



Students for Energy in Africa



Missie

Doelstellingen

- Realiseren van duurzame energieprojecten in Afrika, onderzocht en uitgevoerd door Belgische studenten in samenwerking met de lokale bevolking
- Verbeteren van de technisch-wetenschappelijke kennis van de studenten betreffende duurzame energie en verrijken van hun wereldbeeld
- Informeren van de lokale bevolking over duurzame energie en uitwisselen van technisch-wetenschappelijke kennis
- Financieel steunen van de projecten

Werkwijze



Duurzame energie projecten in Afrika



Haalbaarheidsstudie



Geïnteresseerde, gedreven, bekwame en verantwoordelijk studenten



Meest optimale duurzame energiesysteem



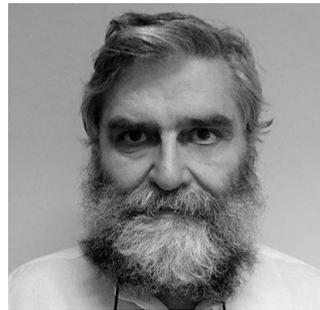
Opbouwen systeem ter plaatse



Team



Voorzitter
Wim Deferme



Schatbewaarder
To Simons



Secretaris
Inge Verboven



Bestuurslid
Karine Evers



Bestuurslid
Luc Heylands



Bestuurslid
Kevin Schrijvers



Bestuurslid
Lore Van Welde



Projecten

- 2013** Biogas Warang - Senegal
- 2015** Windmolen Nianing- Senegal
- 2016** Zonnecollector en optimalisatie keuken Ukunda - Kenia
- 2017** Zonnesysteem en mobiele batterijen Sichem - Togo
- 2018** Energievoorziening en –optimalisatie Mali Juisi - Tanzania
- 2019** Hakselaar Artemisia Sichem - Togo
- 2020** Energievoorziening en duurzame constructie Le Coquetier Social Ndièguène – Senegal (vervolg 2022)
- 2021** Energievoorziening keuken Universiteit Mombasa (TUM-project) - Kenia
- 2022** Watervoorziening Ndhole Primary school (Homa Bay Stichting) Ukunda - Kenia
- 2024** Biogas optimalizatie (Ardhi University) Dar Es Salaam -

2013 Biogas Warang - Senegal

Situatie

- Basisschool *les Cajoutiers* in Warang
 - Bereiding warme maaltijden voor 500 kinderen d.m.v. verbranding hout of butaan (schadelijk voor milieu en personeel en prijzig)
- ⇒ Duurzame energiebron bereiden maaltijden



Biogasinstallatie

- Anaerobe vergisting van biomassa
- Biomassa: organisch afval tuin, keuken en toiletten en algen (strand)
- Digestaat gebruikt voor bemesting tuintje

2015 Windmolen Nianing - Senegal

Situatie

- Basisschool *Futur du Sénégal* in Nianing
 - Beperkt elektriciteitsnet voor verlichting en ventilatie
 - Regelmatige stroomonderbrekingen
- ⇒ Duurzame energiebron opvangen stroomonderbrekingen



Windmolen

- Gebruik wind vlakbij kust
- Hugh Piggott technologie
- Duurzame, eenvoudige en efficiënte windmolen
- Gel batterijen voor energieopslag

2016 Zonnecollector en optimalisatie keuken Ukunda - Kenia

Situatie

- Basisschool *Rainbow4kids* in Ukunda
 - Bereiding warme maaltijden voor 350 kinderen d.m.v. verbranding hout (schadelijk voor milieu en personeel en prijzig)
- ⇒ Duurzame energiebron bereiden



Zonnecollector

- Omzetting zonne-energie naar warmte
- Zonnepanelen met grid gevuld met glycerine en warmtewisselaar in watertank
- Opwarming water tot 65°C

2016 Zonnecollector en optimalisatie keuken Ukunda - Kenia

Situatie

- Basisschool *Rainbow4kids* in Ukunda
 - Zware potten, rook- en warmtehinder keuken
- ⇒ Optimalisatie kookproces en keuken



Optimalisatie kookproces en keuken

- Ergonomisch fornuis met het rocket stove principe
- Kraan met takel liften zware kookpotten

2017 Zonnestysteem en mobiele batterijen Sichem - Togo

Situatie

- Plattelandsgemeenschap Sichem in Togo
 - Elektriciteitsonderbrekingen of zelfs geen toegang elektriciteit
- ⇒ Duurzame energiebron en energieopslag



Zonnepanelen en mobiele batterijen

- Zonnepanelen op dak
- Mobiele batterijen
 - Elektriciteit voor omliggende dorpen
 - Business model

2018 Energievoorziening en -optimalisatie Mali Juisi - Tanzania

Situatie

- Instabiele stroomvoorziening vruchtensap bedrijfje Mali Juisi in Tanzania
 - Reduceren energiekosten (verwarming van water)
- ⇒ Noodsysteem en verwarming water (optimalisatie productieproces)



Dieselgenerator en zonnecollector

- Dieselgenerator als noodstelsysteem
- Zonnecollector voor opwarmen water en dus optimalisatie en reductie kosten productieproces (> 25 %)

2019 Hakselaar Artemisia Sichem - Togo

Situatie

- Versnijden plant Artemisia (thee ter bescherming tegen Malaria)
- ⇒ Installatie hakselaar



Hakselaar

- Opgebouwd uit lokale materialen (onderhoud en herstelling)
- Versnijden Artemisia

Situatie

- Regelmatige stroompannes bij pluimveebedrijfje Le Coquetier Social (van organisatie Afractie) Ndièguène in Senegal
 - Degradatie constructies door regenval
- ⇒ Duurzame energiebron voor IR-verlichting, ventilatie kippenrennen en koeling en versteviging en ventilatie constructies



Windmolen en constructiestudie en ventilatie

- Installatie windturbine gestaakt door COVID-19 pandemie
- Constructiestudie en ventilatie geannuleerd door COVID-19 pandemie
- Vervolg 2022: Constructie zonnepanelen installatie

2021 Energievoorziening keuken Universiteit Mombasa (TUM-project) - Kenia

Situatie

- Duurzame energievoorziening keuken Universiteit Mombasa in Kenia
 - Educatie en onderzoek naar anaerobe vergisting van biomassa (keukenafval) in combinatie met zonne-energie (verwarming water)
- ⇒ Opbouw biogasinstallatie en zonneboiler



Biogasinstallatie en zonneboiler

- Voordelig milieu (vermindering afval en milieuvervuiling)
- Reductie energiekosten
- Praktisch lessen hernieuwbare energie (kennisoverdracht)

Situatie

- Kinderen moeten elk morgen 10 km wandelen voor waterverzameling
 - Water niet zuiver
- ⇒ Grondwaterput



Grondwaterput

- CO2 neutraal oppompen, zuiveren en opslaan water
- Zuiver water voor school en omliggende gemeenschap
- Geen grondwater gevonden door climate change en grondverschuiving

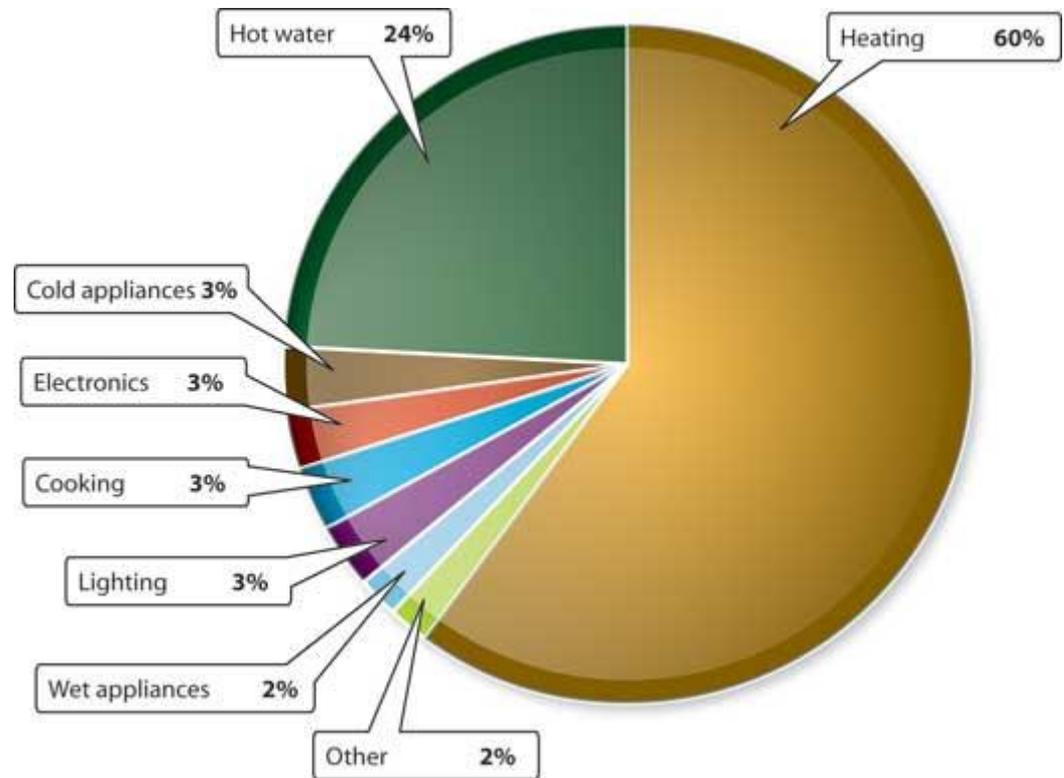
Biogas in Africa

ing. Kenneth DRIES
ing. Louis MACOURS

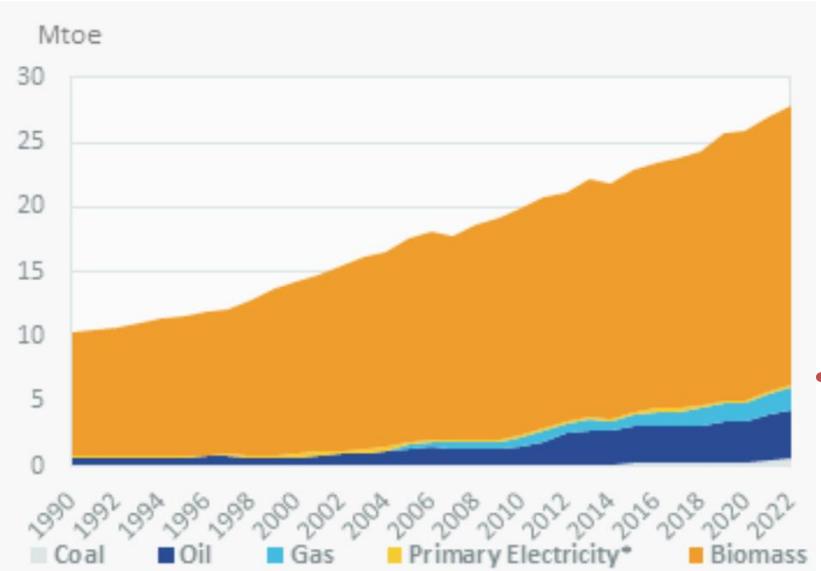
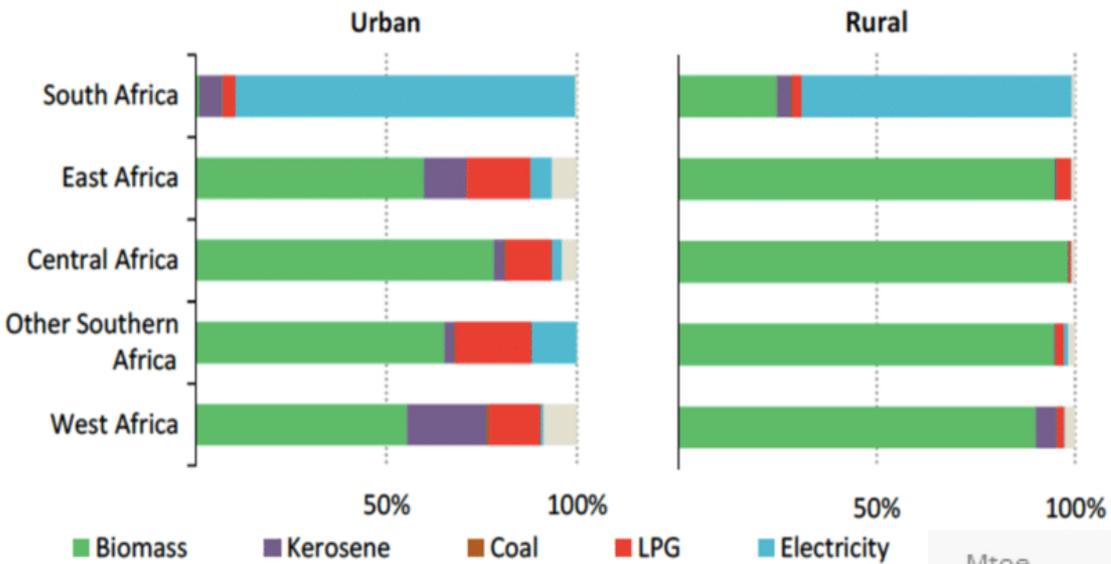
De opleiding industrieel ingenieur is een gezamenlijke
opleiding van UHasselt en KU Leuven



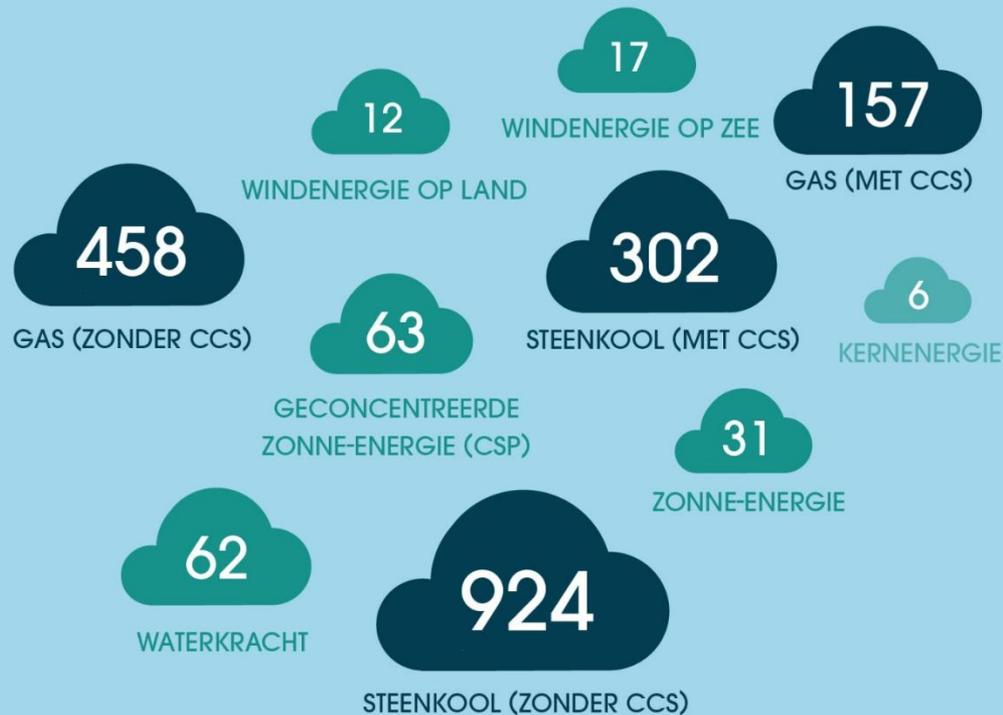
Wat is de grootste energie bron in Africa?



Introduction



Vergelijking van de CO₂-uitstoot voor de verschillende elektriciteitsbronnen



Gram CO₂/kWh

Bron : UNECE (2022)

2 projecten:

Master's Thesis Engineering Technology

2020-2021

Design and implementation of a hybrid biogas plant to reduce environmental pollution and food waste

Daan Vanhoudt
Master of Energy Engineering Technology

Tobias Cortouthouts
Master of Energy Engineering Technology

Situation

The Technical University of Mombasa (TUM) provides hot meals for about 2,000 students per day. To achieve this, 800 kg of wood and 120 kg of LPG per month is needed.

Problem definition

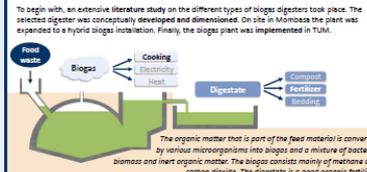
The use of fossil fuels is expensive and contributes to greenhouse gas emissions and climate change. Providing hot meals every day in the university results in 100 kg of organic food waste per day, while these food residues could be used as an energy source.

Objectives

This master's thesis focuses on designing a biogas plant that converts food waste into biogas. The food waste from TUM will be converted as efficiently as possible into biogas which will be used for cooking.

Method

To begin with, an extensive literature study on the different types of biogas digesters took place. The selected digester was conceptually developed and dimensioned. On site in Mombasa the plant was expanded to a hybrid biogas installation. Finally, the biogas plant was implemented in TUM.



The organic matter that is part of the feed material is converted by various microorganisms into biogas and a mixture of bacterial biomass and inert organic matter. The biogas consists mainly of methane and carbon dioxide. The digester is a good organic fertilizer.

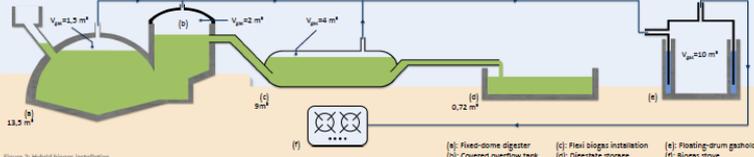


Figure 3: Hybrid biogas installation

(a) Fixed-dome digester

The fixed-dome digester is one of the simplest and most common digesters in developing countries. A well-founded installation can withstand high external loads and high internal pressure, resulting in a lifespan of up to 25 years.

Properties

- Robust design
- No moving parts
- Underground construction
- Low efficiency (= biggest disadvantage)
- Building material: bricks and cement



Figure 3: Fixed-dome digester, overflow tank and inlet reservoir

Hybrid biogas installation

Purpose of the hybrid installation

- Eliminating the disadvantages of the fixed-dome digester
- Making the installation more interesting for educational purposes

Covering the overflow tank

- Eliminate gas losses in the overflow tank
- Reducing greenhouse gas emissions

Expansion with a flex biogas installation

- Improve efficiency
- More complete digesting process



Figure 4: Biogas site

(f) Floating drum gasholder

Properties

- Provides constant pressure
- Adjustable pressure by placing weight on the drum
- Small difference between consumption and production
- Visual representation of gas content by height of the drum

A simulation shows that a total gas storage of 15.09 m³ is required. Considering a safety margin of 20% and the other gas storages, 18.6 m³ should be stored in the floating drum gasholder.

The size of the gasholder depends on:

- Size of the gas storage in the other digesters
- Production is 11.88 m³/day
- Consumption

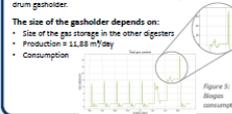


Figure 5: Biogas consumption

Conclusion

At the time of departure to Belgium, the plant was mostly complete (as shown in figure 4) but some tasks still need to be completed. Therefore, in June 2021, the works on the biogas plant are still in progress. As the project is part of a multi-year project, the continuation of the works is guaranteed. Close consultation is taking place with the university staff in order to bring the implementation of the biogas plant to a successful end.

Supervisors / Co-supervisors / Advisors

Prof. dr. ir. Wim Deferme
Dr. Juma Saulo Michael

[1] Y. Wang, C. Hu, L. Li, A. Guler, S. Diner and C. Zurbrugg, Anaerobic Digestion of Biomass in Developing Countries, Elsevier, E. Energy, 2014.

[2] S. Ludwig, K. Christoffer and K. Akwa, Improved Biogas Unit for Suburban, Deutsche Zentrum für Technische Zusammenarbeit, 2010.

[3] E. C. Betsab, Technical evaluation and classification of biogas plants in Ghana, Karami, Karami Nuraiah University of Science and Technology, 2009.

Master's Thesis Engineering Technology

2024-2025

Design and implementation of a sustainable solution for upgrading and distributing biogas in rural Tanzania

Kenneth Dries
Master of EM Engineering Technology

Louis Macours
Master of EM Engineering Technology

SITUATION

Across rural Africa, charcoal and firewood still dominate household energy, driving deforestation and indoor air pollution. Through anaerobic digestion, kitchen waste and agricultural waste can be transformed into renewable biogas, a sustainable fuel for cooking and heating. To explore this potential, Ardu University deployed a test setup in Kijimi, a rural ward in Tanzania. Figure 1 illustrates this test site. Figure 2 shows the digester at this test site.



Figure 1: The biogas test site



Figure 2: Digester

METHOD

To design this biogas purification and compression system, several steps were taken:

- Literature review**: Identified the most promising CO₂ removal and H₂S-scrubbing techniques under local conditions.
- Small-scale testing**: Tested and compared two CO₂ removal processes and four H₂S absorbents.
- Kijimi setup & validation**: Implemented the most suitable CO₂ removal process and H₂S absorbent at the Kijimi test site, and supplied a sustainable, independent power supply.
- Techno-economical analysis**: Evaluated the technical viability of the setup and compared it with a larger scale implementation and the other traditional fuel sources.
- Conclusion & recommendations**

PROBLEM DEFINITION

The current setup produces a low-pressure, unpurified biogas. Due to the low methane concentration and the presence of impurities, visible in Table 1, combustion is inefficient, making it difficult to generate enough heat for cooking. Additionally, the low pressure complicates storage and transport, limiting the practical usability of the gas.

Component	Symbol	Concentration (Vol %)
Methane	CH ₄	55-65
Carbon Dioxide	CO ₂	35-45
Water	H ₂ O	2-7
Hydrogen sulphide	H ₂ S	20-2000ppm (2%)

OBJECTIVE

The aim of this master's thesis is twofold: designing and implement an installation that purifies and compresses the biogas. The final product should reach at least 75% methane to ensure efficient combustion and reduce H₂S levels to below 5 ppm to ensure safety. The biogas should be pressurized to 8 bar to facilitate transportation.

UNIVERSITY SETUP

A test setup was constructed at Ardu University (Figure 3) to evaluate suitable purification methods under local conditions. Firstly, two CO₂ removal techniques were compared:

- absorption using calcium hydroxide (Ca(OH)₂),
- water scrubbing.

Secondly, for H₂S removal, four locally available adsorbents were tested:

- iron wool,
- rusted iron-wool,
- granulated iron-oxide (Fe₃O₄),
- activated carbon.

Finally, to ensure longevity of the project, manuals and guide videos were made.

PURIFICATION

Firstly, the H₂S removal techniques were tested. H₂S removal is important to improve safety and prevent corrosion of the downstream components. The tested absorbents react with the H₂S, removing it from the biogas.

Table 2 illustrates the results from the H₂S removal test. The untreated biogas had 795 ppm H₂S. The granular Fe₃O₄ reached the highest removal, achieving 3 ppm. The more cost-effective rusted steel wool also performed well, reducing the H₂S concentration to 7 ppm.

Secondly, the CO₂ removal techniques were evaluated. In the water scrubbing process, water flows counter-current to biogas, allowing CO₂ to dissolve into the liquid phase. The removal efficiency proved pressure dependent, negligible in the beginning and rising as the pressure rises. However, the systems water pump failed at approximately 5 bar, unable to achieve the 8 bar. The results are illustrated in Figure 4.

The absorption tests, where Ca(OH)₂ reacts with the CO₂ to form CaCO₃, showed more stable results. It reached 8 bar while maintaining consistent removal efficiency.

ECONOMICAL ANALYSIS

In addition to the small-scale setup, a large-scale biogas setup was also evaluated. An economic analysis was done on both setups, determine the selling price if no profit would be made. These prices were compared to the levelized cost of energy (LCOE) of other traditional fuels in Figure 5.

Small-scale biogas purification results in a high LCOE of 1,508 TZS/kWh, making it economically unfeasible in comparison to other fuels. It would have a total discounted cost of ownership of TZS 2,822,433, with a capital cost of TZS 2,144,500 and an annual TZS 80,526 maintenance cost. In contrast, the large-scale setup, capable of processing 6,500 L of unpurified biogas per day, achieves a much lower LCOE of 233 TZS/kWh. This cost is lower than the cost of LPG at 270 TZS/kWh, underscoring the critical impact of scale on cost efficiency.

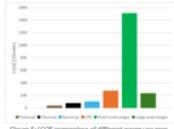


Figure 5: LCOE comparison of different energy sources

CONCLUSION

Ca(OH)₂ absorption and rusted steel wool scrubbing were found most optimal for the local Kijimi situation, reducing H₂S from 795 ppm to 3 ppm, and boosting methane purity to 85%. Distribution is achieved by a compressor effectively compressing the biogas to 8 bar.

Considering economic viability, the small-scale system has an LCOE of 1,581 TZS/kWh, scaling to 6,500 L/day lowers LCOE to 145 TZS/kWh. This signifies the importance of scale and community cooperation.



Figure 3: The university setup



Figure 6: The biogas setup

Supervisors / Co-supervisors / Advisors

Prof. dr. ir. Wim Deferme
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Dr. Emmanuel Nsekela

[1] Y. Wang, C. Hu, L. Li, A. Guler, S. Diner and C. Zurbrugg, Anaerobic Digestion of Biomass in Developing Countries, Elsevier, E. Energy, 2014.

[2] S. Ludwig, K. Christoffer and K. Akwa, Improved Biogas Unit for Suburban, Deutsche Zentrum für Technische Zusammenarbeit, 2010.

[3] E. C. Betsab, Technical evaluation and classification of biogas plants in Ghana, Karami, Karami Nuraiah University of Science and Technology, 2009.






sharing minds, changing lives




20




Deel 1: Productie van biogas

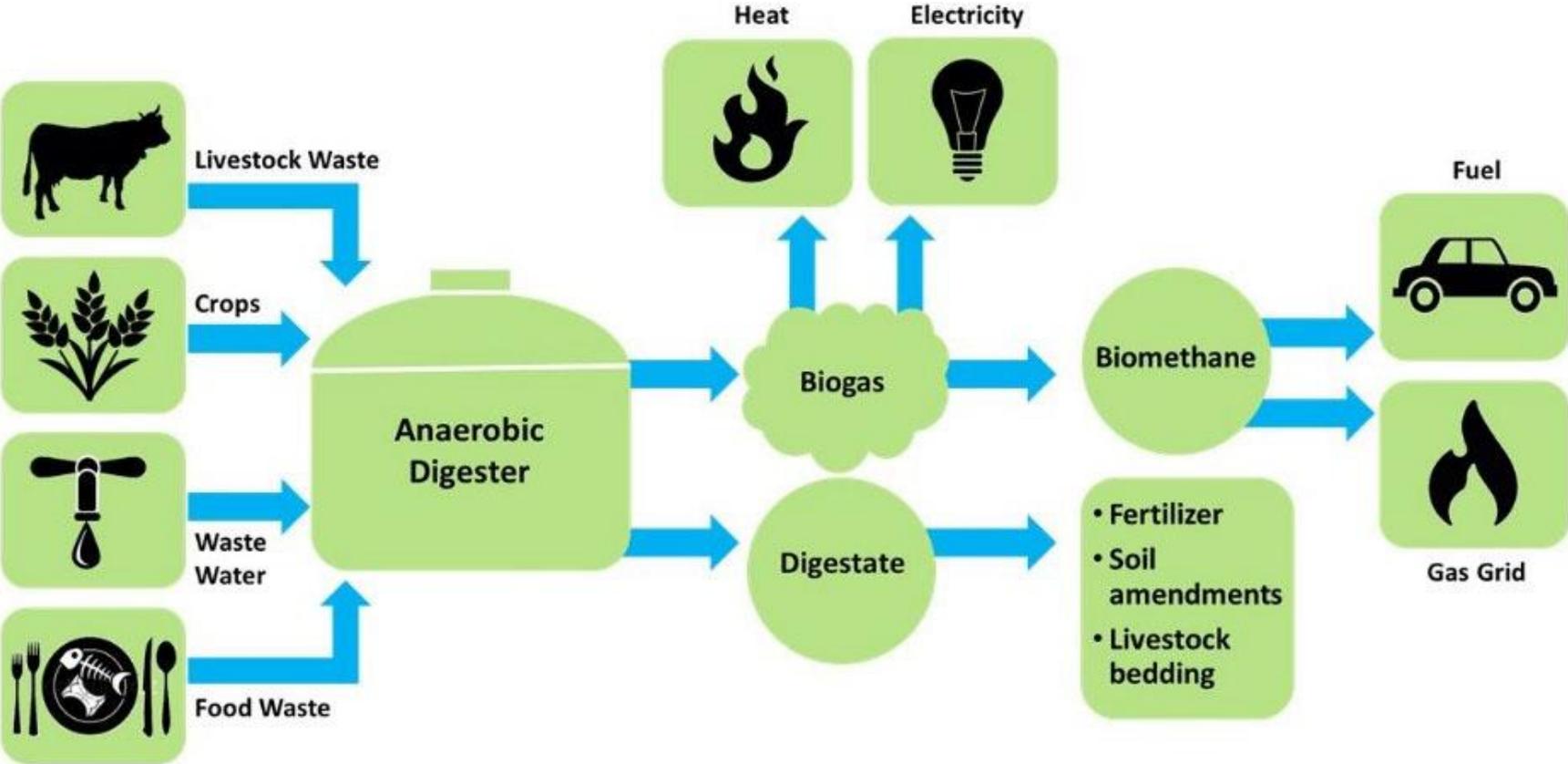
Introductie: Kenia



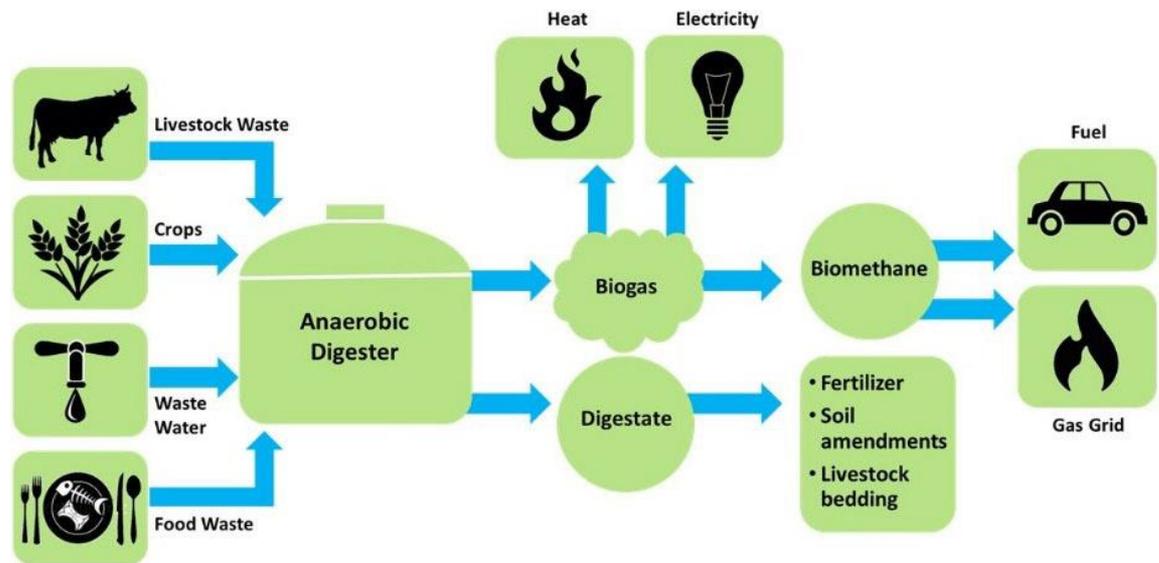
Hoe wordt biogas gemaakt?



Process biogas



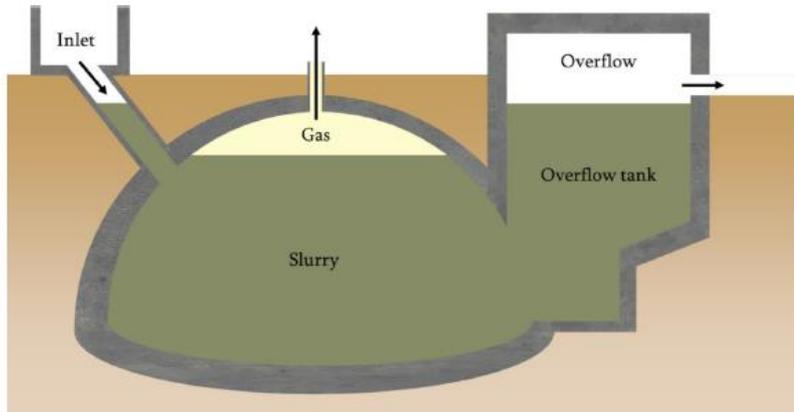
Welk soort afval is het meest geschikt voor de productie van biogas?



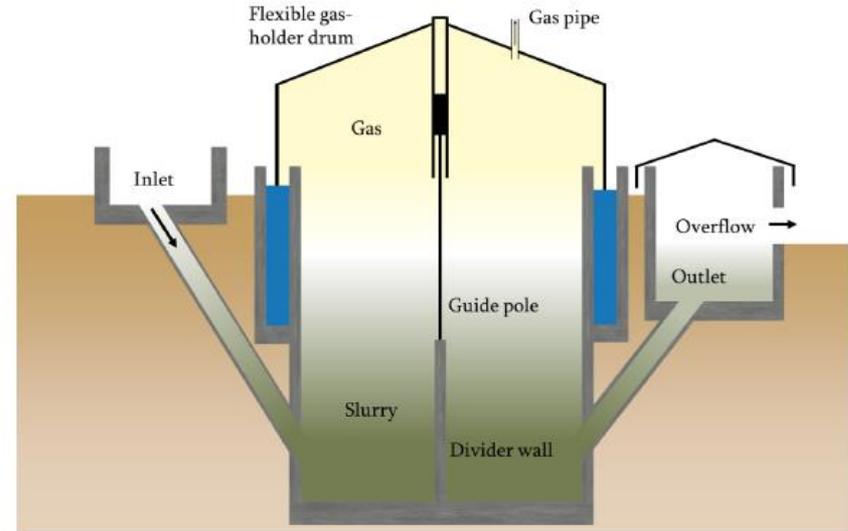
Meest geschikte afval voor biogas

Substrate	Methane Yield (L / kg VS)
Palm oil mill waste	610
Municipal solid waste	360–530
Fruit and vegetable wastes	420
Food waste	396
Rice straw	350
Household waste	350
Swine manure	337
Maize silage and straw	312
Food waste leachate	294
Lignin-rich organic waste	200

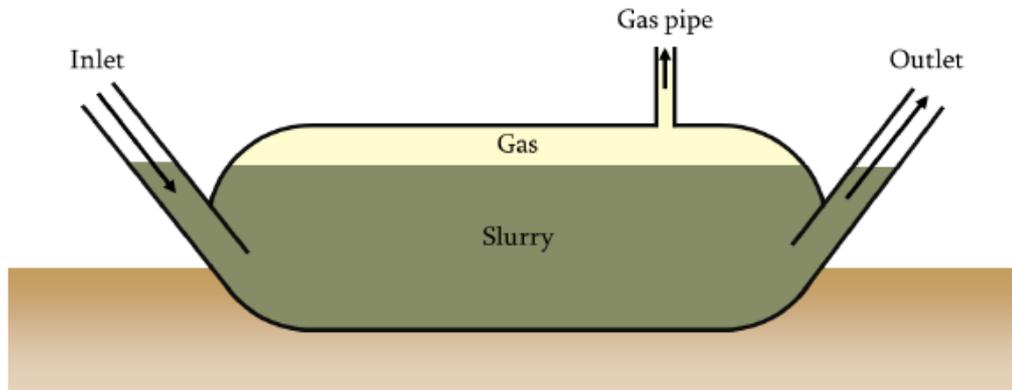
Keuze van de opstelling



Fixed dome opstelling



Floating drum opstelling



Fixed dome opstelling

Uiteindelijke keuze: hybride instalatie

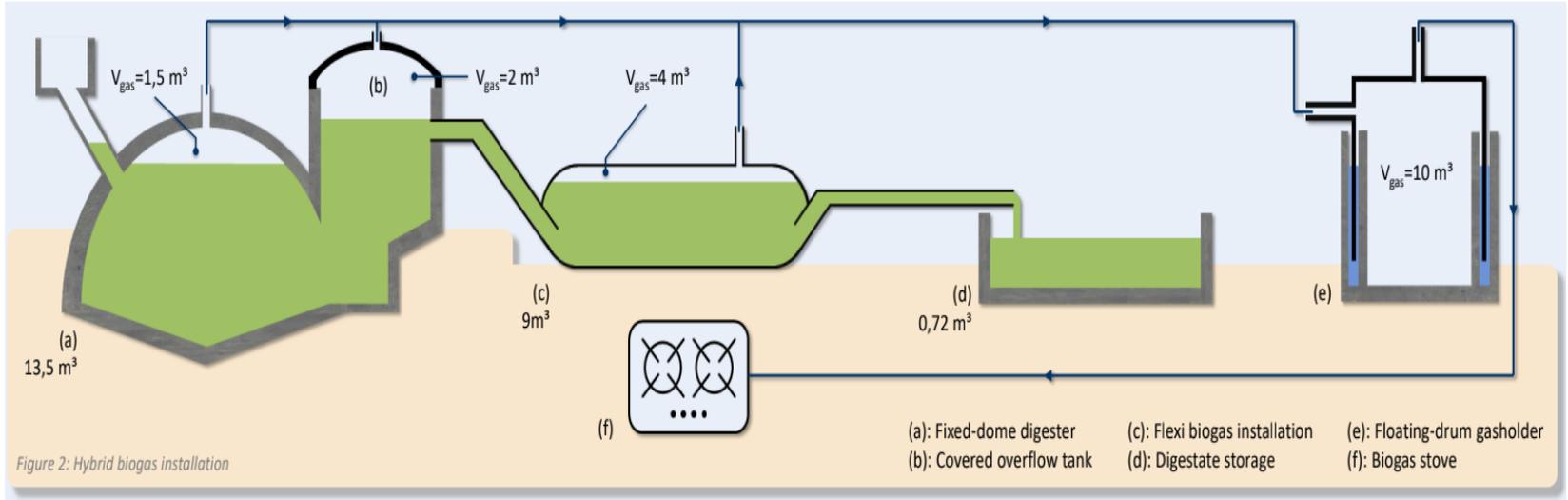
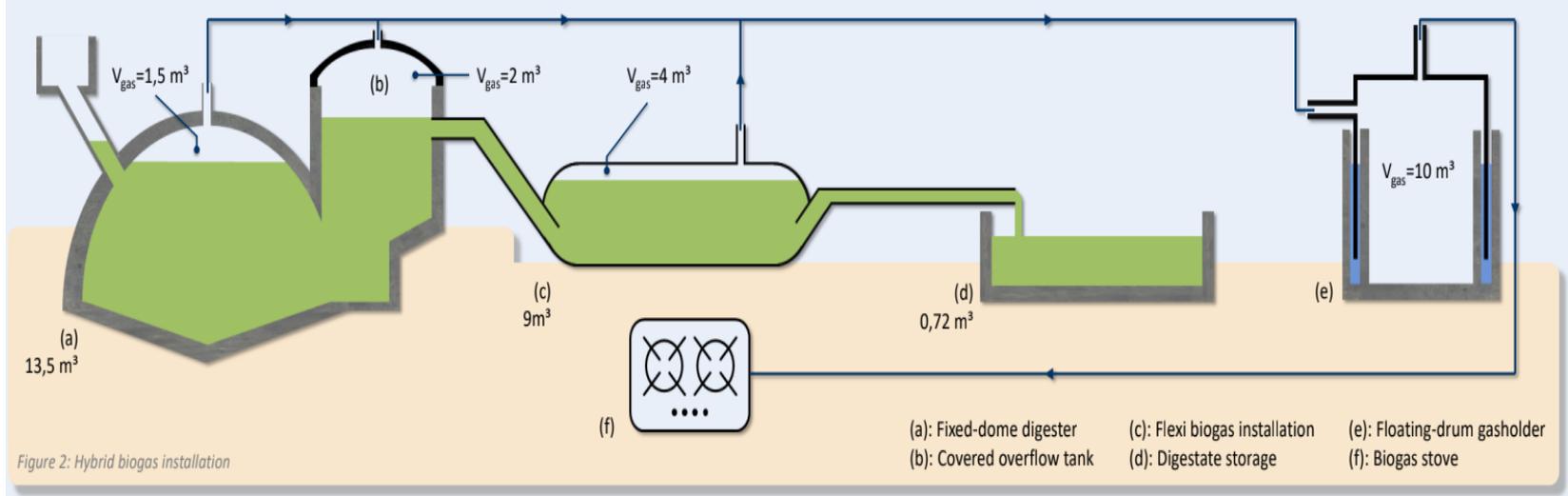


Figure 3: Fixed-dome digester, overflow tank and inlet reservoir

Wat is de beste temperatuur om biogas te maken?



Uiteindelijke keuze: hybride installatie

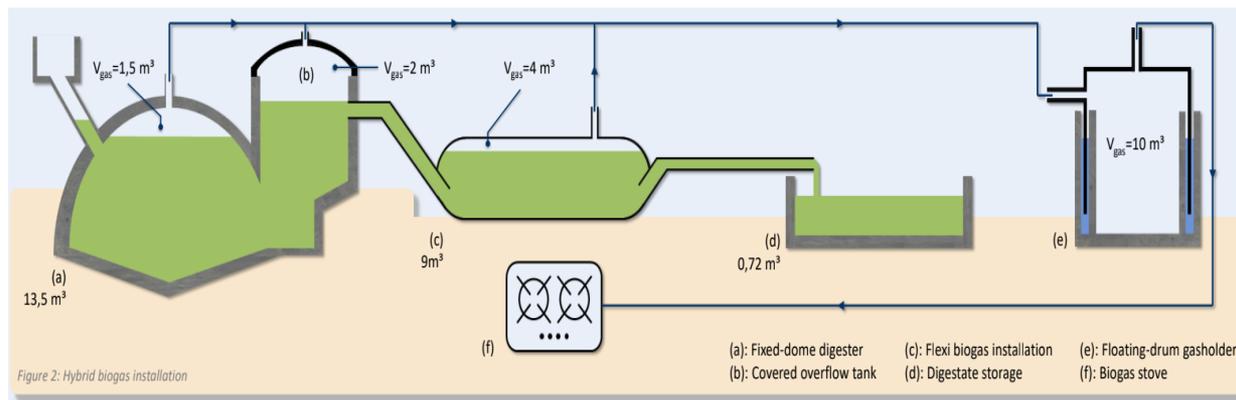
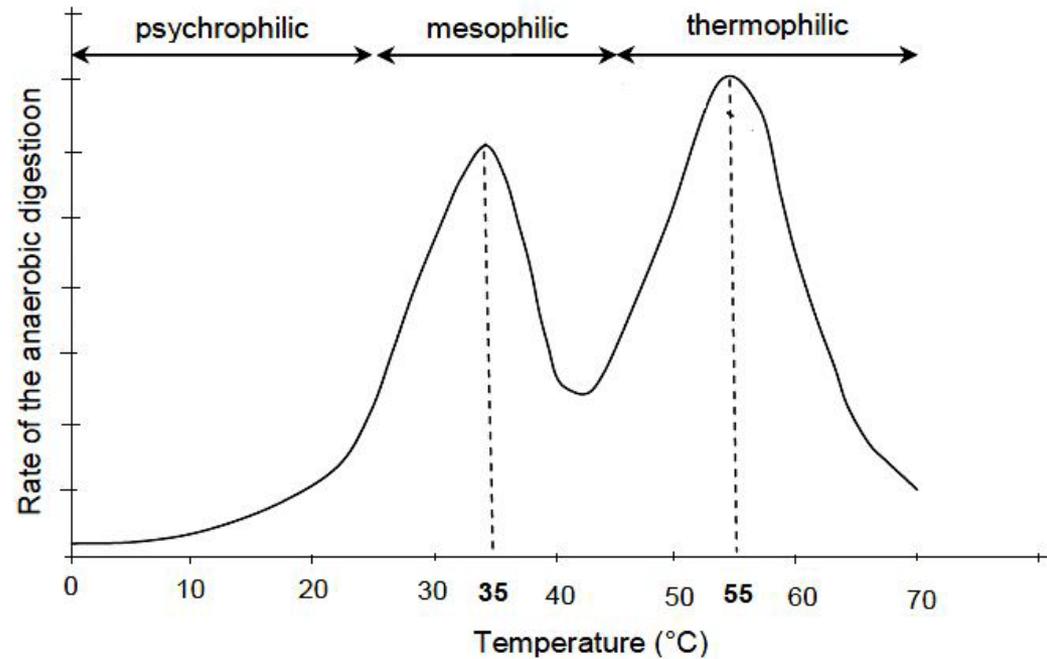
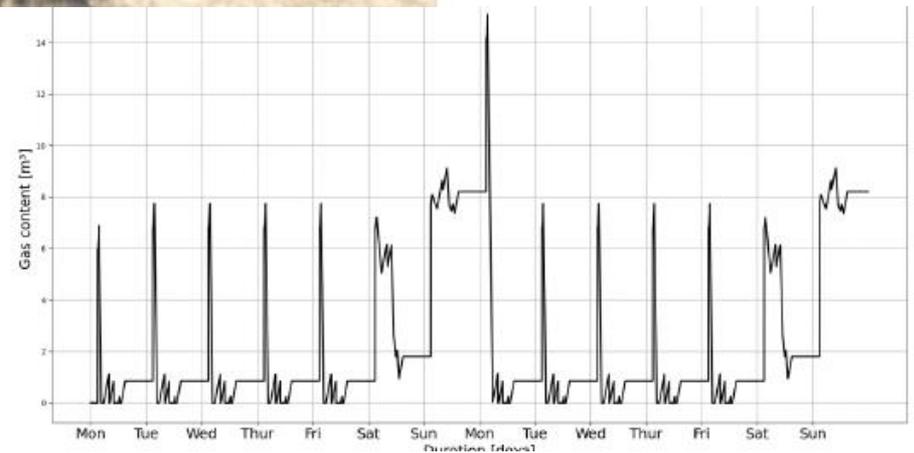


Figure 2: Hybrid biogas installation

Finale opstelling & conclusie



Deel 2: Verwerking van biogas

ing. Kenneth DRIES
ing. Louis MACOURS

Introductie



Figure 1: Afvalsite van het project





Vergister in Kimbiji site



↓ Anaerobe vergisting

Component	Symbol	Concentration (Vol-%)
Methane	CH_4	55-65
Carbon Dioxide	CO_2	35-45
Water	H_2O	2-7
Hydrogen sulphide	H_2S	20-20000ppm (2%)
Nitrogen	N_2	<2
Oxygen	O_2	<2
Hydrogen	H_2	<1
Ammonia	NH_3	<0,05

Welk gas is het belangrijkste onderdeel van biogas?



Component	Symbol	Concentration (Vol-%)
Methane	CH_4	55-65
Carbon Dioxide	CO_2	35-45
Water	H_2O	2-7
Hydrogen sulphide	H_2S	20-20000ppm (2%)
Nitrogen	N_2	<2
Oxygen	O_2	<2
Hydrogen	H_2	<1
Ammonia	NH_3	<0,05

Methaan is het belangrijkste deel van biogas

Component	Symbol	Concentration (Vol-%)
Methane	CH_4	55-65
Carbon Dioxide	CO_2	35-45
Water	H_2O	2-7
Hydrogen sulphide	H_2S	20-20000ppm (2%)
Nitrogen	N_2	<2
Oxygen	O_2	<2
Hydrogen	H_2	<1
Ammonia	NH_3	<0,05



Te weinig methaan

Hoeveel gas heb je nodig om 1 maaltijd te koken?



Figure 1-1: Scullery of the university



Figure 1-2: main kitchen of the university

> 100l biogas per maaltijd

Fuel Source	Calorific Value	Equivalent to 1 m ³ Biogas (approx. 6.0-6.5 kWh/m ³)
Biogas	6-6.5 kWh/m ³	
Propane	25 kWh/m ³	0.24 m ³
Natural gas	10.6 kWh/m ³	0.60 m ³
Liquefied petroleum gas	26.1 kWh/m ³	0.20 m ³
Diesel, Kerosine	12 kWh/kg	0.50 kg
Wood	4.5 kWh/kg	1.30 kg
Cow dung	5 kWh/kg dry matter	1.20 kg
Plant residues	4.5 kWh/kg dry matter	1.30 kg
Hard coal	8.5 kWh/kg	0.70 kg



Lage druk



Methodology

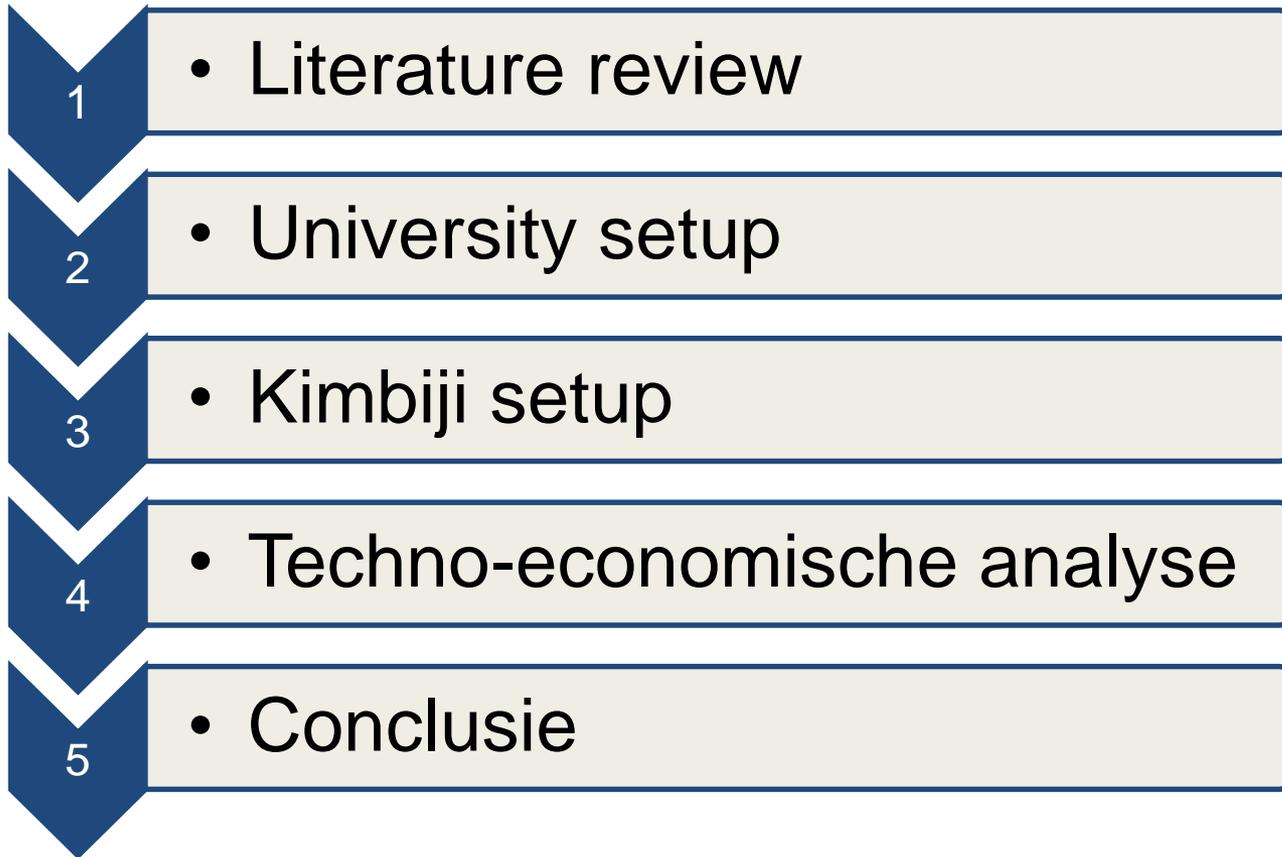


Figure 6: University digester



Figure 7: Kimbiji digester

Concept objective



Figure 8: Distribution

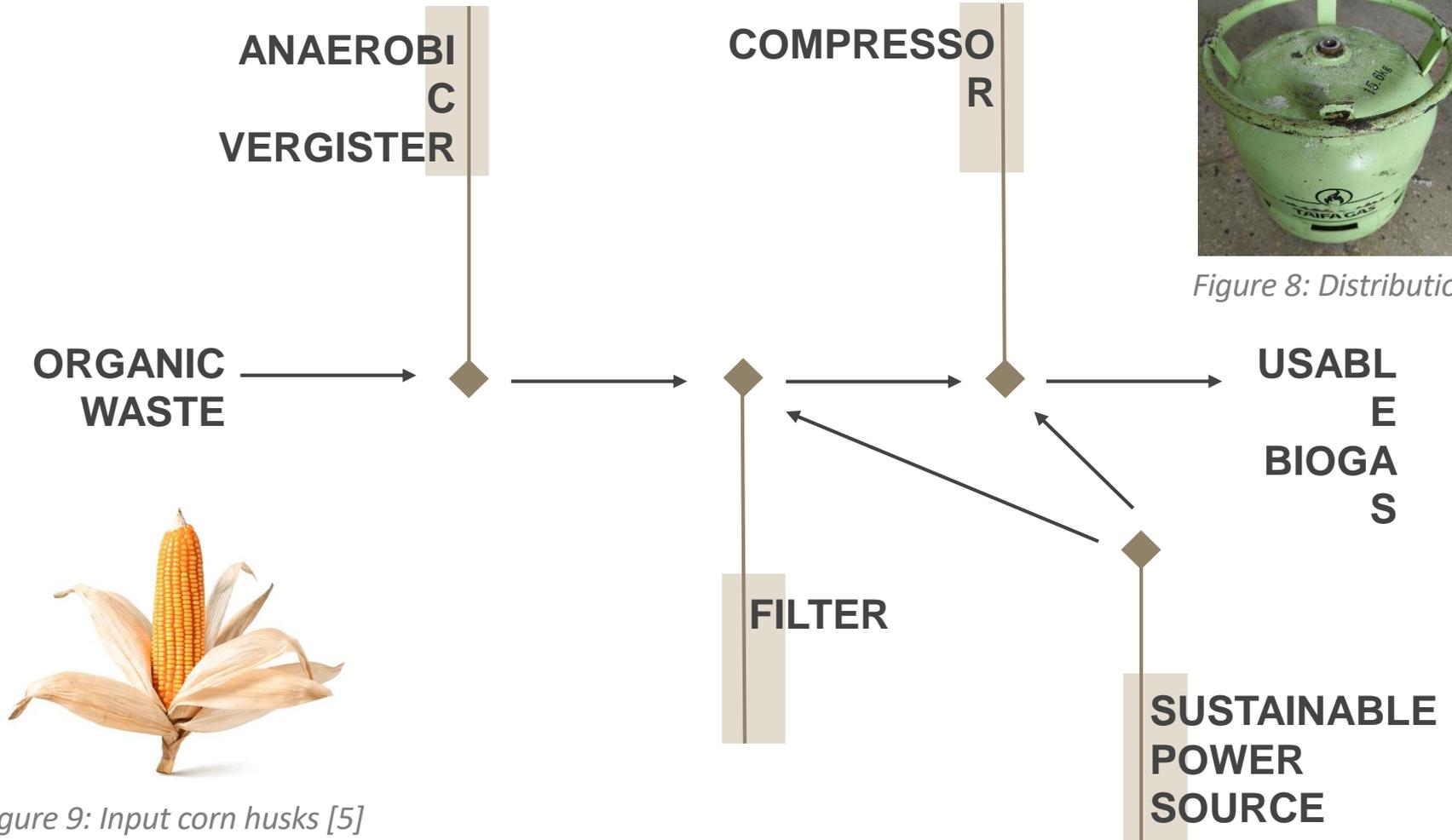


Figure 9: Input corn husks [5]

University setup

De opleiding industrieel ingenieur is een gezamenlijke
opleiding van UHasselt en KU Leuven



Filtering fase: H₂S verwijdering



Figure 10: Testing setup: H₂S removal



Figure 11: Iron oxide before and after testing

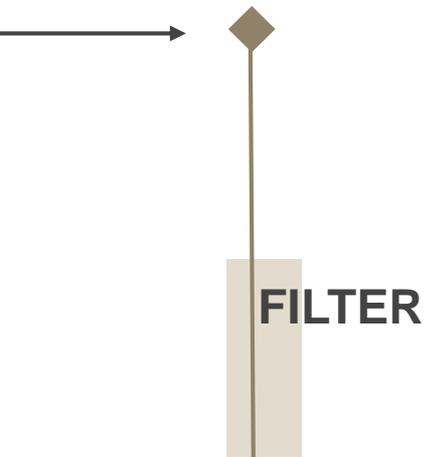


Table 3: H₂S removal using different absorbents

	H ₂ S concentration [ppm]	Needed amount [g]	Price [TZS]
Untreated Biogas	795	/	/
Steel Wool	279	40	1333
Rusted Steel Wool	11	/	/
Iron Oxide	3	1.4	9.3
Activated Carbon	7	8	280

CO2 filtering: absorption

Ca(OH)₂ absorption

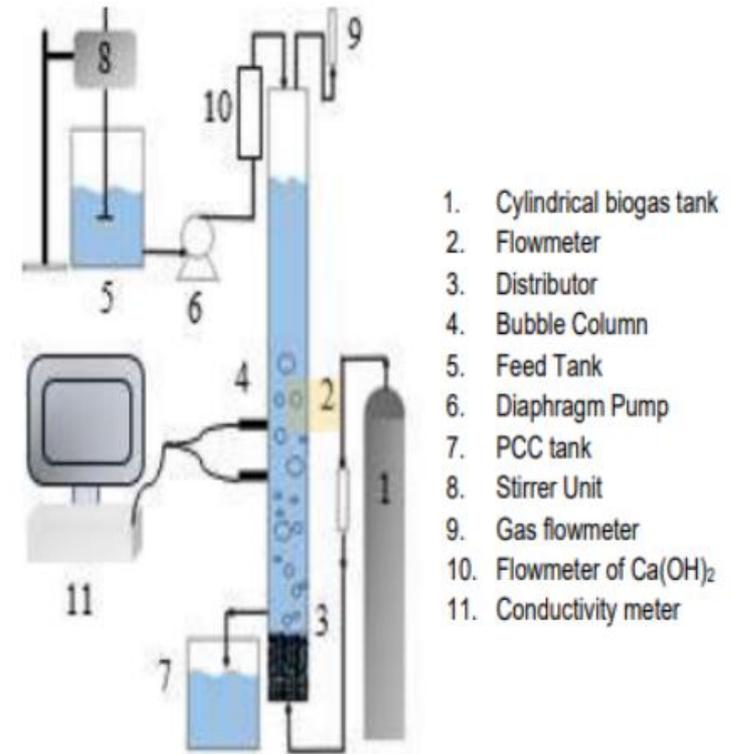
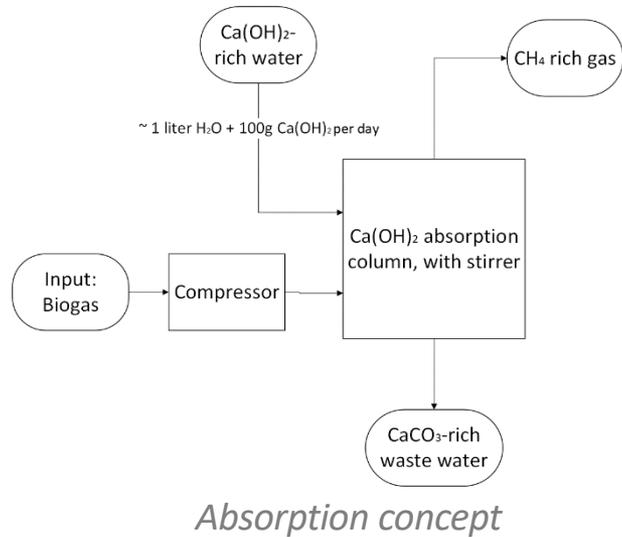


Figure 3.6: Absorption setup [113, p. 287]

input

Substance	Concentration [vol%]
CH ₄	64
CO ₂	35
O ₂	0.5
H ₂ S	705 ppm

FILTER



CO₂ verweidering: water scrubbing

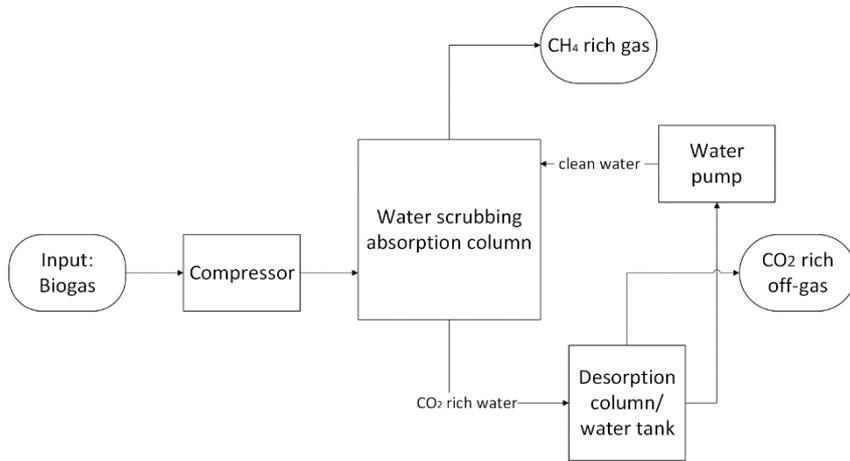
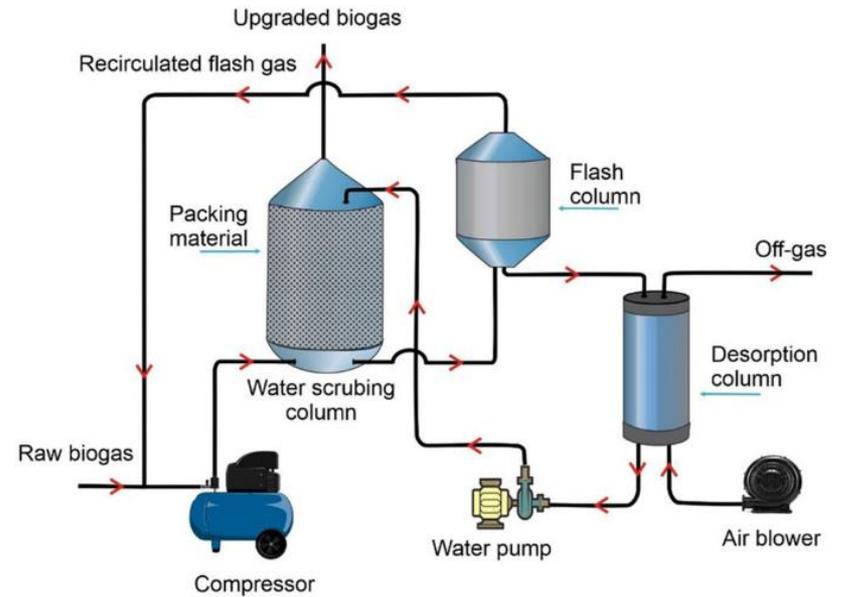


Figure 13: Water scrubbing concept



FILTER

Input

Substance	Concentration [vol%]
CH ₄	64
CO ₂	35
O ₂	0.5
H ₂ S	705 ppm

Test opstelling

Input

Substance	Concentration [vol%]
CH_4	64
CO_2	35
O_2	0.5
H_2S	705 ppm



FILTER



Filtering phase: CO₂ removal

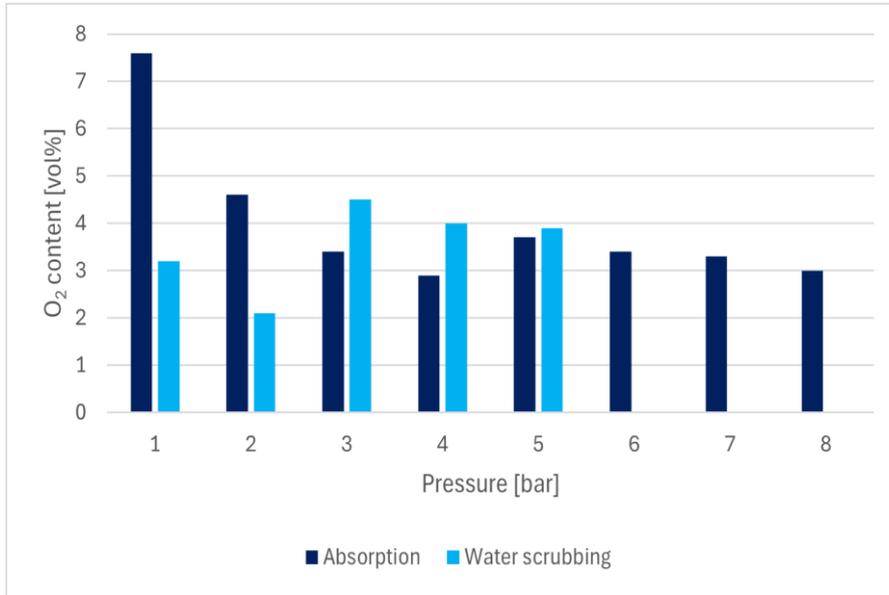


Figure 15: O₂ content in relation to the output pressure

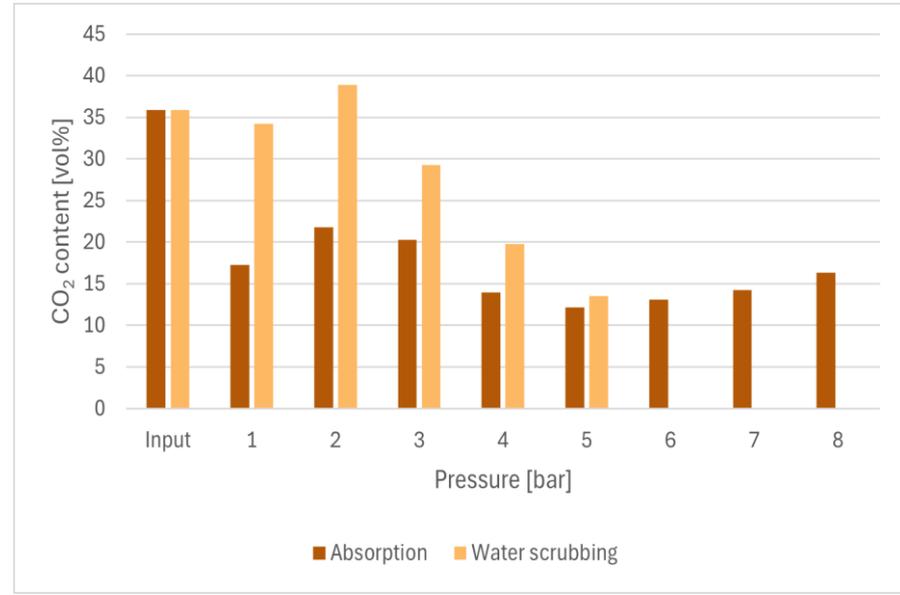


Figure 16: CO₂ content in relation to output pressure

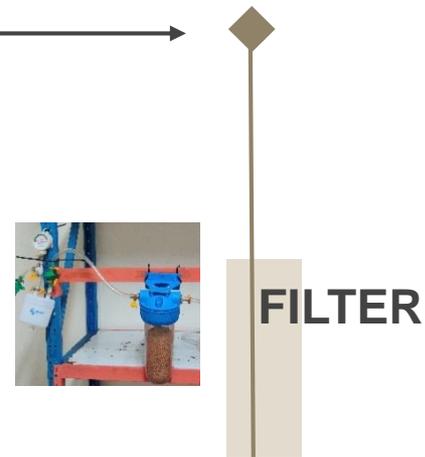


Figure 17: Testing setup

Compression & storage

COMPRESSOR



Figure 18: Refrigerant compressor

USABLE
BIOGAS

FILTER



Figure 19: Biogas used for cooking



Complete university setup

COMPRESSOR



USABLE
BIOGAS

FILTER

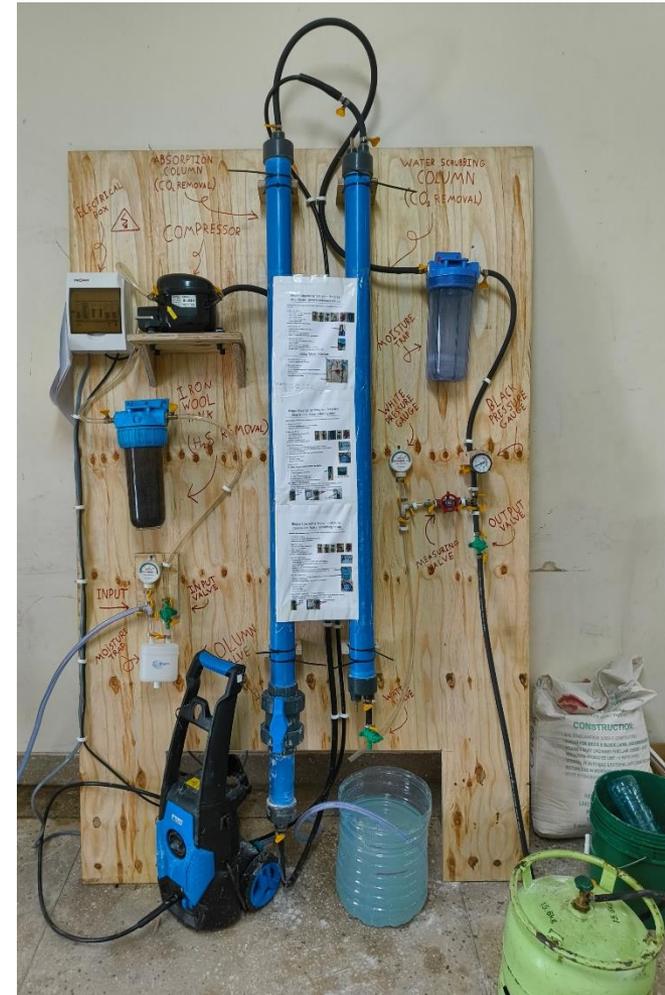


Figure 20: Complete university setup

Kimbiji setup

De opleiding industrieel ingenieur is een gezamenlijke
opleiding van UHasselt en KU Leuven



Solar energy supply

Table 5: Direct normal irradiation in Kimbiji [5]

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0 - 1												
1 - 2												
2 - 3												
3 - 4												
4 - 5												
5 - 6												
6 - 7	9	1		7	5	2		4	11	57	82	50
7 - 8	156	148	201	204	193	179	154	197	238	314	327	279
8 - 9	270	285	349	330	327	329	309	346	366	433	429	373
9 - 10	377	413	423	373	374	400	368	408	469	557	529	457
10 - 11	456	469	470	413	423	455	430	483	573	616	610	530
11 - 12	512	527	502	432	452	488	457	528	624	661	658	581
12 - 13	537	562	520	434	442	492	461	540	636	666	667	612
13 - 14	553	579	536	422	426	479	456	536	641	678	657	615
14 - 15	556	582	546	415	416	455	455	526	627	655	634	613
15 - 16	518	537	531	386	370	419	416	480	566	585	569	553
16 - 17	430	451	426	322	308	343	340	403	458	467	458	453
17 - 18	295	316	260	187	164	178	191	237	250	229	253	273
18 - 19	51	48	13					8	2		1	13
19 - 20												



Figure 21: Solar panels mounted on roof



Figure 22: Electricity box

Final setup



Figure 23: Complete Kimbiji setup

Table 6: Initial and final biogas composition

	Initial composition [vol%]	Final composition [vol%]
CH_4	65	82
CO_2	33	16
O_2	0.5	0.6
H_2S	277 ppm	2 ppm

Proposed large-scale setup

- 210 kg of organic waste per day
- Daily biogas production of 6,500 L

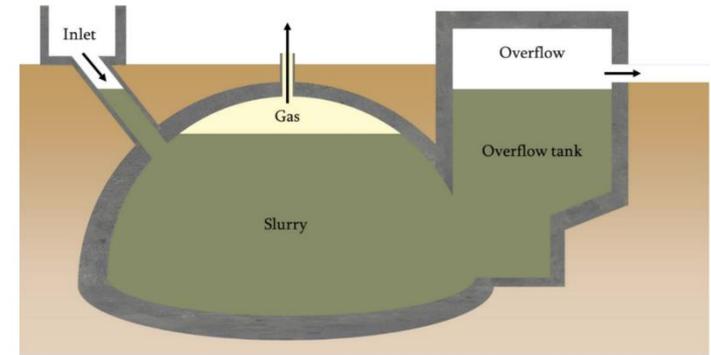


Figure 24: Fixed dome digester [3]



Figure 25: The full Kimbiji site

Proposed large-scale setup

- 210 kg of organic waste per day
- Daily biogas production of 6,500 L

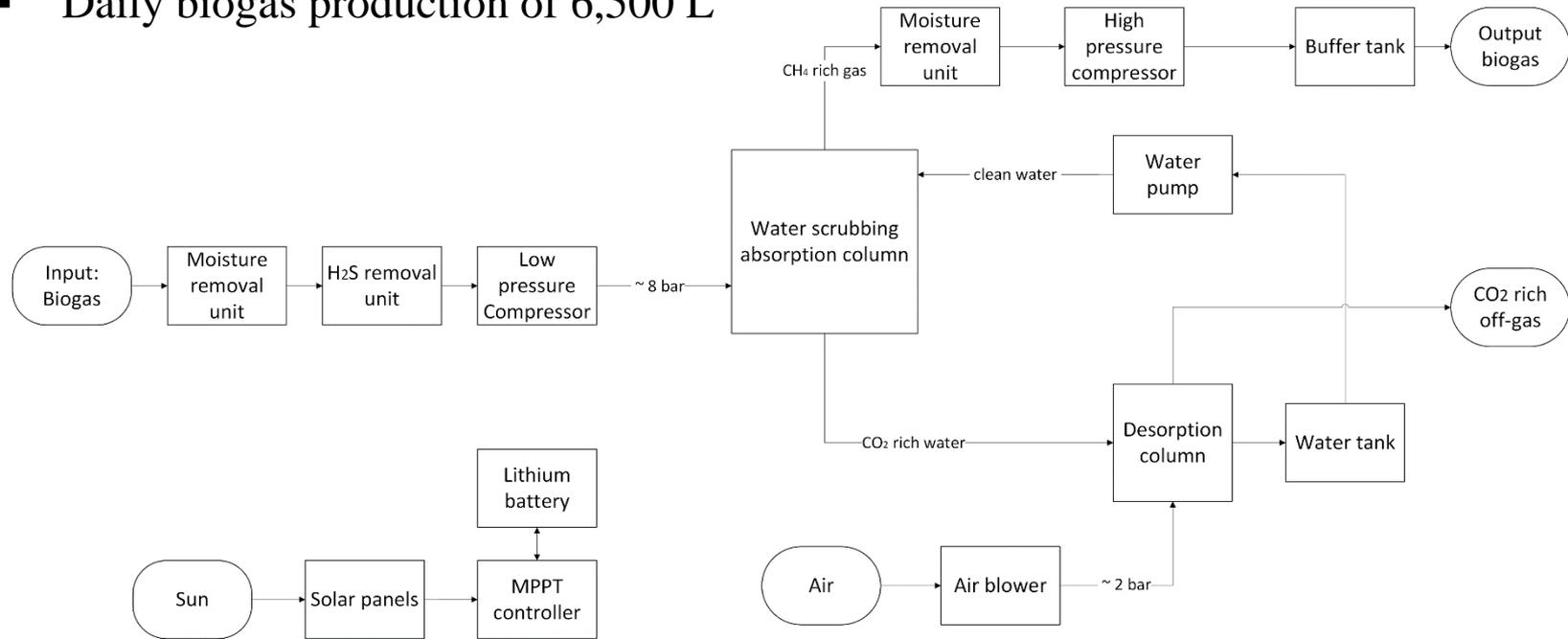


Figure 26: Complete Kimbiji setup

Techno-economische analyse

De opleiding industrieel ingenieur is een gezamenlijke
opleiding van UHasselt en KU Leuven



Levelized cost of energy comparison

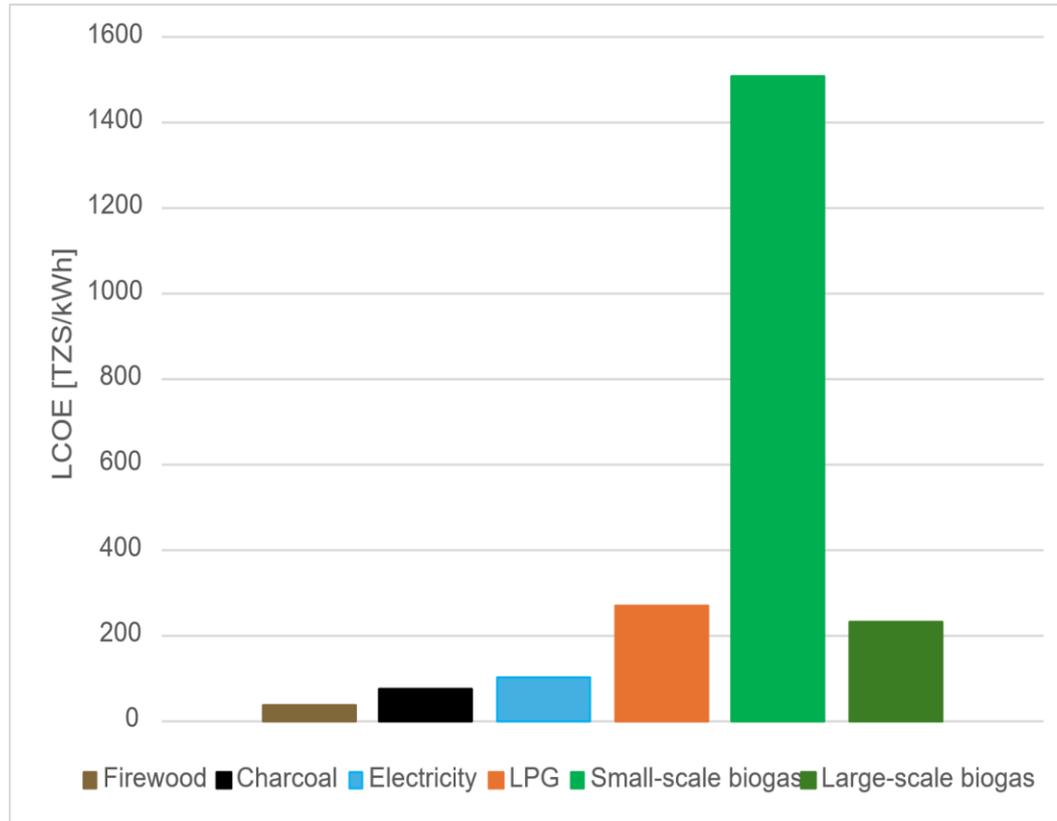


Figure 31: Levelized cost of energy of different energy sources excluding burner efficiency

Levelized cost of energy comparison

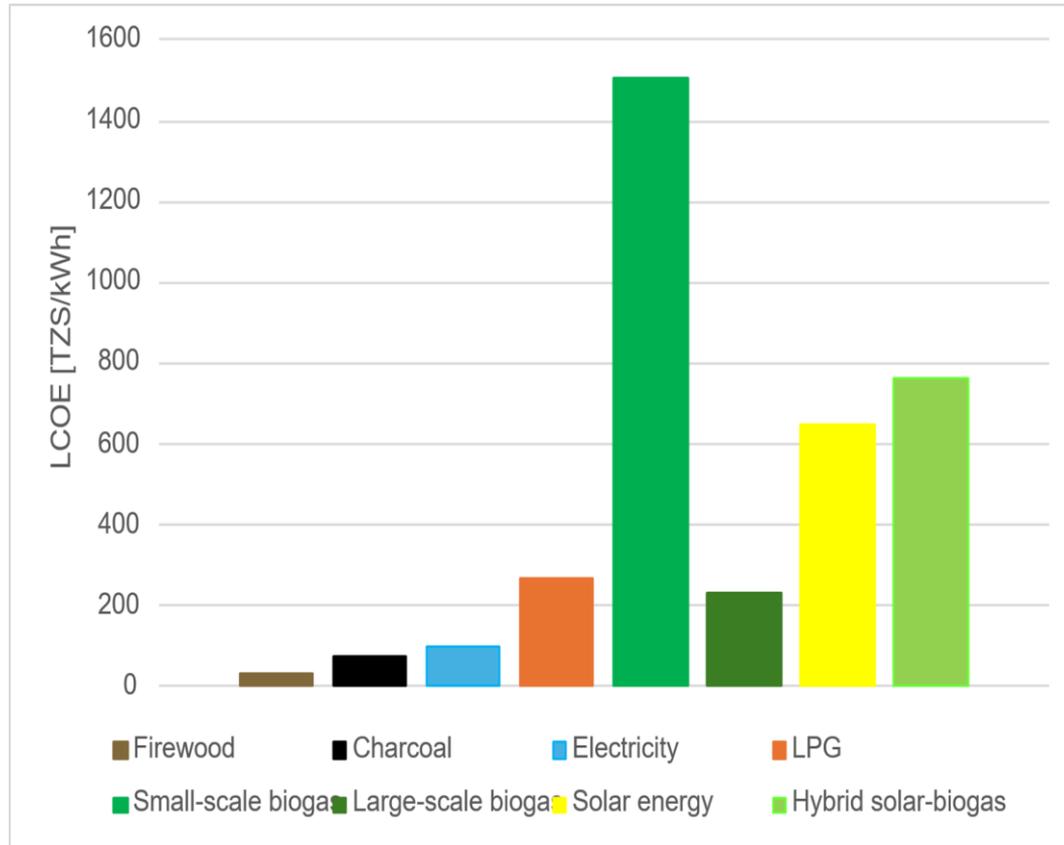


Figure 32: Levelized cost of energy of different energy sources excluding burner efficiency

Levelized cost of energy comparison

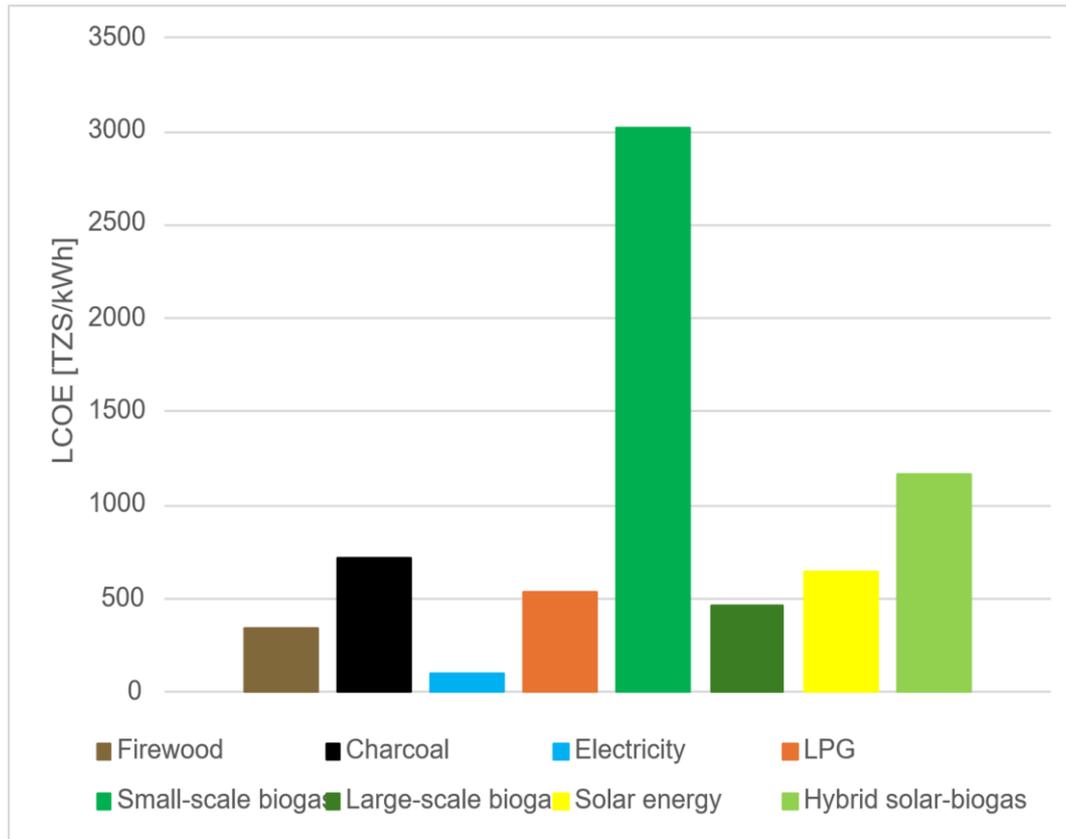
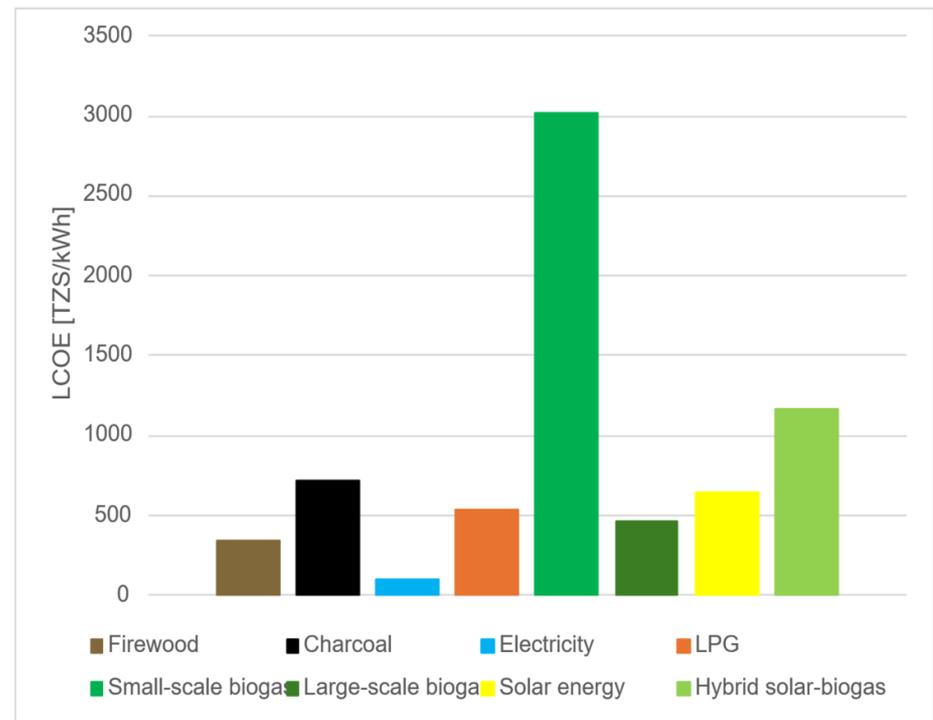


Figure 33: Levelized cost of energy of different energy sources including burner efficiency

Welke factoren beïnvloeden de prijs van biogas het meest?



Small-scale setup

- Biogas productie: 100 L/ dag
- LCOE of TZS 1,572 /kWh (EUR 0,52 /kWh)

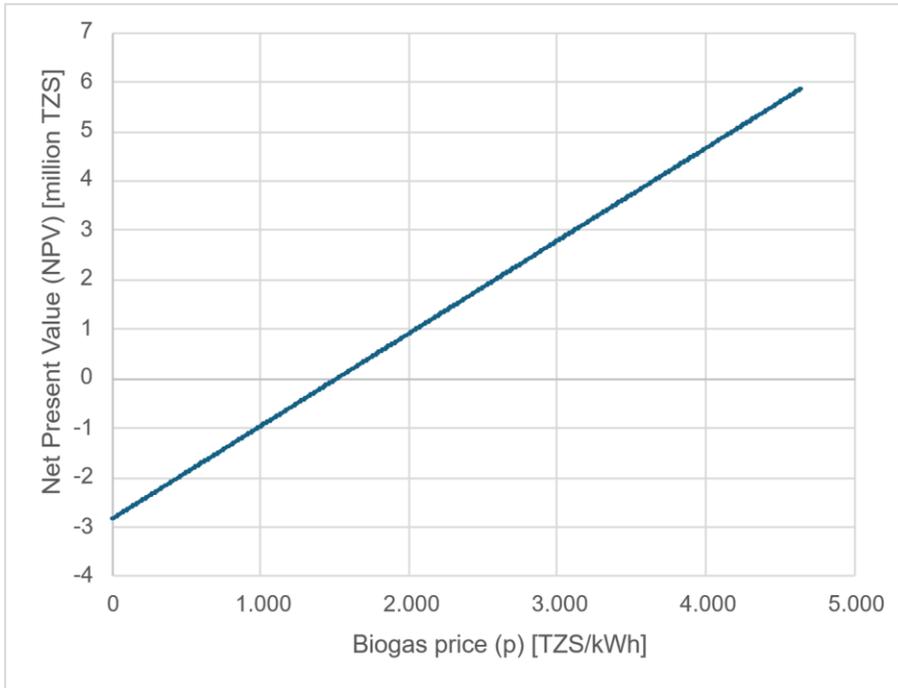


Figure 27: Net present value varying over small-scale biogas pricing

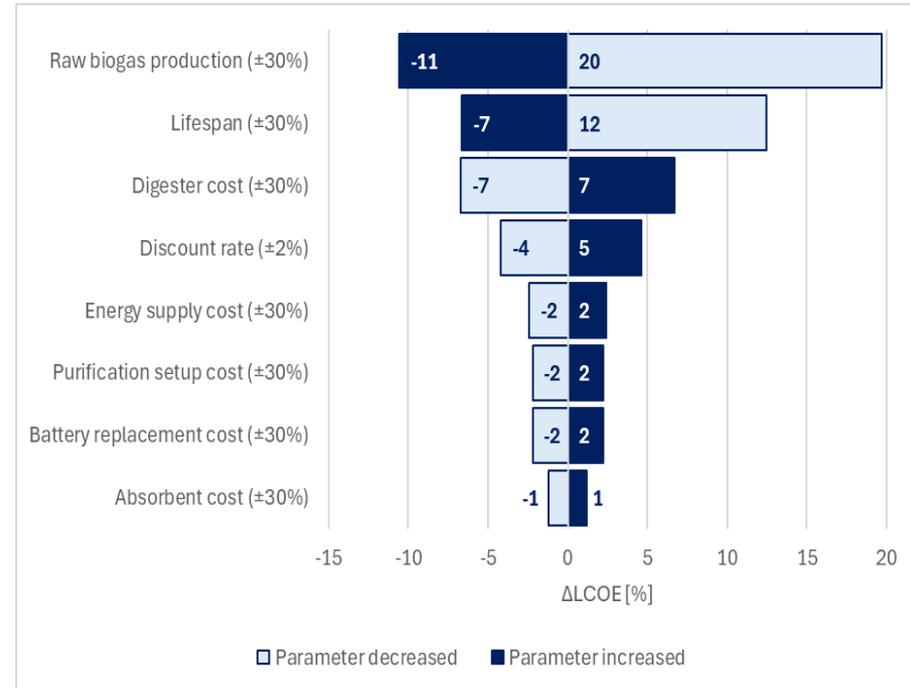


Figure 28: Sensitivity analysis of the small-scale setup

Large-scale setup

- Biogas productie: 6 500 L
- LCOE of TZS 241 /kWh (EUR 0,08 /kWh)

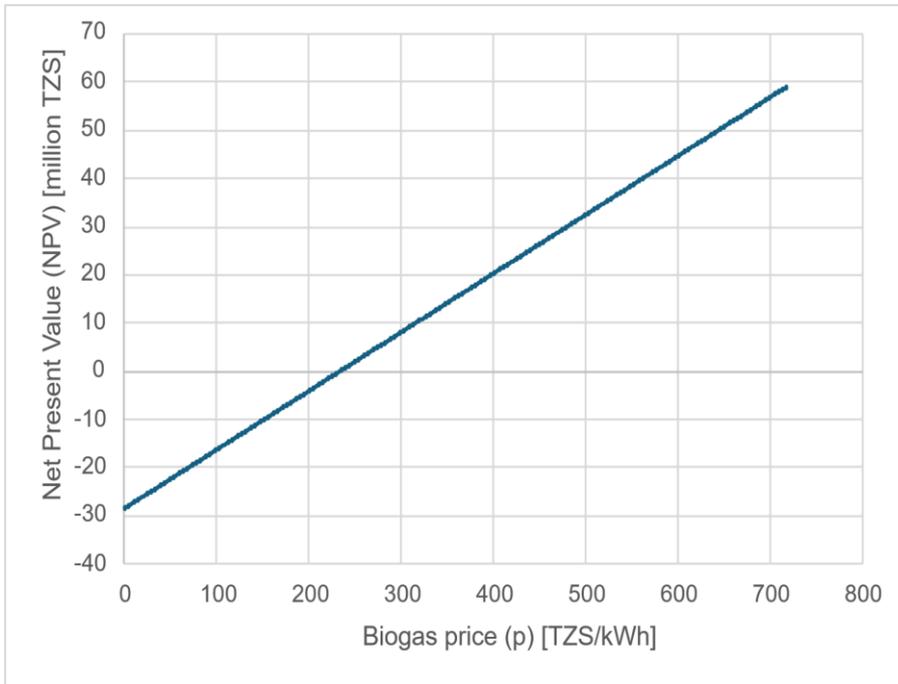


Figure 29: Net present value varying large-scale biogas pricing

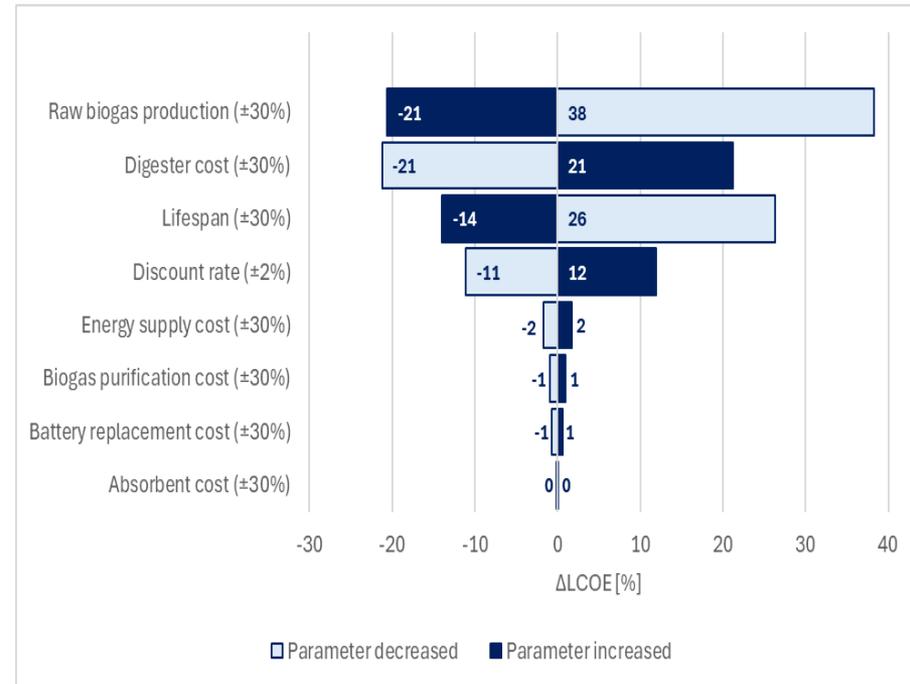
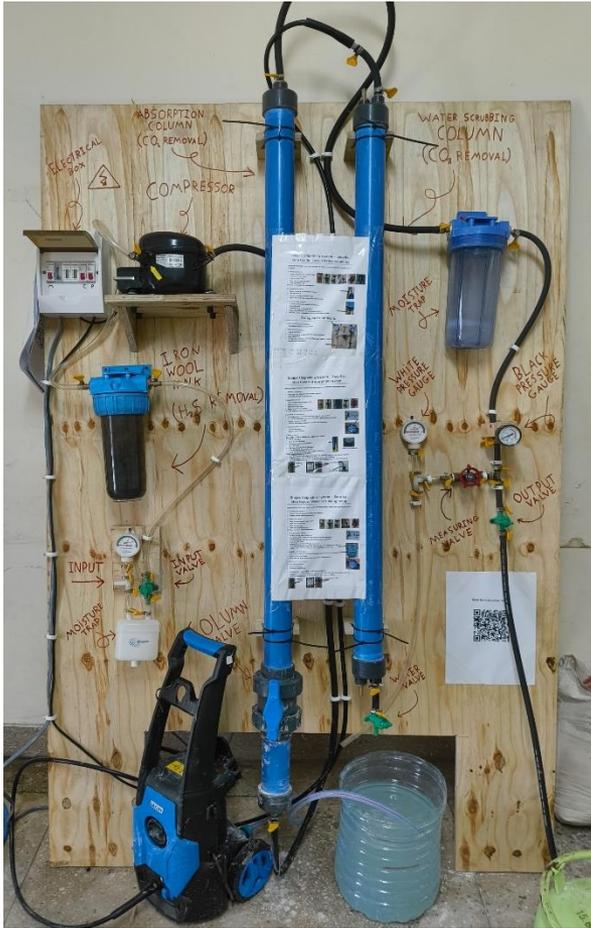


Figure 30: Sensitivity analysis of the large-scale setup

conclusie

- H₂S verwijdering: rusted steel wool
- CO₂ verwijdering: Ca(OH)₂ absorption (small-scale), water scrubbing (large-scale)
- Kimbiji Setup: 2 ppm H₂S and 82% CH₄
- Small-scale biogas niet economisch haalbaar
- Haalbare alternatieven: larger-scale biogas of hybrid solar-biogas

Volgende stap



De Universiteit setup



De Kimbiji site

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Bedankt voor de aandacht!

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