FH MÜNSTER EGU FB Energie · Gebäude · Umwelt Energy · Building Services · Environmental Engineering

Interreg Deutschland – Nederland CREATE

Energy Recovery from Wastewater

Interreg D-NL Project CREATE

05.11.2026

Project Consortium

Funded by

1

Content

1. Welcome

- Who we are

2. Introduction

- Project Overview
- Results from Practical Example
- SME-Calculation Tool

3. Lessons Learned & Next Steps

4. Discussion (Q&A)



Figure: EGSB-Reactor at the Bioenergy Park Saerbeck, © FH Münster

2

Research Team

Prof. Brügging and Prof. Wetter



Figure: Group photo of research team Prof. Brügging and Prof. Wetter from the IEP (FH Münster)

Currently 40 team members
23 research associates
2 administrative assistants
5 non-scientific employees
10 research assistants

Three research groups
For more than 25 years at the institutes **IEP** and **IWARU** with a total of approx. 120 successfully executed R&D projects

CEW

Centre of Expertise Water Technology



The **Centre of Expertise Water Technology (CEW)** is a unique collaboration in education, government and business, with the goal the strengthening of knowledge in the field of water technology.

You can reach us for applied research and development in the field of water technology.

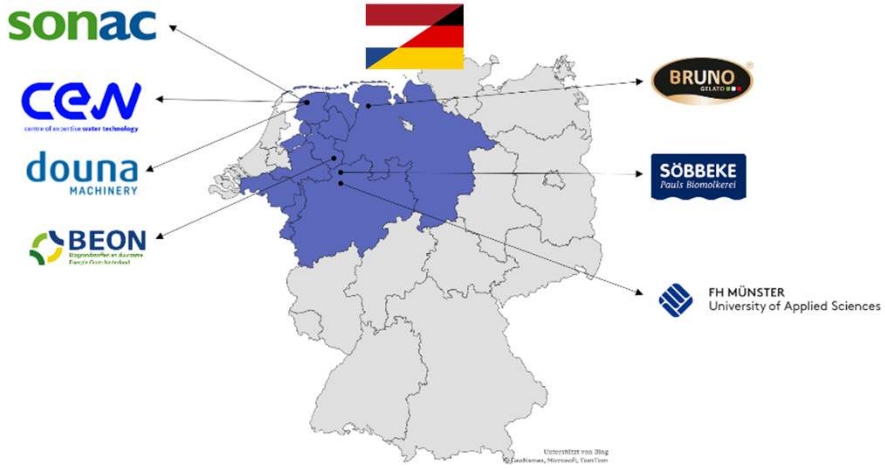

Experimental Hall


Microbiological Lab


Chemical Lab


Molecular Biological Lab

Project Consortium



5

Which gas is the main energy-carrying component of biogas?

Welk gas is de belangrijkste energiedrager in biogas?

- Methane (Methaan) ✓
- Oxygen (Zuurstof)
- Carbon dioxide (Koolstofdioxide)

6

Project Overview

Interreg Deutschland – Nederland CREATE | CEN | FH MÜNSTER

Use of **sources** for energy generation and reduction of greenhouse gas emissions

- Dairy industry
- Breweries
- Sweets and candy production

Unlock untapped **potential for energy generation** from wastewater and utilizing other renewable sources to maximize the yield

Facilitate **cross-border exchange** of experience and knowledge in anaerobic wastewater treatment

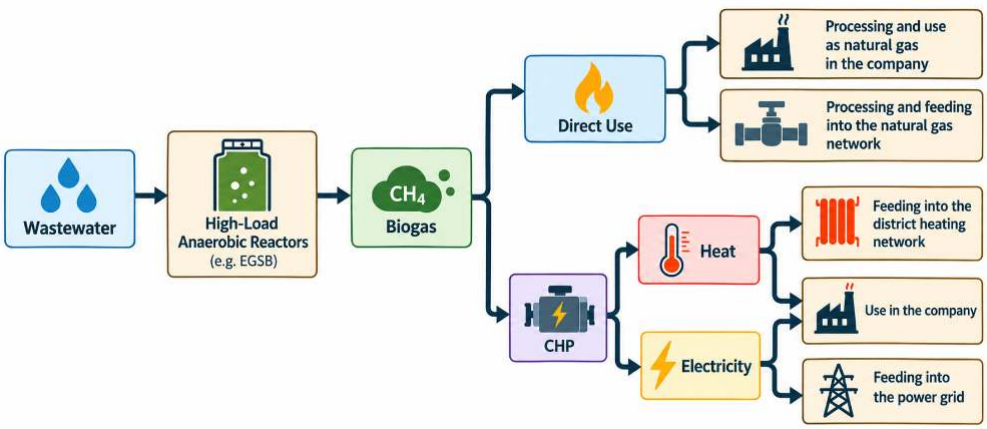
Further development of **anaerobic wastewater treatment (AWT)** using in-situ methanation



7

Project Overview

Interreg Deutschland – Nederland CREATE | CEN | FH MÜNSTER



CHP: Combined Heat and Power (Deutsch: BHKW | Nederlands: WKK)

8

How much can anaerobic treatment reduce the organic load (COD) of suitable industrial wastewater under favorable conditions?

How much the pollutants can be reduced?

In hoeverre kunnen de verontreinigende stoffen worden verminderd?

- 5–15%
- 40–50%
- Over 80% ✓

9

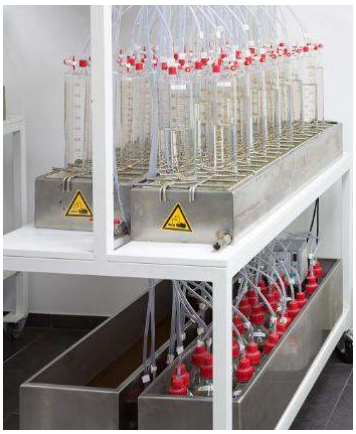
Characterization

VDI 4630 – Biogas Potential Assesment

Identification of usable energy and material flows from wastewater and residual streams

Collection of organically loaded wastewater and side streams

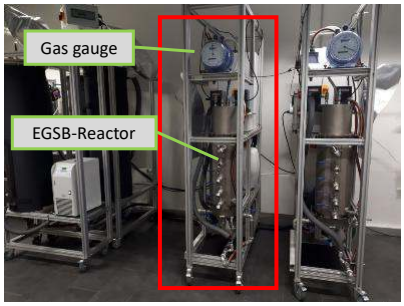
Batch (1L) tests to determine the **Biom**ethane **P**otential (BMP)

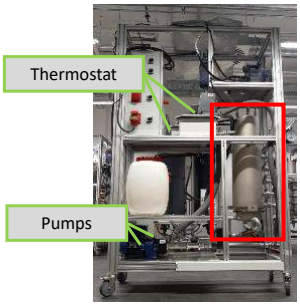


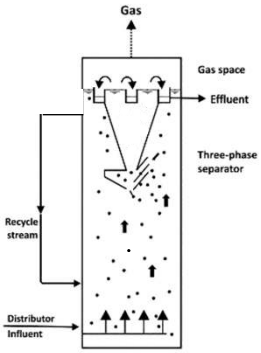
10

Validation

- Operation of an **E**xpanded **G**ranular **S**ludge **B**ed (**EGSB**) reactor with real wastewater
- Visualization and interpretation of measurement results







11

What is the main advantage of EGSB reactors?

What is the main advantage of EGSB reactors?

Wat is het belangrijkste voordeel van EGSB-reactoren?

- They can treat wastewater at high organic loading rates (Ze kunnen afvalwater behandelen bij hoge organische volumebelastingen)
- They eliminate all pollutants (Ze verwijderen alle verontreinigende stoffen)
- They do not produce sludge (Ze produceren geen slib)

12

Sludge Bed Reactors

Biogas from Wastewater Using EGSB Reactors

Advantages of Anaerobic Reactors:

- Energy recovery through biogas
- Low excess sludge production and high microbiome adaptation
- Can degrade substances that are not biodegradable under aerobic conditions
- No compressors required for oxygen supply

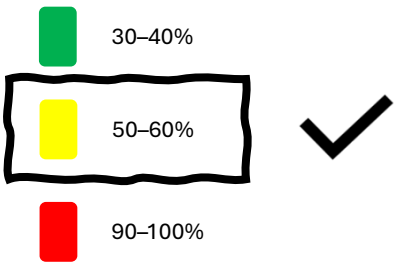
Disadvantages of Anaerobic Reactors:

- Effluent quality for direct discharge can normally not be achieved
- Susceptible to disturbances under certain conditions
- Reactor must be heated to 35°C – 37°C



How much methane is present in biogas?

Hoeveel methaan zit er in biogas?



Practical Example (Söbbeke)

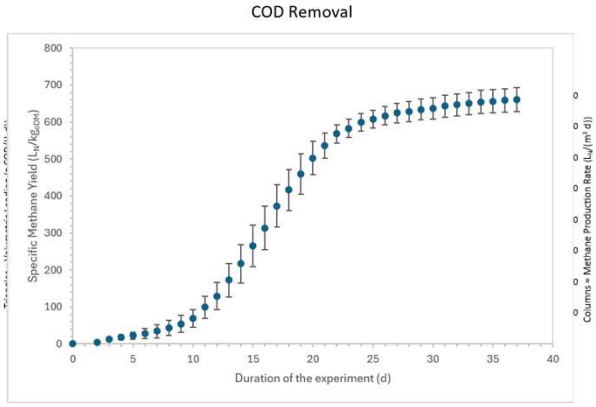
Biogas from Wastewater Using EGSB Reactor

Analyzed materials:

- **Source:** Wastewater, feed milk, and ultra-filtration permeate
- **pH:** 3.6 – 9.7 → wide range, depending on material flow
- **COD:** 3.4 – 120 g O_2/L → high organic load in feed milk

Results:

- **Methane production:** up to 16.5 L/kg fresh matter
- **Methane production:** up to 245 L/kg organic dry matter
- **Methane volume per year:** 40,000 – 50,000 m³
- **Energy potential:** up to **400,000 kWh/a** of usable energy through biogas production and (approx. **7%** of NG could be substituted)



Practical Example (Söbbeke)

F|Heat: District Heating Network Planning



Energy potential: theoretically **200 kW** of usable energy through a heat pump (**6000 hours** per year)

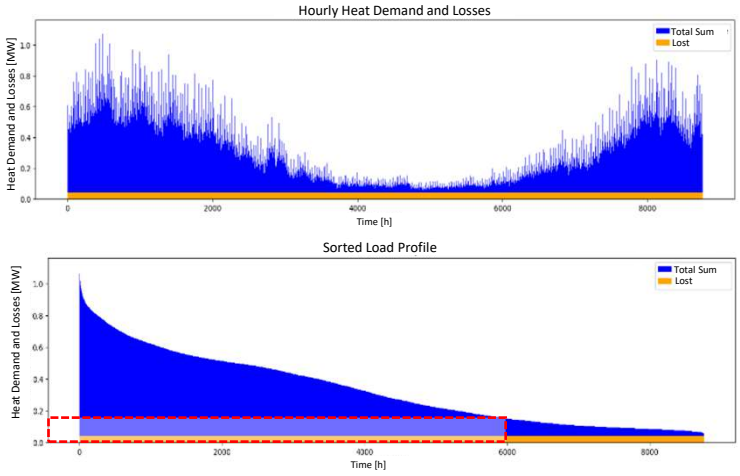
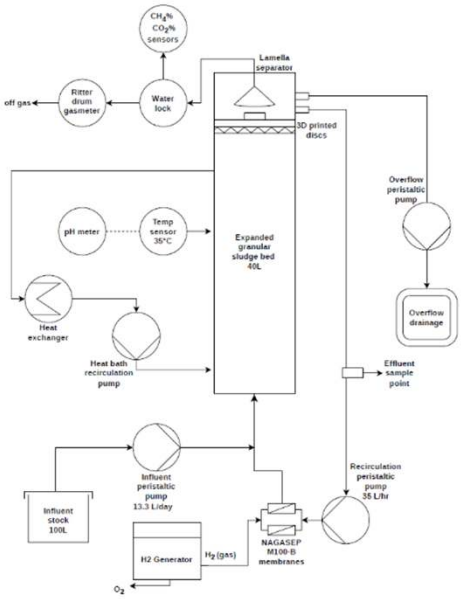


Figure: Possible local heating network including load profile around the location of Söbbeke

Hydrogen addition with hollow fibre membrane



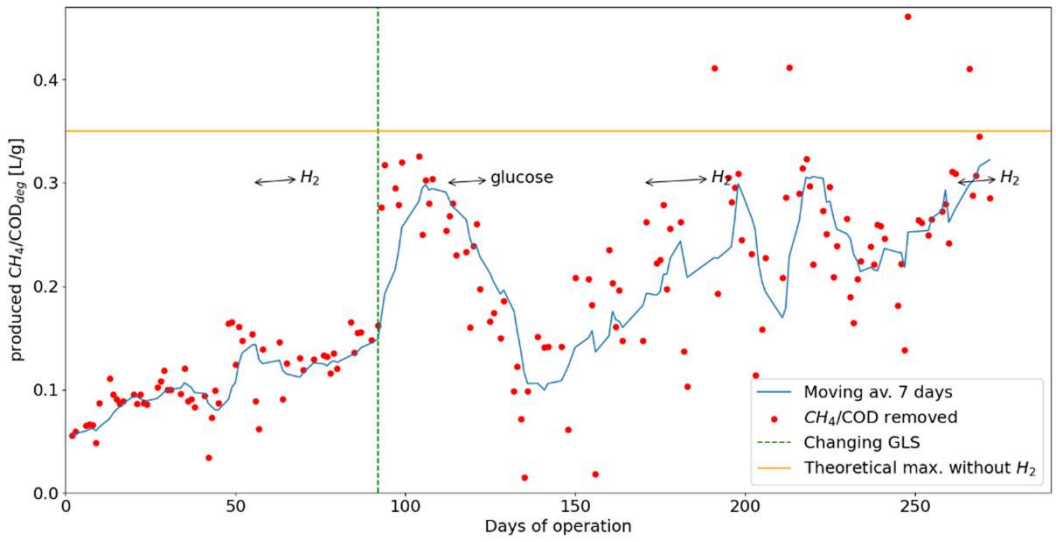




17

17

Produced methane from COD removal



18

18

Reactor microbiology

Optimal growth of Hydrogenotrophic methanogens like Methanobacterium is at a moderate H_2/CO_2 partial pressure around **0.2–0.5 atm**, with growth slowing or stalling above about **0.8–1 atm**.

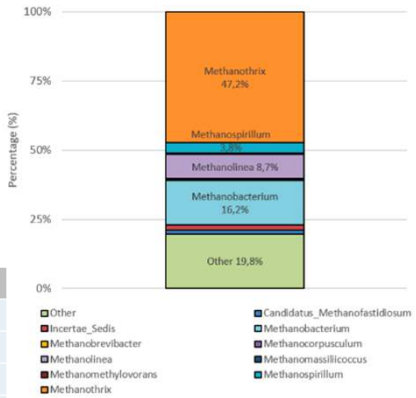
Use a stepwise/gradual introduction of hydrogen gas.
Finally, maintain the right H2:CO2 ratio - **4:1** volume ratio

Improve hydrogen mass transfer (Membranes)

Keep pH in the range – **7.0 for Methanobacterium**
Lower the reactor pH if needed (maybe by lowering acetate concentration or acid dosing)

Source: Microbiological insights into anaerobic digestion for biogas, hydrogen or volatile fatty acids (VFAs): a review

Genus	% of total archaea	Metabolic type
Methanothrix	47.2%	Acetoclastic
Methanobacterium	16.2%	Hydrogenotrophic
Methanolinea	8.7%	Hydrogenotrophic
Methanospirillum	3.8%	Hydrogenotrophic



Source: Bioclear Earth results NGS Archaea (genus)

19

19

Interreg Deutschland – Nederland
CREATE
FH MÜNSTER

Which industrial sector can benefit from anaerobic wastewater treatment?
Welke industriële sector kan baat hebben bij anaërobe afvalwaterzuivering?

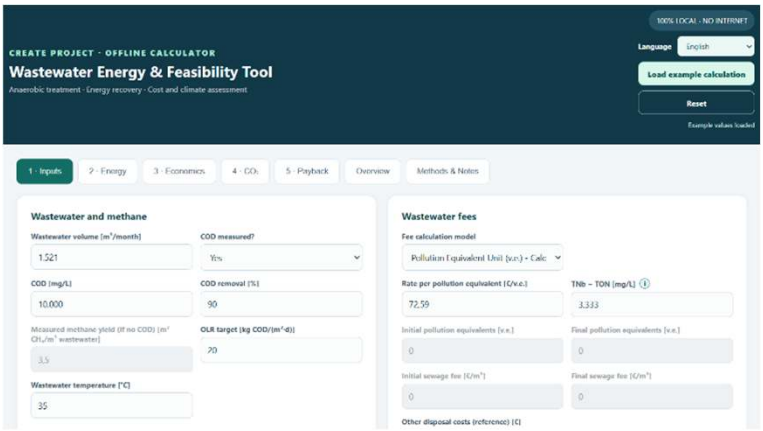
- Dairy industry (Zuivelindustrie) and food processing (Voedingsmiddelenindustrie)
- Breweries (Brouwerijen)
- All of the above sectors (Alle bovenstaande sectoren) ✓

20

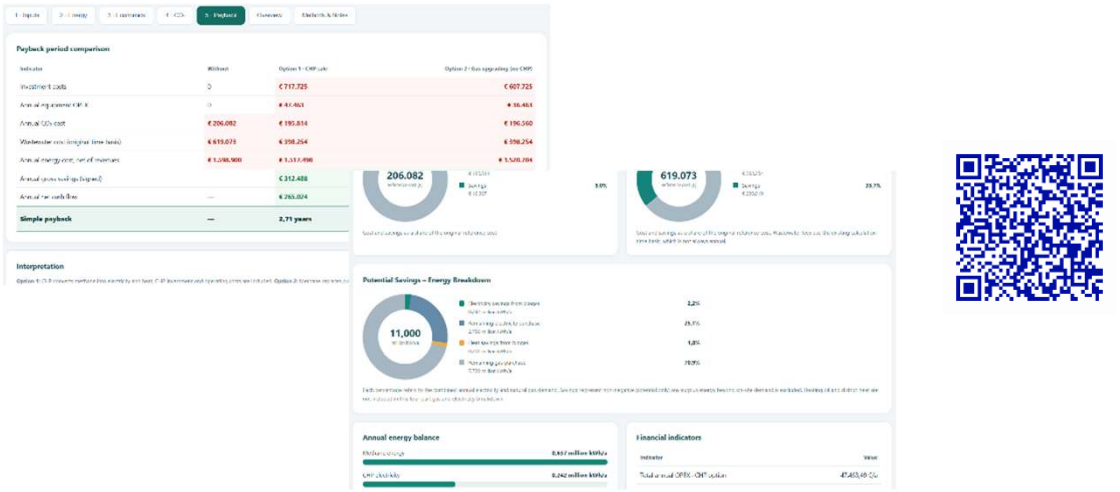
CREATE Tool

Input

- Monthly wastewater volume?
- COD?
- Electricity usage?
- Gas usage?
- Heating oil usage?
- …



CREATE Tool



Lessons Learned & Next Steps

Practical Lessons Learned

- ✓ **In-situ methanation:** Promising, but H_2 injection still requires optimization.
- ✓ **SME awareness:** Many SMEs lack detailed wastewater data and awareness of potential fee reductions and energy recovery.
- ✓ **Breweries:** Show promising potential for anaerobic treatment and energy recovery.
- ✓ **Bakeries:** COD values were sometimes lower than expected.
- ✓ **COD Concentration:** Ideally at least 3,000 mg/L for BMP testing (continuous flow is needed for EGSB)

Next Steps (Further Development)

- ✓ **Hydrogen injection:** H_2 injection control and transfer efficiency.
- ✓ **System integration:** Better combine wastewater, heat and energy flows (vapor recovery, CHP…)



FH MÜNSTER EGU FB Energie · Gebäude · Umwelt
Energy · Building Services · Environmental Engineering

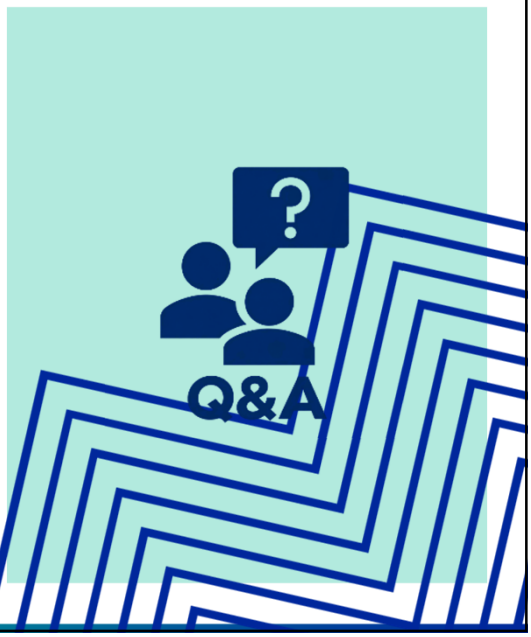
Interreg Deutschland - Nederland
CREATE

CREATE Project

Energy Recovery from Wastewaters

Thank you very much for

Your participation!



Project Consortium

Funded by

25

Contact Information

Research Team



Maarten van de Griend
Researcher

Oostergoweg 9
8911 MA Leeuwarden, NL

+31 6 53809063
m.vandegriend@cew.nl



Martin Woestmann
Project Engineer

Stegerwaldstraße 39
48565 Steinfurt, DE

+49 2551 962041
martin.woestmann@fh-muenster.de



Müjdat Ayasulu
Project Engineer

Stegerwaldstraße 39
48565 Steinfurt, DE

+49 2551 962913
muejdat.ayasulu@fh-muenster.de

26