W2GAS
Waste-To-Compost and Green Energy

CES - Technical background / Potential analysis for Austrian companies

Daniel Fleischmann, Project Manager - CES

W2GAS Event, 26th November 2020

Agenda / Table of Content

- Introduction company CES
- Technical background information
- Potential analysis for Austrian companies
- Summary

INTRODUCTION CES-CLEAN ENERGY SOLUTIONS

Company Profile & Business Units

pro DANUBE MANAGEMENT GMBH ces CLEAN ENERGY SOLUTIONS

Company Profile

- Vienna/Austria based consulting and engineering company
- Focus in general on renewable energy and energy efficiency
- Studies, design, tendering, supervision
- consultancy to the public and private sector
- Founded in 2008 by Mr. Johannes Posch and iC group
- Since 2014 independent
- ISO 9001 - quality management certified

Business Units (1/2)

Renewable energy

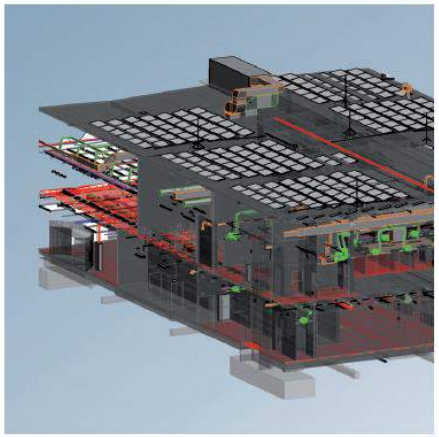
- Hydropower
- Wind power
- Biomass plants
- Geothermal energy
- Photovoltaics
- Solar thermal energy
- Biogas

Energy efficiency and management

- Industrial facilities (glass, paper, cement, food etc.)
- Electrical systems
- Residential and office buildings
- Public buildings
- Shopping centres
- Educational institutions and hospitals
- Urban infrastructure
- Airports

Innovative building technology

- Passive house
- Plus-energy buildings
- Autarkic energy systems
- Building management systems
- Building Information Modeling (BIM)
- Transient system simulation (TRNSYS, Energy Plus etc.)
- Indoor comfort – analysis and optimisation



Business Units (2/2)

Plant engineering

- Industrial facilities
- Biofuels
- District heating and cooling
- Cogeneration / trigeneration
- Solar cooling systems
- Thermal waste treatment
- Utilities supply and discharge
- Sewage treatment plants (industrial wastewater)

© iStock.com/kontrast-fotodesign

Sustainability

- Urban and regional development
- Resource efficiency
- Infrastructure
- Life cycle analysis
- Environmental pollutants
- Building certification systems (LEED, BREEAM, ESTIDAMA, ÖGNB, DGNB / ÖGNI, Green Building, GSAS)

© iStock.com/yogesh_more

Research and development

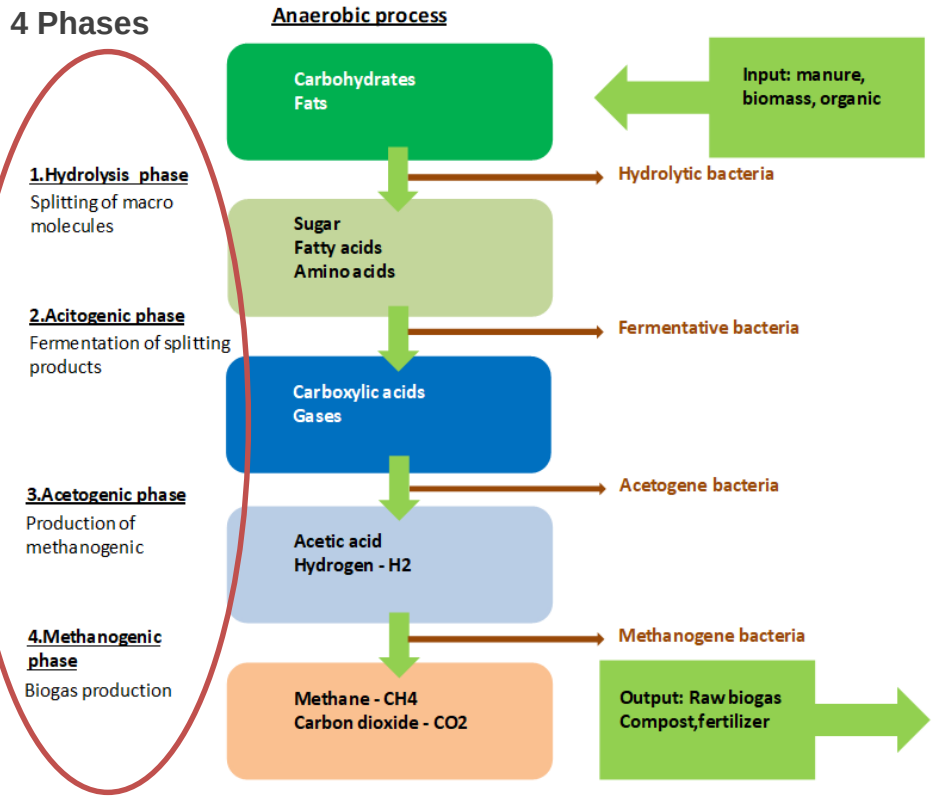
- FP7, H2020, EUREKA, FFG
- Smart City
- Bio economy
- Storage technologies (electrical / thermal / mechanical / chemical)
- Innovative Enterprise Resource Planning (ERP) systems

© iStock.com/Mlenny

TECHNICAL BACKGROUND INFORMATION

Biogas production (anaerobic)

- Anaerobic degradation process, without contribution of air
- Conversion of organic drymass of substrates into CO2 (1/3), CH4 (2/3 ~ 65%) and < 2% trace gases, lower heating value ~ 6,5kWh/m³, density ~ 0,7 – 1,2kg/m³



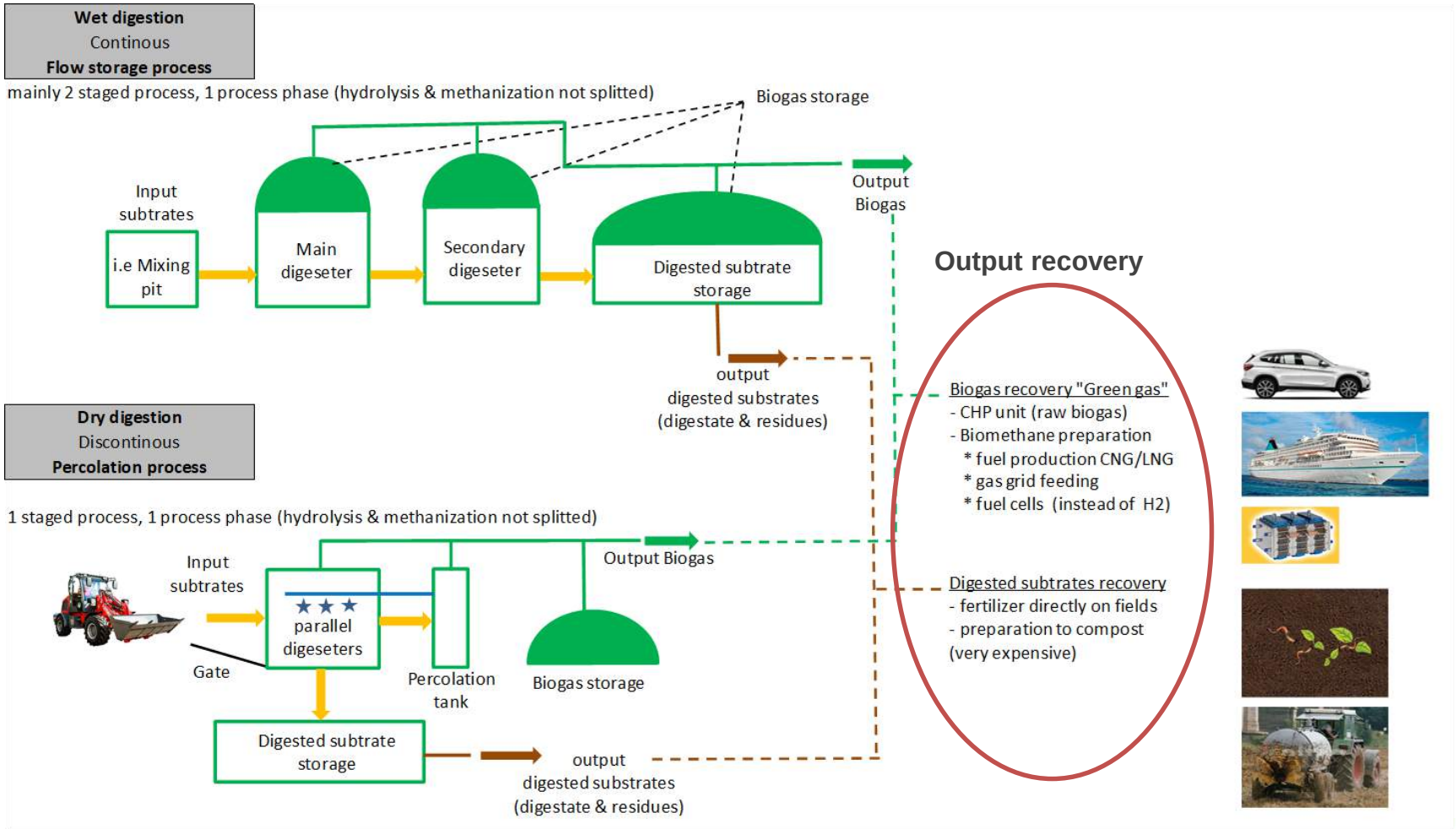
Biogas composition

Parameter	Item	Range	Unit
CH4	Methane	50-75	Vol. %
CO2	Carbon dioxide	25-50	Vol. %
H2S	Hydrogen sulphide	0-0,7	Vol. %
N2	Nitrogen (molecular)	0-0,2	Vol. %
H2	Hydrogen (molecular)	0-0,5	Vol. %
O2	Oxygen (molecular)	traces	Vol. %

Biogas plant types

- Agricultural biogas plants (ABG)
  - Main general target: energy production (electrical power/heat) & improvement of properties of digested substrates, use of harmless substrates (not contaminated) > fertilizer
  - Different plant sizes economically available from large to small scale, mainly Co-fermentation (manure/renewable resources)
  - For municipalities with enough agricultural surrounding areas (no long distances, direct use of digested output on fields)
- Mechanical biological treatment plants (MBP)
  - Main general target: Reduce organic masses in waste collection/preparation > biogas, waste treatment (sorting & screening for further usage)
  - High investment costs, complex technology and processes (waste collection, waste pre- and post-treatment, waste water- & exhaust air treatment), feasible for bigger municipalities (integration in an overall waste management system)
  - Used input substrates for anaerobic digestion (experiences) i.e. Bio wastes, green cut wastes, residual wastes

Agricultural biogas plants – typical concepts

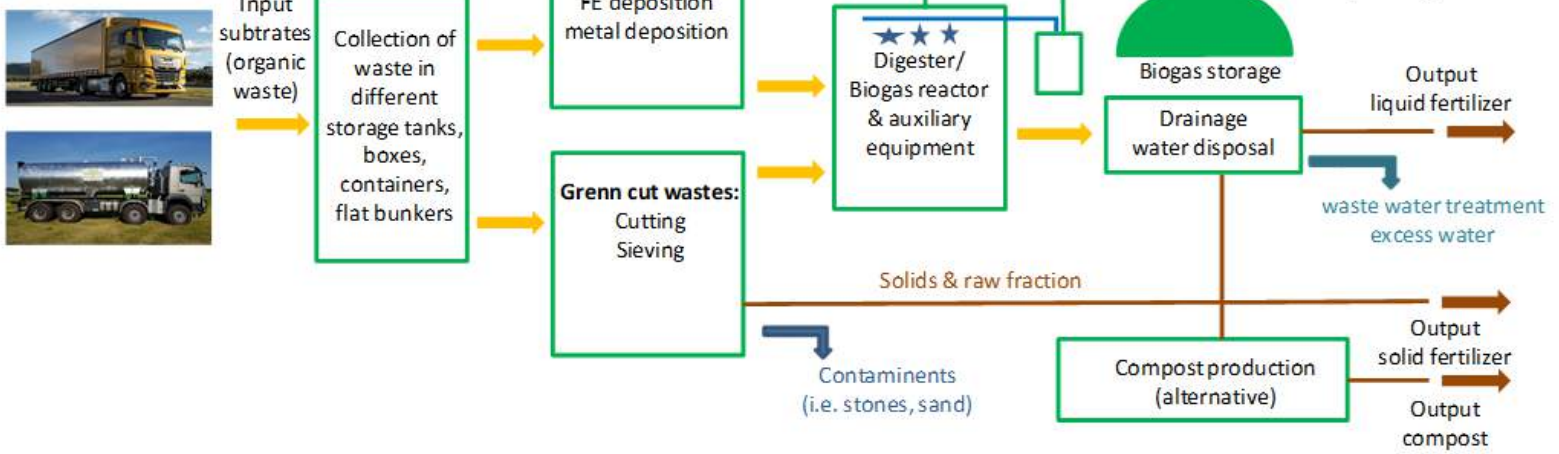


Mechanical biological treatment plants (MBP) – typical concepts

- Dry discontinuous fermentation i.e. Percolation process

Dry digestion
Discontinous
Percolation process

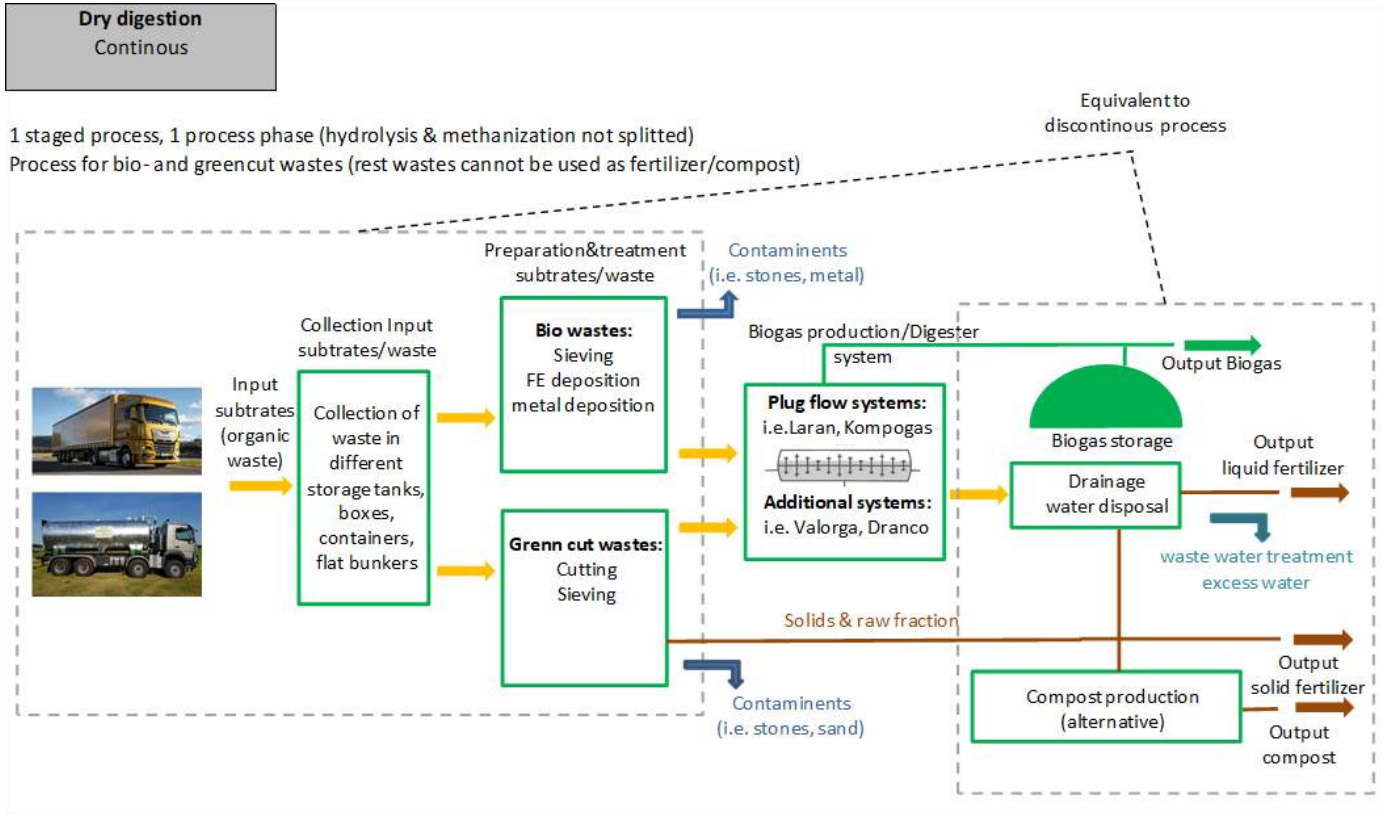
1 staged process, 1 process phase (hydrolysis & methanization not splitted)
Process for bio- and greencut wastes (rest wastes cannot be used as fertilizer/compost)



pro DANUBE MANAGEMENT GMBH ces CLEAN ENERGY SOLUTIONS

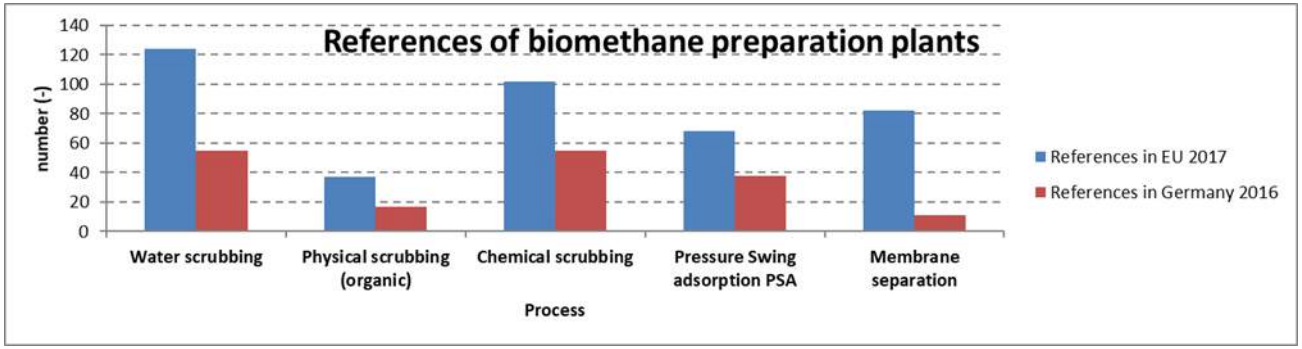
Mechanical biological treatment plants (MBP) – typical concepts

- Dry continuous fermentation (i.e. Axpo Kompogas, Laran “Strabag”, Dranco, Valorga)



“Raw biogas” to Biomethane

- Biogas treatment “Raw biogas” to Biomethane
  - Raw biogas ~ 65% methane, Biomethane > 96% methane
  - Biomethane quality to be used for:
    - Gas grid feeding, fuel substitution (CNG/LNG), fuel cells instead of hydrogen
  - Technologies:
    - Water scrubbing
    - Physical scrubbing
    - Chemical scrubbing
    - Pressure swing adsorption (PSA)
    - Membrane separation
  - References biomethane preparation plants



Biogas treatment technologies - overview

Item	Biomethan production process					Unit
	Water scrubbing	Physical scrubbing (organic)	Chemical scrubbing	Pressure Swing adsorption PSA	Membrane separation	
Process principle	physical absorption	adsorption	absorption	adsorption	adsorption	-
Typical plant capacity - Biomethane	200-1200	300-1500	400-2000	300-800	50-500	m³/h
Typical range of methane content in biomethane	95-99	95-99	> 99	95-99	95-99	vol. %
Typical methane losses - production process						
"methane slip"	1-2	2-4	< 0,1	0,6-3	< 5	vol. %
Operation pressure	4-7	4-7	no pressure	4-7	8-10	bar
Pre cleaning required "desulfurization" ?	no	yes	yes	yes	yes	-
Specific eletricity demand	< 0,25	0,25-0,33	<0,15	0,25	0,35	kWh/m³ biomethane
Heat requirement "process temperature" ?	no	55-80	110-160	no	no	°C
Chemicals requirement	no	yes	yes	no	no	-
Controllability "part load range"	50-100	50-100	50-100	85-115	50-105	%
Typical specific CAPEX of Biomethane preparation plants						
plant 100 m³/h biomethane	10 100	9 500	9 500	10 400	7 300 - 7 600	€/(m³/h) biomethane
plant 250 m³/h biomethane	5 500	5 000	5 000	5 400	4 700 - 4 900	
plant 500 m³/h biomethane	3 500	3 500	3 500	3 700	3 500 - 3 700	
Typical OPEX of Biomethane preparation plants						
plant 100 m³/h biomethane	14	13,8	14,4	12,8	10,8-15,8	cent/m³ biomethane
plant 250 m³/h biomethane	10,3	10,2	12	10,1	7,7-11,6	
plant 500 m³/h biomethane	9,1	9	11,2	9,2	6,5-10,1	
References						
Number of references (general)	high	low	high	mean	mean	-
References in Germany 2016	55	17	55	38	11	-
References in EU 2017	124	37	102	68	82	-

CNG/LNG (Basis)

- Regulations and Standards (references i.e.) – grid feeding, fuel
- Different national standards, overall basis is EN ISO and also laws for quality requirements
- CNG - compressed natural gas as fuel: methane content in general > 96% (> 87% for H gas), expansion relation 1:200, up to 200bar, 12kWh/m³@1bar, ~ 1909kWh/m³@200bar
- LNG - liquified natural gas as fuel: methane content in general ~ 98%, expansion relation 1:600, cool down to ~ -162°C, 12kWh/m³@1bar ("gaseous"), ~ 5714kWh/m³@1bar ("liquified"), liquefaction process "Reverse Brayton cycle"

Fuel energyequivalent

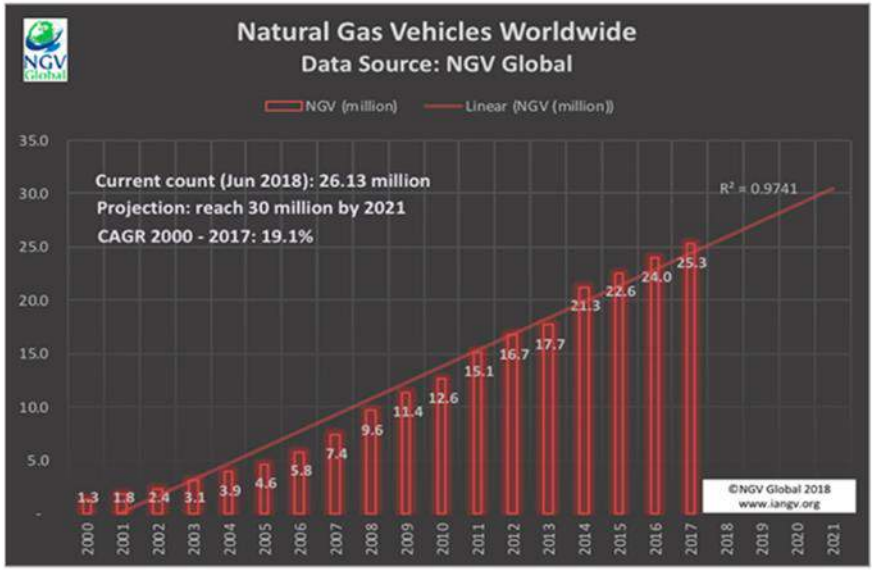
Fuel energyequivalent (gas to standard fuel)
1kg H gas ≙ 1,5l petrol or 1,3l diesel
1kg L gas ≙ 1,2l petrol or 1,1l diesel
1kg biomethane ≙ 1,5l petrol or 1,3l diesel

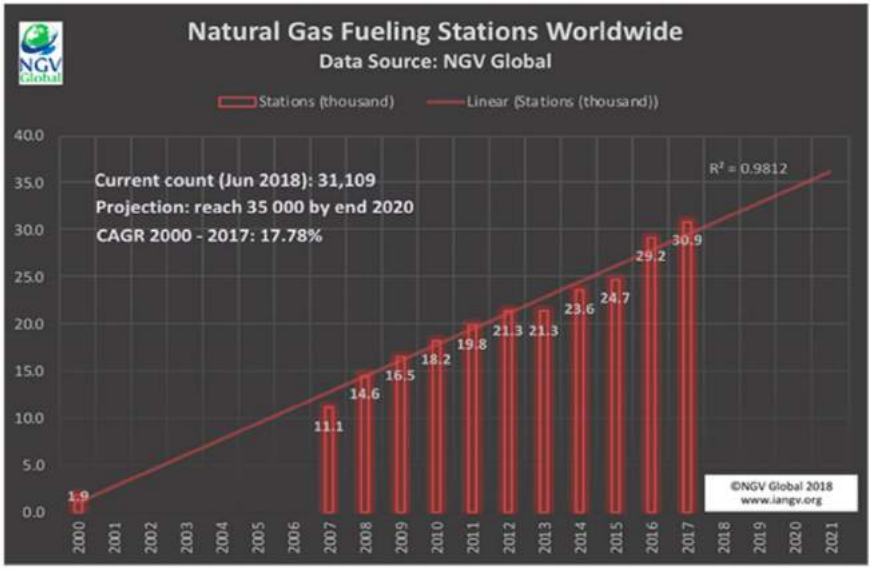
Use of biomethane as fuel

Type of transport	CNG	LNG
Vehicles	x	
Buses	x	x
Trucks	x	x
Ships		x

CNG as fuel for transport

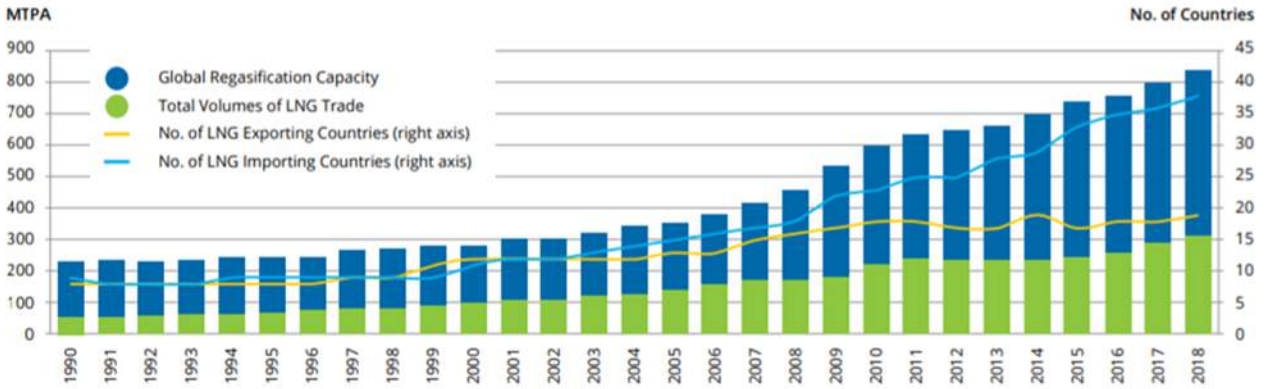
- CNG worldwide market development
  - Growth in gas vehicles and fueling stations

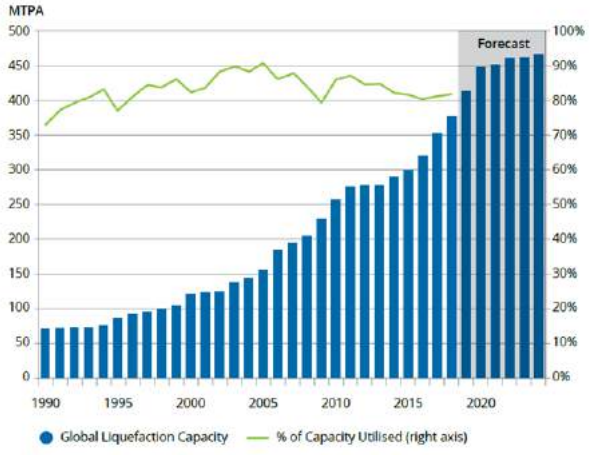




LNG as fuel for transport

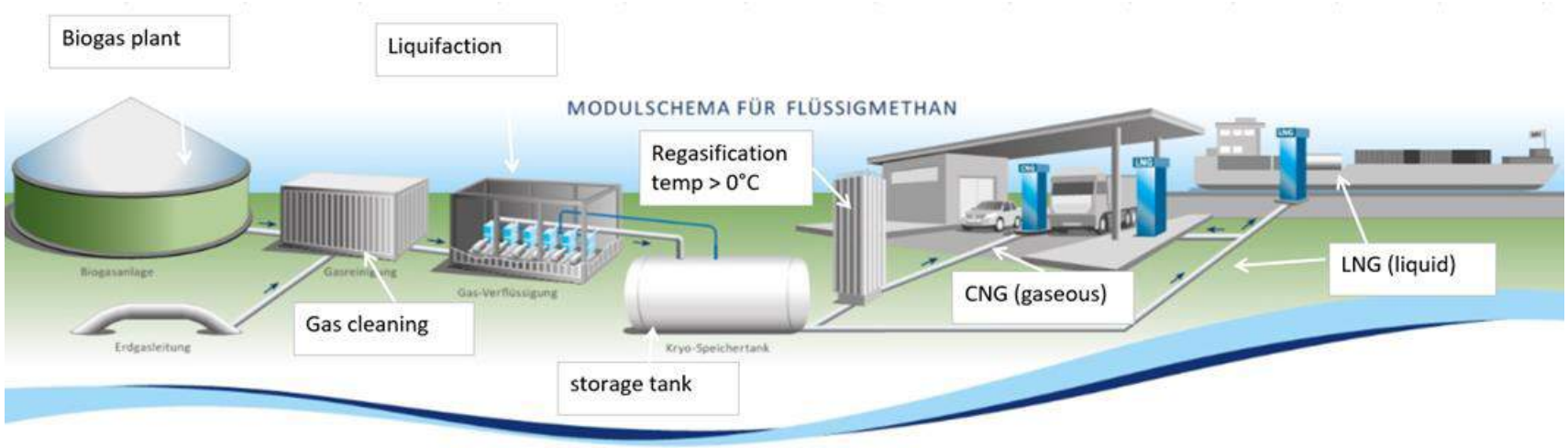
- LNG market development
  - Growth in LNG trade and liquefaction capacity





CNG/LNG – concept

- Biogas Plant, natural gas pipeline > Gas cleaning/treatment
- LNG, gas liquefaction > cryogenetic storage
- Regasification optional > liquid to gaseous (i.e CNG for gas vehicles)/fueling station
- LNG ship terminal



POTENTIAL ANALYSIS FOR AUSTRIAN COMPANIES

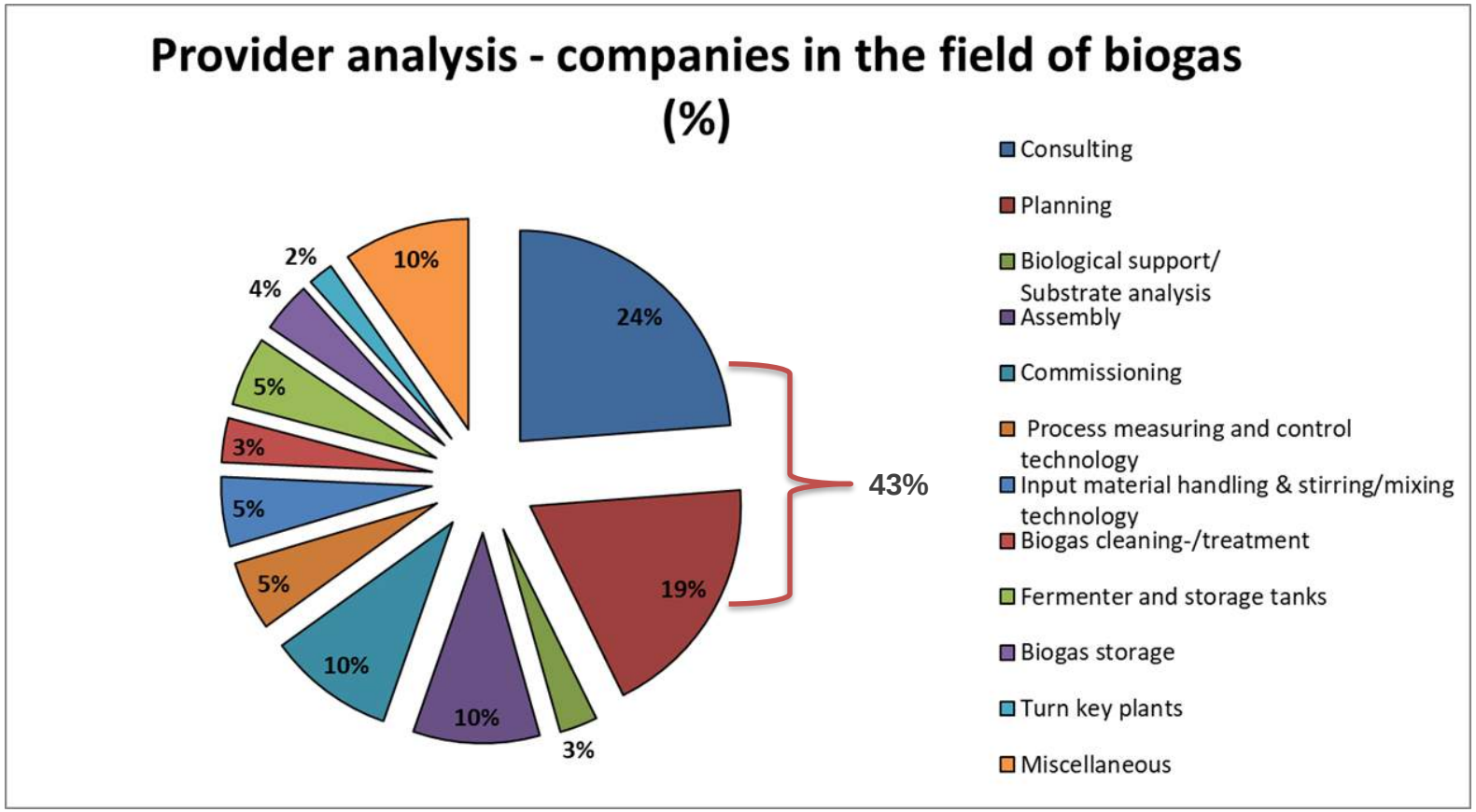
Elaboration list of technology / service providers

- 79 Austrian companies / associations identified and classified
- Elaboration of a short list with 11 companies offering special / innovative processes etc.
- Detailled results > outlined in the study

Contact data, scope of services etc.

Nr	Company	street	Location	Telephone number	Fax number	Email	Homepage/web	Scope of services
1	AAT Abwasser- und Abfalltechnik GmbH	Konrad Doppelmayr Straße 17	A-6960 Wolfurt	+43 (5574) 65190-0 +43 (5574) 65190-18	+43 (5574) 65185-6	office@aat-biogas.at	http://www.aat-biogas.at	Complete biogas plants service, digester systems incl. sanitation & gas preparation Project studies Project accompaniment R&D
2	Axiom Angewandte Prozesstechnik Ges.m.b.H	Wienerstrasse 114, Halle H-J	A-2483 Ebreichsdorf	+43 (2254) 76282	+43 (2254) 74675	office@axiom.at	https://www.axiom.at	Biogas treatment (membrane separation) Assembly Service
4	Flowserve SIHI (Hauptsitz)	Gewerbestrasse 14	A-2351 Wiener Neudorf	+43 (2236) 31530	no nr. available	sales_austria@flowserve.com service_austria@flowserve.com	http://www.sterlingsihi.at	Biogas treatment (membrane separation) Liquid pumps Vacuum pumps Plant technic Service Condition monitoring
19	Bio Trend Entsorgungs und Handels GmbH	Hochneide 33	A-4202 Hellmonsödt	+43 (7215) 3194	+43 (7215) 3194-31	biotrend@aon.at	www.biotrend-entsorgung.at	Organic waste treatment Development of a special biogas reactor
23	EnviCare Engineering GmbH Ingenieurbüro für Verfahrenstechnik	Eisteichgasse 20/36	A-8042 Graz	+43 (316) 3810380	+43 (316) 381038-9	office@envicare.users.aboliton.at	http://www.envicare.at	Planning and Consulting for biogasplants incl. gas treatment "biomethane" and waste disposal plants Process Engineering, R&D membrane preparation
24	Bauertech GmbH Ingenieurbüro - Projektunterstützung	Oberegging 24	A-3254 Bergland	+43 (7412) 52295-0	+43 (7412) 52295-12	office@bauertech.com	http://www.bauertech.com	Planning and Consulting for biogasplants and waste disposal plants Process Engineering Patent for a special developed tube digester
37	BIOGEST Energie- und Wassertechnik GmbH	Inkustraße 1-7/4/2	A-3400 Klosterneuburg	+43 (2243) 20840 00	+43 2243 20840 40	office@biogest-biogas.com	http://www.biogest.at	Planning of biogas plants, special biogasplant concepts (power ring, power compact)
72	Pöttinger Entsorgungstechnik GmbH	Moos 31	A-4710 Grieskirchen	+43 (7248) 9001-8040	+43 (7248) 9001-2429	fermenter@poettinger.at	http://fermenter.poettinger-oneworld.at	Biogas dry fermenter systems "Percolation process" modular system in containers
73	AB ENERGY INTERNATIONAL GMBH	Andreas-Hofer-Straße 43	6020 Innsbruck	+43 (120) 51085574		abenergyinternational@gruppoab.com	https://www.gruppoab.com/de	Biogas preparation & treatment to biomethane (membrane technology)
78	STRABAG Umwelttechnik GmbH	Schatzdorferstraße 9	4021 Linz	+43 (732) 3731 821	+43 (732) 3731 829	sut@strabag.com	http://www.strabag-umwelttechnik.com	Special biogas process (Laran) for continous dry fermentation of bio wastes & bulky wastes, mechanical biological plants full service
79	Thöni Industriebetriebe GmbH	Obermarktstraße 48	6410 Telfs	+43 (5262) 6903-0	+43 (5262) 6903-210	peter.scherl@thoeni.com thoeni@thoeni.com	https://www.thoeni.com	Special developed plug flow reactor/digester for continous dry fermentation. Also solutions for wet and semi fermentation, biogas full service

Quantified Results of Austrian providers - classification



General conclusion of technology analysis

- Austrian companies are experienced in the field of biogas and use in general state of the art of technology & proven biogas systems and processes
- biogas treatment > membrane separation technology is in Austria the mainly used technology by Austrian providers
- Some providers have already entered the Romanian market
- many Austrian providers act in the field of planning & consulting >, advantage in case of supporting Romanian municipalities or public organisations in the following services:
  - Project development (Pre-feasibility studies) & project pre-engineering
  - Project permission (permission engineering)
  - Tender and award (detail engineering, creation of tender documents, request for quotation, offer review, award proposal etc.)
  - Construction supervision

Biogas potential – Romania

- CNG & LNG in Romania
  - 2 CNG fueling stations, 900 natural registered gas vehicles (Austria: 152 CNG fueling stations, ~ 2 LNG fueling stations,11.500 natural registered gas vehicles > growing market
- 16 MBPs are already in the planning phase > improvement of waste management
- Biogas potential (Galati Region as reference)
  - Residues (wastes) of animal keeping (manure/slurry)
  - Non-agricultural residues/wastes i.e. from municipalities
  - Additional “free” areas from cultivated areas – not already used for food production
  - Results (extrapolated) for total Romania:
    - **~ 2.000 plants with a capacity of 700m³/h biomethane – medium scale plants**
    - **~ 5.500 plants with a capacity of 250m³/h biomethane – small scale plants**

Biogas/Biomethane potential in Romania			Mean energy content (KWh/m³)	Energy (MWh/a)
Biogas Total	22 833 798 478	m³/a	6,25	142 711 240
Biomethane total	12 101 007 930	m³/a	10	121 010 079

~ 142 TWh/a

22billion m³/a biogas, 12billion m³/a biomethane

Project opportunity “Galati city” (1/2)

- Potential Biogas plant “Pilot Project Site”
  - MBP in planning phase > agricultural plant possible (2 possible locations)
  - LNG small scale terminal in planning
  - Existing sewage plant

pro DANUBE MANAGEMENT GMBH
ces CLEAN ENERGY SOLUTIONS

Project opportunity “Galati city” (2/2)

- Plant design “rough” based on possible amount of digested output > directly used as fertilizer on surrounding areas ~ 36.000t/a
- Base data: 40.000t/a Co-fermentation plant (40% manure/60% renewable ressources)
- Annual biogas yield ~ 4,5 million m³/a (> 2,5million m³/a biomethane)
- Required area ~ 240x150m (3,6ha), Capex ~ 4,2million € excl. vat

pro DANUBE MANAGEMENT GMBH ces CLEAN ENERGY SOLUTIONS

Market chances

- Romania offers in general good opportunities for generating biogas/biomethane projects > ongoing global rising gas market for traffic/transport
- Romania is at the beginning of providing gas infrastructure for transport purposes (vehicles/ships) > 2 CNG fueling stations, 900 registered gas vehicles
- 16 MBPs are already in the planning phase > chance for suppliers (tendering/award), growing sector of waste management (32 Romanian counties)
- Well-proven culture of cooperation between the Countries Austria and Romania
- Required tendering & award process for public contractors, this could be a potential market for Austrian consulting & engineering companies

Market entry strategy (possible measures)

- Target: Awareness of Romanian clients (i.e. municipalities, public- & private sector) that experienced Austrian companies are available for support in the field of biogas (project development etc.). This could be done by:
  - Info campaigns for public contractors (i.e. for pre-feasibility studies, project development, tender & award, manufacturing supervision)
    - Mainly for supporting consulting & planning companies
  - Biogas technology trade fair
    - Supporting manufacturers and consulting & planning companies
  - Biogas Congress
    - Supporting manufacturers and consulting & planning companies
  - Biogas plant tour
    - Supporting manufacturers and consulting & planning companies
    - Disadvantage: Only some selected companies would benefit from this measure
  - Realization of a Biogas reference/pilot project
    - Supporting manufacturers and consulting & planning companies
    - Disadvantage: Only some selected companies would benefit from this measure

Summary

- Austrian companies are very experienced in the field of biogas
- Many Austrian providers act in the field of planning & consulting ~ 43% > advantage in supporting Romanian municipalities or public organisations (Project development, Tender and award etc.)
- Romania offers in general good opportunities for generating biogas/biomethane projects > ongoing global rising gas market for traffic/transport
- Romania is at the beginning of providing gas infrastructure for transport purposes (vehicles/ships)
- Growing sector of waste management
- Benefits > i.e. experienced companies, well-proven culture of cooperation between Austria and Romania (fast delivery and on-site support, support in tendering & award process)

kit4market - W2GAS

pro DANUBE MANAGEMENT GMBH
ces CLEAN ENERGY SOLUTIONS