Stakeholders discuss the NoMix technology (Photo Karin Güdel)

Work package Nova 7

Evaluation

Research background

Nova 7 is concerned with evaluating the advantages and disadvantages of the NoMix technology. Technology assessments are always difficult – especially when the technologies in question do not yet exist. For example, how are we to determine overall costs or energy consumption merely on the basis of prototypes in the laboratory? And how can we give due consideration to all the various aspects? Nova 7-1 summarizes the main results of Novaquatis obtained in the course of the entire project. Nova 7-2 tests a methodological approach comparing various NoMix options with a conventional solution for a specific scenario. The different options are based on the preferences of actual stakeholders.

Nova 7-1: Evaluation of the NoMix technology

(Tove A. Larsen, Max Maurer, Kai Udert, Judit Lienert)

The NoMix technology makes it possible for nutrients to be comprehensively eliminated or recycled through a relatively minor modification to the wastewater system [1]. However, whether – and in what form – it is worth implementing the technology depends largely on the existing infrastructure and environmental situation. The NoMix technology is particularly valuable where nutrient emissions are subject to stringent regulations. It is also to be recommended in regions where it makes economic sense to recycle nutrients to agriculture.

The importance of the NoMix technology is assessed on a broad scientific basis in [2]. In global cycles, nutrients from human metabolism do not play a significant role. The nitrogen cycle is dominated by biological and industrial nitrogen fixation. Human excretion only accounts for about 5 % of the total production of reactive nitrogen. In the global phosphorus cycle, agriculture is probably the dominant factor. With regard to water resources, by contrast, phosphorus and nitrogen inputs from wastewater are of major importance. It is therefore worth looking for efficient ways of removing these nutrients – especially in densely populated areas where wastewater constitutes the largest proportion of nutrient flows or where conventional technology is overstretched. In Switzerland, one example would be Lake Greifen, where the quality targets specified for phosphorus cannot be complied with. Internationally, a good example is the Chinese city of Kunming (cf. Nova 8). Globally, nutrients from wastewater will play an increasingly important role as a result of population growth. In Europe, too, a trend towards stricter nutrient emission limits is discernible. Urine source separation would also be beneficial for water pollution control, as the ecotoxicological hazard posed by human medicines could be reduced by an estimated 50 % (cf. Nova 5). In countries with chronic shortages of nutrients for agriculture, wastewater represents a local resource. The nutrients which it contains can best be recovered by at-source measures.

The NoMix technology can turn a wastewater treatment plant from an energy consumer into an energy producer: instead of 11 watt per person being consumed, 2 watt of primary energy per person can be generated, as the energy efficiency of many processes is increased and the energy in wastewater can be better exploited [3]. Thus, the wastewater management sector could contribute to the attainment of the "2000-watt society", the Federal Council's aspiration target of reducing Switzerland's primary energy consumption from 6000 watt to 2000 watt per person. Energy savings could also be realized in fertilizer production, with energy-efficient processing of nitrogen and phosphorus for the agricultural sector [4]. In view of the deteriorating quality of artificial phosphate fertilizers – remaining mineral resources of phosphorus have a high heavy-metal content – it would be worthwhile to recycle relatively pure phosphorus from urine [2]. In the case of nitrogen, the key considerations concern energy and the quality of the fertilizer produced.

As the NoMix technology offers numerous environmental advantages, the decision for or against its adoption is largely influenced by human factors: Is the technology acceptable (Nova 1)? And can it be implemented at low cost, or at least without increasing costs? The costs of the NoMix technology cannot yet be comprehensively estimated. But, according to calculations given in [5], investments of around CHF 1250–2100 per household in this technology would not increase current overall costs in Switzerland. This would, however, require a well-planned system transition, as the additional investments in the NoMix technology

Large sewers and treatment plants to cope with the flood of wastewater: Maybe there's an alternative? (Photo Christian Abegglen)

Potential in every bathroom: Should new housing developments be fitted with the NoMix technology? (Photo Andri Bryner)

would have to be financed by reduced investments in wastewater treatment plants. An increase in the total operating costs of the two systems would have to be excluded.

Nova 7-2: Structuring of the NoMix decision-making process

(Mark Borsuk, Max Maurer, Judit Lienert, Tove A. Larsen)

Nova 7-2 is primarily a methodological project, designed to compare various NoMix technology options in a specific scenario [6]. It is based on a decision analysis considering a wide variety of criteria. This was applied to the Glattpark site (lying north of Zurich), which is currently being developed. Wastewater from this development is to be treated at the Kloten/Opfikon plant, which is already operating at full capacity. This gave rise to the hypothesis that application of the NoMix technology would allow a costly expansion of the treatment plant to be avoided or at least postponed.

Initially, the objectives of the five major stakeholder groups were defined. It was then assessed how far each of the various options fulfilled the different stakeholders' objectives. The main options studied were: (A) NoMix toilets only in the Glattpark development, to level out nitrogen loads at the treatment plant (Nova 3-1); (B) NoMix toilets installed throughout the catchment, with separate treatment of urine; (C) expansion of the treatment plant, without urine source separation. Finally, a ranking of options (from most to least preferred) was prepared for each group of stakeholders. In addition, a sensitivity analysis was performed to investigate the significance of uncertain assumptions for the scenario.

The results show that no single option is equally attractive to all stakeholders. The local authority could make considerable savings if urine was separately collected and treated across the entire catchment. Households, however, will only accept the NoMix technology if a very comfortable NoMix toilet is available and the higher costs are subsidized by the local authority. But for the costs of the NoMix toilet to be sufficiently reduced, mass production would be required – and this is not possible within the planning period envisaged for the Glattpark development. However, the sensitivity analysis also shows that, if greater weight is assigned to environmental questions, the NoMix option rapidly becomes attractive even at a higher price. There are indications, for examle, that the new environmental issue of "micropollutants" could shift priorities in favour of this option.

Conclusions

The NoMix technology is attractive because it has the potential, through a minor intervention, to contribute to environmental protection in an energy-efficient way. Both globally and in Europe, the technology offers advantages over the current situation; waterbodies, in particular, will benefit, as nutrient inputs from wastewater can be substantially reduced. Regions where acute population pressures lead to severe eutrophication of waterbodies would be the areas of choice for initial implementation. In addition, the NoMix technology can provide a valuable local source of fertilizers where nutrients for agriculture are in short supply. Combined with conventional end-of-pipe (sewer and treatment plant) technology for the remaining wastewater, the NoMix concept could well become economically competitive in Europe too, given that, for example, up to CHF 2000 or more would be available for each Swiss household for investments in this technology. The challenge for research, in collaboration with industry, is now to develop the appropriate NoMix technology at this price.