Biogas plant for Idre, Sweden - a discussion paper

Question: **"Can a biogas plant be built in Idre where during winter it is usually minus 25 degrees Celsius?"**

The answer: **“Yes.”**
"One or more local high-tech biogas plants according to the SBRS concept can with the method "Optimum Solids Anaerobic Digestion" (OSAD) contribute to:
a) increased sustainable utilization of bioenergy and plant nutrients and
b) reduce costs for transport and pollution that negatively affect health, the environment, and the climate.

Idre Fjäll is one of the largest year-round facilities in Sweden with over 600,000 visitors each year (old information https://www.northcom.se/nyheter/idra-fjall-sepura/). In Idre is only 647 inhabitants (on July 22, 2022).

After bookings, it is possible to calculate how many visitors there will be each day at the facility and plan how much food and toilet waste can be collected each day. If visitors stay in hotels or cottages, collection toilets can be adapted so that encapsulated food and toilet waste can be collected hygienically by staff without disturbing the accommodated visitors.

If 600,000 visitors stay for just one day, 900 tons of food and toilet waste is produced when you calculate that one person per day produces around 1.5 kg.

To balance that amount of wet and nitrogen rich material, about 255 tons of pellets with about 9% water content should be procured to create the right water content and carbon/nitrogen ratio for microorganisms.

The mixture of food and toilet waste with pellets contains approximately 1,188 MWh of bioenergy, of which at least half is in the biogas and the rest in the organic carbon structures of the biofertilizer, which form a carbon sink and provide energy to soil organisms.

The biogas' energy is converted with trigeneration into approx. 30% electricity and 65% heat. If necessary, heat can be converted to cold.

Additional energy in the village Idre should be compared with the energy consumption found in the sewage treatment plant and in the manufacture of chemicals, fertilizers, current equipment, etc.

In the 900 tons of food and toilet waste, there are approximately 9.3 tons of nitrogen (N) and 1 ton of phosphorus (P). The content of organic carbon (org C) is approximately 37 tons. If everything were to be burned up, 135 tons of carbon dioxide (CO2) would be released.

Everything that is written about how the biogas plant can work in Idre in Sweden is just a "vision". Of course, when planning reality there will be people who can solve it even better.

Renewable organic material, i.e., everything from the plant and animal kingdom can in principle be raw material for ecologically, economically, and socially sustainable biological transformation with the help of microorganisms.
Food and toilet waste from both households and restaurants, sports facilities, schools,

hospitals, trains, buses, planes, boats, etc. must be collected hygienically - without diluting it with water! - and without polluting losses delivered to the biogas plant.

To ensure smooth operation of the bioreactor, the village should be divided into two, three or more districts with equal amounts of food and toilet waste. If there are three districts, food and toilet waste is collected every third day from one of districts. In this way the same amount of aqueous material is supplied to the biogas plant every day. Dry, well-ground materials must be in stock.

All material must be transported in such a way that pollution of the air is prevented, and no one is in an unhealthy working environment.

Pellets of straw and wood as well as drier renewable organic materials from municipal waste and from residual products from forestry and agriculture should be used for biological conversion processes. Thermal and chemical processes (combustion, thermal gasification, pyrolysis, esterification) cause pollution that causes health and environmental problems, are costly losses of plant nutrients and organically bound carbon that become carbon dioxide, and damage biodiversity when everything that lives in and on the material be killed.

Local high-tech biogas plants work with optimal anaerobic conversion of renewable organic material without excess water, i.e., "Optimum Solids Anaerobic Digestion" (OSAD).

In a biogas plant that uses OSAD, the need for microorganisms is taken into account for optimal conditions in terms of water content, structure and nutrient balance in the substrate - which is a mixture of different renewable organic materials - with the aim of maximizing the yield of biogas and biofertilizer.

Currently, in biogas plants, methods with a water content above 90% in the bioreactor are mostly used, despite the fact that microorganisms optimally need a water content below 70% (Personal information from professor in microbiology Hans Ljunggren at Swedish university of Agricultural Sciences). The construction of large bioreactors is unnecessarily expensive, and the consumption and transport of water costs quite a lot over many years of operation.

The difference with surplus water methods is that both the water content and the composition of the structure affect the nutrient balance.

In OSAD, food and toilet waste - which is collected hygienically, without dilution with water - is mixed with drier and finely disintegrated material. It creates a structure with a large surface where microorganisms live, multiply and contribute to a higher production of biogas. At the same time, biofertilizer is better adapted to cultivation systems than digestate, which is de facto the nutrient solution produced with methods over 90% water in a bioreactor.

The local high-tech biogas plant must be well insulated like any other house. All equipment for the preparation of the optimal mixture (grinders, mixers, scales, screws to move the material, all pipes in between, etc.) must be of suitable quality without affecting the substrate. Equally important is the high quality of the materials used for the interior of the bioreactor.

The bioreactor must be further thermally insulated and heated to be able to maintain either a mesophilic (30-37 ºC) or thermophilic process (50-60 ºC) to promote maximum yield and safety against various pathogens.

When using OSAD, all equipment must be adapted to create a hygienic working environment.

Before a biogas plant is to be built, a cost-benefit analysis must be carried out.

Data must be collected to evaluate all emissions that affect air, water and land as well as what costs and losses are associated with the current unsustainable management of food and toilet waste and of the dry materials that are mixed in, i.e. pellets and other dry "renewable organic materials" from the municipality's waste and residual products from forestry and agriculture.

The following should be included:

Facts from wastewater management, which includes all emissions from the source (the kitchen, the toilet), up to the discharge of treated water. All costs for water consumption, chemicals, energy consumption, personnel costs, and all other costs throughout the chain.

At least two end products are created in sewage treatment plants:

a) outgoing water that contains nitrogen, phosphorus, organic matter (how many percent of it was there from the beginning?), chemicals from hygiene products and added during the treatment of wastewater, pesticides, drug residues, etc.

b) sewage sludge containing the same as above, requires post-treatment and is difficult to use on cultivated land. If the sludge is burned, additional pollution of air, water and soil is added.

Losses incurred must also be quantified and valued. For example, how much nitrogen and phosphorus have been lost and how much it costs to buy these from abroad. The total value of all plant nutrients should be estimated, as well as the impact on biodiversity and non-occurring carbon storage/sequestration, that would otherwise positively affect physical, chemical, and biological soil properties i.e., soil fertility/production capacity.

Facts from waste incineration and from other thermal and chemical processes such as combustion in cogeneration plants, thermal gasification, pyrolysis, and esterification, for which the drier types of renewable organic material in residues and waste are used. What pollution arises, what happens to all the plant nutrients and microorganisms that live on the raw material are rarely reported.

Unfortunately, composting is an unsustainable method because out of 100 kg of material, approx. 30 kg of compost is of uncertain quality. Losses that pollute make up 70% by weight of composted material.

The total health impact from handling waste and wastewater should be investigated.

Costs for construction and operation of all facilities should be included in accounting.

Design of biogas plant, collection devices, logistics and handling of gray water when food and toilet waste are used separately can be discussed further.

Some devices can be handled with digitization.

The vision for the biogas plant in Idre follows the SBRS concept, which stands for "Sustainable Biological Recycling System" and is described on http://biotransform.eu/wp-

content/uploads/2015/03/DRAFT-H%C3%A5llbart-system-f%C3%B6r-%C3%A5tervinning-av-v%C3%A4xtn%C3%A4ring-RS-20191205.pdf.

OSAD method and sketch of all equipment can be found at http://biotransform.eu/wp-content/uploads/2015/03/OSAD-en-RS-1.pdf.

CC-BAS is a waterless collection device for toilet waste and can be also used for disposal of food waste is at http://biotransform.eu/wp-content/uploads/2022/05/THE-TOILET-OF-THE-FUTURE-CC-BAS-BS-RS-1.pdf

Benefits of CC-BAS - in no particular order because everything is important:

• Hygienic and convenient handling of toilet and food waste at all levels.
• Increased control of pharmaceuticals in the waste.
• Increased cycling of plant nutrients – all the elements that are essential for plants.
• Minimize the use of agrochemicals – fertilizers and pesticides.
• Better utilization of bioenergy when the material is converted into biogas.
• Minimization of emissions that are pollutant losses to air, water, and soil.
• Lower water consumption.
• Easy to install, it takes a maximum of one hour to remove WC and replace with CC-BAS.
• No pollution of water – less discharge to the Baltic Sea.
• Non-use of artificial chemicals for wastewater treatment.
• No particularly costly new investments in the old sewage infrastructure, on the other hand, the possibility of rapid transition -- according to the municipalities' investment plans (in Sweden) for renovation and upgrading of sewer systems, it will take 350-500 years.

Imagine that from 2030, unsustainable processes to handle renewable organic material are prohibited.

1) Water must not be used to transport human and animal excrement or food waste from households, restaurants, etc., to avoid air and water pollution, chemical and energy-intensive treatment of polluted water, which even then pollutes the environment and is expensive for individuals and for society.

2) Thermal and chemical processes will cease where renewable organic matter was used as raw material, i.e., everything that comes from the plant and animal kingdom, for example in combustion, thermal gasification, pyrolysis, and esterification. This prevents emissions that harm health, the environment, and the climate.

From the beginning of 2023, for a period of 7 years, the whole world switched to economically, ecologically, and socially sustainable methods of handling renewable organic material. World hunger was reduced when plant nutrients were recycled locally, thus eradicating poverty. The air and water became much cleaner, and the climate threat has slowed.

All praise goes to the wise decision makers who agreed worldwide.

Einstein: **“Imagination is more important than knowledge.”**
When you have a vision, you seek knowledge that will help you realize the vision.