
4 Summary

The mission of the cluster **Environmental Technology and Microbiology (ETM)**³ is to combine fundamental and applied research to find solutions for a more sustainable society. ETM focuses on understanding and developing processes to supply the world's growing population with sustainable water, platform chemicals, minerals, and nutrients. ETMs' prime focus is on the societal challenge *Advancing circular systems: Inclusive innovation towards closed water, nutrient, and material flows*. In our vision this includes the focus points of the green deal policy of the Netherlands and EU: climate change, water quality, and circular economy.

The team of ETM comprises three chair groups combining scientific excellence in fundamental, technological, and engineering research. The chair of microbiology (MIB) is led by prof. Thijs Ettema as the successor of Prof. Willem de Vos per January 2019, the chair in Biorecovery (BRC) is led by prof. Cees Buisman, and Environment and Water Technology (EWT) is the chair of prof. Huub Rijnaarts. The past six years ETM has expanded, due to increased interest of society in circularity and increasing popularity among students. The expansion includes research, education, and infrastructure thanks to combined subsidiary and societal partner funds. ETM currently has 30 staff members, and 85 PhD's and Post Docs. ETM is balanced in diversity (discipline, gender, age, and cultural background) and has adopted values as integrity, cooperativity, creativity, and originality, while providing a safe working environment.

The research infrastructure of ETM is a great asset that includes the ModuTech Physical-Chemical, Biological and Nature Based Technology Centre, and the Microbiome Centre. These were established by investments through multiple internal and external funding sources. Currently a new facility is being built for defined and open system microbial culturing and biotechnology development (UNLOCK) and will soon be available for ETM and (inter)national visiting researchers. The SIAM program enabled ETM to train a new generation of microbiologists and anaerobic biotechnologists.

The accomplishments of ETM include an output of 100 peer reviewed papers a year, providing the scientific foundation for effective and occasionally game changing environmental solutions in society. Collaboration with private and public partners, such as drinking water companies, water authorities and companies, including spin offs, that focus on commercialization of ETM's technologies, has ensured societal impact. WETSUS and NWO programs provided important focus in such collaborations. ETM works in three research themes. *Theme 1: Renewable Chemicals*. Here ETM develops new biotechnological processes which allow transformation of waste streams into compounds with added value. At the base of this lies new fundamental knowledge on microbial interactions in 'synthetic co-cultures' and enriched open microbial systems. One result is Chaincraft, the only company producing at large scale medium chain fatty acids from organic waste. *Theme 2: Quality of Water*. Here ETM developed technologies to remove organic contaminants, such as pharmaceuticals and pesticides, and salts from water, ensuring environmental and human health, as well as increasing circularity in water and nutrient cycles. Understanding and application of natural and synthetic microbiomes in nature-based technologies, and physical-chemical principles for electro-membrane technologies offered resilient powerhouses for sustainable technologies. Various pilot projects for domestic and industrial water treatment have been established. *Theme 3: Rural-Urban Balances*. This is studied by the Urban System Engineering team as a link between the developed technologies and the societal demand by a suite of modelling tools for mapping resource flows and identifying opportunities for technology implementation in urban-industrial-agricultural settings and connections. Herein we include social and economic sciences, and relevant stakeholders within society. A strong collaboration exists with the Amsterdam Institute of advanced metropolitan solutions – AMS. Insight from this group gives new impulses to innovations of the technology groups of themes 1 and 2.

The strategy for the coming six years. The coming decades, our field will remain important to support society to cope with multiple environmental crises. ETM will build on its strong team and infrastructure with a policy to further develop diversity the coming six years at higher staff levels. The existing three themes of research are at the centre of our field and will be continued, interconnected, and deepened, and no new themes are planned for sake of keeping focus. Smart and selective collaboration in the Netherlands, EU and the global south is foreseen to enhance ETM knowledge and societal impact further to provide sustainable solutions for society.

³ In the WIMEK SER the cluster is named ETE-MIB, which is the same as ETM used here in the cluster report.