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

Anaerobic Digestion Technologies

Contact Information:

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	Date (of filling the TD):	08.09.2017 (Update)		

Technology Description:

NAME OF TECHNOLOGY	Reactor for biomass digestion
ASSIGNMENT OF TECHNOLOGY	Reactor for biomass digestion with innovation mixing system
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	Cage mixing system ensures better biogas release, removes foam from reactor and

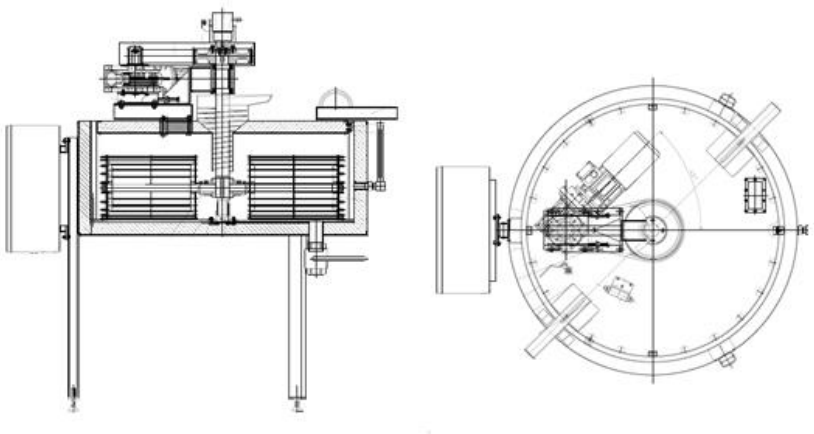
explain here what is innovative on this technology and which problem does the technology solve.)		mechanically grinds the substrate.
Vision of the innovation (Please describe here what impact you see for the future)		Solution can compete with the currently existing system which are dedicated to small biogas plant.
What are the R&D needs for your technology? (Are there any barriers or challenges which still need to be overcome?)		The barrier is the lack of installations of this kind in technical scale. Necessary development of the prototype on a semi-technical scale and selection and optimization of operating parameters.
TECHNOLOGY/EQUIPMENT AVAILABILITY		technology licence sellers Technology supplier has a prototype functioning in technical scale. It is possible to test the technology for potential customers. The technology supplier is not a producing company.
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*	Biogas plant operators

Description of the technology/equipment:

Reactor for biomass digestion with innovation mixing system

The reactor is a tubular tank with internal diameter of D = 1.2 m and height of H = 0.4 m. Operating height, filled with anaerobic sludge, is Hop = 0.3 m. Above, the gas phase is present, in which biogas is collected. In order to provide anaerobic conditions, the reactor is a closed with a dome, which the side walls are located below the liquid level in the reactor. (Fig. 1).

Fig. 1 Sheme of reactor for biomass digestion with mixing cages



The side walls, the bottom and the dome of the reactor are insulated with a layer of polystyrene with a thickness of 5.0 cm. In the bottom of the reactor the heating system is installed, with the possibility of controlling the temperature in the reactor. On the dome, the feed supply valve and the gas valve are located, by which organic substrate is introduced and the biogas is discharged, respectively. In the bottom of the reactor, there is a valve to discharge of the sludge.

Mixing system of the reactor consist of two cylindrical stirrers in the form of cage with diameter of = 0.35 cm. Cages by doing rotation around the axis of the reactor at the same time turn against its own axis. The rotational speed about the axis of the reactor was regulated in the range of 0 to 5 rpm.

Parameters of anaerobic reactor:

Internal diameter	D_w = 1200 mm
Outer diameter	D_z = 1300 mm
Operating height	H_{op} = 300 mm
Internal height	H_w = 400 mm

Active volume V_{ac} = 339 L

Volume of the gas phase V_g = 113 L

Diameter of the mixing cage D_k = 350 mm

Amount of mixing cages 2

Speed range v = 0 – 5 rpm

Fig. 2 Reactor for biomass digestion with innovation mixing system

The construction of the reactor was developed under the Key project entitled “Model agro-energy complexes as an example of distributed cogeneration based on local renewable energy sources” POIG.01.01.02-00-016/08 as part of the Innovative Economy Operational Program 2007-2013, as well as from the European Regional Development Fund.

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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	Biogas production rate of technology at current TRL-level (Nm³/h)	0.012 – 0.030	
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 biogas (%)	50-70%	Depending on the substrate
Capacity	Flow rate and type per substrate (Mg/h)	0.00025-0.00050	
	Biogas production rate (range) (Nm³/h)	0.012 – 0.030	Depending on the substrate
	Possible range for upscaling	up to 300 Nm3/day	Technology for little and middle biogas plant
Data for assessment of economical added value, possible contribution to GHG-reduction and availability	Fermenter and biogas process technology(e.g. continuously stirred reactor, plug flow digester, box or garage type)	CSTR	
	Electricity demand (kWh$_{el}$/Nm³ biogas)	0,9	
	Heat demand (kWh$_{th}$/Nm³ biogas)	1,6	
	Chemical/additives demand (kg/h or kg/Nm³ biogas)	not necessary	
	Demand of other substances (kg/h or kg/Nm³ biogas)	not necessary	
	Temperature in fermenter (°C)	35 - 60	

	Pressure of biogas at exit of fermenter (bar $_{abs}$)	0,01	
	m³ fermenter volume used	0.1	
	Full load hours (h/a)	8000	
	Hydraulic retention time (days)	30 - 60	
	Max. dry matter content (%)	80	
	Organic loading rate (kg VS/m³d)	2 - 4	
	Space requirement (m^2)	2	
	Staff requirement (excluding maintenance) (h/a)	200	
	Specific capital costs (excluding project development, planning, permission and additional building costs) (€/Nm³/h)	Please give exact specific cost if possible, if not please specify range. ☐ < 5.000 €/Nm³/h ☒ 5.000 - 10.000 €/Nm³/h - 10 000 ☐ 10.000 € - 15.000 €/Nm³/h ☐ > 15.000 €/Nm³/h	Not determined on an industrial scale
	Maintenance costs (including spare parts, staff) (€/a or €/operating hour)	200	Not determined on an industrial scale
	Production costs (€/Nm³ biogas)	0,2 – 0,5	Not determined on an industrial scale
	Expected lifetime of unit (years)	15	
Flexibility	Types of substrate (solid and liquid)	Solid and liquid Maize, Cow manure, grass silage	Cage mixing system improving efficiencies of solid substrate fermentation
	Start-stop-flexibility		

	Part-load possibility	☒Yes, 50 – 100 % of full capacity ☐ No	
	Is self-maintenance of technology possible?	☒Yes, 80 % of total maintenance hours per year that can be done by operator himself ☐ No	
	Necessity for adaptions of other parts of the plant	not necessary	
	Advantages/disadvantages of technology	Advantages during the mixing solid substrate (maize, cow manure, grass silage) is gridded Innovative mixing system, where rolls destroy the structure of the substrate - it also destroys the foam which is not good for the biomass /disadvantages high cost of materials	
	Special application area of technology	Technology for substrates with low level of hydration	