

Climate-friendly wastewater management

A major part of the energy loss from new energy-efficient buildings is the emission of warm wastewater to the sewers. This leads to increased interest for heat recovery from domestic wastewater, which may contain up to 800 kWh of energy per person and year in form of heat. As comparison, the strictest low-energy-use standard in Switzerland leads to less than 575 kWh/p/year for heating purposes in single houses and 385 kWh/p/year for apartment buildings.

The notion of climate-friendly wastewater treatment has also become a hot-topic among wastewater professionals. For wastewater treatment plants, climate-friendly means less direct emissions of greenhouse gases such as methane (CH_4) and nitrous oxide (N_2O) and a better overall energy balance. There is thus a strong incentive to develop new, energy-saving treatment schemes – also for economic reasons. The most popular of those processes – the main stream anammox process – has the potential of improving the energy balance at treatment plants by around 20-30 kWh electricity per person and year.

As comparison, a simple heat exchanger in a shower has an energy-saving potential of 100 kWh per person and year, even for disciplined people showering only 5 minutes per day with a water-saving 6 L/min showerhead.

Although heat and electricity cannot be compared directly (electricity is up to three times more valuable than heat), it is not difficult to see that more heat recovery may follow in the household, based on simple heat exchangers or even heat pumps, with a potential of energy saving far beyond what we can do at the treatment plant.

This new development directs our attention towards the temperature requirements of wastewater treatment. In Switzerland, for instance, heat recovery from sewers is regulated to prevent water temperature at the treatment plant that are too low for current biological treatment processes. However, it is not possible or even desirable to limit heat recovery in the households. Although highly unconventional – and today nearly unthinkable – the overall energy balance would in fact be better if wastewater at the treatment plant were heated during a few months in winter: Energy for warm water production can be saved around the year and warm wastewater cool down considerably in the sewers.

In cold climates the treatment plant of the future may thus be more expensive – with a heating system and covered – and the temperature-dependence of processes becomes more important. Nitrogen transformation is especially temperature-dependent: the relevant bacteria grow much slower and recent research shows that the emission of N_2O may be considerably higher at low temperature. It also seems that the main stream anammox process is even more sensitive towards low temperatures than conventional nitrification/denitrification.

In this paper, we looked at three different ways of removing nitrogen from wastewater:

Conventional nitrification-denitrification, the main stream anammox process, and nutrient recovery from source-separated urine. The latter has the highest potential for climate-friendly wastewater treatment: Energy can be recovered not only from organic matter, but also in the form of nitrogen for fertilizer, energy demand is low, emission of N₂O can be avoided if ammonia is not oxidized, and finally the temperature at the treatment plant would be of no consequence because no nitrogen transformation would be required.

At present, urine source separation is in an experimental phase and the technologies for producing a fertilizer without oxidizing nitrogen are still in development. However, for countries with cold winters, heat extraction from wastewater in households may fundamentally change the way we evaluate future wastewater treatment technologies.

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Publication

[CO₂-neutral wastewater treatment plants or robust, climate-friendly wastewater management? A systems perspective.](#)

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