FICHTNER
Consulting Engineers Limited

Runcorn CC Facility - EP Application

Viridor Runcorn CCS Ltd

CHP Report

ENGINEERING CONSULTING

Document approval

	Name	Signature	Position	Date
Prepared by:	Vildan Taylor		Associate Senior Consultant	13/12/2023
Approved by:	James Sturman		Lead Consultant	13/12/2023

Document revision record

Revision no	Date	Details of revisions	Prepared by	Checked by
0	20/10/2023	For Client	VBT	JRS
1	25/11/2023	For Client approval	VBT	JRS
2	13/12/2023	Final for submission	VBT	JRS

Contents

1 Introduction

1.1 Background

Viridor Runcorn CCS Ltd is proposing to install a carbon capture (CC) facility (the CC facility) at the Runcorn ERF to capture carbon dioxide (CO_2) from the Runcorn ERF flue gases for transmission and storage off-shore in the Liverpool bay sub-sea aquifer. The proposed CC facility is based on capturing 98 % of the carbon dioxide from Runcorn ERF flue gas streams under the design nominal case CO_2 loading: operation at 100% maximum continuous rating (MCR) with a fuel NCV of 11.7 MJ/kg. This equates to a capture rate of 140 t/h. At this capture rate, the CC facility requires 131.1 MW_{th} of heat and 14.1 MW_e of electrical power.

The Runcorn ERF site has two phases which includes total of four combustion lines and two turbines, herein referred to as Lines 1 and 2 and Lines 3 and 4.

Lines 1 and 2 currently generates heat and steam which is exported to the adjacent Inovyn industrial facility. Due to the contractual arrangements between Inovyn and Viridor, Viridor is not able to supply heat and power for the operation of the CC facility from Lines 1 and 2. Therefore, the heat required for the operation of the CC facility will be supplied from Lines 3 and 4.

1.2 Objective

The ERF will supply heat and power to the CC facility, which will be a 'heat user'. On this basis, this Combined Heat and Power (CHP) Report will support the application for the EP for the CC facility.

This CHP Report will identify the heat requirements of the CC facility and explain how the export of heat from the ERF has been optimised to maximise the energy efficiency of the CC facility in accordance with the EP and Article 11 of the Industrial Emissions Directive (IED) (Directive 2010/75/EU), which requires regulators to ensure that regulated facilities use energy efficiently.

This CHP Report will consider how the energy efficiency of the ERF relates to the relevant energy efficiency requirements of the Waste Incineration BREF.

2 Carbon capture

2.1 The CC process

In a CC process, CO_2 is extracted from a mixture of gases to create a CO_2 rich stream. The CO_2 captured can then be injected into underground formations (storage), used in the manufacture of a wide range of products, or used as a plant growth enhancer in agriculture. Overall, the process is referred to as carbon capture and storage (CCS). Where the CO_2 can be used as a resource in another process, the process is referred to as carbon capture, usage and storage (CCUS). CCUS can be applied to large scale point sources of carbon including energy intensive industries, power generation, heat production, transport and maritime sectors. The process can be divided into three main steps which are:

1. separation of CO_2 from the gas stream;
2. compression and transportation of the CO_2 (via pipeline or shipping); and
3. use of the captured CO_2 as a resource for other industries or storage within suitable geological formations (saline aquifers, depleted oil and gas reservoirs).

2.2 The CC facility

Following treatment of the flue gases within the ERF, and prior to being ducted to the stack from the ERF, the treated flue gas flow from the ERF will be ducted from all four lines of the ERF to the CC facility. The treated flue gases will be collected in a manifold prior to treatment within the CC facility. As the flue gases will be treated prior to the CC facility, the flue gases will be monitored for compliance with the waste incineration ELVs within the EP prior to being ducted to the CC facility. In the event that the CC facility is not available, or not able to abate the CO_2 emissions within the flue gases, the treated flue gases will be ducted to the existing ERF stack prior to release to atmosphere.

The CC facility will utilise heat from the waste incineration processes for CO_2 stripping, amine regeneration and flue gas re-heating. Steam produced from the ERF will be extracted for use in the CC facility and electrical power for the operation of the CC facility will also be provided by the ERF.

The carbon capture process will consist of the following steps:

- flue gas quenching and scrubbing;
- gas absorption;
- gas desorption/solvent regeneration;
- captured CO_2 conditioning and export; and
- CO2 dehydration and compression.

An indicative process schematic for the carbon capture process is provided in Figure 1 and Appendix A.

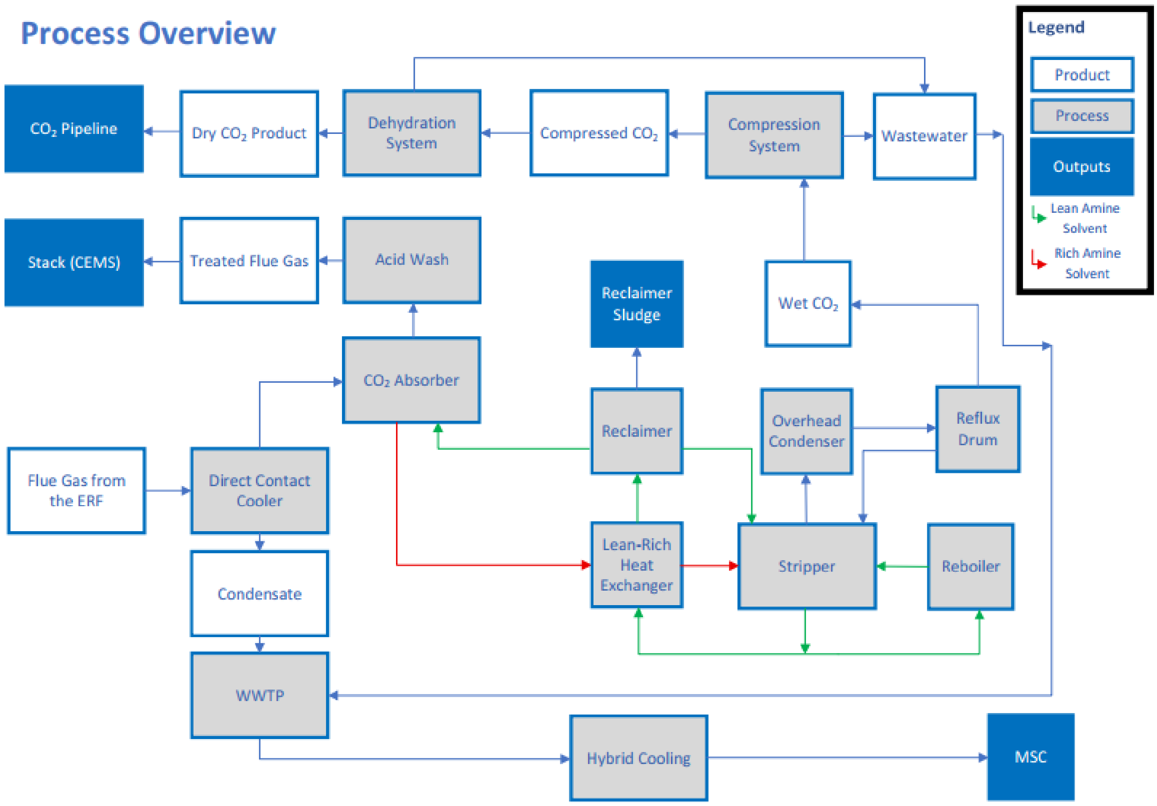


Figure 1 – Indicative process schematic for the carbon capture process

2.3 Heat and power demands of the CC facility

The CC facility requires steam at 4 bar(a) and 144°C and with the condensate being returned from the CC facility at 4 bar(a) and 27°C. The net heat requirement of the CC facility would be at 131.1 MW_{th} and 14.1 MW_e of electrical power.

3 The ERF

The main activities associated with the ERF are the combustion of incoming non-hazardous waste to raise steam and the generation of electricity in a steam turbine/generator.

The ERF includes two phases, which include four separate waste incineration lines. Lines 1 and 2 consists of two waste incineration lines, two moving grate combustion plants, boiler halls and flue gas treatment systems, with steam from both lines being passed to a single turbine to generate power. The waste incineration process for Lines 3 and 4 replicates Lines 1 and 2.

In addition to the main elements described, the ERF also includes the following common/shared systems - waste reception hall/bunker, weighbridges, water, auxiliary fuel and air supply systems, site fencing and security barriers, external hardstanding areas for vehicle manoeuvring, internal access roads and car parking, transformers, a grid connection compound, a firewater storage tank, offices, workshop, stores and staff welfare facilities.

Lines 1 and 2 is designed with a gross electrical output of 35 MW_e when exporting 51 MW_{th} of heat to Innoyvn, with an estimated parasitic load of approximately 4.9 MW_e. The power which is not exported to Inovyn is exported to the national grid. Therefore, Lines 1 and 2 will export approximately 30 MW_e.

Lines 3 and 4 is designed with a gross electrical output of 51.2 MW_e when operating in fully condensing mode, with an estimated parasitic load of approximately 4.9 MW_e. Therefore, Lines 3 and 4 will export approximately 46.3 MW_e in full condensing mode.

The current existing heat and power export from the ERF Lines 1 and 2 and Lines 3 and 4 has been shown in Table 1.

The general thermocycle process of phase 1 and Lines 3 and 4 is as below:

The heat released by the combustion of the incoming waste is recovered by means of a water tube boiler, which is integral to the furnace and will produce (in combination with superheaters) high pressure superheated steam at 54 bar(a) and 397°C. The high pressure steam from the boiler then feeds a high-efficiency steam turbine which will generate electricity. The turbine will have a series of extractions at different pressures that will be used for preheating air and water in the steam cycle.

The remainder of the steam, after expanding to 80 mbar(a), is condensed back to water using a water-cooled condenser. The condensed steam will be returned as feed water in a closed-circuit pipework system to the boiler.

Table 1: ERF Lines 1 and 2 and Lines 3 and 4 current existing heat and power export

Parameter	Unit	Value
ERF Lines 1 and 2 fully condensing turbine with heat supply to Innoyvn		
Net thermal input from waste to the boilers, NCV	MW_{th}	174.2
Gross power generated	MW_e	35.0
Parasitic load	MW_e	4.9
Net power exported	MW_e	30.1
Gross electrical efficiency, NCV	%	26.6
Heat export to Innoyvn	MW_{th}	51.0
ERF Lines 3 and 4 fully condensing turbine with no heat supply to CC facility		
Net thermal input from waste to the boilers, NCV	MW_{th}	174.2

Parameter	Unit	Value
Gross power generated	MW_e	51.2
Parasitic load	MW_e	4.9
Net power exported	MW_e	46.3
Gross electrical efficiency, NCV	%	26.6

3.1 Options for the supply of heat from the ERF

Heat is typically supplied from the energy recovery process in the form of steam and / or hot water, depending on the grade of heat required by the end consumers.

The most commonly considered options for recovering heat to supply the CC facility are:

- Steam extraction from the existing steam turbine bleed; and
- Steam extraction from a new back pressure steam turbine.

These options have been discussed below.

3.1.1 Steam extraction from the existing steam turbine bleed

The existing ERF turbine is not designed to supply the volume of steam required by the CC facility without modifications which would involve creating a controlled extraction by installing a control diaphragm as blade carrier within the steam turbine and replacement of another blade carrier within the steam turbine. A significant turbine outage would be required to accommodate these works. The boilers may continue to operate, but no electrical generation would be possible, limiting the revenue and reducing the efficiency of the ERF during this period.

3.1.2 Steam extraction from a new back pressure steam turbine

A new back pressure steam turbine generator (in addition to the Lines 3 and 4 fully condensing steam turbine generator) will be installed to take high pressure steam from the Lines 3 and 4 boilers and reducing its pressure to the CC facility steam requirements. The Lines 3 and 4 steam turbine will therefore have its flowrate reduced and will be operated at part load. The drop in electrical power this causes will be offset by generation from the back-pressure turbine. However, the total generation from the ERF and back pressure turbine will still be reduced compared to the current design, as the steam expanded through the back pressure turbine is only expanded to 4 bar(a) rather than 80 mbar(a) in the existing Lines 3 and 4 fully condensing steam turbine.

A back pressure steam turbine will expand the steam to a fixed pressure above atmospheric, for use in the CC process as a heat offtake. The back pressure turbine will generate electrical power from expanding this steam. The flow rate through the turbine will be determined by the process demand required at the exhaust pressure.

Implementing this option will require the construction of an additional steam turbine generator. New high pressure (HP) steam supply pipework to the inlet of the back pressure turbine from the HP steam header will also be required for this option. Electrical cabling will also be required, to import ERF power or export power from the CC facility.

The HP steam will be extracted from the HP header, which is located within the ERF Lines 3 and 4 turbine hall.

3.1.3 The proposed solution

Taking the above into consideration, the most appropriate approach to supply heat to the CC facility is by extracting steam from a back pressure turbine (as described in 3.1.2). This method for the supply of heat is considered favourable for the following reasons.

1. The heat requirements of the CC facility (as described in section 4) are too high for the temperatures attainable from the existing Lines 3 and 4 turbine exhaust steam.
2. Extraction of steam from the back pressure turbine offers the most flexibility for varying heat quality and capacity to supply for the CC facility steam requirements.
3. Extraction of steam from the back pressure turbine offers a higher overall electricity generation from the CC facility.
4. Extraction of steam from the existing Lines 3 and 4 turbine would have a higher capital cost than compared to the installation of a back pressure turbine as the existing Lines 3 and 4 turbine would need to be modified significantly in order to meet the CC facility steam demand on its own.

3.2 Integrating CC facility into ERF

Line 1 and Line 2 (Lines 1 and 2) of the Runcorn ERF currently generate heat and steam which is exported to the adjacent Inovyn industrial facility. Due to the contractual arrangements between Inovyn and Viridor, Viridor is not able to supply heat and power for the operation of the CC facility from Line 1 and Line 2. Therefore, the heat and power for the operation of the CC facility will primarily be supplied from Lines 3 and 4.

Steam produced from Lines 3 and 4 will be extracted for use in a back-pressure turbine to generate power while expanding the steam to the required pressure for use in the CC facility. Electrical power for the operation of the CC facility will be provided by the back pressure turbine, which will produce a surplus of power.

The CC facility will have the following demand for heat and power:

- Heat: Steam at 4 bara and 144°C and with the condensate being returned from the CC facility at 4 bara and 27°C to Phase2. The net heat requirement of the CC facility would be at 131.1 MW_{th}, with the condensate being returned from the CC facility to Lines 3 and 4.
- Power: 14.1 MW_e of electrical power

Therefore, to satisfy this heat and power demand, high pressure steam we be bled from the Lines 3 and 4 and supplied to a new back pressure steam turbine generator within the CC facility. This will reduce the electrical output of Lines 3 and 4 turbine from 51.2 MW_e to 5.7 MW_e. However, an average total electrical generation of Lines 3 and 4 turbine and the back pressure turbine would be approximately 26.9 MW_e (5.7 MW_e from the existing fully condensing steam turbine and 21.2 MW_e from the new back pressure steam turbine in the CC facility).

The new combined parasitic load of Lines 3 and 4 and the CC facility would be approximately 19.0 MW_e (4.9 MW_e for Lines 3 and 4 and 14.1 MW_e from the CC facility). Considering the new combine parasitic load, the total net electrical export from the Lines 3 and 4 would be approximately 7.9 MW_e (26.9 - 19).

4 HP Steam Supply to the CC Facility

4.1 Back pressure turbine

A back pressure steam turbine expands HP steam to a fixed pressure above atmospheric, for use in a process or as a heat offtake. The back pressure turbine has been sized such that the exhaust flow rate will match the maximum heat requirements and electrical output will satisfy the power requirements of the CC facility. The back pressure turbine has been designed as set out in Table 2.

Table 2: Back pressure turbine design

Parameter	Unit	Value
CCS heat requirement	MW_{th}	131.1
CCS power requirement	MW_e	14.1
Back pressure turbine generation	MW_{th}	21.2
HP steam from the ERF Lines 3 and 4 to back pressure turbine:		
• pressure	bar (a)	54
• temperature	°C	397
• flow rate	t/h	179.7
• Thermal Energy	MW_{th}	158.8
Exhaust steam from back pressure turbine to CC facility:		
• pressure	bar (a)	4.0
• temperature	°C	144
• flow rate	t/h	179.7
• Thermal Energy	MW_{th}	136.7

4.2 Backup supply

If the back pressure turbine is out of service, the CC facility will be supplied with steam via a bypass system. The bypass system will consist of a let-down valve, which reduces the pressure of the steam from 54 bar(a) to 4 bar (a), with a spray valve, which doses condensate from the condensate tank into the bypass steam. The flow of condensate will be controlled by measuring the outlet temperature of the bypass steam.

5 ERF Lines 3 and 4 Energy Efficiency Calculations

5.1 Heat and power export for Lines 3 and 4

The heat and power export from Phase2 are presented in Table 3.

For modelling and calculation purposes, Lines 3 and 4 has been divided, virtually, into two parts when the CC facility is operating.

- Part A - the portion of the ERF Lines 3 and 4 boilers which supply high pressure steam to the fully condensing Lines 3 and 4 turbine.
- Part B - the remaining portion of the Lines 3 and 4 boilers which supply high pressure steam to the new back pressure turbine, the back pressure turbine itself with the heat being exported to the CC facility.

Table 3: Heat and power export from Lines 3 and 4

Parameter	Unit	Value
Lines 3 and 4 fully condensing turbine with no heat supply to CC facility		
Net thermal input from waste to the boiler, NCV	MW_{th}	174.2
Gross power generated	MW_e	51.2
Parasitic load	MW_e	4.9
Net power exported	MW_e	46.3
Gross electrical efficiency, NCV	%	26.6
Heat supply to CC facility via the back pressure turbine		
Part A: Fully condensing ERF Lines 3 and 4 turbine		
• Effective net thermal input from waste to the Lines 3 and 4 boilers, NCV	MW_{th}	21.6
• Gross power generated from ERF Lines 3 and 4 turbine	MW_e	5.7
• Gross electrical efficiency, NCV	%	26.6
Part B: Back pressure turbine		
• Effective net thermal input from waste to the boiler, NCV	MW_{th}	152.5
• Gross power generated from back pressure turbine	MW_e	21.2
• Net Heat supply from back pressure turbine to CC facility	MW_{th}	131.1
• Gross energy efficiency, NCV	%	99.8
Total gross power generated (Part A+B)	MW_e	26.9
Total power used (ERF Lines 3 and 4 + CC facility)	MW_e	19
• ERF phase 2 parasitic load	MW_e	4.9
• CC facility power requirement	MW_e	14.1
Net power exported (Part A+B)	MW_e	7.9

5.2 BAT 20 of WI BREF

The Waste Incineration BREF[1] was published in December 2019. In accordance with the requirements of the IED, the ERF is required to demonstrate compliance with the requirements of the WI BREF prior to December 2023.

BAT 20 states that the BAT-Associated Energy Efficiency Levels (referred to as BAT-AEELs) given in these BAT conclusions are expressed as:

- gross electrical efficiency in the case of an incineration plant or part of an incineration plant that produces electricity using a condensing turbine; and
- gross energy efficiency in the case of an incineration plant or part of an incineration plant that:
  - produces only heat, or
  - produces electricity using a back-pressure turbine and heat with the steam leaving the turbine.

As the ERF with CC facility will have both a condensing turbine and a back pressure turbine, it does not fit into either category. This is why it has been divided, for modelling purposes, into Part A and Part B, as described earlier. For compliance purposes, it is then assumed that:

- the Gross Electrical Efficiency formula applies to the ERF fully condensing turbine (Part A); and
- The Gross Energy Efficiency formula applies to the back pressure turbine (Part B).

BAT 20 states that the BAT-AEELs for Gross Electrical Efficiency for part of a new waste incineration plant that produces electricity using a condensing turbine (Part A) is 25-35%.

BAT 20 states that the BAT-AEELs for Gross Energy Efficiency for part of a new waste incineration plant that produces electricity using a back-pressure turbine and heat with the steam leaving the turbine (Part B) is 72-91%.

The Gross Electrical and Energy Efficiency of Part A and Part B respectively have been calculated in accordance with the requirements of BAT 20. The results are shown in Table 4. Lines 1 and 2 has already demonstrated this in the Environmental Permitting (England and Wales) Regulations 2016 Regulation 61(1) notice, therefore, we are only considering Lines 3 and 4 with the implementation of the CC facility.

Table 4: BAT 20 - gross efficiency when exporting heat to CC facility

Part of ERF Lines 3 and 4	Unit	Value
Part A: ERF Lines 3 and 4 fully condensing turbine		
Net thermal input from waste to the Lines 3 and 4 boilers, NCV	MW_{th}	21.6
Gross power generated from ERF turbine	MW_e	5.7
Gross electrical efficiency, NCV	%	26.6
BAT-AEEL (%)	*%*	*25-35*
Pass or Fail		***Pass***
Part B: Back pressure turbine		
Net thermal input from waste to the boiler, NCV	MW_{th}	152.5
Gross power generated from back pressure turbine	MW_e	21.2

[1] https://eippcb.jrc.ec.europa.eu/sites/default/files/2020-01/JRC118637_WI_Bref_2019_published_0.pdf

Part of ERF Lines 3 and 4	Unit	Value
Net Heat supply from back pressure turbine to CC facility	MW_{th}	131.1
Gross energy efficiency, NCV	%	99.8
BAT-AEEL (%)	*%*	*72-91*[2]
Pass or Fail		***Pass***

The EA's BREF Implementation Plan states:

"BAT for these plants is to become CHP by connecting to a heat network or supplying a heat user direct where viable opportunities exist."

and

"Existing plants will also be expected to demonstrate that they have maximised their GEE as far as possible and have minimised their parasitic heat and electrical loads."

As explained in section 2, the CC facility will require heat and is a potential heat user for the ERF. In addition, as shown in Table 4, Part A of Lines 3 and 4 , which is the ERF Lines 3 and 4 fully condensing turbine, would achieve a gross electric efficiency of more than 25% whilst the Part B of Lines 3 and 4, supplying heat to the CC facility from the back pressure would achieve gross energy efficiency of more than 72%. Taking this into consideration, the proposed supply of heat from Lines 3 and 4, via a back pressure turbine, to the CC facility is considered to represent BAT.

5.3 Primary energy saving

To be considered high-efficiency cogeneration, the scheme must achieve at least 10% savings in primary energy usage compared to the separate generation of heat and power. The Primary Energy Saving (PES) has been calculated in accordance with European Commission Delegated Regulation (EU) 2015/2402 of 12 October 2015 Annex II part (b).

Efficiency reference values for the separate production of heat and electricity have been taken as 75% and 25% respectively as defined in Commission Delegated Regulation (EU) 2015/2402 of 12 October 2015[3].

When operating in heat supply mode from Lines 3 and 4 via the back pressure turbine to the CC facility (Table 4), the PES has been calculated in accordance with the draft Article 14 guidance[4] and the results are presented in Table 5.

Table 5: Primary energy saving (%)

	Primary energy saving (%)
Lines 3 and 4 + new back pressure turbine	38.4

Therefore, following implementation of the CC facility, Lines 3 and 4 will achieve a PES of 38.4%. This is more than the technical feasibility threshold defined in the draft Article 14 guidance. On this basis, the supply of heat from Lines 3 and 4, via a new back pressure turbine, to the CC facility will qualify as a high-efficiency cogeneration operation when operating in CHP mode.

[2] A gross energy efficiency exceeding the higher end of the BAT-AEEL range (even above 100 %) can be achieved where a flue-gas condenser is used.

[3] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32015R2402

[4] Draft guidance on completing cost-benefit assessments for installations under Article 14 of the Energy Efficiency Directive, V0.9 April 2015

6 Summary

6.1 Technical solution

1. Lines 1 and 2 currently generates heat and steam which is exported to the adjacent Inovyn industrial facility. Due to the contractual arrangements between Inovyn and Viridor, Viridor is not able to supply heat and power for the operation of the CC facility from Lines 1 and 2. Therefore, the heat required for the operation of the CC facility will be supplied from Lines 3 and 4.
2. Lines 3 and 4 with no steam supply to the CC facility has a gross electrical output of 51.2 MWe, (design value when operating in fully condensing mode), with a parasitic load of approximately 4.9 $MW_{e,}$ with the balance exported to the National Grid. Therefore, Lines 3 and 4 exports approximately 45.1 MW_e in fully condensing mode.
3. Viridor is proposing to construct a CC facility which is based on capturing 98% of the capture CO_2 from Runcorn ERF flue gas streams under the design nominal case CO_2 loading: operation at 100% maximum continuous rating (MCR) with a fuel NCV of 11.7 MJ/kg. This equates to a capture rate of 140 t/h. At this capture rate, the CC facility requires 131.1 MW_{th} of heat and 14.1 MW_e of electrical power.
4. The CC facility will utilise heat from the ERF for CO_2 stripping, amine regeneration and flue-gas re-heating. Steam extracted from Lines 3 and 4 via the new back pressure turbine will be used in the reboiler of the CC facility to heat the amine solution drawn from the bottom of the amine regenerator and to the vaporise water in the CO_2 rich amine solvent solution. Power for the operation of the CC facility will be provided by the new back pressure turbine.
5. The current Lines 3 and 4 turbine existing bleed is not able to supply the required volume of steam for the CC facility. The most economic option for supplying steam to the CC facility, at the required pressure, is installation of a back-pressure turbine. Phase2 will be designed with the capability to export of 131 MW_{th} of heat and 14.1 MW_e of electrical power to meet the CC facility demand. This would result in an average total electrical generation of approximately 38.4 MW_e (14.5 MW_e from the existing fully condensing steam turbine and 21.6 MW_e from the new back pressure steam turbine in the CC facility).
6. New HP steam supply pipework to the inlet of the back pressure turbine from the HP steam header will be required. HP steam will be extracted from the HP header, which is located within Lines 3 and 4 turbine hall. Condensate will be returned to Lines 3 and 4 condensate tank.

6.2 Energy efficiency measures

1. Lines 3 and 4 as proposed will have both a fully condensing turbine and a back pressure turbine. Around 12% of the boiler capacity will be used to supply high pressure steam to the fully condensing turbine whilst the remaining capacity (88%) supply high pressure steam to the back pressure turbine.
2. The Gross Electrical Efficiency (NCV) for Part A of Lines 3 and 4 is 26.6 %, which compares favourably with the BAT-AEELs for Gross Electrical Efficiency (20–35% for an existing plant). The Gross Energy Efficiency (NCV) for Part B, is 99.8%, positively exceed the range of the BAT-AEELs for Gross Energy Efficiency (72–91%).
3. In order to qualify as technically feasible under the draft Article 14 guidance, the heat demand must be sufficient to achieve high efficiency cogeneration, equivalent to at least 10 % savings in primary energy usage compared to the separate generation of heat and power. With the average heat demand of 131 MW_{th} from the CC facility, Lines 3 and 4 achieves a PES of 38.4 %,

which is in excess of the technical feasibility threshold defined in the draft Article 14 guidance and would therefore be technically feasible to supply.

6.3 Overall

The EA's BREF Implementation Plan states:

> *"BAT for these plants is to become CHP by connecting to a heat network or supplying a heat user direct where viable opportunities exist."*

and

> *"Existing plants will also be expected to demonstrate that they have maximised their GEE as far as possible and have minimised their parasitic heat and electrical loads."*

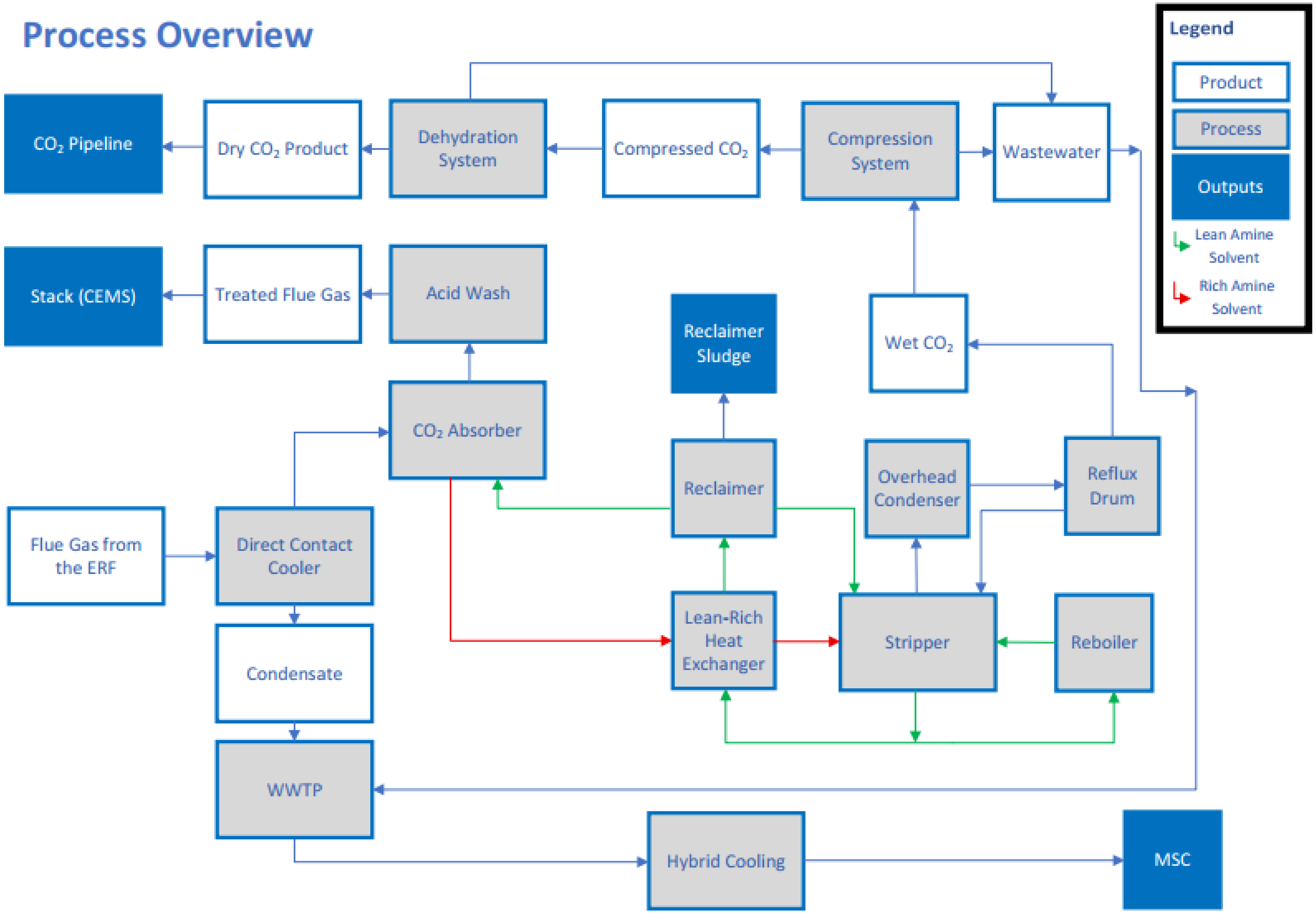
Taking this into consideration, and as set out within this report:

1. the CC facility will require heat and therefore provides an opportunity for Lines 3 and 4 to be classified as CHP; and
2. the supply of heat from Lines 3 and 4 to the CC facility via the new back pressure turbine will have gross electrical efficiency and gross energy efficiency more than BAT-AEELs and PES of more than 10%.

Taking this into consideration, the proposed supply of heat from Lines 3 and 4 to the CC facility via the new back pressure turbine is considered to represent BAT.

Appendices

A Indicative Process Overview


Process Overview
CO2 Pipeline
Dry CO2 Product
Dehydration System
Compressed CO2
Compression System
Wastewater
Stack (CEMS)
Treated Flue Gas
Acid Wash
Reclaimer Sludge
Wet CO2
CO2 Absorber
Reclaimer
Overhead Condenser
Reflux Drum
Flue Gas from the ERF
Direct Contact Cooler
Lean-Rich Heat Exchanger
Stripper
Reboiler
Condensate
WWTP
Hybrid Cooling
MSC
Legend
Product
Process
Outputs
Lean Amine Solvent
Rich Amine Solvent

ENGINEERING CONSULTING

FICHTNER

Consulting Engineers Limited

Kingsgate (Floor 3), Wellington Road North,
Stockport, Cheshire, SK4 1LW,
United Kingdom

t: +44 (0)161 476 0032
f: +44 (0)161 474 0618

www.fichtner.co.uk