EN010120: Drax Bioenergy with Carbon Capture and Storage Project Development Consent Examination	Robert Palgrave, Interested Party No. 20031751 Comments on Deadline 2 documents 9 March 2023

Comments on Document Reference Number: 8.10.1

APPLICANT'S RESPONSES TO ISSUES RAISED AT DEADLINE 1

CARBON CAPTURE RATE

At 5.15 in the table, (page 47) the Applicant responds to concerns raised by Biofuelwatch during the Open Floor Hearing about the carbon capture rate achievable by the proposed development:

> "According to the IEA there are 35 large scale CCUS facilities operating globally and they are capturing around 45Mt of CO2 per annum. In 2030, based on planned projects, the number of CCUS plant will increase to around 200 which would result in 230Mt of captured CO2. The need for this type of Greenhouse Gas Removal Technology (GGR) is clear and is supported by the CCCs 6th Carbon budget which identified 'BECCS Power' as one of the technologies necessary to meet Government targets.
>
> The Applicant has successfully tested the solvent which will be utilised within the BECCS Proposed Scheme on the expected flue gas composition generated by the combustion of biomass. This demonstrated that the solvent was capable of capturing CO2 from flue gas generated from biomass combustion.
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> A recent paper cited as follows: Gibbins, J., Lucquiaud, M. (2022) BAT Review for New-Build and Retrofit Post-Combustion Carbon Dioxide Capture Using Amine- Based Technologies for Power and CHP Plants Fuelled by Gas and Biomass and for Post-Combustion Capture Using Amine-Based and Hot Potassium Carbonate Technologies on EfW Plants as Emerging Technologies under the IED for the UK, Ver.2.0, December 2022, provides the following statement on CO2 capture rates;
> '*PCC can be applied to remove up to around 95% of the CO2 from any flue gas, so, given that net-zero Green House Gas (GHG) emissions must be achieved, it has widespread applications in a range of industries as well as in power plants*.'
> Section 4.5 of the paper focuses on the CO2 capture level and provides the following statement; '*instantaneous capture levels of 95% and above are routinely achievable, and clearly desirable given the UK's target of net zero emissions.*' "

The Applicant here does not claim or provide evidence that any of the "large scale CCUS facilities operating globally" have achieved a carbon capture rate of 95%. The absence of any evidence suggests strongly that such performance levels are still aspirational.

The Applicant states that they have *"successfully tested the solvent which will be utilised…"* but doesn't provide any data on the results of the test, for example the

scale of the test, the duration, the fuel used and the carbon capture rate achieved. This response does not answer Biofuelwatch's point which provided evidence that the world's largest and longest running CCUS on a power station (Boundary Dam 3) has achieved a far inferior carbon capture rate.

The paper cited by the Applicant [The BAT Review] provides an extensive review of the Amine based carbon capture technology, but it does not report any evidence that a power-CCUS has consistently achieved a capture rate of 95%, at either pilot scale or commercial scale. Indeed the paper makes it clear that BECCS with PCC at the scale proposed by DRAX is completely novel:

> *"There are no large-scale CCGT or BECCS power plants with PCC running anywhere in world. Fluor's unit at Bellingham (Fluor, 2008) was the closest example for CCGT, but this has now been closed. " (page 76)*

The BAT Review acknowledges that there is zero real-world, comparable-scale CCUS experience using biomass. It's stated opinion that *"instantaneous capture levels of 95% and above are routinely achievable"* must be therefore be treated as a theoretical aspiration rather than a guarantee that such a level would be delivered by a working system over many years of operation.

A peer-reviewed paper by Robert W. Howarth and Mark Z. Jacobson "How green is blue hydrogen?"published by Cornell University in 2021 reported

> *"We are aware of no data on carbon-capture efficiency from any plant, including any electric power plant, that combusts natural gas, but capture efficiencies of carbon dioxide from the exhaust stream of two coal-burning power plants are reported in the range of 55%-72%.[31-33] Note that efficiencies of up to 90% have been observed in one of the plants when running at full load. However, this does not reflect long-term performance, which is evaluated at average load. Load is less than full load either when the carbon-capture equipment is down for repair or when the demand for carbon dioxide is lower than it is at full load."*

In summary, the Applicant's response provides no evidence from comparable power-CCUS installations that the target carbon capture rate of 95% for Drax BECCS has ever been achieved. It is highly likely therefore that no such evidence exists. Consequently there can be little confidence in the level of carbon capture claimed by the Applicant. Their projections for the amount of carbon they would capture, and the size of the 'negative emissions ' they would provide in support of Net Zero are optimistic and should be re-worked.

AIR POLLUTION

At 5.3 in the same table (page 41) of **Document Reference Number: 8.10.1**, the Applicant responds to comments from Biofuelwatch about the uncertainties in predicting the air pollutants from the Drax BECCS, saying that:

> *"The modelling of amine degradation products is based on the biomass plume characteristics and uses the ADMS v5.2 software package. The theory behind the degradation of amines is well established, the model software has been validated by the developers and the reaction rates used for the amine degradation are specific to the technology (provided by the technology suppliers from literature values).*
>
> *Any model, or indeed monitoring, has associated uncertainties. This is taken into account in the assessment through the employment of highly conservative assumptions that ensure that impacts are not underestimated. Specifically, in the case of the modelling of amines and their degradation, it has been assumed that all degradation products (nitrosamines and nitramines) have the same toxicity as NDMA and act in combination, and the photolytic degradation of products has been neglected as has the time delay between the release of amines and the onset of degradation. "*

The Applicants assurances presented here are not supported by comments in the BAT Review, which at page 32 reported on experience at Boundary Dam 3:

> "More recently (CCSKC, 2020a), based on experience at BD3, it was stated that:
>
> *'..... the research currently available on post-combustion amine-based carbon capture is insufficient for adequately understanding interactions between amines and flue gases.*
> *"Long-term testing of amines was quite often limited in duration around the time that BD3 was built. The data we have on the behaviour of the amine used on this particular facility does not reflect the accelerated degradation that occurred closer to 3,000 or 4,000 hours of run time."*
> *In the presence of the common components and undesirable particulates present in a flue gas stream, amines degrade and must be replaced with fresh amine solution for the capture process to continue optimally. Degradation products and operational challenges are unique to each of the different amines in combination with various flue gas streams. As such, piloting must adequately emulate the conditions of the final, full-scale process. "*

The author refers to accelerated degradation of the amine used at around 3000-4000 hours. The question for the examination is this – has the Applicant's testing on a Drax BECCS pilot been extensive enough to reliably report the results of amine degradation on flue gas composition and hence atmospheric pollution? Why have no reports been published showing the results of testing if it has been done?

Secondly in the above extract from the BAT review, the point is made that *"degradation products and operational challenges are unique to each of the different amines etc"* and that therefore "*piloting must adequately emulate the conditions of the final full scale process".* Again we know very little about the pilot testing done by the Applicant. Were trials run for long enough and at sufficiently large scale using the

proprietary amine mixture to give an adequate level of certainty to its air quality impact assessment?

The Applicant has declined to disclose the composition of the Amine mixture is it proposing for the PCC, citing commercial confidentiality. Consequently, it is difficult if not impossible to interrogate the Applicant's assessment of air quality impacts.

The Applicant wrote in the Environmental Statement at 6.5.22:

> "*Given that the specified reactivity data for the proprietary amine and nitrosamine compounds remain confidential, additional model sensitivity testing has been completed based on applying amine reaction rate coefficients equivalent to proxy amine and nitrosamine compounds, for which published data in the public domain are available".*

Then at 6.5.58 in the ES, the Applicant wrote admitting that the assessment has a further limitation:

> *" Due to the confidentiality of the proprietary amine solvent, it is not possible to present the equivalent toxicity data relating to the assessed amine and nitrosamine compounds, thus representing a limitation to the assessment. However, further sensitivity testing of the amine chemistry modelling has been undertaken to address and reduce uncertainty, as detailed in Appendix 6.3 and outlined in paragraphs 6.5.21 to 6.5.25 and below*."

Overall the Applicant's approach is very concerning: modelling is inherently prone to uncertainties as the Applicant has admitted, and the use of proxies and the failure to disclose results of testing increases the likely margin of error. If it is not known which reactions are occurring within the flue gases or what substances and breakdown products may be present in the flue gases, the air quality impact assessment is deeply flawed.

This all stems from the fact that the proposal is novel and unproven at this scale. To introduce it without further extended and realistic pilot trials poses a serious risk to human health. The BAT paper put forward by the Applicant (at page 77) made it clear that the operational experience of PCC is so limited that reliable assessments of air quality impacts are not so far available.

> *"Given the complex nature of the processes involved and the emerging nature of PCC technology, as already discussed, pilot studies under thoroughly realistic conditions are required for reliable indications of the dispersion, reaction and deposition modelling inputs, and these inputs will still need to be verified by monitoring of the full-scale plant for an extended period after construction, […]"*

It is not precautionary to proceed with a process and substances that are untested or lacking in information: these issues mean that any modelling that has been done has a limited value.

In the Environmental Statement, at 6.14.1 MONITORING BASELINE AND OPERATIONAL AMBIENT AMINE COMPOUNDS MONITORING, the Applicant wrote:

> *"There are currently no data relating to ambient levels of amines and nitrosamines within the UK, a position acknowledged by the EA (Environment*

Agency, 2021), with the Scottish Environment Protection Agency's review of amine emissions from Carbon Capture stating that further work is required to develop a reliable method(s) for measurement (Scottish Environment Protection Agency, 2015). 6.14.2. As acknowledged in paragraph 6.5.54 (Assessment Assumption and Limitations), the absence of background data for amine and nitrosamine compounds represents a limitation to the assessment of operational phase impacts at human receptors"

Here again we have an admission that it is not possible to reliably assess the human health impacts of the air pollution from the proposed development.

For clarification the ExA might explore these questions.

First. Were the Applicant's assessment of air quality impacts reported in the Environment Statement based on the specific atmospheric chemistry of the two amines (Ethylamine (EA) and 2-(Ethylamine) ethanol (EAE) and the Nitrosamine (ENEN) that would be emitted to air by the PCC?

Second. Was the assessment of impacts informed by realistic-scale PCC trials on woody biomass? Will the reports of such trials be made available for scrutiny?