

Supplementary Information

Table SI1A: Capital equipment cost for all processing capacities

EQUIPMENT COSTINGS	DPT				AW/AWS	JUSTIFICATION
	200 kg/h	600 kg/h	1000 kg/h	2000 kg/h	2000 kg/h	
Reactor	£45,000	£135,000	£225,000	£450,000	£450,000	Derived from cost estimates for the equipment available at the Aston University demonstration plant (i.e. the 1 kg/h fast pyrolysis reactor)
Grinder	£100,000	£100,000	£100,000	£100,000	£100,000	Estimate provided by commercial supplier
Sieve Machine	£25,000	£25,000	£25,000	£25,000	£25,000	Estimate provided by commercial supplier
Wet Separator					£19,000	Estimate provided by commercial supplier
Microturbine (Dual Fuel) CHP 100 kW (@ £1280 per kW)	£128,000	£128,000	£128,000	£128,000	£128,000	
Total Equipment Cost	£298,000	£388,000	£478,000	£703,000	£722,000	
Total Equipment Cost (Exc dry pre-treatment)	£173,000	£263,000	£353,000	£578,000	£597,000	

Table SI1B: Staffing level for trommel fines fast pyrolysis energy system (Adapted from Yang et al., 2017)

Capacity (kg h ⁻¹)	Day team		Shift team		Total (head)
	Manager	Technician	Supervisor	Operator	
200	1	0.5	1	2	10.5
600	1	1	1	3	14
1000	1	1.5	1	3	14.5
2000	1	2	1	4	15.5

Table SI2: Energy production, total revenue and landfill costs from DPT trommel fines at different capacities

CAPACITY	200 kg/h	600 kg/h	1000 kg/h	2000 kg/h
Feedstock (Tonnes per year)	1600	4800	8000	16000
Feedstock Calorific value (MJ/kg)	13.80	13.80	13.80	13.80
PT FP process conversion efficiency (η)	41%	41%	41%	41%
CHP efficiency	60.0%	60.0%	60.0%	60.0%
Conversion factor (to kWh)	278	278	278	278
Electricity selling price (£/unit)	£0.055	£0.055	£0.055	£0.055
Heat selling price (£/unit)	£0.0349	£0.0349	£0.0349	£0.0349
Gate fee (£/tonne)	£100	£100	£100	£100
Landfill disposal (£/tonne)	£115	£115	£115	£115
Available energy (GJ)	22080	66240	110400	220800
T Available energy (GJ)	5432	16295	27158	54317
Total Units produced	1510007	4530021	7550035	15100070
Income from heat (£)	£40,020	£120,059	£200,099	£400,197
Income from electricity (£)	£19,982	£59,946	£99,910	£199,820
Energy revenue (£)	£60,002	£180,005	£300,009	£600,018
Gate fee revenue (£)	£160,000	£480,000	£800,000	£1,600,000
Total revenue (£)	£220,002	£660,005	£1,100,009	£2,200,018
PT Land fill cost per year (£)	£184,000	£552,000	£920,000	£1,840,000

DPT – Dry pre-treated trommel fines; FP – Fast pyrolysis

Table SI3: Capital and operating cost for Pyro-CHP of DPT feedstock at different processing capacities

CAPACITY	200 kg/h	600 kg/h	1000 kg/h	2000 kg/h
Total plant cost (TPC) (£)	£1,762,670	£2,295,020	£2,827,370	£4,158,245
Direct plant cost (DPC) (£)	£1,043,000	£1,358,000	£1,673,000	£2,460,500
Operating cost (£/year)	£651,513	£1,002,957	£1,214,360	£1,731,200
Maintenance (£/year)	£44,067	£57,376	£70,684	£103,956
Overheads (£/year)	£35,253	£45,900	£56,547	£83,165
Utility (£/year)	£82,054	£246,162	£410,269	£820,539
Labour cost (£/year)	£490,139	£653,519	£676,859	£723,540

Table SI4: Energy production, total revenue and landfill costs for all three pre-treated feedstocks at 2000 kg/kg processing capacities

SAMPLE	DPT	AW	AWS
Feed (Tonnes per year)	16000	16000	16000
Feed Calorific value (MJ/kg)	13.80	15.70	16.10
FP process conversion efficiency (η)	41%	64%	62%
CHP efficiency	60.0%	60.0%	60.0%
Conversion factor (to kWh)	278	278	278
Electricity selling price (£/unit)	£0.055	£0.055	£0.055
Heat selling price (£/unit)	£0.0349	£0.0349	£0.0349
Gate fee (£/tonne)	£100	£100	£100
Landfill disposal (£/tonne)	£115	£115	£115
Available energy (GJ)	220800	251200	257600
T Available energy (GJ)	54317	96461	95827
Units produced	15100070	26816102	26639962
Income from heat (£)	£400,197	£710,707	£706,039
Income from electricity (£)	£199,820	£354,860	£352,529
Energy revenue (£)	£600,018	£1,065,567	£1,058,568
Gate fee revenue (£)	£1,600,000	£1,600,000	£1,600,000
Total revenue (£)	£2,200,018	£2,665,567	£2,658,568
Land fill cost per year (£)	£1,840,000	£1,840,000	£1,840,000

DPT – Dry pre-treated trommel fines; AW – Agitated Washing; AWS – Agitated Washing with Surfactant (Decon Neutracon); FP – Fast pyrolysis

Table SI5: Capital and operating costs for all three pre-treated feedstocks, each processed at a capacity of 2000 kg/h.

SAMPLE	DPT	AW	AWS
Total plant cost (TPC) (£)	£4,158,245	£4,270,630	£4,270,630
Direct plant cost (DPC) (£)	£2,460,500	£2,527,000	£2,527,000
Operating cost (£/year)	£1,731,200	£1,740,737	£1,741,697
Maintenance (£/year)	£103,956	£106,766	£106,766
Overheads (£/year)	£83,165	£85,413	£85,413
Utility - Electricity consumption (£/year)	£58,939	£58,939	£58,939
Utility - Water usage (£/year)	£761,600	£766,080	£766,080
Utility - Surfactant (£/year)	n/a	n/a	£960
Labour cost (£/year)	£723,540	£723,540	£723,540

DPT – Dry pre-treated trommel fines; AW – Agitated Washing; AWS – Agitated Washing with Surfactant (Decon Neutracon)

Table SI6: Energy production, total revenue and landfill costs at 40% CHP efficiency for all three pre-treated feedstocks at 2000 kg/h processing capacities.

SAMPLE	DPT	AW	AWS
Feed (Tonnes per year)	16000	16000	16000
Feed Calorific value (MJ/kg)	13.80	15.70	16.10
FP process conversion efficiency (η)	41%	64%	62%
CHP efficiency	40%	40%	40%
Conversion factor (to kWh)	278	278	278
Electricity selling price (£/unit)	0.055	0.055	0.055
Heat selling price (£/unit)	0.0349	0.0349	0.0349
Gate fee (£/tonne)	£100	£100	£100
Landfill disposal (£/tonne)	£115	£115	£115
Available energy (GJ)	220800	251200	257600
T Available energy (GJ)	36211	64307	63885
Units produced	10066714	17877402	17759974
Income from heat (£)	£266,798	£473,805	£470,693
Income from electricity (£)	£133,214	£236,573	£235,019
Energy revenue (£)	£400,012	£710,378	£705,712
Gate fee revenue (£)	£1,600,000	£1,600,000	£1,600,000
Total revenue (£)	£2,000,012	£2,310,378	£2,305,712
Land fill cost per year (£)	£1,840,000	£1,840,000	£1,840,000

DPT – Dry pre-treated trommel fines; AW – Agitated Washing; AWS – Agitated Washing with Surfactant (Decon Neutracon); FP – Fast pyrolysis

Table SI7: Energy production, total revenue and landfill costs at 80% CHP efficiency for all three pre-treated feedstocks at 2000 kg/h processing capacities.

SAMPLE	DPT	AW	AWS
Feed (Tonnes per year)	16000	16000	16000
Feed Calorific value (MJ/kg)	13.80	15.70	16.10
FP process conversion efficiency (η)	41%	64%	62%
CHP efficiency	80%	80%	80%
Conversion factor (to kWh)	278	278	278
Electricity selling price (£/unit)	0.055	0.055	0.055
Heat selling price (£/unit)	0.0349	0.0349	0.0349
Gate fee (£/tonne)	£100	£100	£100
Landfill disposal (£/tonne)	£115	£115	£115
Available energy (GJ)	220800	251200	257600
T Available energy (GJ)	72422	128614	127770
Units produced	20133427	35754803	35519949
Income from heat (£)	£533,596	£947,610	£941,385
Income from electricity (£)	£266,427	£473,146	£470,038
Energy revenue (£)	£800,024	£1,420,756	£1,411,424
Gate fee revenue (£)	£1,600,000	£1,600,000	£1,600,000
Total revenue (£)	£2,400,024	£3,020,756	£3,011,424
Land fill cost per year (£)	£1,840,000	£1,840,000	£1,840,000

DPT – Dry pre-treated trommel fines; AW – Agitated Washing; AWS – Agitated Washing with Surfactant (Decon Neutracon); FP – Fast pyrolysis

Table SI8: Capital and operating costs (excluding grinder and sieving unit operations) for all three feedstocks at 2000 kg/h processing capacities

SAMPLE	DPT	AW	AWS
Total plant cost (TPC) (£)	£3,418,870	£3,531,255	£3,531,255
Direct plant cost (DPC) (£)	£2,023,000	£2,089,500	£2,089,500
Operating cost (£/year)	£1,697,928	£1,707,465	£1,708,425
Maintenance (£/year)	£85,472	£88,281	£88,281
Overheads (£/year)	£68,377	£70,625	£70,625
Utility - Electricity consumption (£/year)	£58,939	£58,939	£58,939
Utility - Water usage (£/year)	£761,600	£766,080	£766,080
Utility - Surfactant (£/year)			£960
Labour cost (£/year)	£723,540	£723,540	£723,540

DPT – Dry pre-treated trommel fines; AW – Agitated Washing; AWS – Agitated Washing with Surfactant (Decon Neutracon)

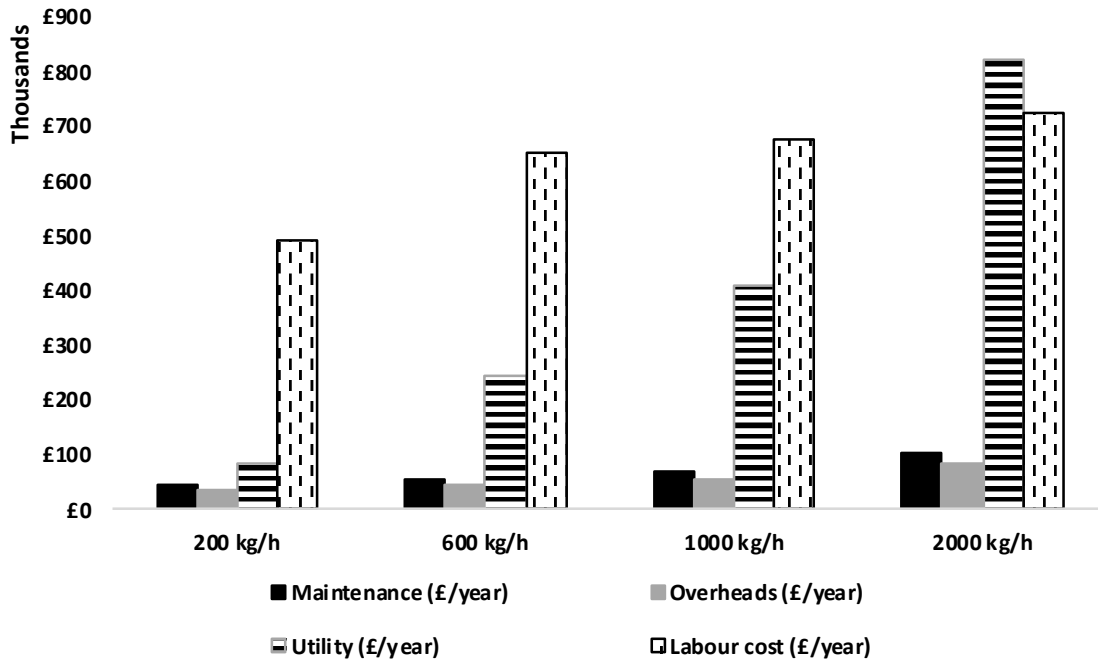


Figure SI1: Breakdown of operating cost for DPT trommel fines Pyro-CHP system at different capacities

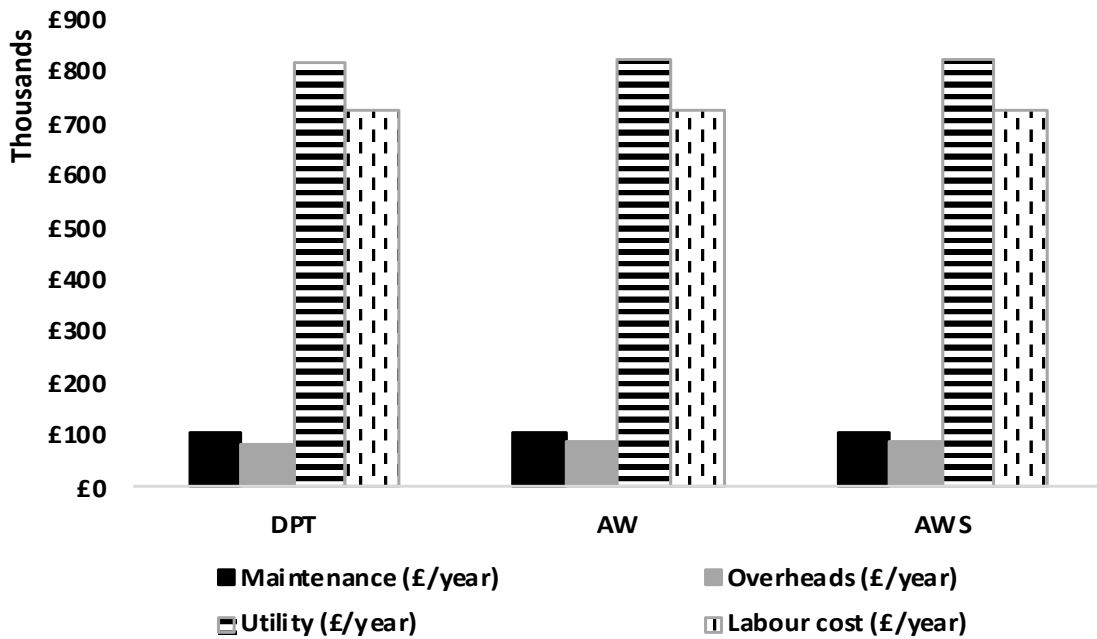


Figure SI2: Breakdown of operating cost for pyro-CHP systems using 2000 kg/h DPT, AW and AWS trommel fines feedstocks

DPT - fry pre-treated Trommel Fines; AW – Agitated Washing; AWS – Agitated Washing with Surfactant (Decon Neutracon)

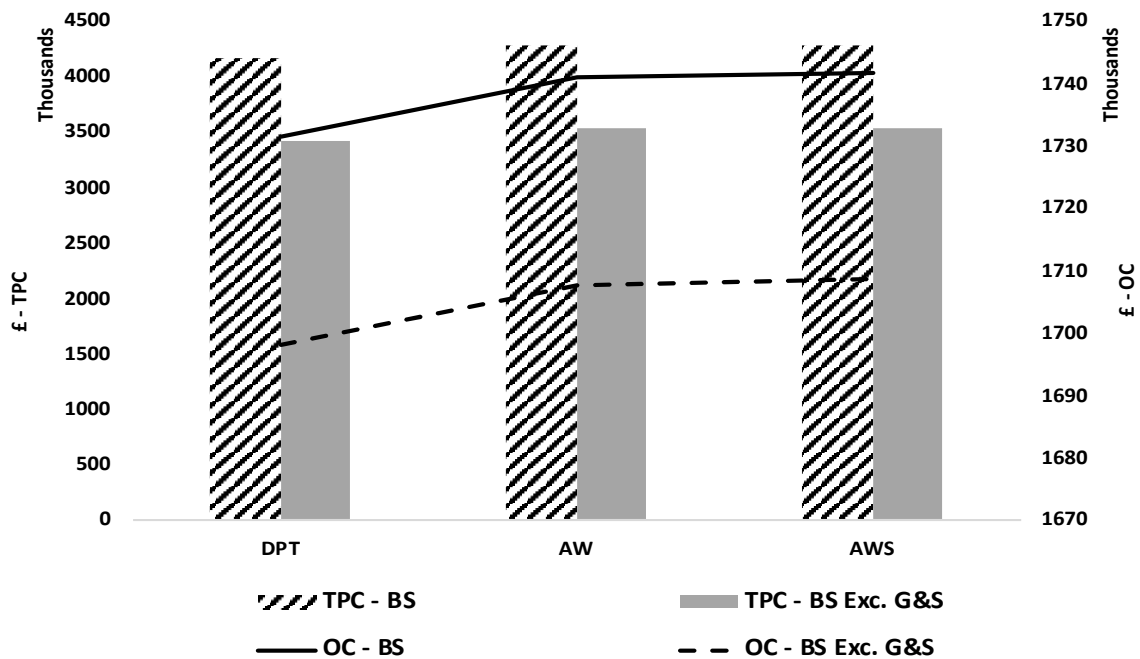


Figure SI3: Comparison of calculated capital investment and operating cost with (Base Scenario) and without grinding and sieving unit operations for pyro-CHP systems using DPT, AW and AWS trommel fines at 2000 kg/h capacities.

DPT - dry pre-treated Trommel Fines; AW – Agitated Washing; AWS – Agitated Washing with Surfactant (Decon Neutracon); TPC – Total Plant Cost; OC – Operating Cost; BS – Base Scenario; BS Exc. G&S – Base Scenario Excluding Grinder & Sieve