

BAT Assessment Summary - Oil Production Facility with Associated Gas Flow

Option Number	Description	Total NPV	NPV vs Base Case
Option 1	Turbine Option to Produce Electricity	-£12,165,733.31	£ -
Option 2	Engine Option to Produce Electricity	-£9,703,883.32	£ 2,461,849.99

Considerations
<ul style="list-style-type: none">• Assessment has been undertaken to determine which technology provides the better results from a financial and environmental perspective.• Costs associated with construction of pipelines or site amendments have not been considered as these will be in place irrespective of the chosen technology.

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Gas Turbine with Gas Export

Year	2024	2025	2026
Carbon Cost per Tonne	£ 256.00	£ 260.00	£ 264.00

Direct Cost to Operator

Gas Generator Capital (CAP Ex)	£ 2,586,903.86	£ -	£ -
Gas Generator Maintenance (Op Ex)	£ 224,000.00	£ 224,000.00	£ 224,000.00
Gas Generator Consumables / Chemicals / Parts	£ -	£ -	£ -
Site Electricity Cost Direct and / or Indirect (Generator Hire + Fuel)	£ -	£ -	£ -
Modifications to Existing Equipment	£ -	£ -	£ -
Additional Land	£ -	£ -	£ -
Civils	£ -	£ -	£ -
Materials	£ -	£ -	£ -
Project Planning (If Not Civils)	£ -	£ -	£ -
Major Refurbishment	£ -	£ -	£ -
Residual Value of Equipment - Enter in Final Year as a Negative Value	£ -	£ -	£ -
Decommissioning - Enter in Final Year	£ -	£ -	£ -
Additional Cost #1 - Pipeline and Site Installation	£ -	£ -	£ -
Additional Cost #2	£ -	£ -	£ -
Additional Cost #3	£ -	£ -	£ -
Additional Cost #4	£ -	£ -	£ -
Financial Cost (Annually)	£ 2,810,903.86	£ 224,000.00	£ 224,000.00

Pollution Quantities

Total Natural Gas Flow (Sm3/hr)	941.00	941.00	941.00
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Gas Turbine	Waste Natural Gas Flow to Engine (Sm3/hr) (Increase rate to meet Site Load)	340.00	340.00	340.00
	Site Load (MW)	1.39	1.39	1.39
	CO ₂ from Methane Gas Turbine Combustion (Tonnes/Year)	4492.18	4492.18	4492.18
	CO ₂ from C2 - C5 Gas Turbine Combustion (Tonnes/Year)	699.52	699.52	699.52
	Number of Turbines	7.00	7.00	7.00
	NOx From Gas Turbine (Tonnes/Year)	4.30	4.30	4.30

Flare and Vent	Waste Natural Gas Flow Cold Vented (Sm3/hr) (Assume 1% Uncombusted)	6.01	6.01	6.01
	Waste Natural Gas Flow to Flare (Sm3/hr) (Assume 99% Combusted)	594.99	594.99	594.99
	Methane Flow Cold Vented (CO ₂ eq (Tonnes/Year)	808.50	808.50	808.50
	CO ₂ from Methane Flare Combustion (Tonnes/Year)	7782.58	7782.58	7782.58
	Methane Slip (CO ₂ eq Tonnes/Year)	800.41	800.41	800.41
	C2-C5 Flow Cold Vented (CO ₂ eq Tonnes/Year)	56.88	56.88	56.88
	CO ₂ from C2 - C5 Flare Combustion (Tonnes/Year)	1211.91	1211.91	1211.91
	C2-C5 Slip (CO ₂ eq Tonnes/Year)	56.31	56.31	56.31
NOx From Flare (Tonnes/Year)	12.93	12.93	12.93	

Total Cost

Methane Emitted	-£ 411,880.70	-£ 418,316.34	-£ 424,751.97
Methane Combusted (CO ₂ Emission)	-£ 3,142,338.87	-£ 3,191,437.91	-£ 3,240,536.96
C2-C5 Emitted	-£ 28,976.71	-£ 29,429.48	-£ 29,882.24
C2-C5 Combusted (CO ₂ Emission)	-£ 489,325.92	-£ 496,971.64	-£ 504,617.35
NOx	-£ 238,576.44	-£ 238,576.44	-£ 238,576.44
Capital & Operating	-£ 2,810,903.86	-£ 224,000.00	-£ 224,000.00
Total Annual Costs Financial and Environmental	-£ 7,122,002.50	-£ 4,598,731.80	-£ 4,662,364.96

Income & Benefit

CO ₂ Offset Equivalent for Power Generation	£ 875,764.76	£ 889,448.59	£ 903,132.41
NOx Offset Equivalent from Power Generation	£ 257,901.70	£ 257,901.70	£ 257,901.70
Total Annual Income/Offset	£ 1,133,666.46	£ 1,147,350.29	£ 1,161,034.11

Summary

Present Value Cost	-£15,379,313.25
Present Value Benefit	£3,213,579.94
Net Present Value	-£12,165,733.31

Gas Engine with Gas Export

Year	2024	2025	2026
Carbon Cost per Tonne	£ 256.00	£ 260.00	£ 264.00

Direct Cost to Operator

Gas Generator Capital (CAP Ex)	£ 861,260.00	£ -	£ -
Gas Generator Maintenance (Op Ex)	£ 201,480.00	£ 201,480.00	£ 201,480.00
Gas Generator Consumables / Chemicals / Parts	£ -	£ -	£ -
Site Electricity Cost Direct and / or Indirect (Generator Hire + Fuel)	£ -	£ -	£ -
Modifications to Existing Equipment	£ -	£ -	£ -
Additional Land	£ -	£ -	£ -
Civils	£ -	£ -	£ -
Materials	£ -	£ -	£ -
Project Planning (If Not Civils)	£ -	£ -	£ -
Major Refurbishment	£ -	£ -	£ -
Residual Value of Equipment - Enter in Final Year as a Negative Value	£ -	£ -	£ -
Decommissioning - Enter in Final Year	£ -	£ -	£ -
Additional Cost #1 - Pipeline and Site Installation	£ -	£ -	£ -
Additional Cost #2	£ -	£ -	£ -
Additional Cost #3	£ -	£ -	£ -
Additional Cost #4	£ -	£ -	£ -
Financial Cost (Annually)	£ 1,062,740.00	£ 201,480.00	£ 201,480.00

Pollution Quantities

Total Natural Gas Flow (Sm3/hr)	849.00	849.00	849.00
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Gas Engine	Waste Natural Gas Flow to Engine (Sm3/hr) (Increase rate to meet Site Load)	241.00	241.00	241.00
	Site Load (MW)	1.39	1.39	1.39
	CO ₂ from Natural Gas Engine Combustion (Tonnes/Year)	3184.17	3184.17	3184.17
	CO ₂ from C2 - C5 Gas Engine Combustion (Tonnes/Year)	495.84	495.84	495.84
	Number of Engines	1.00	1.00	1.00
	NOx From Gas Engines (Tonnes/Year)	11.23	11.23	11.23

Flare and Vent	Waste Natural Gas Flow Cold Vented (Sm3/hr) (Assume 1% Uncombusted)	6.08	6.08	6.08
	Waste Natural Gas Flow to Flare (Sm3/hr) (Assume 99% Combusted)	601.92	601.92	601.92
	Methane Flow Cold Vented (CO ₂ eq (Tonnes/Year)	817.91	817.91	817.91
	CO ₂ from Methane Flare Combustion (Tonnes/Year)	7873.22	7873.22	7873.22
	Methane Slip (CO ₂ eq Tonnes/Year)	809.73	809.73	809.73
	C2-C5 Flow Cold Vented (CO ₂ eq Tonnes/Year)	57.54	57.54	57.54
	CO ₂ from C2 - C5 Flare Combustion (Tonnes/Year)	1226.02	1226.02	1226.02
	C2-C5 Slip (CO ₂ eq Tonnes/Year)	56.97	56.97	56.97
NOx From Flare (Tonnes/Year)	13.08	13.08	13.08	

Total Cost

Methane Emitted	-£ 416,677.98	-£ 423,188.57	-£ 429,699.17
Methane Combusted (CO ₂ Emission)	-£ 2,830,691.50	-£ 2,874,921.05	-£ 2,919,150.61
C2-C5 Emitted	-£ 29,314.21	-£ 29,772.25	-£ 30,230.28
C2-C5 Combusted (CO ₂ Emission)	-£ 440,796.10	-£ 447,683.54	-£ 454,570.98
NOx	-£ 336,573.00	-£ 336,573.00	-£ 336,573.00
Capital & Operating	-£ 1,062,740.00	-£ 201,480.00	-£ 201,480.00
Total Annual Costs Financial and Environmental	-£ 5,116,792.79	-£ 4,313,618.41	-£ 4,371,704.03

Income & Benefit

CO ₂ Offset Equivalent for Power Generation	£ 874,711.04	£ 888,378.40	£ 902,045.76
NOx Offset Equivalent from Power Generation	£ 257,591.39	£ 257,591.39	£ 257,591.39
Total Annual Income/Offset	£ 1,132,302.43	£ 1,145,969.79	£ 1,159,637.15

Summary

Present Value Cost	-£12,913,596.65
Present Value Benefit	£3,209,713.33
Net Present Value	-£9,703,883.32

Site Parameters	
Flow Rate (Sm ³ /hr)	413.00
Annual Hours	8,760.00
Site Electrical Load (MW)	1.40
C1 - Methane Gas Density (kg/m ³) (based on STP)	0.716
Methane Global Warming Potential	28
Methane to CO ₂ Conversion Factor	2.75
Methane Concentration	76.60%
C2 - C5 Average Gas Density (kg/m ³) (based on STP)	2.280
C2 - Ethane Gas Density (kg/m ³) (based on STP)	1.342
C3 - Propane Gas Density (kg/m ³) (based on STP)	1.967
C4 - Butane Gas Density (kg/m ³) (based on STP)	2.593
C5 - Pentane Gas Density (kg/m ³) (based on STP)	3.219
C2 - C5 Global Warming Potential (EA Confirmed)	4.6
C2 - C5 to CO ₂ Conversion Factor	1
C2 - C5 Concentration	10.30%
C2 - Ethane Concentration	6.70%
C3 - Propane Concentration	3.00%
C4 - Butane Concentration	0.40%
C5 - Pentane Concentration	0.20%

Conversion Factors	
Conversion of kWh to CO ₂ in Tonnes (kgCO ₂ /kWh)	0.28088
Conversion of kWh to NO _x in Tonnes (kgNO _x /kWh)	0.00153

Flare Parameters	
Combustion Efficiency - Shrouded Flare	95.00%
Combustion Efficiency - Enclosed Unit	99.00%
CH ₄ to Total Flue Gas Ratio	16.71
Max Allowable Nox Emissions (mg/m ³)	150.00

Gas Engine Parameters (J612)	
Energy per Unit Volume of Gas MJ/Sm ³	44.61
Gas Engine Efficiency	47%
Gas Engine NO _x Emission (mg/Nm ³)	95.00
Engine Electrical Output (MW)	2.00
Engine Size Swept Volume / Displacement (Litres)	150.00
Engine (RPM)	1500.00

Gas Turbine Parameters (Capstone 200KW)	
Energy per Unit Volume of Gas MJ/Sm ³	44.61
Gas Turbine Efficiency (%)	33%
Gas Turbine NO _x Emission (mg/m ³)	18.00
Gas Turbine Electrical Output (High) (MW)	0.20
Gas Turbine Exhaust Flow (kg/s)	1.30
Density of Air (kg/mg)	1.20

Gas Export	
Energy per Unit Volume of Gas MJ/Sm ³	37.60

Gas Volumes (scf to m ³)						
scfd	SG	Sm ³	hours	Sm ³ /hr	Mass (kg)	Mass (t)
510,000.00	0.69	14,441.594	24.00	601.733	9,993.583	9.994
mmscfd		Nm ³		Nm ³ /hr	Mass (kg)	Mass (t)
0.510000		13,689.818		570.409	9,473.354	9.473

Gas Volumes (m ³ to scf)							
Sm ³ /hr	hours	Sm ³	scfd	mmscfd	SG	Mass (kg)	Mass (t)
412.954	24.00	9,910.90	350,000	0.350	0.70	6,937.627	6.938
Nm ³ /hr		Nm ³	scfd	mmscfd		Mass (kg)	Mass (t)
391.457		9,394.97	350,000	0.350		6,576.478	6.576

Pth = V*Hg / 3.6		
Fuel Flow Rate Load	19 m ³ /h	V
Lower Heating Value	44.61 MJ/m ³	Hg
Thermal Input Power	235.44 kWth	Pth
Efficiency	28%	
Electricity Output	65.92	

