

PROCESS & ECONOMICS CALCULATIONS
Scenario B

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FEEDSTOCK PARAMETERS		Cattle Manure	Maize Silage	Food Waste	Feedstock Total
DM	%	8%	33%	25%	18%
ODM	%	87%	95%	90%	93%
CH ₄	%	58%	55%	60%	55%
BMP	m ³ CH ₄ .tonne ^{ODM} ⁻¹	190	400	420	348
Specific Gravity	kg.m ⁻³	1.03	1.05	1.05	1.04
Manure Production	kg.hd ⁻¹ .d ⁻¹	60	-	-	-
Animals	No.	500	-	-	-
Mass	tonne.d ⁻¹	30.0	20.0	0.0	50.0
Volume	m ³ .d ⁻¹	29.1	19.0	0.0	48.2
Mass	tonne.yr ⁻¹	10,950	7,300	0	18,250
Dry matter	tonne.d ⁻¹	2.4	6.6	0.0	9.0
Organic Dry Matter	tonne.d ⁻¹	2.1	6.3	0.0	8.4
Methane Production	m ³ .d ⁻¹	397	2,508	0	2,905
Biogas Production	m ³ .d ⁻¹	684	4,560	0	5,244
DIGESTER CAPACITY CALCULATION					
Mass of Feedstock	tonne.d ⁻¹	-	-	-	50.0
Volume of Feedstock	m ³ .d ⁻¹	-	-	-	48.2
Organic Dry Matter	tonne.d ⁻¹	-	-	-	8.4
Digester Capacity	m ³	-	-	-	2,300
Hydraulic Retention Time	d	-	-	-	47.7
Organic Loading Rate	kg.m ³ .d ⁻¹	-	-	-	3.6
ENERGY BALANCE					
Methane Production	m ³ .d ⁻¹	397	2,508	0	2,905
Energy Value of Biogas	MJ.d ⁻¹	14,163	89,536	0	103,699
Energy Value of Biogas	kWh.d ⁻¹	3,934	24,871	0	28,805
Energy Value of Biogas	kW	164	1,036	0	1,200
CHP Load Factor	%	-	-	-	90%
Biogas for Boiler	%	-	-	-	10%
Electrical Efficiency of CHP	%	-	-	-	39%
Heat Efficiency of CHP	%	-	-	-	46%
Heat Efficiency of Boiler	%	-	-	-	85%

Energy Production

CHP Electricity Output	kW	64	404	0	468
Boiler Heat Output	kW	139	881	0	1,020
CHP Heat Output	kW	75	477	0	552
Heat Production from Boiler	kWh.d ⁻¹	334	2,114	0	2,448
Heat Production from CHP	kWh.d ⁻¹	1,629	10,297	0	11,925
Total Heat Production	kWh.d ⁻¹	1,963	12,411	0	14,374
Electricity Production	kWh.d ⁻¹	1,381	8,730	0	10,111

Digester Heat Input

Temperature of Feedstock	°C	10	25	15	16
Temperature of Digester	°C	-	-	-	40
Heat Input to Feedstock	MJ.d ⁻¹	3,771	1,257	0	5,028
Heat Input to Feedstock	kW	44	15	0	58
Digester Surface Area	m ²	-	-	-	965
Thermal Conductivity	W.m ⁻² .°C ⁻¹	-	-	-	0.35
Outside Air Temperature	°C	-	-	-	5
Digester Heat Loss	kW	-	-	-	12
Digester Heat Loss	MJ.d ⁻¹	-	-	-	1,021
Total Digester Heat Input	MJ.d ⁻¹	-	-	-	6,049
Total Digester Heat Input	kWh.d ⁻¹	-	-	-	1,680
Total Digester Heat Input	kW	-	-	-	70

Energy Balance

Electricity Production	kWh.d ⁻¹	-	-	-	10,111
Digester Electricity Consumption	kWh.d ⁻¹	-	-	-	600
Net Electricity Production	kWh.d ⁻¹	-	-	-	9,511
Digester Electricity : Output	%	-	-	-	6%
Heat Production	kWh.d ⁻¹	-	-	-	14,374
Total Digester Heat Input	kWh.d ⁻¹	-	-	-	1,680
Net Heat Output	kWh.d ⁻¹	-	-	-	12,694
Digester Heat : Available Heat	%	-	-	-	12%

MASS BALANCE

Mass of Feedstock	tonne.yr ⁻¹	10,950	7,300	0	18,250
Volume of CH ₄	m ³ .yr ⁻¹	144,803	915,420	0	1,060,223
Volume of CO ₂	m ³ .yr ⁻¹	104,857	748,980	0	853,837
Mass of CH ₄	tonne.yr ⁻¹	103	650	0	753
Mass of CO ₂	tonne.yr ⁻¹	206	1,468	0	1,674
Mass of Biogas	tonne.yr ⁻¹	308	2,118	0	2,426
Mass of Digestate	tonne.yr ⁻¹	10,642	5,182	0	15,824
% Mass Reduction	%	3%	29%	#DIV/0!	13%

ECONOMIC ASSESSMENT

Feedstock Parameters

Feedstock Mass	tonne.yr ⁻¹	10,950	7,300	0	18,250
DM	%	8%	33%	25%	18%
ODM	%	87%	95%	90%	93%
CH ₄	%	58%	55%	60%	55%
BMP	m ³ CH ₄ .tonne ^{ODM} ⁻¹	190	400	420	348
Feedstock Cost	€.tonne ⁻¹	€ 0.00	€ 35.00	€ 0.00	€ 14.00
Feedstock Gate Fee	€.tonne ⁻¹	€ 0.00	€ 0.00	€ 35.00	€ 0.00
Feedstock Cost	€.yr ⁻¹	€ 0	€ 255,500	€ 0	€ 255,500
Feedstock Gate Fee	€.yr ⁻¹	€ 0	€ 0	€ 0	€ 0
Net Feedstock Value	€.yr⁻¹	€ 0	-€ 255,500	€ 0	-€ 255,500

Digestate Parameters

Digestate Mass	tonne.yr ⁻¹	10,642	5,182	0	15,824
Digestate Value	€.tonne ⁻¹	-	-	-	€ 4.00
Digestate Application Cost	€.tonne ⁻¹	-	-	-	€ 2.00
Digestate Value	€.yr ⁻¹	-	-	-	€ 63,295
Digestate Application Cost	€.yr ⁻¹	-	-	-	-€ 31,647
Net Digestate Value	€.yr⁻¹	-	-	-	€ 31,647

Energy Parameters

Energy Value of Biogas	kW	164	1,036	0	1,200
CHP Electricity Output	kW	64	404	0	468
CHP Electrical Efficiency	%	-	-	-	39%
CHP Load Factor	%	-	-	-	90%
Net Heat Production	MWh.yr ⁻¹	-	-	-	4,633
Net Electricity Production	MWh.yr ⁻¹	-	-	-	3,471
Net Heat Utilisation	%	-	-	-	20%
Net Heat Utilised	MWh.yr ⁻¹	-	-	-	927
Value of Electricity	€.kWh ⁻¹	-	-	-	€ 0.18
Value of Heat	€.kWh ⁻¹	-	-	-	€ 0.08
Value of Net Electricity	€.yr ⁻¹	-	-	-	€ 624,800
Value of Net Heat Utilised	€.yr ⁻¹	-	-	-	€ 74,100
Total Value of Utilised Energy	€.yr⁻¹	-	-	-	€ 698,900

Operating Cost

Labour	€.yr ⁻¹	-	-	-	€ 15,000
Digester Maintenance	€.yr ⁻¹	-	-	-	€ 12,000
CHP Maintenance	€.yr ⁻¹	-	-	-	€ 48,000
Other Costs	€.yr ⁻¹	-	-	-	€ 10,000
Total Operating Cost	€.yr⁻¹	-	-	-	€ 85,000

Capital Cost					
Feedstock Preparation & Storage	€	-	-	-	€ 60,000
Digesters	€	-	-	-	€ 400,000
Pasteurisation	€	-	-	-	€ 0
Digestate Treatment & Storage	€	-	-	-	€ 100,000
Gas Storage, Boiler & CHP	€	-	-	-	€ 500,000
Instrumentation & Controls	€	-	-	-	€ 90,000
Civil Engineering Works	€	-	-	-	€ 500,000
Project Management & Design	€	-	-	-	€ 150,000
Infrastructure Costs	€	-	-	-	€ 200,000
Total Capital Cost	€	-	-	-	€ 2,000,000
Capital Cost (with Factor)	€	-	-	-	€ 2,000,000

Economic Assessment

Income					
Feedstock	€. _{yr} ⁻¹	-	-	-	-€ 255,500
Energy	€. _{yr} ⁻¹	-	-	-	€ 698,900
Digestate	€. _{yr} ⁻¹	-	-	-	€ 31,600
Total Income	€._{yr}⁻¹	-	-	-	€ 475,000
Operating Cost	€._{yr}⁻¹	-	-	-	€ 85,000
Operating Cost (with Factor)	€._{yr}⁻¹	-	-	-	€ 85,000
Net Income (with Opex Factor)	€._{yr}⁻¹	-	-	-	€ 390,000

ECONOMIC SENSITIVITY

BMP	m ³ CH ₄ .tonne ^{ODM} ⁻¹	190	400	420	-
CHP Electrical Efficiency	%	-	-	-	39%
CHP Load Factor	%	-	-	-	90%
Net Heat Utilisation	%	-	-	-	20%
Feedstock Cost	€. _{tonne} ⁻¹	€ 35.00			-
Feedstock Gate Fee	€. _{tonne} ⁻¹	€ 0.00		€ 35.00	-
Digestate Value	€. _{tonne} ⁻¹	-	-	-	€ 4.00
Digestate Application Cost	€. _{tonne} ⁻¹	-	-	-	€ 2.00
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	-	-	-	5.1
Internal Rate of Return (IRR)	%	-	-	-	15.5%