BENGT HANSEN, KEMIRA

Boosting biogas plant performance with selected chemistry

5TH BIOGAS POWER ON, HAMBURG, SEPTEMBER 27-28 2023

kemira

We are global

Pulp & Paper

Industry & Water

2022 REVENUE

€3.6B

MARKET POSITION

#1

IN EUROPE AND NORTH AMERICA

SALES TO

100+

Countries

NUMBER OF EMPLOYEES

~5,000

Worldwide

WE SERVE A WIDE RANGE OF BIOGAS CUSTOMERS

INDUSTRIAL BIOGAS PRODUCERS

Substrate:
Mix of household waste, food waste, green waste, fat, slaughter waste etc

Driver:
Energy production, bio-fuel production, CO_2 reduction

AGRICULTURAL BIOGAS PRODUCERS

Substrate:
Manure as the main substrate in combination with other agricultural substrates

Driver:
Big livestock production, nutrient recovery, hygenization, energy production

ANAEROBIC WASTEWATER TREATMENT PLANTS

Substrate:
High COD wastewater, low SS

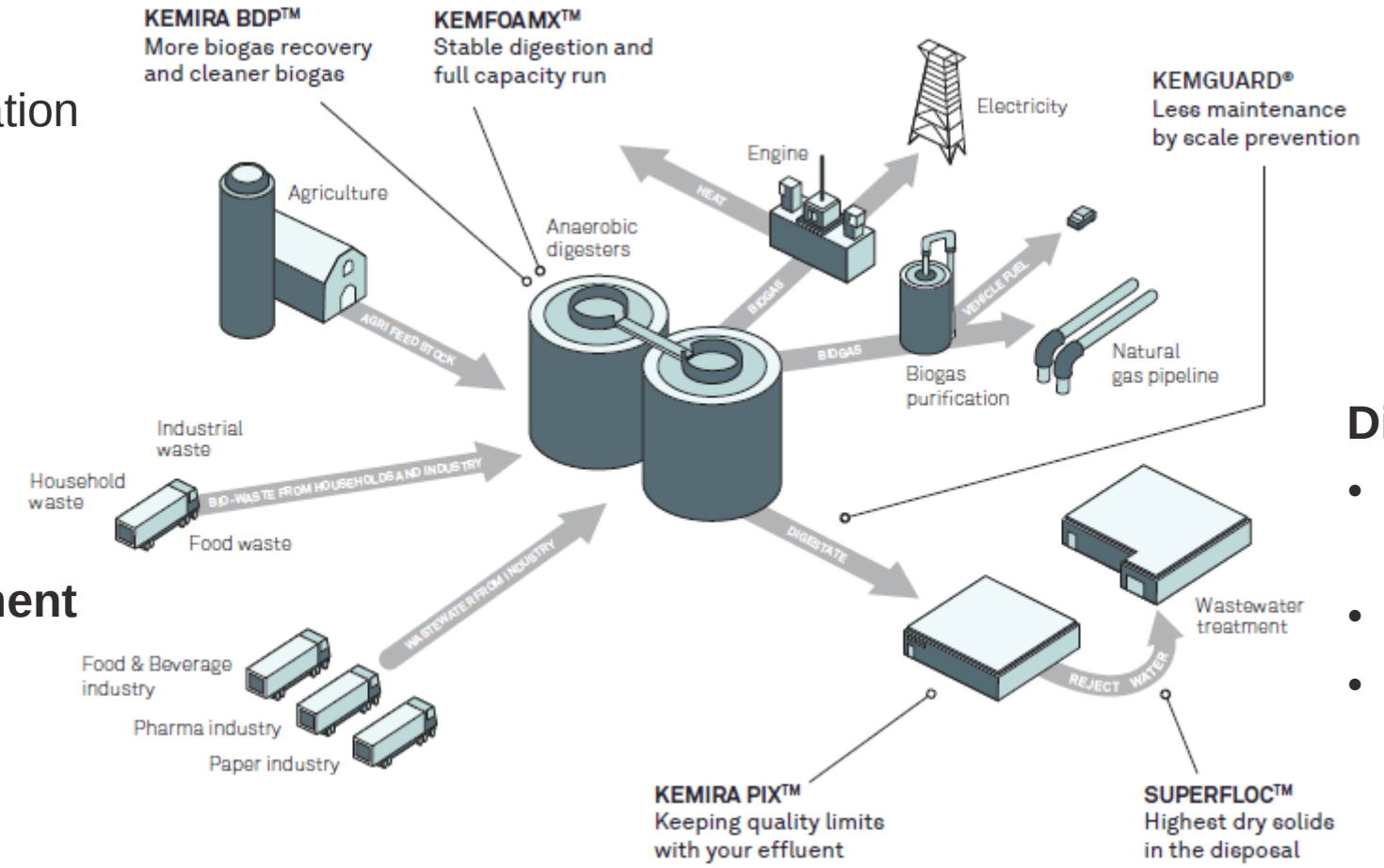
Driver:
Legislation, energy recovery

Kemira is committed and contributes to the SDGs and have **4 goals in priority focus**

Kemira Biogas Program Overview

Biogas Boosting

- Biogas optimization
- Odor control
- Foam control



Substrate pre-treatment

- Odor control
- Foam control

Digestate treatment

- Dewatering & reject treatment
- Scale control
- Foam control

The biogas process and its challenges

Hydrogen sulphide, H_2S

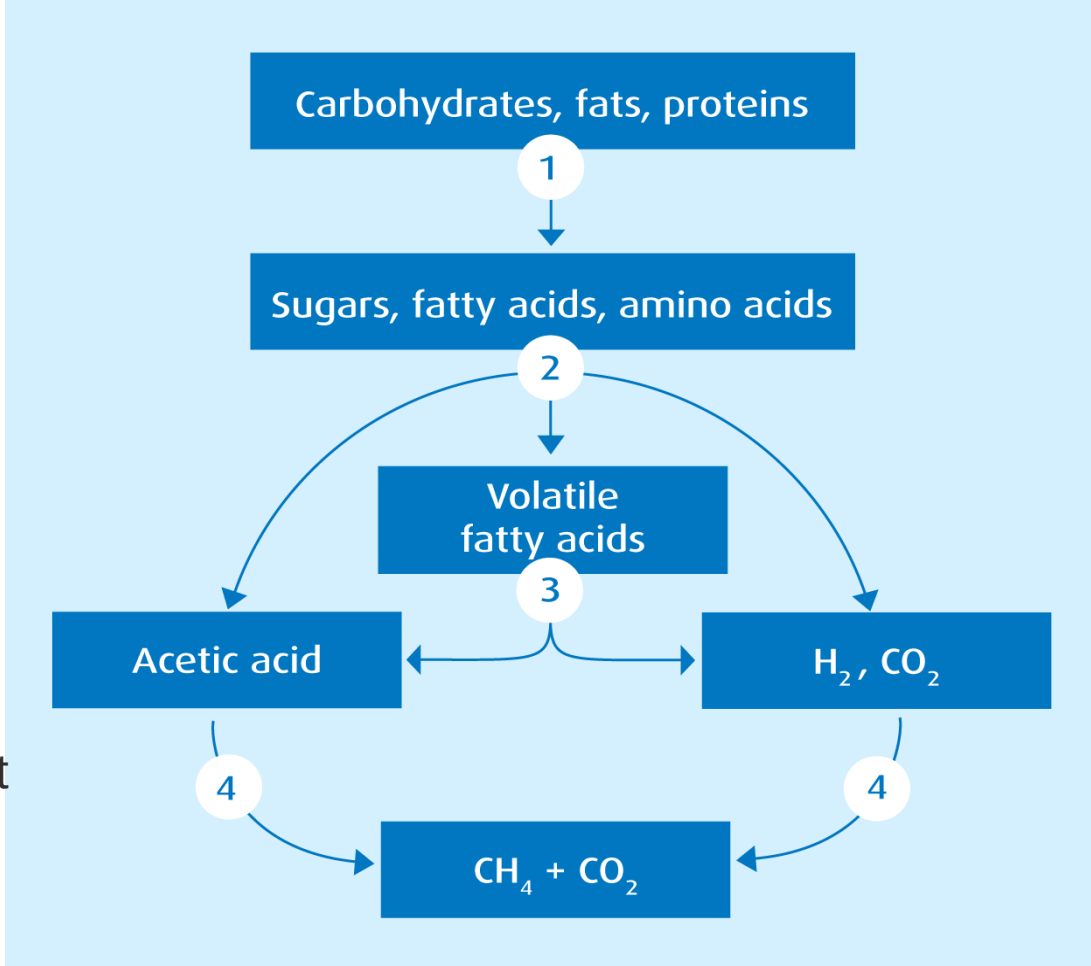
- H_2S is toxic and can inhibit the process in every step
- H_2S is also corrosive and can damage equipment and make gas cleaning unnecessary costly

Ammonia, NH_3

- NH_3 is also very toxic

Poor capacity – unbalanced process

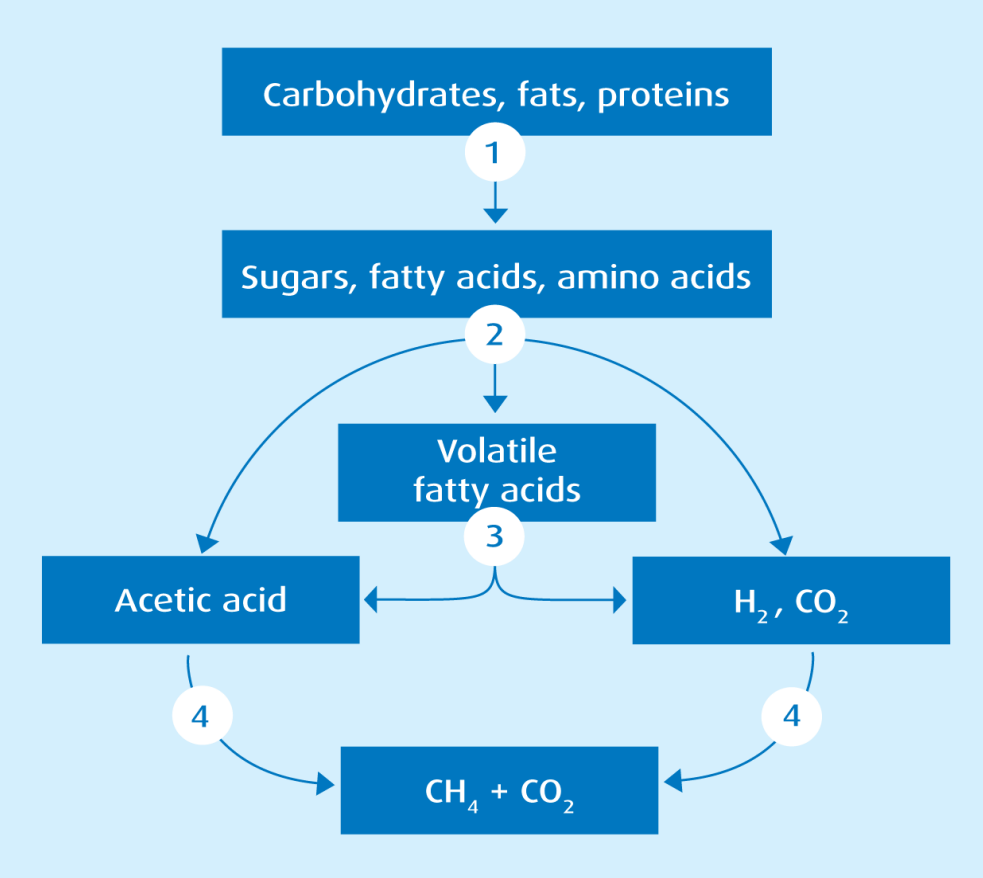
- Normally seen as poor yield and high VFA content
- In many cases due to lack of micro-nutrients



The patented BDP products* controls the challenges with iron (1-4)

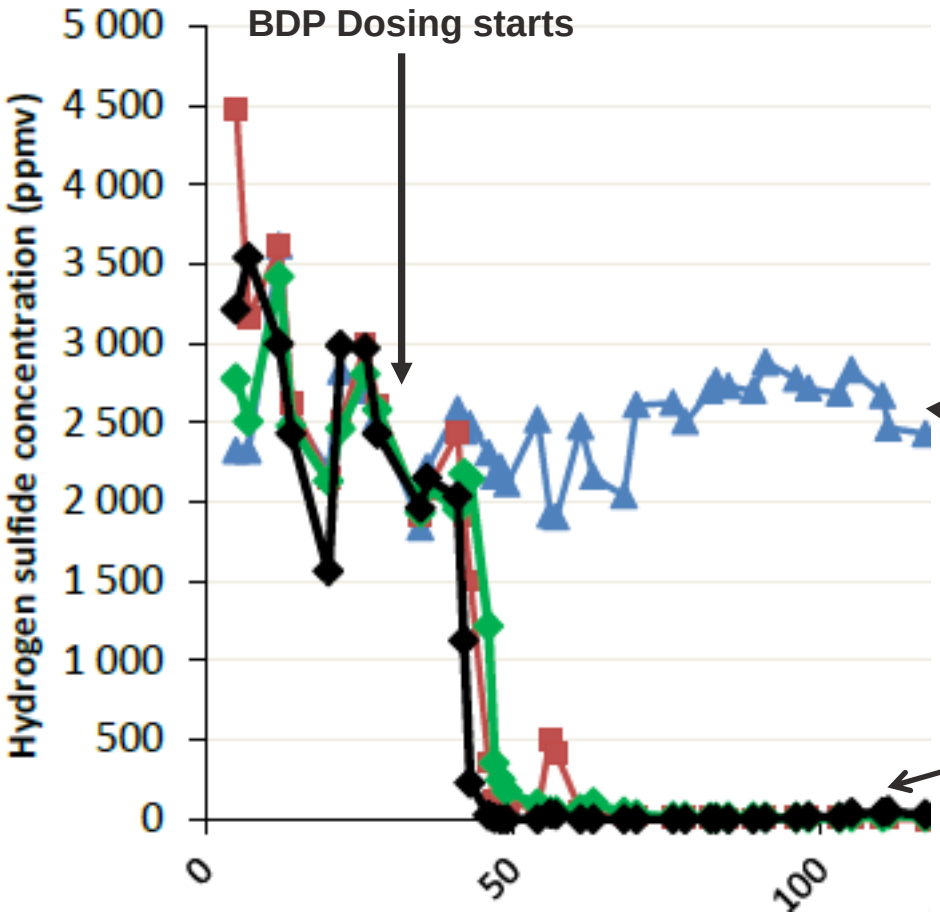
Iron

- A key component in anaerobic digestion involved in all bacterial processes
- Precipitates S^{2-} and inhibits the toxic effect of H_2S
- Iron chlorides are acidic and can reduce the NH_3 toxicity



***BIOGAS DIGESTION PRODUCTS – IRON CHLORIDES WITH VARIOUS CONCENTRATIONS OF SELECTED MICRO-NUTRIENTS**

BDP treatment for H_2S removal gives fast results



H_2S control with BDP in lab-scale trial
Substrate: 70% manure, 30% household waste

BDP dosing started day 41

Control Reactor no BDP

BDP- Reactor

Within 5-6 days a significant reduction of H_2S is achieved

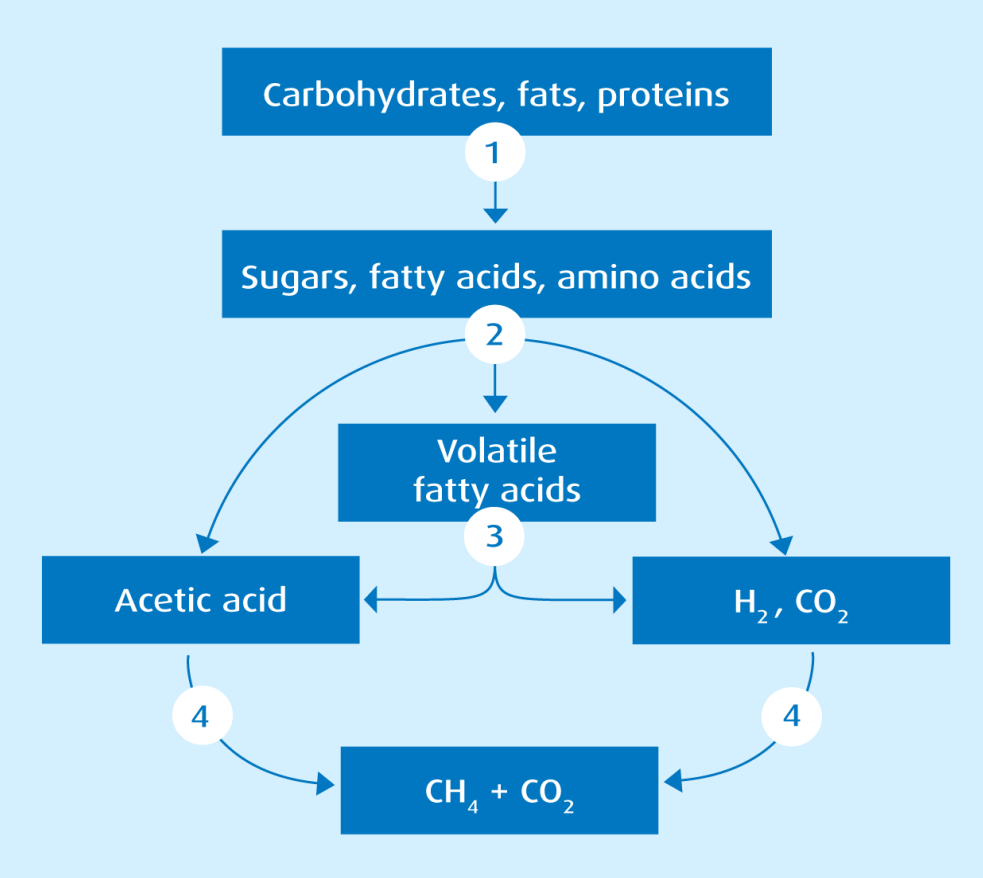
The patented BDP products* controls the challenges with iron and micro-nutrients

Iron (1-4)

- A key component in anaerobic digestion involved in all bacterial processes (1-4)
- Precipitates S^{2-} and inhibits the toxic effect of H_2S
- Iron chlorides are acidic and can reduce the NH_3 toxicity

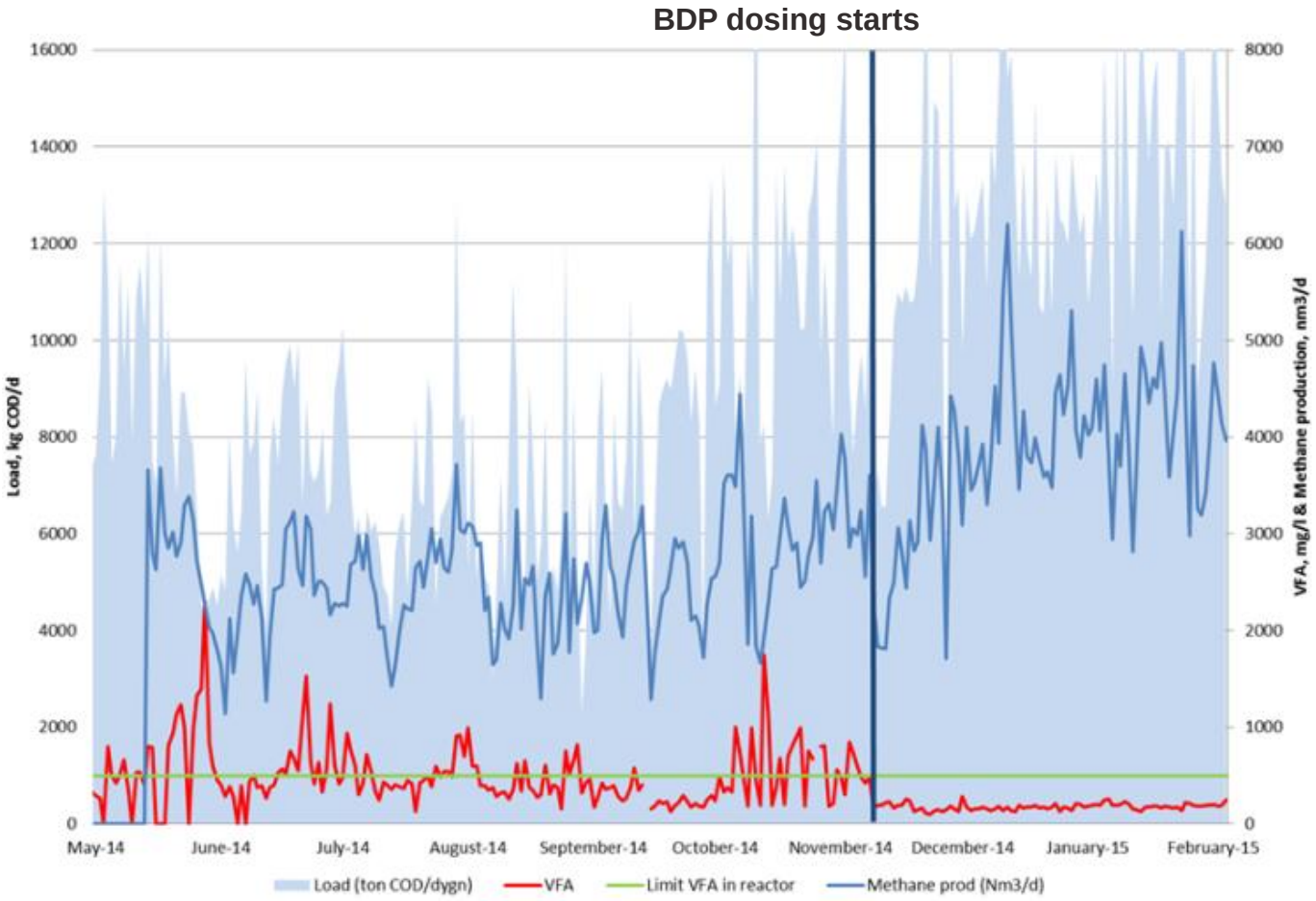
Micronutrients (2-4)

- Like **cobalt, nickel, zinc, iron, selenium, molybdenum and tungsten**
- Essential components in enzymes and coenzymes in the methane formation (2,3,4)



***BIOGAS DIGESTION PRODUCTS – IRON CHLORIDES WITH VARIOUS CONCENTRATIONS OF SELECTED MICRO-NUTRIENTS**

BDP products can improve in several ways



Addition of BDP products (Iron + Trace Elements) to biogas plants can improve:

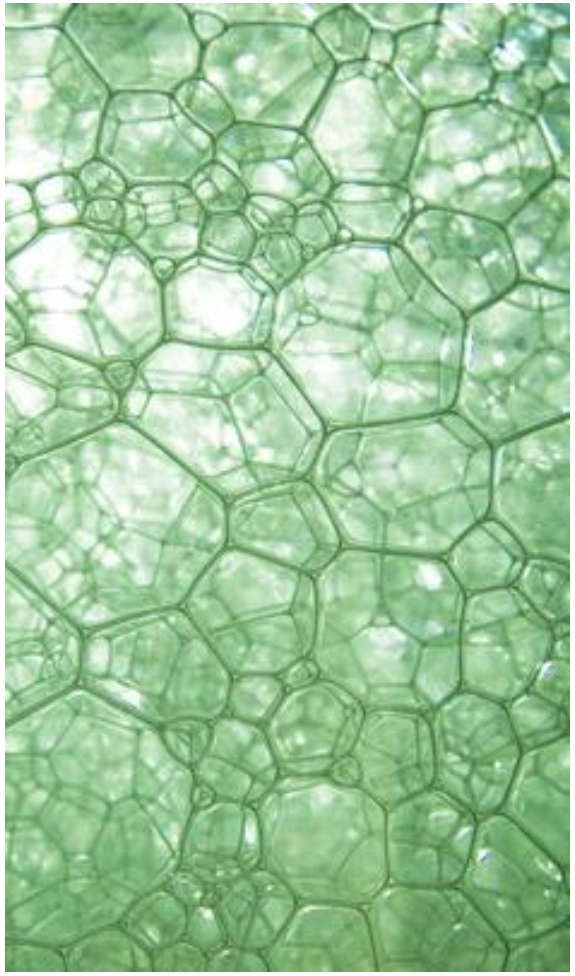
- Stabilized digester performance due to reduced volatile fatty acids (VFA) levels
- Increased biogas production
- Increased substrate loading
- Reduction of hydrogen sulfides (H_2S)

Foam Control

- Foam is a colloidal dispersion of gas in a liquid or a solid
- Pure liquids do not foam
  - Tap water does not foam when aerated, bubbles collapse immediately on surface
- To generate foam, a surface-active component is needed to stabilize the inclusion of dissolved and entrained gases
- Foam formation can cause severe problems in biogas processes. Pressure build-up, fouling, cavitation, incorrect level measurements, handling problems with substrate, etc…

Defoamers like KemFoamX 2500 gives the following benefits:

- Silica free
- Stabilized operation conditions
- Increased capacity



Scale control

- Anaerobic digestion of organic matter releases both cations such as Mg^{2+}, Ca^{2+}, Fe^{2+}, NH_4^+ and anions such as PO_4^{3-}, CO_3^{2-}
- Common scales in anaerobic digestion processes:

$MgNH_4PO_4*6H_2O$	(struvite)
$CaCO_3$	(calcite)
$Fe_3(PO_4)_2*8H_2O$	(vivianite)

- Scaling can occur in anaerobic digesters, pipes, centrifuges
- Scaling causes increased maintenance and energy costs and can be avoided by using antiscalants like Kemira KemGuard

Dewaterability of digestates

- Dewatering of digestate is normally more challenging than for municipal sewage sludge
- Hard to flocculate
- The main reasons are

→ Anionic charge of digestates is high

→ The amount of large dissolved organic substances (e.g. biopolymers and humic kind of substances) is high

Characterization and selected chemistries improves the digestate dewaterability

- Dewaterability of a digestate can be estimated by measuring
  - Charge of the digestate
  - Organic content characterization
- Based on the results, the right products can be selected
- Flocculants are the base in dewatering
  - Typically polyacrylamides (Superfloc®)
  - Bio-based products are entering the market
  - The combination of flocculants and coagulants gives cleaner reject water
    - Easier handling for nutrient recovery

CUSTOMER CASE

Tekniska Verken Biogas Plant, Sweden, in operation since 1997

Wet substrate	100 000 tpa
Substrate composition	Food waste 57%, Food Industry 16%, Slaughterhouse waste 26%, Plant substrates (fat, alcohol, glycerol) 1%
Biogas Production	17 500 000 Nm^3 biogas/year (65% methane)
Energy Production	110 GWh/year
Gas utilization	Compressed and liquified biogas (bio- LNG) for cars, busses, trucks and industry

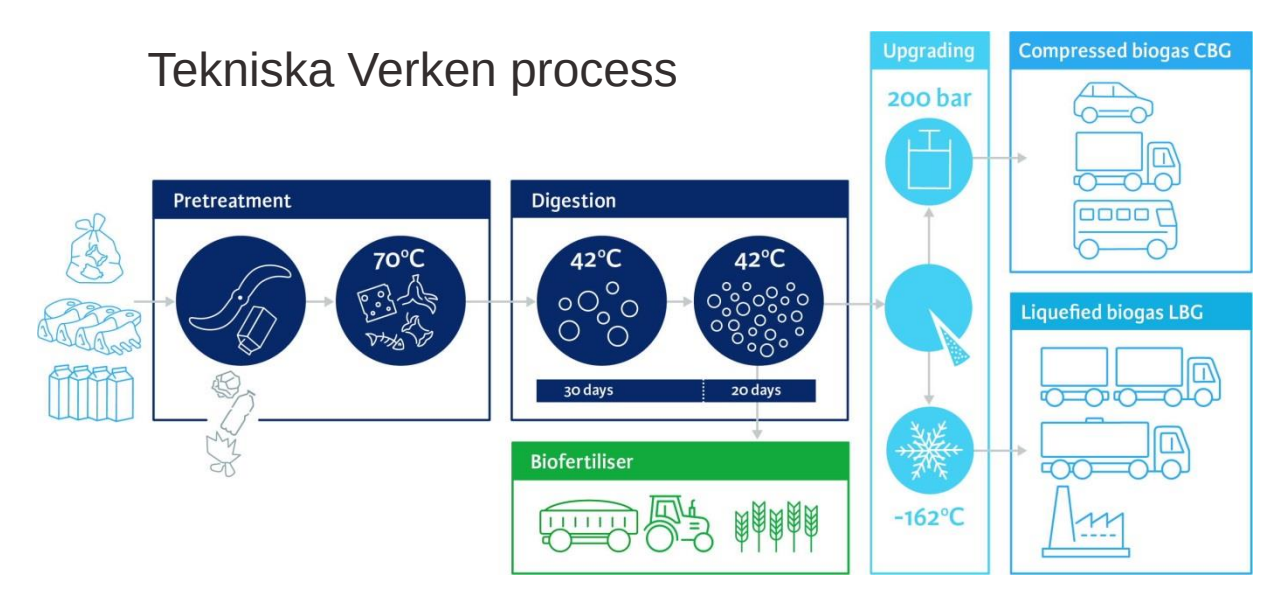
Tekniska Verken Biogas Plant, Sweden

Problems during initial years of operation:

- Bad process performance
- Foaming
- High VFA-levels
- Couldn’t increase Organic Loading Rate

Identified cause for problems

- High H_2S – levels
- Ammonia inhibition
- Lack of trace elements



SOLUTION

Trace element addition (improve microbe activity)

Iron addition (remove H_2S)

HCl addition (decrease pH → lower NH_3-inbibition)

→ **Kemira BDP product**

CUSTOMER CASE

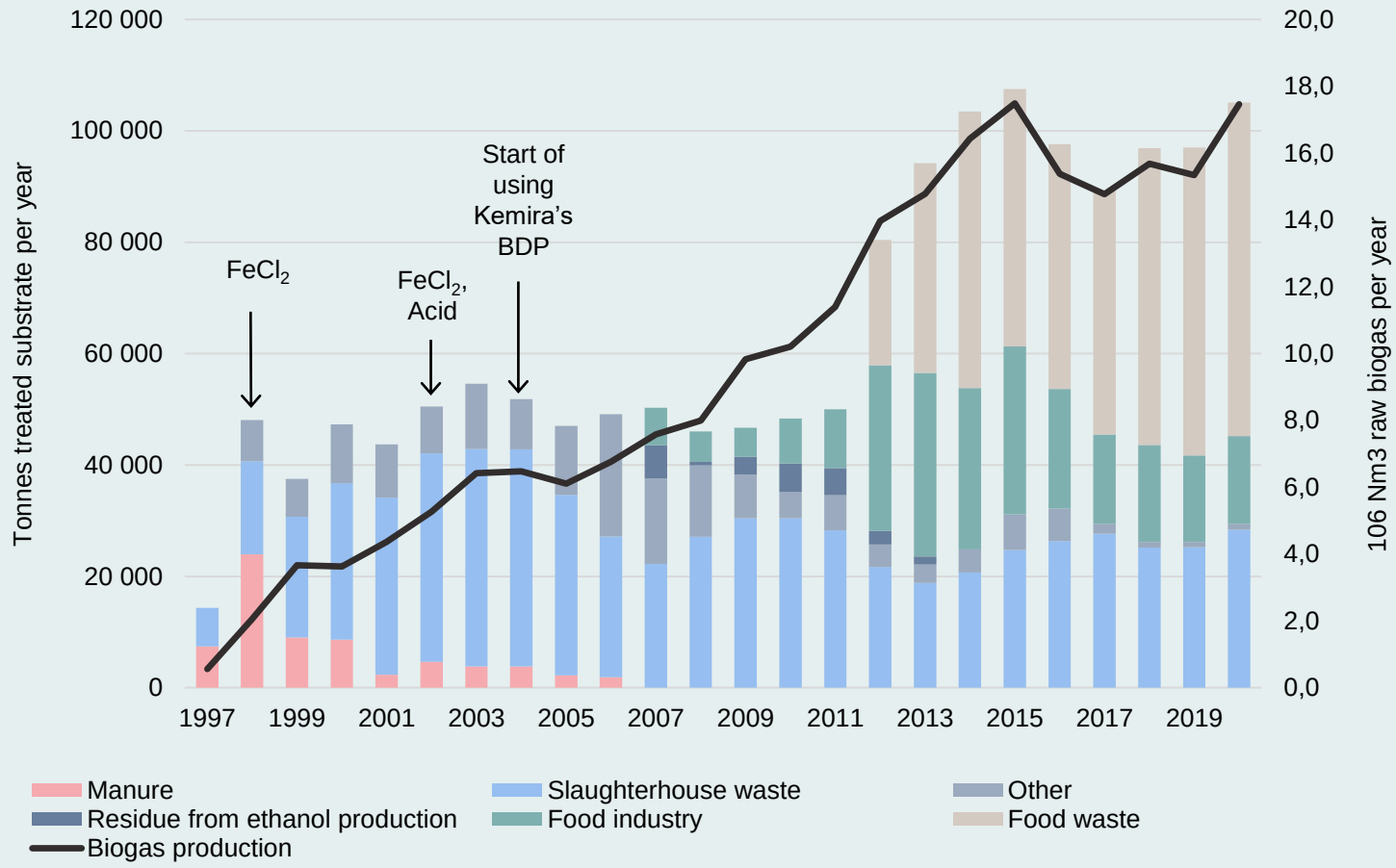
Tekniska Verken Biogas Plant, Sweden

RESULT AND OUTCOME

Kemira BDP-868 resulting in:
Higher Organic Loading Rate (OLR)
Low VFA
High methane yield
Good economy →
Increased revenue of 8 MEUR

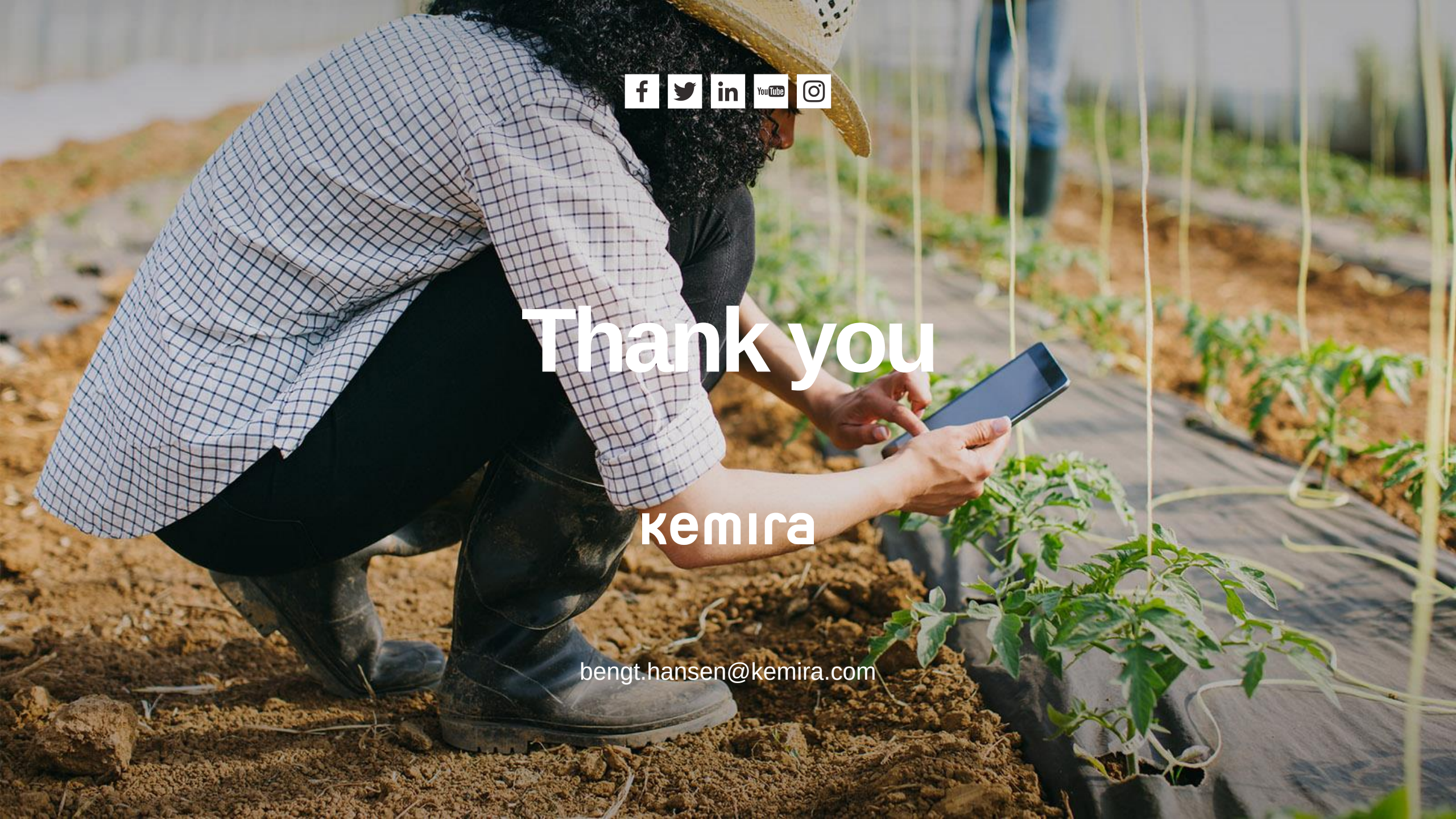
ENVIRONMENTAL BENEFITS

Improved sustainability
Replaces 11 000 000 L petrol
Methane slip decreased by using BDP (reduction of VFA in outlet)



Wrapping up

- Chemistry can improve the performance of the biogas plants by
  - Making it easier to handle the substrate
  - Reduce the content of toxic substances in digester
  - Stabilize the biogas process and increase the yield
  - Reduce the gas cleaning cost and risk for corrosion
  - Save energy and maintenance costs
  - Reduce digestate volumes and simplify nutrients recovery


Thank you
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