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Energy & Resource Efficiency
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Co-siting of Anaerobic Digestion and Waste-to-Energy

Peter Quicker – Qonversion
Uwe Athmann – dezentec Ingenieurgesellschaft mbH
Werner Bauer, Thomas Kroner – ia GmbH
Gerhard Meier – ATAB e.V.

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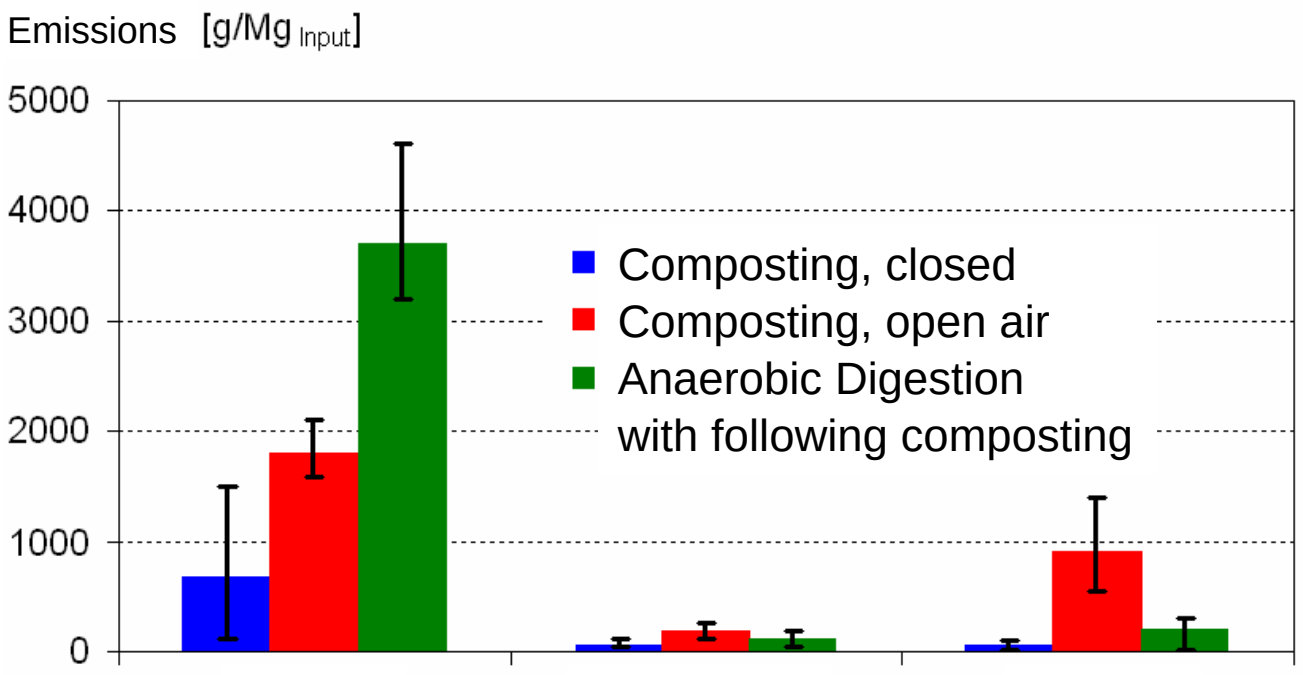
Example Burgkirchen

Results

Summary and Conclusion

Introduction
Current situation for Bio Waste Treatment Plants (BWT)

- Significant emissions of green house gases (CH_4, N_2O) from BWT
  - Treatment of digestion residues
  - Lack of adequate housing (transfer from AD to aerobic treatment) and off-gas treatment (at best bio filters)



Source: Cuhls 2008

Introduction
Current situation for Bio Waste Treatment Plants (BWT)

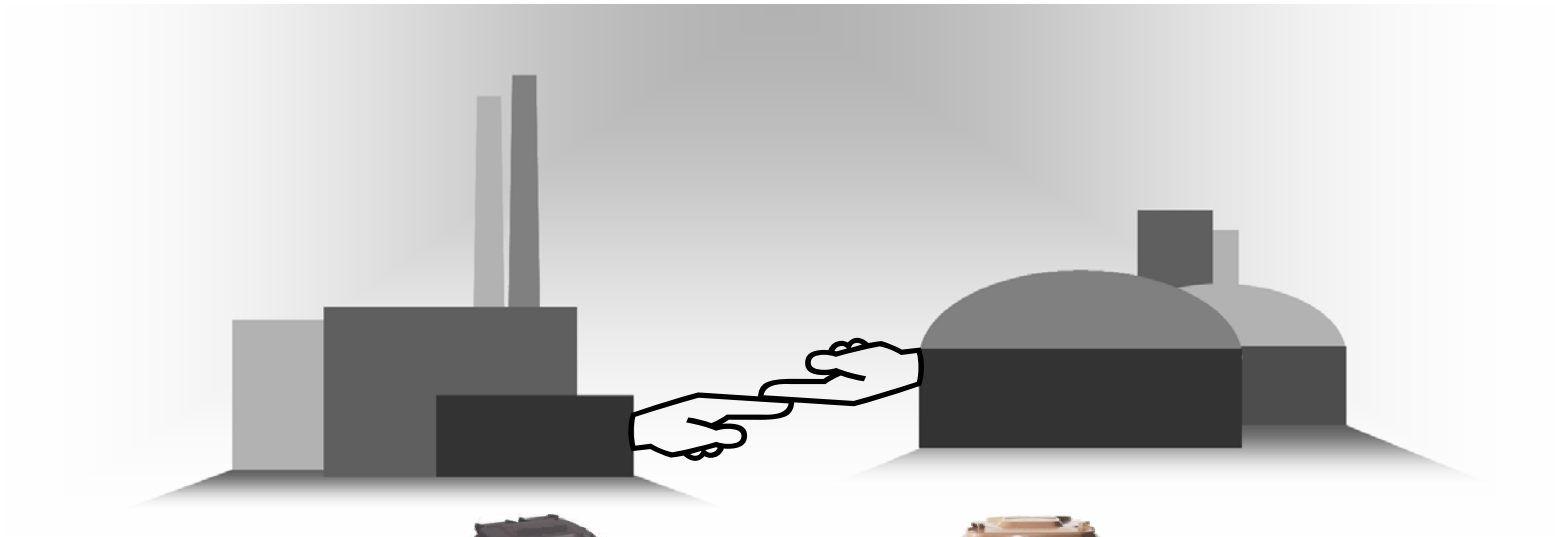
- Significant emissions of green house gases (CH_4, N_2O) from BWT
  - Treatment of digestion residues
  - Lack of adequate housing (transfer from AD to aerobic treatment) and off-gas treatment (at best bio filters)
- Growing input quantities by…
  - Impact of Article 22 European Waste Framework Directive
  - Subsidies by many countries for green energy
- New sites will be developed
- Problems:
  - Emissions
  - Low public acceptance
  - High costs for development of new sites, due to
    - Construction of infrastructure (Roads, power & gas lines, etc)
    - Long lasting legal conflicts (e.g. with citizens' initiatives)
  - Low energy efficiency
    - Unadequate sites (public opposition) → no heat utilization possible

Concept
Key idea

- Construction of new Bio Waste Treatment Plants (BWT)

at already existing sites

of Waste-to-energy Plants (WtE)



WtE

BWT

Concept
Expected synergetic effects

- Potential benefits:
  - Lower green house gas emission by thermal off-gas treatment of BWT plants in WtE plants
  - Common use of infrastructure by BWT and WtE plants
    - Streets, balance, container, trucks
    - Current and gas supply, district heating grid
    - Staff
  - Optimization of heat utilization (exchange of heat on different temperature levels)
  - Disposal of BWT residues
    - Waste water for flue gas conditioning
    - Thermal treatment of residues
  - Improved conditions for biogas upgrading
    - Existing gas grid
    - Supply of process energy for fermenter heating and gas upgrading (amin scrubber) from WtE low temperature heat
  - Gas utilization in WtE (e.g. for burners)

Structure and team

- Project team:
  - Qonversion – sustainable energy
  - ia GmbH

- Partner
  - ATAB e.V. – Working Group of Thermal Waste Treatment Plant Operators in Bavaria e.V.

- Financial support
  - Bavarian State Ministry of the Environment and Public Health

Strategy

- Exemplary investigation of 3 different WtE sites
  - Selection of adequate BWT technology for each site
    → depending on size and local situation
  - Specific planning for each site
  - Evaluation of synergetic effects
  - Calculation of ecological (green house gas reduction) and economic benefits (treatment cost compared to green field plant)
- Prove on universality of determined synergetic effects

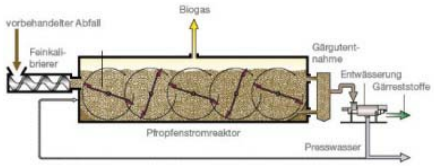
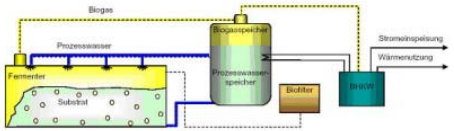
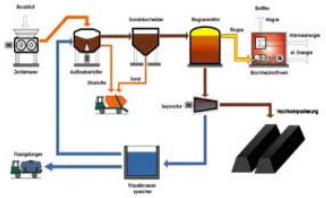
Strategy
Investigated sites

- Configuration of participating WtE plants

	AVA Augsburg	GfA Geiselbullach	ZAS Burgkirchen
			
Input	200.000 t/a	100.000 t/a	230.000 t/a
Lines	3	2 + 1 (Backup)	2
Energy delivery	78 GWh/a electricity 38 GWh/a heat	48 GWh/a electricity 14 GWh/a heat	75 GWh/a electricity 73 GWh/a process steam
Flue gas treatment	electrostatic precipitator 2-step scrubber, SCR fabric filter	dry sorption with $NaH(CO_3)$, fabric filter, SCR	electrostatic precipitator 3-step scrubber, SCR fabric filter

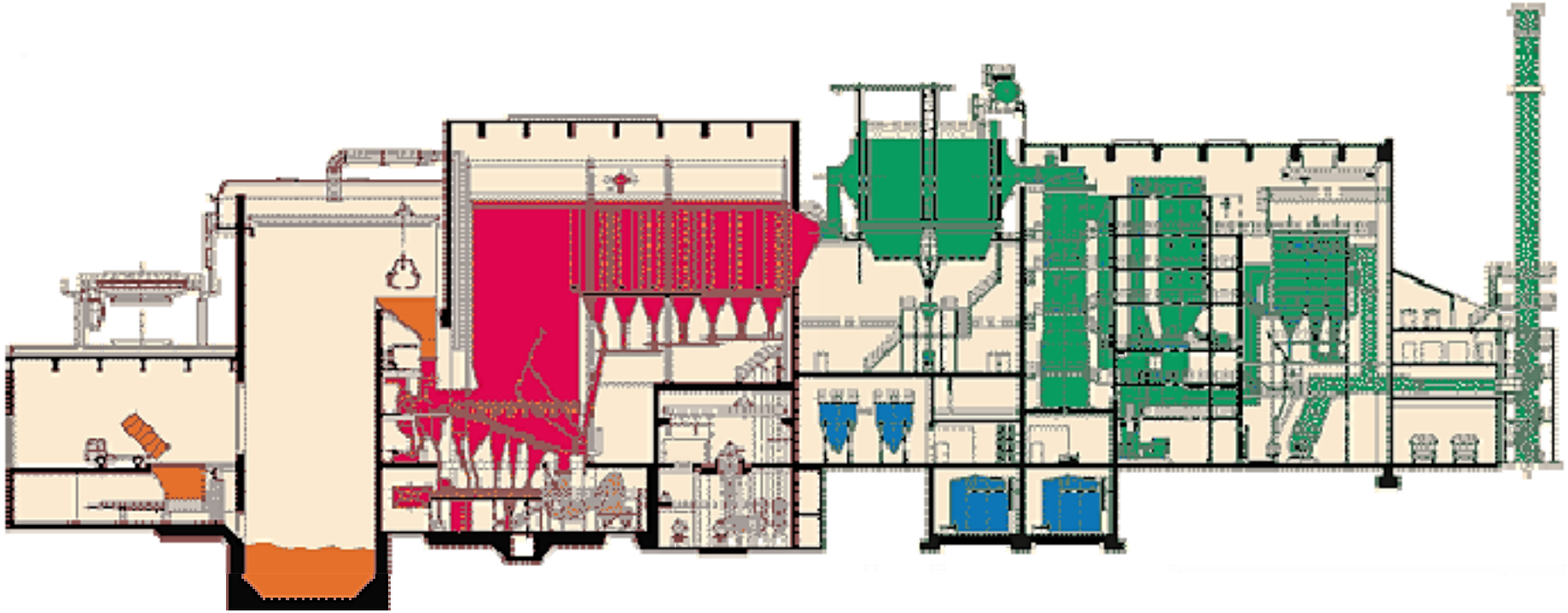
Strategy
Selected Anaerobic Digestion Technology (AD)

- Chosen AD-Technology concept

	AVA Augsburg	GfA Geiselbullach	ZAS Burgkirchen
			
			
Technology	Dry fermentation, plug flow	Dry fermentation, batch in boxes	Wet fermentation, single step
Input	45.000 t/a	15.000 t/a	25.000 t/a
Biogas Utilization	4.200.000 m^3_N/a CHPS, district heating	1.337.000 m^3_N/a CHPS, district heating	2.550.000 m^3_N/a Upgrading for gas grid by amine scrubbing

Example Burgkirchen

- Technology
  Incineration plant

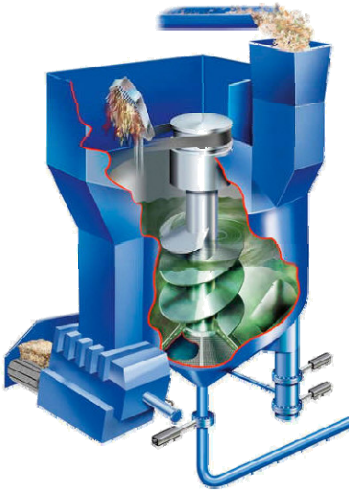


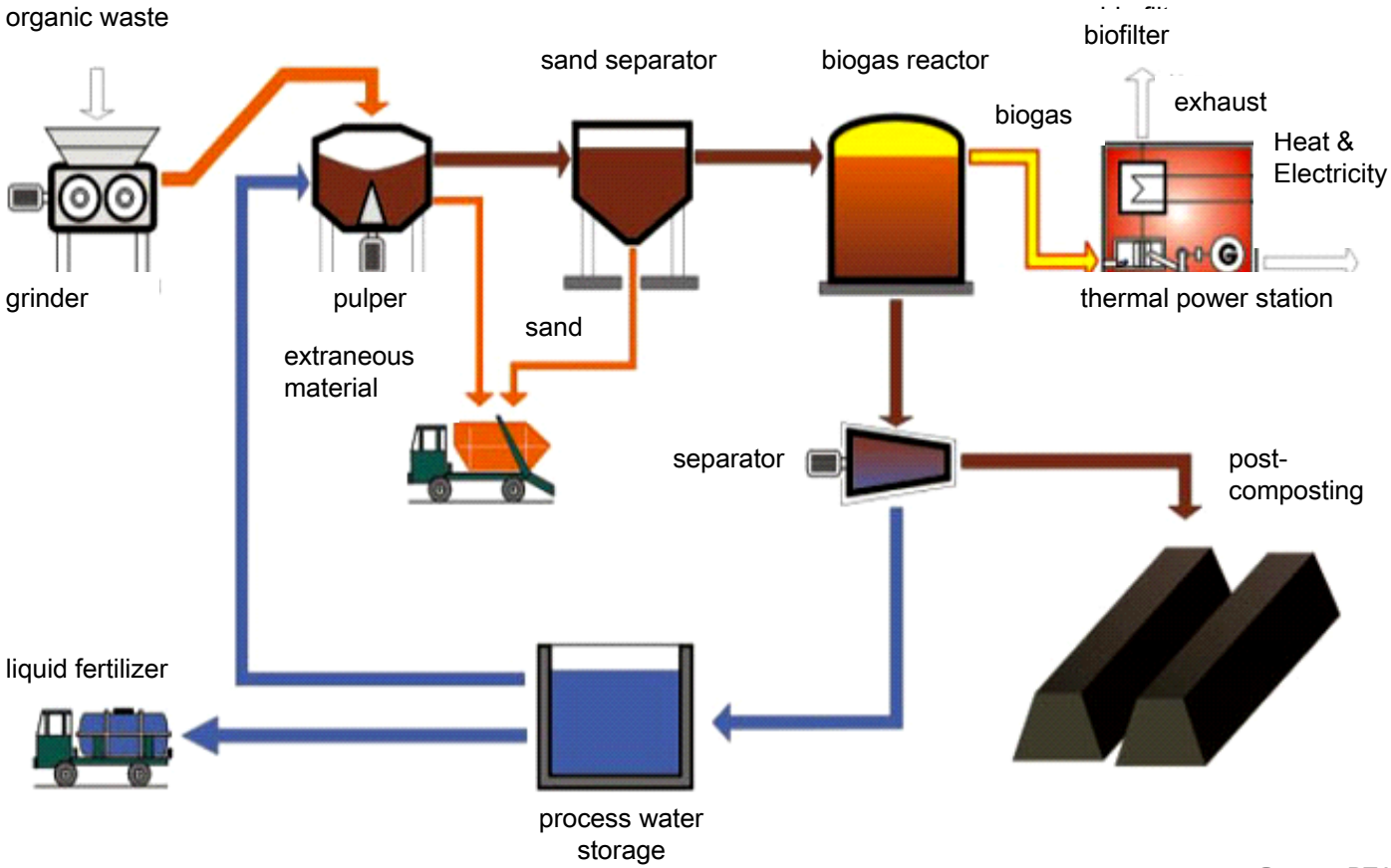
Example Burgkirchen

- Selected technology
  - BTA single step wet fermentation process
  - Amine crubber for biogas upgrading
    - Ideal for sites with heat surplus
    - Advantages
      - Low current demand (no pressure necessary)
      - High biogas purity
      - Low CH_4-loss
  - Utilization of wood fraction for energy recovery
  - Treatment of wet fermentation residue in combustion chamber
    →cheap and simple sanitation
  - Composting of solid digestion residues

Example Burgkirchen

- Technology
  BTA single step wet fermentation

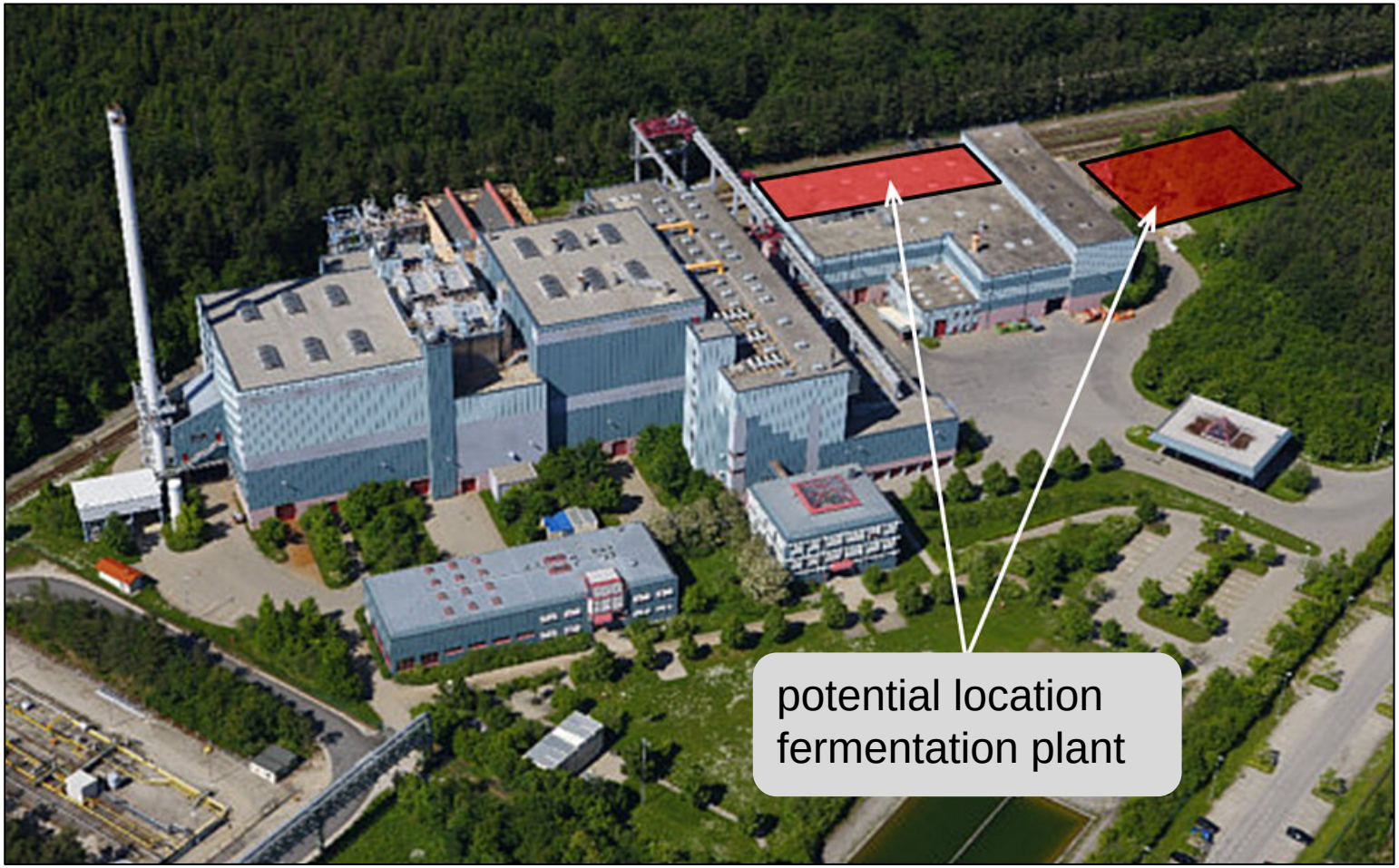




Source: BTA

Example Burgkirchen

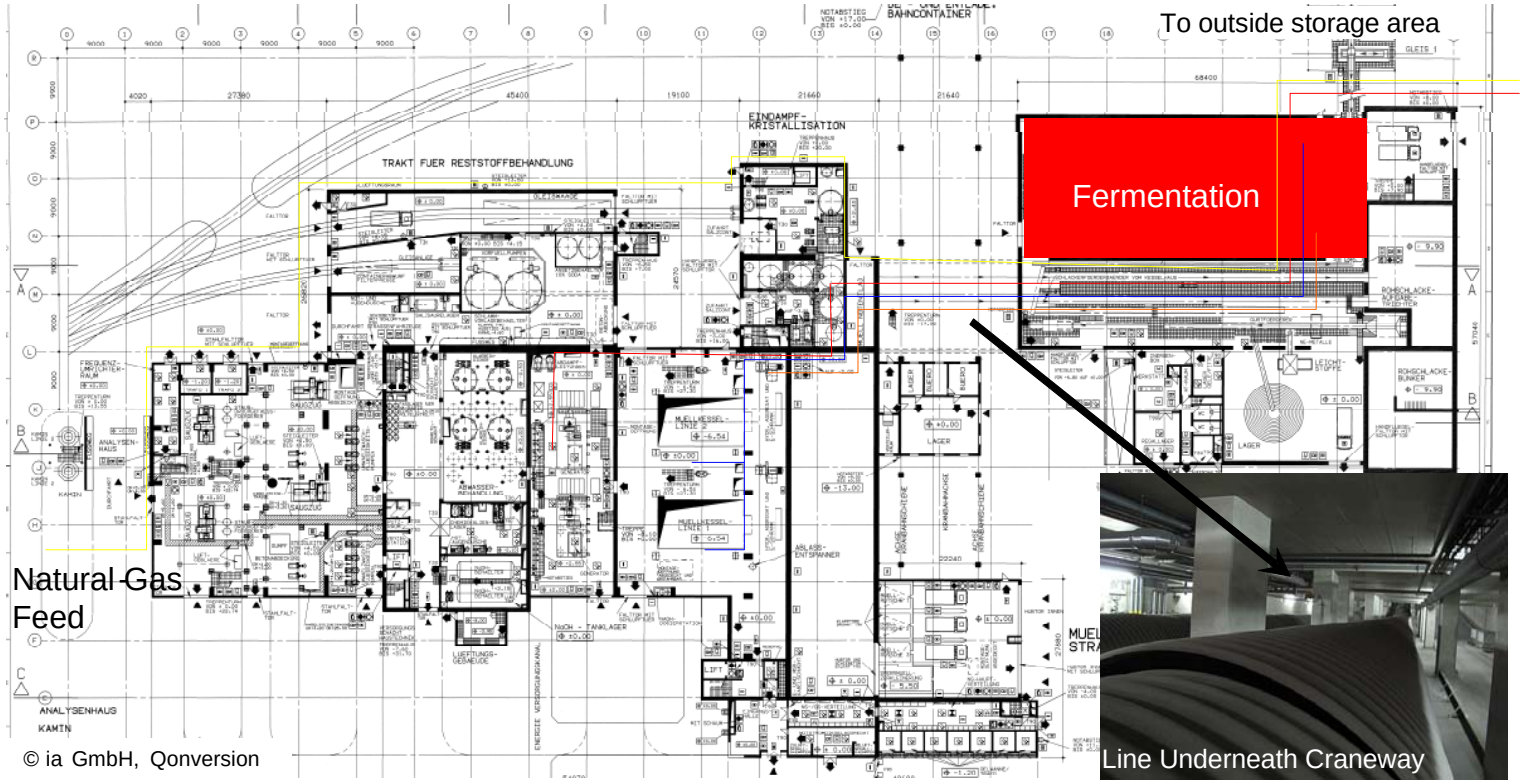
- Site



Source: ZAS Burgkirchen

Example Burgkirchen

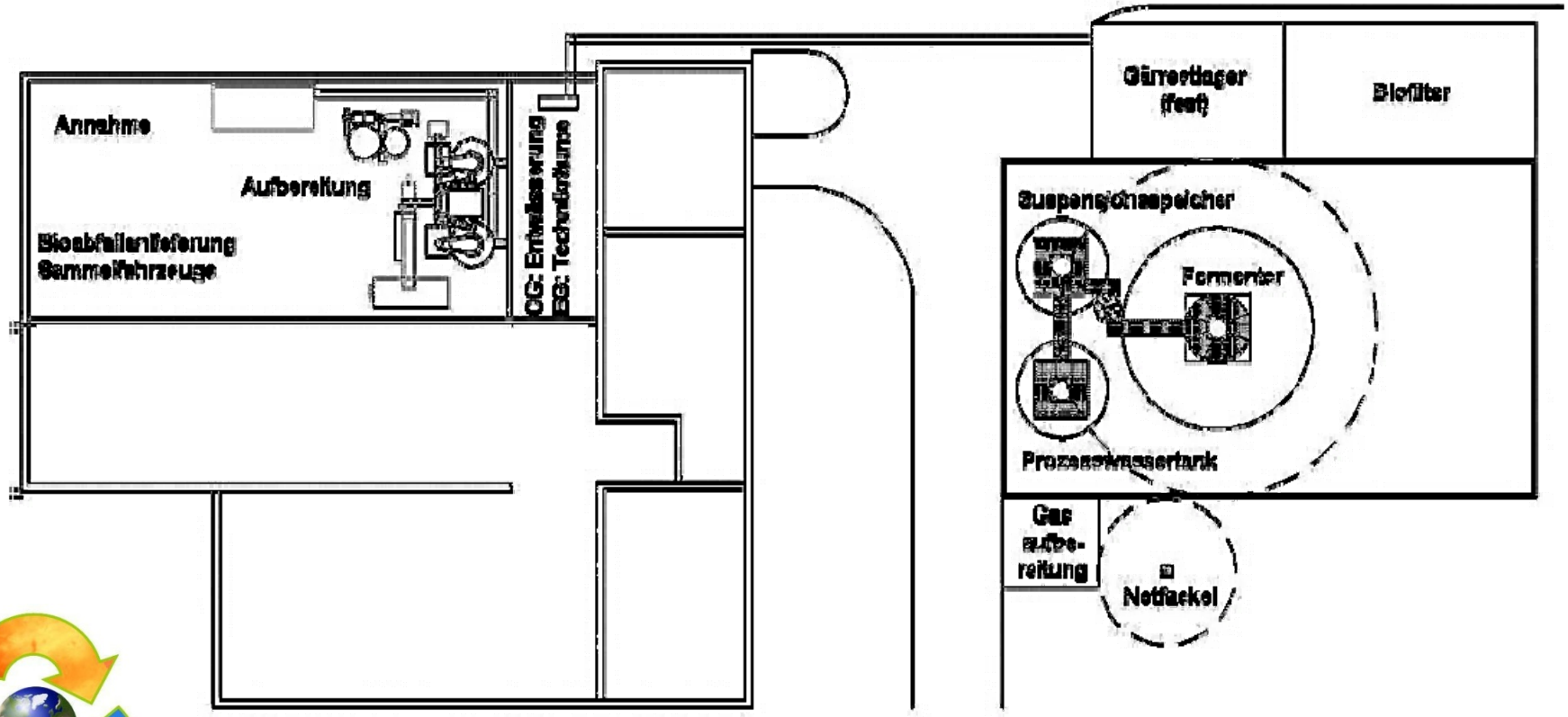
- Integration



Source: ZAS Burgkirchen

Example Burgkirchen

- Integration



Example Burgkirchen

- Treatment of contaminated air and liquid digestion residue

Integration into
the secondary air duct

Injection of wet
fermentation residue

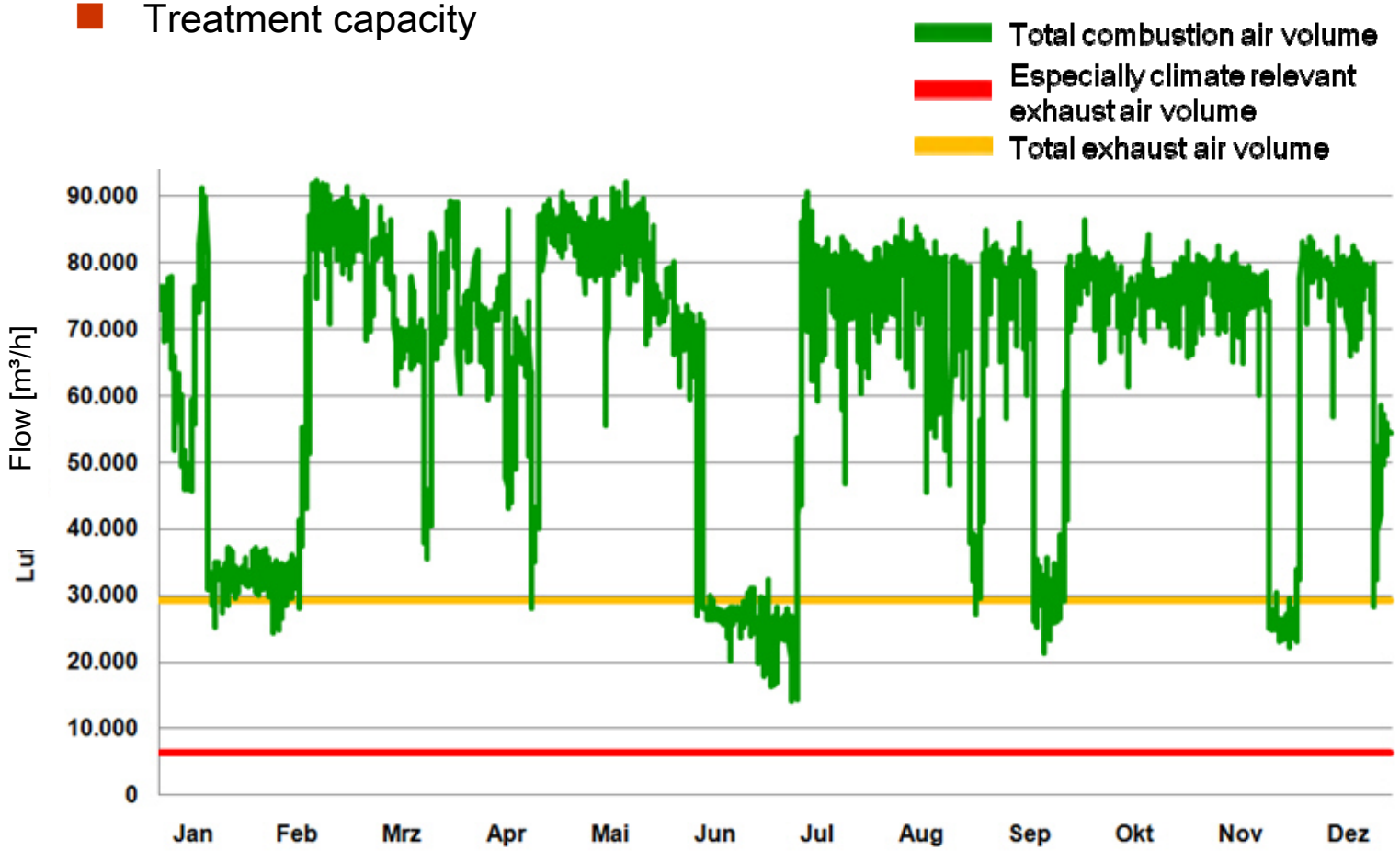
Example Burgkirchen
Results

- Treatment of contaminated air
  - Necessary air treatment amount:

Air from treatment facilities Screw-type mills, lightweight fraction, grit separation, solid discharge, light contaminants' press, enclosed conveyor belt preparation	1,100 m³/h
Air from solid fermentation residue Dewatering fermentation residues (centrifuge and pumping processes), encapsulated conveyer belt to storage, storage	5,400 m³/h
No suction from liquid fermentation residue storage → treatment in combustion chamber	0 m³/h
No suction from composting → off site post-composting	0 m³/h
Air to combustion chamber (sum)	6,500 m³/h
Low contaminated air to bio-filter	22,800 m³/h

Example Burgkirchen
Results

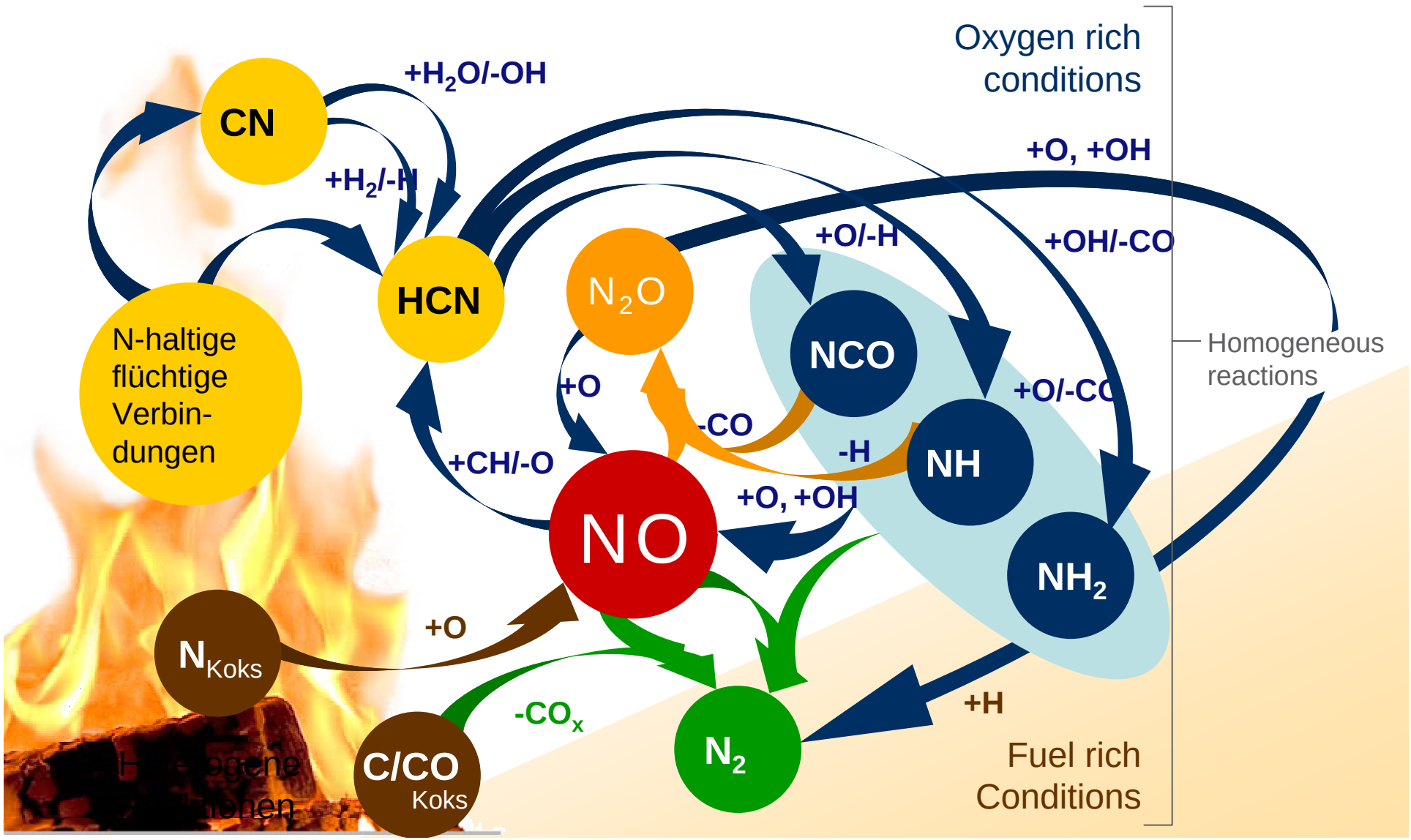
- Treatment of contaminated air
  - Treatment capacity



Thermal treatment of relevant contaminated exhaust air fractions at all operation conditions possible!

Influence on combustion?

Reactions with nitrogen components



Influence on combustion?

- Treatment of contaminated air
  - Performance of CH_4 and NMVOC?
    - → Temperatures and residence time guarantee safe oxidation
  - Performance of NH_3?
    - → Depends on temperature

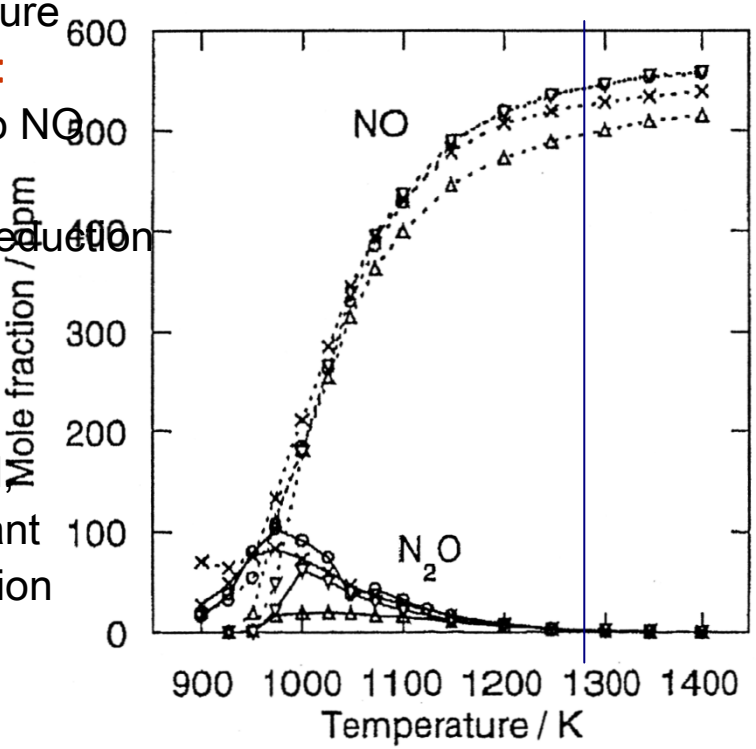
      Worst case:

      Oxidation to NO

      Best case:

      Additional reduction agent
  - Performance of N_2O?
    - → at 1000 °C

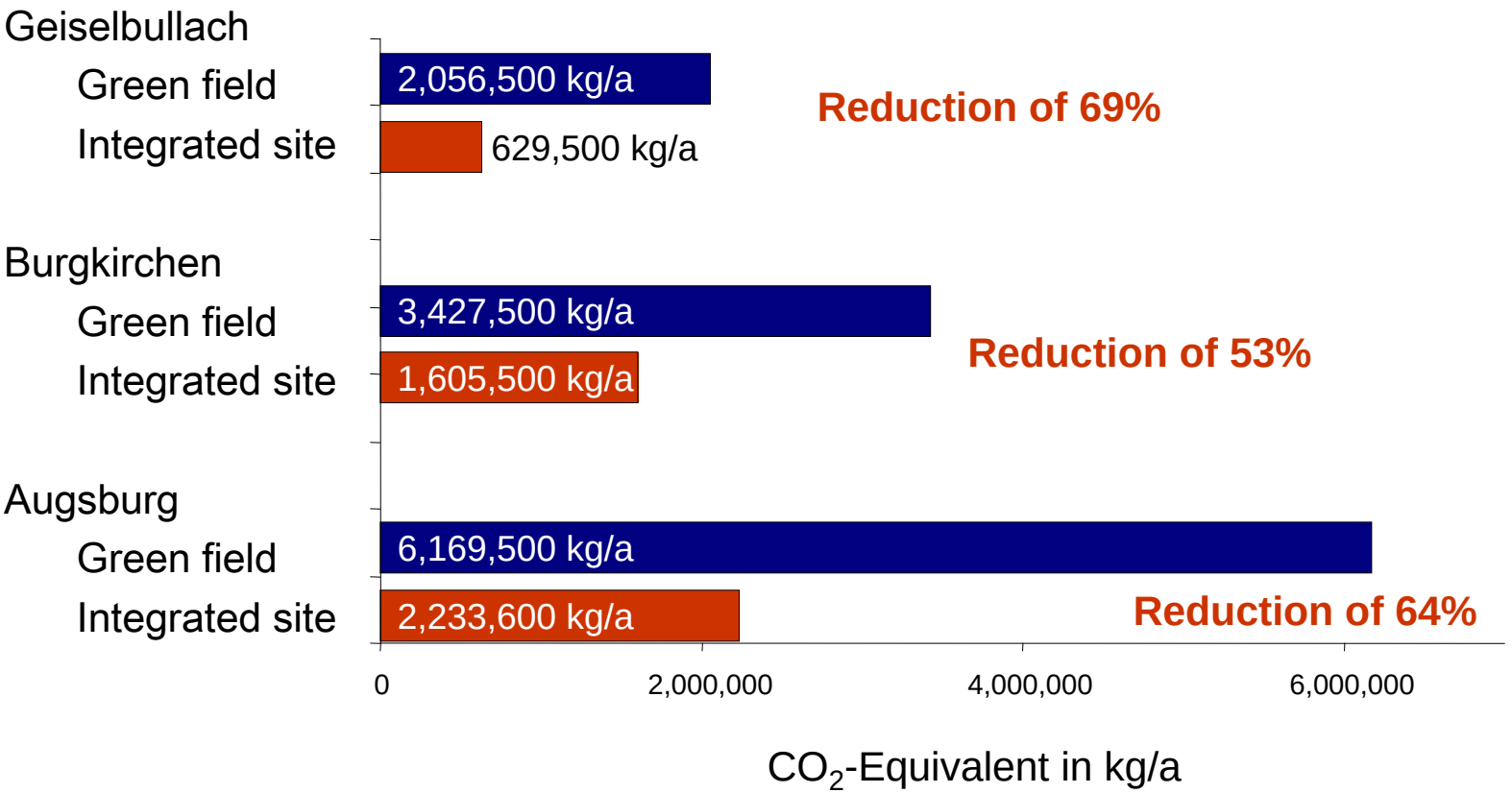
      and beyond, no signidicant NO_2-formation expected



Source: Glarborg, 2002

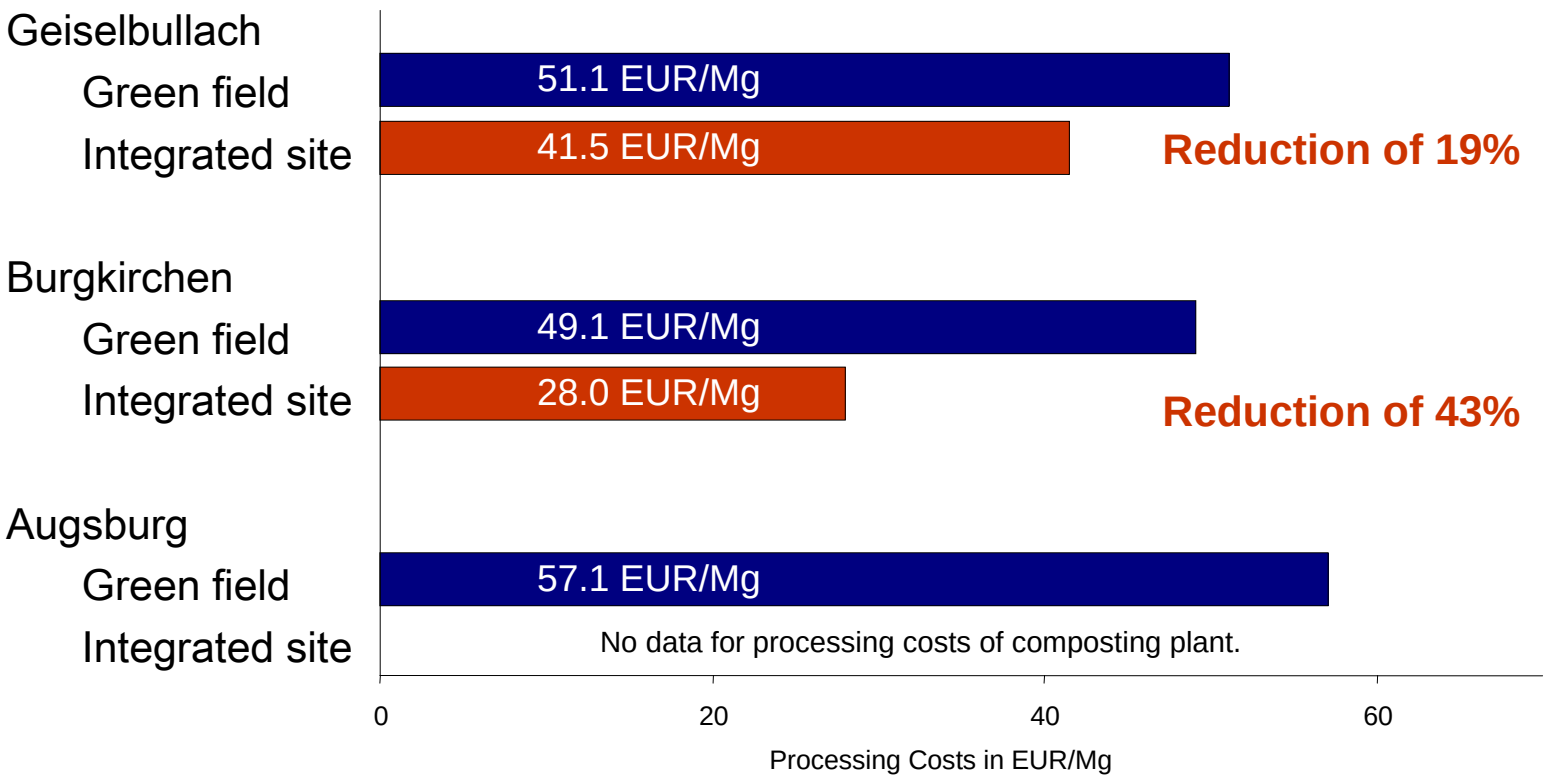
Results
Ecological effects

- Reduction of green house gases in CO_2-equivalents



Results
Economic effects

- Reduction of specific treatment cost in €/kg



Summary and Conclusion

- Thermal and biological waste treatment facilities at integrated sites offer various advantages:
  - Significant reduction of green house gas emissions
    53 – 69 % for investigated examples
  - Reduction between 20 and 40 % of specific treatment cost
    by common use of infrastructure
  - Disposal of liquid digestion residues in combustion chamber possible
  - Optimization of heat utilization
    - Difficult because of different plant capcities (factor 10 – 100)
    - Possibilities:
      - Preheating of feed water for WtE by biogas CHPS
      - Heating of fermenters by low temperature heat of WtE
      - Biogas upgrading by amine scrubbing
- Further options:
  - Transfer of strategy to other thermal power plants, e.g. biomass, sewage sludge, coal, etc
  - Development of integrated concepts already in planning phase
    → optimum of synergetic effects

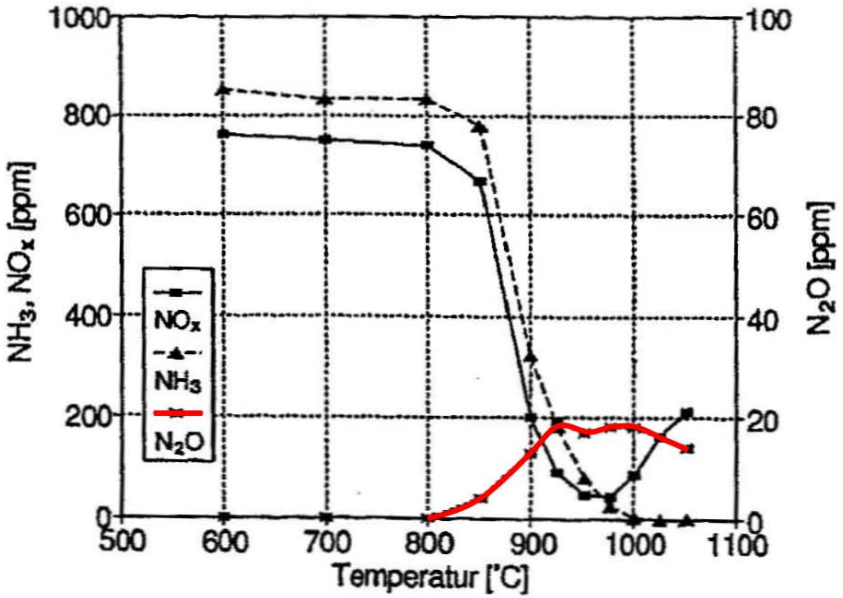
Thank you!

Peter Quicker – Qonversion
Uwe Athmann – dezentec Ingenieurgesellschaft mbH
Werner Bauer, Thomas Kroner – ia GmbH
Gerhard Meier – ATAB e.V.

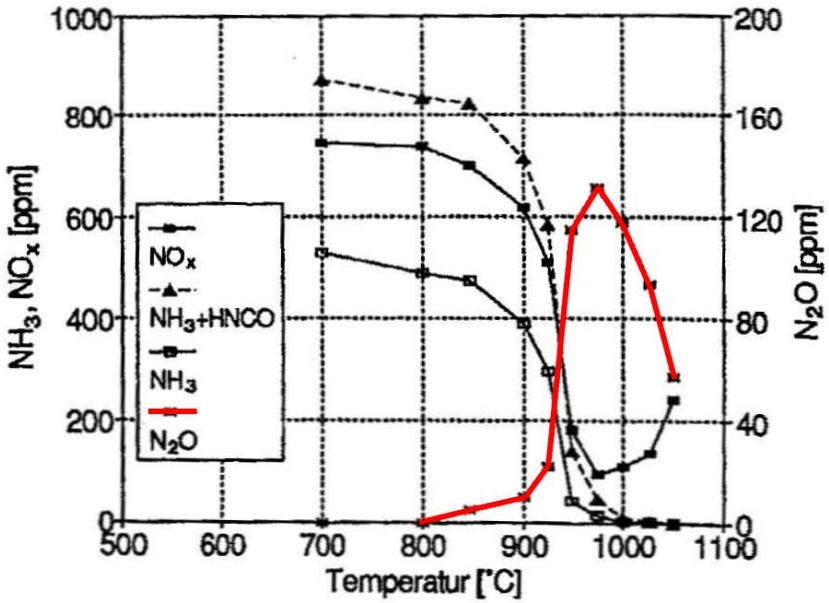
Influence on combustion?

- Treatment of contaminated air
  - Performance of NH_3, N_2O?
    Measurements with artificial flue gas
    10 % H_2O, 4 % O_2, 800 ppm NO_x

with ammonia

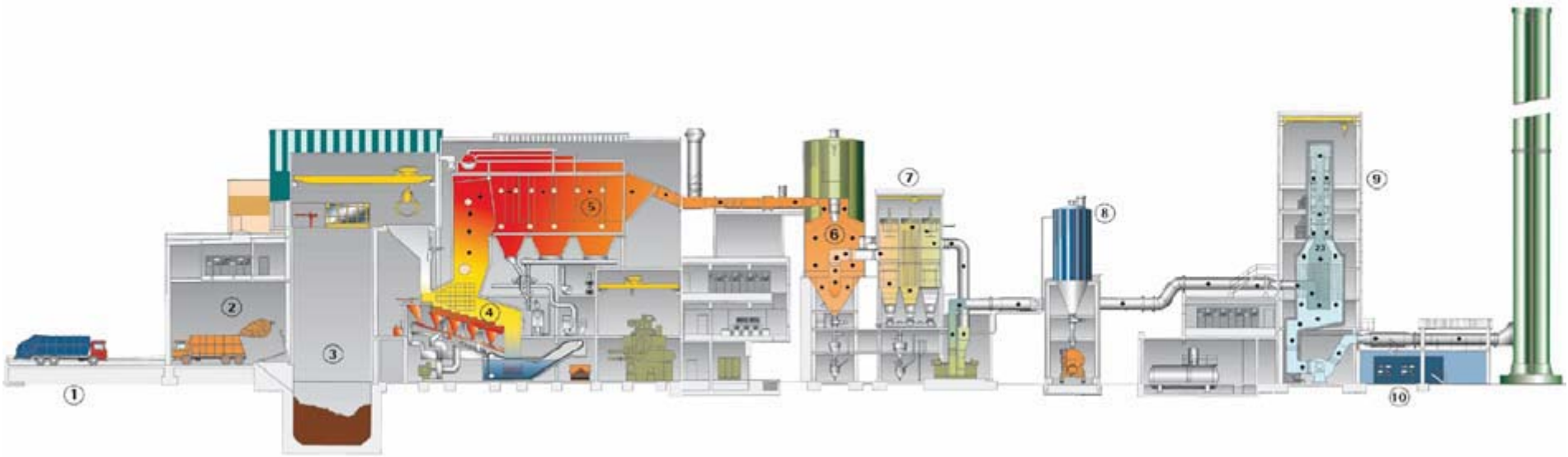


with urea



Source: Koebel 1992

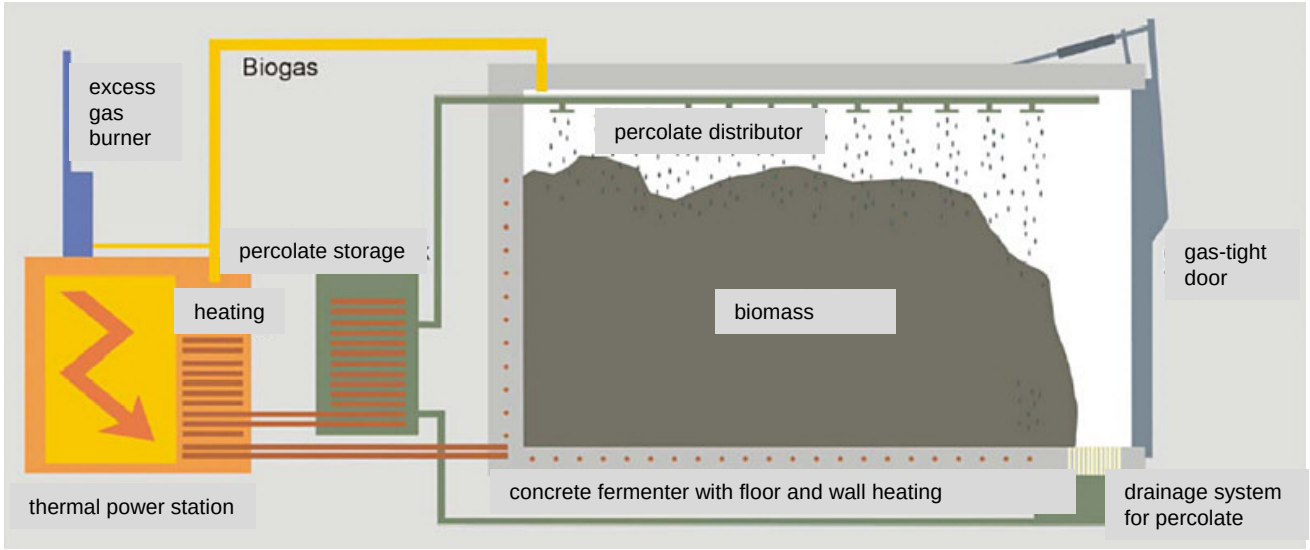
Geiselbullach



Geiselbullach

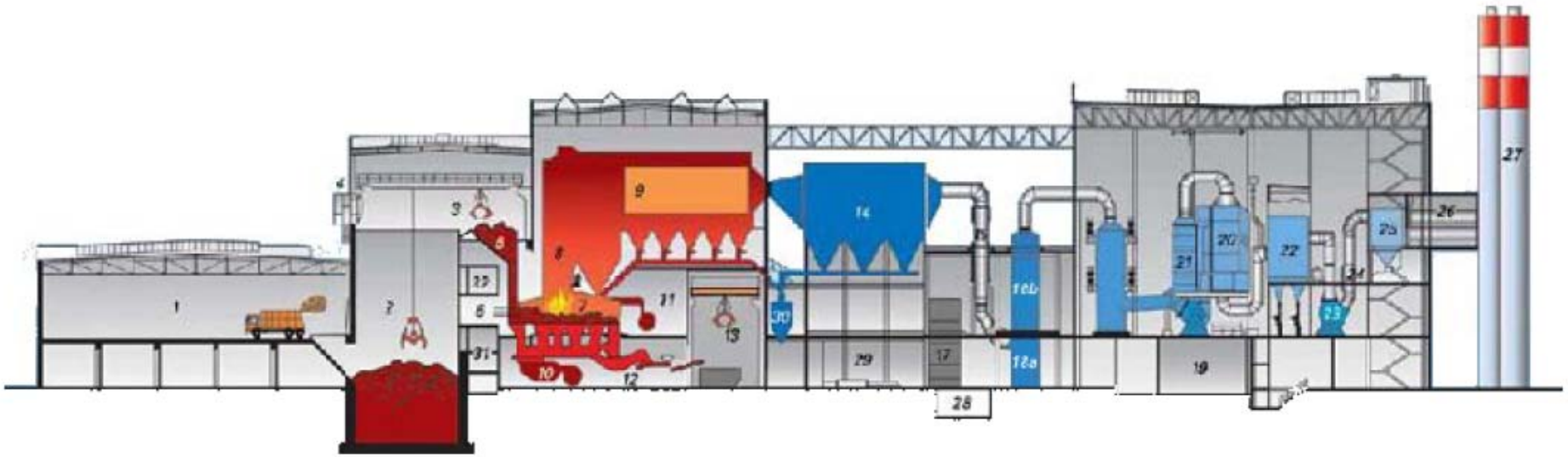
Selected Procedure:

Discontinuous dry fermentation 15,000 Mg/a (closed system)



Source: Bekon

Augsburg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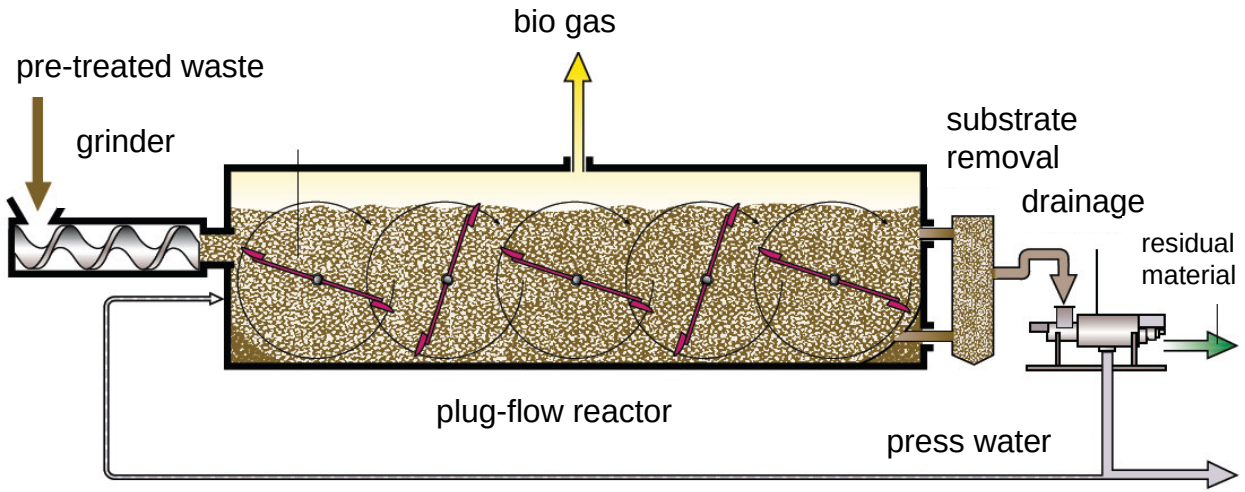
Augsburg

Selected Procedure:

Continuous dry fermentation 40,000 Mg/a (plug-flow process)



Source: Strabag

Option – No content of the study

- Further optimization potenzial by BABIU-process
  - BABIU =
  - BABIU allows bottom ash treatment within hours
  - BABIU enriches CH4-content in biogases up to….