

## Answers to Bidders' questions – 7.12.2017

1- Starting from design according to document a 1500 M<sup>3</sup> digester is giving 1292 M<sup>3</sup> biogas daily. This is very very high efficiency. Design details are not mentioned. Kindly share design details. As biogas plants in practice here are far less efficient as compared to this calculation. The structure can be constructed but this much efficiency with substrate mentioned is a little bit confusing.

The proposed design is based on a standard design for so called "European Agricultural Biogas Plants". The described design concept, which included the main relevant equipment, that facilitates the comparatively higher efficiencies compared to simple biogas plants, is explained under section 3.3.2. Component Specification and Process Description as well as in the flow sheet under Annex D: Flow Diagram for Biogas System. The assumed biogas yields for the requirements in m<sup>3</sup> biogas and methane per kg organic matter are reference values for this type of plants, which can be verified in the respective literature. (e.g. <https://mediathek.fnr.de/broschuren/fremdsprachige-publikationen/english-books/guide-to-biogas-from-production-to-use.html> or the Online European Feedstock Atlas). The constant temperature within the digester of around 35°C through the substrate pre-heating, together with the agitation system and the retention time of 48 days shall facilitate the respective yield. Of course, the respective daily yield of 1.250 m<sup>3</sup> (Table 3) is based on the substrate mix given under Table 2 and section 3.3.1. Baseline for Biogas System, which includes the feeding of cattle dung, corn silage and chicken manure. Additionally, the functional requirements are of course based on the respective organic matter content of the substrate mix and the respective numbers of each substrate. (see also section 6.3.2 Performance Acceptance Procedure Biogas System)

2- Biogas production is strictly dependent on dry matter available in raw material fed to digester. The calculations of dry matter in substrate should be re considered.

Biogas production depends on the organic dry matter content of the substrate and the specific biogas/methane yield per kg organic dry matter per of each substrate. This is why the functional requirements are based on the respective organic matter content of the substrate mix and the respective numbers of each substrate. (see also section 6.3.2 Performance Acceptance Procedure Biogas System).

As for the Bidder's risk during performance tests, it is noted again that the required output of biogas is calculated DEPENDING ON the given input substrate (lab analysis), so if the total oDM of the feed-in substrate is less, the required biogas output is also less.

3- The heat source (when CHP generator is not working) is not clear to me.

Since the CHP is always generating more heat than needed, a heat storage tank can be heated permanently in parallel with hot water of around 90°C, this heat storage tank shall supply the hot water, while the CHP is not operating. A 5 m<sup>3</sup> heat storage tank can thereby provide up to 80 kWh heat with a delta T of 20 K.

4- UAF do have dairy farms why not they assure dung supply from their dairies.

The option will be explored; a definite answer cannot be given at this point as the farms are not under the responsibility of the project management.

5- What is the minimum run time of generator required per day.

The generator must be able to run 24 hours per day. The expected operation time per year is 8.000 h,

including maintenance outages. Actual operation time might be less (minimum 50% of total hours of the year).

6- If the heat exchange media is water that must be treated to avoid corrosion and scaling. Faisalabad water is already very high in TDS.

The pipes of the heat exchanger shall be of anti-corrosion material and are respectively sealed in order to avoid oxidation of the inner parts.

Further questions:

7- Is underground design possible for the digester?

The presented design is a proposal and may be modified. Underground design is principally also possible, but it needs to be ensured that:

- Agitators and all required tubes can be installed from the outside (accessible holes)
- Leakage can be detected and repaired
- All substrate flows need to be ensured by either pumping or gravitation

8- What about first few months of operation? There might no silage be available during the early summer 2018.

During the very first months of operation, if no silage is available on the market nor from UAF fields, feeding with 100% cow dung and respectively lower biogas output is permissible. A special clause can be added to the O&M contract.

Further clarifications:

- Insurance of equipment: Within the overall O&M scope, the O&M operator is also required to buy an insurance policy for the main equipment (esp. CHP) for the O&M period.