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<b>Title</b>	<b>Recycling systems for wastewater treatment – a system evaluation</b>
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### Recycling systems for wastewater treatment – a system evaluation

Ecological sanitation is based on a number of sustainability criteria where one is recycling and resource efficiency. This again needs to be combined with technical and functional criteria, such as "robustness", "functional variability", social and economic aspects and applicability for large and small scale approaches. Centralized (end of pipe systems) can be designed for nutrient recycling either by using technically advanced methods such as ammonia stripping and chemical precipitation of phosphorus or where the combined end product is used for example in aquaculture or wastewater irrigation systems where plants or animals directly utilize the nutrients. However, centralized systems have a problem of expensive infrastructure for the collection system, source control and end product exposure, where toxic substances can be a problem in the recipient environment and pathogenic organisms may pose a health risk through different transmission pathways. Chemical precipitation may remove phosphorus, but if aluminium and iron phosphates are produced the plant availability of the phosphorus is limited. Advanced tertiary systems also have a limited recovery of potassium. In addition to the technical and nutrient recycling criteria, the impact on the environment and human health the economic aspects of recycling resources from end of pipe systems will be covered and compared to different sustainability approaches and source-separating systems.

Source separation of wastewater and recycling of resources are logical consequences when adapting ecological thinking to wastewater treatment to. The majority of, especially smaller, ecosan systems separate the human excreta or household wastewater in two (black- and greywater) or three (brown-, yellow- and greywater) fractions. Both dry collection or composting with urine diversion or extremely water saving toilets have the potential to fulfil sustainability criteria from technical, health, environmental and economical viewpoints. Source separating systems offer a potentially better source control and recycling of all major plant nutrients; nitrogen phosphorus and potassium. Source separation, however requires a change of sewage system infrastructure affecting the use and acceptance at household level, the technical and operational structures and the organisational aspects about responsibility and payment. The system logistics depends on toilet type and collection system.

Different systems options are needed to tailor a sanitary system to meet the natural constraints of different regions, legislation, sociological aspects and budgets as well as personal needs and preferences. In order to do so technical as well as non technical aspects of the different system options need to be considered. The paper includes a system

evaluation of the different technical options focussing on sustainability criteria from technical, environmental, economical, agricultural and health points of view.