TECHNOLOGY FACTSHEET

LARGE-SCALE ANAEROBIC MONO-MANURE DIGESTION FOR ELECTRICITY AND HEAT PRODUCTION (CHP)

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Sector	Agriculture: Other Refers to heat&electricity production from manure in the Netherlands
ETS / Non-ETS	Non-ETS
Type of Technology	Biomass
Description	The process involves a manure storage, mixing tank, digesters, hygienisation/pasteurisation tank and digestate and waste water treatment. The biogas is desulfurized prior to it being fed into a gas motor to produce heat & electricity. The Activities Decree on emissions for combustion plants requires that the gas motors comply with the emission limits for SO2 and NOx. Manure input is assumed to consist of a mixture of pig manure and cattle manure, with a mix of slurry and thick fractions in a ratio of 80/20. This means that the average biogas is slightly below 30 m3 biogas per tonne manure. In the digester, anaerobic micro-organisms break down manure into intermediate substrates and methanogens turn them into biogas. Biogas is a blend of methane (50–75% CH4) and carbon dioxide (25-50% CO2) with some trace amounts of ammonia (NH3), hydrogen sulphide (H2S), and water. Digestate is often separated into a thick and thin fraction. The thick fraction can then be hygienized to make it safe for use or export as a fertilizer. The hygienisation prior to export is mandatory. During hygienisation, the digestate is kept at a temperature of at least 70°C for one hour. The thin aqueous fraction can be further purified to a concentrated fraction and water.
TRL level 2020	TRL 9 AD technology is a widely applied commercial technology.

TECHNICAL DIMENSIONS

	Functional Unit		Value and Range		
Capacity	MWth				5.50
			5.50	-	5.50

	Unit	Region	Current			2030			2050		
Potential	MWth	NL			-			-			-
			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	8,000.00
Unit of Activity	
Technical lifetime (years)	15.00
Progress ratio	
Hourly profile	
Explanation	Both the capacity and the potential refer to MWth biogas. Thus, the potential is presented as biogas potential of manure and it is the same for all monomanure digestion related pathways. DNV GL defines the potential for 2023 and 2035. The 2023 data is presented as 2020 and 2035 data as 2030 potential. The reference capacity considers a mix of wet and dry manure as input. Therefore, we assumed 50% of the dry manure potential in reference Elbersen et al (2015) is fed-into the AD next to the wet potential. The rest of the dry manure is considered as input for the combustion.

COSTS

Year of Euro	2015

	Euro per Functional Unit	Current			2030			2050		
Investment costs	mln. € / MWth			2.14			2.00			1.88
		2.14	-	3.03	2.00	-	3.00	1.88	-	2.93
Other costs per year	mln. € / MWth			-			-			-
		Min	-	Max	Min	-	Max	Min	-	Max
Fixed operational costs per year (excl. fuel costs)	mln. € / MWth			0.19			0.16			0.15
		0.11	-	0.19	0.10	-	0.16	0.09	-	0.15
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 biogas input. The CAPEX and OPEX include all the necessary processes to produce biogas and convert it to electricity and heat. Costs related to treatment of digestate and wastewater are excluded. The cost data are converted to 2015 as they were from 2018. Once the technology is implemented there can be some cost reductions. ETRI indicates cost reduction for AD 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 to SDE+2019 data. It is important to highlight that ETRI does not distinguish between mono- and all digestion. Next to that, they only refer to AD related CAPEX and OPEX, whereas we also include combustion of biogas.

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			-0.41			-			-
			-0.41	-	-0.41	Min	-	Max	Min	-	Max
	Biogas (manure)	PJ			1.00			-			-
			1.00	-	1.00	Min	-	Max	Min	-	Max
	0	PJ			-			-			-
			Min	-	Max	Min	-	Max	Min	-	Max

Energy in- and Outputs explanation	In SDE+ the generic energy content of the wet biomass is assumed as 0,58 GJ/ton. We assumed that a certain share of heat produced is used to meet the internal heat demand. That is why heat efficiency is considered as low as 41%.

MATERIAL FLOWS (OPTIONAL)

	Material	Unit	Current			2030			2050		
Material flows	Digestate	% volume			0.80			-			-
			0.80	-	0.80	Min	-	Max	Min	-	Max
					-			-			-
			Min	-	Max	Min	-	Max	Min	-	Max

Material flows explanation	Digestate is often separated into a thick and thin fraction. The thick fraction can then be hygienized to make it safe for use or export as a fertilizer. The hygienisation prior to export is mandatory. During hygienisation, the digestate is kept at a temperature of at least 70°C for one hour.

EMISSIONS (Non-fuel/energy-related emissions or emissions reductions (e.g. CCS)

	Substance	Unit	Current			2030			2050		
Emissions	CH4	kton			-0.06			-			-
			-0.06	-	-0.06	Min	-	Max	Min	-	Max
					-			-			-
			Min	-	Max	Min	-	Max	Min	-	Max
					-			-			-
			Min	-	Max	Min	-	Max	Min	-	Max
					-			-			-
			Min	-	Max	Min	-	Max	Min	-	Max

Emissions explanation	IBO study indicates the methane emission saving factor as 0,068 ton CO2-eq/ton mest. We assume that the manure fed into a large scale digestion unit is older when compared with the farm level systems. This will cause some methane loss. We assumed, therefore, the methane savings to be 50% reduced. The total methane emission saving is based on the amount of manure with a biogas content of 1 PJ. Manure energy content is assumed as 0,58 GJ/ton. The manure input is calculate as 1/0,58*1000.

OTHER

		Current			2030			2050		
Other				-			-			-
		Min	-	Max	Min	-	Max	Min	-	Max

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.

IBO study