BIOCCUS Phase 2

Environmental Permit Application, Non-Technical Summary

Environment Agency

Contact:

Naser Odeh
Gemini Building, Fermi Avenue, Harwell, Didcot,
OX11 0QR, UK

t: +44 (0) 1235 75 3570
e: naser.odeh@ricardo.com

Ricardo is certificated to ISO9001, ISO14001 and OHSAS18001

Author:

Ryan Grubb, Gus Harmsworth, Alice Burrows

Approved By:

Joshua Dalby

Date:

17 April 2023

Ricardo Energy & Environment reference:

Ref: ED16194 BIOCCUS – Non-Technical Summary Issue 2.1

Table of contents

1 Introduction

1.1 Overview

The Environment Agency (EA) application forms for bespoke permits require a non-technical summary to be submitted in support of the application to explain the application in non-technical language, as much as possible avoiding technical terms, detailed data and scientific discussion.

The Non-Technical Summary for the BIOCCUS facility includes the following:

- a summary of the proposed facility;
- a summary of the environmental management system and permit application fees; and
- a summary of the emissions from the permitted activity.

This Non-Technical Summary should be read in conjunction with the rest of this application which comprises:

- Operating Techniques and BAT Assessment
- Appendix A1: Application Forms
- Appendix A2: Non-Technical Summary
- Appendix A3: Air Quality Assessment
- Appendix A4: Site Plans
- Appendix A5: List of Directors
- Appendix A6: Pre-app Advice

1.2 Regulated Facility

1.2.1 The Site

The site is called Holmsted Farm, located in West Sussex, as shown in Figure 1. The unit also has a connection to mains water and electricity. Two roller shutter loading doors provide the access requirements needed for installing the plant.

The site is located amongst other business units on Holmsted Farm and is surrounded by primarily agricultural land. The B2114 is located approximately 150m to the east of the site and Sloughgreen Lane is approximately 380m to the south of the site. There are various small ponds located in the surrounding area, the closest of which is approximately 85m to the east of the site. The closest residential dwelling is a house approximately 80m to the northeast of the site.

The geology of the site consists of Cuckfield Stone Bed and Lower Grinstead Clay bedrock, designated a moderately productive aquifer. There are no superficial deposits recorded.

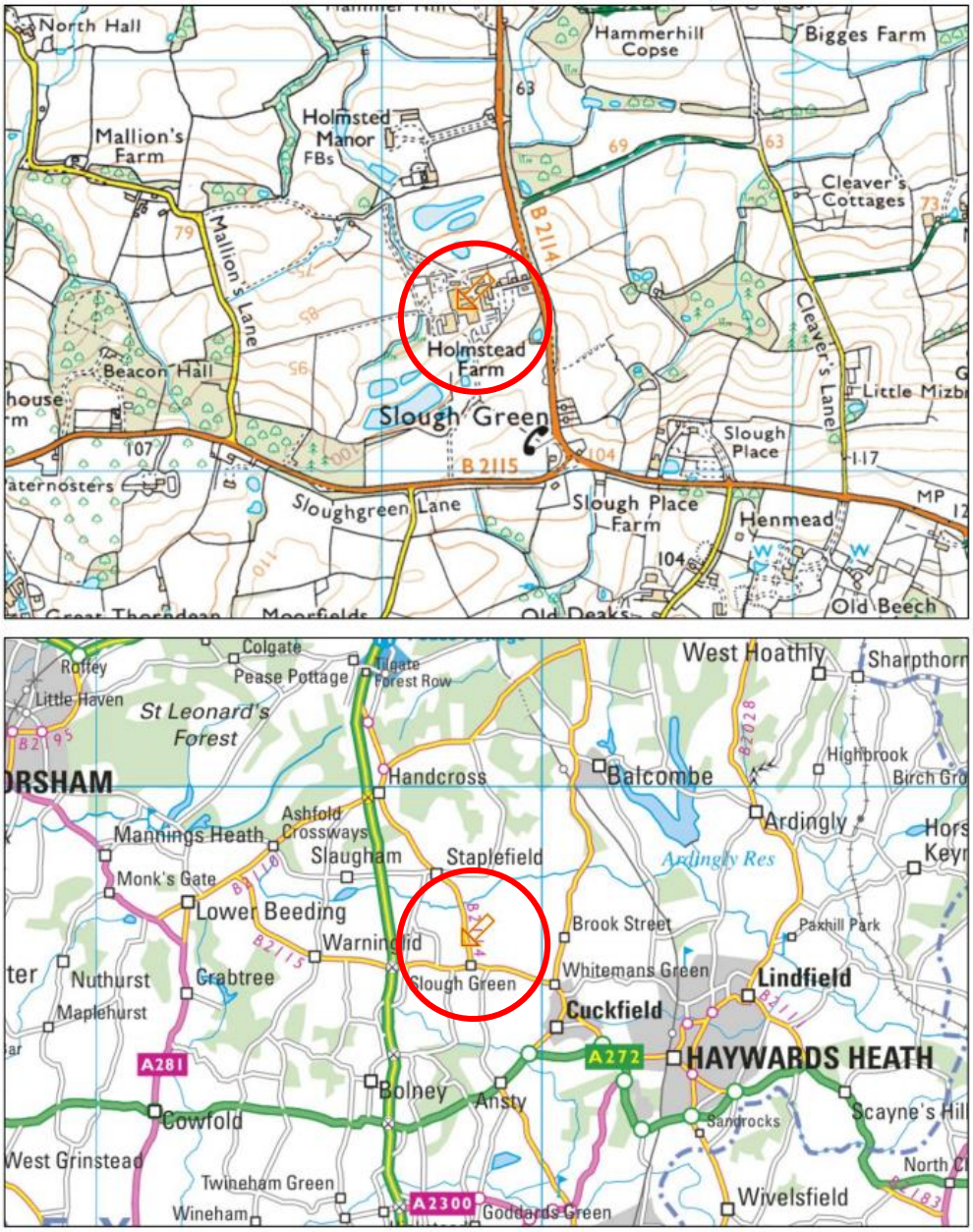

Figure 1: Location of Holmsted Farm

Figure 2: The unit to be rented at Holmsted Farm

1.2.2 Process Description

The proposed facility is a research and development (R&D) project which aims to develop a biomass pyrolysis-based cogeneration system with biochar production and carbon capture, utilisation and storage (BIOCCUS). Biochar will be produced as a by-product, which will capture some of the carbon dioxide from the feedstock, and the carbon dioxide in the flue gases will be captured post-combustion.

This process consists of four key stages: i) pyrolysis of the waste biomass into biochar and syngas; ii) combustion of the syngas; iii) generation of power in the hot air turbine; iv) removal of CO_2 from the flue gas with carbon capture technology.

The fuel for the process will be waste wood from domestic timber production, which is verified as sustainable and sourced locally to the BIOCCUS system. The pyrolysis unit will generate biochar and syngas from this waste wood. Biochar can be sold off-site for use as a soil improver or as an anaerobic digestion sorbent in the wastewater treatment industry. Synthesis gas or 'syngas', is a mixture of hydrogen, carbon dioxide and carbon monoxide.

The syngas is combusted to generate high temperature flue gas. This hot flue is passed through a heat exchanger which is used to raise the temperature of air taken into the process at ambient conditions. This heated air is used within the hot air turbine (Brayton) to generate heat and power. A fraction of generated heat will be consumed parasitically by the carbon capture system. The remaining heat and electricity generated by the turbine will be exported to local domestic and commercial properties.

In a discussion with the EA on 14th March 2023, it was agreed that, while the combustion of waste wood is considered a Section 5.1 Part B activity, the carbon capture activity falls under the exemption for R&D. Should the operator wish to continue with the use of carbon capture beyond the R&D phase, the

air quality assessment would be updated with onsite monitoring data and any relevant published EALs as part of the permit variation application. The R&D phase will be completed by March 2025.

The flue gas produced from the process is rich in carbon dioxide. This gas is passed into the carbon capture unit where the CO_2 is removed using an amine-based absorption-stripping process. Flue gas exiting the hot air turbine heat exchanger is passed through a flue-water economiser before being directed through a scrubber. During this cleaning process particles, contaminants and acid gases are absorbed into the scrubbing water. Lime is dosed into the scrubbing water as required to maintain a neutral pH which neutralizes the acids absorbed from the flue gases. As the gases leave the scrubber, they pass through a mist trap to remove any water vapour from the flue stream prior to entering the amine CO_2 removal plant. The scrubbing water is continuously circulated through a hydro cyclone to separate the captured particulates from the water prior to being pumped back into the scrubber.

The carbon capture unit generates two streams, exhaust gas (with the majority of the CO_2 removed) and a CO_2 rich gas stream. Initially, for the purposes of demonstrating the technology, the captured CO_2 will be merged with the other flue gases and emitted to the atmosphere through the 10.6m stack. The aim is for the carbon dioxide from the system in production to be transported and converted to a permanent end-product, for example CO_2-cured concrete. If this is not possible for local supply-chain reasons, the CO_2 can be supplied to the carbonated drinks industry.

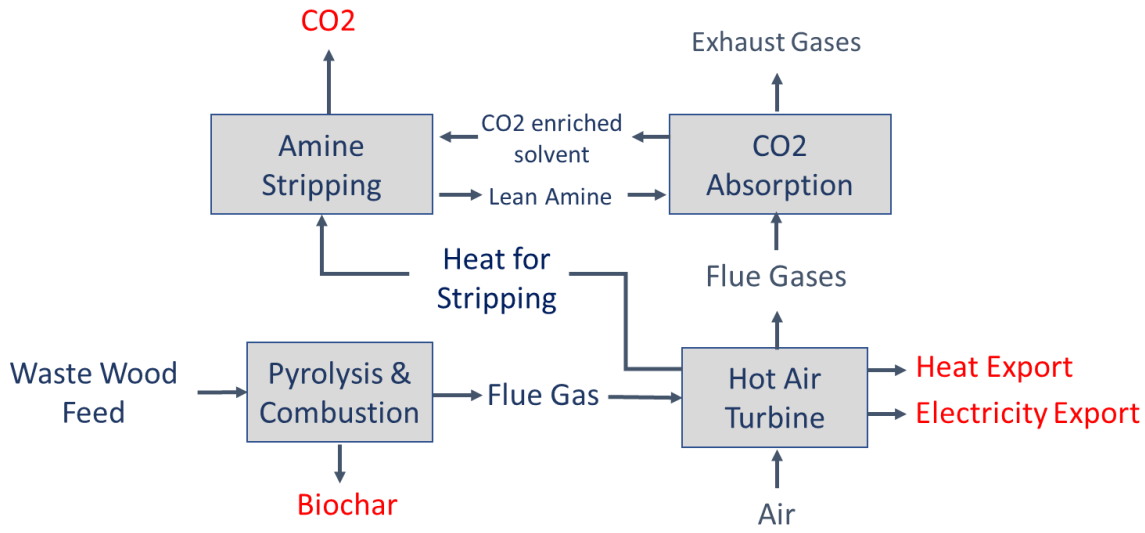

Figure 3: Block Flow Diagram of Process

1.2.3 Regulated Activities

The facility involves a Schedule 1 Section 5.1 Part B(a)(v) activity of the EPR (as amended). In England this activity is regulated by the EA. The Schedule 1 activity is detailed in Table 1 and includes incineration of wood waste at a rate of more than 50 kg per hour.

Table 1: Proposed EPR Schedule 1 Activities

Schedule 1 Activity	Description
Section 5.1B(a)(v)	(a) The incineration in a small waste incineration plant with an aggregate capacity of 50kg or more per hour of the following waste— (v) wood waste with the exception of wood waste which may contain halogenated organic compounds or heavy metals as a result of treatment with wood preservatives or coatings;

The waste wood intended for use as the feedstock falls within those European Waste Catalogue (EWC) codes that are exempt from the requirements of Chapter IV of the Industrial Emissions Directive, as set out in Section 3.1.1 of the Operating Techniques document. The storage and drying of this waste wood prior to burning in the Part B co-incinerator is covered by regulatory position statement (RPS) 213. Virgin wood feedstock will also be trialled at the plant.

The directly associated activities (DAA) that are proposed for the facility are presented in Table 2.

Table 2: Proposed Directly Associated Activities

Directly Associated Activity	Description
Hot air turbine	Operation of a hot air turbine to generate electricity and heat for plant-use and export.
Carbon Capture (CC)	Operation of a CC system with an amine-based absorbent.
Handling of waste wood	Handling, drying and storage of wastes.
Potentially Polluting substances	Storage of potentially polluting substances, to be treated offsite.
Utilities	Supply of utilities and services such as electricity, water, steam, and process cooling.
Biochar production and storage	Biochar is produced as a product from the pyrolysis of biomass.

1.3 Raw Materials and Wastes

The raw materials proposed for the facility include biomass feedstock, lime, and water for the permitted activities, as well as methyldiethanolamine (MDEA), piperazine (PZ) and water for the R&D carbon capture activity. Due to the size and R&D nature of the facility, only small amounts of each raw material will be stored on site at any one time.

In accordance with RPS 213, no more than 125 tonnes of waste wood will be stored on site at any one time. Feedstock acceptance, handling and storage will be carried out in accordance with RPS 213 and guidance note 5/1(18), where applicable.

The solvent used will be approximately 40% amine and 60% water. Approximately 10 tonnes of amine (MDEA and PZ) will be required for the process per annum. Up to 100 tonnes of water will be required per annum to make up the rest of the solvent and for use in small amounts in other parts of the process, such as the water wash. Lime will be used in the flue gas treatment, to neutralise acid gases, and up to 80 tonnes will be required per annum, with no more than 20 tonnes stored on site at any one time.

The wastes produced at the site will include: biochar; amine stream purge; and solid amine-rich wastewater residues. The pyrolysis system will produce 70 kg/h of Biochar (dry weight) which will also contain captured CO_2. The hot biochar is dropped into a wet sump to quench the product before it is further processed and packaged. The biochar will be packaged on-site in the biochar handling plant, immediately after removal from the wet sump. Up to 20 tonnes will be stored on-site at any one time,

short-term, before being collected for use as a soil improver, in anaerobic digestors or as a supplement for animal feed.

The carbon capture system utilises an amine solution. The amines within this solution are degraded over time and hence there is a continuous purge of amine solution from the system. The purged solution will contain: Water, MDEA (Methyl diethanolamine, PZ (Piperazine), a mixture of compounds that are generated as MDEA and PZ degrade. This effluent will be stored in bunded ISO containers onsite and transported off site by a third-party waste contractor for treatment/disposal. Approximately 1-2 tonnes will be stored on site at any one time.

Solid amine-rich wastewater residues will be produced from the carbon capture element of the plant. The exact nature of these residues is not yet known as the carbon capture design has not been finalised. However, these residues will be generated in small quantities, which will be stored in the building and collected by a licensed third-party waste contractor for disposal. The method of containment will be designed for the nature of the residues.

1.4 Energy Efficiency

The estimated net power generation for the facility is presented in Table 3. Power is generated as both heat and electricity from the hot air turbine, and some is consumed parasitically, as detailed in Table 4. Electricity will be drawn from the Grid for start-up, which will involve the use of approximately 50kW for less than 1 hour.

Table 3: Heat and power consumption

	Heat (KWth)	Electricity (kWe)	Total output (kW)
Demand	-192	-38.4	-230.4
Generated	+350	+80	+430
Net	**+158**	**+41.6 to 56**	**+199.6**

* Positive numbers within the table denotes net output in energy generation

Table 4: Parasitic Loads

Source	Parasitic Load (KWe)
Hot air turbine	2.6
Dryer and feedstock conveyors	5
Pyrolysis and biochar bagging	3.5
ID fans and flue gas scrubber	11.8
CHP system	0.3
Amine cycle	3.6
CO2 conditioning	3.1
Remaining balance of plant	2.5
Total	**32.4**

1.5 Environmental Management System

Ricardo will operate an Environmental Management System (EMS) that complies with the requirements of EA guidance which will be in place before commencement of operation. The EMS will be continually reviewed, at least annually and in response to any changes to the site, including but not limited to operations or equipment (including permit variations), any accident, complaint, or breach of the permit.

In summary, the EMS will include the following key elements to comply with the requirements defined in the Environmental Permitting Technical Note 5/1(18) reference document for the incineration/combustion of waste wood:

- Cleaning and maintenance
- Staff training
- Plant operation
- Waste acceptance criteria
- Bottom ash storage and disposal
- Emissions monitoring
- Plant failures
- Record keeping on all of the above

1.6 Management Plans

The pre-application advice from the EA stated that odour and noise management plans are not required for the proposed activity. The location of the site has changed since the pre-application advice was provided and a Habitats Assessment is no longer required for the proposed location.

1.7 Permit application fees

The permit application fees have been calculated as according to the Environment Agency charging scheme[1], charging table section 1.10.2 at £6,550.

[1] https://www.gov.uk/government/publications/environmental-permitting-charging-scheme-2019

2 Emissions

2.1 Air Emissions Risk Assessment

A detailed modelling assessment has been carried out to assess the impact of the pilot BIOCCUS project on local air quality and is provided in Appendix A3 to this application.

The assessment has used the dispersion model ADMS 5.2 to predict the increases in pollutant species released as a result of the emissions released during the operation of the Facility, using best practice approaches. The assessment has been undertaken based on several worse case assumptions including assuming that the facility would emit continuously at the emissions limits, however, emissions from the pilot study is expected to be much lower than the emissions limit.

Despite the R&D exemption, we have also provided an indicative assessment in Appendix A3 to quantify potential impacts from the onsite carbon capture process based on the best available data for ELVs, bearing in mind that there is significant uncertainty around potential emissions as this is a novel process. Should the operator wish to continue with the use of carbon capture beyond the R&D phase, this assessment would be updated with onsite monitoring data and any relevant published EALs as part of the permit variation application.

The results of dispersion modelling indicate that Process Contributions and resultant Predicted Environmental Concentrations of all pollutants at human receptors are of negligible significance, except for benzene and NO2 with a minor to moderate significance. However, this occurs at only four receptors out of the 41 receptors. Furthermore, the predicted environmental concentration at these receptors is well below the AQO and EAL (less than 70%).

Given that several worse case assumptions have been adopted, it is expected that overall, the effects of the proposed Facility are likely to be of negligible significance.

2.2 Monitoring of Emissions to Air

The control and monitoring of emissions to air will be in accordance with the EA guidance on “Monitoring stack emissions: measurement locations” and “Monitoring stack emissions: techniques and standards for periodic monitoring”. The requirements as set out in the reference document with regards to emission limits values (ELVs) and frequency of monitoring. The strictest requirements are all set out in the Environmental Permitting Technical Note 5/1(18) reference document for the incineration / combustion of waste wood, except for the ELV in oxides of nitrogen, which is set out in the specified generator regulations. The facility will employ CEMS where possible for internal monitoring purposes. Where CEMS is not feasible, the minimum required monitoring frequency will be used.

Monitored emissions include:

- Carbon monoxide*
- Dust*
- Smoke
- Oxides of nitrogen*
- Total volatile organic compounds (TVOC)*
- HCN
- Formaldehyde
- Sulphur dioxide*
- Acetaldehyde
- Ammonia*

- Amines (as MDEA or DMA)
- NDMA

**Monitored using CEMS for internal purposes.*

The operator will carry out emission measurements within 4 months of the permit being granted or at the start of operation, whichever is later. Emissions will be recorded, corrected to standard reference conditions and submitted to the regulator at the required frequency in accordance with the environmental permit.

2.3 Emissions to Water

There will be no point source emissions to surface water, sewer or groundwater from the proposed activity. As the activity is confined to a building with fast acting roller shutter doors, any liquid spills will be contained within the building and surface water runoff from the activity will not be an issue.

2.4 Emissions to Land

There are no deposits or proposed point source emissions to land or soil from the proposed regulated activity.

2.5 Monitoring during commissioning

A commissioning plan will be produced and agreed with the EA, which will set out the procedures for commissioning, the tests to be carried out, the frequencies to benchmark performance and the acceptance criteria to be used. Following satisfactory completion of commissioning, sampling will be carried out at the frequencies specified in the environment permit.

2.6 Fugitive emissions

Good housekeeping practices on site will ensure that any spillages of potentially dusty materials are cleared up at the earliest opportunity. Spill kits will be located close to the relevant storage area(s) and/or delivery points. Spill kits will be available for clean-up of all chemicals, oils and liquid reagents stored and used within the plant. The actions to be taken in the event of a spillage will be set out in the site procedures.

Other potential fugitive emissions, such as those to surface water, are likely to be only due to accidents or incidents. Procedures for visual inspection of bunds will be in place to check for damage and accumulation of rainwater.

3 Operating Techniques & BAT Assessment

The Operating Techniques & Best Available Technique (BAT) Assessment document provides a summary of the proposed facility and its operations, details of the operating and management techniques that will be employed and how the facility will comply with the applicable legislation for this type of process. Further details of all of the above sections can be found in the Operating Techniques & BAT Assessment. This document also includes an assessment against the BAT guidance for combustion of waste wood and the post-combustion capture of carbon dioxide.