

Section in the process chain	Component	Technology	Output parameter y	Unit Output parameter	Input parameter x	Unit Input parameter	Lower range input	Upper range input	Regression Type	Coefficient a	Coefficient b	R2	n	Comment/Explanation	Sources
Substrate provision	Liquid feed	-	P el	kW	m liquid	t FM / h	4	50	linear	0.63	10.04	0.45	15		Manufacturer (Rohn, Wangen, Vogelsang, Armatec, Weltec, Netsch, Börger, Stallkamp), KTBL 2013, FNR 2013
Gas upgrading	Desulphurisation	Desulph Blower	P el	W	V air	m3 / h	2	50	pot	8.87	1.42	0.92	14		Manufacturer (Medo, Hiblow, Awite),
Gas production	Agitators	submersible, paddle, long axis, rod	W el	kWh/t FM	m substrate,a	m3/a	1000	30000	pot	1148.80	-0.58	0.92	4 (16)	Average values per type (total)	Härdtlein 2013
Digestate treatment	Digestate separation	screw press	P el	kW	V digestate	m3/h	1.5	170	pot	1.38	0.41	0.59	10		(Cielejewski, 2014; Drosig et al., 2015; Effenberger, 2015; Häring et al., 2011; KTBL, 2013; Leifker, 2012; Theuvsen and Kröger, 2016; TU Braunschweig et al., 2013; Waelkens and Zetzl, 2015; Wetter, 2016)
Gas upgrading	gas cooling	gas cooler	W el	kWh/d	P el inst (CHP)	kW	320	3000	pot	90.77	-1.09	0.82	8		BGA_OPT 2011
Gas utilisation	CHP unit	gas blower	P el	kW	V biogas	m3/h	5	4000	linear	0.01	0.03	0.87	52		Manufacturer (SKV tec, Mapro, GUT mbh,
Gas utilisation	CHP unit	-	CHP coefficient	-	eta el	%	-	-	exp	0.11	0.05	0.61	181		Härdtlein 2013
Gas utilisation	CHP unit	-	CHP coefficient	-	eta el	%	-	-	pot	2417.00	-1.09	0.42	-		Reinhold 2017
Gas utilisation	CHP unit	-	Q engine cooling	kW	Q inst	kW	50	2200	log	-0.07	0.95	0.44	37		Manufacturer (ETW, Enertec, MTU Onsite), Kaths 2012
Gas utilisation	CHP unit	-	eta generator	%	P el inst (CHP)	kW	30	2000	log	0.01	0.91	0.94	26		Manufacturer (ETW, Enertec)
Gas production	Digester	Biogas leakage & losses to internal fittings	Leakage rate	%	year of initial operation/ year of current roof	-	1990	2015	linear	0.00	2.26	Assumption: Older plants less gastight then newer ones, linear course between 3% and 0.2% , +0.1% for regular solid feed position and feed via screw conveyors			Bachmaier 2012, Auburger 2016, Vogel 2013
Gas production	Digester	Gas membrane	Permeation rate	cm3 / (m2 * bar * d)	Gas Temperature	K	290	330	linear	29.94	-8526.05	Assumption: double layer wie PE foil 10% of single EPDM layer			DLG 2009
Gas production	Digester	-	ORL_digester_set	kg VS / m3 d	Manure share	%	20	100	pot	1.84	-0.97	0.77	4	Mean values per power class	Härdtlein 2013
Digestate treatment	Digestate spreading	Liquid digestate	Specific diesel consumption	l/ m3 km	Transport distance	km	1	20	pot	0.52	-0.66	0.52	64		KTBL Feldarbeitsrechner
Digestate treatment	Digestate spreading	solid digestate	Specific diesel consumption	l / t km	Transport distance	km	1	20	pot	0.45	-0.59	0.89	36		KTBL Feldarbeitsrechner
Digestate treatment	Digestate storage	open storage	Residual gas potential	l N CH4 / kg VS	HRT	d	35	140	pot	34472.00	-1.90	0.90	10		Reinhold 2009
Substrates	-	-	cp substrates	KJ/K*kg	TS	%	0	30.0	linear	-6.22	4.41	0.94	7		Gerber 2009
Gas production	Digester	Temperature	Gas space	°C	Ambient temperature	°C	-10	25	linear	0.36	22.53	0.99	8	only for membrane roof	Gerber 2009
Gas production	Digester	Temperature	Near roof space	°C	Ambient temperature	°C	-10	25	linear	0.50	15.55	1.00	8	only for membrane roof	Gerber 2009
Gas utilisation	Gas storage	-	Gas storage capacity	h	capacity factor	-	0.15	1	exp	107.96	-3.86	0.47	33		Aschmann 2013, Fleischer 2016, Barchmann 2016, Holzhammer 2014
Gas utilisation	CHP unit	year of construction <2011, GO	Electric efficiency	%	Pel installed	kW	10	7000	pot	0.24	0.08	0.78	60		ASUE 2005

Gas utilisation	CHP unit	year of construction <2011, IG	Electric efficiency	%	Pel installed	kW	1	350	pot	0.27	0.08	0.90	12	No data available, same as 2011-2014 assumed	ASUE 2005
Gas utilisation	CHP unit	year of construction 2011-2014, GO	Electric efficiency	%	Pel installed	kW	10	6000	pot	0.26	0.07	0.81	174		ASUE 2011
Gas utilisation	CHP unit	year of construction 2011-2014, IG	Electric efficiency	%	Pel installed	kW	1	350	pot	0.27	0.08	0.90	12		ASUE 2011
Gas utilisation	CHP unit		Electric efficiency	%	Pel installed	kW	10	100	pot	0.22	0.12	-			ASUE 2014
Gas utilisation	CHP unit	year of construction > 2014, GO	Electric efficiency	%	Pel installed	kW	100	1000	pot	0.30	0.05	-	294	Number of data points over all three power ranges	ASUE 2014
Gas utilisation	CHP unit		Electric efficiency	%	Pel installed	kW	1000	9000	pot	0.32	0.04	-			ASUE 2014
Gas utilisation	CHP unit	year of construction > 2014, IG	Electric efficiency	%	Pel installed	kW	1	600	pot	0.32	0.06	0.77	6		ASUE 2014

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Gas upgrading	Desulphurisation	Desulph Blower	investment cost specific	€	P el	W	30	5000	pot	16.36	0.65	0.98	14		Manufacturers (Medo, Hiblow, Awite), BGA_OPT 2011, Rahmesohl 2005
Gas production	Gas control & Piping	-	investment cost	€/kW	P el, rated	kW	30	1500	pot	970.29	-0.23	0.99	4		Stenull 20??, biogaspraxis 2012
Gas production	Agitators	submersive	investment cost	€	P el	kW	0.75	22	exp	8680.00	0.02	0.29	4		KTBL 2013, Härdtlein 2013
Gas production	Agitators	long axis	investment cost	€	P el	kW	7.5	19	pot	4610.00	0.36	0.46	4		KTBL 2013, Härdtlein 2013
Gas production	Agitators	rod	investment cost	€	P el	kW	11	22	pot	1271.10	0.77	0.62	6		KTBL 2013, Härdtlein 2013
Gas production	Digester	digester (including heating, insulation and roof)	specific investment cost	€/m3	V brutto	m3	300	10000	pot	2366.00	-0.42	0.79	108	Shares components: Heating 12%, Insulation 6%, Membrane roof: 15%	Biogaspraxis 2012, Stenull 2017, KTBL 2013, FNR 2013, KTBL 2015, Reinhold 2012, Sontopski 2008, Vogt 2008, KTBL Biogasrechner, Härdtlein 2012
Digestate treatment	Digestate separation	screw press	labour time	h/d	h operation	h/d	2	10	pot	0.18	0.38	0.79	12		(Cielejewski, 2014; Drosig et al., 2015; Effenberger, 2015; Häring et al., 2011; KTBL, 2013; Leifker, 2012; Theuvsen and Kröger, 2016; TU Braunschweig et al., 2013; Waelkens and Zetzl, 2015; Wetter, 2016)
Digestate treatment	Digestate separation	screw press	investment cost	€	V digestate	m3/h	1.5	50	pot	16720.00	0.27	0.35	28		
Digestate treatment	Digestate storage	Open storage	specific investment cost	€/m3	V brutto	m3	500	7500	pot	1190.80	-0.45	0.28	38		KTBL 2013, Härdtlein 2013; KTBL 2014; Reinhold 2012; Vogt 2008; Sontopski 2008
Digestate treatment	Digestate storage	Gas tight storage	investment cost	€/m3	V brutto	m3	500	10000	pot	1527.34	-0.38	0.76	73		
Gas upgrading	gas cooling	gas cooler	investment cost	€	V biogas	Nm3/h	50	2500	lin	18.39	16843.00	0.90	19		Rahmesohl 2005, Weidenaar 2014, Panic 2015
Gas utilisation	gas storage	external storage	specific investment cost	€/m3	V brutto	m3	500	10000	pot	1731.50	-0.51	0.65	24		ISWA 2015; Bayernplan 2013; DLG Merkblatt
Gas utilisation	CHP unit	gas blower	specific investment cost	€/kW	P el	kW	0.2	25	pot	363.28	0.03	-0.18	22		Manufacturer (SKV tec, Mapro, GUT mbh, Gastechnik Himmel)
Gas utilisation	Transformator	-	investment cost	€	P el	kW	1	2700	pot	280.48	0.72	0.95	42		Pfeiffer Elektromotoren, Holzhammer 2014; Stenull 2017
Whole plant	-	-	c_administrati on	€/a	P el, rated	kW	75	2400	ln	2041.00	5460.60	0.97	3	Administration, environmental audit, accounting, tax accountancy	Empl 2017
Substrate provision	Substrate	manure solid transport	c_transport_liquid_manur	€/ t FM km	distance	km	1	300	pot	1.11	-0.52	0.82	48		KTBL Feldarbeitsrechner, KTBL 2015
Substrate provision	Substrate	manure liquid transport	c_transport_solid_manure	€/ t FM km	distance	km	1	300	pot	1.49	-0.70	0.98	134		KTBL Feldarbeitsrechner, KTBL 2015, Kowalewsky, Leuer, Laurenz
Substrate provision	Substrate	manure seperation	c_seperation_manure	€/ t FM	substrate mass, annual	t	1500	20000	pot	8684.00	-0.95	0.67	13		Theuvsen 2016
Digestate treatment	Digestate transport & spreading	Liquid digestate	c_spreading_liquid	€/ m3 km	Transport distance	km	1	20	pot	2.77	-0.66	0.63	126		Böhner 2011, Konrad 2010, Böhner et al 2011, Schindler 2012, KTBL 2013, KTBL Feldarbeitsrechner
Digestate treatment	Digestate transport & spreading	solid digestate	c_spreading_solid	€/ t km	Transport distance	km	1	20	pot	4.45	-1.07	0.89	46		Schindler 2012, LW30 2009, KTBL Feldarbeitsrechner
Whole plant	-	Energy consumption	Electricity price	€/ kWh	P el	kW	50	1000	lin	0.00	0.18	0.86	4	Mean values per power class, cap at 0.12 €/kWh	Härdtlein 2013
Substrate provision	Silo	Silaging	c_silaging	€/ tFM	P el, rated	kW	30	2000	exp	2.22	0.00	0.96	6	cap at 0.8 €/t FM	Empl 2017
Substrate provision	Silo	Silo cost	Specific silo cost	€/m3	storage volume	m3	500	27000	pot	562.68	-0.36	0.83	21		KTBL 2014
Substrate provision	Pretank	-	Specific pretank cost	€/m3	storage volume	m3	100	5000	pot	1837.00	-0.51	0.92	10		KTBL 2014, Stenull 2015
Substrate provision	Solid feed	-	Specific solidfeed cost	€/m3	storage volume	m3	4	70	pot	8605.90	-0.49	0.61	14		Biogas Praxis 2012, KTBL 2013, Stenull 2015, FNR 2013

Whole plant		Labour time	specific labour time	h/a kWel rated	Pel rated	kW	70	1000	pot	93.60	-0.57	0.82	20	Härdtlein 2013, Vidjen 2010, KTBL 2013, Fleischer 2015	
Gas utilisation	Heat storage	-	specific investment cost	€/m3	V storage	m3	1	6000	pot	2285.50	-0.33	0.69	78	Güsewell 2013	
Gas utilisation	CHP unit	year of construction <2011	specific investment cost	€/kW installed	Pel installed	kW	10	7000	pot	4639.00	-0.33	-	86	ASUE 2005	
Gas utilisation	CHP unit	year of construction 2011-2014	specific investment cost	€/kW installed	Pel installed	kW	10	100	pot	26683.00	-0.65	-	127	ASUE 2011	
Gas utilisation	CHP unit		specific investment cost	€/kW installed	Pel installed	kW	100	6000	pot	15648.00	-0.54	-		ASUE 2011	
Gas utilisation	CHP unit		specific investment cost	€/kW installed	Pel installed	kW	10	100	pot	10267.00	-0.50	-		ASUE 2014	
Gas utilisation	CHP unit	year of construction >2014	specific investment cost	€/kW installed	Pel installed	kW	100	1000	pot	4276.00	-0.33	-	183	Number of data points over all power ranges ASUE 2014	
Gas utilisation	CHP unit	year of construction >2014	specific investment cost	€/kW installed	Pel installed	kW	1000	9000	pot	1000.10	-0.12	-	120	ASUE 2014	
Gas utilisation	CHP unit		specific maintenance cost	€/kWh	Pel installed	kW	10	7000	pot	4.94	-0.22	-		94	ASUE 2005
Gas utilisation	CHP unit		specific maintenance cost	€/kWh	Pel installed	kW	10	100	pot	26.14	-0.06	-		ASUE 2011	
Gas utilisation	CHP unit	year of construction 2011-2015	specific maintenance cost	€/kWh	Pel installed	kW	100	2000	pot	17.05	-0.48	-	132	Number of data points over all power ranges ASUE 2014	
Gas utilisation	CHP unit	year of construction >2014	specific maintenance cost	€/kWh	Pel installed	kW	10	100	pot	16.10	-0.43	-		ASUE 2014	
Gas utilisation	CHP unit		specific maintenance cost	€/kWh	Pel installed	kW	100	1000	pot	6.87	-0.29	-		ASUE 2014	
Gas utilisation	CHP unit		specific maintenance cost	€/kWh	Pel installed	kW	1000	9000	pot	19.40	-0.41	-	ASUE 2014		

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Gas production	Digester	digestion supplies	c_a	€/a	P el,rated	kW	BGP class I	BGP class I	-	21.81		1		Biogas in der Landwirtschaft 2011, Härdtlein 2013/Survey data
Gas production	Digester	digestion supplies	c_a	€/a	P el,rated	kW	BGP class II	BGP class II	-	15.86		1		Biogas in der Landwirtschaft 2011, Härdtlein 2013/Survey data
Gas production	Digester	digestion supplies	c_a	€/a	P el,rated	kW	BGP class III	BGP class III	-	12.72		1		Biogas in der Landwirtschaft 2011, Härdtlein 2013/Survey data
Gas production	Digester	digestion supplies	c_a	€/a	P el,rated	kW	BGP class IV	BGP class IV	-	11.01		1		Biogas in der Landwirtschaft 2011, Härdtlein 2013/Survey data
Gas production	Digester	Lab analysis	c_a	€/a	P el,rated	kW	BGP class I	BGP class I	-	7.7		1		Stenull 2017, Härdtlein 2013/Survey data
Gas production	Digester	Lab analysis	c_a	€/a	P el,rated	kW	BGP class II	BGP class II	-	5.74		1		Stenull 2017, Härdtlein 2013/Survey data
Gas production	Digester	Lab analysis	c_a	€/a	P el,rated	kW	BGP class III	BGP class III	-	5.58		1		Stenull 2017, Härdtlein 2013/Survey data
Gas production	Digester	Lab analysis	c_a	€/a	P el,rated	kW	BGP class IV	BGP class IV	-	3.5		1		Stenull 2017, Härdtlein 2013/Survey data
Substrate provision	Silo	Foil cost	c_a	€/a	Silo area	m2			-	0.43		1		
Substrate provision	Silo	silo supplies	c_a	€/a	Silo input	t FM/a			-	1.75		1		
-	-	Diesel cost	c_diesel	€/l	diesel consumption	l				1.2		1		
Whole plant	-	labour cost	c_labour	€/h						30				
Substrate provision	Silo	labour time silo	h_labour_silo	h/d		m3		1.5		2.67			weighted average	KTBL 2013
Substrate provision	Silo	labour time silo	h_labour_silo	h/d		m3	1.5	2.3		1.64			weighted average	KTBL 2013
Substrate provision	Silo	labour time silo	h_labour_silo	h/d		m3	2.3			1.10			weighted average	KTBL 2013
Substrate provision	Silo	silage unloading	h_labour_silo	€/d		m3		1.5		1.64			weighted average	KTBL 2013
Substrate provision	Silo	silage unloading	h_labour_silo	e/d		m3	1.5	2.3		1.39			weighted average	KTBL 2013
Substrate provision	Silo	silage unloading	h_labour_silo	€/d		m3	2.3			1.21			weighted average	KTBL 2013
Substrate provision	-	Adjustments to manure share	investment cost specific	€	manure share	%		30		50,000				
Substrate provision	Silo	solid dung storage area	investment cost	€/m2						90				Galler 2009

Substrate provision	Pretank	Pump, centrifugal	investment cost	€							7200				KTBL 2013, Biogaspraxis 2012
Substrate provision	Pretank	Pump, progressive cavity	investment cost	€							8250				KTBL 2013, Biogaspraxis 2012
Substrate provision	Pretank	Pump, rotary	investment cost	€							8500				KTBL 2013, Biogaspraxis 2012
Substrate provision	Liquid feed	-	investment cost	€	Pel liquidfeed							1300			KTBL 2013
Gas upgrading	Desulphuration	Fine desulphuration, active carbon filter	Investment cost	€	Gas flow rate						44.45	11000	2		Nehring 2014
Gas utilisation	Gas flare	-	investment cost	€		BGP class I	BGP class I				5400				Härdtlein 2013
Gas utilisation	Gas flare	-	investment cost	€		BGP class II	BGP class II				7189				Härdtlein 2013
Gas utilisation	Gas flare	-	investment cost	€		BGP class III	BGP class III				12389				Härdtlein 2013
Gas utilisation	Gas flare	-	investment cost	€		BGP class IV	BGP class IV				12015				Härdtlein 2013
StoeV	-	-	investment cost	€							24000			perimeter fence, etc	Holzhammer 2014