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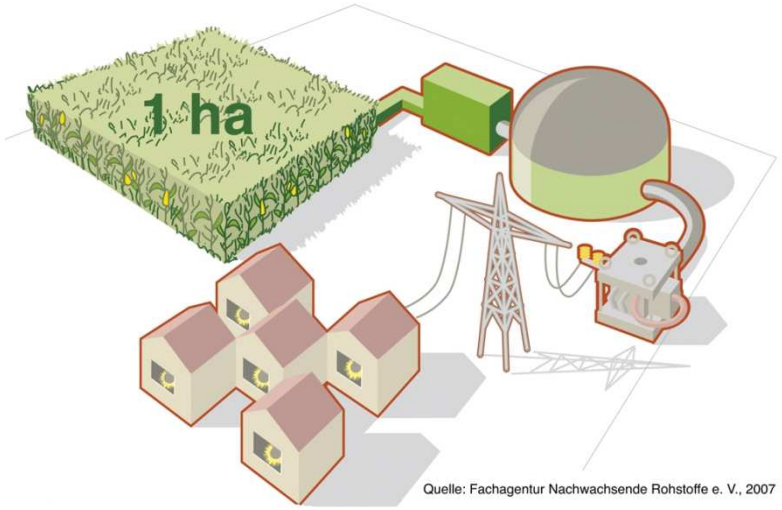
# Biogas production and utilisation



Quelle: Fachagentur Nachwachsende Rohstoffe e. V., 2007

BiG>East
Biogas for Eastern Europe

Leibnitz, 20.04.2009

# BIOGAS

## Heat-, electrical power and fuel production

**Biomass from**

- Agriculture
- Food industry
- Animal feed industry
- Communal waste (biowaste)
- Gastronomy

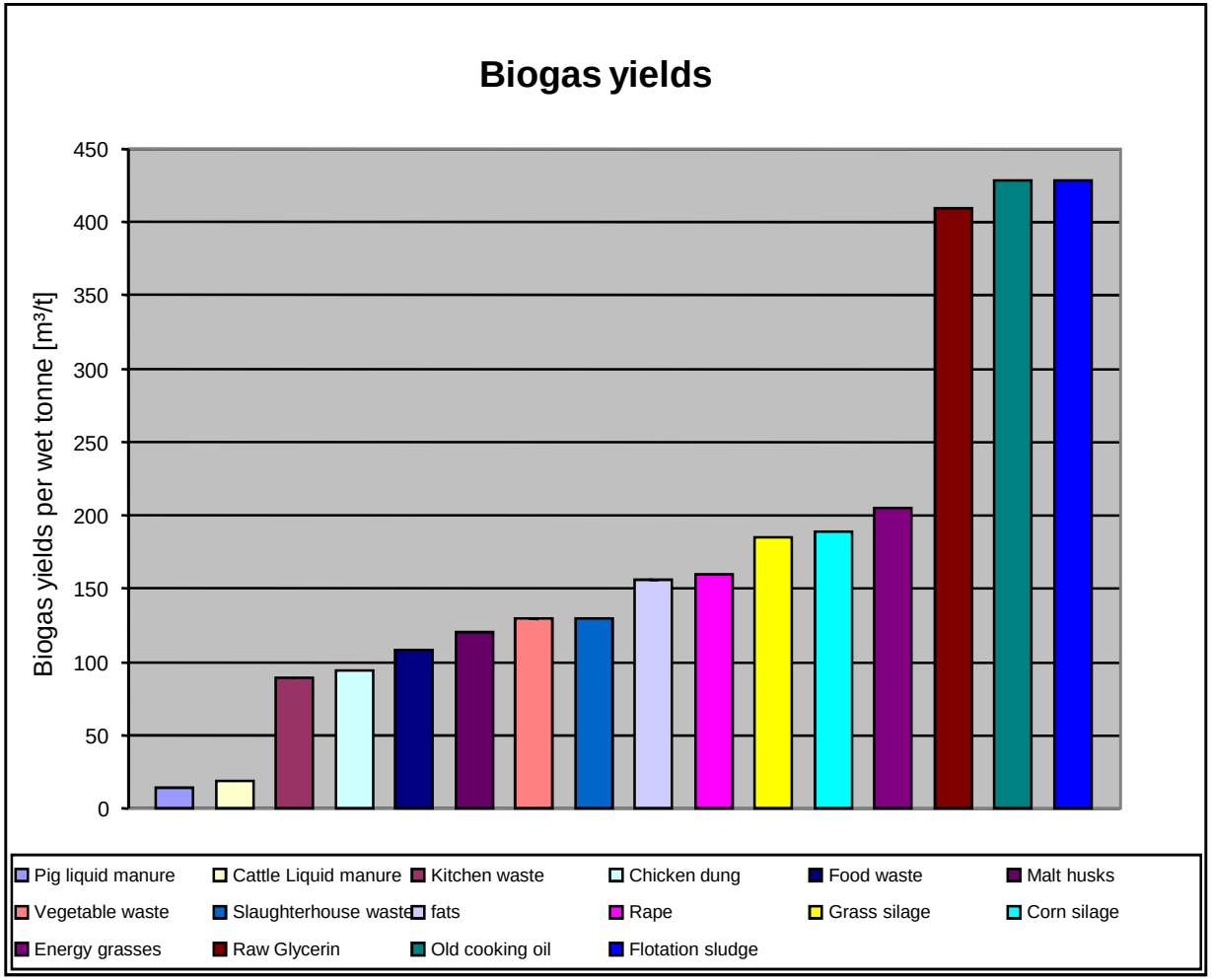
**Production of**

- Electrical power
- Heat
- Fuel
- Fertilizer

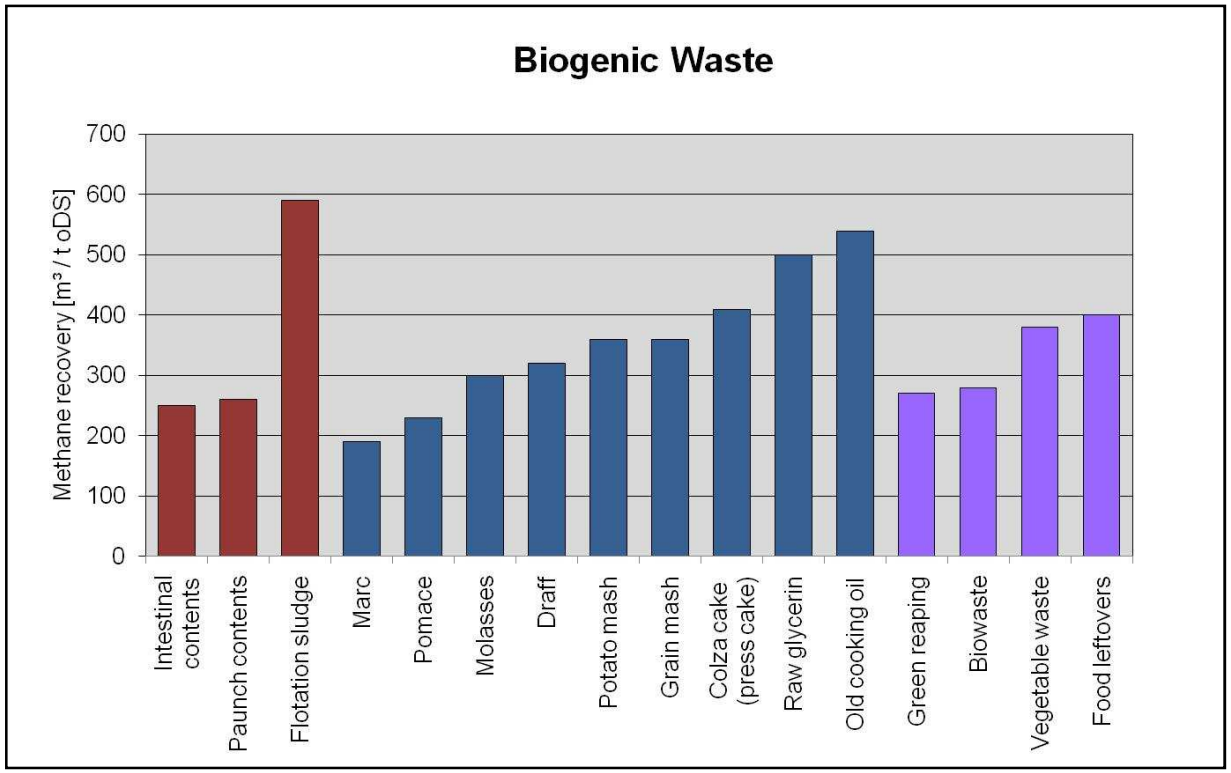
# Possible input material and biogas yield

Corn silage, grass silage, pig liquid manure, cattle liquid manure, chicken dung, energy grasses, vegetable waste, pomace, malt husks, food waste, kitchen waste, biowaste, old cooking oil, chip fat, flotation sludge, glycerin, slaughterhouse waste, ….

**In general almost all organic biomass (in monoculture or mixture) can be used in biogas plants.**

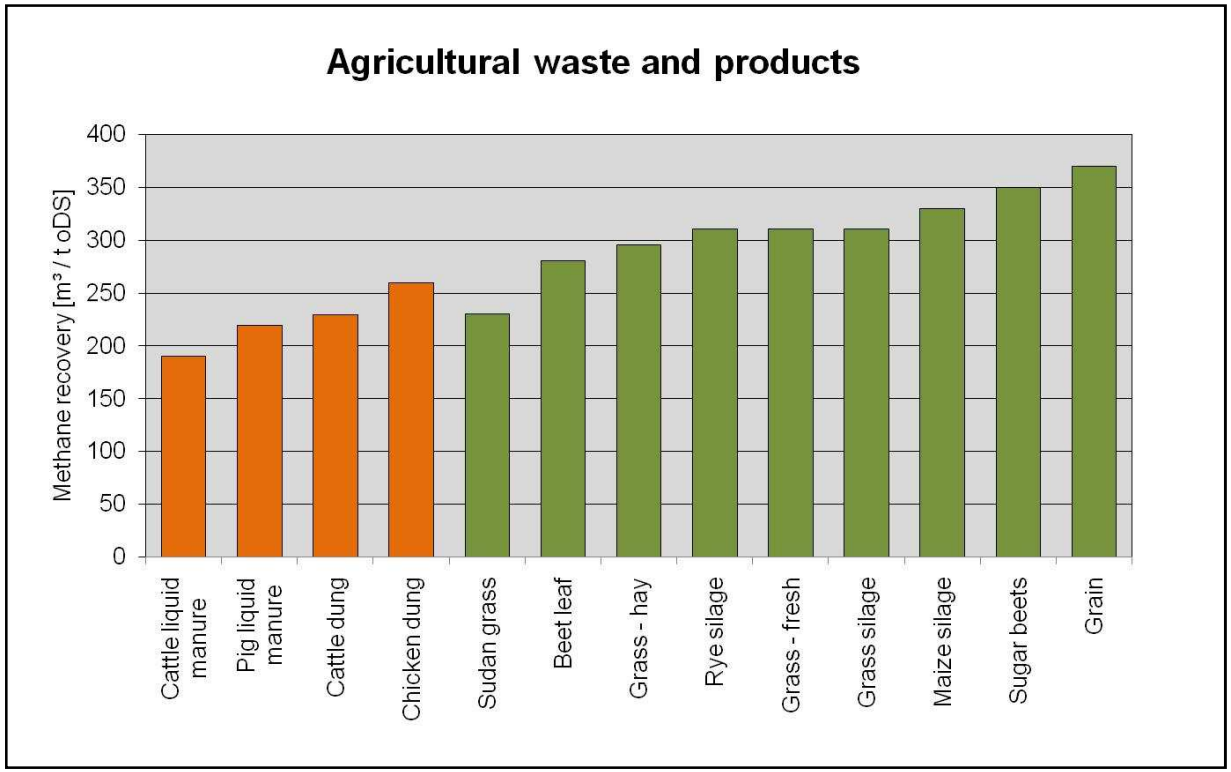


# Biogenic waste




- Around 70 % from households, 1/3 of it fermentable
- Energy value from 17 to 20 MJ/kg DS
- Suitable for anaerobic fermentation (50 to 60 % decomposition)
- Biogas with ca. 70 % $CH_4$
- Methane recovery from approx. 300 to 400 m³ $CH_4$ per t oDS
- Slaughterhouse waste
- Industrial and agricultural waste

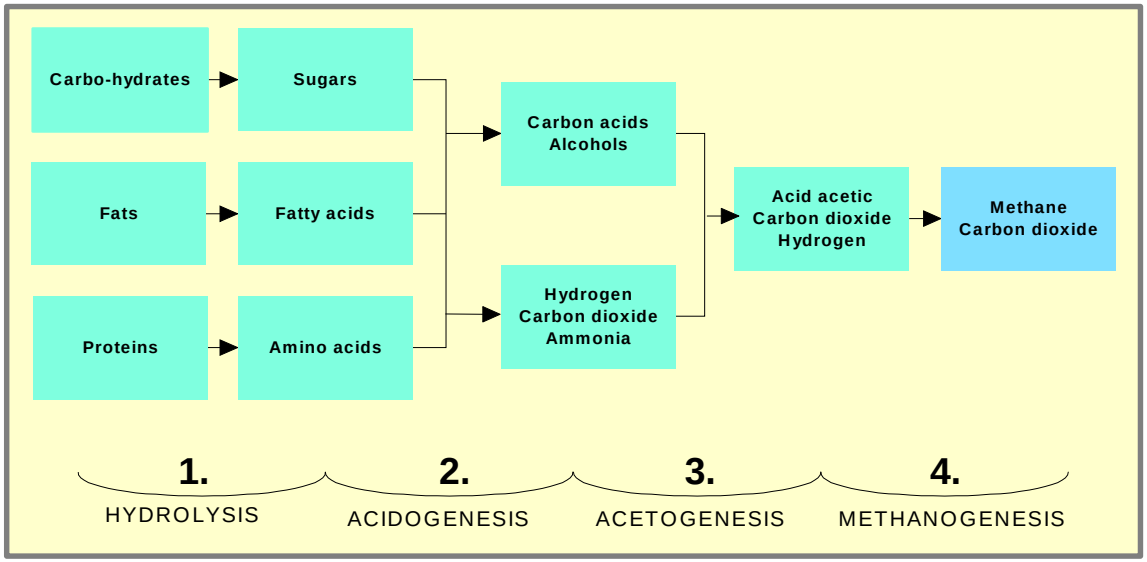
# Agricultural waste and products




- **Farm fertiliser** like manure or dung from cattle, pig or chicken
- Biogas recovery from 200 to 700 m³ biogas per animal unit and per year
- Manure stabilise the fermentation
- **Agricultural by-products** (e.g. beet leaf) and **products** (e.g. maize silage)
- Methane recovery from 3.500 to 6.500 m³ $CH_4$ per hectare and per year

# Biogas process

- Multi-step fermentation process
- Breakdown of organic substances with high molecular weight into substances of lower molecular weight until it reaches methane
- Damp anaerobe environment

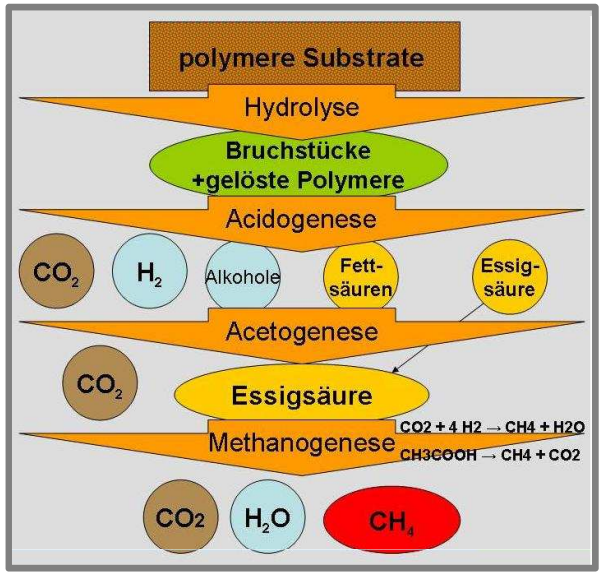



## Stages of fermentation

1. Hydrolysis
2. Formation of acid
3. Formation of acetic acid
4. Formation of methane

# Biogas

- The composition of biogas varies depending upon the origin of the anaerobic digestion process, the substrate mixture and the operating mode of the digester.
- The main components are methane (45 to 70 % $CH_4$) and carbon dioxide (25 to 55 % $CO_2$).




| **Biogas mixture** | Spread | Average |
|---|---|---|
| Methane | 45 – 70 % | 60 % |
| Carbon dioxide | 25 – 55 % | 35 % |
| Damp | 0 – 10 % | 3,1 % |
| Nitrogen | 0,01 – 5 % | 1 % |
| Oxygen | 0,01 – 2 % | 0,3 % |
| Hydrogen | 0 – 1 % | < 1 % |
| Ammonia | 0,01 – 2,5 mg/m³ | 0,7 mg/m³ |
| Hydrogen sulphide | 10 – 30.000 mg/m³ | 500 mg/m³ |

# Fermentation residue

- The quantity of the fermentation residue is approx. 75 to 80 % of the quantity of the input material.
- The capacity of the fermentation residue storage (e.g. a lagoon) is approx. 180 days.
- **Fermentation residue = fertiliser**

**Pros of fermentation residue**

- Higher fertiliser value
- Saving of mineral fertilisers
- Improvement of direct nitric-fertiliser properties by increasing ammonium nitrogen content
- Marked reduction in aroma-building substances
- Reduction of harmful germs

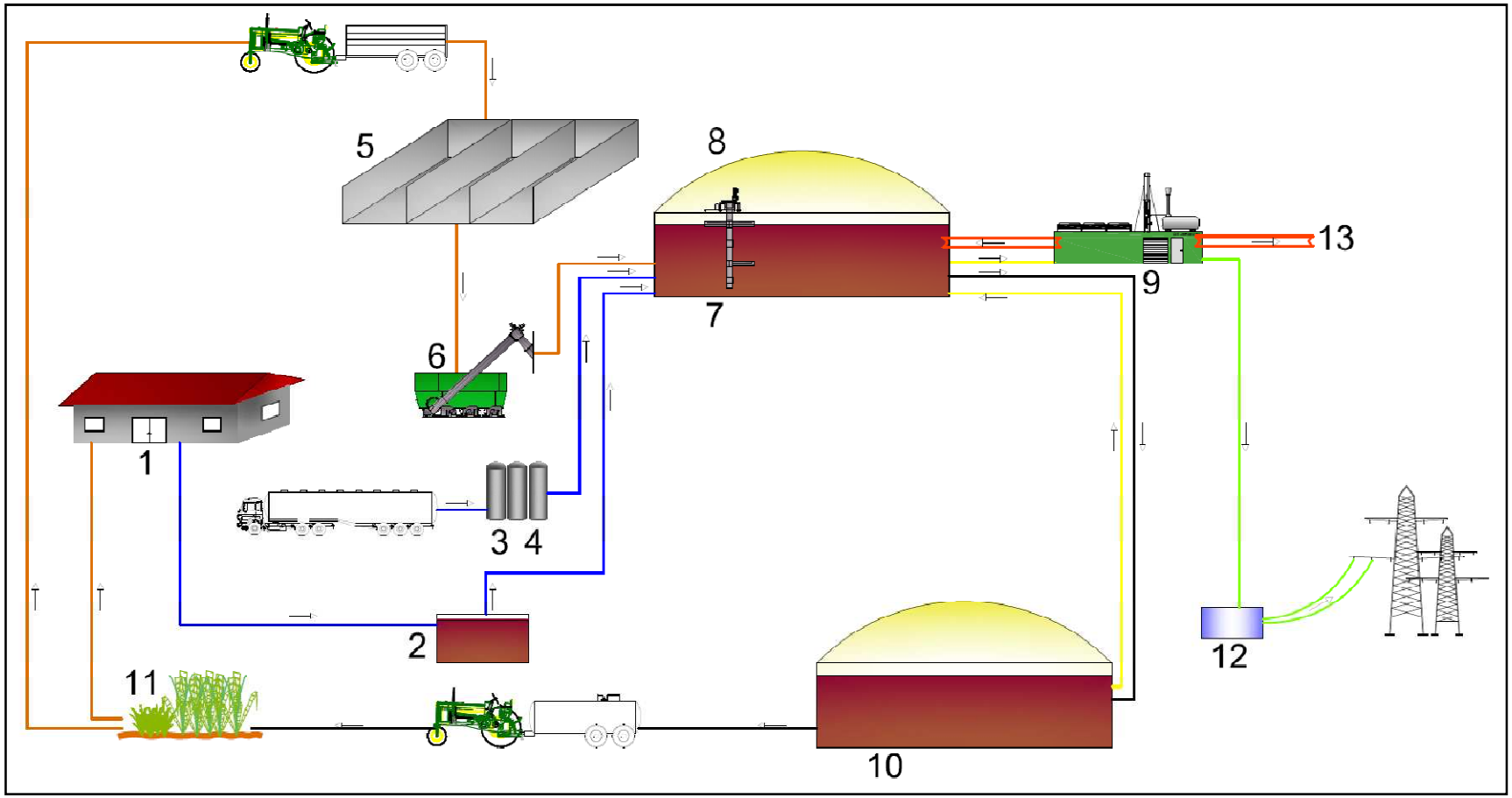
# Biogas plants

Depending on the input material there are 3 types of biogas plants:

- **Waste biogas plants** (biogenic waste from food industry, gastronomy, slaughterhouses, animal feed industry, biowaste from households, …)
- **Agricultural biogas plants** (manure and dung from cattle, pig, chicken, … and agricultural by-products and products)
- **Co-Fermentation biogas plants** (main components are agricultural waste and products combined with biogenic waste)

This 3 types of biogas plants vary in the design, in the equipment and in the operating mode.

# Process flow of a biogas plant

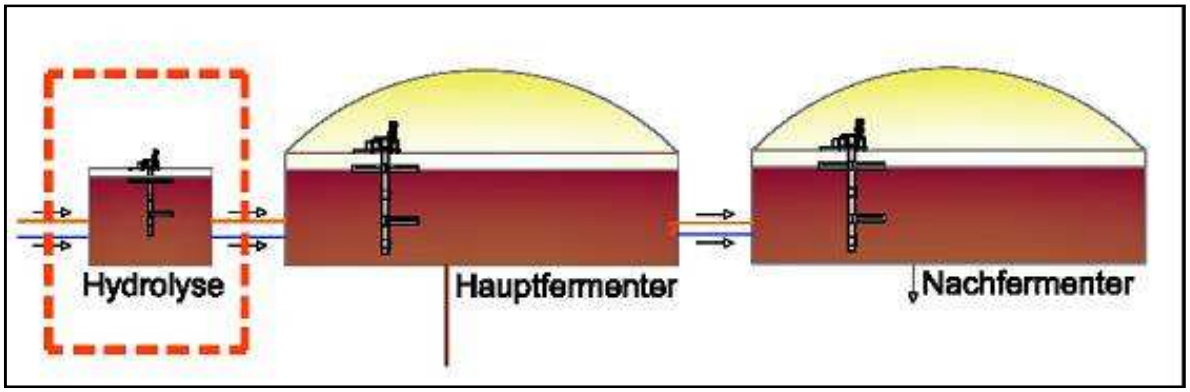



1 Stables
2 Liquid manure pits
3 Collection bins for biogenous waste
4 Pasteurization tank (sanitation)
5 Bunker silo (drive-in silo)
6 Solids delivery
7 Biogas reactor
8 Gas storage tank
9 CHP plant
10 Fermentation residue storage
11 Agricultural fields
12 Transformer, power to grid
13 Heat utilisation

# Innovative technology – hydrolysis step

Hydrolysis step is an important part for fermentation. It is a critical step by fermentation. Hydrolytic bacteria have different environmental requirements than aceto- and methanogenic bacteria .

Parted hydrolysis and fermentation steps result in up to 30 % higher biogas yield because of better decomposition of biomass.




**Technological processes**

- RM-Hydrolysis
- Thermo-Pressure-Hydrolysis

# Biogas utilisation

- Direct combustion and heat utilisation
- Combined heat and power generation (CHP) - Gas-Otto-engines, Pilot-injection gas motor, Stirling-motor, Biogas micro-turbines, Fuel cells
- Biogas upgrading - vehicle fuel
- Biogas upgrading (biomethane production) - injection to public natural gas grid

**$CO_2$-separation**

- After combustion eliminated from the exhaust or by biogas upgrading eliminated from the biogas
- $CO_2$ can be used in agriculture as fertiliser in greenhouses

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# Thank you for your attention !!

## Consulting & Information

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