Biogas from organic residues and outlook on heterofermentative alcohol production

Günther Bochmann

IFA-Tulln University of Natural Resources and Life Sciences

Why anaerobic fermentation

- Degradation of organic substances
  - Reduction of waste
- Reduction of green house gases
- Energy production
  - Gaseous
  - Liquid
- Production of fertiliser





AD plants in Austria

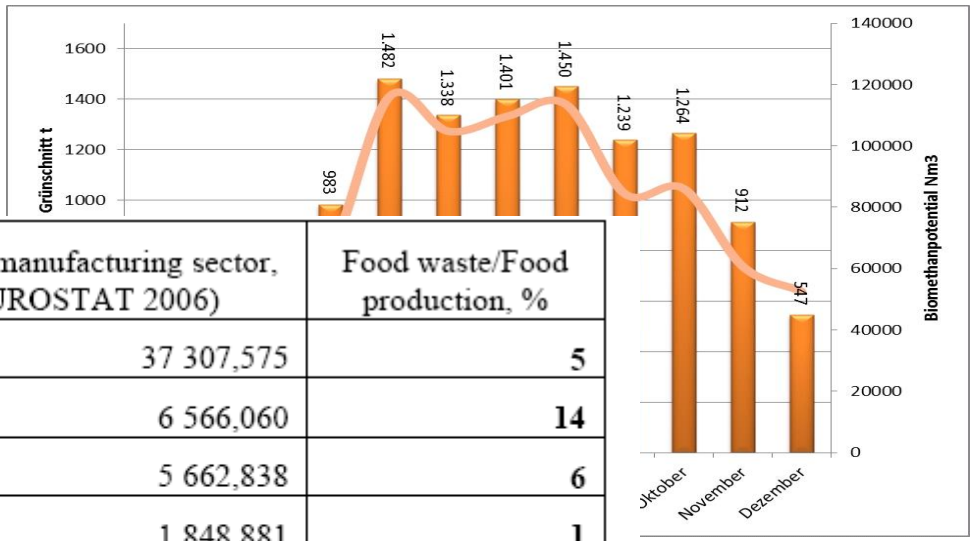
Substrate / Plant type	Number of plants	Mio. Nm^3 biogas per year	% Percentage
Landfill	62	45 - 100	21
Sewage sludge	134	75 - 100	26
Agricultural plants (including co-digestion)	350	121 - 182	45
Industry (including anaerobic wastewater pre-treatment)	25	9 - 14	3
Plants from municipalities and waste associations	15	15 - 18	5
TOTAL	**586**	**265 - 414**	**100**

Source:Braun, 2008

Potentials organic residues

- Organic waste from households
  - Methane yield 70-80 Nm³/t FM

- Organic residues from industry



	Food production, tonnes (EUROSTAT 2006)	Food waste in manufacturing sector, tonnes (EUROSTAT 2006)	Food waste/Food production, %
EU27	766 179,686	37 307,575	**5**
Poland	47 233,940	6 566,060	**14**
Italy	97 088,841	5 662,838	**6**
Germany	138 078,334	1 848,881	**1**
France	106 199,337	626,000	**1**
Austria	9 914,359	570,544	**6**
Czech Republic	13 034,071	361,813	**3**

Organic waste




Separation/Treatment


Fine fraction

0-35 mm

Coarse fraction

> 35 mm

Overview digester types

Green waste and organic residues

Wet fermentation

Plug flow fermenter

Box fermentation

Wet fermentation

- Wet fermentation < 10 % TS
  - Digester with settling sediment collector
  - Upstream system
  - CSTR incl. „window“

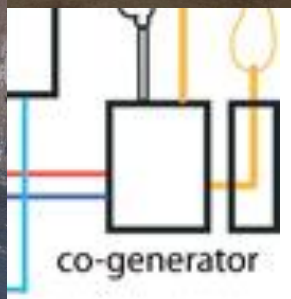
Plug flow digesters

- Dry digestion > 15 % TS

Source: www.walter-hof.de

Box digesters

- Perculation
- 30 – 50 % digestate and perculate



: www.zorg-biogas.de, Seiringer

Biogas Vienna

<u>capacity:</u> **17.000 t/a (upgradeable up to 34.000 t/a)**

<u>technology:</u>

Processing, mashing, two-stage floating technique, dewatering, biogas utilization for district heating, exhaust air treatment, fermented residual preparation for composting

<u>gas production:</u>

1.125.000 Nm^3/a CH4
(first expansion stage)

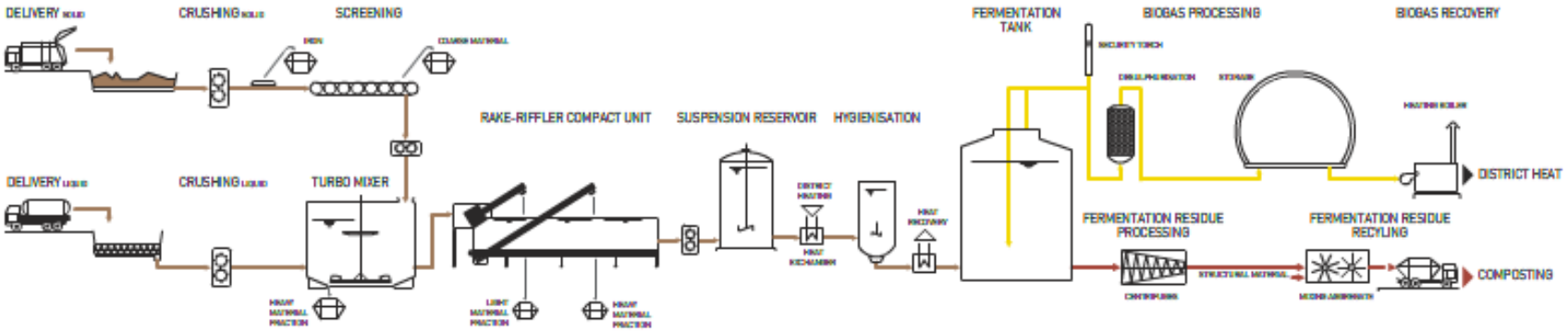
<u>energy transform method:</u>

Hot water boiler technology for district heating (for 300 households)

<u>costs:</u> **13,5 Mio. €**

Source: Rogalski, MA48, 2012

Process scheme biogas Vienna



Source: Rogalski, MA48, 2012

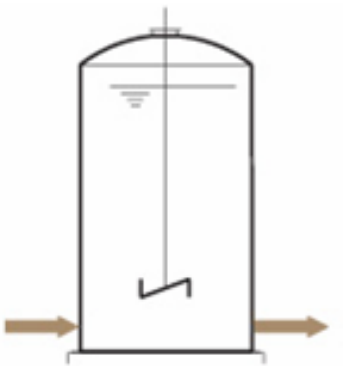
Suspension Reservoir

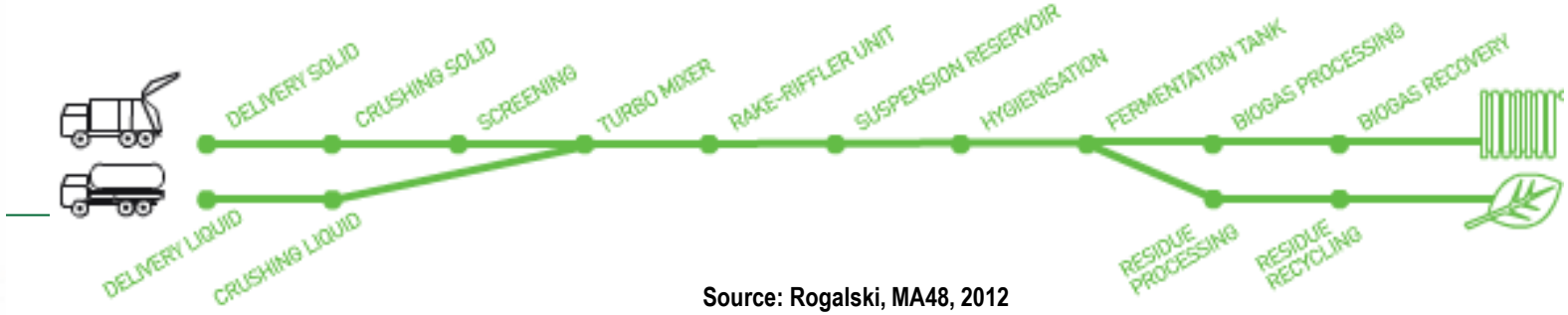
SUSPENSION RESERVOIR

TECHNICAL DATA:

Usable Volume	200 m³

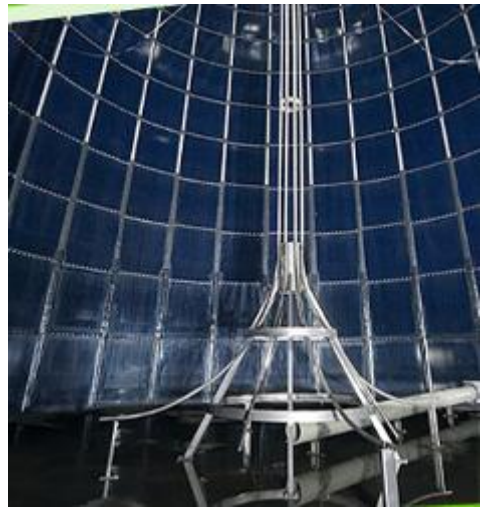
The suspension reservoir provides constant feeding into the hygienisation facility. The contents of the container are mixed with a central stirring device in order to prevent sedimentation process.

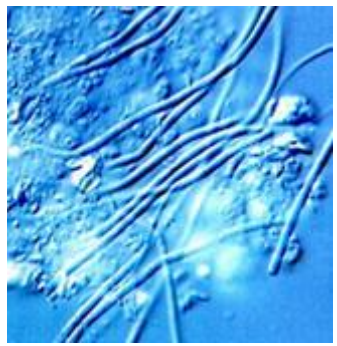


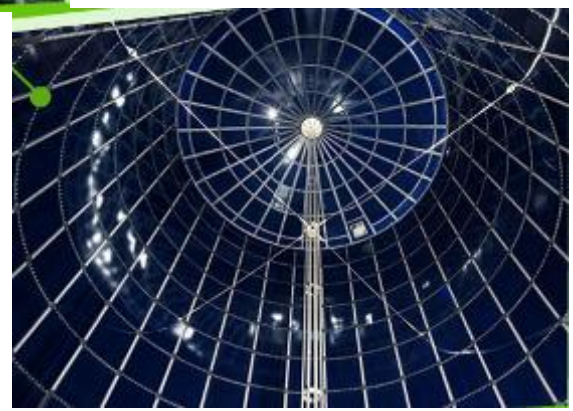


Source: Rogalski, MA48, 2012

Fermentation Tank







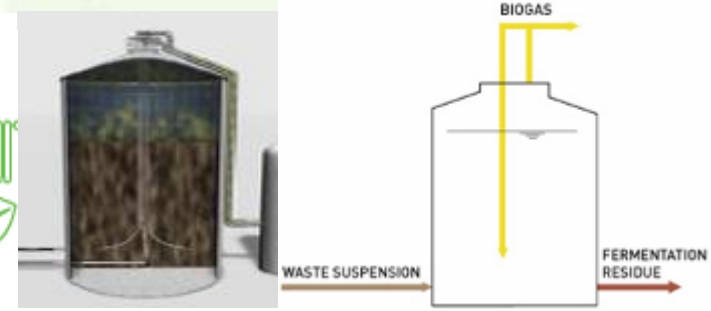
FERMENTATION TANK

TECHNICAL DATA:

Usable Volume	2.600 m³
Height	19 m
Diameter	14 m
Process	mesophile (37 - 40 °C)
Retention Time	20 days

Under anaerobic conditions, micro-organisms convert the organic ingredients from the waste suspension at the temperature from 37 to 40 °C into biogas.

Source: Rogalski, MA48, 2012



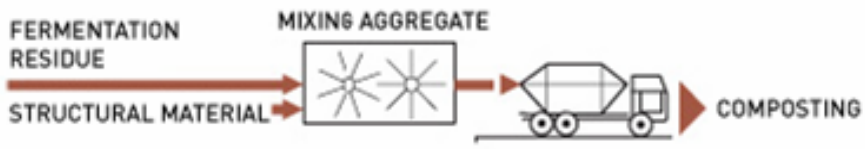
Digestate management

FERMENTATION RESIDUE RECYCLING

TECHNICAL DATA:

Bunker:	
Usable Volume	60 m³
Mixing Aggregate:	
Power	55 kW
Mixing Ratio	1:1

The fermentation residue is mixed with structural material in a mixer, filled into containers and transported to the composting facility.



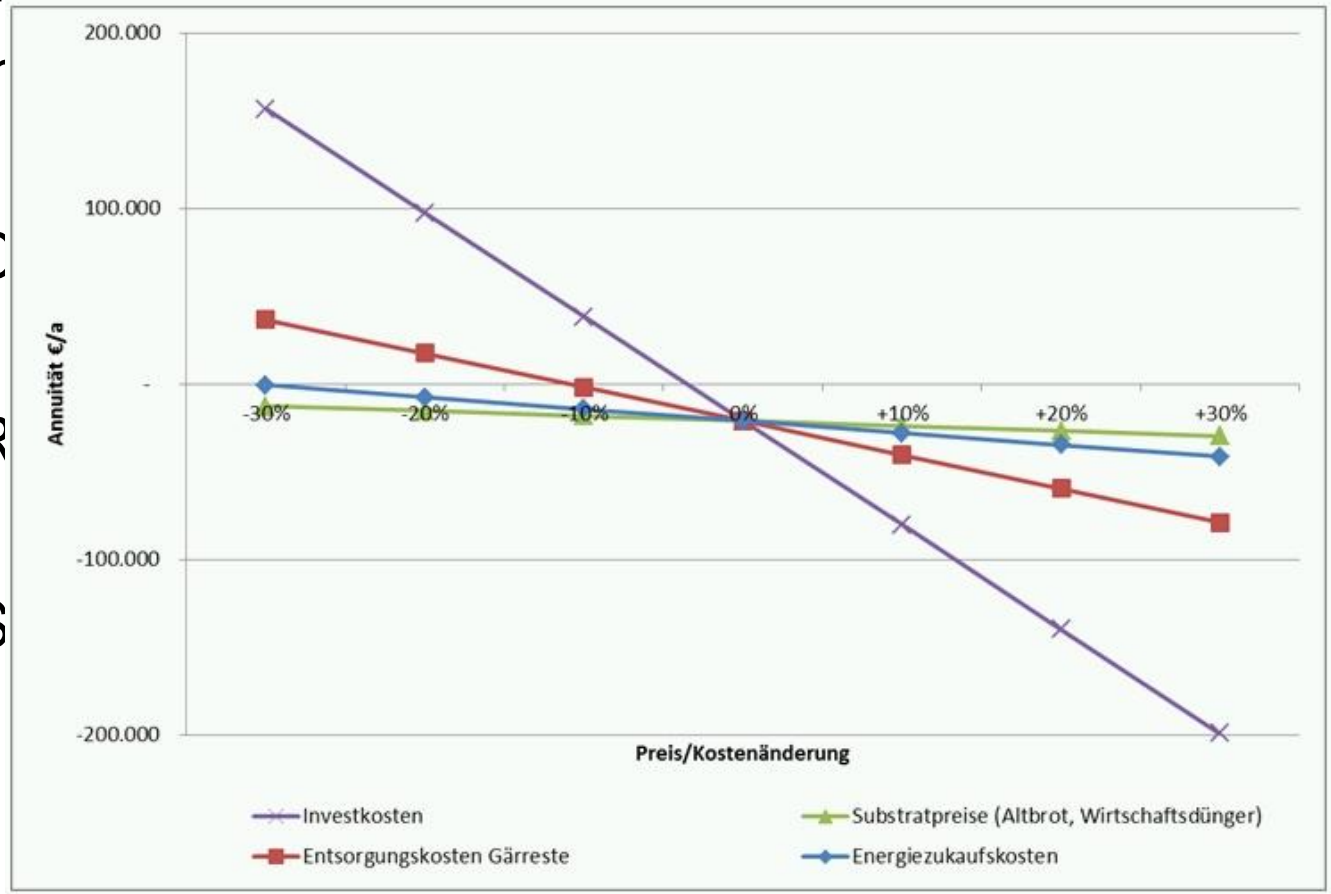
Source: Rogalski, MA48, 2012

Lower Austria

- Study about potentials
- 227,300 t/a biowaste
  - 17,000,000 Nm^3 CH_4 or 170 GWh
- 25 % of total biowaste potential
  - CHP 16,000 MWh_{el} or 17,000 MWh_{therm}
  - 0.15 % of electricity demand

Costs

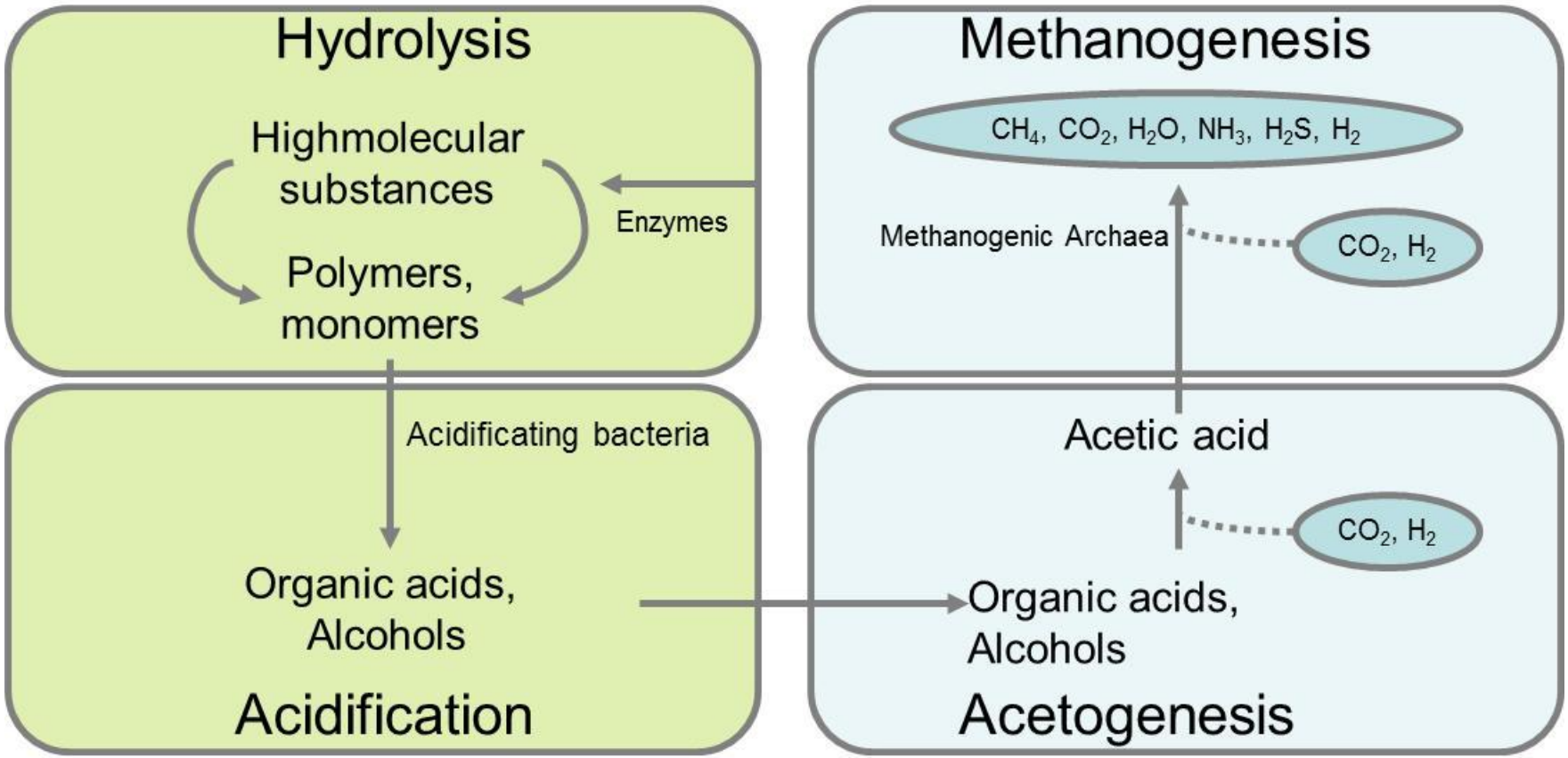
- 20.000 t/a → 10.000 t/a for biogas production
- Ir
- C
- R
- S



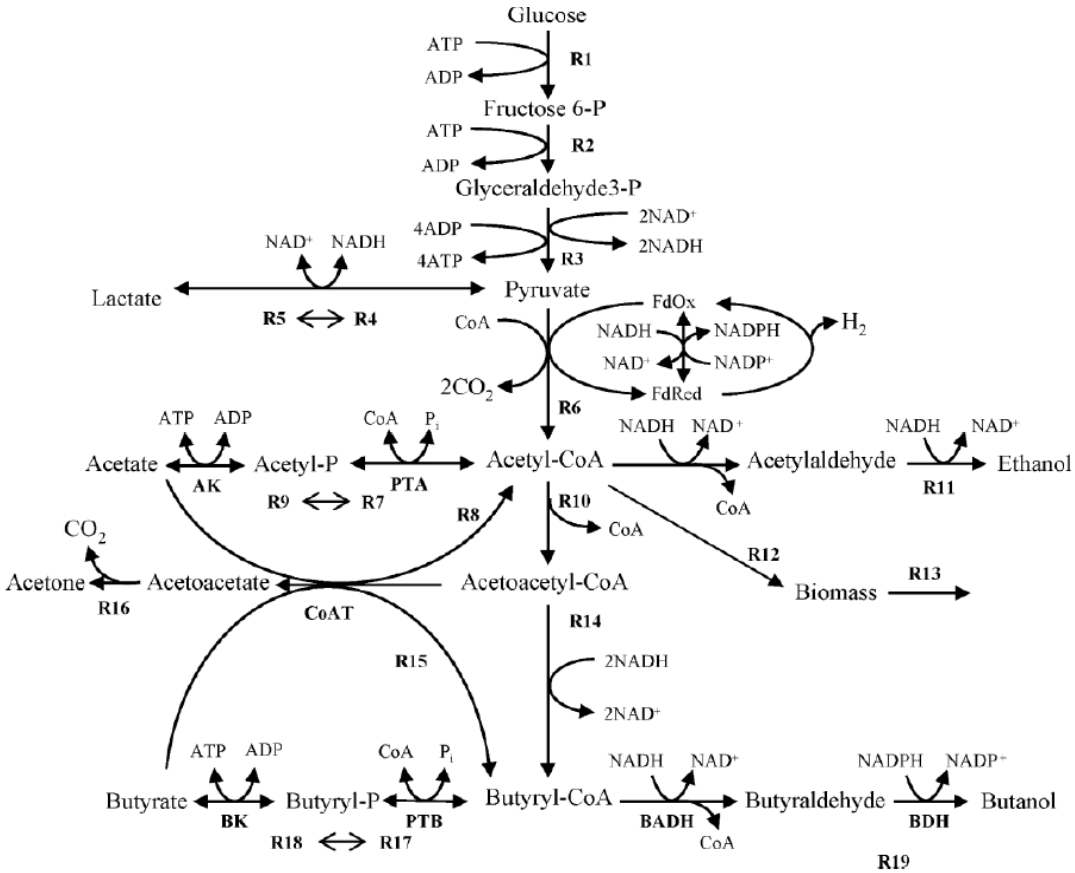
ABE Fermentation

- Weizmann-process
- Heterofermentative organisms
- Fermentation of sugars
- Utilisation of acetic acid and butyric acid
- pH initiates the solventogenesis
- Production of aceton, butanol and ethanol
- Relation 3:6:1
- 12 – 20 g/L butanol
- Market price (650-1534€/t)

4 steps of AD


Hydrolysis
Highmolecular substances
Enzymes
Polymers, monomers
Acidificating bacteria
Organic acids, Alcohols
Acidification
Methanogenesis
CH_4, CO_2, H_2O, NH_3, H_2S, H_2
Methanogenic Archaea
CO_2, H_2
Acetic acid
CO_2, H_2
Organic acids, Alcohols
Acetogenesis

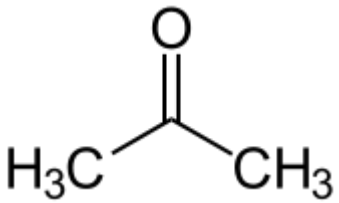
Pathway ABE Fermentation



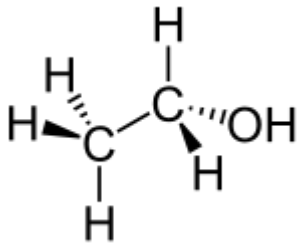
Advantage of the products

- Butanol
  - Widely used bulk chemical
  - Varnish, pharmaceutical industry, biofuel

- Acetone
  - Solvent
  - Inks, oils, plastics, varnish, resin, pharmaceutical industry



- Ethanol
  - Main alcohol
  - Solvent, biofuel, polypropylen



Advantages ABE + biogas

- Combination with anaerobic digestion process
  - Digestion of residues
    - Biomass, unused compounds
    - Fermentation gases
  - Production of energy/process energy
  - Fertiliser
- Will it make the process economical feasible?

Question?

Günther Bochmann
University of Natural Resources and Life Sciences
Department IFA-Tulln
Institute of Environmental Biotechnology
Konrad-Lorenz-Strasse 20
A-3430 Tulln
+43 2272 66280 536
guenther.bochmann@boku.ac.at
www.ifa-tulln.ac.at