

PROCESS & ECONOMICS CALCULATIONS
Scenario A

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FEEDSTOCK PARAMETERS		Cattle Manure	Maize Silage	Food Waste	Feedstock Total
DM	%	8%	33%	25%	8%
ODM	%	87%	95%	90%	87%
CH ₄	%	58%	55%	60%	58%
BMP	m ³ CH ₄ .tonne ^{ODM} ⁻¹	190	400	420	190
Specific Gravity	kg.m ⁻³	1.03	1.05	1.05	1.03
Manure Production	kg.hd ⁻¹ .d ⁻¹	60	-	-	-
Animals	No.	500	-	-	-
Mass	tonne.d ⁻¹	30.0	0.0	0.0	30.0
Volume	m ³ .d ⁻¹	29.1	0.0	0.0	29.1
Mass	tonne.yr ⁻¹	10,950	0	0	10,950
Dry matter	tonne.d ⁻¹	2.4	0.0	0.0	2.4
Organic Dry Matter	tonne.d ⁻¹	2.1	0.0	0.0	2.1
Methane Production	m ³ .d ⁻¹	397	0	0	397
Biogas Production	m ³ .d ⁻¹	684	0	0	684
DIGESTER CAPACITY CALCULATION					
Mass of Feedstock	tonne.d ⁻¹	-	-	-	30.0
Volume of Feedstock	m ³ .d ⁻¹	-	-	-	29.1
Organic Dry Matter	tonne.d ⁻¹	-	-	-	2.1
Digester Capacity	m ³	-	-	-	600
Hydraulic Retention Time	d	-	-	-	20.6
Organic Loading Rate	kg.m ³ .d ⁻¹	-	-	-	3.5
ENERGY BALANCE					
Methane Production	m ³ .d ⁻¹	397	0	0	397
Energy Value of Biogas	MJ.d ⁻¹	14,163	0	0	14,163
Energy Value of Biogas	kWh.d ⁻¹	3,934	0	0	3,934
Energy Value of Biogas	kW	164	0	0	164
CHP Load Factor	%	-	-	-	80%
Biogas for Boiler	%	-	-	-	20%
Electrical Efficiency of CHP	%	-	-	-	32%
Heat Efficiency of CHP	%	-	-	-	53%
Heat Efficiency of Boiler	%	-	-	-	85%

Energy Production

CHP Electricity Output	kW	52	0	0	52
Boiler Heat Output	kW	139	0	0	139
CHP Heat Output	kW	87	0	0	87
Heat Production from Boiler	kWh.d ⁻¹	669	0	0	669
Heat Production from CHP	kWh.d ⁻¹	1,668	0	0	1,668
Total Heat Production	kWh.d ⁻¹	2,337	0	0	2,337
Electricity Production	kWh.d ⁻¹	1,007	0	0	1,007

Digester Heat Input

Temperature of Feedstock	°C	10	25	15	10
Temperature of Digester	°C	-	-	-	40
Heat Input to Feedstock	MJ.d ⁻¹	3,771	0	0	3,771
Heat Input to Feedstock	kW	44	0	0	44
Digester Surface Area	m ²	-	-	-	394
Thermal Conductivity	W.m ⁻² .°C ⁻¹	-	-	-	0.35
Outside Air Temperature	°C	-	-	-	5
Digester Heat Loss	kW	-	-	-	5
Digester Heat Loss	MJ.d ⁻¹	-	-	-	417
Total Digester Heat Input	MJ.d ⁻¹	-	-	-	4,188
Total Digester Heat Input	kWh.d ⁻¹	-	-	-	1,163
Total Digester Heat Input	kW	-	-	-	48

Energy Balance

Electricity Production	kWh.d ⁻¹	-	-	-	1,007
Digester Electricity Consumption	kWh.d ⁻¹	-	-	-	50
Net Electricity Production	kWh.d ⁻¹	-	-	-	957
Digester Electricity : Output	%	-	-	-	5%
Heat Production	kWh.d ⁻¹	-	-	-	2,337
Total Digester Heat Input	kWh.d ⁻¹	-	-	-	1,163
Net Heat Output	kWh.d ⁻¹	-	-	-	1,174
Digester Heat : Available Heat	%	-	-	-	50%

MASS BALANCE

Mass of Feedstock	tonne.yr ⁻¹	10,950	0	0	10,950
Volume of CH ₄	m ³ .yr ⁻¹	144,803	0	0	144,803
Volume of CO ₂	m ³ .yr ⁻¹	104,857	0	0	104,857
Mass of CH ₄	tonne.yr ⁻¹	103	0	0	103
Mass of CO ₂	tonne.yr ⁻¹	206	0	0	206
Mass of Biogas	tonne.yr ⁻¹	308	0	0	308
Mass of Digestate	tonne.yr ⁻¹	10,642	0	0	10,642
% Mass Reduction	%	3%	#DIV/0!	#DIV/0!	3%

ECONOMIC ASSESSMENT

Feedstock Parameters

Feedstock Mass	tonne.yr ⁻¹	10,950	0	0	10,950
DM	%	8%	33%	25%	8%
ODM	%	87%	95%	90%	87%
CH ₄	%	58%	55%	60%	58%
BMP	m ³ CH ₄ .tonne ^{ODM} ⁻¹	190	400	420	190
Feedstock Cost	€.tonne ⁻¹	€ 0.00	€ 35.00	€ 0.00	€ 0.00
Feedstock Gate Fee	€.tonne ⁻¹	€ 0.00	€ 0.00	€ 35.00	€ 0.00
Feedstock Cost	€.yr ⁻¹	€ 0	€ 0	€ 0	€ 0
Feedstock Gate Fee	€.yr ⁻¹	€ 0	€ 0	€ 0	€ 0
Net Feedstock Value	€.yr⁻¹	€ 0	€ 0	€ 0	€ 0

Digestate Parameters

Digestate Mass	tonne.yr ⁻¹	10,642	0	0	10,642
Digestate Value	€.tonne ⁻¹	-	-	-	€ 0.75
Digestate Application Cost	€.tonne ⁻¹	-	-	-	€ 0.00
Digestate Value	€.yr ⁻¹	-	-	-	€ 7,981
Digestate Application Cost	€.yr ⁻¹	-	-	-	€ 0
Net Digestate Value	€.yr⁻¹	-	-	-	€ 7,981

Energy Parameters

Energy Value of Biogas	kW	164	0	0	164
CHP Electricity Output	kW	52	0	0	52
CHP Electrical Efficiency	%	-	-	-	32%
CHP Load Factor	%	-	-	-	80%
Net Heat Production	MWh.yr ⁻¹	-	-	-	428
Net Electricity Production	MWh.yr ⁻¹	-	-	-	349
Net Heat Utilisation	%	-	-	-	25%
Net Heat Utilised	MWh.yr ⁻¹	-	-	-	107
Value of Electricity	€.kWh ⁻¹	-	-	-	€ 0.18
Value of Heat	€.kWh ⁻¹	-	-	-	€ 0.08
Value of Net Electricity	€.yr ⁻¹	-	-	-	€ 62,800
Value of Net Heat Utilised	€.yr ⁻¹	-	-	-	€ 8,500
Total Value of Utilised Energy	€.yr⁻¹	-	-	-	€ 71,300

Operating Cost

Labour	€.yr ⁻¹	-	-	-	€ 5,000
Digester Maintenance	€.yr ⁻¹	-	-	-	€ 5,000
CHP Maintenance	€.yr ⁻¹	-	-	-	€ 5,000
Other Costs	€.yr ⁻¹	-	-	-	€ 4,000
Total Operating Cost	€.yr⁻¹	-	-	-	€ 19,000

Capital Cost					
Feedstock Preparation & Storage	€	-	-	-	€ 10,000
Digesters	€	-	-	-	€ 90,000
Pasteurisation	€	-	-	-	€ 0
Digestate Treatment & Storage	€	-	-	-	€ 30,000
Gas Storage, Boiler & CHP	€	-	-	-	€ 90,000
Instrumentation & Controls	€	-	-	-	€ 30,000
Civil Engineering Works	€	-	-	-	€ 70,000
Project Management & Design	€	-	-	-	€ 30,000
Infrastructure Costs	€	-	-	-	€ 50,000
Total Capital Cost	€	-	-	-	€ 400,000
Capital Cost (with Factor)	€	-	-	-	€ 400,000

Economic Assessment

Income					
Feedstock	€. _{yr} ⁻¹	-	-	-	€ 0
Energy	€. _{yr} ⁻¹	-	-	-	€ 71,300
Digestate	€. _{yr} ⁻¹	-	-	-	€ 7,900
Total Income	€._{yr}⁻¹	-	-	-	€ 79,200
Operating Cost	€._{yr}⁻¹	-	-	-	€ 19,000
Operating Cost (with Factor)	€._{yr}⁻¹	-	-	-	€ 19,000
Net Income (with Opex Factor)	€._{yr}⁻¹	-	-	-	€ 60,200

ECONOMIC SENSITIVITY

BMP	m ³ CH ₄ .tonne ^{ODM} ⁻¹	190	400	420	-
CHP Electrical Efficiency	%	-	-	-	32%
CHP Load Factor	%	-	-	-	80%
Net Heat Utilisation	%	-	-	-	25%
Feedstock Cost	€. _{tonne} ⁻¹	€ 35.00			-
Feedstock Gate Fee	€. _{tonne} ⁻¹	€ 0.00		€ 35.00	-
Digestate Value	€. _{tonne} ⁻¹	-	-	-	€ 0.75
Digestate Application Cost	€. _{tonne} ⁻¹	-	-	-	€ 0.00
Value of Electricity	€. _{kWh} ⁻¹	-	-	-	€ 0.18
Value of Heat	€. _{kWh} ⁻¹	-	-	-	€ 0.08
Operating Cost Factor	%	-	-	-	100%
Capital Cost Factor	%	-	-	-	100%
Simple Pay-Back	yr	-	-	-	6.6
Internal Rate of Return (IRR)	%	-	-	-	9.5%