



# Supersludge

Slibsymposium

Soest



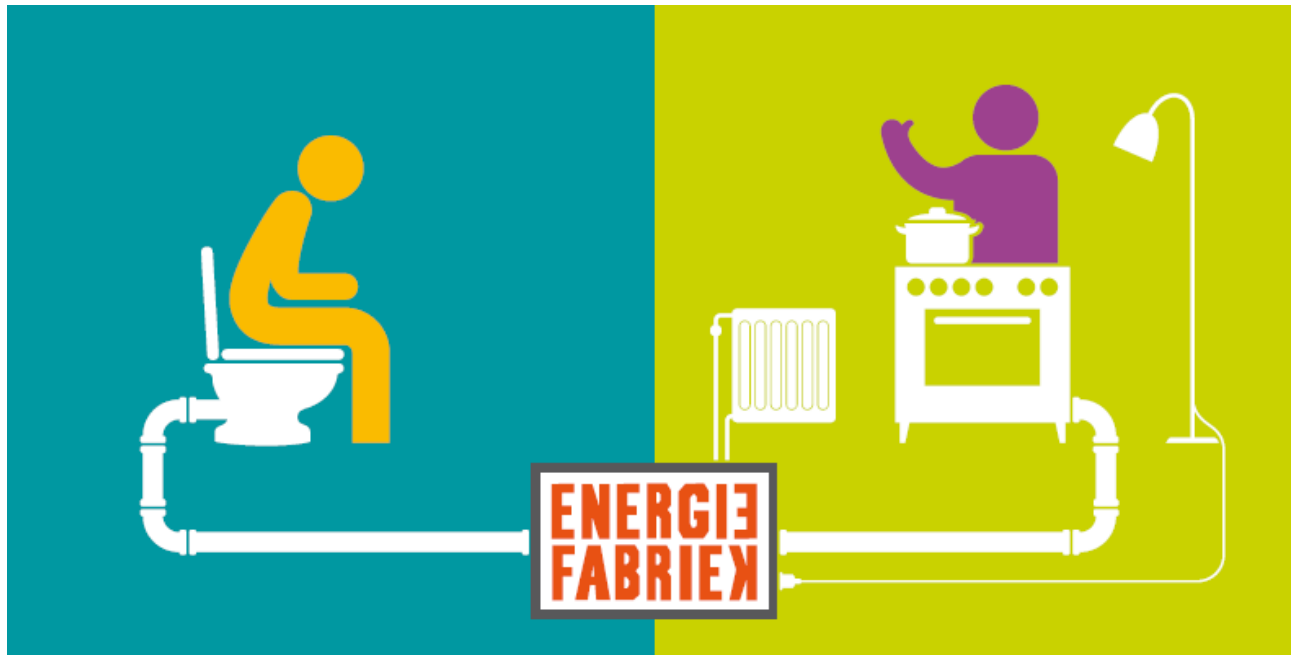
electron thermal processing equipment by  
Industrial furnaces & heat technology



STICHTING  
TOEGEPAST ONDERZOEK WATERBEHEER

# Award 'Energy factory (2009-2010)'

- Energy neutral treatment of wastewater
- from 1.6 MW<sub>HHV</sub> in influent of a typical 100.000 ie WWTP, 1 MW<sub>HHV</sub> leaves with sludge and is normal burned autothermal
- 'innovative' design: based on supercritical gasification.



# Maximaal energie winnen uit slib

Superkritisch vergassen (SKV) is een innovatieve techniek voor de verwerking van zuiverings-slib. Het levert veel meer energie op dan de huidige slibverwerkingsmethodes.

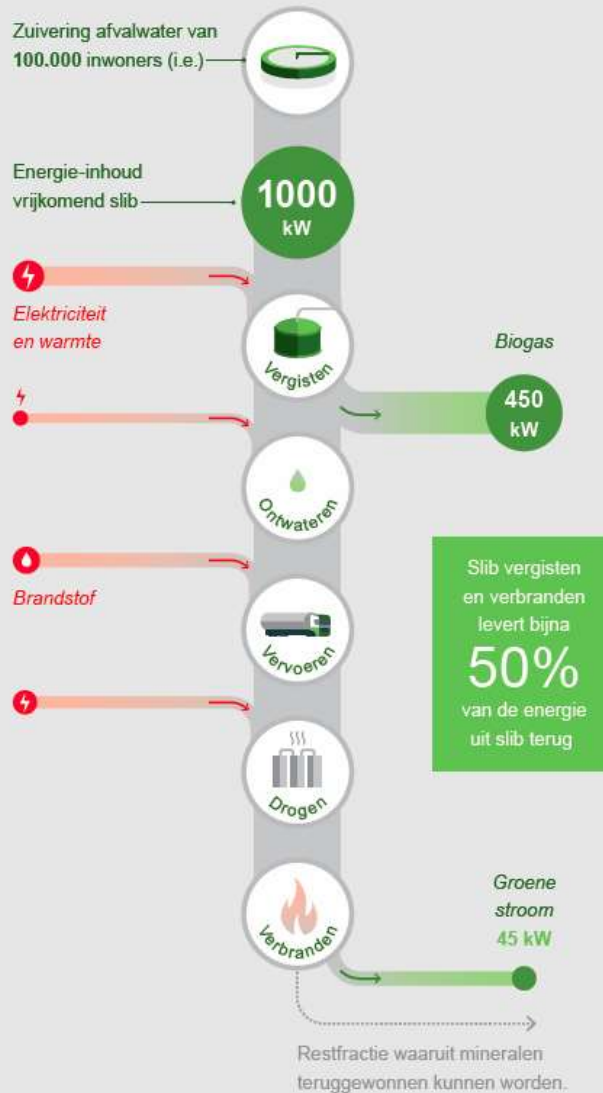
## Samenwerking Supersludge

De waterschappen Aa en Maas en De Dommel, STOWA, slibverwerker SNB en de bedrijven Procede Biomass en Electron Thermal Processing Equipment werken samen in het project Supersludge. Hiermee willen zij de technologie voor het superkritisch vergassen van zuiverings-slib doorontwikkelen tot een beproefde methode voor slibverwerking.

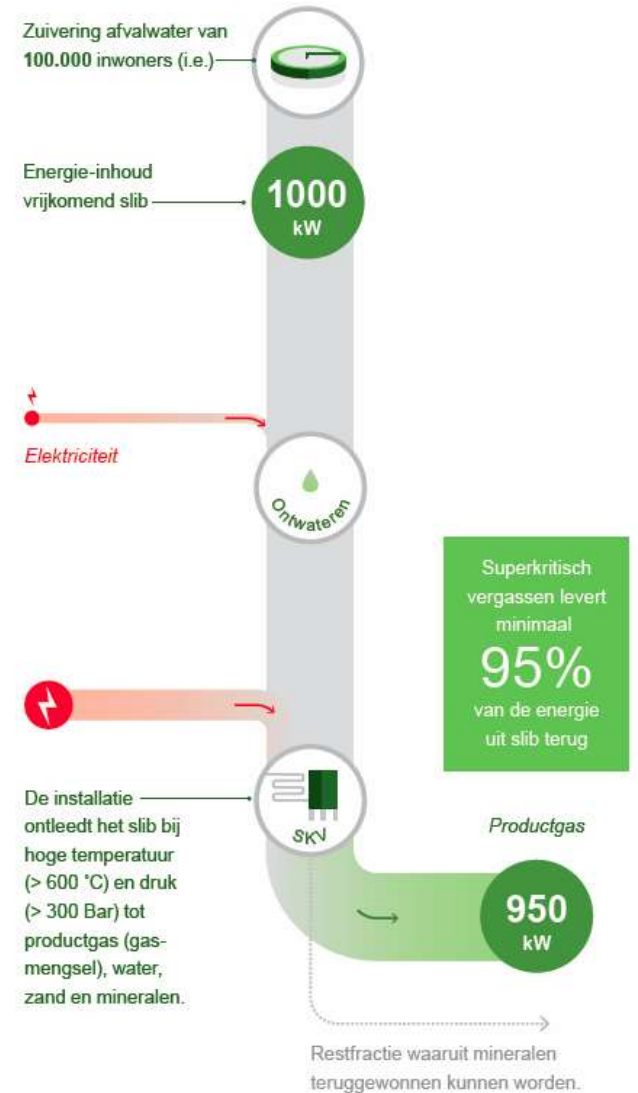
De gevisualiseerde volumes laten de relatieve verhoudingen zien. Exacte verhoudingen kunnen per situatie verschillen. Weergegeven volumes en cijfers zijn gebaseerd op een realistische schatting.

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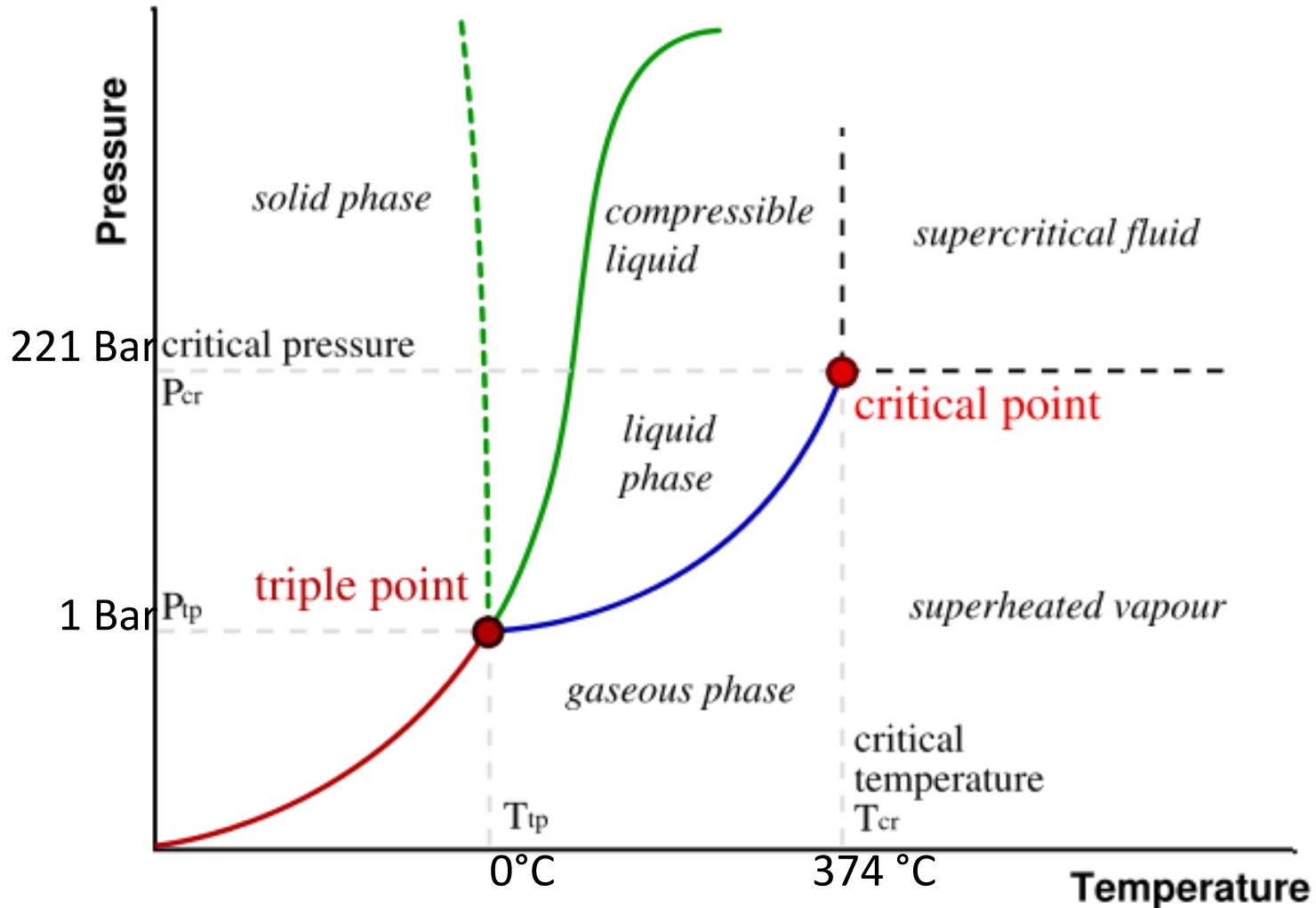
## Zo winnen we nu energie uit slib



## Dit levert superkritisch vergassen op



# Phase diagram for water



# Solubility under SCWG conditions

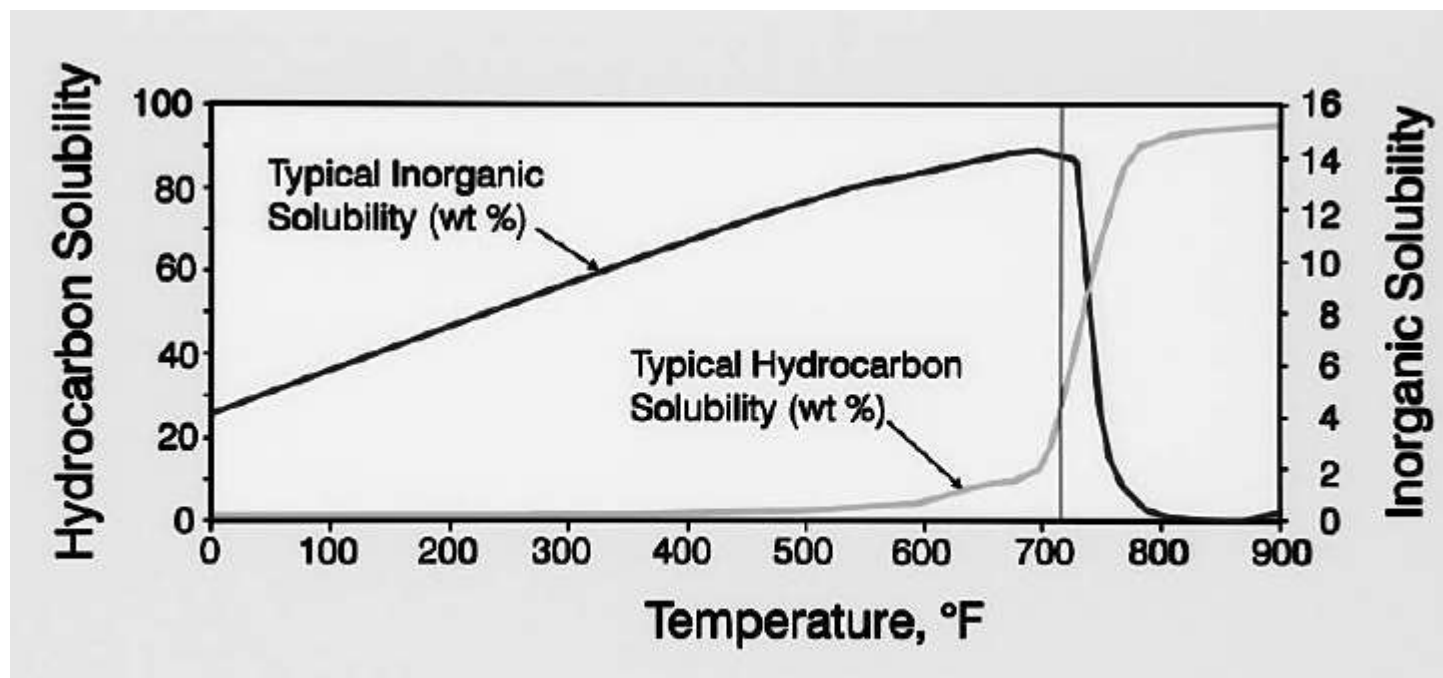
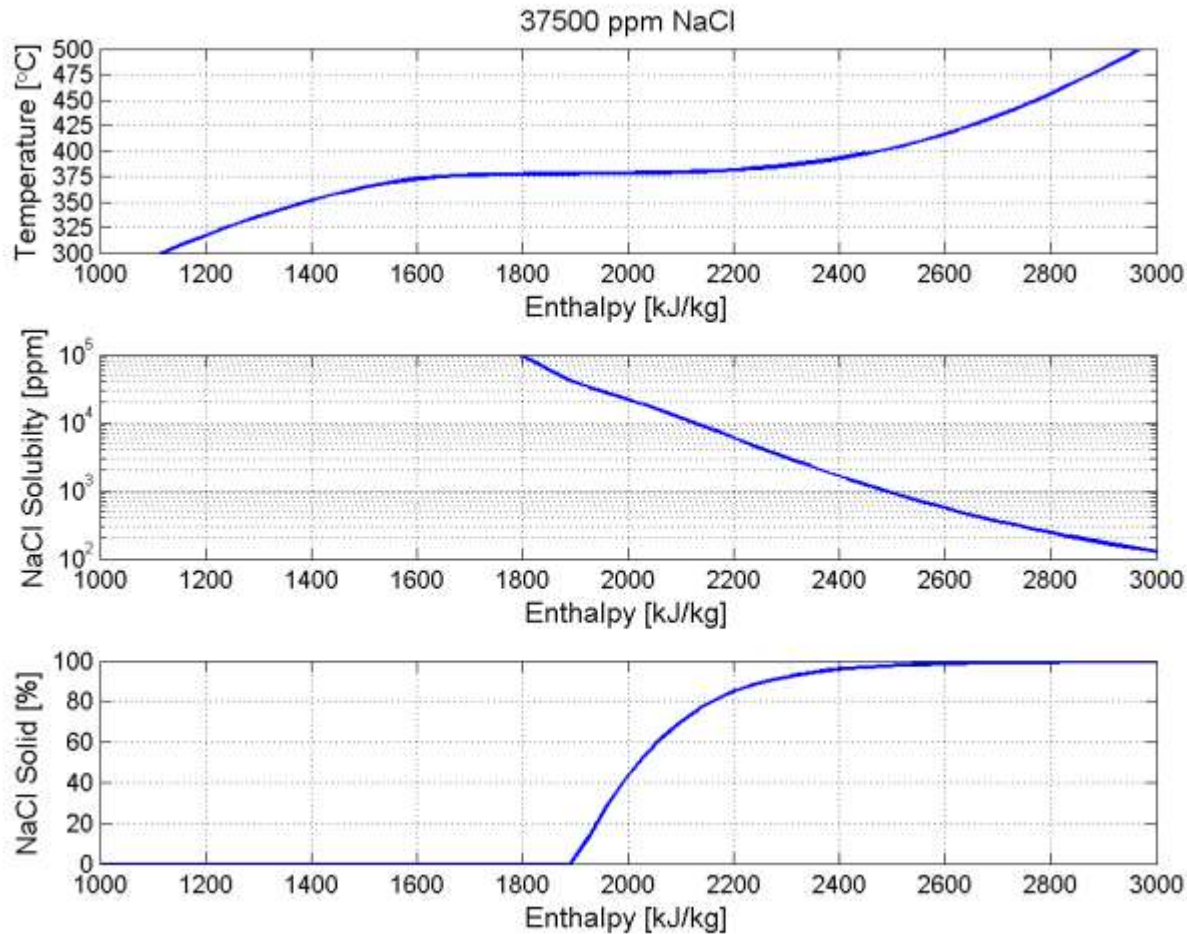


Fig. 2 Water Solvency at 221 bar (3205 psia)

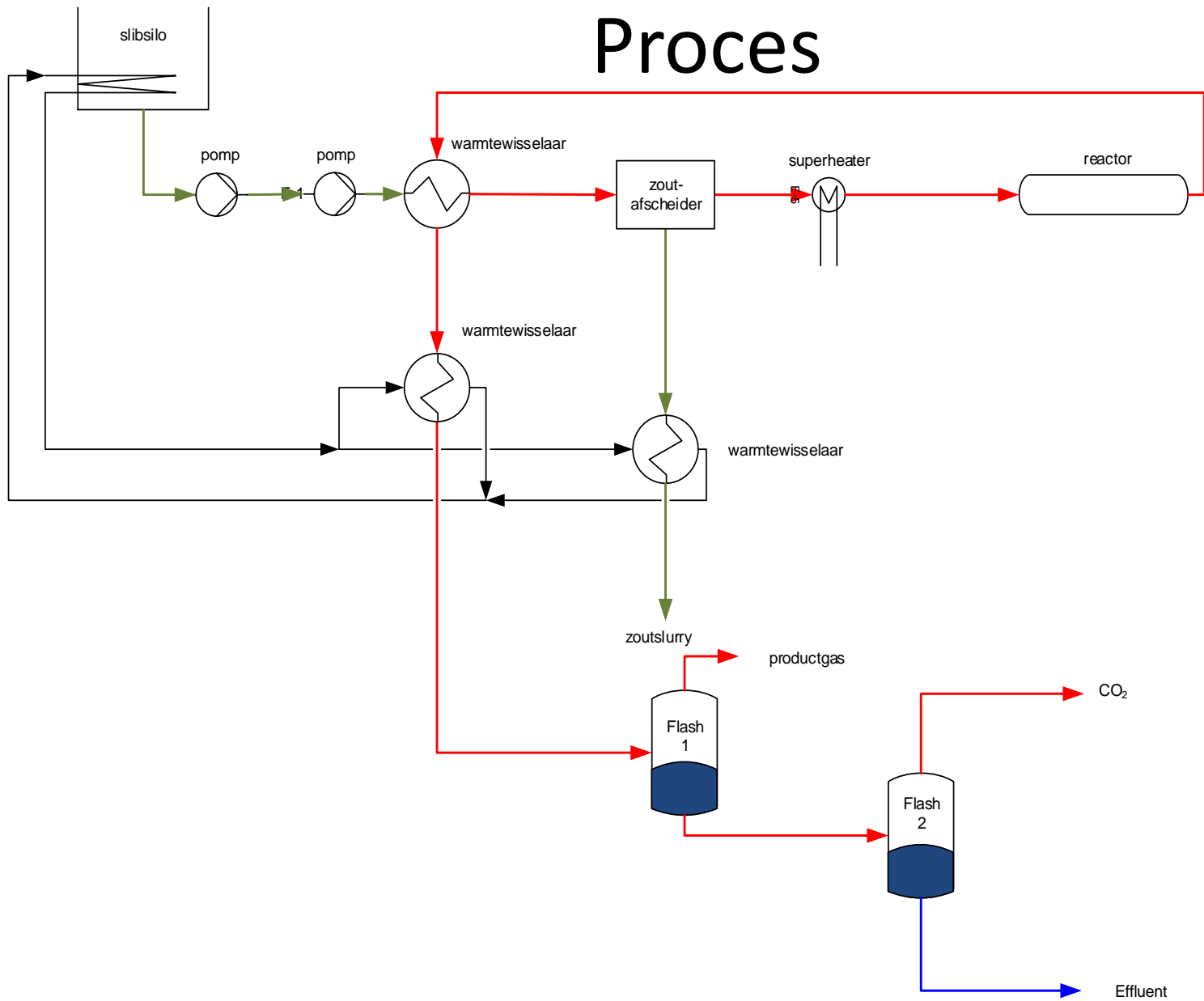
- Organic matter converted to  $\text{CH}_4$ ,  $\text{H}_2$ ,  $\text{CH}_4$ ,  $\text{CO}$
- Inorganic components can be removed in a concentrated brine
- Incoming ammonium largely unaffected under reducing conditions
- Reaction time 2-4 minutes

# Modelling solubility of salts under supercritical conditions

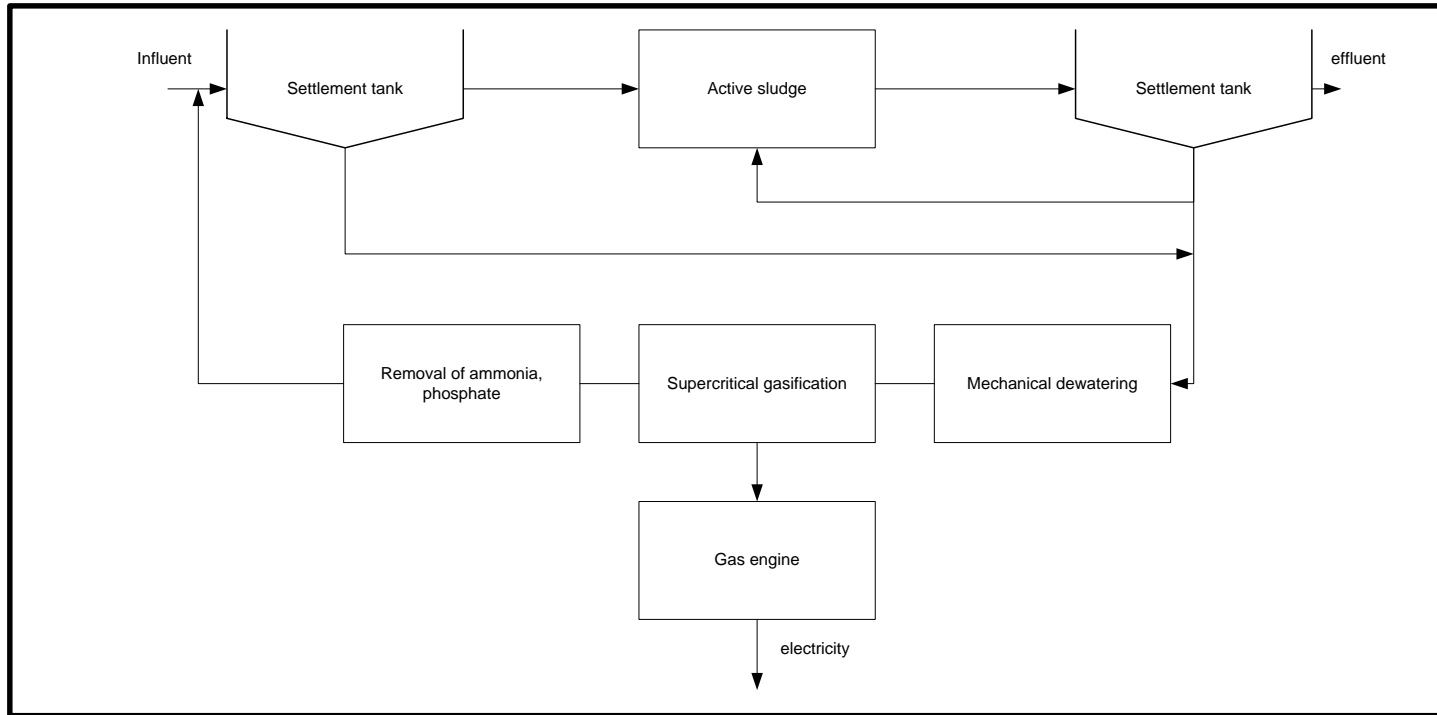


Source: earlier work of Procede, 2010-2013

# Proces



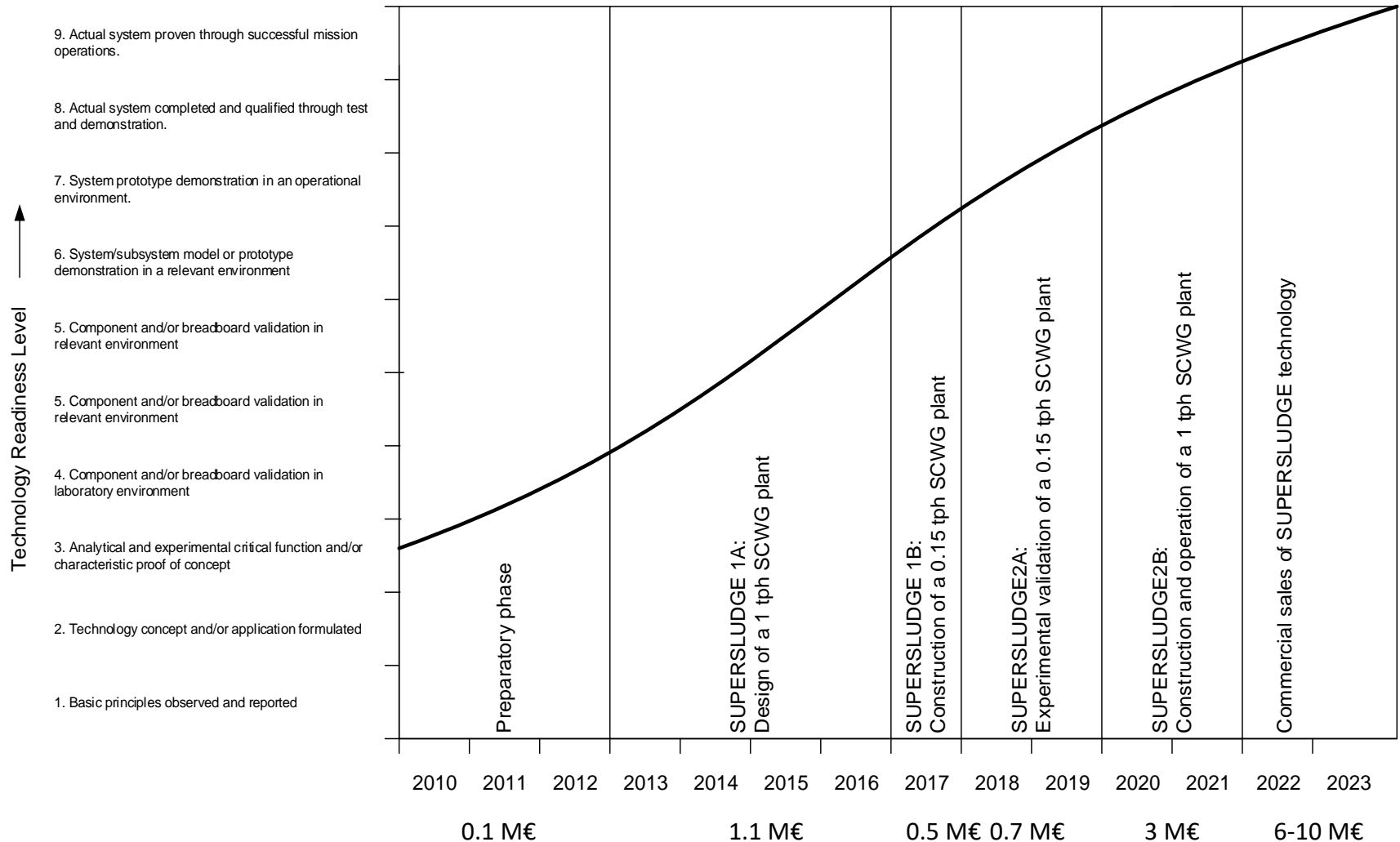
# Diagram for application at a WWTP



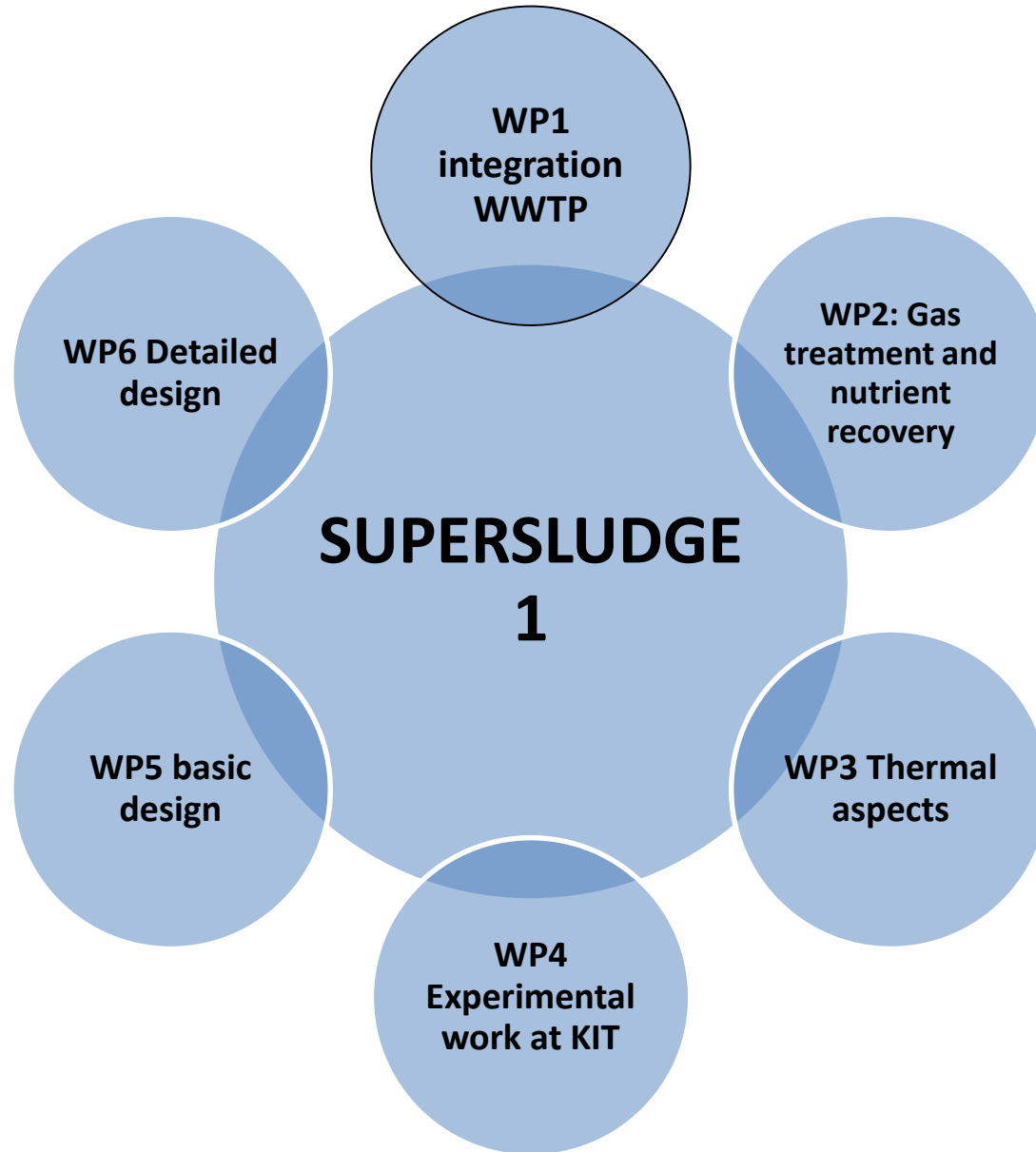
- AD disappears, produced gas to gas engine or biological SNG production
- Ammonia to be recovered from water phase
- Phosphate recovery from brine



# Development trajectory



# Supersludge 1 (2013-2017)

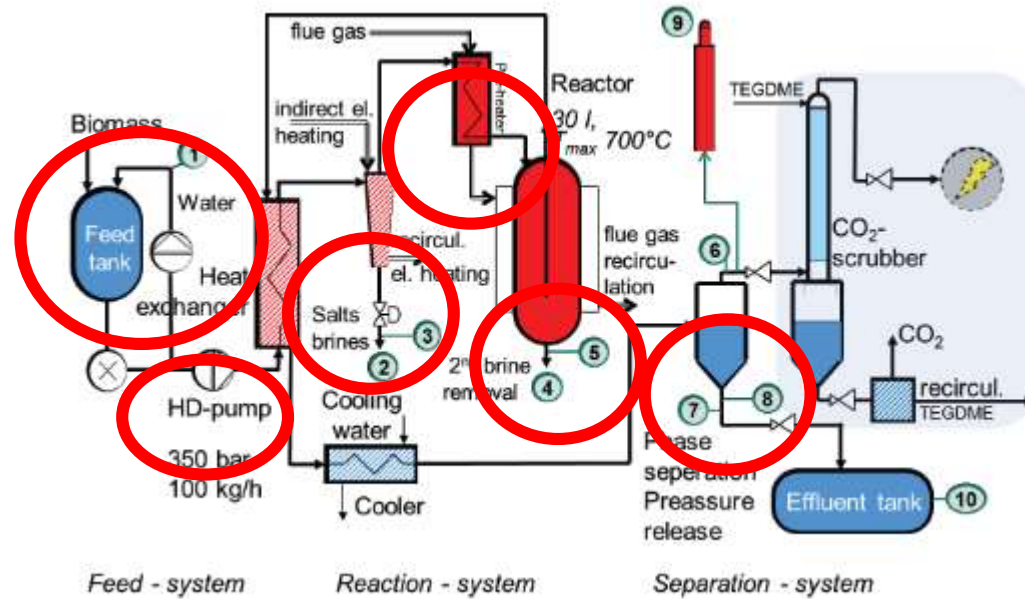


# VERENA plant KIT

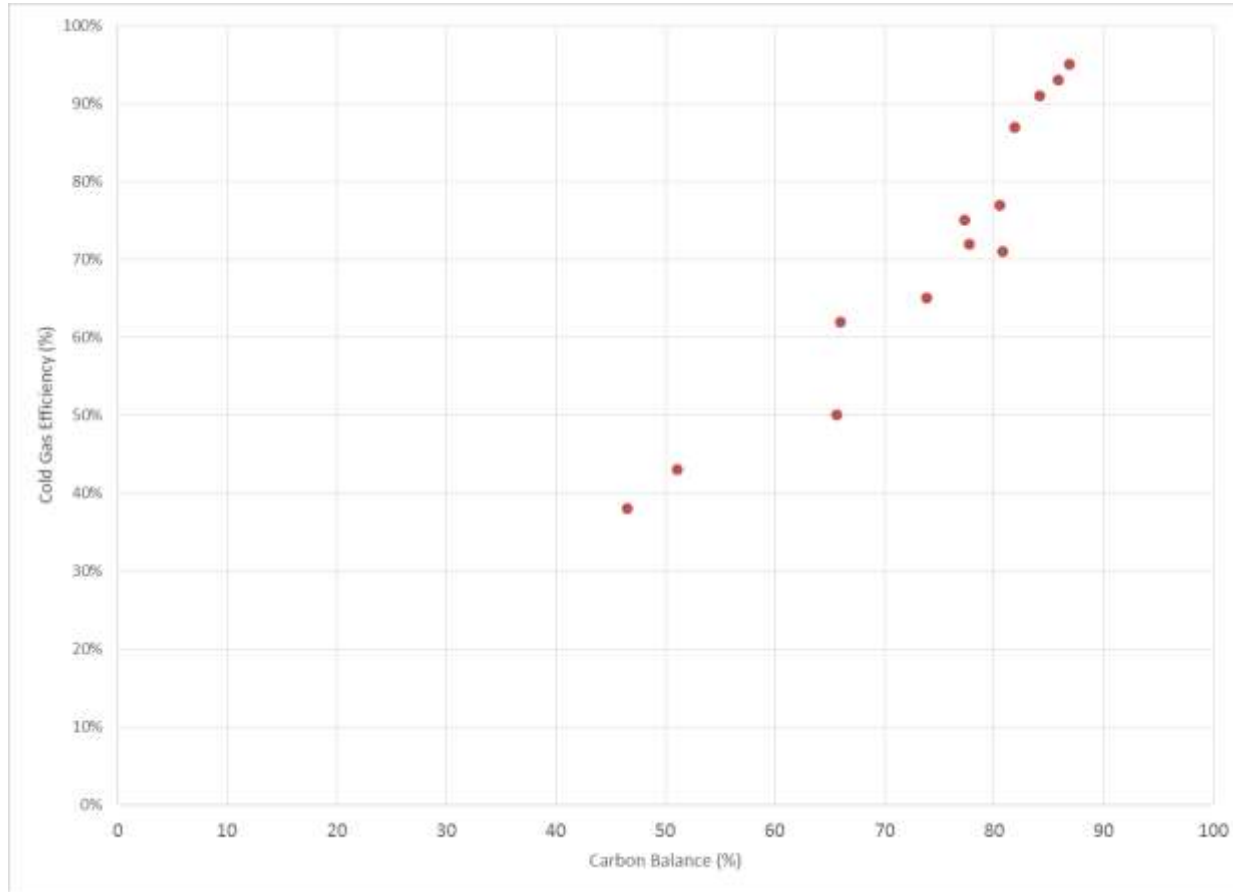
Experiments show:

- Good conversion
- Good CGE

Chemically the process works, but there are several operational problems that should be addressed



# Results of KIT at 270 Bar



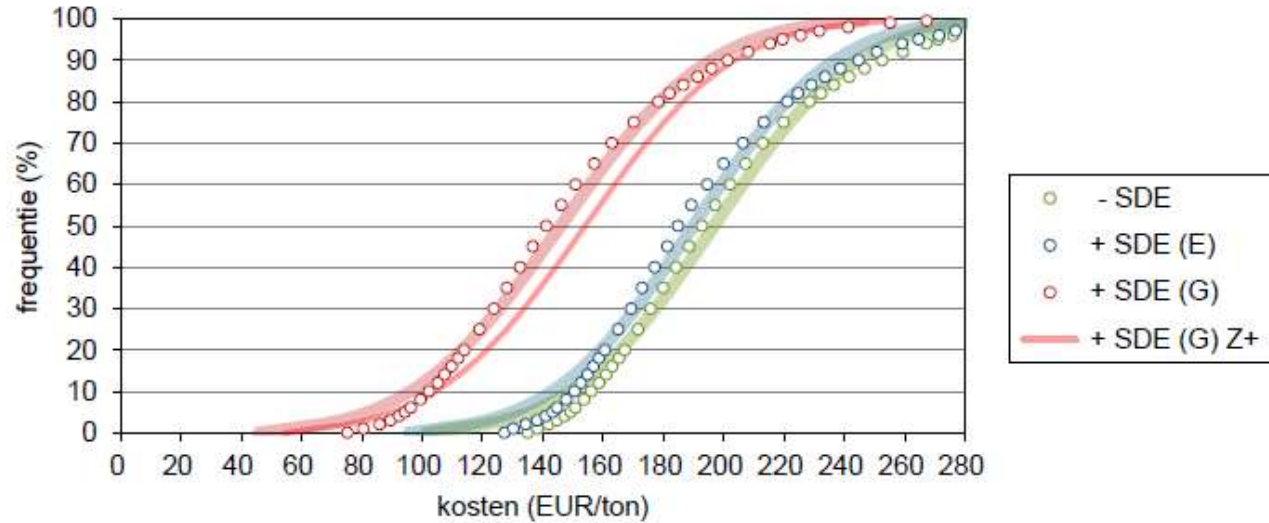
- Cause of limited CGE is in deposits in the process, so CGE  $\rightarrow$  100% if no deposits!

# Other design work done previously

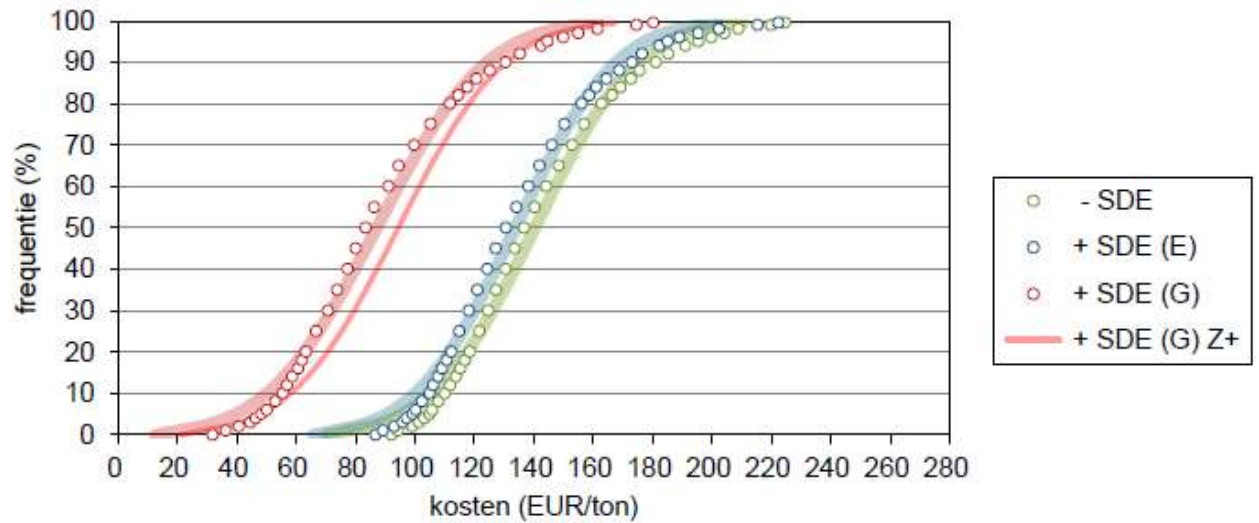
- Salt collection system
- Ammonia and phosphor recovery
- Sludge pressurisation
- Flash vessel design
- Gas cleaning technology
- Effluent ammonia stripping
- Emergency blow down
- Site selection and integration

# Result of Monte Carlo analysis for total sludge processing costs, independently verified

1 tph @ 17% ds



5 tph @ 17% ds



# SCWG reactor designs

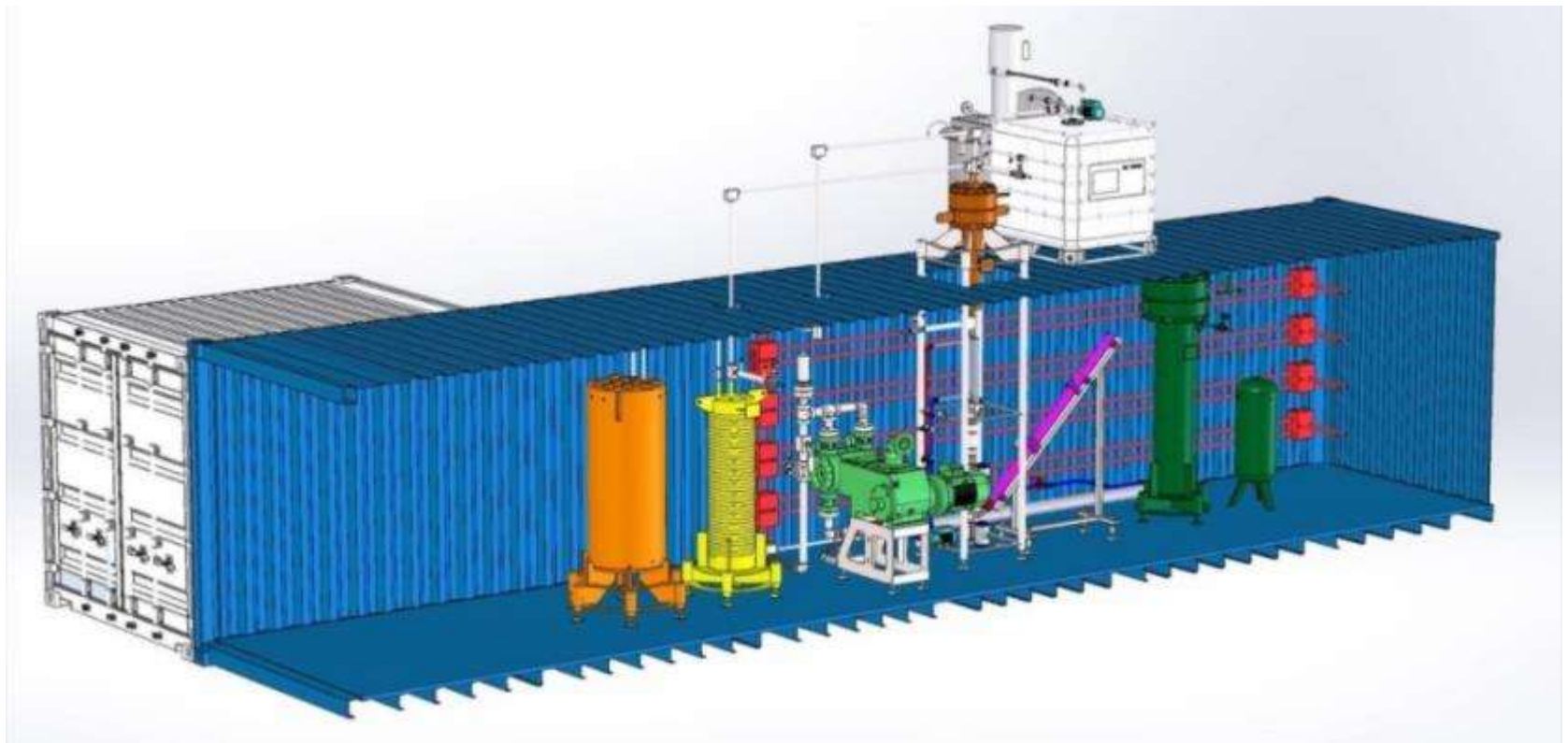
## Plug flow

- Relatively simple construction
- Little spread in residence time
- Risk of pipe blocking
- Option of insitu salt removal
- Heat integration possible, essential for efficient operation

## Mixed reactor

- Short heat up time
- Larger spread in residence time
- Robust
- Heat integration difficult, therefore more energy intensive

# Supersludge 2A: pilot plant





# Validation of individual process components and overall process

- 150 kg/h at 17% dm
- CGE > 95%
- Salt removal >90%
- Corrosion: 50.000 hours
- 90% heat recovery
- Continuous run of a week

# The future

- Until end of 2019 experiments with pilot plant
- If research objectives are achieved, proceed to full scale demo installation (> 1 tph)
- Partner wanted for commercialisation
  - Practical experience on pressurised sludge processing
  - Already involved in sales of sludge processing equipment and aware of market developments
  - Complementary in role to existing consortium partners
  - Cash and in kind contribution to phase 2
- Open for collaboration with other research groups if IP is properly addressed

# Take home messages

- **Eindoplossing op de RWZI**, in plaats van een complexe keten met allerlei (dure) tussenstappen en uiteindelijk toch verbranding van het slib zonder energierterugwinning
- Veel **hoger energetisch rendement** doordat water geen nadelige rol speelt. Belangrijk voor een bijdrage aan de aardgasproductie in Nederland uit reststromen
- Syngas kan naast energie **ook de basis zijn voor chemische bouwstenen**, dus producten en dus hoogwaardiger dan alleen methaan (i.t.t. biogas)
- **Decentrale terugwinning van P en N**, in plaats vanuit de asrest of via de struvietroute