5. ASSESSMENT OF THE CLUSTER ENVIRONMENTAL TECHNOLOGY AND MICROBIOLOGY

5.1. Organisation

The following chair groups are involved in the cluster Environmental Technology and Microbiology (ETM):

- Microbiology
- Biorecovery
- Environment and Water

In total, the cluster contains 53 academic staff members (in fte's), of whom 46 are non-permanent staff (PhD students and postdoctoral researchers) and 7 are permanent staff.

5.2 Aims and strategy

The mission of the ETM cluster is to combine fundamental and applied research in order help reduce the human footprint and safeguard a sustainable supply of water, energy, food and other resources for the world's growing population. Six years ago, the transition towards a circular economy became a global priority, driven by the depletion of petroleum-based resources and the increasing need to reduce emissions of greenhouse gases and pollution. This transition to circularity and renewable resources requires novel solutions, and ETM has taken on the challenge to develop the concepts and technologies that are needed to provide these.

ETM has defined five focus areas:

- Renewable products: develop renewable fertilisers from waste and redirect residual carbon flows to renewable products and healthy soil;
- Circular water: eliminate contaminants like micropollutants, pathogens, salts, and redesign water provision;
- Fundaments for circularity: apply deep insights into ecology and physiology of microbial communities to development of biotechnologies and nature-based solutions; dedicate physical-chemical treatment to reuse of residual stream-based resources;
- Balance in food-waste cycles: design rural-urban smart grids, and ii) include the energy factor in technological solutions in rural-urban systems;
- Circular examples: collaborate with societal stakeholders on practical showcases for technologies and system integration enabling active knowledge uptake with inclusion of start-ups, pilots, and demo projects.

ETM's prime focus is on WIMEK's Grand Environmental Challenge III: Advancing circular systems, inclusive innovation towards closed water, nutrient and material flows. ETM also contributes to challenges I (Finding fair and effective solutions for climate change mitigation and adaptation) and II. (Managing our future biosphere, developing strategies for the sustainable use of soil, water, atmosphere, biodiversity, ecosystems and landscapes). To contribute to solving these challenges ETM develops technologies based on the principles of biological cycles. These bio-based technologies, rooted in the action of microorganisms, are supported by physical-chemical techniques when needed.

ETM participates in mission driven research programs of the Dutch Top Sectors (Water, Food, Energy and Chemistry), the Dutch Research Council and the EU. Its goal is to ensure the transfer of knowledge and newly developed technologies to the relevant private companies, authorities, and applied knowledge institutes in the environmental and biobased sectors. The close contact and collaboration with stakeholders make many of the projects thoroughly transdisciplinary.

The committee remarks that the themes of the three chair groups are very well aligned with global trends in circular economy and sustainability. It appreciates that the cluster is trying to open up new fields, and even to change established paradigms, such as decentralized wastewater treatment or water cycle management. The committee

fully agrees with the 'science for impact' and 'from principles to technology' strategy the cluster has chosen and thinks that such a strategy can be very fruitful. The committee does recommend more focused strategy-forming. A clear articulation of outcome expectations at the end of six years, from a problem-solving perspective, may greatly enhance the attractiveness of the cluster both to potential staff members and to external partners and stakeholders.

The ETM cluster has a wide range of open access laboratory facilities. They include climate controlled walk-in incubators, high-tech machines such as a Triple Quadrupole Mass Spectrometer, outdoor pilot scale wetland facilities, equipment for anaerobic cultivation, instruments for gas, chemicals and bio-products detection and quantification and equipment for molecular ecological studies. Recently, the cluster added the UNLOCK infrastructure for microbiome research. It would like to further expand its open access research facilities and share them with users from Wageningen University but also from outside the university and outside the Netherlands. The cluster asked the committee to recommend on a course of action to stimulate this shared use of facilities.

The committee remarks that the ETM field of research is a strategic priority in The Netherlands and across Europe, North America and East Asia. The infrastructure therefore will likely be in substantial demand, but the cluster will need to shape its proposition to the requirements of industry, and market its capabilities. To achieve this, the committee suggests the cluster to conduct strategic pre-market assessment research, which is designed to determine the client needs and which of its strengths is in greatest demand. The ETM self-evaluation demonstrates many influential private sector and government partners. They can be consulted, and the cluster can possibly investigate whether is it possible to widen the range of clients and possible markets. Then the cluster can shape its infrastructure proposition to meet what it learns are the greatest demands are. The cluster could also consider investing in marketing for its infrastructures, using traditional and social media in Western countries and in for instance China. The latter may offer potential collaborations on various areas if the labs are advertised through suitable mechanisms.

According to the committee, expanding the use of its excellent infrastructures can have multiple benefits for the cluster. More extensive use of ETM's excellent infrastructures by the international community will presumably lead to both research collaborations as well as opportunities to generate additional revenue for research enhancement. However, the committee also advocates a more inclusive approach towards young scientists from the Global South, who are normally severely resource-constrained. This could be done by facilitating the remote access of this infrastructure for their research purposes and the provision of services. Research design would obviously remain in the hands of the remote researcher.

The committee thinks that taking up leadership positions in international/European research as recommended below is another avenue to showcase the infrastructures. They could lead international programs such as COST actions and organize activities such us international summer schools. This is a way to find new opportunities and partners.

5.3. Research Quality

The committee found that the ETM cluster has done well in the past six years in terms of research quality. The examples given in the self-evaluation report of breakthrough research (such as the discovery of novel pathways for CO_2 fixation, proof-of-principle for bioremediation of micropollutants in groundwater, and a geospatial design tool that allows for optimally balancing nutrient supply and demand) are quite convincing.

The committee did note that both productivity and the use of research products by peers seems to have declined in the past years. It is aware of the fact that this cannot be directly translated to conclusions concerning research quality but does recommend the groups to investigate this and try to determine the underlying cause. A number of suggestions were already discussed during the site visit. A possible explanation is that the groups have launched a relatively large number of new projects in the past years, which need some time to be recognized within the field.

The committee also notes that the recent grant successes seem to have led to a major workload with some groups, which might have impacted the time researchers can spend on producing high-quality papers. Finally, it might be that the early years in the census period were exceptionally successful and not realistically sustainable at such a high level. However, in discussions with the cluster, there was mention of concern that effort and quality could be diluted by the large scale of new projects that are being funded. ETM should not be defensive or overly concerned, but it would be good to investigate this and keep an eye on it the next couple of years. Because of the enormous range of activity and the large success in grant income – and acknowledging the limitation of staff numbers, given the rate of growth of activity – it is good to be on guard.

5.4. Societal Relevance

Over the years, the ETM cluster has demonstrated its ability to transfer technology and transform its findings into products or services. It has achieved world-class results, such as procedures for municipal and industrial water treatment and for desulfurizing waste streams or recovering sulfur. The cluster has built mutual relations with prestigious companies and administrations and developed a very good alliance policy at various levels. On a scientific level, the SIAM network for anaerobic microbiology linking several Dutch research institutes and the CHINED-4D co-operation with Chinese universities in the field of environmental science are examples. On a technological level the cluster has built a close and exemplary relationship with WETSUS, the European center of excellence for sustainable water technology and the Amsterdam Institute of Advanced Metropolitan Solutions AMS. These relations allow the cluster to take prominent positions in its field. ETM's technologies and concepts have also been successfully put into practice through an impressive number of spin-off companies, such as DeSaH BV, ChainCraft, AquaBattery, LeAF and Plant-e.

In spite of these achievements, the committee thinks ETM has the potential to realise even more impact. In its view, it would be useful for the cluster to have some understanding of the gap between potential for societal impact and its realisation, which in turn would help to maximize the cluster's societal impact through cooperation with industry and/or spin-off activities. Wageningen University might be able to provide support for such activities at the central level.

Finally, the committee is of the opinion that possibly ETM could enhance its impact by including more societal issues in its research programme, in collaboration with social scientists. For example, social acceptance and perception of technologies by its users – including those in the Global South – seem to be very promising and topical themes.

Open science
Thanks to the excellent relations of ETM at different levels of private and public society, stakeholders are strongly involved in the design and execution of ETM research. This is worthy of a compliment.

To further improve its international positioning, ETM could, in the committee's view, seek more European leadership positions. It could organize international events such as summer schools, symposia and conferences, or lead international research initiatives that could for instance seek funding from the European Cooperation in Science and Technology COST. On top of building new projects and alliances, such leadership would also allow ETM to better showcase its excellent research infrastructures.

ETM has adopted the general university rules to stimulate open access publishing and accessible storage of research data. The percentage of open access publications has steadily risen over the past years from 25% in 2015 to 73% in 2020. This satisfies the committee. It encourages ETM to keep investing in open science, with the aim of making all publications open access. The implementation of the UNLOCK infrastructure should be able to ensure that the FAIR principles are applied. The committee recommends ETM to make these ambitions more explicit and measure progress in FAIR data sharing.

5.5. Viability

Future outlook
According to the committee, ETM correctly assesses that its expertise will remain in great demand, due to the current urgent environmental crises, the societal calls for a circular economy and the interest of new generations in environmental issues. The ETM cluster has everything in place to respond to these demands.

Academic culture
The cluster invests in a collaborative atmosphere in multiple ways, and has implemented the key values originality, integrity, togetherness and personal involvement. However, from the documentation it has not become entirely clear to the committee what institutional mechanisms and practices are in place to support these values, and more in general a positive culture for inclusion, safety and equality. The same goes for research integrity. Setting clear goals in these areas might help ensure that research integrity is achieved in all domains of research. For inclusion, safety and equality the committee recommends not solely depending on an open culture but having some mechanisms that safeguard these aspects.

Perhaps an unexamined weakness as perceived by the committee (for it does not occur in the SWOT analysis) is the limited collaboration among cluster members. While collaborations do exist, the committee thinks they could most likely be scaled up to a higher level, allowing ETM to tackle more ambitious projects. The committee therefore recommends putting measures in place to actively stimulate collaboration between cluster members.

Talent management
Human resource policy at ETM is oriented towards developing talents and guarding the sustainability of the groups. The cluster notes that diversity of research areas and associated research methods makes it challenging to have all required expertise in the house. ETM plans to continue its policy to create resilience as a cluster by adequately replacing colleagues that leave and temporarily hiring people to cope with periods of high workload. The committee endorses these ambitions.

Diversity
The committee found that ETM is well-balanced in disciplines, age, gender, and cultural background.

5.6. PhD training and education

The committee was favorably impressed by ETM's initiative to create peer groups for PhDs candidates. These group meetings are much appreciated and there is momentum to scale the idea to other clusters. The PhD candidates at ETM are also happy about the hiring of extra postdocs to increase the capacity available for supervision.

However, on some points, the PhD supervision at ETM could be improved, in the committee's view. It found that the frequency of supervision per PhD student varies widely, depending on the supervisor. In some cases, having more supervision would be beneficial, PhD candidates told the committee. The committee recommends making sure that every PhD candidate gets sufficient supervision. Also, an external mentor could be beneficial, in the committee's view: someone who is not directly related with the research activities of the PhD candidate. Such an external mentor can focus on the social aspect of coaching without there being a potential conflict of interest between mentor and mentee. The PhD student might then feel able to speak more freely.

In its discussion with the committee, ETM staff stated that PhD trajectories are not always comparable and flexibility in their duration is sometimes good. However, the PhD candidates at ETM acknowledged the WIMEK-wide issue of long PhD trajectories to be an issue. ETM has tried to reduce the duration of PhD trajectories by asking the supervisors to help shorten it, but this did not resolve the issue. The committee agrees with the PhD candidates that perhaps the ambitions for PhD projects should be set less high in order to be more realistic to complete within four years. Furthermore, it may be useful for WIMEK to put in place a central PhD counsellor who will track the

development of PhD students and provide annual consolidated feedback to the leadership of WIMEK on the health and success of the PhD programme.