

Biogas instead of fossil natural gas

2022-03-14

The war in Ukraine has started and the supply of fossil natural gas, oil, uranium, phosphates, etc. from Russia is very uncertain. Therefore, it is important to further develop as soon as possible equipment, methods and systems that utilize the unused bioenergy and recycle the for life essential elements found in residual products, by-products, and waste.

Bioenergy - the energy of life. A proposal for a scientific definition of the term BIOENERGY can be found at <http://biotransform.eu/wp-content/uploads/2022/02/BIOENERGY-definition-RS-2022-02-25.pdf>.

The essential elements for all living organisms are described at <http://biotransform.eu/wp-content/uploads/2021/12/Essential-elements-for-all-living-things-RS.pdf>.

A project with ambitions to use biological transformation processes with modern technology is described as the SBRS concept and stands for "Sustainable Biological Recycling System". Presentation of the SBRS concept with some pictures can be found at <http://biotransform.eu/wp-content/uploads/2021/10/From-Photosynthesis-to-Photosynthesis-according-to-SBRS-concept-2021-05-RS.pdf>.

We are seniors who are ready to pass on our knowledge to younger people who can build different parts of the SBRS concept. More information is available at www.biotransform.eu.

Human survival depends on waste management.

The cities' central waste and sewage systems are expensive, pollute air, water and soil and cause losses of plant nutrients, biodiversity, and organic carbon storage. The difference between sustainable and unsustainable methods of using bioenergy is described at <http://biotransform.eu/wp-content/uploads/2015/04/Bioenergy-Compare-three-methods-of-use.pdf>.

Hydrogen can replace natural gas. Blue hydrogen is produced from natural gas with the resulting carbon dioxide emissions captured and stored at this time. Carbon capture and storage (CCS) is expensive technology and therefore unsustainable. Green hydrogen is created by electrolysis of water. This process uses renewable electricity and is therefore carbon-free. - If unsustainable methods to produce renewable electricity are used, costly environmental damage occurs.

Transition to local biological systems for waste and wastewater management which, with the help of digitization, innovations, and increased precision, **should have the highest priority to reduce pollution and increase the production of biogas** - for electricity, heating, cooling - **and biofertilizer** to recycle plant nutrients and phase out imported mineral fertilizers, increase the biological diversity in the soil and increase the soil's organic carbon sequestration.

Although the biological method that uses **anaerobic digestion in biogas plants is sustainable**, it is still mostly used as a 100-year-old method where the water content in bioreactors is over 90% and which makes construction and the process unnecessarily costly.

“Commercial biogas facilities often tend to have a relative low efficiency and low profitability, resulting in the worldwide biogas potential not being utilized to its full extent.”

<https://www.diva-portal.org/smash/get/diva2:1448800/FULLTEXT01.pdf>

Research on High Solids Anaerobic Digestion (HSAD) was conducted at The National Renewable Energy Laboratory (NREL) in the United States in the 1980s. The results showed that with a water content of around 70%, smaller and thus cheaper bioreactors can be built and biogas production per bioreactor volume can be increased 4 to 6 times. Research was paid for by the oil industry. When it was shown that everyone could produce biogas efficiently - projects were terminated prematurely.

To maximize the yield of biogas and biofertilizer, it is necessary to create substrates at each local biogas plant according to the availability of different types of raw materials. The conversion method should be called **Optimum Solids Anaerobic Digestion (OSAD)**, as the water content should be optimal for microorganisms that will process the specific substrate created by local Renewable Organic Materials.

In the table 2 shows examples of how different types of Renewable Organic Material could be included in substrates for OSAD. Each tonne of the mixture's dry matter contains an estimated 5,000 kWh of bioenergy. Between 40 to 60% is converted to biogas and the rest of the bioenergy remains in biofertilizer.

TRIGENERATION. Simultaneous production of Power, Heat and Cold from biogas.

<https://www.tedom.com/wp-content/uploads/2018/03/TEDOM-Trigeneration-2015-05-EN.pdf>.

Energy efficiency: Of 1,000 kWh of bioenergy in the biogas, about 300 kWh of electricity and 650 kWh of heat can be produced, which can be converted to cooling if necessary. A biogas car consumes 45 kWh / 100 km while an electric car only 14 kWh / 100 km. Biogas car drives about 2,222 km on 1,000 kWh of biogas. Electric car drives about 2,143 km on 300 kWh of electricity and there is still about 650 kWh to use for heating or cooling.

| 1 000 persons | ton/day | days | ton/year | DM | ton DM/year | ton C/year | ton CO ₂ /year |
|-------------------------------|------------|------|------------|-------------|-------------|------------|---------------------------|
| Human excreta (HE) | 1,2 | 365 | 438 | 0,07 | 31 | 15 | 56 |
| Food waste (FW) | 0,3 | | 97 | 0,30 | 29 | 15 | 53 |
| Totally HE and FW | 1,5 | | 535 | 0,11 | 60 | 30 | 110 |
| Different pellet types | 0,5 | | 167 | 0,91 | 152 | 76 | 278 |
| Mixture/substrate | 1,9 | | 702 | 0,30 | 210 | 105 | 386 |

Table 1: A proposal for a suitable substrate for Optimum Solids Anaerobic Digestion. Well-ground pellet types or woody material from the city's green area are suitable structure carriers for methane fermentation at about 70% water content.

For a city with **300,000 inhabitants**, the need for pellets or other woody materials that increase the proportion of carbon rich dry matter to around 30% is at least 50,000 tonnes per year.

Estimated gross amount of **manure in Sweden**: 22 million tonnes / year can generate 3.4 - 7.0 TWh of biogas / year and 104,000 tonnes nitrogen (N) + 23,000 tonnes phosphorus (P).

[https://morebiogas.se/onewebmedia/2-](https://morebiogas.se/onewebmedia/2-Ri%CC%82tning%20av%20stallgi%CC%82dse%20i%20o%CC%82stersji%CC%82perspektiv,%20Mats%20Edstrom%2029%20aug%202017.pdf)

[Ri%CC%82tning%20av%20stallgi%CC%82dse%20i%20o%CC%82stersji%CC%82perspektiv,%20Mats%20Edstrom%2029%20aug%202017.pdf](https://morebiogas.se/onewebmedia/2-Ri%CC%82tning%20av%20stallgi%CC%82dse%20i%20o%CC%82stersji%CC%82perspektiv,%20Mats%20Edstrom%2029%20aug%202017.pdf). It is difficult to estimate how much of different pellet types or other carbon rich dry materials will be needed to mix with all animal excrement to create suitable substrates for OSAD.

On the other hand, one can estimate the value of the three plant nutrients nitrogen (N), phosphorus (P) and potassium (K) which are usually imported as mineral fertilizers. In a city with 300,000 inhabitants, it is about 15,000,000 SEK (1,504,723.50 US dollars) per year that N, P and K are found in food and human excreta, and which today are mostly lost as pollutants of air, water, and soil. The current wastewater treatment plant sends 481 tonnes of nitrogen (N) and 12 tonnes of phosphorus (P) to the sea every year.

A combined heat and power plant in Sweden uses 310,000 tonnes of fuel / year and uses "bark, cave, RT chips, sawdust and peat". Some Renewable Organic Material is imported with questionable content, which results in environmentally hazardous ashes.

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To be able to calculate losses of plant nutrients nitrogen (N), phosphorus (P), potassium (K) and sulphur (S), the assumption is made that the plant uses only pellets of pine where analysis results are available. This means that in fuels used, there is little difference between the content of plant nutrients while the content of the element carbon is relevant. Analyses of dry matter show that pellets contain 9% water. The calculated emissions per year are shown in Table 2.

| | ton | ton N | ton P | ton K | ton S | ton CO ₂ |
|-----------------------------|---------|-------|-------|-------|-------|---------------------|
| Cogeneration plant per year | 310 000 | 564,2 | 9,9 | 141,6 | 16,1 | 536 289 |

Table 2: Some emissions from a combined heat and power plant. During combustion, water vapor (H₂O) is emitted, which is also a greenhouse gas. The farmers' cost for the purchase of the corresponding mineral fertilizer that is lost in the CHP plant per year is SEK 7,563,350 (USD 758,716.70).

Slaughterhouse waste and dead animals are ground, boiled, dried and annually there are about 165,000 tons. How much bioenergy and plant nutrients are lost and become polluting emissions? The material would be of greater societal benefit if it was mixed with pellets of different materials (wood, straw) and used as a substrate to produce biogas and biofertilizer.

These were just some examples of what is being done unsustainably at the expense of society, without using The Polluter Pays Principle. Environment, health, climate, and expenses are negatively affected.

With access to suitable laboratory equipment and knowledgeable people, we and many others can within a few months perform tests that can provide answers to which equipment and which methods give results that are worth scaling up to get the desired result. This is provided that the necessary resources can be secured without lengthy procedures, which are unfortunately practiced by most government donors.

As early as 2002, I submitted a proposal to the EU (available at http://biotransform.eu/wp-content/uploads/2015/03/0-2002-EoI-int_26219-RS.pdf) and received feedback from 17 countries where researchers wanted collaborate to apply for funding for projects. We did the best we could, but our five applications were rejected. Copies of these five applications to the EU - which now, 20 years later, would include many improvements in technology, digitization, robotics, analysis, etc. - are available at <http://biotransform.eu/proposals/> at the bottom of the page.

If the EU were to invest in biogas 20 years ago, we would have cleaner air and water, biogas for electricity and heating / cooling, without having to import fossil natural gas, and domestic biofertilizer instead of imported mineral fertilizer. Now it is in a hurry, transition to knowledge based sustainable society needs to be done with sustainable methods and systems. The SBRS concept positively affects all SDGs.

The responsibility lies with decision-makers who should direct resources to the further development of biogas plants, including adaptation of infrastructure to minimize costly losses of bioenergy and the essential chemical elements that make up all living organisms. The city's representatives can ensure that sustainable management of renewable organic material in waste and sewage must be included in the EU's renovation wave to reduce housing costs. It is not enough to additionally insulate the houses when the bioenergy is wasted, and the soil degradation continues and threatens the production of food and other vital products.

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CV can be seen at www.biotransform.eu on the first page at the bottom.