Energetic autarky wastewater treatment in Germany

WWTP Rheda-Wiedenbrück / WWTP Grevesmühlen

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Fields of specialization

Environmental Protection

Industrial wastewater

Municipal wastewater

Sewerage Systems

Water supply

Cost and fee calculation

Biogas-Project

Solid waste treatment

Plant operation

Project management

Turn-Key-Projects

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Solid Waste Treatment Centre Hannover

WWTP Hannover-Gümmerwald, (Capacity 800.000 PE)

WWTP Athens/ Greece, 4,5 Mio PE

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Energy consumption in the world

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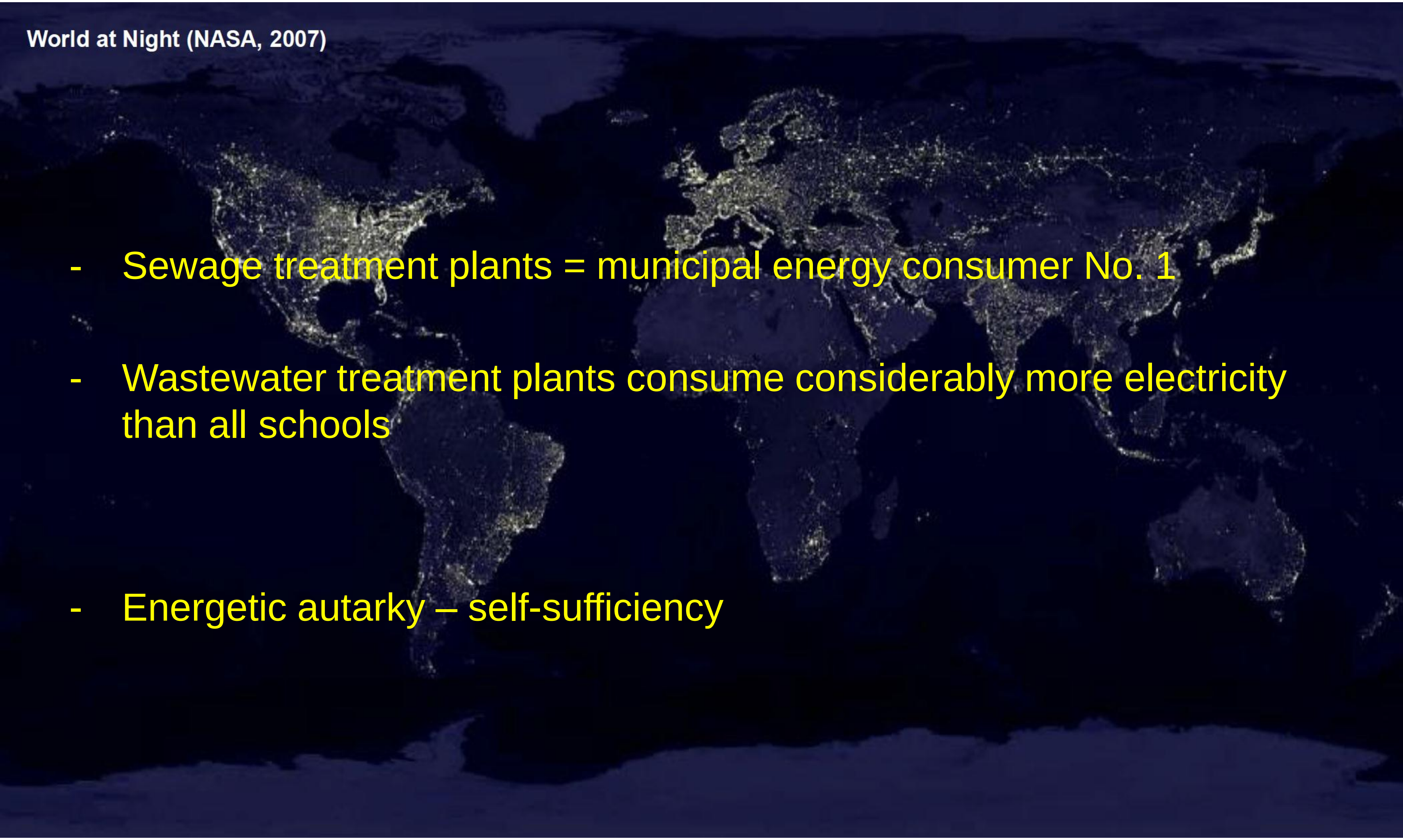


World at Night (NASA, 2007)

- Sewage treatment plants = municipal energy consumer No. 1
- Wastewater treatment plants consume considerably more electricity than all schools
- Energetic autarky – self-sufficiency

Biogas for energy usage

Energy balances on the basis of the COD

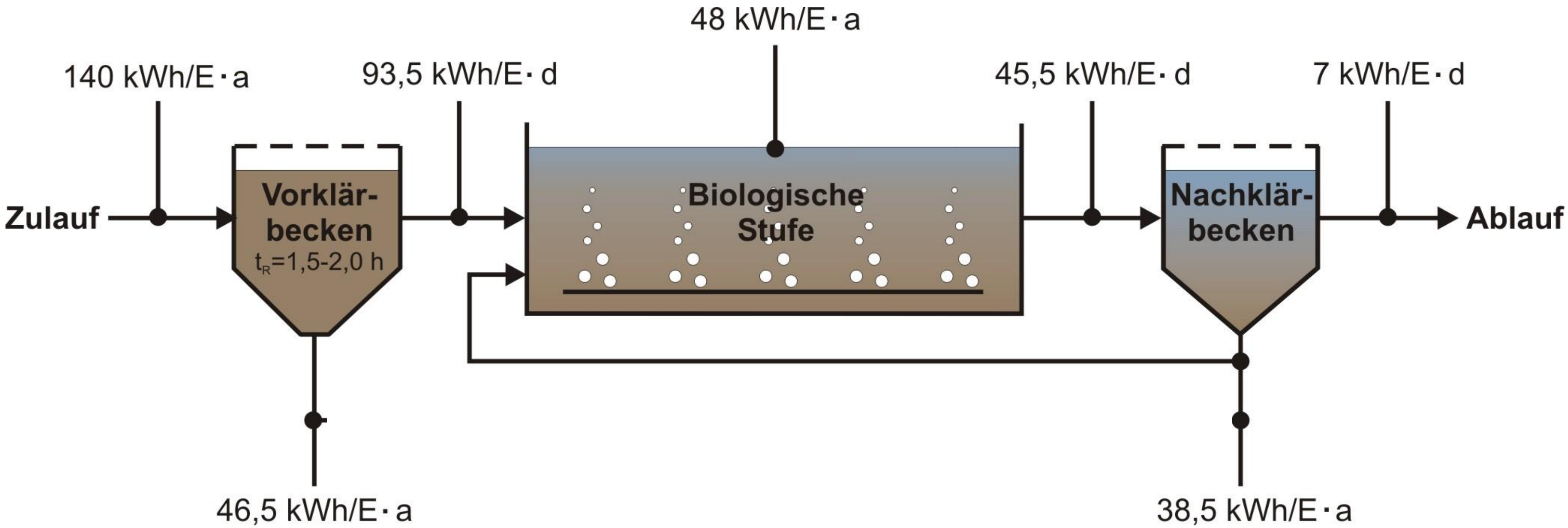
- COD-balances are the basis for all simulations
- COD-balances can be used for the operation control
  (Examples: control of a gas flow measurement and analysis)
- Basis of the comparison:

  120 g COD/ PE•day ➔ 140 kWh/ PE • year

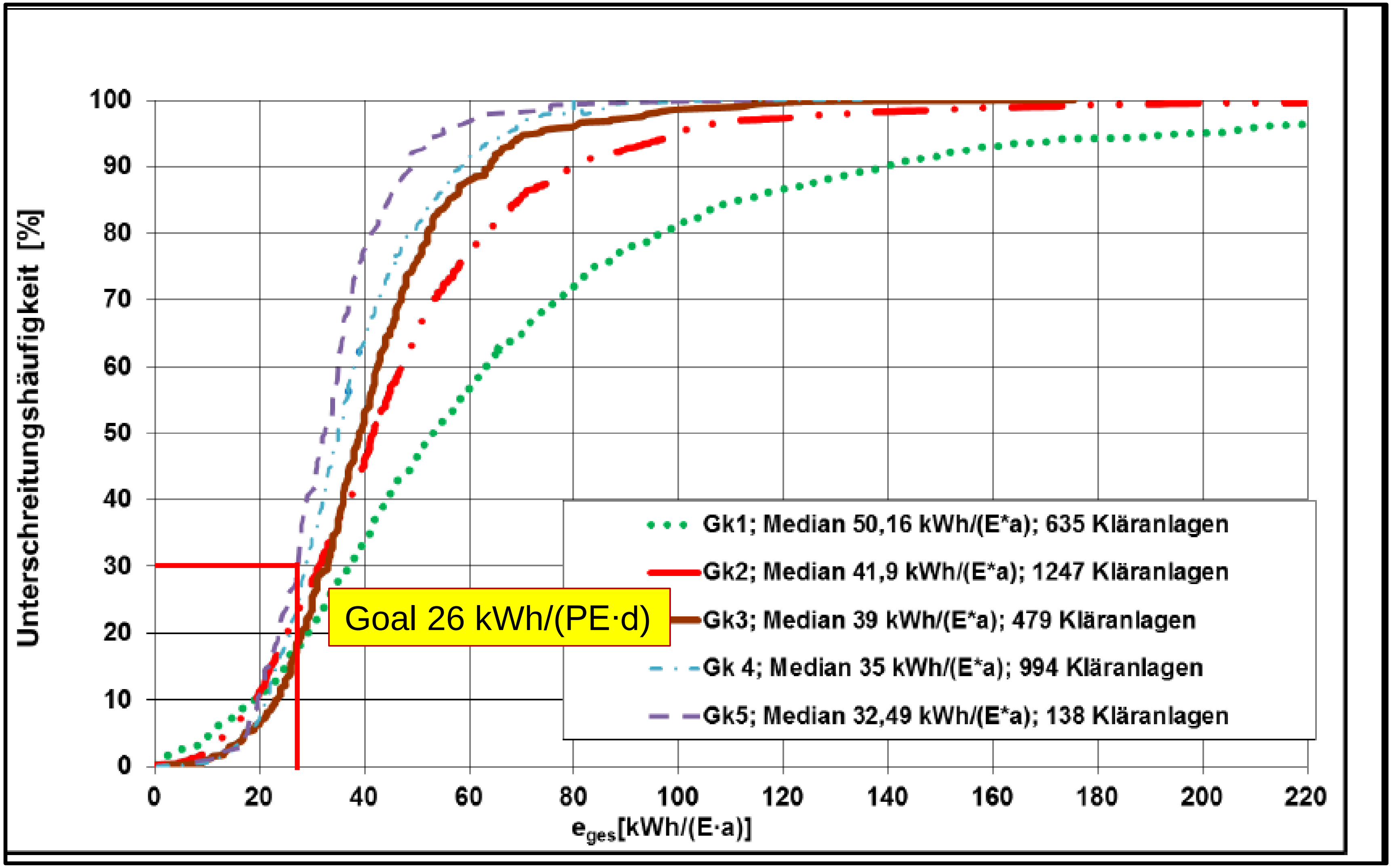
  (320 l CH_4 per kg COD, 10 kWh per m^3 CH_4)

- For each separate treatment step a COD-balance is possible

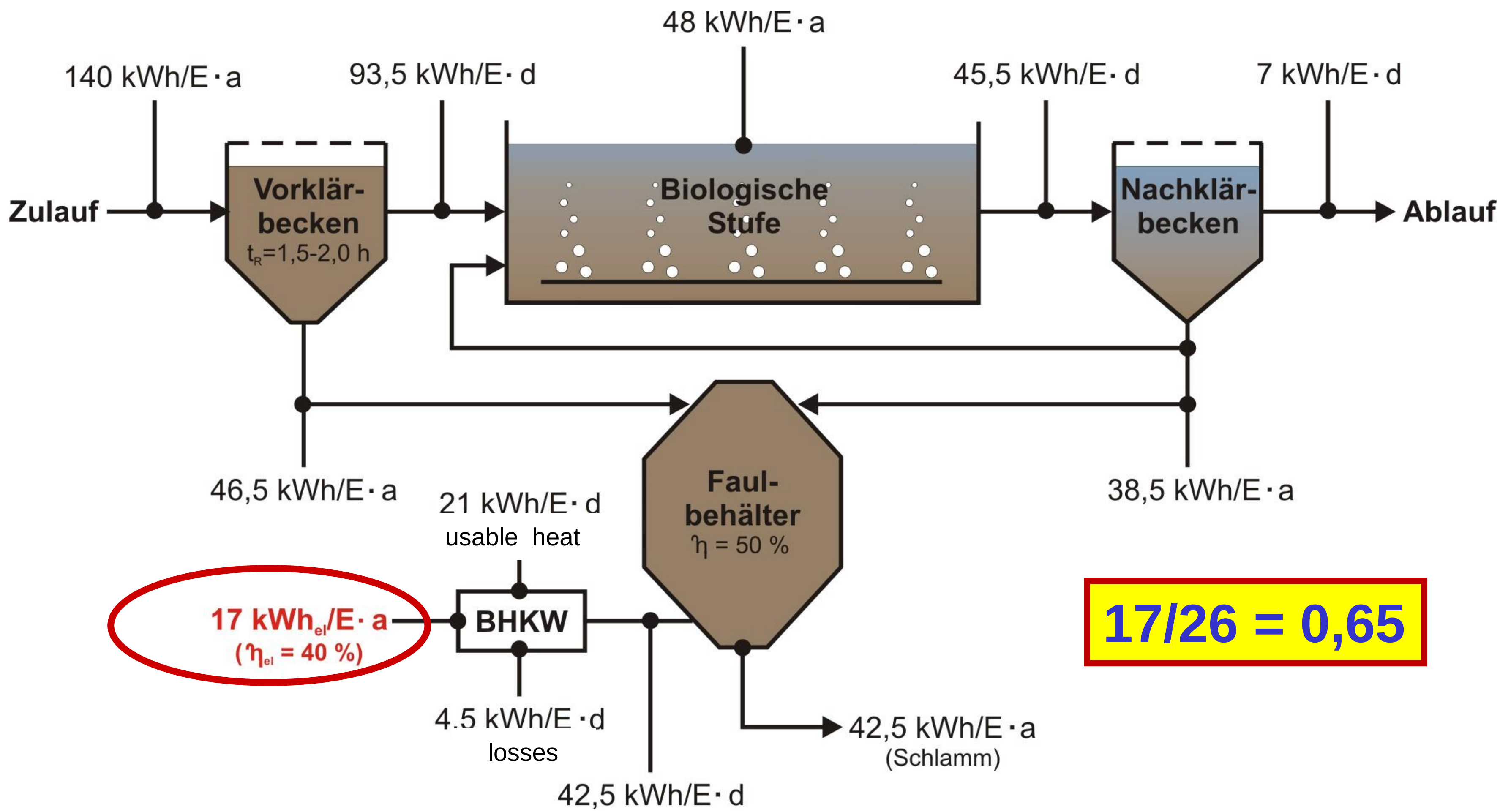
Energy balance on a wastewater treatment plant (Basis:COD)



Specific Energy demand of around 3.500 waste water tretament plants in Germany

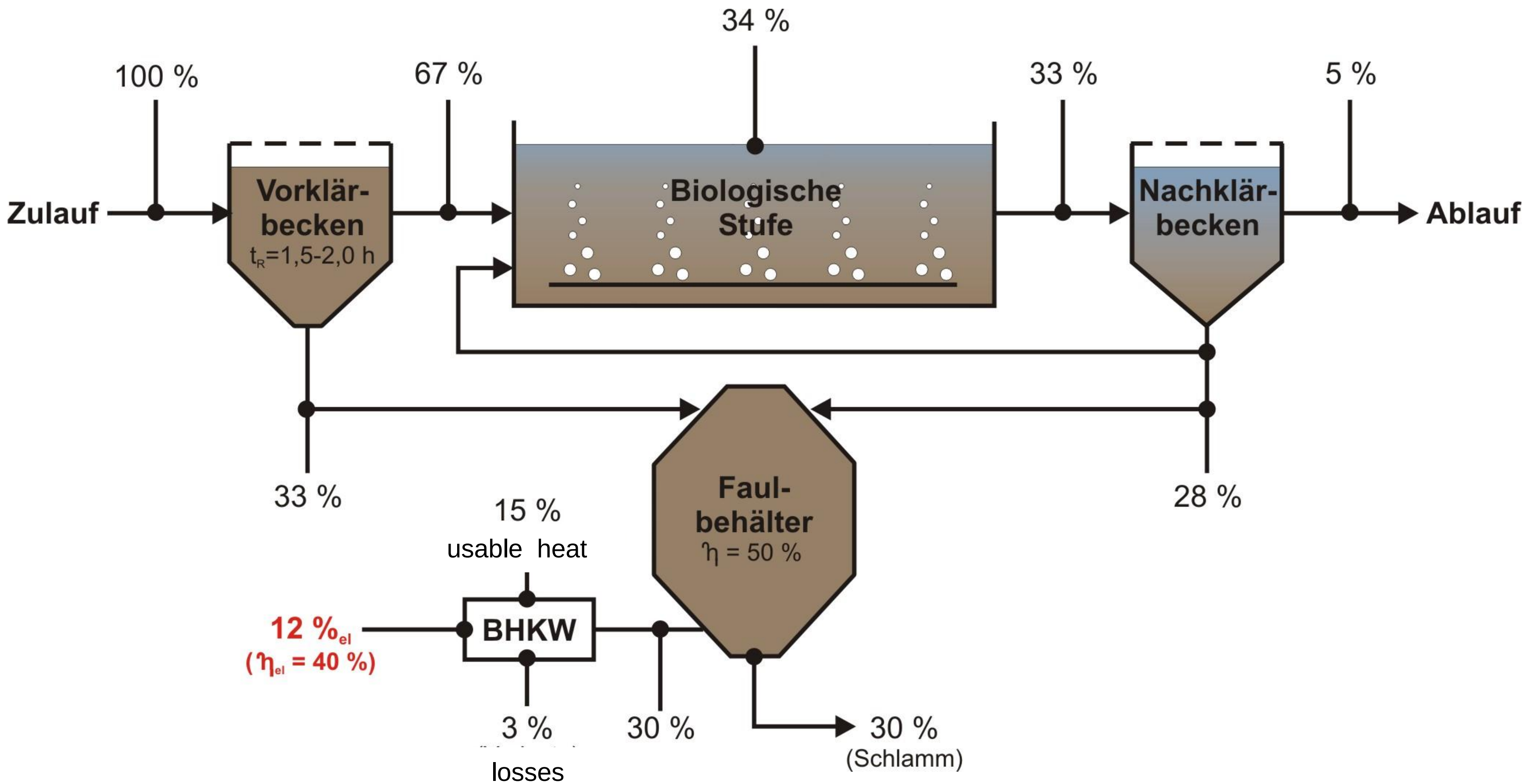


Energy balance on a wastewater treatment plant (Basis:COD)

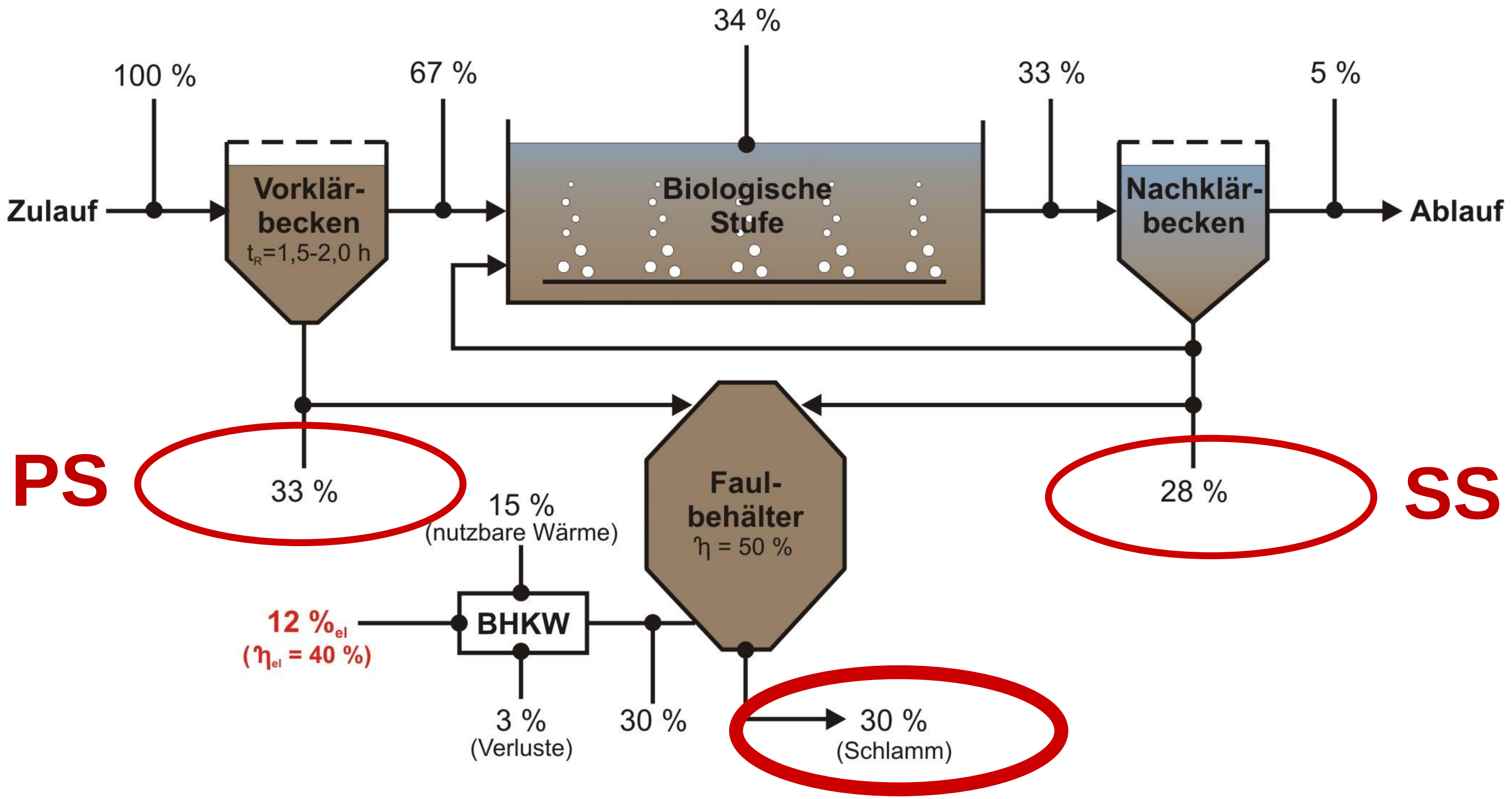


Goal for the energy demand: 26 kWh/PE•year (> 100.000 PE)

Distribution of the COD from the inflow during the wastewater and sludge treatment



Distribution of the COD from the inflow during the wastewater and sludge treatment



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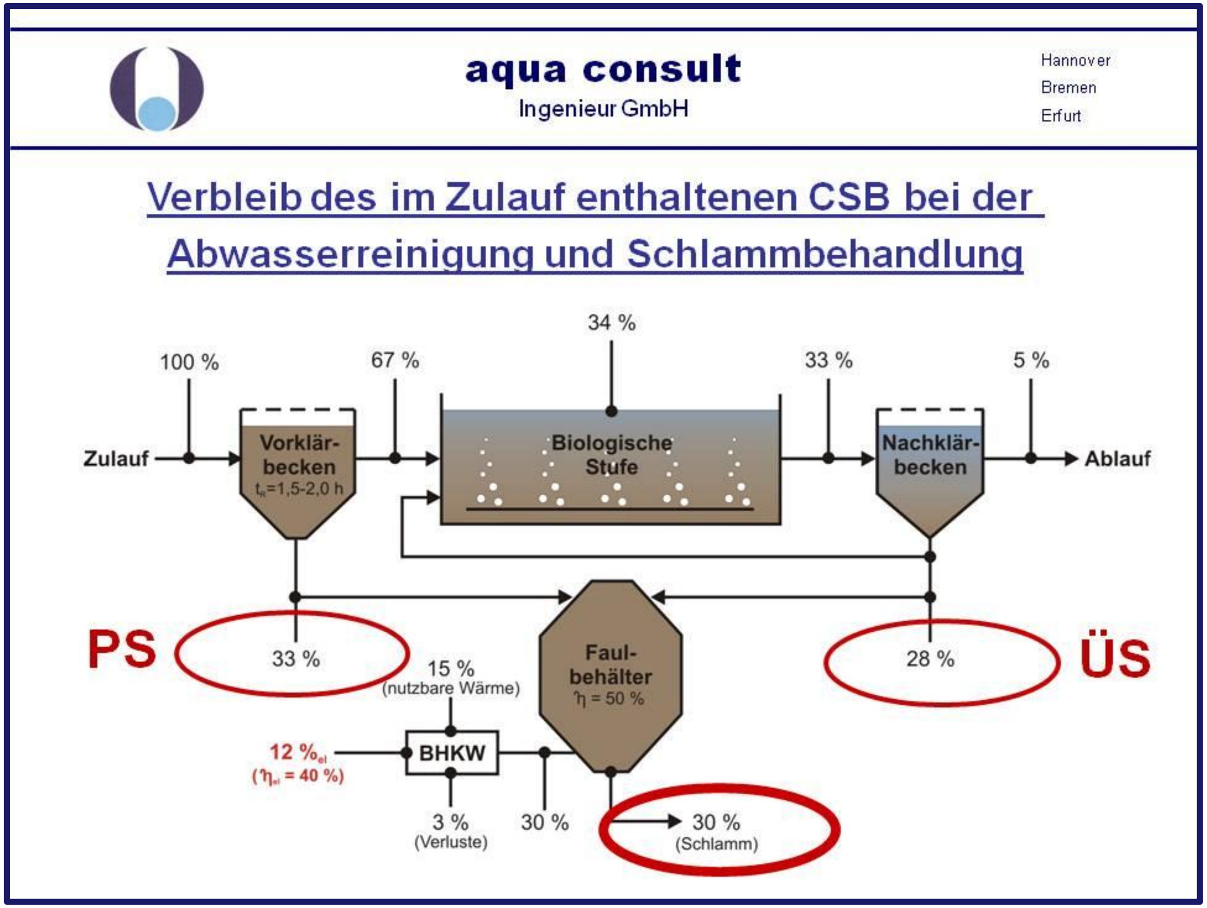

Optimization of the energy demand

- More energy to be bound in the sludge (PS, sludge age)
- Less energy in the remaining sludge (Hydrolysis)
- Energetic usage (Degasification, Hydrothermal treatment?)

Energy-Balances for WWTP's

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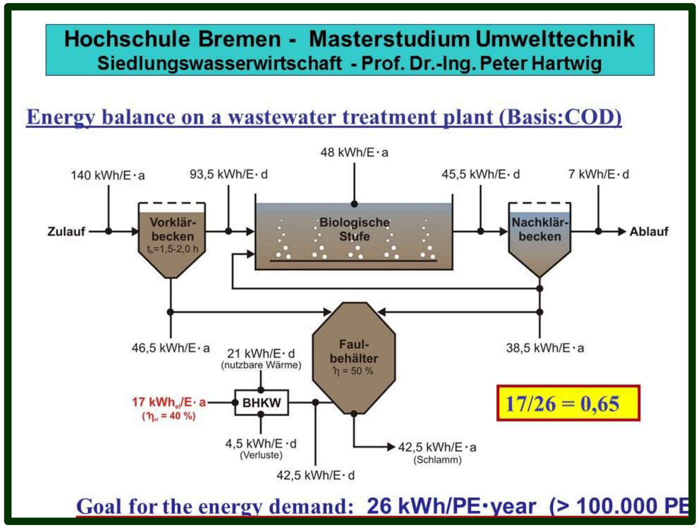
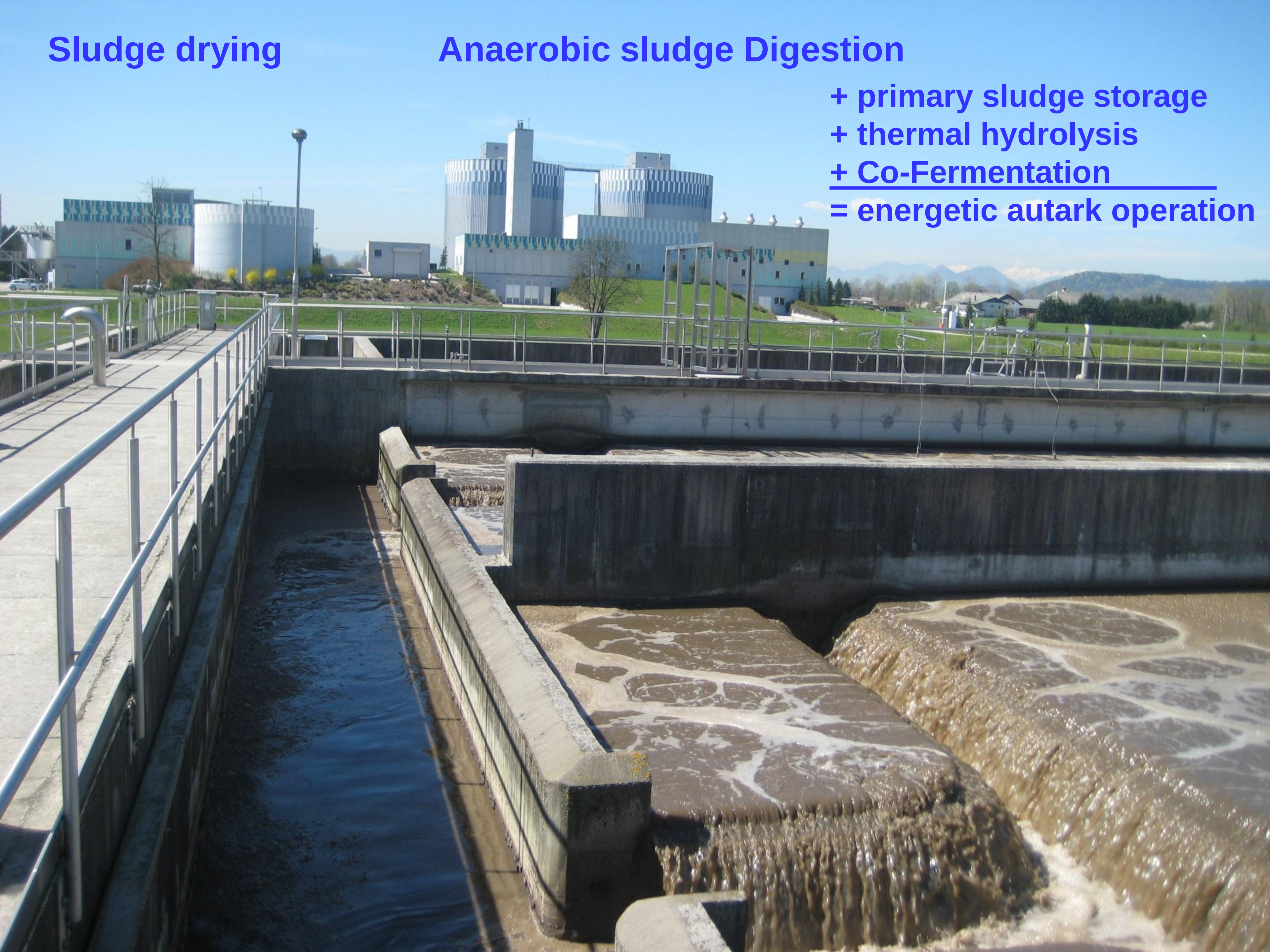
Result:

Around 2/3 of the required electric energy can be produced by the biogas from the anaerobic digester

- How to be energetic autarky?



Thermal Hydrolysis


Sludge drying
Anaerobic sludge Digestion
+ primary sludge storage
+ thermal hydrolysis
+ Co-Fermentation
= energetic autark operation

Example for co-fermentation

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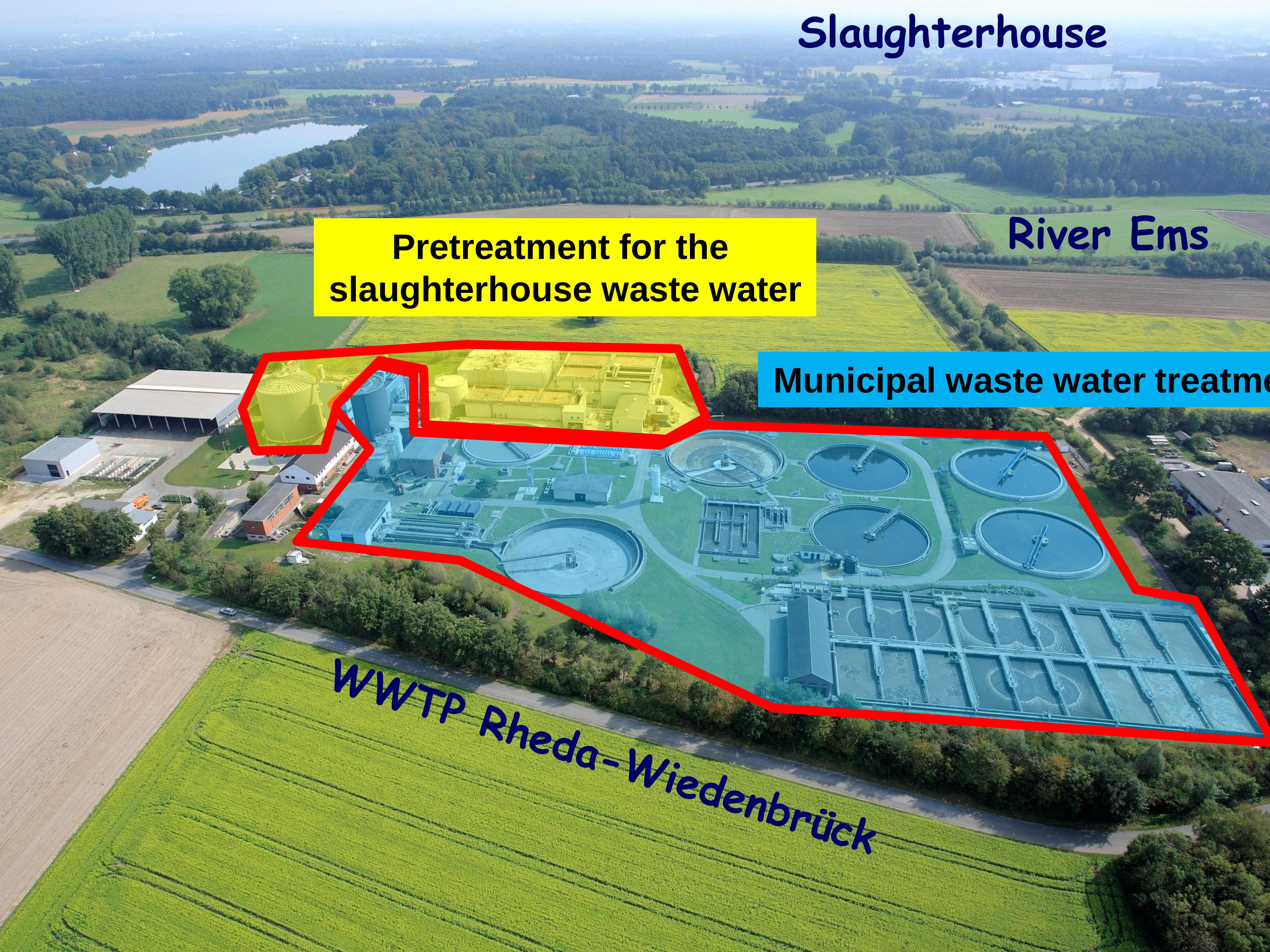
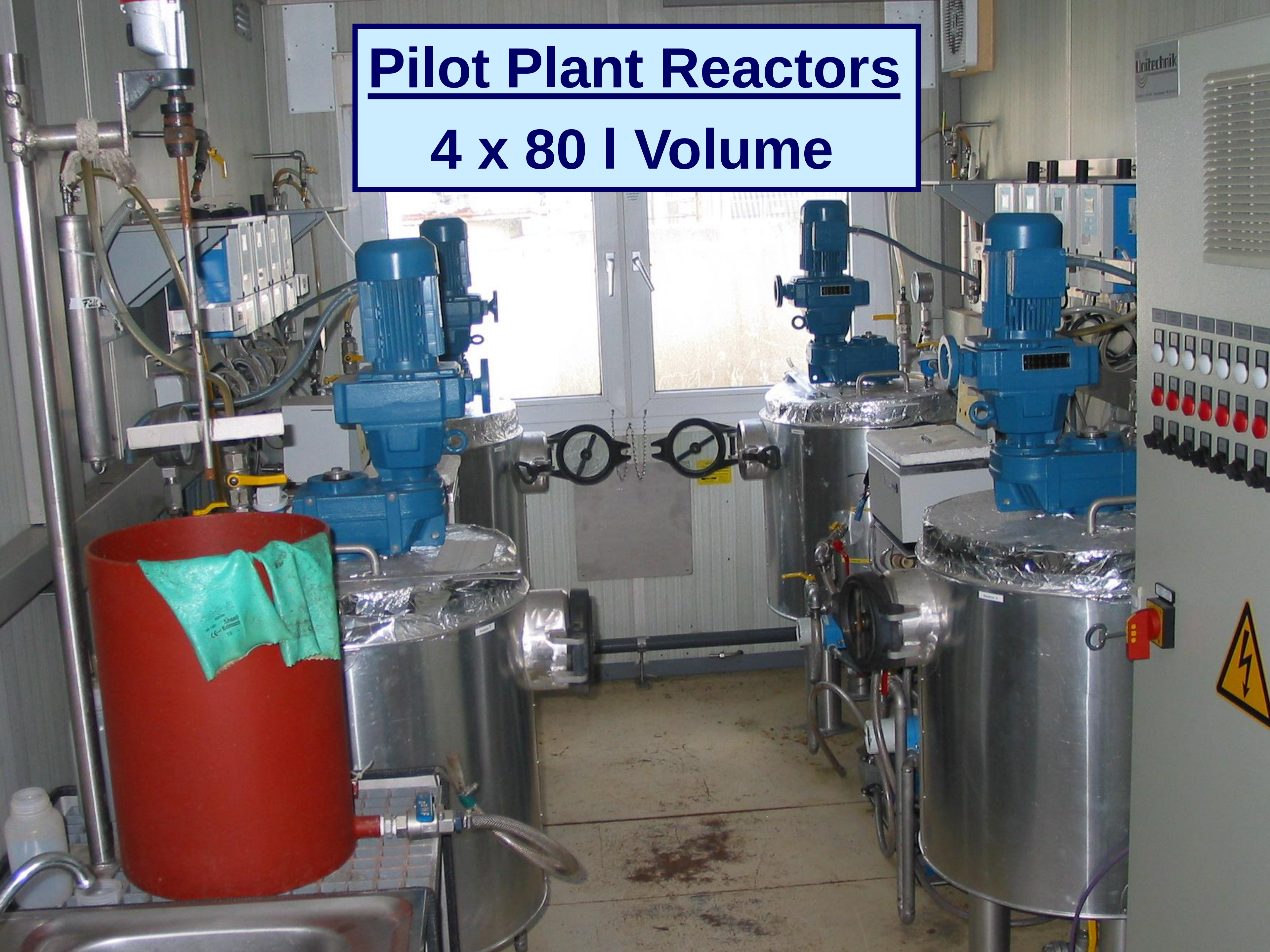
Slaughterhouse (capacity 30,000 pigs per day)


Slaughterhouse
River Ems
Pretreatment for the slaughterhouse waste water
Municipal waste water treatme
WWTP Rheda-Wiedenbrück

Anaerob Pilot Plant

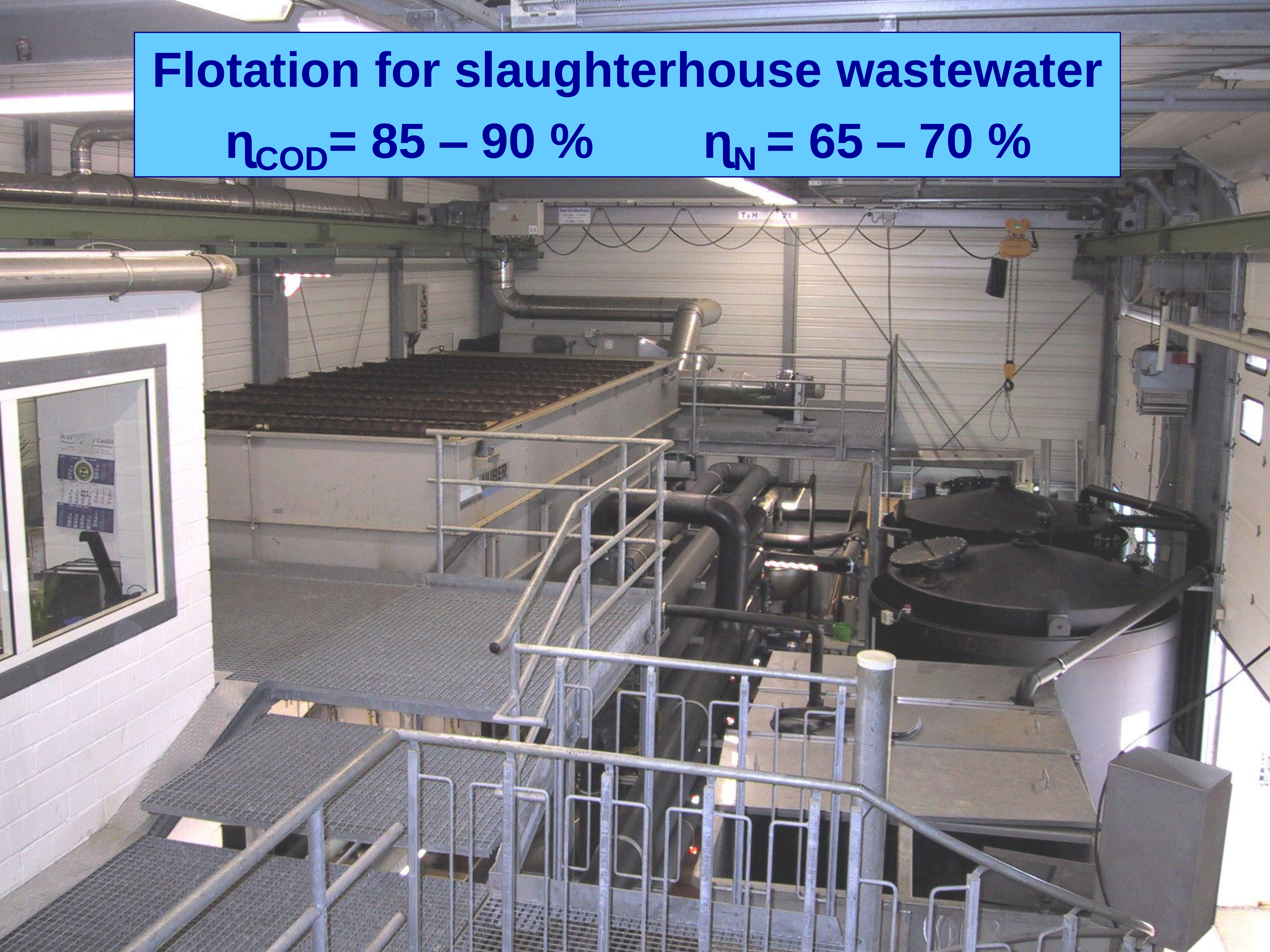
Pilot Plant Reactors

4 x 80 l Volume



Flotation for slaughterhouse wastewater

η_{COD} = 85 – 90 % η_{N} = 65 – 70 %



Pre-treatment after flotation

Предварительная обработка после флотации

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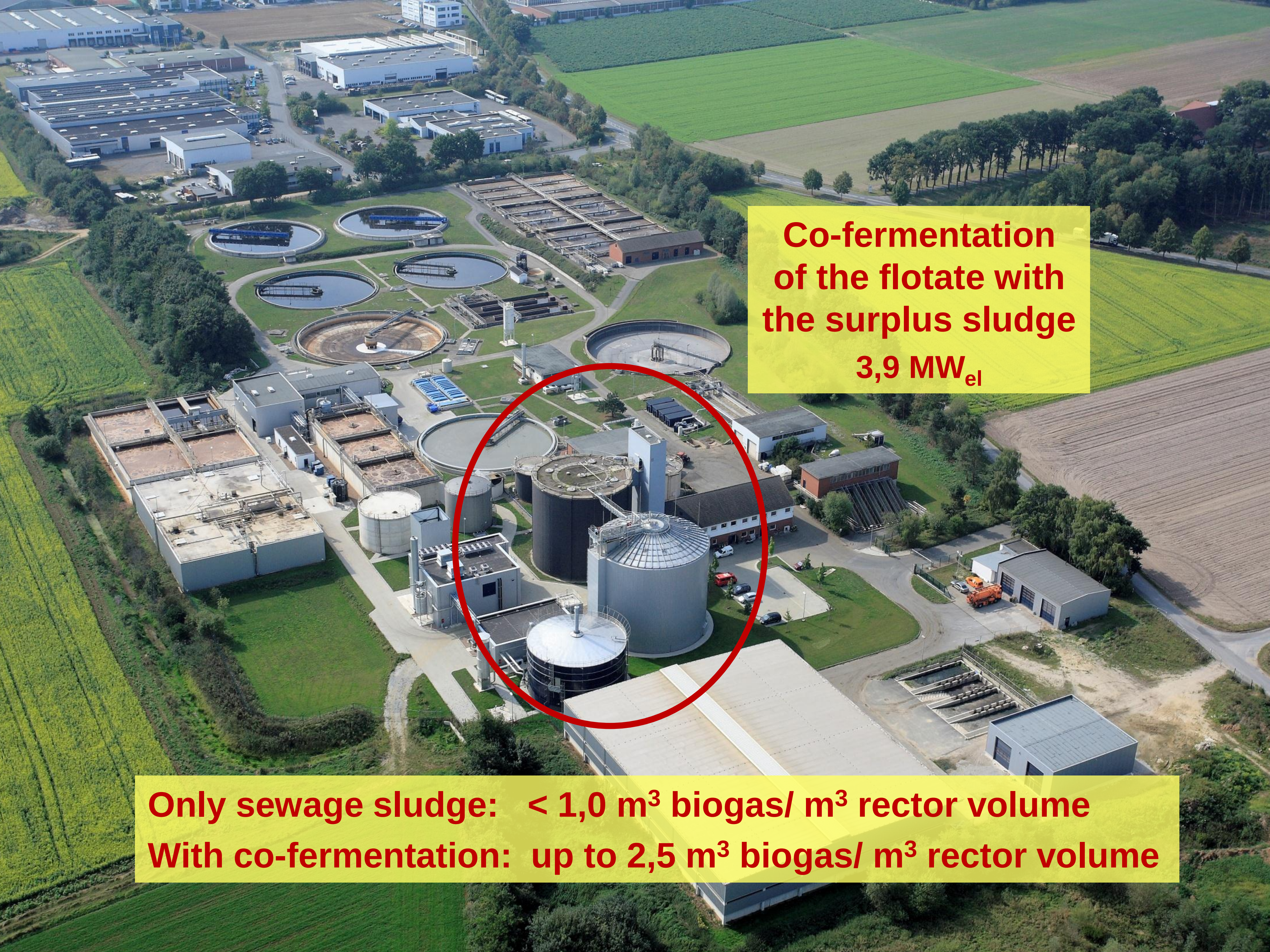
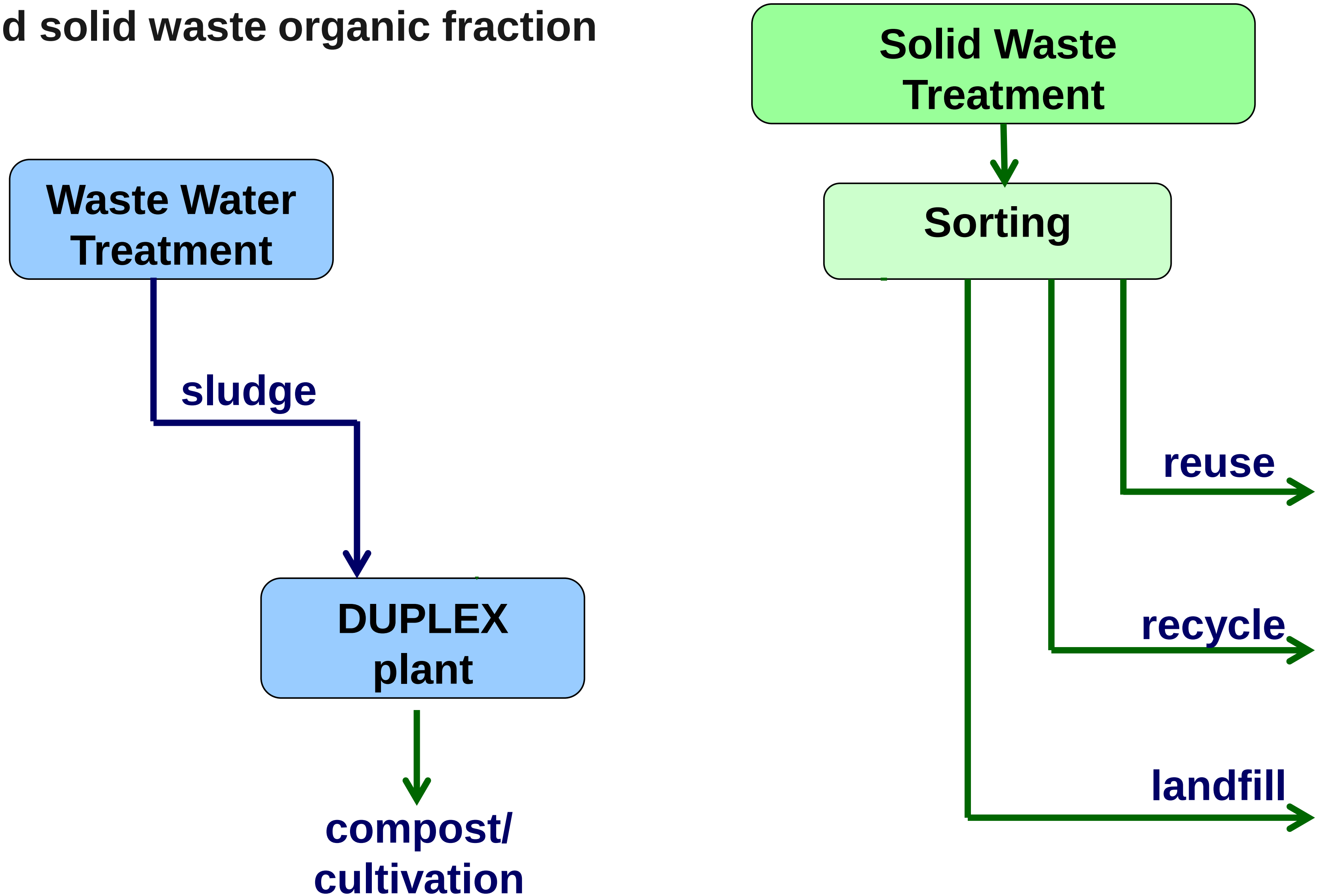
Flotate as valuable energy source


Co-fermentation
of the flotate with
the surplus sludge
3,9 MW_{el}
Only sewage sludge: < 1,0 m^3 biogas/ m^3 rector volume
With co-fermentation: up to 2,5 m^3 biogas/ m^3 rector volume

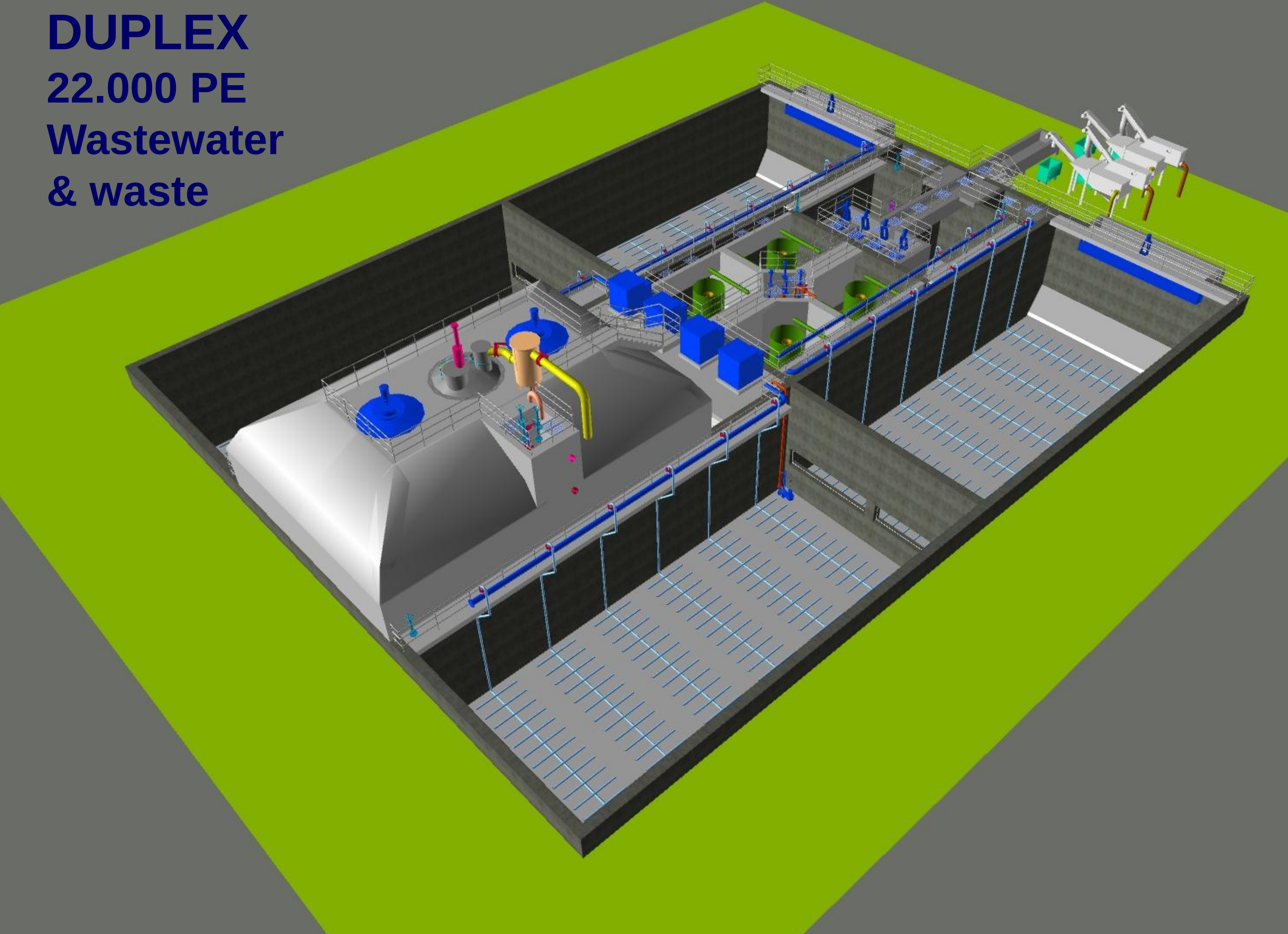

Sludgedrying
Anaerobic sludge Digestion
+ primary sludge storgae
+ thermal hydrolysis
+ Co-Fermentation
= energetic autark operation
How to increase co-fermentation?

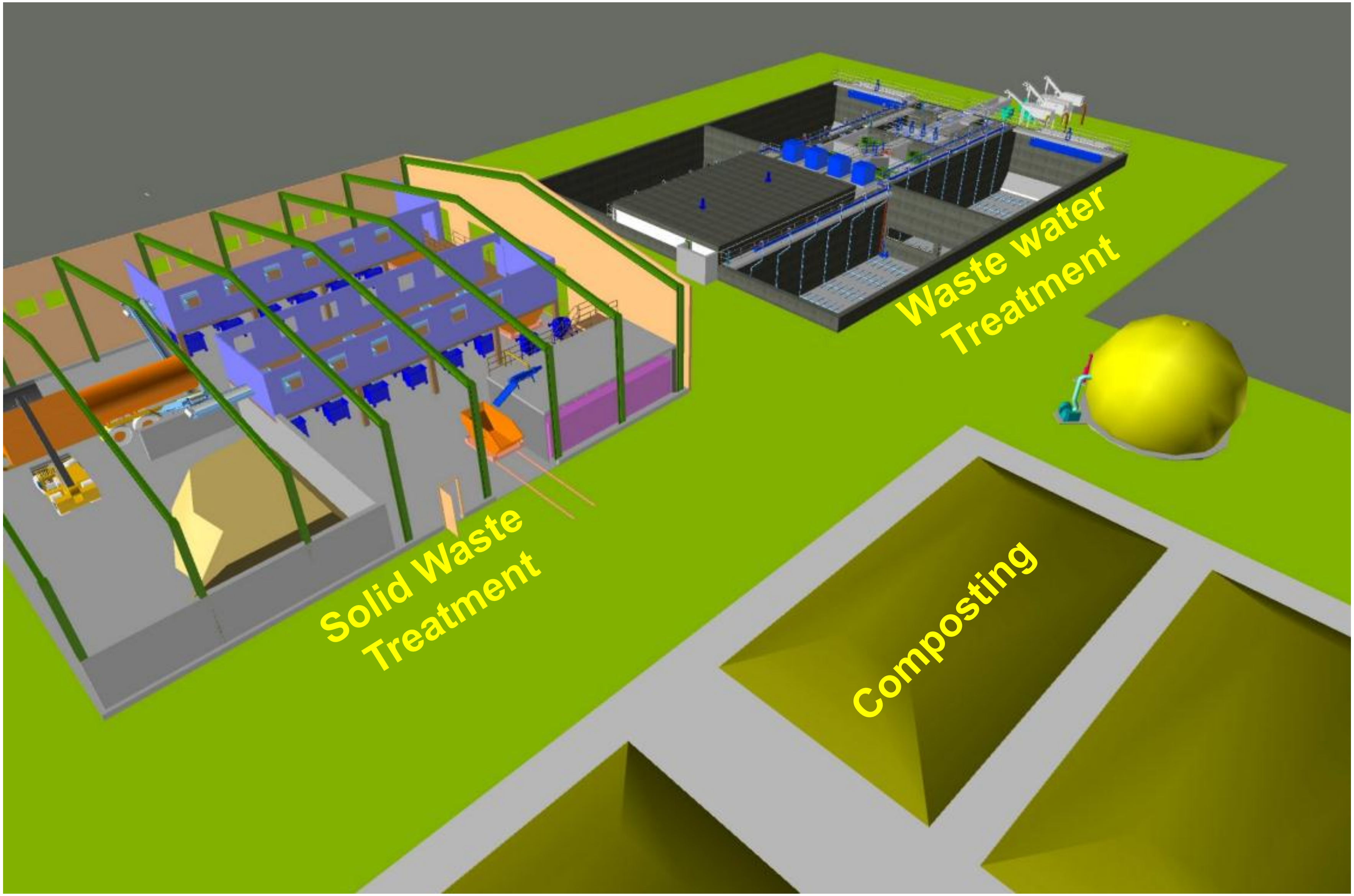
Duplex-Technology

Co-fermentation of Sewage sludge and solid waste organic fraction



DUPLEX
22.000 PE
Wastewater & waste




Waste water
Treatment
Solid Waste
Treatment
Composting

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H-Batch-System in Srinagar/ India
(5.400 m^3/d & 16.100 m^3/d)

WWTP Grevesmühlen, 65 000 PE

IWAMA-Research-Project

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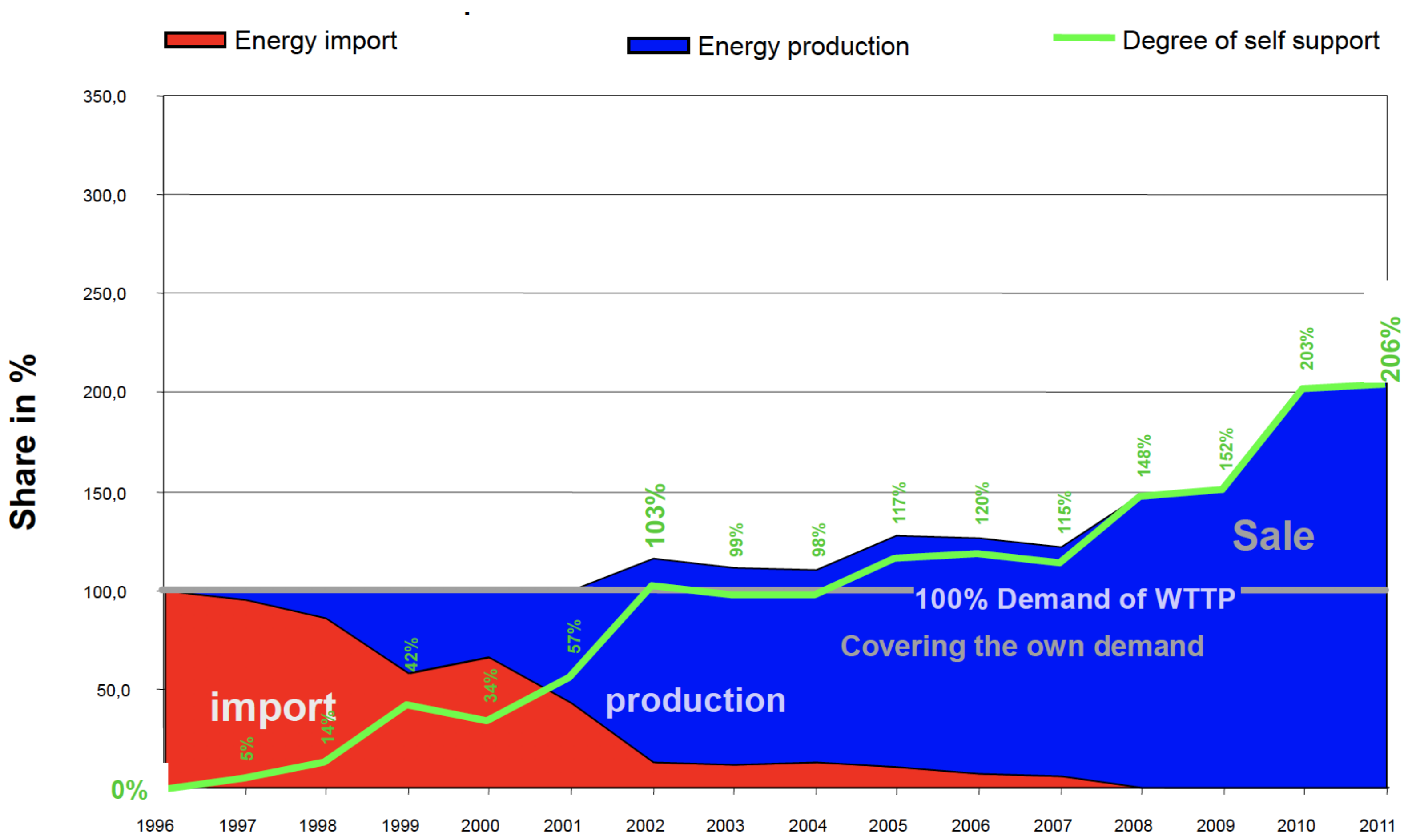
Expansion from 40,000 PE to 65,000 PE

- Approx. 60% from industry (creamery/coffee roaster)
- Centralized sludge treatment
    - Primary sludge
    - Surplus sludge
    - External sludge
    - Co-Substrates

→ approx. 140,000 PE → High nitrogen removal

Engery+ WWTP Grevesmühlen

Approx. 60% from industry (creamery/coffee roaster)



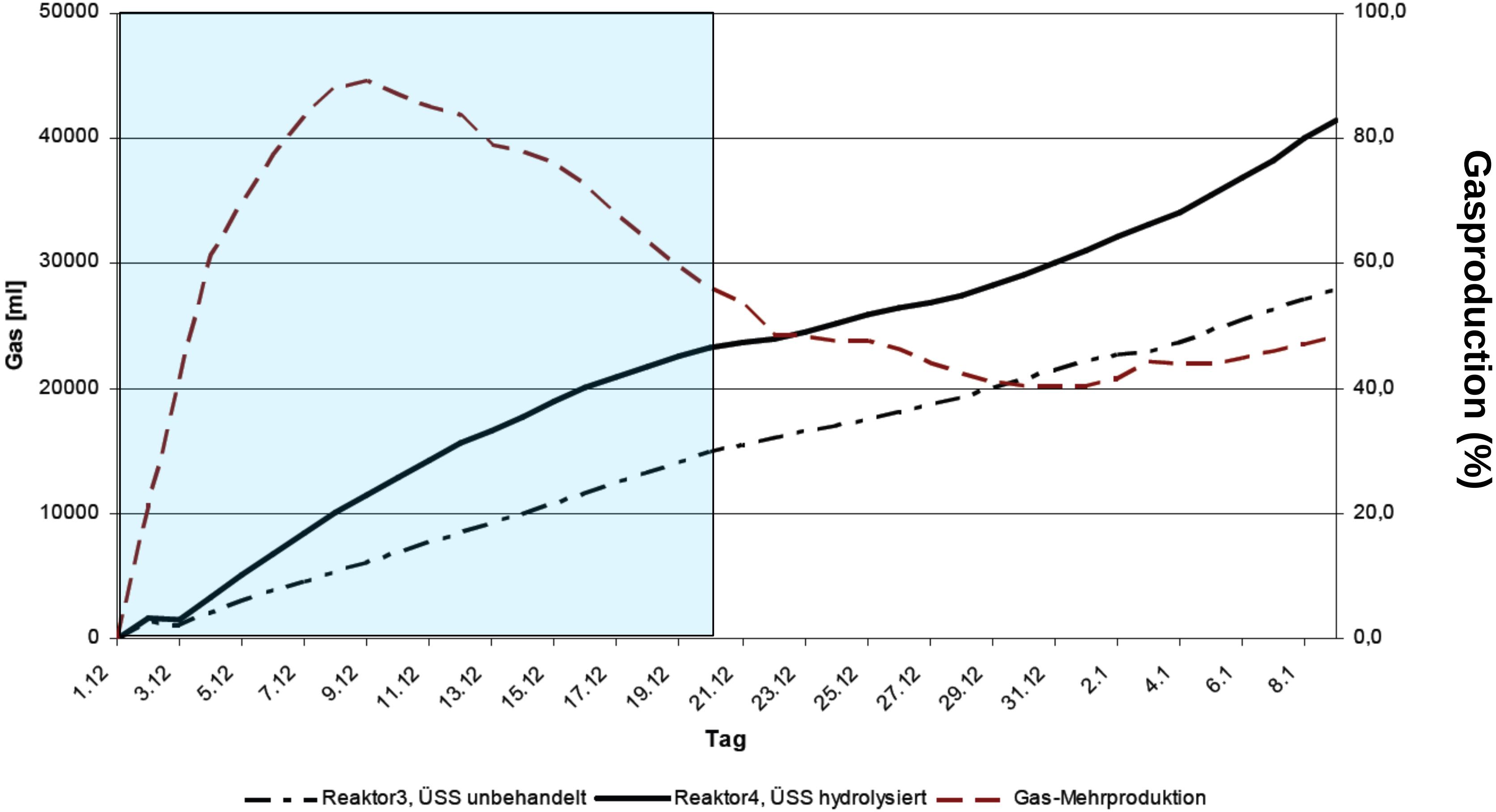
Simulation Model of Thermal Hydrolysis

- Cooperation with the Zweckverband Grevesmühlen
- Development of a simulation-based decision-making tool
- Pre-treatment, biological treatment, **thermal hydrolysis,** digestion, co-fermentation, deammonification (Plant Wide Modeling)
- Energetic and material optimization of KA Grevesmühlen

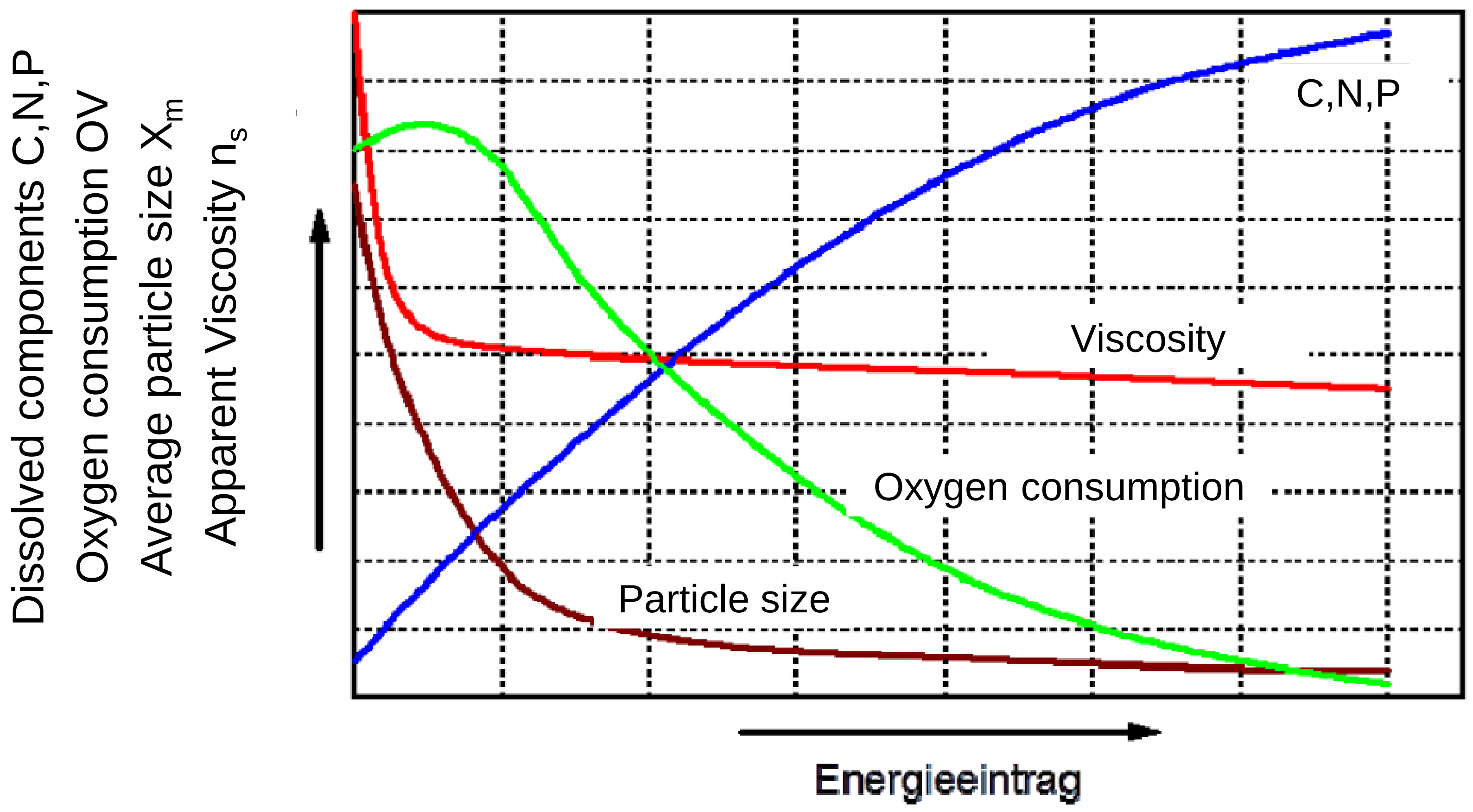
Sludge hyrdolysis
Influence on gas production

Laboratory digestion test

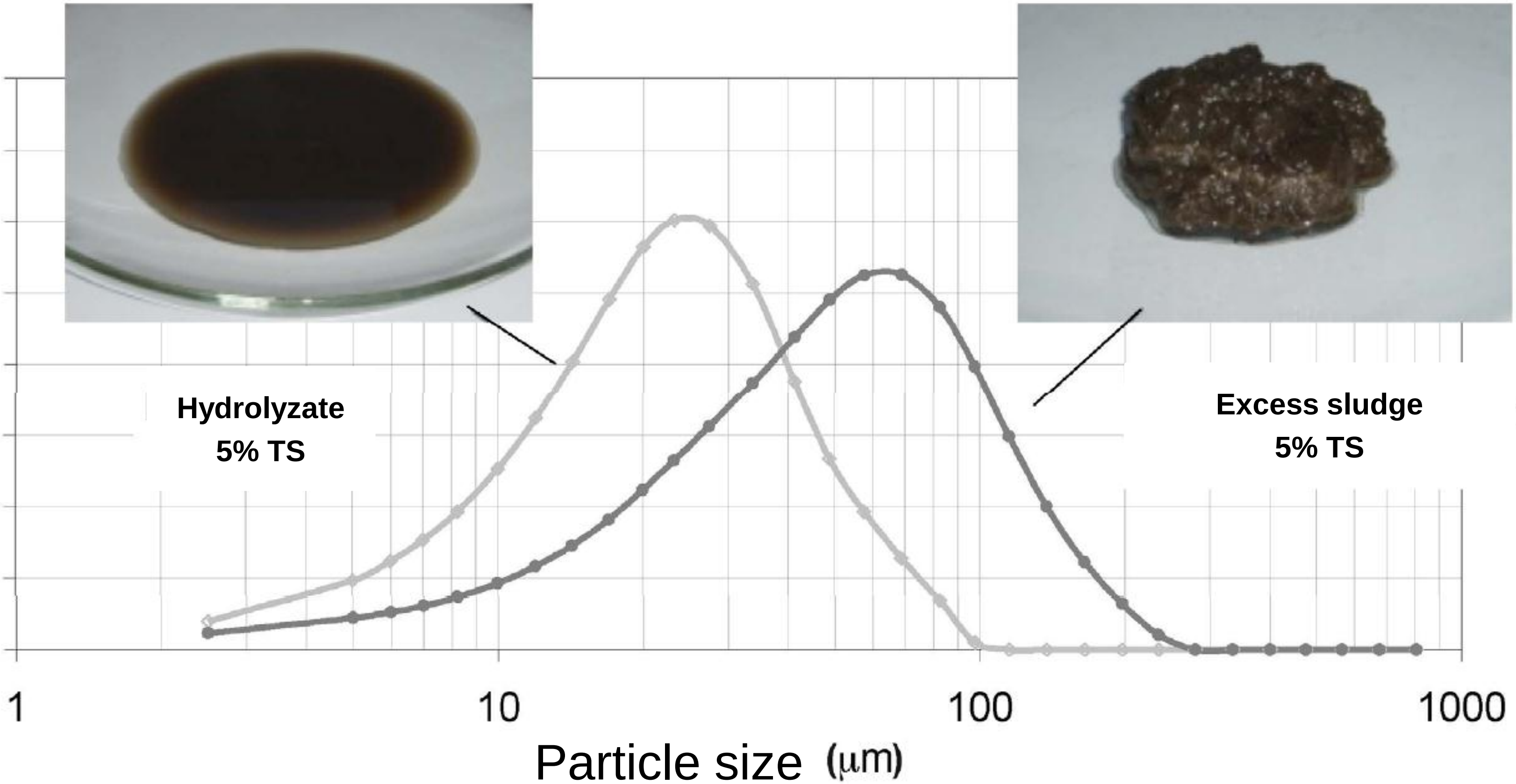
100% Excess sludge



Sludge hydrolysis
Influence on gas production

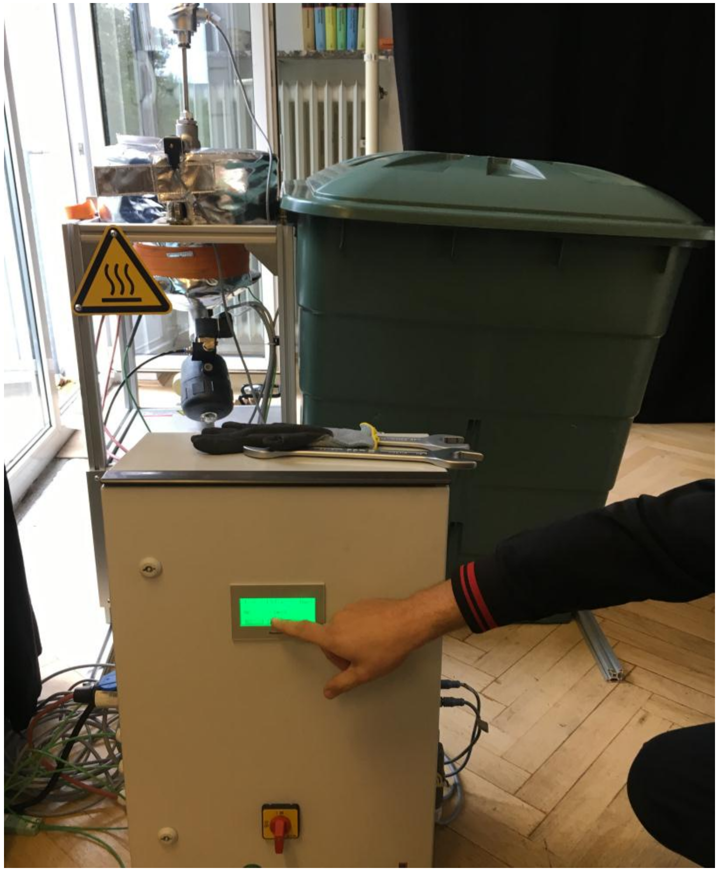


Sludge hydrolysis
Viscosity change



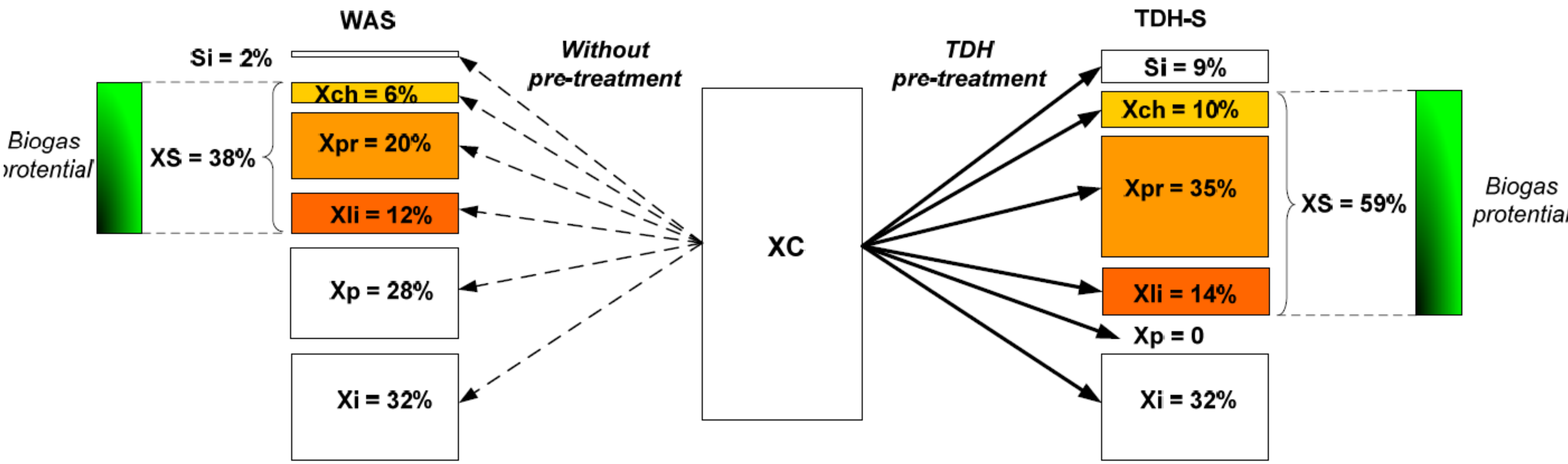
INCREASED DEWATERABILITY !

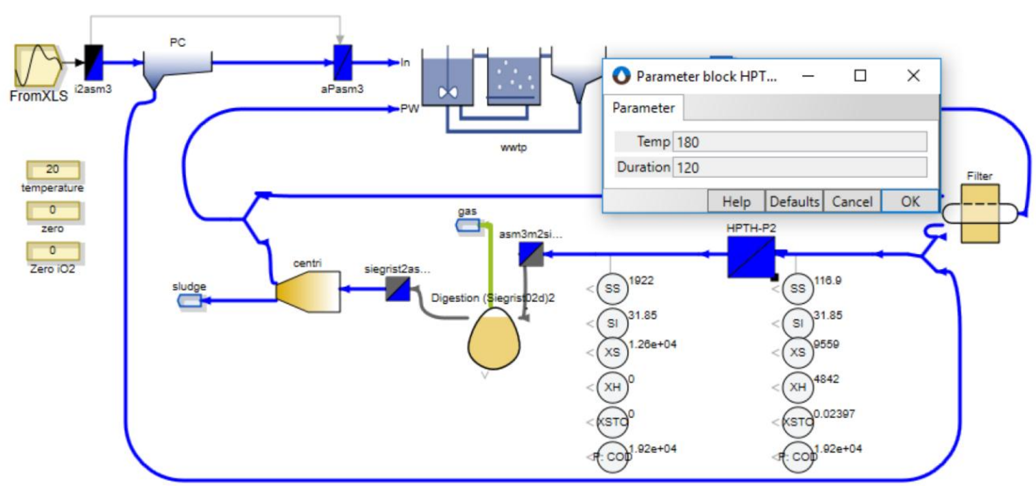
Calibration of the thermical Hydrolysis with a pilot plant at WWTP Grevewmühlen



Simulation Model of Thermal Hydrolysis

Building the model based on literature research





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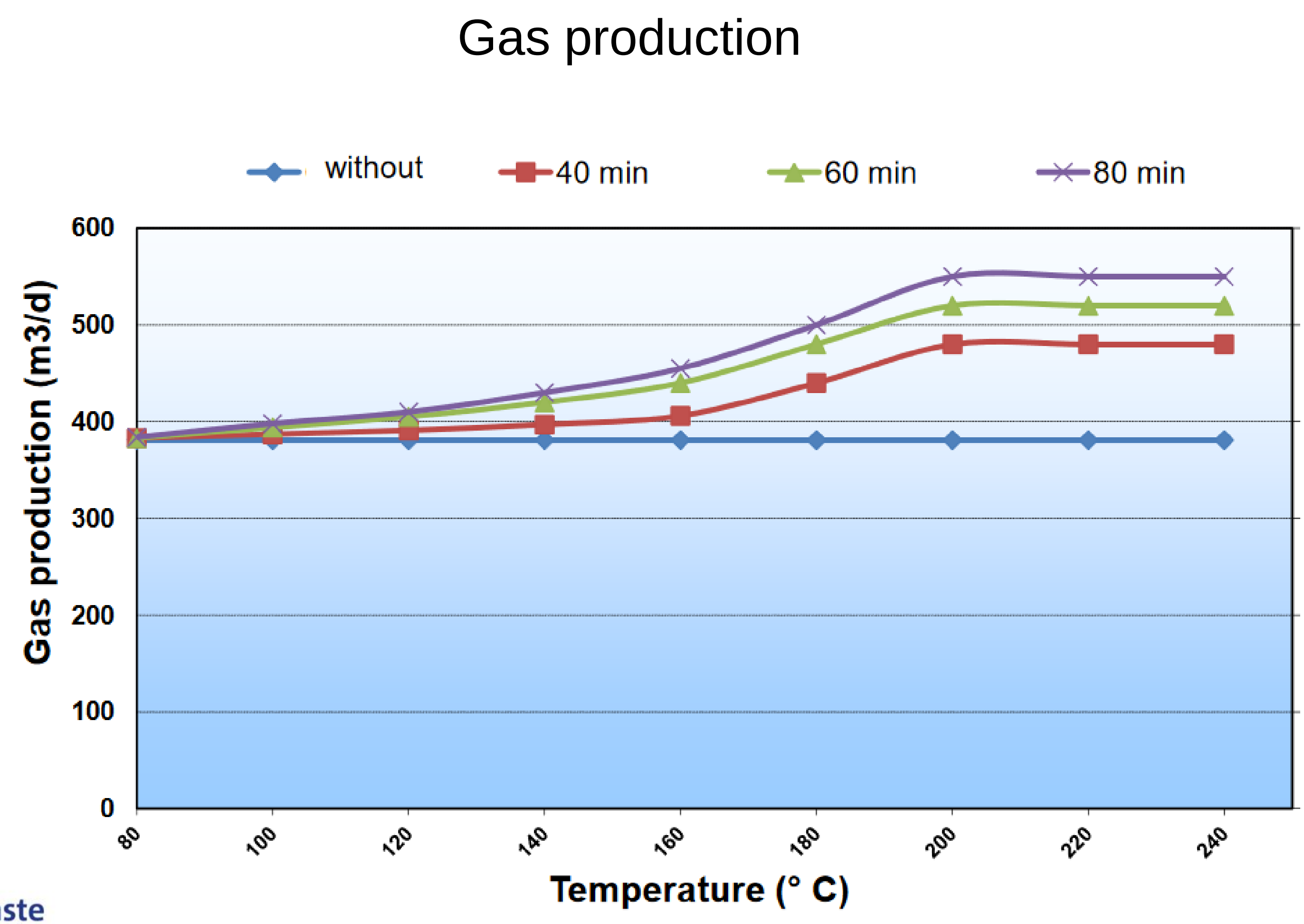
Simulation Model of Thermal Hydrolysis



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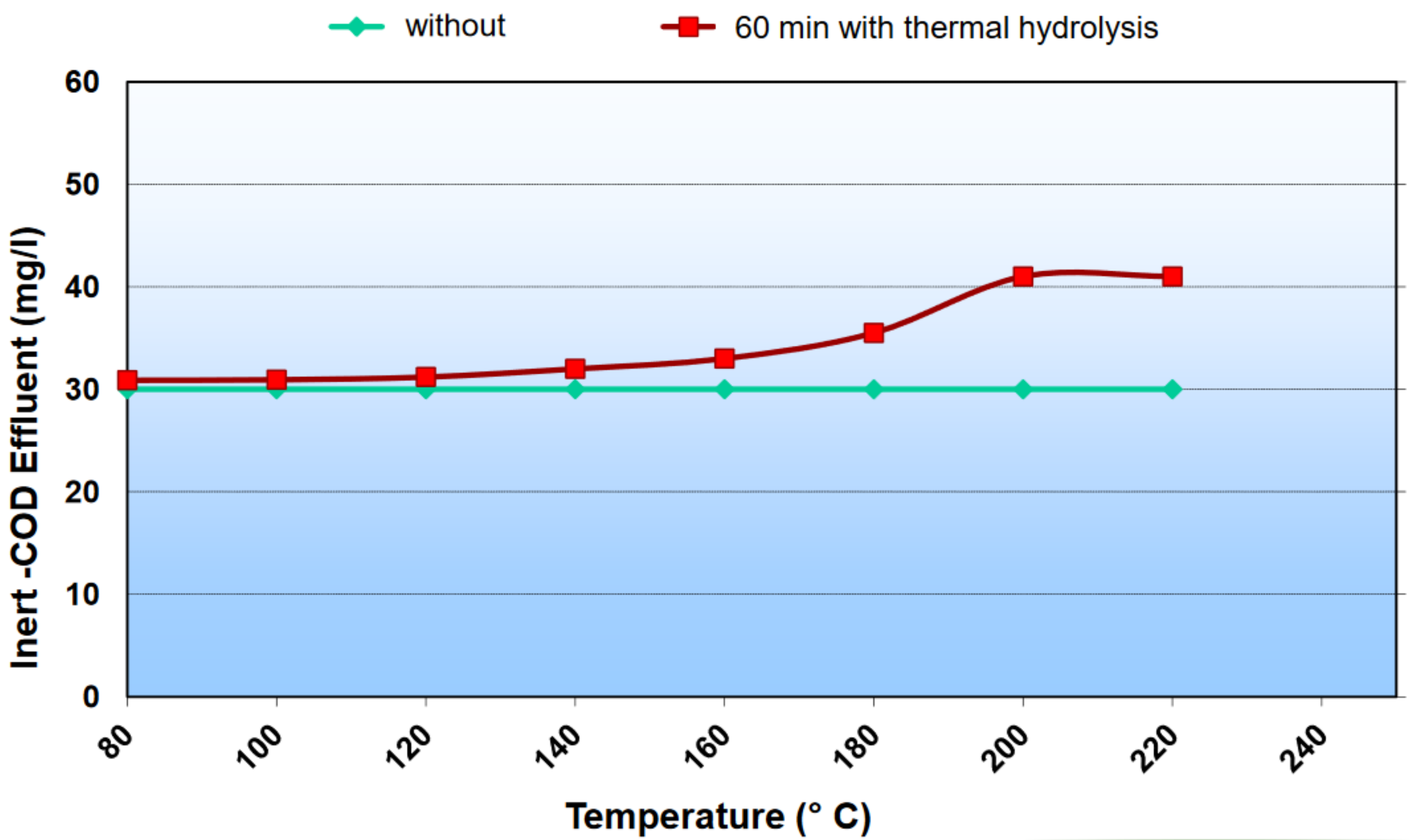
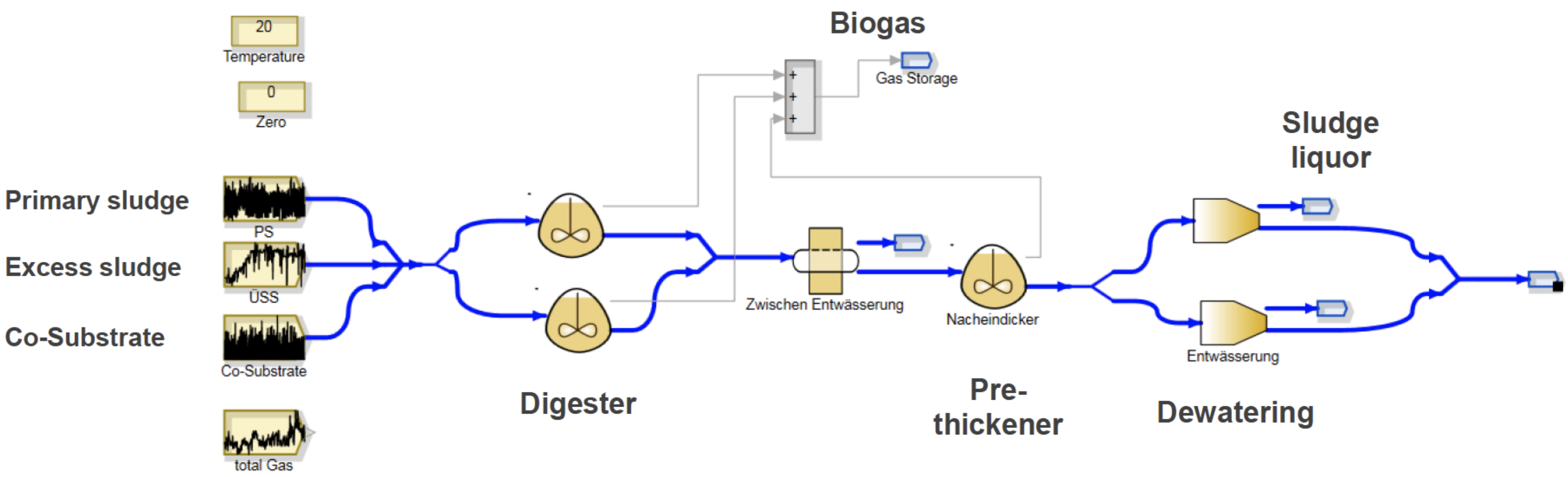
Simulation Model of Thermal Hydrolysis

Inert COD



Development of a decision making tool
Simulation Model – Sludge treatment



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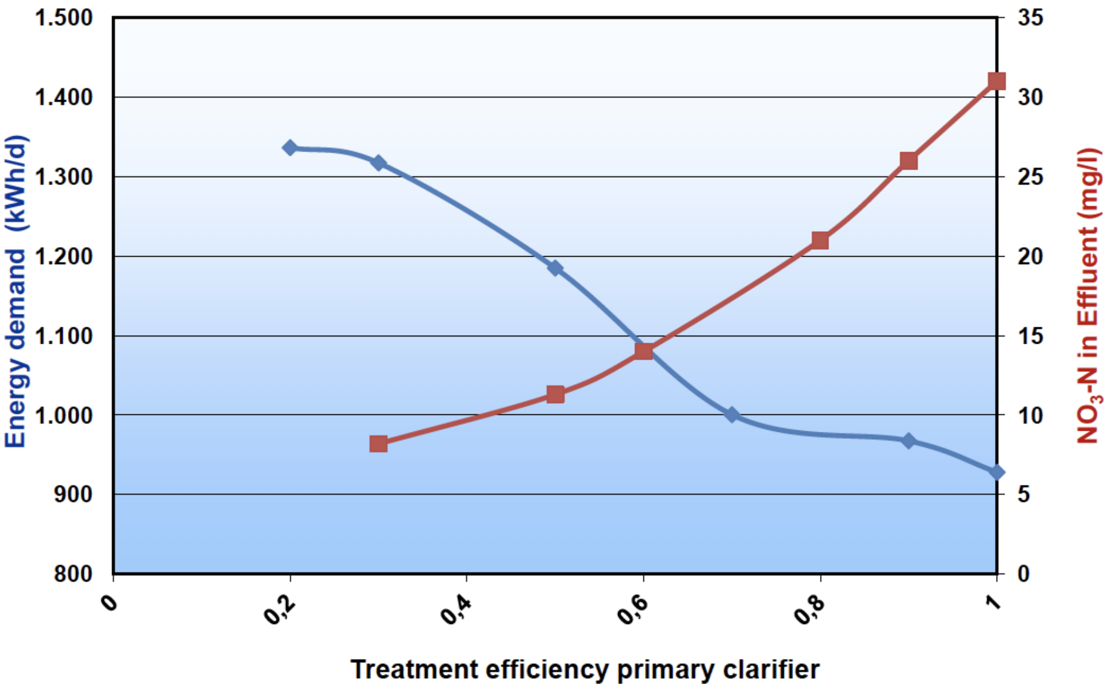
Simulation Model – Sludge treatment



- Variation of treatment efficiency of primary clarification
- High efficiency
  - → BOD removal
  - → decreased oxygen demand
  - → lack of carbon source for denitrification

! Optimization problem

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Conclusions

- **Co-fermentation of organic residues increases the efficiency of a digester**
  (up to 2,5 instead of < 1 m^3 biogas per m^3 reactor)
- **Thermal hydrolysis is one alternative to achieve autarky**
- **Operation becomes more complex**
- **Model driven optimization is facilitates operation in difficult conditions and fluctuating feed occasions**
- **Examples for large scale application are available internationally**

Thank you!

Looking forward for a mutual cooperaton!

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