Technology Endorsement: Public Evaluation Statement

Prepared by Puro.earth for HAIQI

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Purpose of evaluation and assessment criteria

The purpose of this evaluation is to verify the environmental and climate performance of the equipment, in terms of emissions of air pollutants, management of solid and liquid wastes, and emissions of greenhouse gases. In addition, the aim is to evaluate the capability of the equipment to produce high quality biochar. This evaluation follows the requirements set out in the Puro Standard for Biochar (Edition 2022, Version 2).

Puro's evaluation of pyrolysis equipment is built around the following 7 assessment criteria:

Criteria 1: Methods to ensure complete combustion

Criteria 2: Methods to ensure low emissions of air pollutants

Criteria 3: Methods to ensure safe disposal of any waste stream

Criteria 4: Emission testing of air pollutants

Criteria 5: Emission testing of greenhouse gases

Criteria 6: Testing of biochar quality

Criteria 7: Material choices and expected equipment lifetime

Endorsed technology partner, equipment models and configurations

Technology Partner Information	
Name of the manufacturer	SHANGHAI HAIQI ENVIRONMENTAL PROTECTION TECHNOLOGY CO.,LTD
Country where manufacturer is registered	China
Website	www.haiqienvtech.com
Name and contact details of representative, date of submission	Name of representative: Steven Su Contact information Tel: 15652453195 Email: Steven@haiqimachine.com Submission date: December 4, 2023

Equipment model and configurations applicable
CNBC Carbonization System, including 6 models: - CNBC-100 (50-100 kg/h of biochar output) - CNBC-200: *model for which data is provided*. (150-200 kg/h) - CNBC-300 (250-300 kg/h) - CNBC-500 (400-500 kg/h) - CNBC-1000 (800-1000 kg/h) - CNBC-1500 (1200-1500 kg/h) Possible additions to CNBC Carbonization System, for energy recovery: - Biomass carbonization waste **heat recovery system**: *model for which data is provided.* - Biomass carbonization waste **heat drying system** Key components of a **CNBC Carbonization System** with **waste heat recovery** are: 1. feeding system, 2. pyrolysis carbonization system,

3. water cooling carbon output system,
4. syngas dust removal system,
5. syngas combustion system,
6. waste heat recovery system,
7. flue gas purification system,
8. electric control system,
9. compressed air system

All the 6 models, with the 2 heat recovery configurations, are declared by the partner to behave in the same way, with respect to i) pyrolysis technology and ii) processing of syngas/oil (i.e. not equipped with pyrolysis oil condensation technology: all pyrolysis oil and tars are combusted), the main difference being the processing capacity of the reactor. The models and configuration can therefore be assessed together. *This is confirmed by Puro's understanding of the technology based on technical drawings and pictures shown.*

Assessed criteria and summary of observations

Note – the summary of observations in this public version have been redacted to not disclose any confidential information, and the redaction has been approved by the Technology Partner. Interested buyers may request additional information directly from the Technology Partner.

Criteria 1: Methods to ensure complete combustion of pyrolysis gases and oils
☒ Criteria is met, in full. ☐ Criteria is met partially. ☐ Criteria is not met.
Observations: Criteria 1 is met in full, thanks to the design measures listed (including temperature of combustion, residence time, air-to-fuel ratio, design of burners and nozzles, insulation of combustion chamber, turbulence of air flow), and evidenced with pictures, technical drawings, and written declarations.

Criteria 2: Methods to ensure low emissions of air pollutants
☒ Criteria is met, in full. ☐ Criteria is met partially. ☐ Criteria is not met.
Observations: Criteria 2 is met in full, thanks to the design measures and the various options to install relevant flue gas equipment. For most clean biomass feedstocks (e.g. forest residues, agricultural residues, but not e.g. sewage sludge), the default flue gas treatment system design seems sufficient. It will then be verified on a project basis that equipment installed meets the regulation applicable locally. It is appreciated that the manufacturer has the capacity and knowledge to assist clients for specific requests.

Criteria 3: Methods to ensure safe disposal of any waste stream
☒ Criteria is met, in full. ☐ Criteria is met partially. ☐ Criteria is not met.

Observations:
Criteria 3 is met in full, as the information provided identifies all waste streams and quantifies the amounts generated during normal operations. The models assessed are burning most of the pyrolysis oil, and thereby minimize generation of pyrolysis oil/tar (residual tar generation represents about 10% of the biochar fresh weight output). Weekly or bi-weekly maintenance and cleaning of the system is also estimated to generate liquid waste, 220 kg of wastewater per cleaning for the CNBC-200. Other waste streams from the flue gas system are also quantified (ash and particulate matter, spent filter bags). It will then be verified on a project basis, during regular facility and output third-party audits, that equipment installed meets the regulation applicable locally and that waste streams are disposed accordingly.

Criteria 4: Emission testing of air pollutants

☒ Criteria is met, in full.
☐ Criteria is met partially.
☐ Criteria is not met.

Observations:
Criteria 4 is met in full, with the data provided here. It should be noted that at this stage, it was not shown that environmental permits had been obtained for machinery operating outside of China (only jurisdiction for which data was reported). It should also be noted that residual oxygen levels seem relatively high, and that the dry standard flowrate seems rather variable (as affected by temperature, moisture, variability in process). It will then be verified on a project basis, during regular facility and output third-party audits, that equipment installed meets the regulation applicable locally.

Criteria 5: Emissions testing of greenhouse gases

☒ Criteria is met, in full.
☐ Criteria is met partially.
☐ Criteria is not met.

Observations:
Criteria 5 is met in full meaning that GHG emissions have been quantified and can be used for determining the carbon footprint of biochar produced with this equipment (although N_2O quantification relies on only 1 measurement). Puro notes that CH_4 emissions are low (representing < 0.1% of the carbon stored in biochar). Puro notes that N_2O emissions are non-negligible (representing about 5% of the carbon stored in biochar), and efforts should be made to reduce N_2O emissions, alongside NOx.

Criteria 6: Testing of biochar quality

☒ Criteria is met, in full.
☐ Criteria is met partially.
☐ Criteria is not met.

Criteria 6 is met in full, meaning that it has been demonstrated that the equipment can be operated with certain biomass feedstocks (woodchips, wood pellets) in a way that leads to biochar of sufficient persistence and sufficient environmental quality for most applications, e.g. soil applications. It will then be verified on a project basis, during regular facility and output third-party audits, that biochar produced is of sufficient persistence and sufficient environmental quality.

Criteria 7: Material choices and expected equipment lifetime
☒ Criteria is met, in full. ☐ Criteria is met partially. ☐ Criteria is not met.
Criteria 7 is met in full, meaning that material and energy usage for reactor manufacturing have been disclosed, enabling calculation of embodied emissions from reactor manufacturing and disposal, as well as an expected lifetime of the reactor. The expected lifetime included in carbon footprint accounting may be conservatively reduced to 10 years (in the absence of evidence that similar machinery has been in operation for more than 10 years). As for any other endorsed technology provider, the terms and conditions apply, and interested buyers are encouraged to conduct own due diligence with respect to equipment material quality, expected lifetime, availability of spare parts, support from manufacturer and warranty.

Other comments
None.

Decision
☒ The applicable equipment by the Technology Provider have successfully passed the Puro.earth evaluation against the requirements set out in the Technology Provider Evaluation Criteria. ☐ The submission requires revisions before the evaluation of the applicable equipment by the Technology Provider can be finished. ☐ The applicable equipment by the Technology Provider have not passed the Puro.earth evaluation against the requirements set out in the Technology Provider Evaluation Criteria.
Documents submitted on 2023-12-07 First review concluded on 2023-12-18. Additional documents submitted on 2023-12-27. Second review concluded on 2024-01-04.