

# Public evaluation statement by Puro.earth

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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).

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	PYREG GmbH
Country where manufacturer is registered	Germany
Website	<a href="https://pyreg.com/">https://pyreg.com/</a>
Name and contact details of representative	Robert Kovach CSO/Head of Sales r.kovach@pyreg.com +4915234222610

Equipment model and configurations applicable
<p>PYREG <b>Pyrolysis Equipment</b>, including 5 models:</p> <ul style="list-style-type: none"> <li>- PYREG P500</li> <li>- PYREG P1500</li> <li>- PYREG PX500</li> <li>- PYREG PX1500</li> <li>- PYREG PX6000</li> </ul> <p>The models above come with energy recovery systems, primarily thermal energy, which can be customized, and flue gas treatment systems depending on the type of biomass feedstock.</p> <p>All the 5 models 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. <i>This is confirmed by Puro’s understanding of the technology based on technical drawings and pictures shown.</i></p>

## 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, controlled air-to-fuel ratio, design of low-NOx burner, insulation of combustion chamber), 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 (e.g. pre-combustion gas filter, low-NOx burner) and the options to install relevant flue gas treatment equipment for certain feedstocks (e.g. sewage sludge). 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 shall 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 with respect to flue gas treatment (e.g. addition of scrubbers and/or activated carbon filter for S-rich feedstocks).

### 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. All models assessed combust the entire flow of pyrolysis gas, without condensation of liquid products (potentially liquid phases are kept gaseous during the entire process). A cyclone (in the P-series) or a process gas filter (in the PX-series), used for pre-cleaning of the pyrolysis gas, generates a minor amount of solid char residue that is disposed with the biochar output, deemed without negative effects on the biochar quality. The newer PX-series is deemed to not require weekly maintenance, in comparison to the P-series. Overall, the models assessed do not generate any significant amount of solid or liquid waste stream.

**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. Emissions of common air pollutants have been measured on multiple instances, and environmental permits in multiple jurisdictions have been obtained (e.g. Switzerland, USA, Germany). It shall still 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. Puro notes that CH<sub>4</sub> emissions are very low (representing < 0.05% of the carbon stored in biochar). Puro notes that N<sub>2</sub>O emissions are non-negligible (representing about 5% of the carbon stored in biochar), but this value is in line with default values for thermochemical processing of solid biomass.

**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 most biomass feedstock in a way that leads to biochar of sufficient persistence and sufficient environmental quality for most applications, e.g. soil applications. It shall still 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, as well as an expected lifetime of the reactor. The expected lifetime is also demonstrated to be of at least 10 years, due to equipment already in operation (P-series), while for the newer PX-series, lifetime is expected to be in the range of 15-20 years, due to technology improvement.

As for any other vetted 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**

Overall, the equipment is deemed of high-quality and high reliability for biochar production, with energy recovery, and without waste generation. The high-level of automation and monitoring also reduces need for maintenance and manual labour during operation.

**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 2023-06-21  
Review concluded on 2023-07-07.