Malmö is planning a sewer tunnel and a new wastewater treatment plant

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"In 2021, approximately 351,000 natural persons were connected" according to Appendix 1 of the consultation document Sjölunda sewage treatment plant (vasyd.se).

Presented here are the latest calculations based on available analysis and data from various sources to derive nitrogen (N) and carbon dioxide (CO2) emissions.

Management of nitrogen (N) in Malmö's sewage system.
Each resident leaves about 5 kg of nitrogen per year in wastewater - from urine, faeces and about a third of the food waste that is flushed down according to the Swedish Environmental Protection Agency. This amounts to a total of 1,755 tonnes of nitrogen per year. Some nitrogen is released into the air already on its way to sewage treatment plants. Since the nitrogen also comes from sources other than households, in 2021 the total amount was 1,844.6 tons of nitrogen (MR 2021 Sjölunda ver 1.pdf).

1) Release of nitrogen to the water.

The Sjölunda sewage treatment plant reported that ***561.9 tons*** were released into the Lommabukten in 2021. This means that approx. 30% of the nitrogen that comes to the sewage treatment plant pollutes the Öresund.

2) In the sludge, it is usually calculated to find about 25% of nitrogen (not reported) that goes to sewage treatment plants. This corresponds to ***approx. 461.22 tons*** of nitrogen which in 2021 remained in 26,978 tonnes of dewatered sludge with a dry matter of 6,448 tonnes.

3) Release of nitrogen into the air.

In biological purification, about 45% of nitrogen is released into the air in the form of nitrogen gas (N_2) and nitrous oxide (N_2O). In 2021, just ***over 820 tons*** of nitrogen have been sent into the air using an energy-intensive method.
How much does it cost to send 1 kg of nitrogen into the air in Malmö? In the USA, the same process costs an average of 140 dollars per pound of nitrogen, which corresponds to about 300 euros per kilogram of nitrogen. Some nitrogen becomes nitrous oxide (N_2O). In Linköping, 13% of separated nitrogen left as nitrous oxide. What percentage of nitrogen was turned into nitrous oxide in Malmö?

In many municipalities, the incineration of sludge is planned, which would mean more health-threatening nitrogen oxides (NO, NO_2) and that no nitrogen returns from sewage to cultivated land.
Sludge incineration is already used, for example, in Vienna, where 1.9 million inhabitants are connected. The loss to air is approx. 9,500 tonnes of nitrogen (N) per year. Farmers must purchase mineral nitrogen fertilizers manufactured using energy-intensive methods that usually use natural gas as an energy source to capture the air's nitrogen.
Citizens must pay for costly sewage treatment, for more expensive food and for increased health problems.

Management of organically bound carbon (C-org) in Malmö's sewage system.
In 2021, urine and faeces from 351,000 people contained approximately 5,265 tons of C-org, while in a third of the food waste, the amount of C-org was 1,755 tons.
In total, the content of C org was 7,020 tons, which corresponds to 25,763 tons of carbon dioxide (CO_2) per year. It is estimated that some organic carbon (C-org) can leave with treated water to the sea (30%? – not reported) and some remains in the sludge (25%? – not

reported). Assume that 45% departed as carbon dioxide, forming 11,593 tons of CO_2 to the air in 2021.
If the proportion of nitrous oxide (N_2O) were 13% of the nitrogen that was sent to the air (ie the same as in Linköping), 13% of 820 tonnes is about 106 tonnes. Emissions of 1 kg of nitrous oxide correspond to emissions of approximately 298 kg of carbon dioxide (CO_2) from a 100-year perspective (https://doi.org/10.1017/CBO9781107415324). Emissions of 106 tonnes of nitrous oxide (N_2O) correspond to 31,588 tonnes of carbon dioxide (CO_2).
Can estimate of outgoing carbon dioxide be 11,593 + 31,588 tons, i.e. a total of 43,181 tons of CO_2 per year?

Transition to sustainable management of renewable organic material in waste streams requires new thinking, new laws, coordination, and new technical aids where there is always respect for the laws of biology. Technology in the service of biology should favour biological/biochemical transformation methods that favours biodiversity, reduce losses that pollute and economically benefit citizens.

Therefore, SBRS concepts are proposed that need to be improved with the help of many specialists in different fields. SBRS stands for "Sustainable Biological Recycling System" and is presented with images at http://biotransform.eu/wp-content/uploads/2022/08/From-Photosynthesis-to-Photosynthesis-SBRS-concept-RS-BS.pdf.

To maximize the yield during biological conversion to biogas and biofertilizer, a balanced carbon-nitrogen ratio (C/N ratio), a water content of around 70% instead of today's 94% which makes the process unnecessarily expensive. The microorganisms responsible for the biological transformation must have fine structure in the substrate for anaerobic digestion to have good access to all plant nutrients.
Biogas plants must have high-tech equipment with modern logistics, mechanization, automation, and digitization to offer a hygienic working environment.

Presented below are estimates of today's unsustainable management of renewable organic material by incineration, as this carbon-rich feedstock with typically low water content should be used to balance nitrogen-rich materials that are often aqueous.

Handling of carbon (C) in Malmö's waste incineration plant.
Of household waste (466 kg/person and year), 49.5% is sent to incineration, i.e. approx. 230 kg/inhabitant and year. Assume that 200 kg contains material containing the element carbon - approximately 80 kg per person per year both in organic material and in various plastics. From 351,000 inhabitants, there will be 28,080 tons of carbon (C)/year, which forms approx. 103,054 tons of carbon dioxide (CO_2)/year. In addition to carbon dioxide, nitrogen oxides, sulphur dioxide, particles, various metals, and dioxins are released into the air. About 25% of fuel turns into environmentally hazardous ash.

N.B. In 1997, SYSAV in Malmö applied to the Environmental Court to build an incineration plant for waste. 14 municipalities agreed to send all waste to incineration over the next 20 years. Since then, many waste incineration plants have been built - with the permission of the environmental laws - without having to pay for pollution that harms health, the environment, the economy of citizens and, by extension, the climate.

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Some thoughts on sustainability.

Is it sustainable to build a very expensive sewage tunnel and traditional sewage treatment plant in a city where the sewage network itself is in poor condition and the replacement of old pipes is planned to take about 400 years considering the allocated resources?

Is it sustainable to use drinking water to flush down food and toilet waste, which contributes to problems with rats, use of some dangerous chemicals to treat wastewater, the working environment is unhygienic and with the treated water flows into the sea approx. 30% nitrogen, 10 % of phosphorus, all the chemical elements important for cultivation systems, drug residues and chemicals used in households, companies, hospitals, schools, etc?

Are there any thoughts anywhere in the world about developing technical, easy-to-handle aids with which food and toilet waste are collected hygienically to be processed locally together with plant waste for biogas and biofertilizer? Gray water can be purified with known systems locally and used for irrigation, fountains, etc.

"BAS-konsult AB" make suggestions as SBRS concept at www.biotransform.eu. Resources will be used sustainably and at the same time energy and costs are desreased. Local systems are less vulnerable, provide more local jobs and reduce pollution from waste and sewage systems and from reduced transport. Transparent systems increase citizens' willingness to cooperate.

The table below contains estimates of some of the life important chemical elements and bioenergy in Malmö. Approx. 100 plants for anaerobic digestion and 100 for biological treatment of grey water can be built according to the SBRS concept for the same cost as building a sewer tunnel.

351 000 persons ton/y	Mass	DM	C-org	CO_2	N	P	K	S	MWh per year
Human excreta	153 738	10 762	5 381	5 381	1 193	204	267	105	53 808
Food waste	34 047	10 214	5 107	5 107	347	28	105	25	51 071
Different pellet types	58 477	53 215	26 606	26 606	106	2	27	32	159 635
Mixture/substrate	**246 262**	**73 878**	37 094	37 094	1 647	233	399	161	**264 514**

Table 1: The amount of material, the content of some vital chemical elements that flow with wastewater to the treatment plant per year from 351,000 inhabitants and the energy content of the material. To create as close to optimal substrate for microorganisms active during anaerobic digestion, the water content should be around 70%. The aim is to make use of bioenergy in the form of biogas and at the same time locally produce biofertilizer that can replace mineral fertilizers. Here, wood pellets with a known analysis are used to show the way to calculate the content of elements and energy. It is appropriate to use different types of pellets when plant material from the city's green spaces and renewable organic material from municipal waste are not enough to balance the water and nutrient content of food and toilet waste.

Each of the 100 biogas plants would produce per year (i) approx. 1.3 GWh of "planable energy" in the biogas, which with trigeneration would provide 0.39 GWh of electricity and 0.84 GWh of heat that can be converted into cooling during the summer, and (ii) the rest of energy, all the essential elements and micro-organisms remain in biofertilizer, which ensures the soil's fertility.