ATBEST

Surplus electricity to biogas via hydrogen

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Work experience - Education

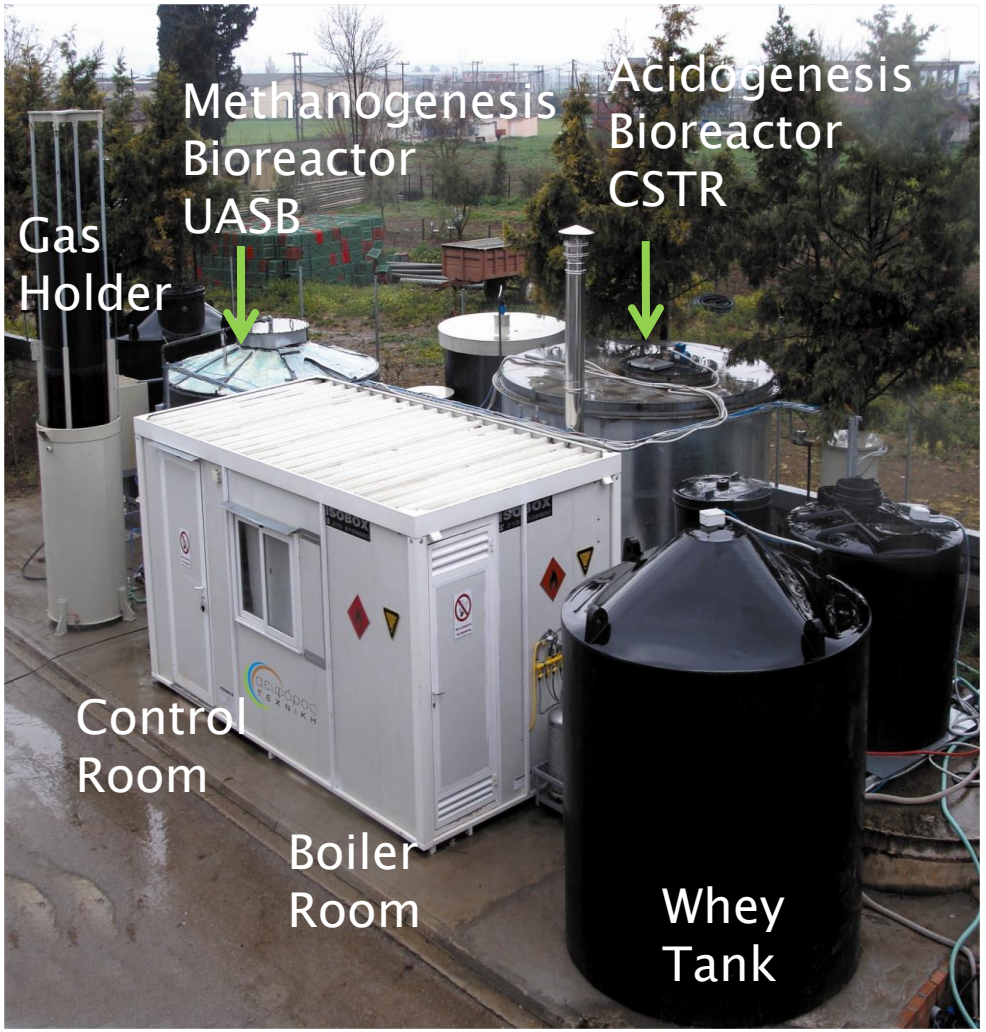
- **Bachelor studies:** Chemistry

  Direction: Chemical Analysis – Environment

- **Master studies:** Environmental Engineering

  Direction: Management of waste and water resources

Work experience: Biogas production - Anaerobic digestion of cheese whey wastewater through a two – stage system



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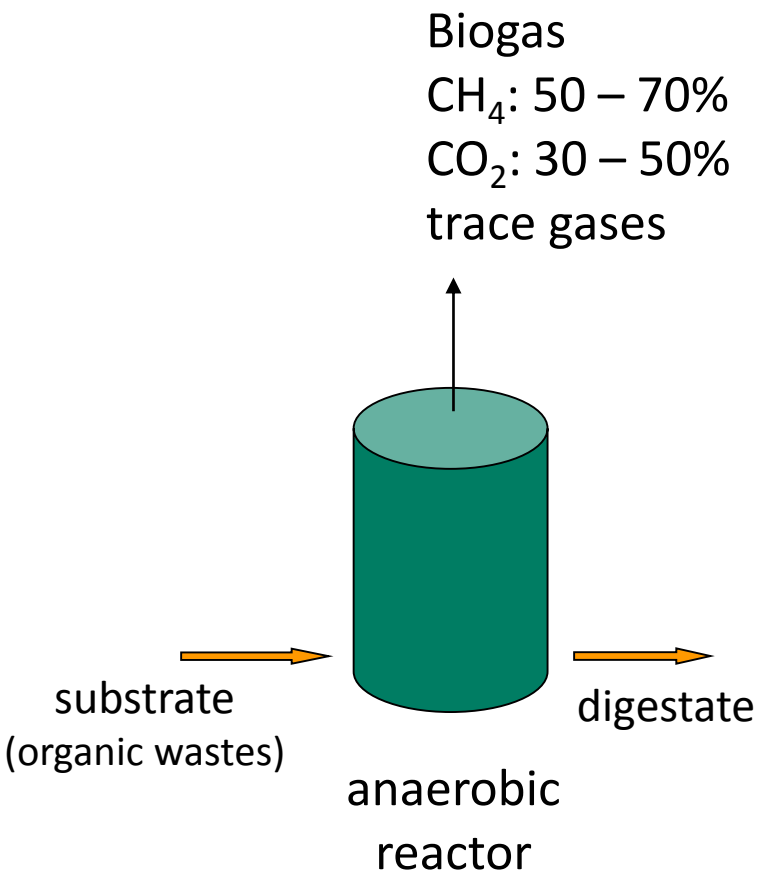
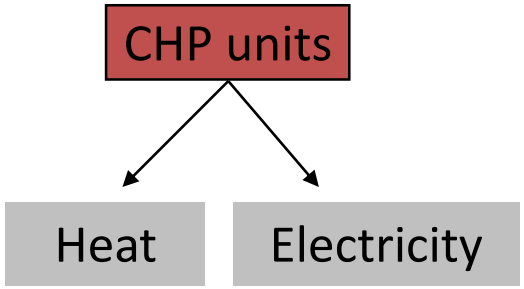
Biogas production and utilisation

Anaerobic digestion



Biogas utilisation:



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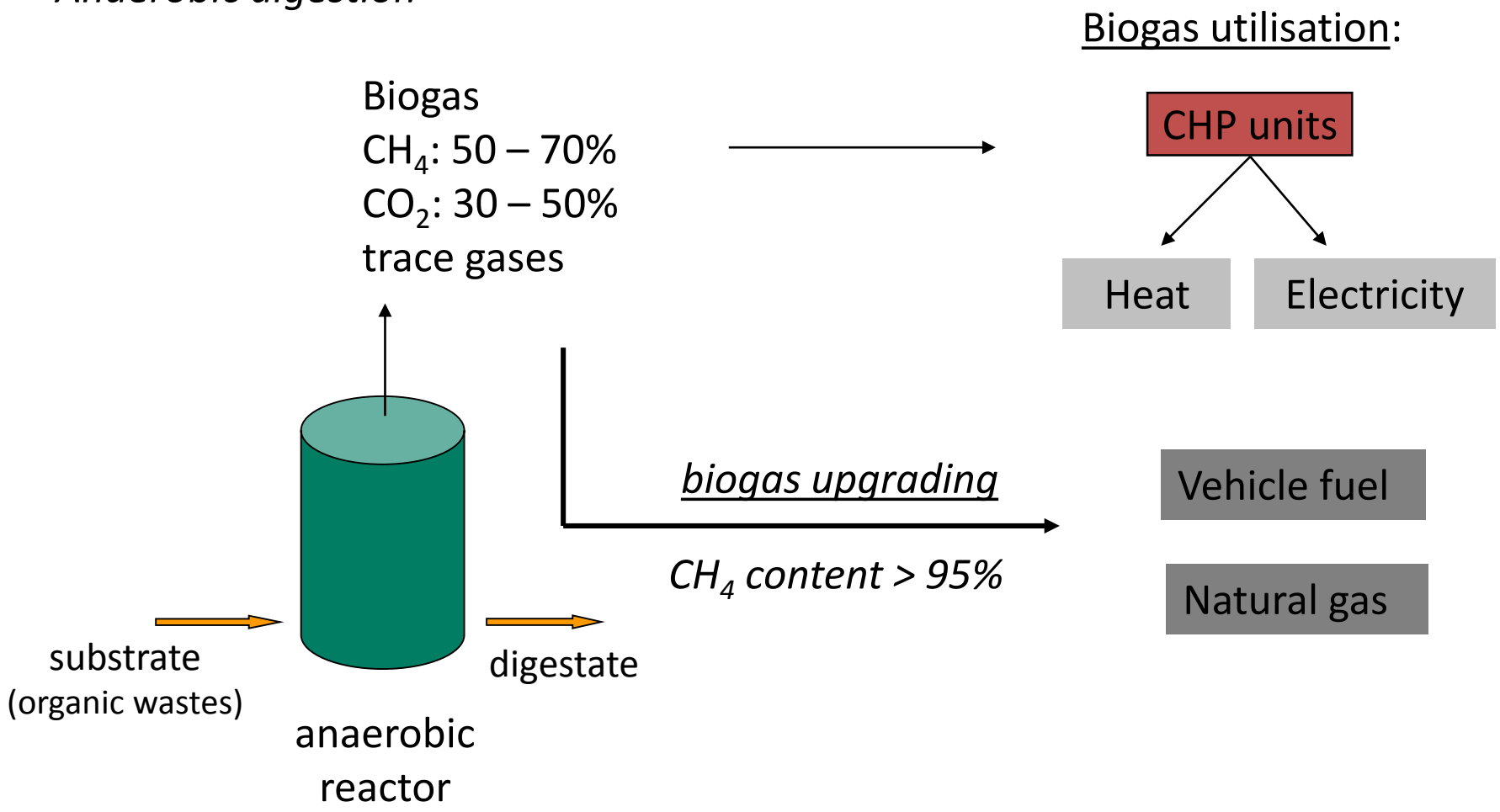
Biogas production and utilisation

Anaerobic digestion



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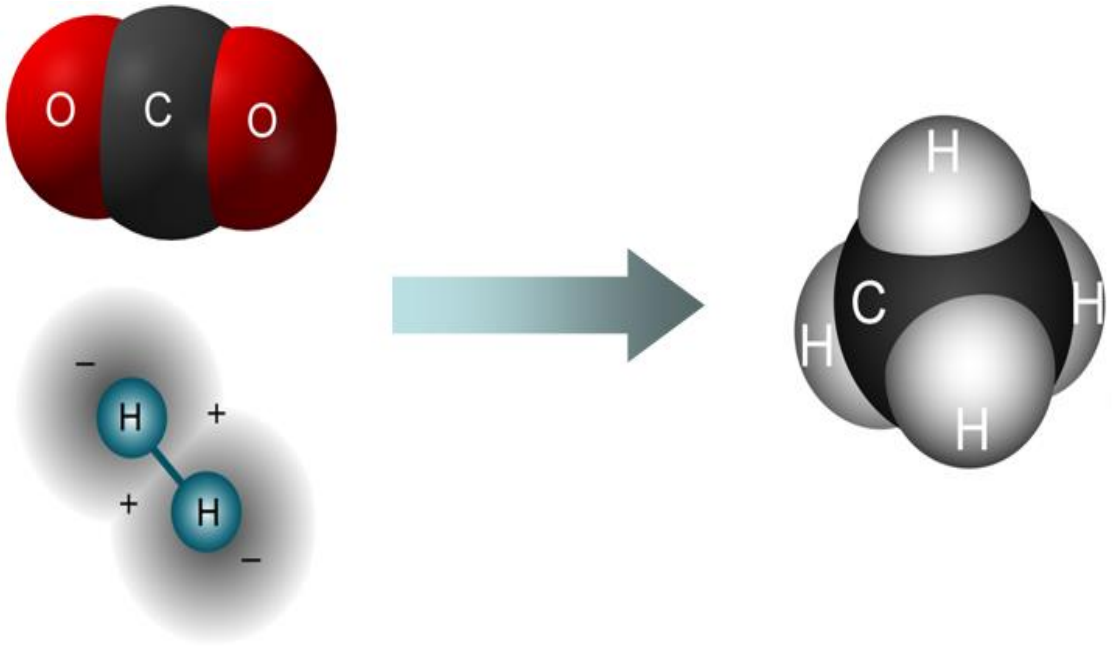
Biogas production and utilisation

Sabatier process: $CO_2 + 4H_2 \rightarrow CH_4 + 2H_2O$ $\Delta H = -165.0$ kJ/mol



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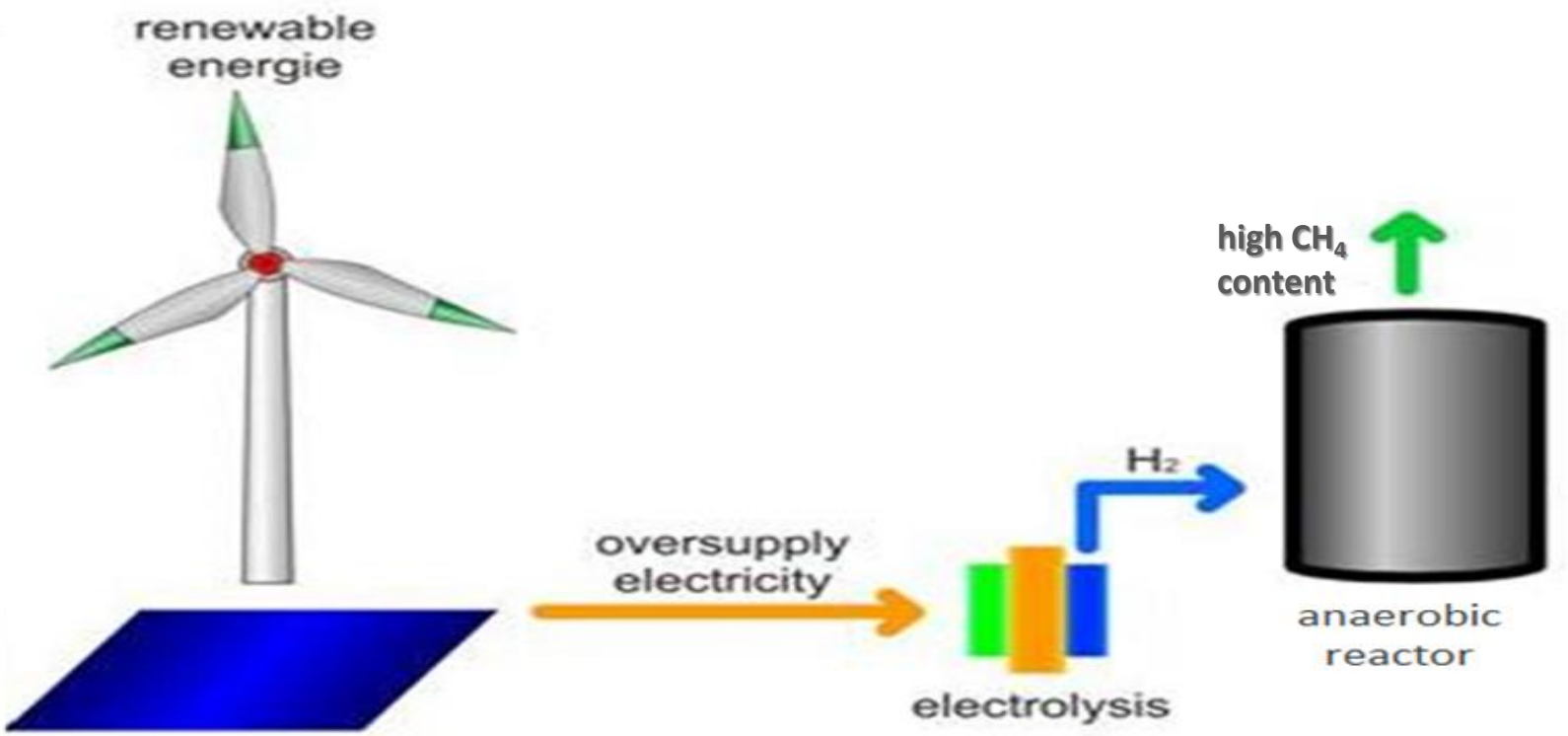

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Objectives

- Supply H_2 to the organic waste feeding stream of an anaerobic digester to upgrade biogas *in situ*
- Modify the anaerobic configuration so that H_2 is used to enhanced the biogas efficiency
- Optimize H_2 consumption by the hydrogenotrophic methanogens in anaerobic reactors

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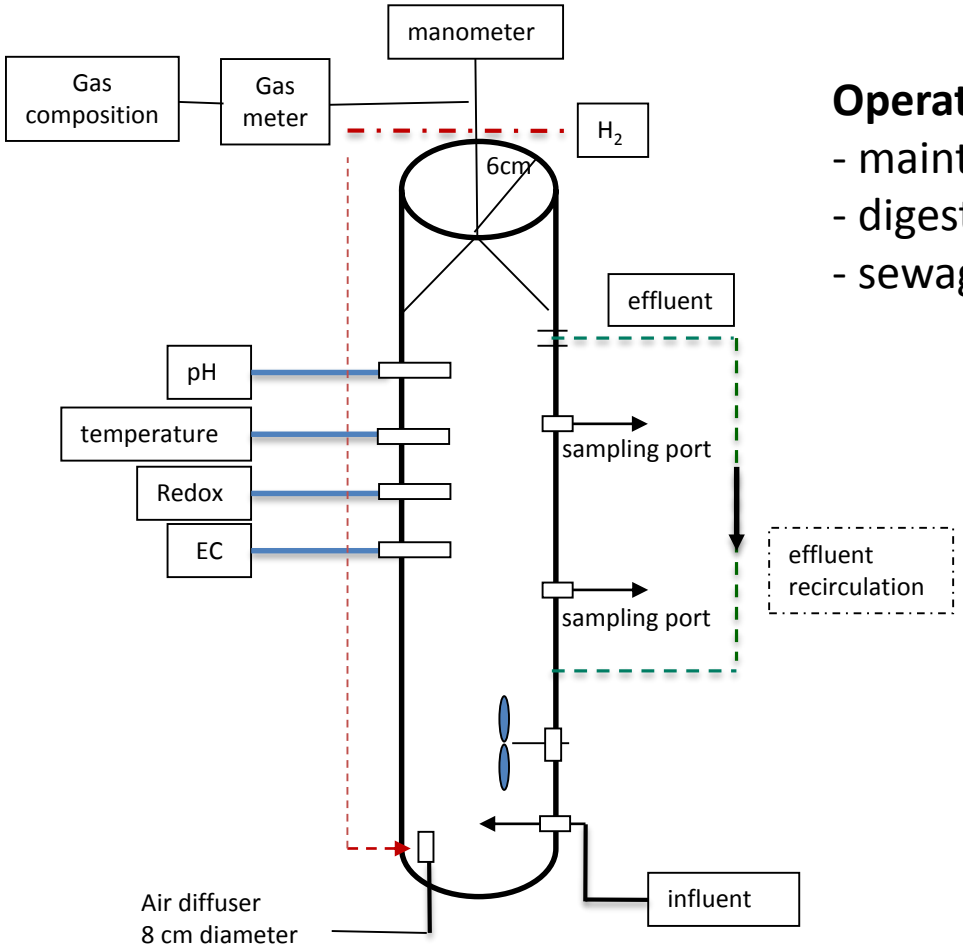
Experimental configuration



Operational conditions:

- maintained at 37° C
- digested sludge as inoculum
- sewage sludge as substrate

Modifications:

- stirring velocity
- effluent recirculation
- biogas recirculation

Waste characteristics

Parameter	Value
pH	7.32
TS (g/L)	35.8 ± 1.81
VS (g/L)	23.9 ± 1.15
% VS/TS	67.48 ± 2.41
COD (g/L)	23.4 ± 0.83
$NH4^+$-N (mg/L)	1138 ± 263

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Performance of the system

Parameter	Phase #1 (21 – 51d)	Phase #2 (52 – 84d)	Phase #3 (85 – 105d)	Phase #4 (106 – 138d) effluent recirculation
Flow rate (L d^{-1})	0.33	0.38	0.44	0.48
HRT (d)	28.8	25.2	21.6	19.6
OLR (g VS L^{-1} d^{-1})	0.79	0.98	1.13	1.27
Biogas yield (L_{biogas} / gVS_{fed})	0.259	0.299	0.334	0.372
CH_4 yield (L_{CH_4} / gVS_{fed})	0.178	0.207	0.227	0.256

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Performance of the system

The system corresponded well. The production rate, biogas and CH_4 yield followed the changes of HRT and OLR. The system exhibited:

- stable operation
- robust process
- pH ~ 7.18
- CH_4~ 68%

Fluorescence in situ hybridization (FISH):
Methanosaetaceae, acetotrophic methanogens.

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Next steps

Inject H_2 into the system.

- Volume corresponding to ratio $4H_2$:CO_2
- Monitor CH_4 yield
- Evaluate system's stability and energy efficiency
- Identify hydrogenotrophic methanogenic archaea

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Outcome

The expected outcome of this project is to establish an efficient process which will contribute to the:

– increase of net CH_4 production

– conversion of the excessive renewable energy into a storable gas

– decrease of biogas upgrading costs

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Thanks for listening

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Project coordinated by the QUESTOR Centre
at Queen's University Belfast
www.qub.ac.uk/questor