

BIOGAS

THE BEST SOLUTION

**A proposal for alternative thinking and participating in
limiting the use of fossil fuels for heating**

Contribution for the school competition

”COMBATE CLIMATE CHANGES”

arranged by National Geographic and Vattenfall

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Our idea is to set up a large biogas plant somewhere discrete at the Zoo. All animal dung will be fed into the plant and this will produce lots of methane gas that can burn and be used for heating the tropical greenhouses at the Zoo.

Apart from not having to get rid of the dung, it will also be possible to save a lot of money and the slurry that remains in the container can either be sold as fertiliser or be transformed into fertiliser pellets which can also be sold to other countries.

Biogas

Actually, very close to our school in Copenhagen there is an area where many animals live all year round.

You can visit the Zoo and observe the many different kinds of animals, study their exterior and their habitat, and acquire an awful lot of knowledge about them by visiting the homepage of this special place.

The area is Copenhagen Zoo.

Many of the Zoo's animals are exotic ones from tropical and sub-tropical parts of the world. In order to survive here they have to live in heated areas with temperatures that do not exist in our climate for several months of the year and in some cases, for the entire year.

Therefore, the Zoo has great heating expenses. Every year the Zoo consumes 2,885 MWh of heating, which costs more than 1 million DKK!

However, with our fantastic idea we know how the Zoo can reduce their heating expenses and at the same time perhaps even earn some money in another way.

The solution is to build a big biogas plant somewhere discrete at the Zoo, perhaps underground.

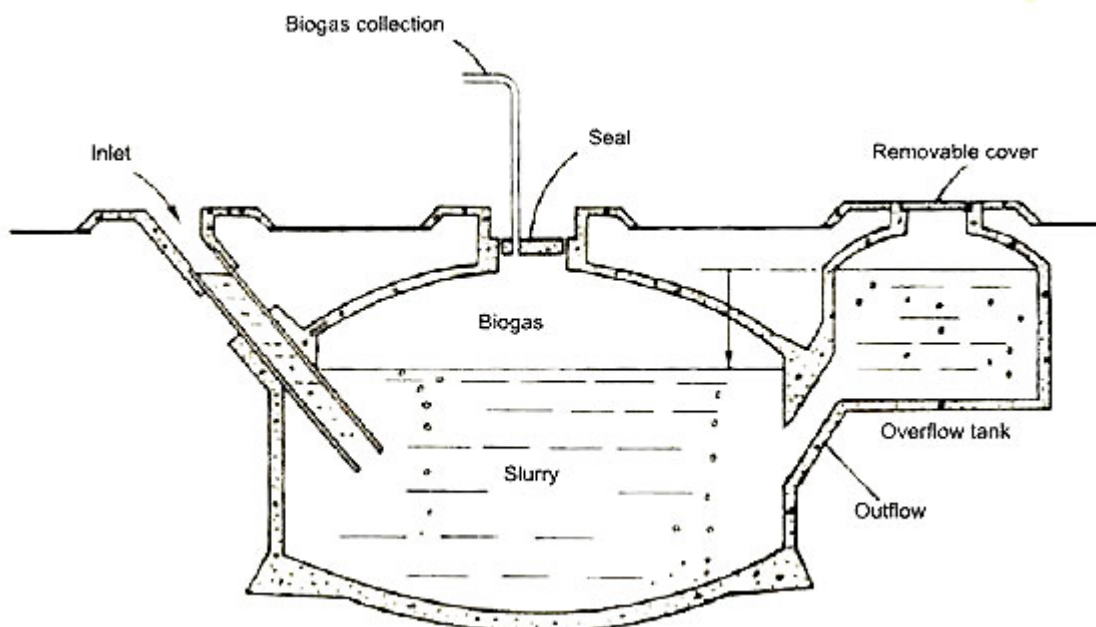
The biogas plant shall be feed with enormous amounts of dung, which the Zoo's animals produce every day.

Biogas plant

A biogas plant consists in principle of a closed tank with organic material which decomposes without the presence of oxygen.

The putrefactive bacteria turn the organic material into so-called digested slurry during the development of methane (CH_4). Methane is a greenhouse gas and the burning of it has no effect on the environment.

Methane can burn and even has a high burning value. During combustion, carbon dioxide and water are developed.



On the above illustration you can see the inlet on the left where the animal dung is added to the big tank (the digester). The biogas, which is formed in the tank, rises and is collected via the narrow tube at the top of the tank. To the right there is an overflow tank that works as a security valve.

A biogas plant functions as follows: the biomass, for example from the stables at Copenhagen Zoo, is introduced into a chamber and from there it is pumped further into the processing tank either as a steady supply or it is loaded at intervals, like in the so-called batch-loader digester, i.e. several digester tanks are used (process tanks).

Inside the airtight process tank the biomass is heated typically to approx. 40° C and under these circumstances the methane bacteria form biogas.

The biogas that consists of 50 – 75 % methane, 25 – 50 % carbon dioxide, 0 – 1 % hydrogen sulphide and a tiny bit of hydrogen is sent further into a gas store. The digested material is emptied into a storage tank from where it can be used elsewhere (see below).

The biogas can be used directly for incineration in a gas-fired furnace or it can be transformed to electricity in a motor-driven generator.

The best energy exploitation however is achieved in a combined heat and power plant. Here the gas is burned in a gas motor that runs a generator and the heat is extracted from the motor's cooling water and exhaust.

The utility value of the energy conversion in a combined heat and power biogas plant is approx. 60 %; the energy is distributed as follows:

- 25 % electricity
- 35 % exploited heat

Advantages

There are several advantages of setting up a biogas plant at Copenhagen Zoo:

Firstly, it will be comparatively easy to get rid of the organic waste produced at the zoo. Here we are also taking animals that die of old age or are put down into account. As the situation is today, it is quite a costly affair having the waste transported out of the city. Transportation takes place in lorries that use fossil fuel (diesel oil), which on the one hand has an impact on the greenhouse effect and on the other contributes to air pollution in general, the consequence of which is an increasing number of cancer cases in city areas.

Secondly, the biogas (methane) could be used immediately as a source of heating in the many places at the zoo that need tropical heat. Today, the houses etc. are heated via district heating which is not the most expensive solution but one that in the long run is much more costly than 'own produced' heating.

Thirdly and the most important, biogas is a CO₂-neutral source of heating. The district heating typically comes from combined coal-fired heat and power plants – coal being a fossil fuel. Therefore the use of biogas would also contribute to reducing Denmark's CO₂ emissions.

Fourthly, the technology concerning biogas plants is well-known, and there are many successful plants around the world. Therefore, there is no risk of running into initial difficulties.

Figures

Each year, Copenhagen Zoo produces 1,860,000 kilos of fertiliser, and we have worked out that this can produce up to 252,960 m³ methane gas. And there would be a steady and constant supply of fertiliser, so the possibilities for a large and well-working biogas plant are most definitely present.

Side benefits

The digested slurry at the bottom of the digestion tank constitutes good fertiliser, rich in nitrogen. There is almost no smell attached and it can be sold to the agricultural sector as is, or it can be used as raw material in the production of fertiliser pellets, which then could be sold abroad.

Finally, it can be dried and burned at an incineration plant and in that way used in the production of heat and electricity.

In Denmark biogas is used solely for the production of electricity and heat. However, in Sweden they have progressed further in the development of biogas for transportation; for passenger vehicles, buses and trains. In Helsingborg, part of the public bus service is run on biogas. The gas comes from a biogas plant that processes household and slaughterhouse waste. One of the advantages of using biogas for fuel in cars is the low emission of cancer-causing substances – much lower than when using biofuel (ethanol). Thus, it is possible to achieve environmental and health payoffs by increasing the use of biogas in the production of power and heat as well in transportation fuel.

Finally, a large extended biogas plant would in future be able to receive other forms of organic waste, for example household waste, sludge from sewage treatment plants and waste from the food processing industry.

The greenhouse effect

Surrounding the Earth is a layer of so-called greenhouse gases of which the two most important are water vapour and carbon dioxide (CO₂).

These greenhouse gases reduce the loss of heat from the Earth into space and that means that the temperature on Earth is quite high. If the greenhouse gases did not exist, the temperature on Earth would be approx. 33° C lower today.

The augmented greenhouse effect problem is caused by man's burning of fossil fuels (oil, coal and natural gas), which increases the amount of carbon in the air.

Together, the greenhouse gases will prevent the heat radiation from Earth from increasing, making the temperature rise.

This creates the risk of increased amounts of water on Earth and major climate changes. This is why all countries are at present working on reducing their emissions of greenhouse gases, primarily CO₂, and this is done by, amongst other things, shifting the production of energy from fossil fuels to for example, renewable energy sources and biofuels.

Conclusion

The way we see it, it would be a great advantage if the Zoo were to establish a big biogas plant.

We have mentioned the financial aspects in relation to the present as something of importance however the most important thing is in fact that a biogas plant is a good way of reducing the emission of humanly created carbon which hopefully can inspire others to do something similar.

An important part of the Zoo's job revolves around communication, and therefore it would be a good idea if the Zoo were to use a biogas plant to demonstrate how you can collaborate with nature in producing energy.

Furthermore, the Zoo puts enormous efforts into preserving and exchanging threatened species with other Zoos, and therefore it would also be quite natural if Copenhagen Zoo were to take an active part with regard to protecting the global climate, which is the foundation for the existence of so many of the World's animals.