

**PROCESS & ECONOMICS CALCULATIONS**  
Scenario C

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FEEDSTOCK PARAMETERS		Cattle Manure	Maize Silage	Food Waste	Feedstock Total
DM	%	8%	33%	25%	19%
ODM	%	87%	95%	90%	92%
CH <sub>4</sub>	%	58%	55%	60%	56%
BMP	m <sup>3</sup> CH <sub>4</sub> .tonne <sup>ODM</sup> <sup>-1</sup>	190	400	420	363
Specific Gravity	kg.m <sup>-3</sup>	1.03	1.05	1.05	1.04
Manure Production	kg.hd <sup>-1</sup> .d <sup>-1</sup>	60	-	-	-
Animals	No.	500	-	-	-
Mass	tonne.d <sup>-1</sup>	30.0	20.0	10.0	60.0
Volume	m <sup>3</sup> .d <sup>-1</sup>	29.1	19.0	9.5	57.7
Mass	tonne.yr <sup>-1</sup>	10,950	7,300	3,650	21,900
Dry matter	tonne.d <sup>-1</sup>	2.4	6.6	2.5	11.5
Organic Dry Matter	tonne.d <sup>-1</sup>	2.1	6.3	2.3	10.6
Methane Production	m <sup>3</sup> .d <sup>-1</sup>	397	2,508	945	3,850
Biogas Production	m <sup>3</sup> .d <sup>-1</sup>	684	4,560	1,575	6,819
<b>DIGESTER CAPACITY CALCULATION</b>					
Mass of Feedstock	tonne.d <sup>-1</sup>	-	-	-	60.0
Volume of Feedstock	m <sup>3</sup> .d <sup>-1</sup>	-	-	-	57.7
Organic Dry Matter	tonne.d <sup>-1</sup>	-	-	-	10.6
Digester Capacity	m <sup>3</sup>	-	-	-	3,000
Hydraulic Retention Time	d	-	-	-	52.0
Organic Loading Rate	kg.m <sup>R</sup> <sup>-3</sup> .d <sup>-1</sup>	-	-	-	3.5
<b>ENERGY BALANCE</b>					
Methane Production	m <sup>3</sup> .d <sup>-1</sup>	397	2,508	945	3,850
Energy Value of Biogas	MJ.d <sup>-1</sup>	14,163	89,536	33,737	137,435
Energy Value of Biogas	kWh.d <sup>-1</sup>	3,934	24,871	9,371	38,176
Energy Value of Biogas	kW	164	1,036	390	1,591
CHP Load Factor	%	-	-	-	90%
Biogas for Boiler	%	-	-	-	10%
Electrical Efficiency of CHP	%	-	-	-	41%
Heat Efficiency of CHP	%	-	-	-	44%
Heat Efficiency of Boiler	%	-	-	-	85%

**Energy Production**

CHP Electricity Output	kW	67	425	160	652
Boiler Heat Output	kW	139	881	332	1,352
CHP Heat Output	kW	72	456	172	700
Heat Production from Boiler	kWh.d <sup>-1</sup>	334	2,114	797	3,245
Heat Production from CHP	kWh.d <sup>-1</sup>	1,558	9,849	3,711	15,118
Total Heat Production	kWh.d <sup>-1</sup>	1,892	11,963	4,508	18,363
Electricity Production	kWh.d <sup>-1</sup>	1,452	9,177	3,458	14,087

**Digester Heat Input**

Temperature of Feedstock	°C	10	25	15	16
Temperature of Digester	°C	-	-	-	40
Heat Input to Feedstock	MJ.d <sup>-1</sup>	3,771	1,257	1,048	6,076
Heat Input to Feedstock	kW	44	15	12	70
Digester Surface Area	m <sup>2</sup>	-	-	-	1,151
Thermal Conductivity	W.m <sup>-2</sup> .°C <sup>-1</sup>	-	-	-	0.35
Outside Air Temperature	°C	-	-	-	5
Digester Heat Loss	kW	-	-	-	14
Digester Heat Loss	MJ.d <sup>-1</sup>	-	-	-	1,219
Total Digester Heat Input	MJ.d <sup>-1</sup>	-	-	-	7,294
Total Digester Heat Input	kWh.d <sup>-1</sup>	-	-	-	2,026
Total Digester Heat Input	kW	-	-	-	84

**Energy Balance**

Electricity Production	kWh.d <sup>-1</sup>	-	-	-	14,087
Digester Electricity Consumption	kWh.d <sup>-1</sup>	-	-	-	1,500
Net Electricity Production	kWh.d <sup>-1</sup>	-	-	-	12,587
Digester Electricity : Output	%	-	-	-	11%
Heat Production	kWh.d <sup>-1</sup>	-	-	-	18,363
Total Digester Heat Input	kWh.d <sup>-1</sup>	-	-	-	2,026
Net Heat Output	kWh.d <sup>-1</sup>	-	-	-	16,337
Digester Heat : Available Heat	%	-	-	-	11%

**MASS BALANCE**

Mass of Feedstock	tonne.yr <sup>-1</sup>	10,950	7,300	3,650	21,900
Volume of CH <sub>4</sub>	m <sup>3</sup> .yr <sup>-1</sup>	144,803	915,420	344,925	1,405,148
Volume of CO <sub>2</sub>	m <sup>3</sup> .yr <sup>-1</sup>	104,857	748,980	229,950	1,083,787
Mass of CH <sub>4</sub>	tonne.yr <sup>-1</sup>	103	650	245	998
Mass of CO <sub>2</sub>	tonne.yr <sup>-1</sup>	206	1,468	451	2,124
Mass of Biogas	tonne.yr <sup>-1</sup>	308	2,118	696	3,122
Mass of Digestate	tonne.yr <sup>-1</sup>	10,642	5,182	2,954	18,778
% Mass Reduction	%	3%	29%	19%	14%

## ECONOMIC ASSESSMENT

### Feedstock Parameters

Feedstock Mass	tonne.yr <sup>-1</sup>	10,950	7,300	3,650	21,900
DM	%	8%	33%	25%	19%
ODM	%	87%	95%	90%	92%
CH <sub>4</sub>	%	58%	55%	60%	56%
BMP	m <sup>3</sup> CH <sub>4</sub> .tonne <sup>ODM</sup> <sup>-1</sup>	190	400	420	363
Feedstock Cost	€.tonne <sup>-1</sup>	€ 0.00	€ 35.00	€ 0.00	€ 11.67
Feedstock Gate Fee	€.tonne <sup>-1</sup>	€ 0.00	€ 0.00	€ 35.00	€ 5.83
Feedstock Cost	€.yr <sup>-1</sup>	€ 0	€ 255,500	€ 0	€ 255,500
Feedstock Gate Fee	€.yr <sup>-1</sup>	€ 0	€ 0	€ 127,750	€ 127,750
<b>Net Feedstock Value</b>	<b>€.yr<sup>-1</sup></b>	<b>€ 0</b>	<b>-€ 255,500</b>	<b>€ 127,750</b>	<b>-€ 127,750</b>

### Digestate Parameters

Digestate Mass	tonne.yr <sup>-1</sup>	10,642	5,182	2,954	18,778
Digestate Value	€.tonne <sup>-1</sup>	-	-	-	€ 4.00
Digestate Application Cost	€.tonne <sup>-1</sup>	-	-	-	€ 7.00
Digestate Value	€.yr <sup>-1</sup>	-	-	-	€ 75,112
Digestate Application Cost	€.yr <sup>-1</sup>	-	-	-	-€ 131,447
<b>Net Digestate Value</b>	<b>€.yr<sup>-1</sup></b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-€ 56,334</b>

### Energy Parameters

Energy Value of Biogas	kW	164	1,036	390	1,591
CHP Electricity Output	kW	67	425	160	652
CHP Electrical Efficiency	%	-	-	-	41%
CHP Load Factor	%	-	-	-	90%
Net Heat Production	MWh.yr <sup>-1</sup>	-	-	-	5,963
Net Electricity Production	MWh.yr <sup>-1</sup>	-	-	-	4,594
Net Heat Utilisation	%	-	-	-	20%
Net Heat Utilised	MWh.yr <sup>-1</sup>	-	-	-	1,193
Value of Electricity	€.kWh <sup>-1</sup>	-	-	-	€ 0.18
Value of Heat	€.kWh <sup>-1</sup>	-	-	-	€ 0.08
Value of Net Electricity	€.yr <sup>-1</sup>	-	-	-	€ 826,900
Value of Net Heat Utilised	€.yr <sup>-1</sup>	-	-	-	€ 95,400
<b>Total Value of Utilised Energy</b>	<b>€.yr<sup>-1</sup></b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>€ 922,300</b>

### Operating Cost

Labour	€.yr <sup>-1</sup>	-	-	-	€ 50,000
Digester Maintenance	€.yr <sup>-1</sup>	-	-	-	€ 25,000
CHP Maintenance	€.yr <sup>-1</sup>	-	-	-	€ 67,000
Other Costs	€.yr <sup>-1</sup>	-	-	-	€ 20,000
<b>Total Operating Cost</b>	<b>€.yr<sup>-1</sup></b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>€ 162,000</b>

Capital Cost				
Feedstock Preparation & Storage	€	-	-	€ 200,000
Digesters	€	-	-	€ 450,000
Pasteurisation	€	-	-	€ 120,000
Digestate Treatment & Storage	€	-	-	€ 150,000
Gas Storage, Boiler & CHP	€	-	-	€ 550,000
Instrumentation & Controls	€	-	-	€ 150,000
Civil Engineering Works	€	-	-	€ 800,000
Project Management & Design	€	-	-	€ 200,000
Infrastructure Costs	€	-	-	€ 380,000
<b>Total Capital Cost</b>	<b>€</b>	<b>-</b>	<b>-</b>	<b>€ 3,000,000</b>
<b>Capital Cost (with Factor)</b>	<b>€</b>	<b>-</b>	<b>-</b>	<b>€ 3,000,000</b>

#### Economic Assessment

Income				
Feedstock	€. <sub>yr</sub> <sup>-1</sup>	-	-	-€ 127,750
Energy	€. <sub>yr</sub> <sup>-1</sup>	-	-	€ 922,300
Digestate	€. <sub>yr</sub> <sup>-1</sup>	-	-	-€ 56,300
<b>Total Income</b>	<b>€.<sub>yr</sub><sup>-1</sup></b>	<b>-</b>	<b>-</b>	<b>€ 738,200</b>
<b>Operating Cost</b>	<b>€.<sub>yr</sub><sup>-1</sup></b>	<b>-</b>	<b>-</b>	<b>€ 162,000</b>
<b>Operating Cost (with Factor)</b>	<b>€.<sub>yr</sub><sup>-1</sup></b>	<b>-</b>	<b>-</b>	<b>€ 162,000</b>
<b>Net Income (with Opex Factor)</b>	<b>€.<sub>yr</sub><sup>-1</sup></b>	<b>-</b>	<b>-</b>	<b>€ 576,200</b>

#### ECONOMIC SENSITIVITY

BMP	m <sup>3</sup> CH <sub>4</sub> .tonne <sup>ODM</sup> <sup>-1</sup>	190	400	420	-
CHP Electrical Efficiency	%	-	-	-	41%
CHP Load Factor	%	-	-	-	90%
Net Heat Utilisation	%	-	-	-	20%
Feedstock Cost	€. <sub>tonne</sub> <sup>-1</sup>	€ 35.00			-
Feedstock Gate Fee	€. <sub>tonne</sub> <sup>-1</sup>	€ 0.00		€ 35.00	-
Digestate Value	€. <sub>tonne</sub> <sup>-1</sup>	-	-	-	€ 4.00
Digestate Application Cost	€. <sub>tonne</sub> <sup>-1</sup>	-	-	-	€ 7.00
Value of Electricity	€. <sub>kWh</sub> <sup>-1</sup>	-	-	-	€ 0.18
Value of Heat	€. <sub>kWh</sub> <sup>-1</sup>	-	-	-	€ 0.08
Operating Cost Factor	%	-	-	-	100%
Capital Cost Factor	%	-	-	-	100%
<b>Simple Pay-Back</b>	<b>yr</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>5.2</b>
<b>Internal Rate of Return (IRR)</b>	<b>%</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>15.1%</b>