



Fachverband  
**BIOGAS**

German Biogas Association  
Association Allemande du Biogaz  
Asociación Alemana de Biogás  
[www.biogas.org](http://www.biogas.org)

# Biogas technology basics

**Frank Hofmann**

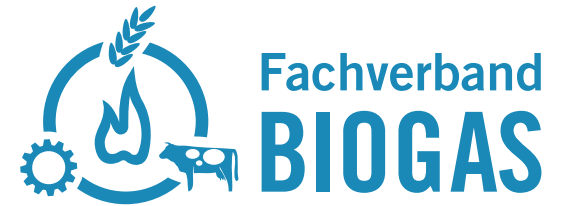
Fachverband Biogas e.V., German Biogas Association

**Biogas  
can do it!**

# Content

- Biogas Technology overview
- Industrial sized Biogas plants
  - Continuously stirred tank reactor, CSTR
  - Plug flow digester
  - Dry batch systems
  - Lagoon biogas plants
  - Gas utilisation
- Domestic Biogas
  - Floating drum digester
  - Fixed dome digester
  - Plastic bag digester

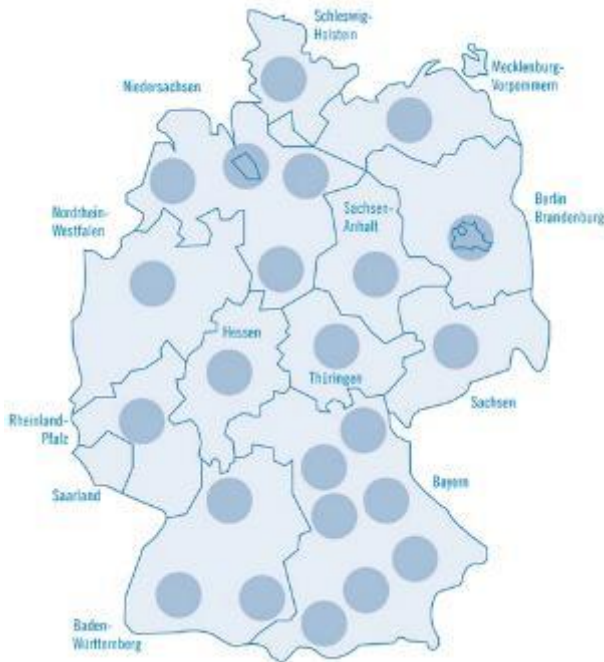
# The German Biogas Association



**4700 members**  
throughout Germany



- Operators of biogas plants
- Technology manufacturers
- Research institutions
- Public authorities
- Feedstock providers
- Interested individuals



**40 employees**  
dedicated to the topic

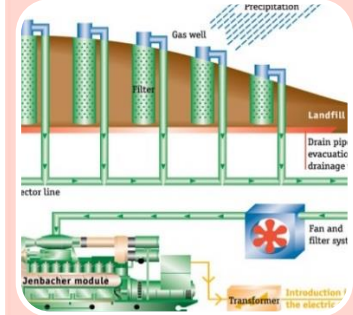
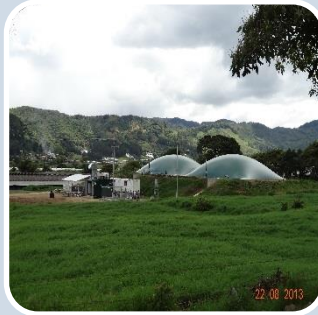
## Main objective: promotion of the biogas sector

- Definition of legal framework and technical standards
- Exchange of information
- Lobbying on federal, state and EU level

# Technology overview



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**BIOGAS**



## (Stirred) tank digester

- Agricultural biogas plants
- Waste treatment plants
- Industrial biogas

## Lagoon digester

- Waste water treatment plants

## Sewage gas

- Waste water treatment plants
- Sewage sludge (bacteria)

## Home digester systems

- Small scale digesters

## Landfill gas

- Waste
- Low control of the process
- High methane emissions

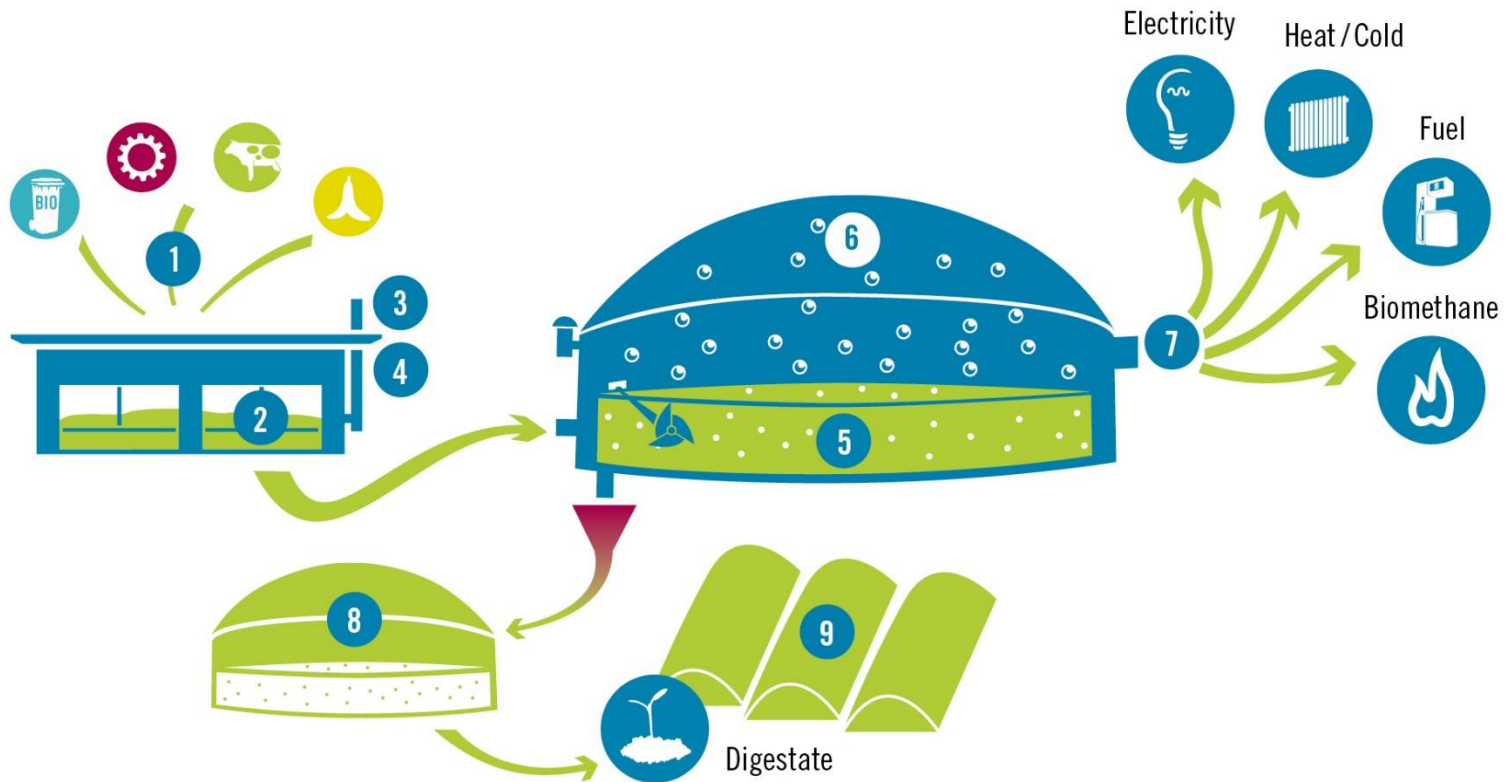
# Feedstock

## Feedstock categories

-  Organic fraction from Municipal Solid Waste (MSW)
-  Source-separated municipal biowaste
-  Municipal sewage sludge
-  Industrial and commercial wastes
-  Animal by-products
-  Vegetable by-products
-  Energy crops

# Components of a biogas plant

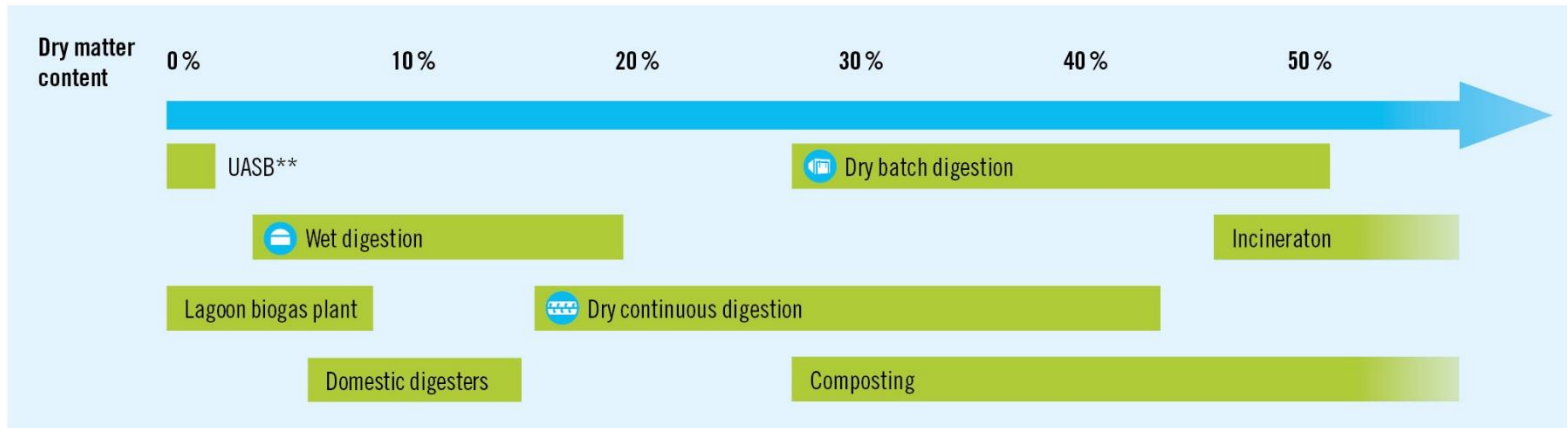
Components of a waste treatment biogas plant





# Overview of digester technologies

Overview of technologies depending on dry matter content for the possible operating mode\*

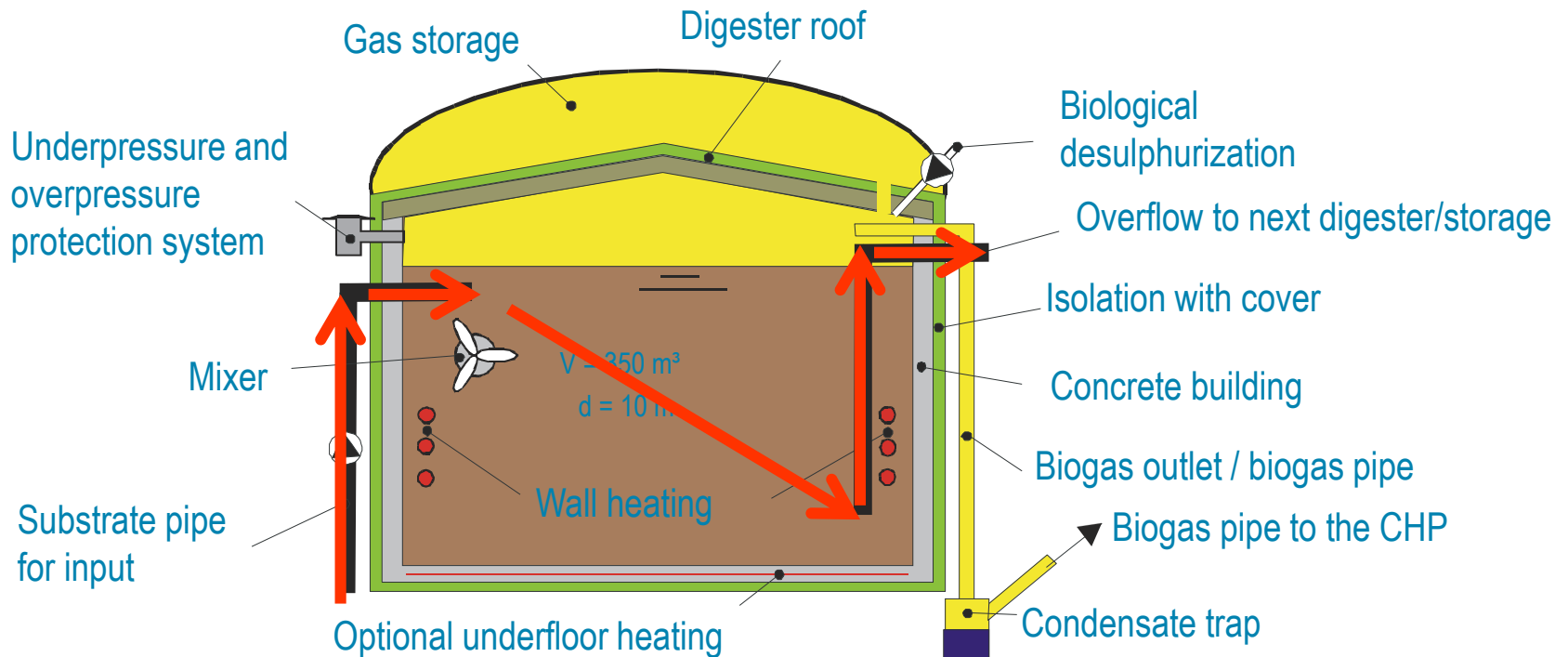


\*Almost all feedstocks can be diluted to the needed dry matter content of each digester technology.

\*\*UASB: Upflow anaerobic sludge blanket technology is a form of anaerobic digestion designed for materials with high water content (e.g. waste water or process water treatment).



# Continuously stirred tank reactor (CSTR)



Building material: steel-concrete, stainless-steel



# Inside of a CSTR digester



© Schmack Biogas AG Schwandorf  
Fotografie Herbert Stolz Regensburg

# CSTR - Characteristics

## Material flow

- Continuous feeding

## Feedstock

- DM content ranges between 6 and 15%
- Feedstock has to be pumpable



## Agitation

- Necessary

## Process temperature

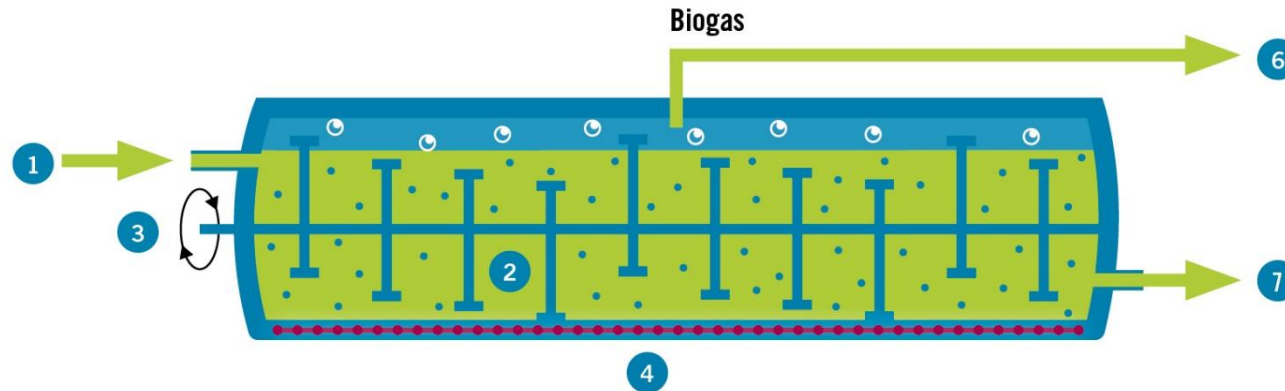
- Mesophilic or thermophilic

## Other technical characteristics

- The process can operate in single stage or multi stage configurations (separate hydrolysis tank)
- Usually one or more main digesters and a post digester and digestate storage

# Plug-flow reactor

Plug-flow reactor



- 1 Input
- 2 Biomass
- 3 Agitator
- 4 Heating system
- 5 Biogas storage
- 6 Biogas utilisation
- 7 Output



# Inside of a plug flow reactor and stirrer



# Plug flow reactor - Characteristics

## Material flow

- Continuous feeding

## Feedstock

- DM content range between 15 and 45%



## Agitation

- agitators along or transvers to the flow. Some systems (vertical flow) are without agitators

## Process temperature

- Mainly thermophilic

## Specific reactor characteristics

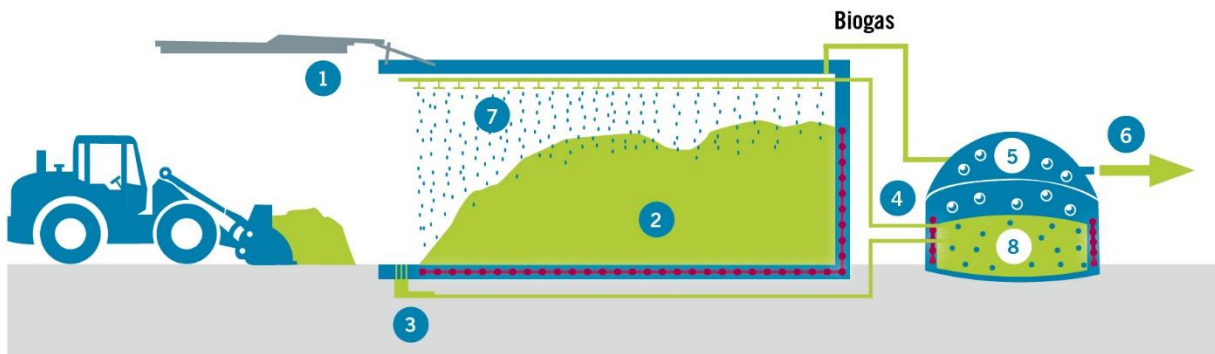
- Horizontal or vertical digester
- High reactor load possible
- Reactor volume is usually limited to between 1,000 and 2,000 m<sup>3</sup> because of the strong radial forces

## Other technical characteristics

- Minimum amount of approximately 20.000 t of feedstock/a are necessary

# Garage system

Garage systems



- 1 Gastight door
- 2 Biomass
- 3 Drainage system for percolation liquid
- 4 Heating system
- 5 Biogas storage
- 6 Biogas utilisation
- 7 Percolation liquid distribution
- 8 Percolation liquid storage tank



# Garage system



Source: Bekon Energy Technologies GmbH & Co. KG

# Garage system – Characteristics

## Material flow

- Discontinuous feeding

## Feedstock

- DM content higher than 30%.
- Suitable feedstocks are stackable



## Agitation

- Not necessary – no moving components in the reactor ensure robust reactor, reliable operation and low maintenance costs

## Process temperature

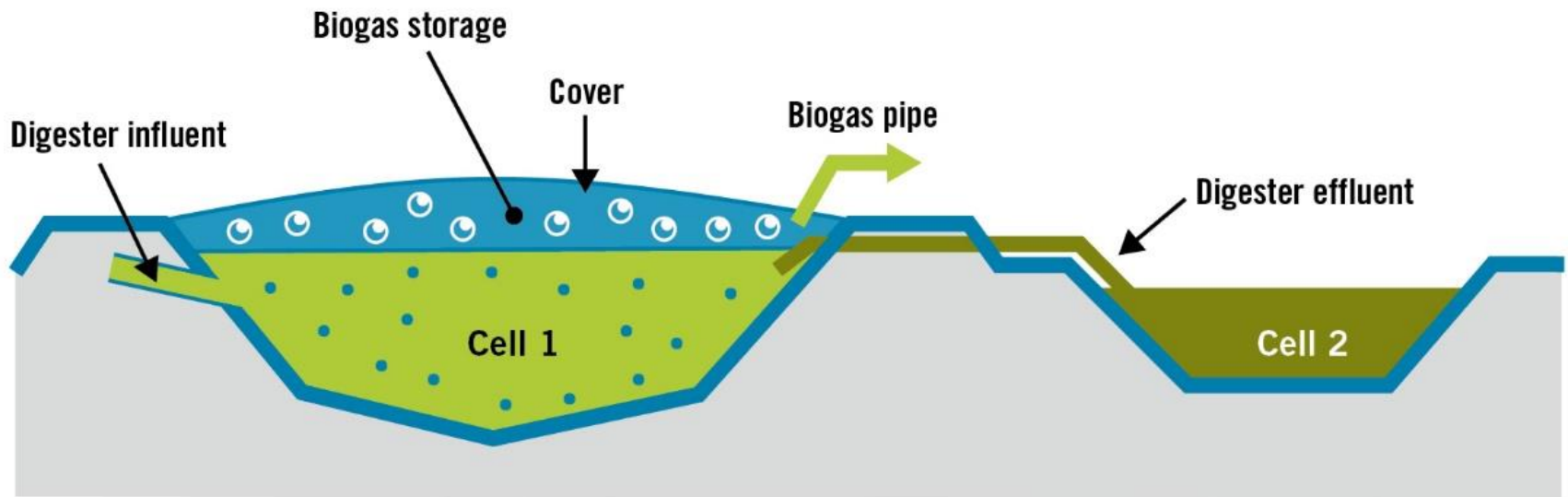
- Mesophilic

## Other technical characteristics

- Fresh input material has to be mixed with old digestate to bring in the necessary bacteria
- Percolation system for optimal distribution of the bacteria (inoculum)

# Lagoon digesters

## Lagoon biogas plant



# Lagoon digesters





# Lagoon digesters - Characteristics

## Material flow

- Almost continuous feeding with longer HRT (typically more than 100 days)

## Feedstock

- High water content 1-8% DM
- Typically process water



## Agitation

- Is a challenge, because of the big volumes
- Agitation is done sometimes by means of the material being pumped into the lagoon

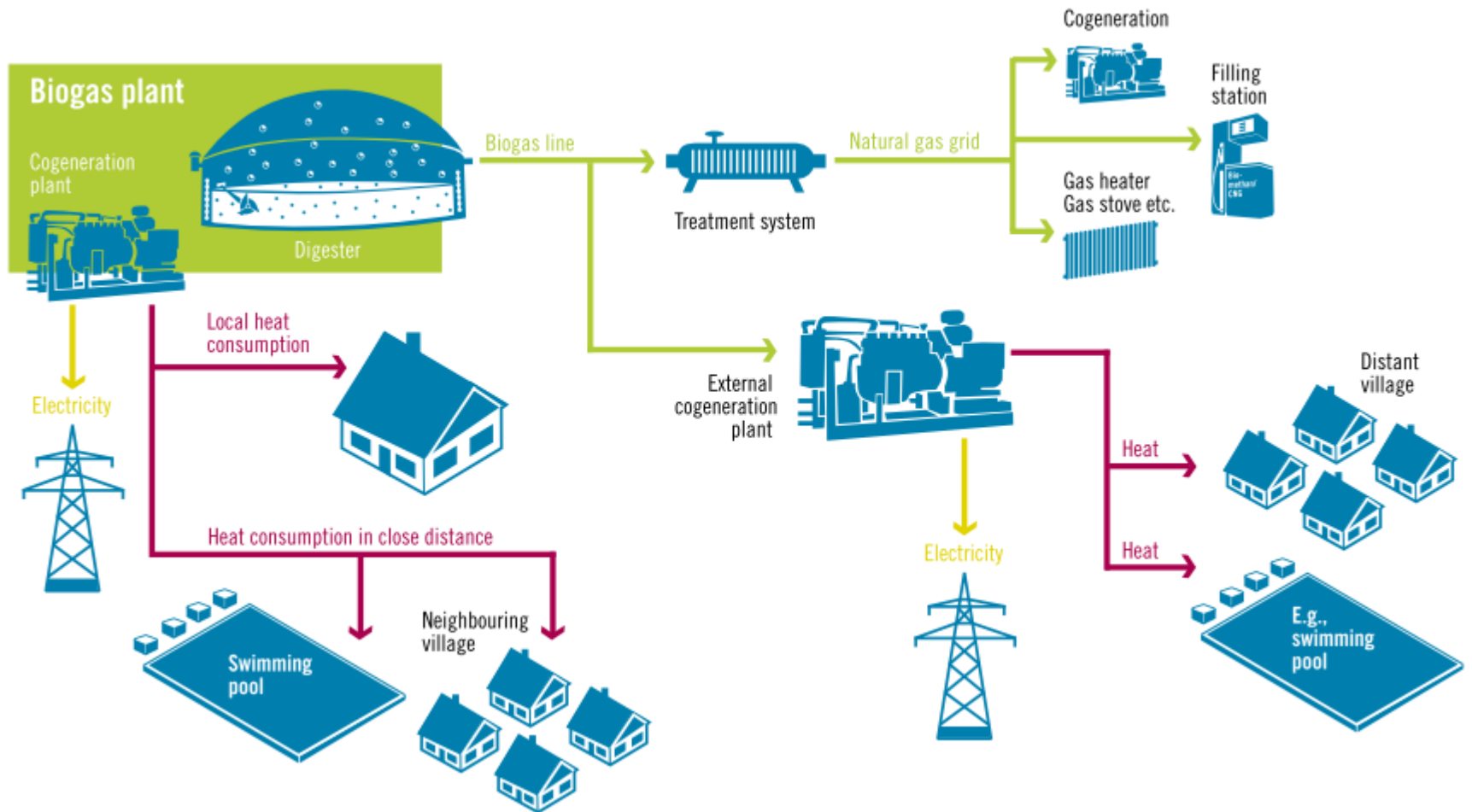
## Process temperature

- Ambient temperature, not heated; sometimes little heating by injection of warm process water

## Other technical characteristics

- Huge volumes of material, often between 1,000 and 20,000 m<sup>3</sup>
- Safety issues, especially in heavy weather conditions

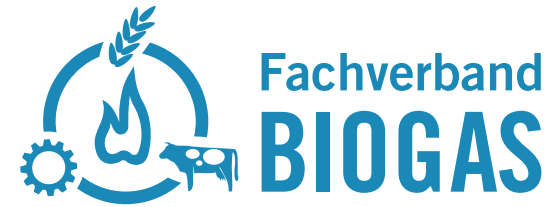
# Biogas utilization



Source: Biowaste to Biogas



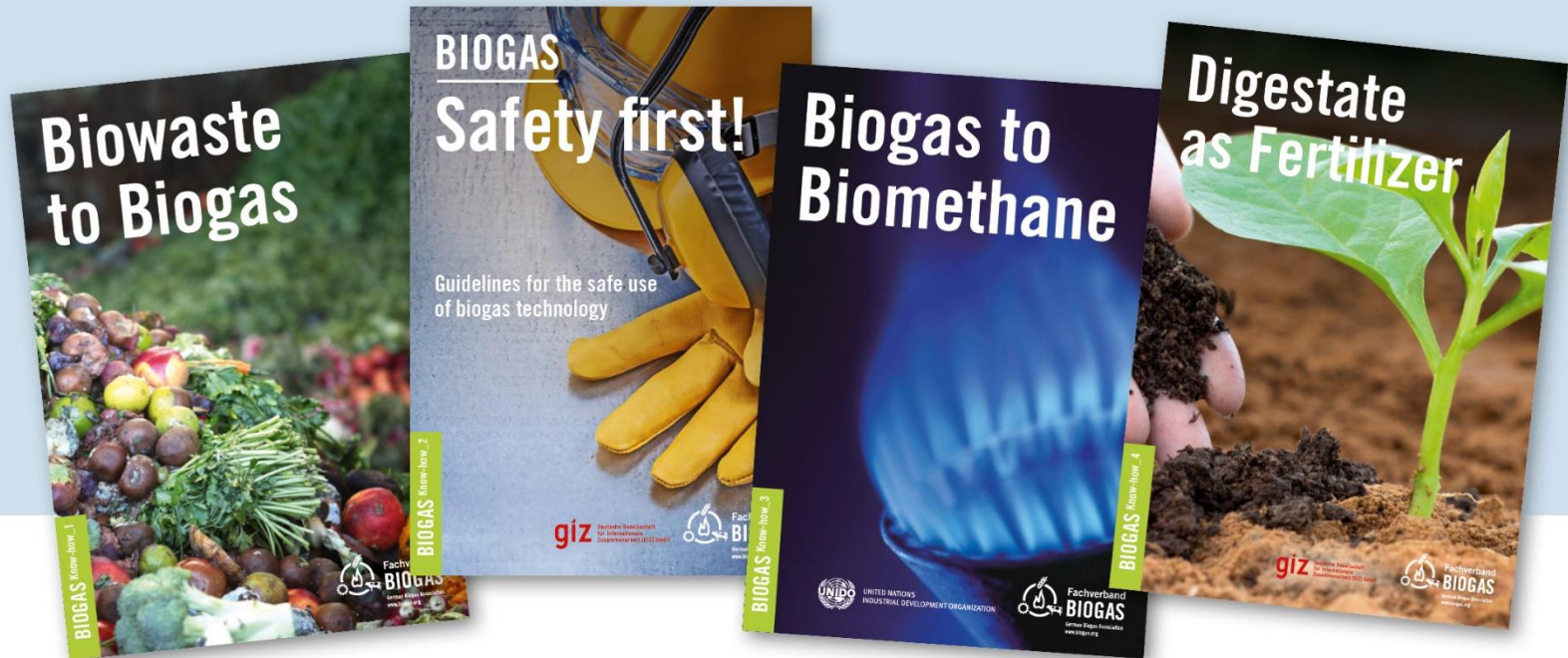
# Summary, industrial sized biogas plants



- A biogas plant is „state of the art“ technology.
- Decades of experiences in thousands of operation biogas plants in Europe, especially in Germany.
- Biogas plants are technical optimized and reliable.
- Each biogas plant should be adapted to the local conditions, regarding:
  - Feedstock
  - Size
  - Components are adapted to the needs of the process
  - Climate
- Most important is that all components fit together in their functions, are robust and reliable.

# Information material

AVAILABLE ONLINE



[www.biowaste-to-biogas.com](http://www.biowaste-to-biogas.com)



[www.biogas-safety.com](http://www.biogas-safety.com)



[www.biogas-to-biomethane.com](http://www.biogas-to-biomethane.com)



[www.digestate-as-fertilizer.com](http://www.digestate-as-fertilizer.com)

Thank you for your attention!

