Swadlincote Energy Recovery Facility

Cost Benefit Assessment

Appendix 2

CHP Readiness Assessment

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Prepared By

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Project Quality Control Sheet

ORIGINAL	Author	Checked by	Approved by
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Location: **Willshee's Depot 3, Keith Willshee Way, Swadlincote, DE11 9EN**

Grid Reference: SK268190

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1 Introduction

R&P Clean Power Ltd are applying for an environmental permit for a facility known as the Swadlincote Energy Recovery Facility (SERF) which will be located at Keith Willshee Way, to the south-west of Swadlincote in South Derbyshire. The postcode for the site is DE11 9EN and the grid coordinates for the centre of the site are SK267190.

SERF comprises of an Energy Recovery Facility (ERF) designed to accept up to 186,000 tonnes of Refuse Derived Fuel (RDF) per annum, and will generate approximately 20.5MW of electricity (gross), of which 18.5MW will be exported to local industrial users and public electricity distribution network operated by National Grid Energy Distribution (NGED).

It is required that the Best Available Techniques (BAT) are used for new energy from waste facilities and one element of BAT is that the plant should operate with as high an energy conversion efficiency as possible and this is demonstrated by the undertaking of an assessment of the potential for the plant to operate in a way that it can supplies heat as well as electricity to customers as combined heat and power (CHP).

In circumstances that a heat load cannot be identified at the outset of the plant operation, for facilities with a throughput of greater than 3 tonnes per hour of non-hazardous waste it is required that it is demonstrated that the plant is substantially ready to supply heat should the opportunity arise in the future and thus be 'CHP ready' (CHP-R). This report presents the required CHP-R Assessment that has been completed in line with the guidance provided by the Environment Agency[1].

[1] CHP Ready Guidance for Combustion and Energy from Waste Power Plants V1.0, Environment Agency, 2013

2 CHP Ready Assessment

Ref	Description	Units	Response
Requirement 1: Plant, plant location and potential heat loads			
1.1	**Plant name**		Swadlincote Resource Recovery Park
1.2	**Plant Description**		The facility will treat approximately 23 t/hr of refused derived fuel (RDF with EWC Codes; 19-12-10; 19-12-12; 20-83-01) and other wastes listed in Table 1b of Form B3 via a single combustion chamber incorporating reciprocating inclined grate. The facility includes a reception hall incorporating fuel storage an air emissions abatement plant and ash handling facilities. The thermal capacity of the boiler is 67.7MWth and the resulting steam is used within a single steam turbine to generate a gross electrical output of 20.5MW_e. Following meeting electrical demands of the facility any excess electricity is exported to local industrial users and the local electricity distribution network operated by National Grid Energy Distribution (NGED). Exhaust steam from the turbine is passed to a condenser where it will be cooled and the resulting condensate returned to the boiler system.
1.3	**Plant Location**		The plant is located at land off Keith Wilshee Way, Swadlincote. The postcode for the site is DE11 9EN. The grid coordinates for the site are SK267190. A site plan is provided within the application.
1.4	**Factors influencing selection of plant location**		During the development process, consideration was been given to sites that may be suitable as alternatives to the site proposed development. In the absence of a currently applicable formal waste plan for Derbyshire, a process of identifying criteria that are constraints or opportunities for such a development as the one proposed has been prepared. This has included identifying an area of study that encompasses southern Derbyshire and the City of Derby. Waste processing facilities of this type normally carefully consider locational issues such as highway access, site characteristics and neighbouring land uses. However, in the context of an energy recovery facility from residual wastes, particular attention needs to be given regarding the ability of both electricity and heat to be effectively utilised. This is to ensure that the maximum benefit can be realised from the development that can be considered within the planning balance. Drawing on multiple data sources and local consultation, a short list of sites that may be applicable has been prepared and each site (or development area) assessed against the criteria developed to provide a non-weighted order of preference. This assessment concludes that the Proposal Site at Depot 3 is the preferred location within the Study Area, scoring highly not only on key aspects such as primary road network access and proximity to waste arisings, the existing waste processing infrastructure, but also significantly on the opportunity that heat distribution into Swadlincote affords compared to other sites considered.
1.5	**Operation of plant**		
a.	Proposed operational plant load	%	100
b.	Thermal input at proposed operational plant load	MW	67.66

c.	Net electrical output at proposed operational plant load	MW	Gross: 20.5MW Parasitic loads: 2.0MW Net output: 18.5MW
d.	Net electrical efficiency at proposed operational plant load	%	27.3%
e.	Maximum plant load	%	100%
f.	Thermal input at maximum plant load	MW	67.66MW
g.	Net electrical output at maximum plant load	MW	Gross: 20.5MW Parasitic loads: 2.0MW Net electrical output: 18.5MW
h.	Net electrical efficiency at maximum plant load	%	27.3%
i.	Minimum stable plant load	%	75%
j.	Thermal input at minimum stable plant load	MW	50.75 [= 75% of NCR – being maximum boiler turn down].
k.	Net electrical output at minimum stable plant load	MW	13.38MW [= 20.5*0.75 = 15.38 – 2.0 Parasitic loads]
l.	Net electrical efficiency at minimum stable plant load	%	26.4%
1.6	**Identified potential heat loads**		
			IVC Brunel (Pharmaceutical Manufacturers) Projected maximum heat load 28GWh, 4.8MW_{th} (Sites 1 & 2) Assumed hot water supply and return See Figure 1 in Section 3 for assumed pipeline route
1.7	**Selected heat load(s)**		
a.	Category (e.g. industrial / district heating)		District Heating, including industrial and commercial loads
b.	Maximum heat load extraction required	MW	4.8
1.8	**Export and return requirements of heat load**		
a.	Description of heat load extraction		Hot Water
b.	Description of heat load profile		Seasonal variation, but with year round process and hot water requirements
c.	Export pressure	Bar a	n/a
d.	Export temperature	°C	90
e.	Export flow	t/h	115
f.	Return pressure	Bar a	n/a

g.	Return temperature	°C	60
h.	Return flow	t/h	115
Requirement 2: Identification of CHP Envelope			
2.0	**Comparative efficiency of a standalone boiler for supplying the heat load**	% LHV	85%
2.1	**Heat extraction at 100% plant load**		
a.	Maximum heat load extraction at 100% plant load	MW	10.0MW
b.	Maximum heat extraction export flow at 100% plant load	t/h	n/a
c.	CHP mode net electrical output at 100% plant load	MW	15.91MW
d.	CHP mode net electrical efficiency at 100% plant load	%	23.5% (Net electrical output/waste heat import)
e.	CHP mode net CHP efficiency at 100% plant load	%	38.3%
f.	Reduction in primary energy usage for CHP mode at 100% plant load	%	25.9%
2.2	**Heat extraction at minimum stable plant load**		
a.	Maximum heat load extraction at minimum stable plant load	MW	7.0MW
b.	Maximum heat extraction export flow at minimum stable plant load	t/h	n/a
c.	CHP mode net electrical output at minimum stable plant load	MW	12.44MW
d.	CHP mode net electrical efficiency at minimum stable plant load	%	24.5%
e.	CHP mode net CHP efficiency at minimum stable plant load	%	38.3%
f.	Reduction in primary energy usage for CHP mode at minimum stable plant load	%	28.0%
2.3	Can the plant supply the selected identified potential heat load (i.e. is the identified potential		Yes

	heat load within the CHP envelope)?		
Requirement 3: Operation of the plant with the selected identified heat load			
3.1	**Proposed operation of plant with CHP**		
a.	CHP mode net electrical output at proposed operational plant load	MW	17.8MW
b.	CHP mode net electrical efficiency at proposed operational plant load	%	26.3%
c.	CHP mode net CHP efficiency at proposed operational plant load	%	33.3%
d.	Reduction in net electrical output for CHP mode at proposed operational plant load	MW	0.7MW [=18.5-17.8]
e.	Reduction in net electrical efficiency for CHP mode at proposed operational plant load	%	1.1% (=27.3 - 26.2)
f.	Reduction in primary energy usage for CHP mode at proposed operational plant load	%	28.4%
g.	Z ratio		6.49 (= 4.8/0.7)
Requirement 4: Technical provisions and space requirements			
4.1	**Description of likely suitable extraction points**		It is most likely that heat would be extracted from bleed from the turbine – but details are yet to be established.
4.2	**Description of potential options which could be incorporated in the plant, should a CHP opportunity be realised outside the 'CHP envelope'**		n/a – CHP option within the 'envelope'
4.3	**Description of how the future costs an burdens associated with supplying the identified heat loads/ potential CHP opportunity have been minimised through the implementation of an appropriate CHP-R design**		Modifications would be required to the steam turbine during a shut down and a steam to water heat exchanger would need to be installed. Space is available for this along with the required pumping and control equipment cabin.
4.4	**Provision of site layout of the plant, indicating available space which**		See drawing in Figure in Section 4

	could be made available for CHP-R		
Requirement 5: Integration of CHP and carbon capture			
5.1	**Is the plant required to be CCR?**		The plant is not currently requirement to be CCR. However, it has been designed to be retrofitted with appropriate equipment should viable market conditions be forthcoming
5.2	**Export and return requirement identified for carbon capture**		
	100% plant load		
a.	Heat load extraction for carbon capture at 100% plant load		N/A
b.	Description of heat export (e.g. steam/ hot water)		N/A
c.	Export pressure		N/A
d.	Export temperature	°C	N/A
e.	Export flow		N/A
f.	Return pressure		N/A
g.	Return temperature		N/A
h.	Return flow		N/A
i.	Likely suitable extraction points		N/A
	Minimum stable plant load		
j.	Heat load extraction for carbon capture at minimum stable plant load	MW	N/A
k.	Description of heat export (e.g. steam / hot water)		N/A
l.	Export pressure	bar a	N/A
m.	Export temperature	°C	N/A
n.	Export flow	t/h	N/A
o.	Return pressure	bar a	N/A
p.	Return temperature	°C	N/A
q.	Return flow	t/h	N/A
r.	Likely suitable extraction points		N/A
5.3	**Operation of plant with carbon capture (without CHP)**		
a.	Maximum plant load with carbon capture	%	N/A

b.	Carbon capture mode thermal input at maximum plant load	MW	N/A
c.	Carbon capture mode net electrical output at maximum plant load	MW	N/A
d.	Carbon capture mode net electrical efficiency at maximum plant load	%	N/A
e.	Minimum stable plant load with CCS	%	N/A
f.	Carbon capture mode CCS thermal input at minimum stable plant load	MW	N/A
g.	Carbon capture mode net electrical output at minimum stable plant load	MW	N/A
h.	Carbon capture mode net electrical efficiency at minimum stable plant load	%	N/A
5.4	**Heat extraction for CHP at 100% plant load with carbon capture**		
a.	Maximum heat load extraction at 100% plant load with carbon capture [H]	MW	N/A
b.	Maximum heat extraction export flow at 100% plant load with carbon capture	t/h	N/A
c.	Carbon capture and CHP mode net electrical output at 100% plant load	MW	N/A
d.	Carbon capture and CHP mode net electrical efficiency at 100% plant load	%	N/A
e.	Carbon capture and CHP mode net CHP efficiency at 100% plant load	%	N/A
f.	Reduction in primary energy usage for carbon capture and CHP mode at 100% plant load	%	N/A
5.5	**Heat extraction at minimum stable plant load with carbon capture**		
a.	Maximum heat load extraction at minimum stable plant load with carbon capture	MW	N/A

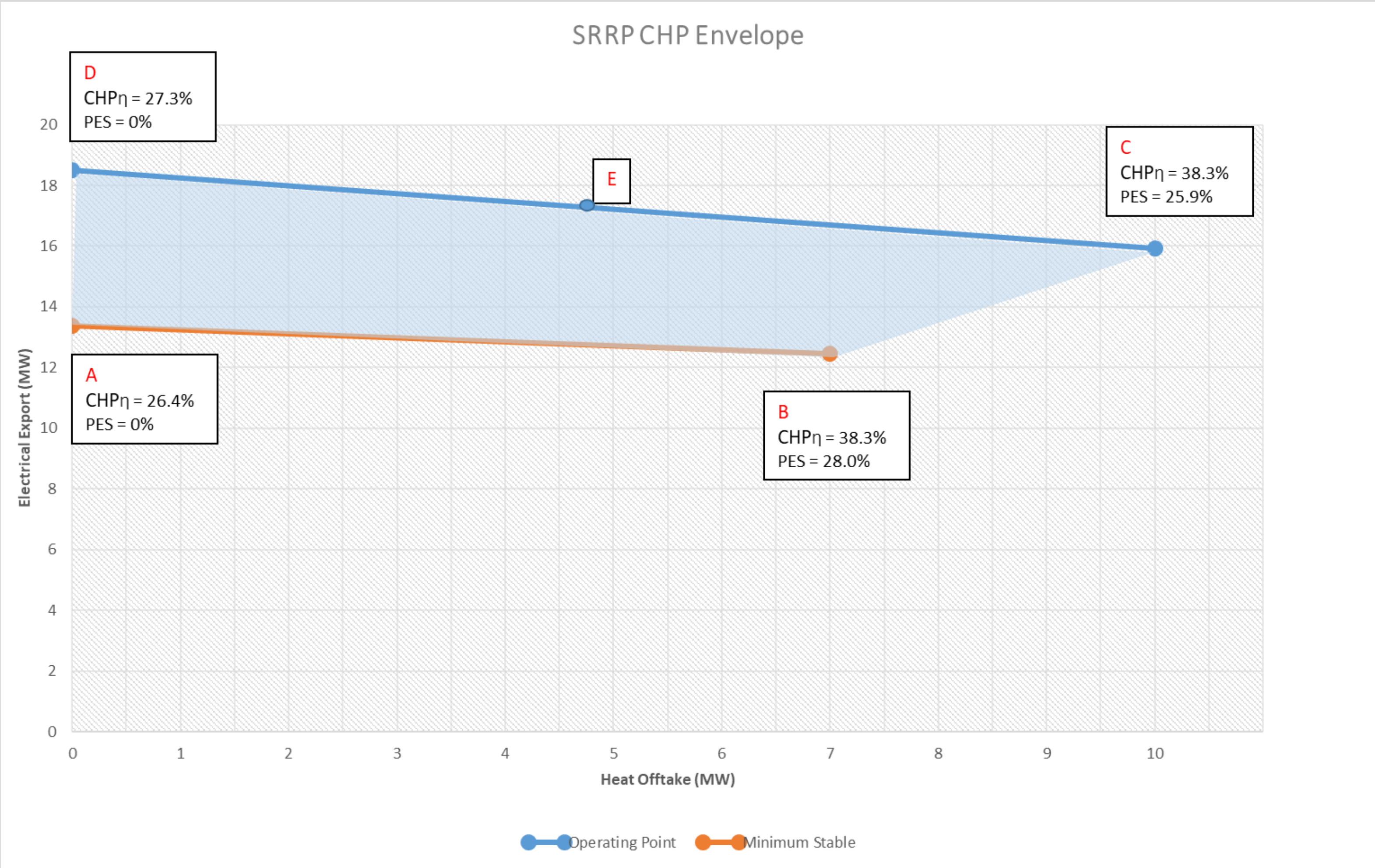
b.	Maximum heat extraction export flow at minimum stable plant load with carbon capture	t/h	N/A
c.	Carbon capture and CHP mode net electrical output at minimum stable plant load	MW	N/A
d.	Carbon capture and CHP mode net electrical efficiency at minimum stable plant load	%	N/A
	Carbon capture and CHP mode net CHP efficiency at minimum stable plant load	%	N/A
	reduction in primary energy usage for carbon capture and CHP mode at minimum stable plant load	%	N/A
5.6	**Can the plant with carbon capture supply the selected identified potential heat load (i.e. is the identified potential heat load within the 'CHP and carbon capture envelope')?**		N/A
5.7	**Description of potential options which could be incorporated in the plant for useful integration of any realised CHP system and carbon capture system**		N/A
Requirement 6: Economics of CHP-R			
6.1	**Economic assessment of CHP-R**		A high level economic/cost benefit analysis has been provided based on the potential future revenues relating to heat supplies and the costs. The summary of this calculation is provided in Appendix 3 to the CBA (Document Ref 2354-R004-00)
BAT assessment			
	Is the new plant a CHP plant at the outset (i.e. are there economically viable CHP opportunities at the outset)?		No.
	If not, is the new plant a CHP-R plant at the outset?		Yes
	Once the new plant is CHP-R, is it BAT?		Yes

3 Assumed pipeline route

Figure 1 below provides the assumed pipeline route used for the assessment of the CHP-R assessment and for the calculation of capital cost, operating cost and heat losses within the Cost Benefit Analysis.

Figure 1: Assumed pipeline route to process heat load customer (IVC Brunel Site 1)

4 'CHP Envelope' Diagram



5 Layout of the plant