TECHNOLOGY FACTSHEET

ANAEROBIC DIGESTION OF WET BIOMASS FOR GREEN GAS PRODUCTION

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Sector	Gas supply
	Refers to all residues from food & beverage industry, biodegradable waste, residues from biofuel installations, vegetable, fruit and garden wastes or organic wet fraction of household wastes, etc.
ETS / Non-ETS	Non-ETS
Type of Technology	Biomass
Description	Wet biomass in this category refers to organic wastes such as residual flows from the food & beverage industry, vegetable, fruit and garden wastes, or organic wet faction of household wastes. The residual flows are mentioned in the NTA8003 and published by the Netherlands Standardization Institute. For this category, a minimum biogas production of 25 Nm3 (natural gas equivalent) for tonne feedstock is requested. Manure is not included in this category. For this technology, the biomass is digested in a state-of the-art anaerobic digestion (AD) installation to produce biogas. The AD installation consists of storage and pre-treatment, digestion installations, further processing of biogas and post treatment and storage of digestate (i.e. dewatering, drying, in some cases hygenisation and storage). On average, the residence time of the organic waste in the digestor is around 30 days and biogas is produced. Biogas consists mainly of methane (on average 60%) and carbon dioxide (33-38%) in addition to contaminants such as sulfur, water vapour and oxygen. The reprocessing process aims to separate a large part of the carbon dioxide from the biogas in order to increase the methane concentration. A higher methane concentration leads to a higher heating value of the gas. The CO2 that is removed from the biogas can be recovered and liquefied to be sold. The biogas is further processed using the highly efficient membrane technology to the natural gas quality. Desulfurization of biogas takes place in the digester by injection of air, whereby H2S is converted into elemental sulfur, that is precipitated as solid. In order to protect the reprocessing plant for a too high sulphur content, an activated carbon filter is used. The activated carbon filter can absorb and remove the last traces of sulfur, which is beneficial for the lifespan and maintenance costs of the reprocessing plant. In case of a fault in the fermentation installation, biogas may escape. In that case H2S is the most important component that causes odour nuisance. However, the amount of biogas that may be released is limited.
TRL level 2020	TRL 9
	AD technology is a widely applied commercial technology. Biogas upgrading can be done via a number of different technologies and they are also commercially applied.

TECHNICAL DIMENSIONS

	Functional Unit		Value and Range								
Capacity	MWth		5.5								
			-			-			-		
Potential	MWth	NL	Current			2030			2050		
			-			-			-		
			Min	-	*Max*	*Min*	-	*Max*	*Min*	-	*Max*
Market share	%		-			-			-		
			Min	-	*Max*	*Min*	-	*Max*	*Min*	-	*Max*
Capacity utlization factor	1.00										
Full-load running hours per year	8,000										
Unit of Activity											
Technical lifetime (years)	15										
Progress ratio											
Explanation	Both the capacity and the potential refer to MWth biogas. Thus, the potential is presented as biogas potential of organic waste streams (excluding manure) and it is the same for all digestion related pathways. The potential specified above refers to the total biogas potential from food & beverages industry, GFT (vegetables, fruit and garden waste) & OWF (organic wet fraction), straw, other agricultural residues and energy crops. DNV (2017) defines the potential for 2023 and 2035. The 2023 potential data is presented as 2020 and 2035 data as 2030. Aquatic biomass potential is not included in the figures. Elbersen et al. (2015) also does not include aquatic biomass. The report Routekaart Hernieuwbaar Gas (2014) considers a small value (0.1 PJ biogas) for seaweed in 2020 increasing to 16.7 PJ in 2030. DNV GL (2017) indicates aquatic biomass potential to be around 18 PJ in 2023 and increasing to 53 PJ in 2030. The wet biomass potential ratio among the sectors industry, households and agriculture are 38%, 36%, 26% in 2020 and 34%, 32%, 34% in 2030, respectively.									

COSTS

Year of Euro	2015									
Investment costs	Euro per Functional Unit		Current			2030			2050		
	mln. € / MWth		0.97			0.91			0.88		
			0.97	-	3.03	0.91	-	3.00	0.88	-	2.93
Other costs per year	mln. € / MWth		0.23			0.00			0.00		
			0.23	-	0.23	*Min*	-	*Max*	*Min*	-	*Max*
Fixed operational costs per year (excl. fuel costs)	mln. € / MWth		0.11			0.09			0.08		
			0.11	-	0.12	0.09	-	0.12	0.08	-	0.12
Variable costs per year	mln. € / MWth		-			-			-		
			Min	-	*Max*	-	-	-	-	-	-
Costs explanation	MWth refers to MWth input. The costs data are converted to EUR2015. The main reference costs are based on SDE+ Eindadvies (2019) and the potential cost reductions are based on the ETRI database. ETRI (2018) indicates a cost reduction for anaerobic digestion installations to be in the range of 2.1%-0.5% per year for the first 5 years, and 0.1-0.6% per year for the following years. The baseline cost reduction rates of ETRI are applied. It is important to highlight that ETRI (2018) neither distinguishes between different digestion options nor explains how the CAPEX is determined. Therefore, it is not possible to clarify the reasons why this dataset presents higher figures. Also, they refer to anaerobic digestion related CAPEX and OPEX, whereas SDE+ also includes further processing of biogas. Therefore, a direct comparison of the datasets is not possible.									

ENERGY IN- AND OUTPUTS

	Energy carrier	Unit	Current			2030			2050		
Energy carriers (per unit of main output)	*Main output:* SNG	PJ	-0.95			-			-		
			-0.95	-	-0.95	*Min*	-	*Max*	*Min*	-	*Max*
	Biogas (wet streams)	PJ	1.00			-			-		
			1.00	-	1.00	*Min*	-	*Max*	*Min*	-	*Max*
	Electricity	PJ	0.08			-			-		
			0.08	-	0.08	*Min*	-	*Max*	*Min*	-	*Max*
			-			-			-		
			Min	-	*Max*	*Min*	-	*Max*	*Min*	-	*Max*
Energy in- and Outputs explanation	The total electricity demand includes electricity needed for the digestion reactor and further processing of biogas into natural gas quality. For this value chain, the biogas content of the wet stream is mentioned above as input to the membrane reactor where it will be upgraded to the natural gas quality (so called synthetic natural gas or SNG).									

MATERIAL FLOWS (OPTIONAL)												
Material flows	Material	Unit	Current			2030			2050			
	Digestate	% dry (volume)	0.80			-			-			
			0.80	-	0.80	*Min*	-	*Max*	*Min*	-	*Max*	
			-			-			-			
			Min	-	*Max*	*Min*	-	*Max*	*Min*	-	*Max*	
Material flows explanation	The volume of digestate will be around 90-95% of what was fed into the digester. Digestate can be: 1) Composted in case the input stream consists of GFT (vegetables, fruit and garden waste) and sold to be used on agricultural land when it complies with the conditions of the Fertilizer Act. To be classified as compost it should include no animal manure. 2) Further treated in case the waste stream is organic waste. The digestate treatment mainly consists of dewatering, drying and storage. The dried product can further be pelletized and become suitable as fuel (for instance for co-firing plant). An indicative price for this fuel can be around 35 Euro/ton.											
EMISSIONS (Non-fuel/energy-related emissions or emissions reductions (e.g. CCS)												
Emissions	Substance	Unit	Current			2030			2050			
			-			-			-			
			Min	-	*Max*	*Min*	-	*Max*	*Min*	-	*Max*	
			-			-			-			
			Min	-	*Max*	*Min*	-	*Max*	*Min*	-	*Max*	
			-			-			-			
			Min	-	*Max*	*Min*	-	*Max*	*Min*	-	*Max*	
			-			-			-			
			Min	-	*Max*	*Min*	-	*Max*	*Min*	-	*Max*	
Emissions explanation												

REFERENCES AND SOURCES
SDE+ Eindadvies, 2019.
DNV GL, 2017. Biomassapotentieel in Nederland. Verkennende studie naar vrij beschikbaar biomassapotentieel voor energieopwekking in Nederland. Paula Schulze, Johan Holstein, Harm Vlap. GCS.17.R.10032629.2
ETRI study, 2018. Cost development of low carbon energy technologies. Scenario-based cost trajectories to 2050, 2017 edition.
Elbersen et al., 2015. Biomass potential in the Netherlands (as part of the Biomass Policies project, co-funded by the European Commission).
Routekaart Hernieuwbaar Gas, 2014. See https://groengas.nl/wp-content/uploads/2015/07/Routekaart-hernieuwbaar-gas.pdf