIC GA in Halle with information of the project (publication in "Energie aus Pflanzen" expected for August 2019; publication in "Umweltmagazin" expected for September 2019);
- an article in the local newspaper "MZ" written by an independent journalist (7th of June 2019);
- BENAS plant video has being realized: the preparation and shooting are complete (German with English subtitles) and the video is expected to be finalized in September 2019.



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Horizon 2020

Systemic large-scale eco-innovation to advance circular economy and mineral recovery from organic waste in Europe

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