How to Organize a Biogas Project in Thailand

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ABSTRACT

Krieg & Fischer Ingenieure GmbH is an internationally active engineering office with more than 25 years of experience in the planning and construction of biogas plants. The scope of activities extends from conception to commissioning and includes the entire spectrum from design to detailed planning. More than 20 employees from various disciplines work together on project processing in interdisciplinary groups. An engineering team is typically a combination of civil engineers and process engineers. Environmental engineers and qualifications in the fields of agriculture and biology are incorporated.

The planning and construction of a biogas plant comprises numerous contract work sections, starting with earth moving and tank construction through pump, piping and stirrer technologies, to process control and automation. In addition, the digester in a biogas plant needs to be optimally adjusted for the "biological system" due to microbiological conversion processes in this core part of the biogas plant. It is complex system engineering involving expertise from many specialist fields.

A biogas plant in Thailand must be planned and constructed based on Thai laws and regulations. In addition to purely technical aspects such as process temperatures, retention times, tank sizes, etc. the national and local background should be considered in every country. This cannot be covered by European companies. This publication shows that local construction companies in Thailand are not yet capable of engineering and constructing totally on their own a plant in terms of planning and technology - assuming it is to be a state of the art biogas plant. Hence it is neither possible to entrust the construction of a "turn-key" biogas facility in Thailand to a local nor to a European or international plant construction company. For this reason a biogas project in Thailand can only be implemented in a cooperation between local and international companies and the system components should be awarded to several suppliers – some local, some international companies.

This publication and the accompanying presentation provide examples of the Krieg & Fischer Ingenieure GmbH field of experience in the worldwide implementation of biogas projects.

Keywords: Biogas plant, regenerative energy, energy crops, general contractor, piece-meal

INTRODUCTION

The construction and operation of biogas plants will not only produce renewable energy in the form of biogas or electricity and heat, but it will also promote the local economy. In addition to slurry and manure, crop residues, organic waste from the food industry and organic kitchen and household waste, specially cultivated energy crops are also suited as substrates. In Thailand the sustainable cultivation of energy crops, especially napier grass is supported by the government. In rural areas where no organic residues are available it is possible to use a combination of slurry, crop residues and energy crops as substrate. The cultivation of energy plants and the maintenance and operation of the biogas plant creates additional sources of income for farmers and villagers in rural areas. However,

biogas plants which use only slurry and manure as input material, are barely economically possible to be operated. The use of energy crops in addition to manure make the economic operation of biogas plants in rural areas possible. On the one hand the use of slurry and on the other hand the replacement of fossil energy sources also reduce emissions and contribute to climate protection. Biogas can secure the regional supply of electricity, gas or fuel, particularly in remote regions. The growing dependence on imported oil and natural gas under growing energy consumption can be reduced. The money remains in the region, leading to a regional added value.

Another advantage is the ability to use the digestate as a valuable fertilizer. This enables energy-intensive manufactured fertilizers to be saved and nutrients from the manure do not pollute the water bodies and ground water, but are specifically returned to the natural cycle. This is a sensible solution for waste water and waste problems for animal-holding facilities. The mono-fermentation of energy crops is also possible. In 2002/2003 Krieg & Fischer were the first biogas company in the world to make such a concept into reality. (Obernjesa 2003).

Experience from the Krieg & Fischer Engineers

Due to the variety of combined contract work sections such as earthworks, tank building, piping, and control technology, the construction of a biogas plant falls into the field of system engineering. In addition to the above skills, other engineering services are required, such as subsoil reports, safety aspects ("hazard assessment"), surveying or environmental impact reports, which are generally awarded locally. Then a specialist company that has the appropriate expertise and experience is necessary for the overall planning and organization. Depending on the coordination and organization, this may be a locally based company in Thailand, which relies on the expertise from abroad, or a foreign company, which relies on locally available Thai expertise. It is important to understand that a biogas plant is always composed of several technical components that are logically fit into the construction process, that everything has to be implemented based on local law, and - normally - communication between the parties is in English.

It is also important that local, national or regional products that are manufactured in Thailand and neighbouring countries are generally less expensive than those (that have to be) imported from Europe. The organization of spare parts deliveries from local suppliers is easier than from Europe "from the other side of the world". Even the delivery of the accompanying documentation for each component in the national language is often a challenge for European companies and leads to higher costs for the end client. For this reason it is preferred to have as many deliveries by local manufacturers as possible. On the other side, this is not always possible. Several components, such as certain stirrers, heat exchangers and pumps as well as certain safety components are not manufactured in Thailand or in Asia. Based on Krieg & Fischer's experience these components are only made in designated "biogas countries" in Europe, i.e. Denmark, Germany, Austria and Switzerland, and all projects around the world are supplied from there. In other cases, cost comparisons will be necessary to find out the most favourable option for individual cases. Thus, we have supplied large tanks (digester tanks, secondary digester tanks) and also gas engines for projects in Japan or Canada from Europe.

During construction of the biogas plant the various contract work sections on site are coordinated by the site manager, and he also monitors the construction phases. A so-called "Cold start-up" is conducted to test the system without substrate. Only afterwards does the biological commissioning follow with the given input material. In this phase in which digester biology development and inexperienced operator meet, it is especially important to have competent support at the plant. It takes several weeks or months before the plant reaches its nominal throughput and thus its performance level. Biological and engineering support for the plant is useful for the further plant operation. Disorders in the digester biology that are not detected early can cause major system failures and lead to significant economic losses.

Individual Operating Concept

Not only are slurry and manure from livestock suited as substrates for biogas plants in Thailand, but also residues from farming and food production such as residues from cassava starch production and ethanol production. Waste from slaughterhouses, kitchen and food waste and organic waste, and also specially cultivated energy crops are

interesting because of the “Alternative Energy Plan (AEDP)”. In Thailand Napier grass (Pennisetum purpureum) is particularly suitable as an energy crop. It can be harvested 5-6 times per year and can reach a fresh mass yield of 500 tons per acre per year. With a biogas yield of about 70-110 m³ per ton of fresh mass (Holzhausen 2014) 45,000 m³ of biogas can be generated per hectare. That is more than three times the amount of biogas produced per hectare in Germany using corn as an energy crop.

The conservation of plant material, as is common and necessary in Europe, is not possible but also not necessary under tropical conditions. Due to the tropical climate in Thailand conservation through silaging and silo storage is difficult, and on the other hand fresh plant material is available year-round. Crop residues cannot be conserved, but be only added to the system seasonally. The use of fresh rather than silaged substrate must be considered during the planning of the biogas plant, of course, both technically and from a biological standpoint.

Biogas plants have different complexities depending on the nature of the input material. While plants that process only liquids such as slurry or liquid residues have a relatively simple design, plants that process for example, organic waste from different area in households are highly complex. Depending on the composition of the input material, specially adapted pre-treatment methods are required to produce a substrate which can be fermented in a digester without problems. In each case the biogas plant must be adapted to the customer's wishes and requirements. Does the customer want a high-tech system with a high degree of automation or a simple system with correspondingly higher (human) support costs? There are numerous possibilities for the practical implementation of a biogas plant both in process engineering as well as in a civil work aspect. Next to complex industrial plants, there are also simple and inexpensive system concepts - of course the respective input material must always be taken into consideration.

A biogas plant must also be adapted to the local climate. Krieg & Fischer have many years of experience in the building of biogas plants in extreme climates. In Canada, a biogas plant had to be adapted to temperatures of -40 °C and large amounts of snow. In Spain biogas plants are built with special cooling systems, to be operated at temperatures of + 40 ° C without overheating of the gas engine and the biological system. This also applies to biogas plants under tropical conditions as in Thailand. There the high temperature is compounded by the high humidity. Additional cooling of the motors at high temperatures can be accomplished by strengthening ventilation and increasing the cooling surface. However, the higher the humidity the more difficult the cooling becomes. All surfaces must be protected against corrosion due to the high humidity. Other additional conditions which must be observed when constructing a biogas plant are earthquake safety and sea climates.

Anaerobic biological conversion processes are exothermic. The higher the energy density in the input material is, the more relevant the planning of the biogas plant technology is. Particularly in the case of mesophilic operation of the fermenter, if the fermenter is not cooled, it is possible for the fermenter temperature to increase above the intended operating temperature due to intrinsic temperature development and high outside temperatures.

The points listed emphasise that adaptation to the input material is particularly important in the planning of a biogas plant. There is simply no way to transfer simple, standardized system concepts from Europe to Asia (“copy-paste” model).

Piece-meal or EPC-contractor

The dream of every customer is the assignment of a single technically competent company, that delivers biogas plants, turnkey and inexpensive. Ideally, this company would take over the approvals and financing of the project. Unfortunately, that's not the way the world works.

When building a biogas plant several contract work sections come together: Earthworks, civil engineering operations, the construction of digester and other tanks, and the delivery and pre-treatment halls, the installation of pumps, electrical operations, pipeline and mains connection work, etc. A general contractor (EPC contractor) provides all contract work sections and provides all construction services for the construction of the biogas plant at a fixed price. The fixed price includes the EPC-surcharge of about 25-50%, and abroad often more. For this the general contractor takes over the organization and responsibility of the entire project.

A general contractor generally provides a standardized type of biogas plant. This type of system has been designed by engineers and is used again and again in Germany and perhaps Europe. Well-known and experienced suppliers are available for the components. Earthworks, silage slabs and transformers are often produced by the customers themselves. Therefore the construction of a biogas plant by a solely responsible plant engineer is an illusion, even in Germany. But even the usual general contractor's limited concepts used in Germany cannot be applied to projects in Asia. Rather the corresponding biogas project organization must be developed for each specific project. The central issue is the installation of the large vessels. While in Europe the vast majority of fermenters are built as a concrete tanks, in North America mostly enamelled or epoxy-coated steel tanks are selected. Our experience shows that in Japan completely enamelled steel tanks are used, in China welded steel tanks are considered to be technically sensible and economical. Depending on the selected fermentation system and the selected fermenter material the necessary foundations must be prepared in consultation with local suppliers and in accordance with Thai regulations. While the piping is traditionally supplied by local suppliers based on European planning, the necessary pumps and valves may have to be shipped from Europe - depending on requirements. Big digesters in industrial plants are often equipped with so-called central stirrers, which are only manufactured in Europe. Heat exchangers for highly viscous substrates are neither available Japan nor in other Asian countries. Special measuring equipment can only be supplied by European suppliers.

Example European general contractor (EPC-contractor): all major suppliers are known by the experienced biogas companies, but taking into account local regulations and suppliers, there is no experience in the implementation of projects in Asia.
Example of Thai general contractor (EPC-contractor): the experienced local general contractors do not know which companies in Europe are suitable to deliver quality products that allow the construction of a biogas plant using the state of the art.
Either way, even in those cases where the delivery or the construction of a biogas plant is mainly performed by a general contractor (EPC-contractor), significant surcharges between purchase and sale of components can be expected, as the general contractor (EPC-contractor) can of course charge for uncertainties and risks accordingly.

For the client, ordering the individual components (“piece-meal approach”) is always less expensive than awarding the contract to a general contractor (EPC-contractor). Engineering companies which are familiar with construction projects are needed on both the European and on the Thai sides. Surcharges between purchasing and sales of components do not arise. The coordination of the battery limits (interfaces) is of considerable importance. Battery limits must be meticulously defined, not only between European suppliers and Thai suppliers, but with all companies involved. Even at the building site organization between companies must be ensured according to project progress. One must reckon with significant additional organization work compared to German or Thai internal construction projects. It is important to understand that it is a joint engineering team. Of course a clear accountability structure must be implemented during the project development phase. But after that the team counts!

An engineering firm such as Krieg & Fischer creates customized technical planning for each biogas plant, tenders the contract work sections and components of the system individually which provides for an optimally adapted biogas plant. Each contract work section is awarded separately by the customer directly. For the implementation of a construction project, the site management, supervision and coordination of the various services require in-depth knowledge, considerable experience and efforts. Typically, our engineers need to visit the construction site 10 - 20 times throughout the course of a project. This leads to relevant cost, which of course the customer must be aware of in advance for the financing of the project. However, it is certain that these costs will be well below the cost of hiring a general contractor (EPC-contractor).

The end customer receives his training parallel to the project through extensive documentation for selection of potential suppliers as part of the planning and tendering of contract work sections. Ideally, the future operating staff, e.g. the technical manager of the biogas plant is involved in the planning and monitoring of the construction site. The hazard assessment carried out under European law to ensure proper operation will be coordinated with him. This simplifies commissioning and subsequent regular operation of the biogas plant with regard to high safety requirements.

Method and Organisation

When Krieg & Fischer receives a request for a biogas plant from Thailand, first a rough concept is developed as a basis. This includes rough sizing of tanks and system components and an estimation of the investment costs - all adapted to the given input material. A first profitability assessment is conducted by the customer. If this estimate is positive, it makes sense to conduct preliminary planning by obtaining project-related offers - possibly from local providers. Preliminary planning includes a site plan and process flow diagram and a detailed cost calculation. The result of this planning is the basis for the preparation of the application for approval by a local Thai company. Concrete results in terms of the investment costs and the economic viability are becoming more and more clear. And finally, the project development includes conducting detailed planning, monitoring the construction and commissioning of the biogas plant. Every project is different. Every customer is different. Project development ends with project organisation being discussed, and responsibilities and costs are regulated.

CONCLUSION

German general contractors (EPC-contractors) are used to constructing standardised biogas plants based on standard components. This does not work in Thailand. Rather, local regulations must be considered and it is necessary that local suppliers provide many of the components. Thai general contractors (EPC-contractors) do not (yet) have sufficient experience to construct a state-of-the-art biogas plant. Therefore, it is not possible for a single company to supply a complete biogas plant in Thailand. The cooperation between a Thai and a German company is almost imperative in order to cover all requirements.

Therefore, Krieg & Fischer as an engineering firm prefers the individual awarding of components with a clear definition of battery limits (interfaces) and responsibilities. Thus, the system components and the contract work sections come not only from Germany and Europe but “preferably” from Thailand too. Local companies are also involved. In addition to the cost savings this results in benefits for the plant operation and acceptance, and it also promotes the regional economy.

REFERENCES

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