TECHNOLOGY FACTSHEET

ANAEROBIC DIGESTION OF WET BIOMASS FOR COMBINED HEAT AND POWER (CHP) GENERATION

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Sector	Electricity and heat generation
	Refers to all residues from food and beverage industry, biodegradable waste, residues from biofuel installations, fruit, vegetable and garden wastes and the organic faction of municipal wastes. Thus, it covers the sectors industry, households and agriculture.
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 and 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. The biomass is digested in a state-of the-art anaerobic digestion installation to produce biogas. The installation consists of storage and pre-treatment, digestion installations, combustion 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 fermenter is around 30 days and biogas is produced. Biogas consists mainly of methane (in average 60%) and carbon dioxide (33-38%) in addition to contaminants such as sulphur, water vapor and oxygen. The biogas is desulfurized prior to it being fed into a gas motor to produce heat and electricity. The Activities Decree on emissions for combustion plants requires that the gas motors comply with the emission limits for SO2 and NOx.
TRL level 2020	TRL 9
	Anaerobic digestion technology and CHP are widely applied commercial technologies.

TECHNICAL DIMENSIONS

	Functional Unit	Value and Range								
Capacity	MWth	5.5								
		-		-			-			
		Current			**2030**			**2050**		
Potential	MWth	-			-			-		
		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	-
Hourly profile	
Explanation	The capacity and the potential refers 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, excluding manure digestion. The potential above refers to the total biogas potential from VGI, GFT&ONF, straw, other agricultural residues and energy crops. DNV GL defines the potential for 2023 and 2035. The 2023 data is presented as 2020 and 2035 data as 2030 potential. Aquatic biomass potential is not included in the figures. Elbersen et al (2015) also do not include aquatic biomass. Routekaart Hernieuwbaar Gas report 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 18PJ in 2023, 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

	Euro per Functional Unit	Current			2030			2050		
Investment costs	mln. € / MWth	0.88			0.87			0.84		
		0.88	-	3.03	0.87	-	3.00	0.84	-	2.93
Other costs per year	mln. € / MWth	0.23			-			-		
		0.23	-	0.23	*Min*	-	*Max*	*Min*	-	*Max*
Fixed operational costs per year (excl. fuel costs)	mln. € / MWth	0.08			0.06			0.06		
		0.08	-	0.12	0.06	-	0.12	0.06	-	0.12
Variable costs per year	mln. € / MWth	0.01			0.01			0.01		
		0.01	-	0.01	0.01	-	0.01	0.01	-	0.01

Costs explanation	MWth refers to MWth input. The costs data are converted to 2015 as they were from 2018. Potential cost reductions are based on the ETRI database. ETRI indicates 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. We apply the baseline cost reduction rates of ETRI. It is important to highlight that ETRI neither distinguishes between different digestion options nor explains how the CAPEX were determined. Therefore it is not possible to clarify why this dataset presents higher figures. Next to that they only refer to anaerobic digestion related CAPEX and OPEX, whereas SDE+ data also include cost of a gas motor. Therefore a direct comparison of the datasets are not possible.

ENERGY IN- AND OUTPUTS

	Energy carrier	Unit	Current			2030			2050		
Energy carriers (per unit of main output)	*Main output:* Electricity	PJ	-0.41			-			-		
			-0.41	-	-0.41	*Min*	-	*Max*	*Min*	-	*Max*
	Heat	PJ	-0.44			-			-		
			-0.44	-	-0.44	*Min*	-	*Max*	*Min*	-	*Max*
	Biogas (wet streams)	PJ	1.00			-			-		
			1.00	-	1.00	*Min*	-	*Max*	*Min*	-	*Max*
	Electricity	PJ	0.02			-			-		
			0.02	-	0.02	*Min*	-	*Max*	*Min*	-	*Max*

Energy in- and Outputs explanation	In SDE+ the generic energy content of the wet biomass is assumed as 3,4 GJ/ton. Roughly 5% of biogas is used to meet the internal heat demand. The electricity demand refers to the electricity needed for the digestion process.

MATERIAL FLOWS (OPTIONAL)

	Material	Unit	Current			2030			2050		
Material flows	Digestate	% dry(volume)	0.80			-			-		
			0.80	-	0.80	*Min*	-	*Max*	*Min*	-	*Max*
			-			-			-		
			Min	-	*Max*	*Min*	-	*Max*	*Min*	-	*Max*

Material flows explanation	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. It should include no animal manure to be classified as compost. 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)												
	Substance	Unit	Current			2030			2050			
Emissions			-			-			-			
			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
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