Is Anaerobic Digestion the Way to Go? – A Feasibility Assessment Tool

Prior to implementing an urban biogas project to valorise the organic fraction of municipal solid waste, an in-depth evaluation is essential to determine its appropriateness in the specific local context. A tool was thus developed and tested in Bahir Dar, Ethiopia, to facilitate this crucial step in project planning. Christian Riu Lohri[1], Ljiljana Rodić[2], Christian Zurbrügg[1]

The high fraction of biowaste in developing countries presents a double-edged sword. On the one hand, it poses a considerable health and environmental risk if not properly managed and treated. On the other, the material has a significant valorisation potential. Anaerobic digestion (AD) is not only a well-known technology in manure treatment, but it is also considered a promising method to address the issue of organic solid waste, i.e. it is an effective treatment option to reduce the amount of waste destined for disposal and also to generate valuable products, such as energy-rich biogas and nutrient-rich digestate.

Yet, experience reveals that many AD projects at institutional and municipal level in developing countries face severe operational problems or have even failed [1]. One of the reasons is that AD installations are often chosen and implemented based merely on their theoretical potential. If any feasibility assessment is conducted, only technical and short-term financial criteria are primarily accounted for. The challenge of selecting the most appropriate setup (including technology, scale, location, and stakeholder involvement/responsibilities) adapted to the local social, economic and environmental context thus remains.

Moving beyond the technical

Our research developed an integrated feasibility assessment tool that accounts for the experiences and lessons learned from various AD projects in low-income countries. It also focuses specifically and systematically on the enabling environment [2]. The objectives comprised development of a tool:

- using sustainability factors as feasibility criteria
- specifying key requirements for successful AD projects
- revealing differences in stakeholder perspectives and priorities
- creating a basis for discussion and negotiation
- quantifying feasibility
- allowing capacity testing of the institution designing and installing the system
- comparing the different AD technologies and their respective suitability in a given context.

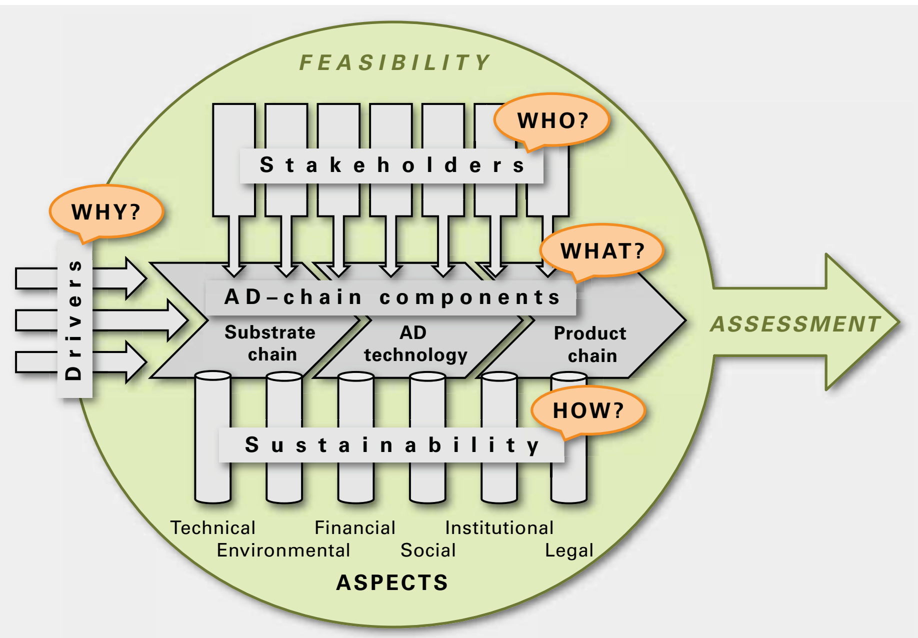

Figure 1: Structure of feasibility assessment tool for urban anaerobic digestion in developing countries.

The tool, designed to be used in a participatory manner, helps to identify strengths and weaknesses of a specific AD setup. This thereby allows, already during the planning and decision-making stage, to adapt the project to the needs and capacities of the stakeholders involved.

Structure of the assessment tool

The feasibility assessment tool defines four distinct yet interrelated dimensions, each answering a specific question (Fig. 1):

- **WHY?** What are the ***driving forces*** and motivations behind an AD project?
  - Social drivers (public awareness or pressure from other stakeholders).
  - Environmental drivers (resource recovery to achieve environmental sustainability).
  - Economic drivers (financial considerations, valorisation of resources).
  - Other drivers (e.g. tourism, institutional changes, political or academic interests).
- **WHO?** Who are the ***stakeholders*** and what are their roles, powers (high, medium, low), interests (supportive, neutral, disruptive), and means of intervention?
- **WHAT?** What are the proposed ***physical components and flows*** in the AD process chain, which can be divided into:
  - Substrate chain (waste generation, collection, transport).
  - AD technology (pretreatment, AD process, posttreatment).
  - Product chain (distribution and use of biogas and digestate).
- **HOW?** How are the ***sustainability criteria*** met by the proposed AD system?
  - Technical-operational feasibility criteria: Issues related to the substrate chain (waste quantity and quality, water use, distance of generation to AD plant), the AD technology (space and

material availability, performance, maintenance strategy, flexibility and robustness), and product chain (biogas quality, digestate quality).
- Environmental feasibility criteria: Use of non-renewable materials. Degree of environmental degradation as well as destruction of habitat and natural ecosystems.
- Financial-economic feasibility criteria: Funding sources, extent and conditions to cover capital investments in AD projects, running costs, expected revenue from AD-derived products, cost-benefit analysis.
- Socio-cultural feasibility criteria: Stakeholders' acceptance of AD-derived products, willingness to change behaviour, impacts enhancing people's capacities to meet their needs.
- Institutional feasibility criteria: Institutional capacity, stakeholder cooperation.
- Policy and legal feasibility criteria: AD-related policies, legislations and standards.

The first three dimensions (Why? Who? What?) outline the specific context of the AD project and test it for thorough project planning. The fourth dimension (How?) examines the six sustainability criteria the project is embedded in and on which it has an impact.

How to use the tool

Each dimension includes a comprehensive set of questions, which can be answered by AD project documentation and by consulting the stakeholders (through interviews and/or stakeholder workshops). Moreover, the stakeholders involved accord a certain priority (weight) to each sustainability aspect, thereby expressing the relative importance given to the individual aspects. A simple mathematical algorithm used in the feasibility assessment matrix then combines the results of the assessment (*scores*) and their relative importance (*weights*), while accounting for the risk that conditions may develop differently than planned or that the data used for the assessment is uncertain (*uncertainty factors*). An Excel spreadsheet facilitates applicability and visualisation of the results. The sequence of questions is similar to that of a checklist covering all relevant items that ought to be considered during the planning stage. Disruptive constellations or potential pitfalls in the AD proposal are thus revealed (red flags) and can be addressed, clarified and improved during discussions with the respective stakeholders.

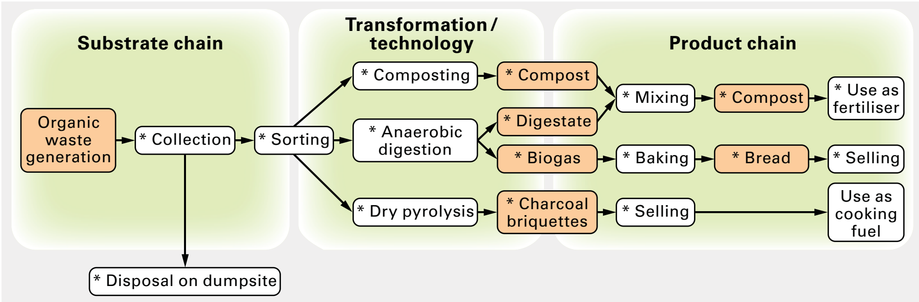

Figure 2: Schematic material flow in the pilot project of Bahir Dar (*conducted/controlled by Dream Light).

Organic waste recycling in Bahir Dar

The solid waste management system of Bahir Dar, a city of 220000 inhabitants in the northwest of Ethiopia, is characterised by a successful collaboration between the municipality and the private company Dream Light (DL). This public-private partnership has improved waste collection coverage from 51% in 2005 to 71% in 2010 [3]. Waste is still predominantly disposed of in an open dumpsite. DL initiated an Organic Recycling Centre using three different biowaste valorisation technologies, i.e. composting, anaerobic digestion and charcoal-briquetting (Fig. 2).

Feasibility assessment in Bahir Dar

The developed tool was tested in Bahir Dar and subsequently adapted according to the feedback received from a stakeholder workshop. The assessment showed that one of the main strengths of the project is Dream Light's overall responsibility and control over the entire supply chain (cf. Fig. 2). This allows DL to rapidly influence the activities along the AD chain according to their motivation of keeping the project operational and thus profitable. The idea of a diversified portfolio of waste recycling products (compost, biogas, charcoal-briquettes) addresses different market segments and thus offers a risk distribution option. These products either show high demand (biogas used in a bakery), a guaranteed market (sale of charcoal-briquettes to an organisation disseminating improved cooking stoves) or the product is used by DL itself (compost for their agricultural fields). The marketing strategy related to the use of an AD product (biogas) to make another product with an existing or high potential demand (bread) prevents the sale of a product not yet established qualitatively or accepted by the public at large. However, application of a wide range of technologies requires in-depth knowledge of an array of different processes and technologies, an aspect still lacking in DL. This concern is partly addressed by starting the project on a pilot scale, learn from experiences and mistakes, modify, expand, and scale-up.

Yet, the technical weaknesses and the absence of a maintenance service strategy are decisive elements requiring additional efforts so as to ensure successful and long-term project operation.

Outlook

After having proven its merits in Bahir Dar, the assessment tool needs to be validated and its usefulness tested in various AD projects in other cities. If you are interested in the feasibility assessment tool, we will send you the Excel version of the tool together with a brief user manual. Sandec welcomes critical feedback to further refine this assessment tool.

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[3] UNEP (2010): Assessment of the Solid Waste Management System in Bahir Dar Town and the Gaps identified for the Development of an ISWM Plan. Forum for Environment, June 2010.

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