This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691911

Technology Description (TD) for

Biogas Upgrading Technologies

Contact Information:

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	Date (of filling the TD):	25.09.2017		

Technology Description:

NAME OF TECHNOLOGY	In-situ methane enrichment
ASSIGNMENT OF TECHNOLOGY	Upgrading raw biogas
TECHNICAL READINESS LEVEL **TRL 1** - basic principles observed **TRL 2** - technology concept formulated **TRL 3** - experimental proof of concept **TRL 4** - technology validated in lab **TRL 5** - technology validated in relevant environment (industrially relevant environment in case of key enabling technologies) **TRL 6** - technology demonstrated in relevant environment (industrially relevant environment in case of key enabling technologies) **TRL 7** - system prototype demonstration in an operational environment **TRL 8** - system completed and qualified **TRL 9** - actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)	1 2 3 4 **5** 6 7 8 9
What is the core innovation? (Please explain here what is innovative on this technology and which problem does the	Using air to desorb CO2 directly from the digester content to increase the methane concentration in the raw biogas. This reduces the capacity requirement of down stream

technology solve.)		conventional or developing biogas upgrading technologies and enables the whole system to be more economical. The main discovery is that the fact that air is blown through the digester content has no significant adverse effect on the production of methane.
Vision of the innovation (Please describe here what impact you see for the future)		The vision for this technology is to be used as a pre-treatment step before conventional upgrading technologies or as a pre-treatment to our ash filter technology to reduce the demand for ash. Another possible scenario is that it under certain conditions may be possible to reach German L-gas specs with in-situ methane enrichment as a single upgrading technology. Many vehicles are already approved for and fully capable of running on L-gas (Natural gas with a lower methane content of down to 85%).
What are the R&D needs for your technology? (Are there any barriers or challenges which still need to be overcome?)		The main barrier is heat loss during desorption. Another challenge is that the in-situ methane enrichment system is intimately connected with the digestion process and therefore has to be optimized on a case by case basis.
TECHNOLOGY/EQUIPMENT AVAILABILITY		
PATENT RIGHTS		YES/**NO**
METHOD OF MAKING THE TECHNOLOGY AVAILABLE	*Licence selling*	**YES**/NO
	Licence granting	**YES**/NO
POSSIBLE END USERS OF TECHNOLOGY	*Please name end users/ contacts that should be invited to project workshops*	Sala Heby Energi, Jokkmokk municipality, Sötåsens naturbruksgymnasium, Julmyra horsecenter, Sörby slakteri, lövsta egendom, Jällaskolan, MMG konsult, Swedish biogas international, Air Liquid, Biogas Systems AB, Norups gård, Wapnö Gård, Purac Puregas, Biolectric, IQlink, energiutvecklarna, Atlas Copco Compressor Technique Scandinavia, Ecobiofuel, Malmberg Water AB, Scandinavian Biogas Fuels AB.

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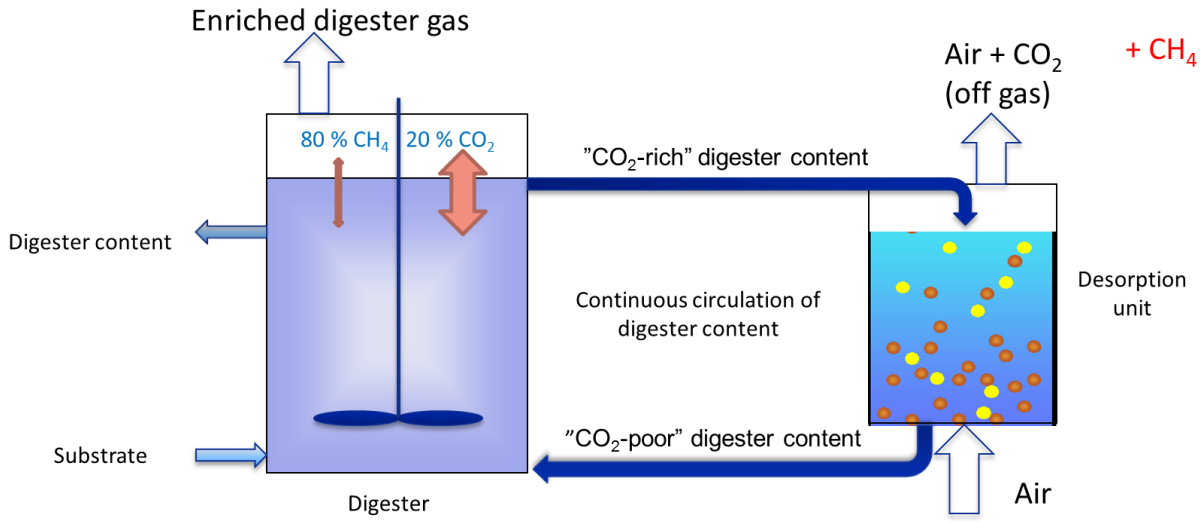
Description of the technology/equipment:

The sludge is recirculated from the digester to a desorption column and back to the digester. Air is introduced into the column in order to desorbe the carbon dioxide. Thus, the result is a digester gas enriched in methane.



Technical Data:

Parameter		Value (please fill or tick) If value not available, please give estimate (and indicate with *).	**Comments** (e.g. which condition does the entered value correspond to?)
Current technology	Upgrading capacity of technology at current TRL-level (Nm³ raw gas/h)	0-10	This is the capacity of the industrial pilot that we have running at Sötåsen
Data basis for following data list	1.: market ready stage of technology (based on test runs of current techn.) **<u>Please only use 2. or 3. if 1. not at all possible.</u>** 2.: market ready stage of technology (based on estimate) 3.: current level (TRL) of technology	1 ☒ (preferably) 2 ☐ 3 ☐	

Technical efficiency	Methane content in raw gas (%)	55 - 70	
	Methane content in product gas (%)	70 -85	Depending on in-going methane concentration
Capacity	Flow rate (range) /upgrading capacity (Nm^3 raw gas/ h)	0 - 100	
	Flow rate biomethane (Nm^3/h)		
	Possible range for upscaling	Yes	Unlimited in principle. We have economical calculations for a 30 GWh/year case that looks promising
Data for assessment of economical added value, possible contribution to GHG-reduction and availability	Electricity demand (kWh_{el}/Nm^3 raw gas)	0,2-0,3	
	Heat demand (kWh_{th}/Nm^3 raw gas)	---	No data available for this as we are purposefully trying to develop this technology to not have a need for external heat.
	Chemical/additives demand (kg/h or kg/Nm^3 raw gas)	0	
	Demand of other substances (kg/h or kg/Nm^3 raw gas)	0	
	Biomethane slip (range in % of biomethane production)	0,5 – 3	
	Delivery pressure at exit of upgrading plant (bar $_{abs}$)	No pressure increase	Whatever the system pressure is for the biogas plant is maintained
	Full load hours (h/a)	7000 - 8760	
	Exhaust gas treatment	None or combustion air to a gas boiler	Unless used as combustion air, this is where the methane slip will occur
	Usable heat (external) through heat extraction (kWh_{th}/Nm^3 raw gas)	0	Please indicate temperature
	Space requirement (m^2)	Ca 20 - 60 m2	Depends on the size. Need space for desorption tank at an approximate volume of 5% of the digester volume right next to the digester

	Staff requirement (excluding maintenance) (h/a)	50 - 150	The operation is maintained by biogas plant owner
	Specific capital costs (excluding project development, planning, permission and additional building costs) (€/Nm³ raw gas)	Please give exact specific cost if possible, if not please specify range. ☐ < 4.000 €/Nm³ ☒ 4.000 - 6.000 €/Nm³ ☒ 6.000 € - 8.000 €/Nm³ ☐ > 8.000 €/Nm³	1 GWh: ca 7000 €/Nm³/h 2 GWh: ca 5000 €/Nm³/h
	Maintenance costs (including spare parts such as new membranes, staff) (€/a or €/operating hour)	8000-12000	€/a
	Production costs (€/Nm³ biomethane)	0,2	
	Expected lifetime of unit (years)	15	
Flexibility	Start-stop-flexibility	Yes	Very limited lag-time at start.
	Part-load possibility	☐Yes, 0 - 100% of full capacity ☒ No	
	Is self-maintenance of technology possible?	☒ Yes, 100 % of total maintenance hours per year that can be done by operator himself ☐ No	
	Does the upgrading technology remove also H_2S or is this necessary in a separate unit?	☒ Yes, 50-80 % of total H_2S-content of rawgas ☐ No	

	Necessity for adaptions of other parts of the plant	Yes	2 pipes for sludge connection to the digester
	Advantages/disadvantages of technology	Ad: No explosive areas with electricity. No pressurized tanks. Disad: Don't reach 95 % methane, need extra upgrading afterwards.	
	Special application area of technology	See the segment “Vision of the innovation” above	