
Biogas

Biogas - Application and Product Development

Planning a biogas plant

Before building a biogas plant, there are different circumstances which should be considered. For instance, the natural and agricultural conditions in the specific countries are as important as the social or the economic aspects. To consider the most important factors, we provide a checklist for the planning procedure, a planning guide and a checklist for construction of a biogas plant.

Failure or unsatisfactory performance of biogas units occur mostly due to planning mistakes. The consequences of such mistakes may be immediately evident or may only become apparent after several years. Thorough and careful planning is, therefore, of utmost importance to eliminate mistakes before they reach irreversible stages.

As a biogas unit is an expensive investment, it should not be erected as a temporary set-up. Therefore, determining siting criteria for the stable and the biogas plant are the important initial steps of planning.

A general problem for the planning engineer is the interference of the customer during planning. As much as the wishes and expectations of customers have to be taken into consideration, the most important task of the planner is to lay the foundation for a well functioning biogas unit. As in most cases the customer has no experience with biogas technology, the planner has to explain all the reasons for each planning step. Planners should have the courage to withdraw from the planning process, if the wishes of the customer will lead to a white elephant on the farm.

Moreover, all extension-service advice concerning agricultural biogas plants must begin with an estimation of the quantitative and qualitative energy requirements of the interested party. Then, the biogas-generating potential must be calculated on the basis of the given biomass production and compared to the energy demand. Both the energy demand and the gas-generating potential, however, are variables that cannot be accurately determined in the planning phase. Sizing the plant (digester, gasholder, etc.) is the next step in the planning process.

In the case of a family-size biogas plant intended primarily as a source of energy, implementation should only be recommended, if the plant can be expected to cover the calculated energy demand.

Information about the economic evaluation of a biogas plant can be found in the section on Costs and Benefits.

Design

Throughout the world, a countless number of designs of biogas plants have been developed under specific climatic and socio-economic conditions. Chosing a design is essentially part of the planning process. It is, however, important to familiarize with basic design considerations before the actual planning process begins. This refers to the planning of a single biogas unit as well as to the planning of biogas-programs with a regional scope.

Physical conditions

The performance of a biogas plant is dependent on the local conditions in terms of climate, soil conditions, the substrate for digestion and building material availability. The design must respond to these conditions. In areas with generally low temperatures, insulation and heating devices may be important. If bedrock occurs frequently, the design must avoid deep excavation work. The amount and type of substrate to be digested have a bearing on size and design of the digester and the inlet and outlet construction. The choice of design will also be based on the building materials which are available reliably and at reasonable cost.

Skills and labor

High sophistication levels of biogas technology require high levels of skills, from the planner as well as from the constructor and user. With a high training input, skill gaps can be bridged, but the number of skilled technicians will get smaller the more intensive the training has to be. In addition, training costs compete with actual construction costs for scarce (project) resources. Higher technical sophistication also requires more expensive supervision and, possibly, higher maintenance costs. To which extent prefabricated designs are suitable depends largely on the cost of labor and transport.

Standardization

For larger biogas programs, especially when aiming at a self-supporting dissemination process, standards in dimensions, quality and pricing are essential. Standard procedures, standard drawings and forms and standardized contracts between the constructor, the planner, the provider of material and the customer avoid mistakes and misunderstandings and save time. There is, however a trade-off between the benefits of standardization and the necessity of individual, appropriate solutions.

Types of plants

There are various types of plants. Concerning the feed method, three different forms can be distinguished:

- **Batch plants**
- **Continuous plants**
- **Semi-batch plants**

Batch plants are filled and then emptied completely after a fixed retention time. Each design and each fermentation material is suitable for batch filling, but batch plants require high labor input. As a major disadvantage, their gas-output is not steady.

Continuous plants are fed and emptied continuously. They empty automatically through the overflow whenever new material is filled in. Therefore, the substrate must be fluid and homogeneous. Continuous plants are suitable for rural households as the necessary work fits well into the daily routine. Gas production is constant, and higher than in batch plants. Today, nearly all biogas plants are operating on a continuous mode.

If straw and dung are to be digested together, a biogas plant can be operated on a **semi-batch** basis. The slowly digested straw-type material is fed in about twice a year as a batch load. The dung is added and removed regularly.

Concerning the construction, two main types of simple biogas plants can be distinguished:

- fixed-dome plants
- floating-drum plants

But also other types of plants play a role, especially in past developments. In developing countries, the selection of appropriate design is determined largely by the prevailing design in the region. Typical design criteria are space, existing structures, cost minimization and substrate availability. The designs of biogas plants in industrialized countries reflect a different set of conditions.

Parts of a biogas plant

The feed material is mixed with water in the influent collecting tank. The fermentation slurry flows through the inlet into the digester. The bacteria from the fermentation slurry are intended to produce biogas in the digester. For this purpose, they need time. Time to multiply and to spread throughout the slurry. The digester must be designed in a way that only fully digested slurry can leave it. The bacteria are distributed in the slurry by stirring (with a stick or stirring facilities). The fully digested slurry leaves the digester through the outlet into the slurry storage.

The biogas is collected and stored until the time of consumption in the gasholder. The gas pipe carries the biogas to the place where it is consumed by gas appliances. Condensation collecting in the gas pipe is removed by a water trap.

Depending on the available building material and type of plant under construction, different variants of the individual components are possible.

The following (optional) components of a biogas plant can also play an important role and are described seperatly: Heating systems, pumps, weak ring.

Construction details

The section on construction of biogas plants provides more information on:

- Agitation
- Heating
- Piping systems
- Plasters and Coats
- Pumps
- Slurry equipement
- Underground water

Starting the plant

Initial filling

The initial filling of a new biogas plant should, if possible, consist of either digested slurry from another plant or cattle dung. The age and quantity of the inoculant (starter sludge) have a decisive effect on the course of fermentation. It is advisable to start collecting cattle dung during the construction phase in order to have enough by the time the plant is finished. When the plant is being filled for the first time, the substrate can be diluted with more water than usual to allow a complete filling of the digester.

Type of substrate

Depending on the type of substrate in use, the plant may need from several days to several weeks to achieve a stable digesting process. Cattle dung can usually be expected to yield good gas production within one or two days. The breaking-in period is characterized by:

- low quality biogas containing more than 60% CO_2
- very odorous biogas

- sinking pH and
- erratic gas production

Stabilization of the process

The digesting process will stabilize more quickly if the slurry is agitated frequently and intensively. Only if the process shows extreme resistance to stabilization should lime or more cattle dung be added in order to balance the pH value. No additional biomass should be put into the biogas plant during the remainder of the starting phase. Once the process has stabilized, the large volume of unfermented biomass will result in a high rate of gas production. Regular loading can commence after gas production has dropped off to the expected level.

Gas quality

As soon as the biogas becomes reliably combustible, it can be used for the intended purposes. Less-than-optimum performance of the appliances due to inferior gas quality should be regarded as acceptable at first. However, the first two gasholder fillings should be vented unused for reasons of safety, since residual oxygen poses an explosion hazard.

Managing input- and output-material

Substrate input

For a simple, small-scale biogas system, only a minimum amount of time and effort must be spent on procuring the feedstock and preparing it for fermentation. The technical equipment is relatively inexpensive. Theoretically any organic material can be digested. Substrate pre-processing and conveying depends on the type of material to be used. One of the most important problems in substrate management to be considered is the problem of scum.

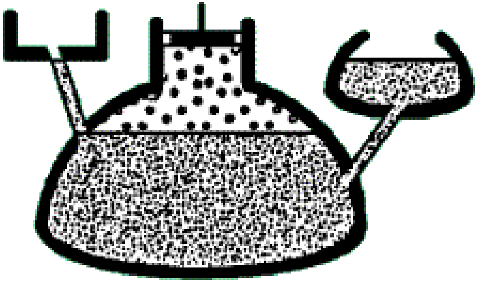
Effluent sludge

The sludge resulting from the digestion process represents a very valuable material for fertilization. The following aspects of sludge treatment and use are considered here:

- Sludge storage
- Composition of sludge
- Fertilizing effect of effluent sludge
- Sludge application and slurry-use equipment

Biogas

BIOGAS Digest



- Basics
- Framework Conditions
- Application and Product Development
- Costs and Benefits
- Program Implementation
- Country Reports
- Publications
- Internet links
- Imprint

- Contact
- Table of Contents

Biogas plants constitute a widely disseminated branch of technology that came into use more than 30 years ago in developing countries. There are hundreds of thousands of simple biogas plants now in operation, and each one of them helps to improve the living conditions of people in rural areas. Biogas systems are an efficient way of dealing with organic waste, dung and crop residues while making optimal use of their energetic as well as nutrient content.

In addition to generating renewable energy, biogas systems help to stimulate ecologically beneficial closed-loop systems in the agricultural sector while improving soil quality and promoting progress in animal husbandry and farming.

While the main focus is on biogas systems of simple design, the technology is nonetheless complex enough to warrant close attention to its proper application, planning and construction. Only a well-planned, carefully constructed and properly functioning biogas system will fulfill its purpose of improving living conditions in rural areas.

You will find useful and detailed information about all aspects of biogas plant design and maintainance, biogas appliances, social, political, economic and ecological framework conditions, planning and dissemination of biogas systems and last but not least country- and project-specific information.