Report for the research review of the Faculty of Science and Engineering University of Groningen

Engineering and Technology Institute Groningen (ENTEG)

Energy and Sustainable Research Institute Groningen (ESRIG)

Groningen Biomolecular Sciences and Biotechnology Institute (GBB)

Groningen Institute for Evolutionary Life Sciences (GELIFES)

Stratingh Institute for Chemistry (Stratingh)

Van Swinderen Institute for Particle Physics and Gravity (VSI)

Zernike Institute for Advanced Materials (ZIAM)

May 2024

Content

Preface

This report presents the review and assessment of the Faculty of Science and Engineering (FSE) of the University of Groningen including seven institutes and the graduate school. It was performed in accordance with the Strategy Evaluation Protocol. The review committee visited the faculty from October 30 to November 2, 2023. The programme was very well prepared by both the university staff and the review committee's secretaries.

The committee was impressed by the quality of the review documents that were provided in advance of the visit. We also very much enjoyed the frank and open discussions with members of FSE staff and management, and with postdocs and PhD candidates during our visit. Also, the well-prepared lab tours gave inspiring insights into the daily life in the state-of-the-art laboratories. Together, this provided an excellent and complete overview on the basis of which we wrote this report.

Overall, as this report will show, we are very impressed by the way FSE is managed and by the quality of the research at FSE. We also have recommendations that we think can help FSE perform even better. As expected by the Strategy Evaluation Protocol, we have evaluated FSE at the level of institutes, and not the principal investigators (PIs). We sometimes provide strong recommendations for the institutes regarding their strategy or mode of working. That said, we realise the most important element in the success of FSE are the PIs. It became clear to us that FSE is a scientific powerhouse composed of inspiring PIs that are all strongly driven by scientific discovery. We wish them success in carrying out the exciting research plans that they formulated for this review.

I want to thank the committee secretaries for supporting the evaluation process, and the review committee and sub-committee members for their work and a very enjoyable and inspiring time together.

Albert Polman
Review committee chair

Executive summary

The **Faculty of Science and Engineering** (FSE) is a very strong and resilient faculty. It is housed on a campus that shows a thriving atmosphere, with many modern state-of-the-art buildings and facilities. FSE attracts PhD candidates and students from all over the world and has world-class research programmes at its institutes. The research portfolio of FSE institutes is very broad and complete, which is suitable for a general comprehensive university, and FSE distinguishes itself by a strong engineering component.

FSE institutes all have their own mode of operation, one being more independent than the other. The institutes generally attract large amounts of external research funds, also creating means to fund overhead and support costs of FSE. The allocation model for the money streams between the University of Groningen (UG), FSE and institutes is not clear to everyone involved and this must be corrected. The committee recommends establishing a "mission budget" for each institute, giving it freedom to make its own strategic choices in its organisational structure, hiring support personnel, financing contract extensions, etc. The committee also recommends a strategic discussion between FSE and the Institute Boards on what is the best overhead distribution model within the bounds of the FSE budget.

The committee is glad that the heavy reliance on international fellowship grants for PhD candidates comes to an end and thinks there are many alternative complementary collaborative funding opportunities for research projects. These will create new opportunities for the institutes to better connect to external partners in the Netherlands. Moreover, a reduced dependence on scholarships will create a better balance of nationalities in the research teams.

The committee noted several issues related to the central support facilities of the UG and recommends a revision of the mutual way of working. The committee advises FSE not to further grow its PI staff, given the limited budget for external grants for which they must compete nationally and does recommend efforts to increase the proportion of Dutch PhD candidates. The active incorporation of new recognition and rewards principles is lauded. This requires the development of clear new metrics, next to the conventional ones, by which these should be judged and a definition of the corresponding rewards. The average duration of PhD projects is much too long across the entire FSE (5.5 years), and this must be improved. Social safety and a focus on diversity is a priority across the full FSE, albeit for one institute more than the other. Open access and data policies are generally well taken care of. Several institutes have gender-balanced staff and PIs, others must urgently make further efforts to create more balance.

The research programmes of FSE all have very high societal relevance. However, the actual measurable impact of many of the research programmes is unclear. For example, for knowledge transfer to industry: what products are developed, what is the (predicted) added value to the economy? For influencing natural ecosystem policy: how much nature is affected, how many greenhouse gas emissions will be avoided? For outreach: how many people are reached, with what impact? A quantitative analysis of these impacts can help explain to society the importance of fundamental research at FSE. The committee recommends introducing an "impact plan" methodology (as e.g., used by NWO) to help PIs in guiding research beyond scientific output towards practical use (by others, and where relevant) and to define metrics by which the success of knowledge transfer can be measured. The strong engineering focus, with ENTEG embedded in FSE, creates opportunities to connect FSE to other faculties in the UG. An example is the potential collaboration with the Faculty of Medical Sciences in medical robotics, imaging technology, and the use of artificial intelligence.

The FSE staff encounter unfavourable conditions if they want to start a company from their research. Spin-offs create many benefits for the university, and the committee recommends the UG to align its regulations by not limiting the share of company ownership nor imposing a reduction of UG-employment for its entrepreneurial staff. Furthermore, FSE should allow its staff to maintain their own website to make their work (and publications) better visible to the outside world.

The research programmes of FSE institutes are of excellent quality, as also testified to by the large number of awards and prestigious personal grants. The institutes generally have a very collegial spirit and working culture. With the new Feringa building recently opened, FSE strongly enhanced the quality

of its building infrastructure. Nevertheless, further building development is necessary to house all FSE institutes in a modern environment.

In Chapters 3-10, the committee describes in detail the many highlights of the different institutes. Here, the committee briefly mentions some of the main recommendations for each institute.

The **Graduate School of Engineering** (GSSE) plays a key role within FSE in managing the large cohort of PhD candidates. Its courses and support facilities are essential, highly valued, and must be further improved. It should play an active role in FSE-wide efforts to reduce the duration of the PhD projects to four years. The unequal distribution of cum laude distinctions between women and men must be urgently corrected.

The **Zernike Institute for Advanced Materials** (ZIAM) develops expertise in functional materials that are relevant for the development of sustainable energy generation and storage, more sustainable fabrication and use of materials, and novel cutting-edge technologies. It should further expand its collaborations with industry partners and develop a more active patent application plan. It should develop systematic impact plans towards applications for the relevant parts of its research programme and in doing so can set an example for the entire FSE.

The **Engineering and Technology Institute Groningen** (ENTEG) develops sustainable and smart processes and products that are relevant for high-tech design and manufacturing, sustainable chemical engineering, and biotechnology. It should define clear metrics to define goals for its technology research and should reserve higher-TRL-level research for projects with clearly defined pathways to external users. ENTEG should further explore collaborations with the humanities and social sciences within the UG in ethics, human perception in robotics, consumer behaviour in energy and climate resilience.

The **Stratingh Institute for Chemistry** (Stratingh) focuses on (molecular) chemistry addressing key questions in chemistry of life, chemical conversion, and chemistry of materials, in addition to a highly original programme on the creation of artificial systems that mimic life. The institute's publication output is stellar. Stratingh's successes in acquiring external research grants serve as an example for other institutes. Its strategic goal of "fuelling innovations" requires the development of more detailed plans to translate fundamental knowledge to applications and to develop metrics to measure the impact within its industrial collaborations.

The **Groningen Biomolecular Sciences and Biotechnology Institute** (GBB) addresses a broad range of topics in chemistry and (molecular) biology with relevance in molecular immunology, cell and systems biology, and more. It has strong management that has developed effective internal strategic processes that can serve as inspiration for other institutes. It is recommended that GBB leads a discussion on this with the boards of FSE and the other institutes. GBB has successful collaborations with many industry partners. It should therefore quantitatively measure its impact across several technological fields, which is likely to be significant. GBB can set an FSE example by doing this.

The **Groningen Institute for Evolutionary Life Sciences** (GELIFES) is a large institute that develops understanding of adaptive processes from molecules and genes to individuals, populations and ecosystems. The research is relevant for nature conservation, mitigating climate change, neurological pathologies, and more. GELIFES too should develop metrics to measure the concrete impact of the flow of knowledge to external users, as that can strengthen the visibility of the institute. It should better communicate the unique interdisciplinary nature of its research to the outside world, and it can increase its output of impactful publications. To retain its large size, it should develop an action plan to acquire more funding from NWO and EU grants, including those for more applied research.

The **Energy and Sustainability Research Institute Groningen** (ESRIG) is a small institute that covers a large number of topics that are relevant for the mitigation of climate change. The institute has a strong mission to contribute to sustainable energy utilisation, but it lacks focus and critical mass on several of its research topics. This hampers its impact because the best impact is nearly always created by collaborating research groups that inspire each other. It also impedes acquiring (inter-)national visibility and (co-)leadership in the areas in which it is active. ESRIG has world-class facilities, e.g., in radiocarbon dating, which serve as efficient service facilities. ESRIG should develop a more focused strategic vision, taking advantage of the strongest elements in the research programme and should

take initiatives to become a (co-)leader in sustainable energy research programming within FSE.

The **Van Swinderen Institute for Particle Physics and Gravity** (VSI) studies nature's fundamental forces and building blocks of matter over a wide range of length scales. It has a strong mission that is closely integrated with large-scale collaborative national and international research programmes, while it also runs very complex large-scale experiments itself. It should consider focusing on fewer experiments and increase the effort for the eEDM experiment that has world-level potential if successful. As a research institute working on developing high-tech instruments, it should expand its collaboration with high-tech industries, and it should take more advantage of its partnership within Nikhef.

Altogether, the seven institutes that the committee reviewed form a very powerful part of FSE and cover a broad and comprehensive range of elements of modern science. They cover the length scales from elementary particles to molecular chemistry, nanoscale materials, biological soft matter, all the way up to living systems, genetics, the dynamics of populations and ecosystems, and the origin of the universe. The research topics form an effective breeding ground for PhD candidates, postdocs and master's students, and train them with relevant knowledge for their next jobs in society and to develop technologies of the future.

Our modern society finances fundamental research in order to gain insight into the origin, structure and future of the world around us, and use these insights for the creation of a sustainable and further improved way of life. The FSE's research portfolio is central to achieving these goals and its fundamental research is top-class.

To sustain this successful mode of operation it is essential to also adapt to the growing urge of our society that universities should develop practical applications from scientific research. Many elements of FSE's research lend themselves to this approach and there are many unexplored opportunities that should be more actively grasped. The committee recommends that FSE establishes a vision of the future in which it operates as part of a knowledge and innovation ecosystem network. To do so, it should adjust, and in some cases redesign, its research and education programmes together with ecosystem partners to further transfer knowledge to many aspects of society. FSE is in a very strong position to successfully make this transition.

Importantly, raising the level of fundamental scientific understanding of the world around us is an important societal goal in itself as well. This lies at the core of what drives the principal investigators at the university, and this should be very strongly cherished.

1. Introduction, scope of the assessment

The Executive Board of the University of Groningen (UG) commissioned a review of the research conducted in seven institutes of the Faculty of Science and Engineering (FSE) over the period 2017-2022 (in the order in which they were evaluated):

- Zernike Institute for Advanced Materials (ZIAM)
- Engineering and Technology Institute Groningen (ENTEG)
- Stratingh Institute for Chemistry (Stratingh)
- Groningen Biomolecular Sciences and Biotechnology Institute (GBB)
- Groningen Institute for Evolutionary Life Sciences (GELIFES)
- Energy and Sustainable Research Institute Groningen (ESRIG)
- Van Swinderen Institute for Particle Physics and Gravity (VSI)

The Executive Board also commissioned a review of the Graduate School of Science and Engineering (GSSE) and of the operation of FSE as a whole.

In addition to the seven institutes that are evaluated in this review, FSE has three additional institutes that were evaluated earlier in separate evaluations:

- Bernoulli Institute for Mathematics, Computer Science and Artificial Intelligence
- Groningen Research Institute of Pharmacy
- Kapteyn Astronomical Institute

According to the self-evaluation report, FSE comprises half of the research capacity of the UG, in terms of research staff and PhD candidates.

The review is part of the regular six-year quality assurance cycle of the university and is intended to monitor and help improve the quality of the research and fulfil the duty of accountability towards government and society. The quality assessment in this report is based on the Strategy Evaluation Protocol 2021-2027 (SEP) for public research organisations drawn up by UNL, NWO and KNAW.

The review committee evaluated the performance of the seven institutes on three main criteria: **Research Quality, Societal Relevance and Viability**. To evaluate how the institutes and FSE organise and perform the research and their daily operations the committee also evaluated the policies for **Open Science, PhD Policy & Training, Academic Culture and Human Resources Policy.**

This report describes the observations and recommendations of the committee for FSE (Chapter 2), for the GSSE (Chapter 3) and for the seven institutes (Chapters 4-10). Recommendations are given in the text and are summarised at the end of each chapter.

The Faculty Board asked the committee to reflect on some specific questions posed by FSE, GSSE and the institutes. The questions and the response of the committee are provided in the relevant chapters.

An overview of the committee members is listed in Appendix A. Details on the method of working of the committee are presented in Appendix B, the schedule of the site visit in Appendix C. Appendix D summarises information on personnel and finances for each institute.

2. Faculty of Science and Engineering (FSE)

2.1. Introduction

During the review period FSE has seen many important developments under the guidance of two Deans: Prof. J. Knoester (2017-2022) and Prof. J.W.M. Frenken (2022-present). The committee sees FSE as a very strong and resilient faculty, also driven by very strong activities of the FSE research institutes. FSE shows strong leadership and organisation, making the total much stronger than the sum of the parts. A notable and praiseworthy development is the increased focus on engineering, which is unique for a university with a general comprehensive academic profile in the Dutch system. FSE is housed on a campus that shows a thriving atmosphere, with many modern state-of-the-art buildings and facilities. FSE has strong educational programmes that attract PhD candidates and students from all over the world, in addition to world-class research programmes. Altogether, FSE is a true scientific powerhouse of research and education.

2.2. FSE Research Strategy

FSE covers a very broad range of topics. This reflects the role of the UG as a broad university that must offer multiple research fields to its master's students, PhD candidates and postdocs. While this breadth could be considered a weakness, it clearly is not: each of the research topics covered by the institutes addresses important societal questions, trains students in relevant fields, and creates research results that are highly relevant. Altogether, the offers an attractive portfolio of research fields to the master's and PhD programmes.

There are many shared interests and facilities between institutes that are actively exploited, which makes FSE as a whole very strong. The division of research topics over the seven institutes that were reviewed seemed logical. Some institutes are less coherent than others, sometimes because of mergers in the past. This is unavoidable in such a large and complex organisation. Overall, FSE research and education portfolio is very strong and coherent.

The committee noted that the self-evaluation reports for the institutes were detailed in the description of internal strategic processes. In some cases, the reports lacked a description of how strategic choices of scientific research directions were made in the context of international developments. SWOT analyses that were made for the report have helped FSE and the institutes identify strategic elements. The committee recommends FSE to maintain its strong multidisciplinary research strategy and stimulating inter-institute collaboration.

2.2.1. Organisational structure

FSE is headed by a Faculty Board (FB) that is collectively responsible for the core task of research and education and is accountable to the University Executive Board. Aside from the Dean, the Faculty Board is composed of the vice-Dean, Prof. Rob Timmermans, and the managing director, Dr. Esther Marije Klop, and includes a student assessor with a term of one year. All research within FSE is executed in the (multi)disciplinary research institutes, each headed by a scientific director. The committee sees this as a good model for FSE. The FB meets monthly with all institute directors and has yearly meetings with the boards of each institute. Based on discussions at the interviews the committee thinks the frequency of interaction between institutes' boards and FB should be increased as that will further strengthen both FSE and the institutes.

The success of the institutes is partly due to their relatively autonomous functioning, with many responsibilities and strategic choices taken at the institute level. The committee thinks such a bottom-up approach is healthy and lies at the basis of the success of FSE. At the same time, FSE offers key facilities and services that are essential for the institutes to operate effectively. The committee learned that the degree to which institutes play an autonomous role is different between institutes, which is understandable as they are different in nature.

Aside from the institutes, FSE has a wide range of structures that are aimed at organising and stimulating research in important upcoming new areas and/or across disciplines. These are 1) Faculty-wide research themes, 2) University-wide schools, and 3) the International University of the North, an initiative to strengthen regional collaborations. These networks provide added value to FSE; at the same time, they add complexity to the and UG organisational structure. In the end, the success of

these structures is determined by whether individual PIs are attracted to them through the availability of research funding, and such funding is scarce at the central university level. Nonetheless, the committee noted several examples of achievements funded or stimulated by themes, schools and the University of the North. That said, from the perspective of the institutes top-down-defined overarching FSE-broad themes are less relevant than the more specialised research fields determined by the institutes themselves, through their own strategic considerations.

An example of a cross-institutional FSE programme is CogniGron (between Zernike and Bernoulli). The committee sees this as a good example of cross-institutional collaboration. The committee stimulates FSE to create more of these collaborative programmes where opportunities arise. With the broad research portfolio of the institutes there must be many unique opportunities that FSE can tackle with its wide range of expertise.

2.2.2. Financial structure at FSE

FSE has an annual budget of approximately €180M from UG central, second and third money streams and other income (e.g., sector plans). Part of these budgets is allocated for education and research purposes, housing and overhead. Tenured, tenure-track academic and support staff appointments are allocated to the research institutes by means of a budget allocation model.

FSE PIs are generally very effective in attracting external funding for research projects that pay for fixed-term positions (PhD candidates and postdocs). These projects are financially assigned to the institutes, whereby typically a part of the acquired budget is assigned to the FB and EB. These funds are then used to finance overhead (use of facilities, administration) and to finance strategic research directions or developments, most often at FSE level.

The committee did not get a clear understanding of the allocation models for the money streams between the UG Executive Board, FSE and the institutes, in all directions. There is no doubt that the university, the faculty, and the institutes can only run well with properly arranged financial entanglement, and this must be done through transparent systematics that are clear and practical for everyone involved.

The committee thinks the overall organisation of decision making regarding the money streams between FSE to the institutes must be made clearer to all involved. The committee got signals that institutes refrained from certain acquisitions, since the allocation model and overheads charged made them not profitable at institute level. Similarly, the committee got signals that such constraints next to rules on hiring staff prevented them to e.g., hire postdocs or support staff where they felt they were needed. The committee thinks that this can eventually lead to an improved system for all involved, at all levels of the organisation, in order to distribute financial means over the institutes in a way that is considered fair and transparent. FSE should hold open discussions with institute directors on the degree of independence and own HR decision making power of the institutes that works best, and what financial allocation model fits best. Additionally, the committee recommends FSE to assign a dedicated “mission budget” for each institute within which the institute can make its own choices in hiring of e.g., support personnel, financing contract extensions, etc.

A sensitive issue that was raised in several of the interviews (by PIs and institute management) is the degree to which FSE charges overhead, in particular on European grants. While the committee did not know the precise rules, this may hinder effective development of starting PIs in their research. The committee recommends consulting with the institute boards and PIs what is the best overhead model, within the bounds of the FSE budget, and to create special systematics for starting PIs. It was also repeatedly mentioned in the interviews that the institutes desire support from FSE to cover the missing fourth-year salary for PhD candidates hired on some EU grants. Introduction of a mission budget for each institute as proposed above can help solve this problem.

In the review period, several (not all) institutes within FSE were strongly dependent on income from individual fellowships from PhD candidates coming from abroad. While the committee sees the financial benefit, a strong dependence on external sources from a limited number of countries is undesired for strategic reasons. In particular, the committee noted the unusually large number of CSC-grants from China. The committee notes that in several FSE institutes, and also at other Dutch universities, PIs manage to run healthy research groups without extensive funding from fellowships, taking advantage

of NWO, Industrial funding, EU, and other granting schemes. To realise a better balance in funding sources the committee recommends reducing the number of PhD candidates with foreign fellowships and compensate this by a stronger focus on national and European grants. This will lead to further creation of networks and collaborations that will benefit all.

The committee notes that several institutes have difficulties recruiting a sound fraction of master's students from the bachelor's programmes, and then recruiting them as PhD candidates. It is important that FSE designs further measures to recruit a larger fraction of UG bachelor's students as master's students and subsequently as PhD candidates. The committee also noted the sometimes very large fraction of international PhD candidates at institutes. While internationalisation is obviously something that should very much cherished, a Dutch university should also train a significant fraction of Dutch students. The committee recommends that FSE takes measure to increase the fraction of Dutch students and PhD candidates.

At the time of the site visit, it had just become clear that FSE is facing strong budget cuts in the coming years. It will be a major task for the FSE Board, the institute boards, and PIs, to make a shared action plan to deal with this. This may involve painful cuts in some research programmes. At the same time, it is very important that the action plan is also used to invest in new research directions that match with important new societal and technological trends.

2.2.3. Facilities and infrastructure

All institutes have state-of-the-art and very often unique and impressive technical infrastructure. It is essential to have technical support staff to maintain and run these instruments. PIs and institutes often struggle with allocating funding for this, as that often goes at the expense of funding PhD candidates and postdocs. Here too the introduction of a mission budget for each institute can help.

As with many academic institutions, the career opportunities within the organisation for highly skilled technical staff are limited, especially for instrument specialists. To ensure their retention and to create an attractive working place, the committee recommends that FSE develops an action plan for the development of technical careers. This could also set an example to (other) technical universities and institutes in the Netherlands.

FSE is lucky to move many of its activities into an entirely new, state-of-the-art building. As is often the case, the new building is already too small for everyone and all wishes. As one priority, FSE should make sure that junior PIs are awarded sufficient lab space. Further new building construction is needed to host all of FSE's institutes in a modern state-of-the-art environment. The committee recommends the Board of the UG to realise modern buildings for all FSE institutes, if possible. There may also be opportunities to economise on lab space and office space.

Every big organisation aims to effectively streamline its organisation to minimise costs and to operate effectively. It is logical that support services for technical and building maintenance, Human Resources, finances, and ICT are organised at a central UG level. Nonetheless, the striving for efficiency sometimes goes at the expense of effectiveness. Centralisation naturally leads to a larger distance, both literally and figuratively, between the personnel working in the centralised facilities and the personnel (PIs, management boards) that depends on them. The committee learned that specific areas where this leads to problems for PIs and institute boards are, for example, financial project information through the AFAS administration software and support of Human Resources. While it is clear that everyone tries to do their work at the highest possible level, this issue must be addressed.

Therefore, the committee recommends fostering more awareness among central support services about the unique requirements of individual institutes, the competences that are needed to address these, and to improve access to e.g., AFAS administration software and enhance responsiveness of Human Resources. To enhance communication and facilitate support, designating a local point of contact or representative at FSE (or even institute) level may help. This approach could help ensure that support staff feel integrated in FSE and give added value to the institutes. Some support may be better organised at FSE or institute level. Overall, the committee recommends reconsidering the division of some tasks at the UG and FSE levels to a revised organisational support structure that is better for all, at the same cost.

2.3. Talent Development

2.3.1. Onboarding

Within a large faculty, where new employees often deal with the institute as first organisational level, and not FSE, an effective onboarding programme to get acquainted with FSE is essential. A lot of information is available, often online, and it is important that FSE maintains its efforts to keep making new staff members aware of the existence of relevant important onboarding information, and where to find it.

2.3.2. Junior PIs

FSE offers competitive starting packages to new PIs, who then further develop their research group with externally acquired grants and generally do so successfully. That said, many PIs struggle with the Dutch funding system. In the Netherlands large amounts of funding were made available in the past decade to attract new PIs, while the volume of funds from NWO for their subsequent grants has not kept the same increasing pace. This affects young PIs as well as their more senior colleagues. Increased funding for scientific research by the present government has (temporarily) helped alleviate this to some extent, and new opportunities for academic research (though at a more applied level) through the new National Growth Fund grants have also helped some PIs. Nonetheless, the committee recommends that FSE does not further expand the number of PIs in research.

A key aspect for new young PIs is the career path towards a permanent position. The UG is moving away from a tenure-track to a career-track model. In the latter, tenure is decided after 1-3 years, with the PI remaining in the assistant professor position. The decision on promotion to associate professor then may come at a later stage. What is the most beneficial scheme is debated among the young PIs. For example, even though all scientific staff who fulfil the requirements can apply for *ius promovendi*, including assistant professors, it was mentioned in the interviews that the tenure-track speeds up the process. For others, the career-track system is an improvement because of the security offered by a tenured position. The committee noted that uncertainty about the choice between the two options that are available creates some uncomforting aspects for the present young PIs; the committee assumes this will disappear as the new system is fully implemented.

2.3.3. Recognition and rewards

In the past years, also under strong guidance of the previous Dean, FSE has made strong new policies for the introduction of more diverse recognition and reward systematics for personnel. The committee strongly praises these initiatives that fit in the well-acknowledged growing recognition that scientific research has many diverse benefits to society, and that PIs often make many other contributions outside research.

That said, a balanced introduction of the new recognitions is challenging as each scientific researcher has strong feelings and pride towards what they themselves consider the most important and rewarding contribution they make with their work at FSE. The committee recommends that FSE maintains a fully balanced and transparent introduction of the new policies and recognises and rewards researchers over the full spectrum, ranging from a pure focus on fundamental science published in top-tier journals to the development of effective outreach activities, to mention just two examples of the multidimensional world of recognitions and rewards.

Carrying out a diverse recognition and rewards policy also implies that new metrics must be developed to judge the achievements that are recognised. For example, for *knowledge transfer to industry*: what strategy is followed? what products are developed, what economic analysis, what is the (predicted) added value to the economy? For *outreach*: how many people are reached, with what impact? For *influencing natural ecosystem policy*: how much nature is affected, how many greenhouse gas emissions will be avoided? These are just examples. Of course, the standard for *top-quality fundamental research* must be maintained for the relevant PIs, in relation to their peers within their specific community: what publications in leading international journals, how many citations?

All these metrics are needed for a fair and transparent judgement of PIs. Also, the potential rewards (a bonus, promotion, research funds) must be made clear in advance. This also implies that within institutes, the management should clearly express its recognition of all these different talents and make clear what the FSE criteria are for e.g., promotions.

The committee mentions all these elements extensively because it was missing such information

in the self-evaluation reports. It trusts that several of these aspects already are in place, although significant differences between the institutes are observed in the way these topics are described in their reports.

The committee did learn that – although differences exist – the overall teaching load is high for young (and senior) PIs, especially in bachelor programmes. The committee thinks the educational directors of the research institutes have a responsibility to make sure that young PIs are tasked with a balanced set of educational duties, compatible with building up a research line, writing grant applications, and building a network.

2.3.4. PhD candidates

The role of PhD candidates is evaluated separately in Chapter 3 on the GSSE. The committee has one important conclusion, which is that across the entire FSE the average duration of the PhD period is much too long (> 5 years). This is generally not to the benefit of the PhDs, for which their project at FSE is a learning experience that should be followed up by a next job in which they can develop further new talents. FSE, GSSE and institutes should develop a firm action plan to reduce the duration of the PhD. The committee recommends that the FSE board develops an incentive scheme that rewards the institutes that are successful.

2.3.5. Postdocs

Despite some efforts of FSE and the group of postdocs itself, postdocs receive less mentoring and professional career support than PhD candidates. As the UG's financial allocation model rewards the hiring of PhD candidates more than that of postdocs, the postdoc population is relatively small. Therefore, it is difficult to form a postdoc community at the institute level. The committee recommends that FSE further develops and supports FSE-wide postdoc community building activities and postdoc-targeted support and mentoring. It could benefit from learning from other universities that have successfully done this, such as e.g., the Cambridge University Postdoc Academy.

2.4. Academic community and culture

2.4.1. Social safety

FSE has well organised policies regarding social safety, with several trusted advisors and the starting of a Safe and Pleasant Work Environment programme. For junior staff, the GSSE has a PhD and postdoc counsellor and a website on individual counselling for PhD candidates. It was noted that not all institutes specifically report on social safety in their self-evaluation reports. The committee emphasises that in the end social safety is not determined by just policy, but rather by all employees within all their roles and tasks. The committee recommends holding a regular FSE employee survey (*medewerkerstevredenheids-onderzoek*) that can help identify if the policies are effective for everyone, and where further improvements can be made. The committee also recommends appointing a trusted advisor at every institute, where that is not already the case. Trusted advisors for all institutes can regularly meet and share experiences and trends (obviously while keeping confidentiality).

The committee also suggests putting social safety as a regular agenda item on the meetings between FB and institute directors (where that is not already the case) and that examples of issues are openly discussed so that best practices can be developed. Another suggestion on this important topic is to consider organising activities (for example MindLab) which help all staff members (senior, junior, management, support personnel, etc.) reflect on their own thoughts and positions in this aspect.

2.4.2. Diversity

Like many faculties in the (technical) sciences FSE is strongly unbalanced in many aspects of diversity. All institutes pay attention to improving the gender balance, but with varying success. The committee encountered several examples of institutes taking initiatives to proactively scout female talent. Some institutes lag behind in their initiatives. The committee recommends that FSE actively supports institutes that are lagging behind in their efforts to create a more balanced gender distribution and stimulates the sharing of best practices between institutes.

One striking issue brought up by some young parents is the strict safety policy implemented around pregnancy and lab work by the university. While there is obviously no discussion about the importance of safety, there are many creative opportunities to solve this problem, by providing aid for specific tasks. FSE should play a more active and supporting role in supporting lab work during pregnancy.

Another topic that was brought up by young parent PIs was the fact that sometimes informal meetings are held after regular working hours. This is an obvious disadvantage for PIs with parenting tasks. The institute directors have the responsibility to make sure that not only formal but also informal meetings are held within regular working hours.

Overall, the committee recommends exchanging best practices from institutes within FSE concerning the enhancement of gender balance, with a specific focus on raising awareness about biases, attracting, and retaining female candidates, implementing family friendly work practices, and fostering a secure and inclusive work environment.

2.5. Research quality and viability

2.5.1. FSE research portfolio

A core strategy of FSE is to perform top-quality scientific research by stimulating and supporting the ten research institutes in their scientific strategies and to help them attract and optimally embed new scientific staff of the highest quality. The research of the seven institutes reviewed by this committee is of top-quality. This judgement is based on the quality and impact of publications as well as many other types of research results, the development of top-quality research infrastructure, marks of recognition from peers, memberships in important boards and committees, the use of knowledge by stakeholders and peers, and the acquisition of prestigious, highly competitive research funds, particularly on the European level. This will be discussed in detail in the chapters for each institute. Here, the committee focuses on organisational aspects that are related to the research strategy of FSE.

At the faculty level, the institutes together form a diverse and complete portfolio of research activities, that, as said in the introduction, reflects the role of the UG as a broad university that must offer multiple research fields to its students. The FSE-wide themes, UG-wide schools and participation in University of the North create some further links that strengthen this portfolio. These networks are important to help FSE and UG express a vision towards the outside world and to show that its research vision is aligned with major societal trends that can benefit from research and education. In this respect the committee considers the themes and topics of the schools relevant and well chosen. The committee recommends expanding the FSE themes with a theme on sustainability (energy transition, materials scarcity, sustainable chemistry). With its world-class leading expertise in its institutes, FSE is already playing a key role in this area.

Finally, the committee notes the potential of starting new collaborations between FSE and the Faculty of Medical Sciences; the committee noted enthusiasm from both sides and recommends starting a UG seed funding scheme for collaborative projects between FSE and the Faculty of Medical Sciences that helps PIs acquire subsequent joint research grants. This area is one example of where FSE has the great benefit of being part of a comprehensive university and having a focus on engineering. Many potential initiatives in, e.g., medical robotics, imaging technology, and the use of artificial intelligence for data analysis come to mind where the two faculties would strongly benefit each other. The new Dean of the Faculty of Medical Sciences, Prof. Wiro Niessen, with world-class expertise in (biomedical) imaging technology is the logical link here from the medical side.

The committee also sees opportunities for collaboration between the science and engineering programme at FSE and the humanities and social sciences faculties at UG, for example in ethics and AI, human perception in robotics, consumer behaviour in energy transitions and climate resilience. With multidisciplinary research becoming increasingly important in many fields, the unique attribute of a general comprehensive university and a strong engineering expertise can further strengthen the unique position of the UG in the Netherlands.

2.5.2. Engineering at UG

A dedication to engineering for FSE, centred at ENTEG and strongly represented in other FSE research institutes, provides unique opportunities to capitalise on the results from fundamental insights and bring them towards applications. The committee strongly supports these initiatives, for which the basis was laid at FSE many decades ago, and strongly supports FSE's strategy and organisation for the coming years. The organisational structure with the ENTEG institute that is embedded within FSE seems the best way to exploit the many opportunities that are offered (rather than establishing a separate faculty). The establishment of a special Director of Engineering (with a well-defined set of tasks, responsibilities, and mandates) is a logical and effective way to create further impact.

Major opportunities in engineering lie in participation of FSE in several National Growth Fund Programmes. FSE can also further exploit advantages of the proximity to the Eems harbour also in relation to the new hydrogen economy that is being built up and taking advantage of the debt-of-honour grants (*ereschuldmiddelen*) awarded to the province of Groningen by the Dutch government.

In the Netherlands, the technical universities in Delft, Eindhoven and Twente and the Wageningen University and Research Centre, together form the 4TU association. It would be very natural if the UG with its FSE would also become associated to the 4TU. The committee sees this has some practical and organisational dilemmas (for the 4TU); in any case, FSE should stay connected with engineering activities within 4TU and take advantage of what the 4TU network has to offer.

The committee understands that strengthening the engineering profile would benefit from a special bachelor's programme in mechanical engineering. The committee thinks the industrial network in the North will also strongly support this. It also learned that the number of bachelor's students that the UG can accommodate is limited.

2.5.3. Funding

Overall, the PIs within FSE are very successful in the acquisition of external research grants, for example in the competitions for personal grants from NWO (VIDI, VICI) and the EU (ERC Grants). This testifies to the very high quality of the FSE research staff. The overall success rate in the (inter)national competition for personal grants is very low, even for excellent proposals. Therefore, it is good to see that FSE can compensate with one-time dedicated research grants in case of an unsuccessful application.

PIs are also becoming increasingly successful in acquiring larger collaborative grants, such as in the National Research Agenda (NWA) and the National Growth Fund. The success in these competitions testifies to the societal relevance of the research that is undertaken at FSE. Aside from the external funds acquired, FSE assigned a significant fraction of the faculty budget for PhD positions for projects that are jointly supervised by PIs from two different institutes. In the past years, FSE, like all Dutch faculties with physics and chemistry programmes, has benefitted strongly from the Dutch national sector plans for physics, chemistry and biology, aimed at boosting these research fields.

Despite an outstanding track record in research grant acquisition, from the perspective of many PIs, the funding situation in the Netherlands is worrisome, with limited budgets and low success rates. As mentioned above, this is partly due to the strong increase in the number of PIs in the past decade, while budgets for research did not keep up.

2.5.4. Scientific integrity

The self-evaluation reports present several examples of proper attention to scientific integrity and ethics. The UG has a formal complaints procedure regarding scientific integrity and the trusted advisor also monitors scientific integrity at FSE level. The GSSE offers mandatory training in scientific Integrity to PhD candidates.

That said, issues with breaches of integrity happen in any academic institution and the committee was (positively) surprised few were mentioned in the interviews. The committee does feel that the degree of awareness for this issue varies between institutes and encourages the institutes and FSE to (keep) discussing frequently and openly topics concerning scientific integrity, talking openly about examples as learning experiences, such as potential issues with authorship on papers, representation of data, plagiarism, and fraud.

2.6. Societal Relevance and viability

Societal relevance has many aspects. It relates to how insights from scientific research and education eventually benefit society and the quality of life. Examples are the development of (sustainable) technology that is brought on the market and creates value for the economy, new insights that help improve the natural quality of our environment, or the development of insights that help develop new medical treatments. Raising the level of scientific understanding is in itself a societal goal as well. FSE has a very strong profile in many of these societally relevant fields. The committee reports on the evaluation of societal relevance and viability in the chapters for each institute. Here observations and recommendations for FSE as a whole are described.

2.6.1. Technology transfer

Knowledge transfer from academic research to applications is a complex process in which many hurdles must be taken. It requires an effective transfer of *output* of scientific research (publications, patents, workflows) to *outcome*: the take-up of these

results by an (often industrial) partner that then brings it further and creates *impact* with it.

Several PIs have been very successful in this mode of operation. They have started their own companies or have transferred knowledge through public-private collaboration programmes with industrial partners. The committee thinks that established public-private collaboration programmes of NWO (KIC, OTP, LTP, etc.) are good vehicles to help shape these collaborations and suggests exploiting these opportunities more.

The committee recommends FSE to train its PIs in the well-established "impact plan" or "Theory of Change" methodology (for example, see https://www.nwo.nl/en/impact-plan-approach). Here researchers are challenged to analyse and describe their research vision in terms of a chain from *output* to *outcome* to *impact*.

2.6.2. Entrepreneurship

The committee devotes a separate section to entrepreneurship because it is an essential element in the transfer of scientific results to technology and economic and societal value. In the past six years, research in FSE has led to a significant number of start-ups. However, there are big differences between institutes, which is obviously related to the differences in research profiles. Yet, taking other high-tech universities elsewhere in the world as a reference, some FSE institutes clearly have unused opportunities for the creation of start-ups that can be exploited.

The committee assigns this to two main factors. First, a cultural factor with lower eagerness in PIs and Dutch researchers for entrepreneurship compared to some top universities abroad. Second, unattractive conditions imposed by the UG on entrepreneurial staff members. The committee recommends the UG to modify and align spin-off ownership conditions with those of other universities and drop the rules 1) imposing a maximum share of ownership while being a (full-time) staff member, and 2) imposing a reduction of UG-employment for staff members involved in spin-off companies. Nearly every startup starts with significant ownership of the initiators but that the ownership usually rapidly dilutes to a small value once investors are on board. Large ownership of a startup (that the UG presently considers unwanted) in most cases only takes place in the founding phase and is often necessary to make a start-up a success.

Start-up activities are beneficial for everyone: PIs can see their work put into practice, the university gains prestige and (potential) licensing fees and new local jobs are created. In the end start-up companies can also (co-)sponsor basic research in the PI's labs. The committee encourages FSE to further stimulate start-up formation and entrepreneurial spirit in general. The committee heard that in some cases the connections with the Technology Licensing Office at UG could be improved. The committee recommends organising a regular (voluntary) training session for entrepreneurship by its own successful role models.

Finally, the committee notes the relatively low number of patents filed within FSE. This is surprising given the strong high-tech profile of the faculty. It is not recommended that FSE keeps its own patent portfolio, but a more targeted strategy on what to file as a patent and what not, and how to do that, is strongly beneficial for the PIs and FSE.

2.6.3. Impact of knowledge transfer to society

As described in the self-evaluation reports, FSE carries out many research projects that aim at contributing to the solution of important societal problems. Although this is a key strength of FSE, it is not presented in a quantitative way to what extent that aim is achieved. Clearly, all institutes have carried out successful scientific work that, by the metrics used, has strongly lifted the general level of scientific understanding, which in itself is an important societal goal. FSE should consider itself highly successful in this impact category.

That said, it is less clear what has been achieved in activities towards the generation of sustainable technology, natural ecosystem modifications, new medical treatments, to mention just a few important goals mentioned in the documents. The committee recommends that FSE develops quantitative metrics of the impact that is achieved with the research and challenges each institute to provide quantitative estimates where possible. The committee thinks the outcome will be rewarding and will help strengthen the profile of FSE's societal impact.

2.6.4. Networking, external visibility and outreach

The UG is the most northern university in the Netherlands and in the interviews, it was expressed that PIs often perceive negative effects of the distance to their colleagues across the country. The committee considers this more a cultural than a geographical consideration, as most colleagues can

be reached in a convenient train ride. Nonetheless, the UG would strongly benefit from a faster, high-speed rail connection to Amsterdam.

Unrelated to the geographical location, in the past six years, FSE has further increased its visibility in the Dutch academic landscape and has increasingly taken leadership in e.g., consortia for large national research grants. The committee values the upgoing trend in this respect and emphasises continued efforts to create eagerness to take the lead in major initiatives where possible. Reducing the dependence on fellowships for PhDs and increasing the number of collaborative Dutch and EU grants will also enhance visibility. Effective leadership of large initiatives works best if it is compensated by a reduced teaching load.

All institutes and FSE itself have attractive and efficient outreach programmes and make efforts to present their work to the general public. As it seems for technical reasons, the UG website offers limited opportunities for individual PIs and institutes to present themselves in a complete and attractive way. As an interim solution the committee recommends FSE to stimulate individual PIs and institutes to maintain their own websites, if desired. This is a common procedure in many universities and creates the highly needed and desired flexibility for the researchers to present their work to the outside world in their desired way. This includes clear separate overviews of the publications and other output metrics for each PI.

2.7. The university of the future

The role of universities in our society has dynamically changed over the centuries. It is important for FSE and UG to analyse how its mission must evolve in the coming decades and how to actively adapt the research and education strategies to that. From the many successful developments at FSE in the past years it becomes clear that FSE is becoming increasingly embedded in ecosystems with a multitude of stakeholders, which the committee sees as an excellent development. The participation in National Growth Fund programmes, where research, innovation and industrial development go hand in hand, are examples of this. Working with nature organisations and policy makers is another example, and there are several more. This more networked way of working is referred to as the University 4.0 model (beyond teaching, research, and valorisation).[1] The UG is already successfully pioneering with this new networked mode of working in its research activities.

Such an ecosystem model also implies that some of the educational activities of the university should be redesigned. In a rapidly changing world with new economies, rapid innovations, changing labour markets and the upcoming role of AI, the university must teach a broader range of skills, so that it stays aligned with the needs of its students and researchers (PhD candidates, postdocs) after they leave the university. Vice versa, the university should ask itself what new skills are needed by the society at large so that it can train the master's students, PhD candidates and postdocs the needed skills.

This topic also relates to the impact discussion in Section 2.6.1, where the committee describes that only delivering research results (output) is not sufficient to make impact in society. To address this, the future university must offer education for a broader range of skills, set up integrated teaching and research programmes with e.g., innovation hubs, lifelong learning, and develop targeted career plans for students and researchers by actively involving stakeholders in the educational programmes. In this way, the university research and education become an integral part of an effective ecosystem for generation and application of knowledge, in contrast to the linear model in which it delivers knowledge to others that than must take it further to create impact. This mode of working could also lead to new master's programmes that train students for specialised skills linked to knowledge utilisation.

The committee recommends FSE to develop a future vision for FSE (and UG) operating as part of a knowledge and innovation ecosystem network of the future (University 4.0). The committee notes that this new model still needs and keeps elements of the original linear educational and research model, and thinks that all PIs, with their different interests, can find a natural place in it, and are all needed to make it a success.

2.8. Recommendations at FSE level

Recommendations to the Board of UG

Central facilities, buildings

- Foster greater awareness among central UG support services about the unique requirements of individual institutes, improve access to AFAS administration software and enhance responsiveness of Human Resources.
- Reconsider the division of tasks at the UG and FSE levels to a revised organisational support structure that is best for all.
- Realise state-of-the-art buildings for all institutes. Develop incentives to economise on space.

Knowledge transfer

- Modify and align spin-off ownership conditions with those of other universities. Drop the rules: 1) imposing a maximum share of ownership while being a (full-time) staff member, and 2) imposing a reduction of UG-employment for staff members involved in spin-off companies.

Cross-faculty collaboration

- Start a UG seed funding scheme for collaborative projects between FSE and the Faculty of Medical Sciences that helps PIs acquire subsequent joint research grants.

Recommendations to the Board of FSE

FSE strategy, collaboration

- Maintain a strong multidisciplinary research strategy, stimulating inter-institute collaboration.
- Expand the general faculty themes with a theme on sustainability (energy transition, materials scarcity, sustainable chemistry)
- Develop a future vision for FSE (and UG) operating as part of a knowledge and innovation ecosystem network of the future ('University 4.0').

Funding streams, overhead and institutes

- Assign a dedicated mission budget to each institute with which the institute can make autonomous choices in hiring of e.g., support personnel, financing contract extensions.
- Reduce the number of PhD candidates with foreign fellowships and compensate this by a stronger focus on (collaborative) national and European grants.

Career development, new staff

- Develop clear metrics for different kinds of recognition and rewards within the new recognition and reward policies.
- Develop a firm action plan, together with the GSSE and the institutes, to reduce the duration of the PhD trajectories; develop an incentive scheme that rewards the institutes that are successful at this.
- Develop and support FSE-wide postdoc community building activities and postdoc-targeted support and mentoring.
- Take measures to increase the proportion of Dutch students and PhD candidates.
- Develop an action plan for career development of technical support personnel.
- Do not further expand the number of PIs.

Communications

- Make the UG/FSE website more flexible, while stimulating personal websites for PIs and institutes.

Societal impact, knowledge transfer

- Train PIs in the well-established Impact plan methodology, challenging researchers to describe their research vision in terms of a chain from output to outcome to impact.
- Develop quantitative metrics for assessing the impact that is achieved with the research and challenge each institute to provide quantitative estimates where possible.
- Organise regular (voluntary) trainings for entrepreneurship featuring role models from FSE startups.

Academic culture

- Promote a more balanced gender distribution among PIs in institutes where gender disparity exists. Actively support institutes that lag behind in their diversity efforts and stimulate the sharing of best practices between institutes.
- Appoint a trusted advisor at every institute, where that is not already the case.
- Conduct regular employee surveys (*medewerkerstevredenheidsonderzoek*) to evaluate the efficiency of policies and identify further improvements.
- Share and implement best practices from institutes within the faculty aimed at improving the gender balance, with a specific focus on raising awareness about biases, attracting, and retaining female candidates, implementing family friendly work practices, and fostering a secure and inclusive work environment.

FSE posed four specific questions to the committee. These are addressed in the sections mentioned below.

1) *FSE stimulates interdisciplinary collaboration across research institutes through the faculty themes. Another aim of the research themes is to better profile our research to the outside world. Does the committee think that the themes are accomplishing these goals?* **See Section 2.2.1 and 2.5.1.**

   Sub-question: CogniGron is a special example of a collaboration between two Institutes (Zernike and Bernoulli) and is not one of the Faculty Themes. How can we better support this programme? **See Section 2.2.1.**

2) *What more can FSE/Groningen do to become better positioned for influencing and joining (or leading) national initiatives (for example research collaborations)?* **See Section 2.6.4.**

3) *FSE recently introduced their new Career Paths policy, which considers diverse career paths. What does the committee think about our new FSE Career path policy, and do they have suggestions for the next update?* **See Section 2.3.2.**

4) *Engineering: how can FSE/Groningen better exploit the combination of Science and Engineering at our University?* **See Section 2.5.2.** *How can we optimise our connection with the 4TU network?* **See Section 2.5.2.**

FINAL Note: Upon its request, the committee received a document that provided an extensive list of wishes and recommendations of the institutes towards FSE. Several of the recommendations are addressed in this Chapter of the report but several others (often mentioned by multiple institutes) were too detailed or technical for the committee to judge and require a direct discussion between those involved.

[1] see e.g. M. Bogers and M. Steinbuch, De vierde generatie universiteit: het nieuwe tijdperk van open innovatie en ecosysteemdenken, *Holland Management Review*, 208 (2023), pp 62-71.; B. Giesenbauer and G. Müller-Christ, Sustainability **17**, 3371 (220).

3. Graduate School of Science and Engineering (GSSE)

3.1. Introduction

The Graduate School of Science and Engineering (GSSE) oversees the PhD programme within FSE. It hosts over 1,400 PhD candidates whose research projects are embedded in the institutes of FSE, where they receive direct supervision and research training. The GSSE administers the PhD projects using the Hora Finita system and develops general PhD policies for FSE. In addition, the GSSE develops and offers the PhD candidates training and support for a wide range of complementary skills. To keep track of their progress the GSSE collects and reviews the annual performance reports for the PhD candidates. The committee thinks a coordinated graduate student organisation such as the GSSE is important for a large faculty that hosts a large number of PhD candidates with a wide range of backgrounds that work in a wide range of research fields.

3.2. Organisation and mission

The GSSE is led by a director (Prof. Sabeth Verpoorte) and is staffed with a coordinator (Dr. Ika Neven) and a small team of trainers and administrative staff. The management and its structure seem well equipped for the GSEE's tasks. The GSSE management seems in control of the administration of PhD projects, including the initial hiring of PhD candidates and their eventual graduation. It is essential for FSE to have the detailed and structured oversight on the status and wellbeing of the large cohort of PhD candidates as is offered by the GSSE.

The overarching mission of the GSSE is to promote a culture of intellectual curiosity, ethical responsibility, and lifelong learning, and to prepare the PhD candidates to be independent thinkers in their research fields. The GSSE is committed to fostering a community of diverse and collaborative PhD scholars who are equipped with the skills and knowledge necessary to tackle the complex scientific and technological challenges of our time. The committee considers these all-well-chosen goals.

3.3. PhD intake

Over the past decade, the annual intake of PhD candidates at FSE has increased from 170 to 220, with the percentage of non-Dutch PhD candidates growing from 71% in 2014 to 80% in 2022. This development was mainly driven by the introduction of the UG scholarship programme in 2016 that in 2023 accounted for nearly half of the total intake of PhD candidates. The increased intake of PhD candidates due to the scholarship programme has put considerable strain on the GSSE processes and capacity. However, the scholarship programme has now come to an end. The committee analysed this development in Chapter 2 and supports it.

In its self-evaluation report, the GSSE lists several tasks as its future goals: developing new programmes, new scholarship opportunities, and strengthening partnerships with other universities with the aim to "diversify PhD intake". The committee thinks that the GSSE is not in the right position within FSE to carry out these tasks and thus recommends not to carry these out. The committee believes that the main initiative for attracting PhD candidates from new funding sources must lie at the institute level, as PhD recruitment is directly related to the strategic research plans. Based on the past experiences within the GSSE, the committee also does not think the focus should lie on attracting more scholarship opportunities. Furthermore, new partnerships with other universities should evolve from novel research collaborations that will form through the institutes, rather than through the GSSE. That said, many key tasks of the GSSE remain, see below, and the GSSE can focus its efforts on these.

3.4. PhD Training and support

In 2019, the GSSE introduced the PhD Academy through which it offers PhD candidates training in four domains: (1) research and education, (2) wellbeing and employability, (3) personal leadership and empowerment, and (4) culture and communication. The courses also address research integrity, writing skills, academic culture, and open science. The GSSE organises periodic lunch talks, aiming to inspire, motivate, and raise awareness among PhD candidates.

The committee thinks that these course themes and the complementary activities are well chosen and that the PhD Academy addresses key skills that can help PhD candidates in bringing a PhD project to a successful end. In addition, they help raise the PhD candidates' knowledge in a wider range of skills than

the research alone, which helps them prepare for the next steps in their career and life.

From the interviews with PhD candidates the committee got the impression that the courses are generally well regarded by the candidates. The committee was unable to create a thorough and complete overview of how the candidates perceived the quality and effectiveness of all courses. It understood that mechanisms to give feedback, which would help the GSSE to finetune or further improve certain aspects of courses could be improved and the committee recommends this is done. The PhD council can provide valuable assistance in this.

Aside from the general courses that are offered to all PhD candidates, the GSSE actively supports individual PhD candidates that are affected by a variety of issues. A significant number of PhD candidates face mental health challenges during their research projects in the institutes and over the review period there has been an increased focus on monitoring wellbeing and providing assistance where needed.

In the interviews the committee found that PhD candidates highly value services provided by the faculty's PhD counsellor with whom an average of 80-90 PhD candidates seek assistance annually. This is quite a significant number; it implies that, on average, for each FSE institute every year more than 10 PhD candidates seek help or advice. Approximately half of these seek help for psychological problems and stress, while the others typically ask advice on more practical issues. The UG also offers university-wide options for mental health support, including e-health modules, workshops, support groups, and individual contact with PhD psychologists. The UG/GSSE hold surveys about PhD wellbeing, which is a good initiative as these gave insightful information about PhD candidate wellbeing.

Apart from focusing on PhD candidate wellbeing, GSSE has prioritised providing support to PhD supervisors, which is also a positive development. This also includes training in how to select the most suitable PhD candidates, how to support PhD candidates that experience certain problems, and more, which is a good initiative.

3.5. Relation GSSE with institutes

The GSSE suffers from the quite complex position that it has within FSE. Its mission is to help PhD candidates carry out successful research projects and to support their well-being. But the research itself is done within the institutes under the supervision of one or more PIs that work in that institute and who are primarily responsible for the PhD candidate's project. This makes it difficult for the GSSE to reach its overarching goals regarding wellbeing of PhD candidates in all aspects.

The committee stresses that this is not a criticism of the GSSE. It only notes that the GSSE operates in a complex environment with limited mandate. This also implies that the GSSE can only assume limited responsibilities. As an example, the committee mentions the problem of the overlong average duration of the PhD project in all institutes. The GSEE sees it as its task to help reduce this, but it has no direct means to impact this. As a result, it can also not take responsibility for it. That said, an effective example of supportive action by the GSSE is the organisation of boot camps to help PhD candidates whose contract has ended to finish their PhD thesis.

Furthermore, it seems that not all PIs in the institutes are aware of the value that the courses that the GSSE offer present to their PhD candidates. As a result, not every candidate is motivated by their supervisor to attend these courses. This is undesired, as the GSSE courses help train the PhD candidates with a wide range of skills, beyond the direct research experience, and that is essential for their careers.

This said, the committee found that PhD candidates often expressed that they were well aware of when to turn to the GSSE for practical queries. Moreover, they appeared knowledgeable of the available channels for reporting issues related to social safety and integrity, and for discussing mental health concerns.

The GSSE also organises a "career perspective series" aimed at training PhD candidates in soft skills and how to translate these skills to successful careers outside academia. Organising career days focused on the specific types of jobs and job markets that a PhD at FSE prepares for, may be an interesting initiative as well.

From the tables in the self-evaluation report, it appears that 47% of the PhD candidates find an academic job after graduation. This seems a very

high percentage, and it is a bit surprising, given the high-tech profile of FSE. In fact, given the important role of the university in our knowledge ecosystem it would be good if more PhD candidates would find a job in industry and contribute their knowledge there.

3.6. PhD duration

As already said before, the average duration of the PhD within FSE is much too long. Only a small minority, approximately 8% of all PhD candidates, successfully defend their theses within four years and only 45% graduate within five years. The committee notes that these figures do not account for delays caused by sick or maternity leave. It also acknowledges that the pandemic has created significant delays. However, statistics from before the pandemic, as given in the report, indicate this is a structural problem in FSE. This problem is not to blame just on the PhD candidates, nor on the GSSE; it is mainly a responsibility of the PIs and the institutes.

The committee notes that here too, there is a wide range of attitudes among the PIs. Many of them make great effort to make sure the PhD candidates finish in time. Also, some institutes, e.g., VSI, do better on average than others. But the committee has also interviewed PIs in biology that bluntly stated that a PhD in biology should take 6 years because of the characteristically long duration of research projects in biology. At this stage, the committee sees no room for discussion on the flexibility of the PhD duration as four years for completing a manuscript approved for submission to the evaluation committee is the norm amongst funding organisations and universities.

The committee underscores the necessity of a substantial, centralised effort to alter the faculty-wide culture regarding completion of the PhD. Evidently a cultural shift is needed to ensure that all supervisors prioritise timely completion, regardless of the prevailing publication culture in specific fields. As argued in section 2.2.3, the committee recommends that the FSE board develops an incentive scheme that rewards the institutes that are successful in reducing the PhD period. The GSSE can provide support in working out the details of such an incentive scheme.

While the GSSE does not have a mandate to change this situation, it can take a clear role here, being the central organisation within FSE that addresses the PhD candidates' wellbeing. This should be done in coordination with the general FSE management. The committee learned that, collaborating with the newly established Supervisor Advisory Committee, the GSSE plans to streamline progress monitoring processes and provide more structure to each consecutive phase of the PhD trajectory, with a focus on strengthening the supervisor-PhD candidate relationship. During the site visit, the committee learned that the start to the new policy is now on paper and will be presented to the institute directors shortly. The committee applauds this development.

3.7. *Cum laude* distinctions

From the table in the report, it appears that on average 6,8% of graduating male PhD candidates receive a *cum laude* distinction, while 3,5% of the female candidates do. These numbers are derived from a total of 1829 graduations, so statistical variations are small. The committee concludes there is a big gender gap in these recognitions and that there must be (unconscious) biases in the judgment of the quality of PhD projects by the PIs. The committee recommends that the GSSE and FSE urgently investigate this issue and take appropriate steps to solve it.

3.8. Recommendations for GSSE

With the aim of strengthening the GSSE's role in supporting and enhancing the experience of PhD candidates within FSE and thereby underscoring its added value, the committee makes the following recommendations:

- Improve the feedback and quality monitoring system for GSSE courses, involving the PhD council.
- Assist FSE management in creating measures to reduce the duration of PhD projects at all institutes.
- Establish more regular information exchange between GSSE, institute PhD coordinators, and PIs, where the GSSE regularly provides data on PhD candidate wellbeing and provides advice to the PIs on how to deal with this.
- Help resolve (unconscious) biases in the judgment of the quality of PhD projects by the PIs that lead to lower fraction of *cum laude* rates for female PhD candidates.
- Leave the development of new programmes, new scholarship opportunities, and strengthening partnerships with other universities as goals of the institutes.

GSSE asked the opinion of the committee on two specific questions:

1. The recruitment of PhD candidates to FSE has become very dependent on large international scholarship programmes such as the China Scholarship Council. *What are the committee's thoughts on this dependence, and how could we eventually diversify our PhD recruitment?* (SEP criteria: PhD Policy). **This is addressed in Section 2.2.2 and Section 3.3.**
2. The Graduate School of Science and Engineering will, together with the Faculty Board and the research institutes, be tackling a persistent issue in the next review period, namely the long average duration of PhD trajectories (now at about 5.5 years, where they should be 4 years). *What advice can the committee give us as measures that could be taken to decrease the average duration of PhD trajectories?* (SEP criteria: PhD policy). **This is addressed in Section 2.3.3 and Section 3.6.**

4. Zernike Institute for Advanced Materials (ZIAM)

4.1. Introduction

The focus of the Zernike Institute for Advanced Materials (ZIAM) is to design, understand and control functional materials that are relevant to societal problems by covering the full materials research chain from curiosity-driven fundamental research, via synthesis and advanced characterisation, theoretical understanding and prediction, up to devices. ZIAM has a staff of 38 PIs, 30 postdocs and about 200 PhD candidates. The institute has an administrative and technical support staff of a total of 45 people. The scientific staff is working in one or more of the following (interconnected) research themes: energy materials, quantum materials, sustainable polymers, (supra-)molecular assemblies, advanced instrumentation, materials for the semiconductor industry, and cognitive materials & devices. ZIAM combines materials research expertise from physics, chemistry, biosciences, and engineering within one institute, creating many opportunities for multidisciplinary discoveries.

4.2. Organisation and strategy

4.2.1. Organisation

In the past period, the institute was led by a scientific director (Prof. Caspar van der Wal, 2017-2022, Prof. Moniek Tromp, 2022-2023), a director of education (Prof. Bart Kooij) and an institute board. The directors and board are supported by a coordinating office. An independent International Advisory Panel advises the institute. Based on the interview the committee thinks the management of the institute and its organisational and technical support is very well organised.

4.2.2 Internal strategy

ZIAM has defined four main objectives: 1) to address fundamental and challenging questions in the fields of functional materials that are relevant to societal problems; 2) to facilitate and encourage the transfer of knowledge and overall synergy of all disciplines relevant for materials research (physics, chemistry, biology, and engineering), 3) to train new generations of researchers in cross-disciplinary approaches to research and to equip them with the diverse skills required by modern science, and 4) to maintain and strengthen its position as an internationally recognised, leading materials research and training institute.

The committee thinks ZIAM has a strong and well-balanced mission, and that it is effectively pursuing all four objectives of its mission. The research programme of ZIAM is well aligned with the main international trends in in the field of interdisciplinary (nano)materials science. The research topics are consistently chosen to be relevant for a range of potential applications. Together, this forms an effective breeding ground for PhD candidates, postdocs, and master's students to be trained in relevant fields of science. This is also evident from the consistent "excellent" ranking of the ZIAM top master's programmes. ZIAM is well recognised as an international leading centre for materials research and has maintained and strengthened that position in the period under review.

In the review period, ZIAM defined four high-priority goals which directly link to its mission and objectives: 1) prepare collective research efforts and large-scale funding proposals for the future beyond the Bonus Incentive Scheme Grant (BIS, 2021), 2) simplify the recruitment of new scientific personnel, make it more efficient in terms of planning, offer clear instructions to candidates and the hiring committee, and achieve a better degree of success, 3) improve public relations, communication and outreach, 4) provide the resources to perform cutting-edge and multidisciplinary research.

The committee thinks ZIAM made effective progress towards all these four goals. ZIAM took several initiatives to become more successful in acquiring and participating in major external grants, also as a follow-up of the ending internal BIS grant. An increased focus on EU funding was very successful. ZIAM is also involved in the major photovoltaics and battery programmes of the National Growth Fund, in NWO-Gravitation, NWA-ORC, Pathfinder and ERC grants. As described in the self-evaluation report, the institute made strong efforts to create a further optimised hiring strategy, with effective strategic discussions among the staff and consultation with other FSE institutes. It is clear this has paid off: a diverse group of young tenure track PIs was attracted with complementary research plans, covering fundamental and more applied research.

The hiring processes were used as an opportunity to further strengthen ZIAM in research fields with high scientific potential and, at the same time, importance for applications.

Furthermore, new initiatives were created in public relations and outreach, for which impact will become clear in the coming years. The research infrastructure of ZIAM is state-of-the-art, mostly funded by externally acquired grants, supplemented by investments from ZIAM and FSE. The committee reviewed ZIAM's data use and open access policies and found them well in order. The institute also has a well-developed strategy to deal with integrity issues.

In the review period, the number of PIs has grown by 20% and the number of PhD candidates has grown proportionally. This indicates that the new PIs have been effective in attracting funds for PhD research projects as they were developing their research lines, testifying to their high quality. The institute has a good distribution in age, gender (37% female) and nationality (16 different countries of origin). The committee sees that the advantages of having a diverse research staff are strongly embraced in the institute. The committee notes that the number of Dutch PhD candidates is very small (16%) and finds it desirable to raise this number to make it match national trends and create cultural balance fitting a Dutch university.

From the interviews it was clear that, overall, the PIs feel well supported by the ZIAM management, and that new young PIs are actively and effectively mentored by more senior PIs. Young PIs feel that they are given ample freedom to develop their own research, with independence on the one hand and the advantage of collaboration within ZIAM on the other hand. Internal communication at the PI-level is well organised and weekly *chat & chalk* lunches for PIs allow for rapid informal exchange of information and discussion of scientific ideas and collaborative approaches. The committee thinks the group of PIs has clear influence on decision-making at institute level. In the interviews several PIs indicated a struggle with a high teaching load, and it was mentioned that increased support by teaching assistants is desired. Altogether, ZIAM radiates a thriving, creative, and supportive work atmosphere, which is a joint achievement of all staff and management.

ZIAM has a very visible top master programme, Nanoscience, a unique asset of ZIAM that is highly rated nationally. A point of concern is that a relatively large number of bachelor's students leave UG to start a master's programme elsewhere. According to the committee, it should attract a larger number of PhD candidates from its own master's programme. The committee noted that, as in many FSE institutes, the duration of PhD trajectories at ZIAM is too long, although this can be partly assigned to the effect of the pandemic. ZIAM should develop measures to reduce the PhD duration. As described in Chapter 2, the committee recommends doing this through an FSE-wide initiative, supported by the GSSE.

4.2.3. External strategy

As described in Chapter 2, the UG has a wide collection of university-wide themes, schools and other collaborative organisations and networks that aim to stimulate interdisciplinary collaboration. ZIAM is partner in several of these, and also collaborates with other institutes within FSE, in particular ENTEG, GBB, and Stratingh. The committee thinks that these collaborations testify to the openness of the ZIAM staff to connect to other research fields and to take advantage of what collaboration can offer. The committee concludes that ZIAM is effectively participating in many relevant networks and collaborations within UG and that these strengthen the profile of ZIAM.

ZIAM participates in and/or leads several important research networks and collaborations on a national scale in battery technology, sustainable polymers, photovoltaics, and green chemistry. It has contacts with Campus Groningen, the Groningen municipality and province, including NOM, Seaports and Eemshaven. These networks strengthen the research portfolio of ZIAM in the high-tech and sustainability fields. ZIAM is partner in NanoLabNL which enabled the institute to make major investments in its nanofabrication and characterisation facilities through the Quantum Growth Fund programme.

ZIAM directly collaborates with some industry partners. Given the strong high-tech expertise of ZIAM, the committee had expected a larger number of these collaborations. It does see that the new ZIAM strategy targets this explicitly and is confident there are many additional opportunities that can be seized in the coming years. The new National Growth Fund programmes in which ZIAM participates will be natural vehicles for this. Other opportunities within NWO programmes (OTP, KIC, Perspectief-grants, etc.)

are also logical to explore further. Overall, the committee sees strong participation of ZIAM in highly relevant research networks, including some with industrial partners, and it sees further opportunities to collaborate within public-private-partnership programmes with companies at the PI level, using smaller research grants. In the past six years ZIAM was directly involved in setting up two start-ups. The committee expects this number to increase in the coming period. With so much technologically relevant research output, the committee recommends ZIAM to enhance its activities to file patents and transfer or licence them to relevant parties.

4.3. Research quality

ZIAM has an excellent research portfolio, with an impressive track record and recognition by others in the field. Bibliometric data shows the leading role of many researchers in their respective fields. Many (inter)national awards show the high visibility and success of PIs and other staff. Another strong mark of recognition is the success in grant applications, including personal grants (ERC, VIDI, VICI).

ZIAM houses high-quality, state-of-the-art research infrastructure that is continuously being updated and renewed. The new technologies (TEM, NMR, X-ray spectroscopy) are state-of-the-art and provide new collaboration and partnership opportunities, and further high-impact results.

According to the committee, ZIAM is an excellent institute. This is partly due to the strong bottom-up culture, in which all PIs explore their talents and exploit them to create strong output and impact. According to the self-evaluation report, the "2021 Index Materials Science" of the University Groningen is a "powerhouse in materials science". This is to a very large extent due to the very high quality of research at ZIAM.

4.4. Societal relevance

ZIAM develops insights that are important for the development of sustainable energy generation that can have impact on the energy transition in society (photovoltaics, batteries). It develops novel materials that contribute to a more sustainable fabrication and use of materials (sustainable polymers, green chemistry) and develops insights that can lead to novel high-tech technologies that improve the quality of life and that can contribute to the economy (quantum technology, sensing). ZIAM also raises the level of scientific understanding of the materials' world, which is in itself a societal goal as well.

A key question is how the insights developed in ZIAM's research create targeted impact. This requires an effective impact plan that transfers research output (papers, patents, workflows), to outcome: the taking-up of these results by an (often industrial) partner that then takes them further and creates impact with them. The committee thinks that the ZIAM staff can train itself further to develop, for each of its research programmes, effective impact plans, defining the chain from output to outcome to impact. It can then also develop metrics to measure success in knowledge transfer to users and the creation, in the longer term, of impact. The committee thinks ZIAM can set the example for such a mode of operation for the entire FSE, such that other institutes can learn from it.

The committee also sees that in many of the more applied research programmes, such as the National Growth Fund, these impact plans are already embedded in the granted programmes. Enhanced collaboration with industrial partners in the high-tech industry will help raise the impact of ZIAM's research in that field. The committee recommends ZIAM to further connect to industry roadmaps and inform itself about future industry needs in, e.g., the semiconductor industry and sustainability. The development of additional (small-scale) public-private-partnership programmes between one or more PIs and one (or more) companies can also help, as well as generating start-up companies.

4.5. Viability

ZIAM has a strong future ahead. As described, it has a research programme that focusses on key fundamental materials questions in highly relevant technology fields. It trains bachelor's and master's students with knowledge that prepares them well for careers in areas where they are highly desired. The participation of ZIAM in several National Growth Fund programmes (SolarNL, BatteryNL) guarantees the flow of research results to industrial users.

The large number of research topics within ZIAM is a strength, as it creates multidisciplinary collaboration opportunities. The committee thinks the present balance is good and recommends ZIAM not to further expand its research topics, but rather to consolidate the existing portfolio of research fields that are successfully covered and expand the efforts to enhance knowledge transfer to users in industry

and society at large, while maintaining the focus on fundamental science. ZIAM (and FSE) should not expand the number of PIs in research.

Furthermore, ZIAM should reduce its strong dependency on fellowships from other countries (ZIAM has ~20% Chinese students, see chapter 2). With fewer funded scholarships/fellowships and the end of the BIS funding, ZIAM needs adjustments in its funding strategy, including a larger focus on NWO and EU grants. It can also expand its collaborations with industrial partners through, e.g., NWO OTP, KIC and Perspectief-grants. This might lead to an increase in the fraction of Dutch-trained PhD candidates, which is desired. The high quality of its staff and the relevance of its research themes provide ZIAM PIs with ample opportunities to submit grant proposals and be successful in fundamental and more applied funding schemes. The participation in networks such as NanoLabNL and SolarNL will create future funding opportunities as well.

4.6. Conclusion and recommendations

ZIAM is a true powerhouse in materials science. It combines top-quality research with an open eye for applications. It is an effective breeding ground for young starting PIs that develop the technologies of the future, and it creates a diverse base for teaching programmes for master's and PhD candidates in highly relevant fields. ZIAM has developed balanced internal and external strategies for the years to come and the leadership is well on its way to continue these successes and expand them further. ZIAM has a bright future ahead.

To continue and further increase the impact of ZIAM's research the committee has the following recommendations:

- Maintain and consolidate the balanced multidisciplinary research programme.
- Develop effective strategies to increase impact of research projects using the impact plan methodology and develop metrics to measure successes in knowledge transfer to users.
- Enhance collaboration with companies through small-size (one or a few PI) public-private-partnership programmes.
- Enhance activities to file patents and transfer or licence them to relevant parties.
- Connect to industry roadmaps and inform itself about future industry needs in, e.g., the semiconductor industry and sustainability.
- Continue the pathway to improve the gender balance and setting an example for other FSE institutes.
- Develop measures to attract more graduates from the Groningen master's programmes to the ZIAM PhD programme and to increase the fraction of Dutch-trained masters and PhD candidates.

ZIAM asked the opinion of the committee on two specific questions:

1. *How does the panel assess the size and research diversity of our institute? Is the large diversity a threat or a strength? How to make best use of diversity present?* **This is addressed in Sections 4.2.2 and 4.5.**
2. *How best to further enhance/stimulate technology transfer*? **This is addressed in Sections 4.2.3, 4.4 and 4.5.**

5. Engineering and Technology Institute Groningen (ENTEG)

5.1. Introduction

The Engineering and Technology institute Groningen (ENTEG) focuses on the development of innovative sustainable and smart processes and products. Through research partnerships, ENTEG aims to transfer knowledge, share expertise, and contribute to the growth and competitiveness of the industrial engineering sector. ENTEG was founded in 2006 to strengthen the engineering profile of FSE and UG. In 2022, ENTEG had a staff of 39 faculty, 15 postdocs, approximately 150 PhD candidates, and a support staff of 21 people. ENTEG performs research in three main areas: 1) mechanical, materials & robotics engineering, 2) optimisation, systems and control, and 3) sustainable chemical engineering & biotechnology. The institute trains a large number of bachelor's and master's students in modern developments in industrial, chemical, mechanical, and biomedical engineering, and provides research projects to over 100 of them.

5.2. Organisation and strategy

5.2.1. Organisation

The leadership of ENTEG is composed of a scientific director (Prof. Bayu Jayawardhana) and an educational director (Prof. Francesco Picchioni 2020-2023, Prof. Gert-Jan Euverink (2023-present)) that report to the Faculty Board. The ENTEG Board comprises several PIs and advises and serves as a sounding board for the management. ENTEG's former directors, Prof. Jacqueline Scherpen (2013-2019, and is the current UG rector) and prof. Erik Heeres (2019-2022), have played a key role in shaping ENTEG in the past years. The new leadership has convincingly filled the gap left by professor Scherpen. ENTEG's research is organised within ten research units, each led by a full professor and consisting of up to eight PIs with significant autonomy in hiring staff and finding resources. The committee thinks this management and organisational structure is working well.

5.2.2. Internal strategy

The mission of ENTEG is to conduct excellent research and education in the engineering sciences that contribute to sustainable and smart products and processes for society. To strengthen its position in all research domains of the institute ENTEG formulated four strategic objectives: 1) strengthening the research profile and coherence, 2) providing educational programmes for careers in academia and industry, 3) providing a safe and stimulating research environment and 4) building and maintaining strategic partnerships and outreach.

The committee thinks ENTEG has made clear progress along all four lines. The institute has further grown and established itself as a key and integral part of FSE. It covers a large number of research topics, which is common for a large institute with many PIs, while keeping sufficient overlap between the research goals to create a coherent research profile. ENTEG's engineering educational programmes attract a large number of students and train them in highly relevant technical fields. Its research and education help strengthen the high-tech profile in the northern part of the country and serve the local industry. Furthermore, ENTEG has established research partnerships with companies elsewhere in the Netherlands. The institute has carried out a targeted hiring process of new PIs to help create coherence along relevant research directions that are of societal relevance.

With the completion of the new Feringa building of the UG, ENTEG will move part of its activities to a modern state-of-the-art environment. Since not the entire institute can relocate, this poses a risk to the cohesion of ENTEG. The committee hopes that a solution for this will be found in the coming years. In the interim period, the management should take all it can do to create measures to make sure the cohesion of the institute is maintained.

ENTEG's research contributes to many UG-wide themes and schools. The committee recommends exploring opportunities for collaboration between ENTEG and the humanities and social sciences faculties at UG, for example in ethics and AI, human perception in robotics, consumer behaviour in energy transitions and climate resilience. ENTEG has played a key role in elevating the prominence of engineering at UG. With multidisciplinary research becoming increasingly important in many fields, the unique attribute of a general comprehensive university and a strong engineering expertise can further strengthen the unique position of the UG in the Netherlands and ENTEG plays a key role here.

5.2.3. External strategy

At the regional level, ENTEG participates for example in an initiative of the University of the North to create a hydrogen technology and economy. ENTEG also collaborates with the Hanzehogeschool en NHL-Stenden Hogeschool in research. Care should be taken that the tasks of a university and a hogeschool are clearly separated as they have distinctly different tasks in the educational system. ENTEG has developed a master's degree in mechanical engineering that is aligned with Innovation Cluster Drachten. This is a good example of the University 4.0 approach, in which universities are part of a broader (local) ecosystem and align their research and education programmes with the ecosystem partners.

ENTEG has secured substantial external research funds (over € 32M in the review period) from NWO, regional funds, and contract research with industrial partners, Dutch top sectors, and the ministry of economic affairs. This shows the high quality and strong competitiveness of ENTEG's research programme. The committee recommends that ENTEG expands its efforts to initiate and develop further collaborative European research programmes, as well as individual ERC grants.

5.2.4. HR policy

ENTEG has implemented excellent recruitment, onboarding, and talent management procedures, supporting tenure-track assistant professors in their academic career development. The PIs noted that leadership development opportunities are available at several levels. The tenure-track PIs are satisfied with their level of independence and are supported with effective starting funds for establishing their research lines. ENTEG has a good coaching and training system, which includes a faculty-wide mentorship programme and an optional course in PhD supervision, which is valued by foreign tenure trackers as an introduction to the Dutch PhD system. The committee learned that stronger support in network building for junior and mid-career staff would be helpful. ENTEG deserves recognition for its achievements in improving gender balance in its staff. It successfully adjusted its recruiting strategy, and 48% of new hires since 2016 are female. The overall female representation in ENTEG increased from 7% to 31% in 2022. As only two of the 13 full professors are female, there is still much work to do in the future.

5.2.5. PhD policy and training

In 2022, ENTEG hosted 153 PhD candidates, an increase by 70% since 2017, nearly all come from abroad. Notably, 65% of these PhD candidates are scholarship students, predominantly from China. The committee thinks this an unhealthy situation that is undesired to create a culturally and socially balanced team spirit. Moreover, transfer of engineering knowledge to applications that are relevant in our society requires research projects that are composed with predominantly national or European industrial and societal users. The committee recommends grasping the many opportunities in the NWO and EU funding system to acquire such grants and to hire PhD candidates and postdocs from a broad mix of nationalities. The committee also recommends that ENTEG develops a strategy to attract more Dutch PhD candidates to its programme. Partnering more with European partners also alleviates issues around knowledge security.

A significant fraction of ENTEG's graduates transition to industry positions, which testifies to the high quality of the engineering programme. A handicap for ENTEG's research programme is the fact that there is limited influx from its own master's students to its PhD programme as many of them move to industry PhDs positions outside Groningen. The committee recommends developing a strategy to attract more PhD candidates from the FSE's master programme to ENTEG's programme. The committee endorses plans to launch a bachelor's programme in mechanical engineering, which is currently only offered at master's level at UG. This could contribute to expanding the pool of UG engineering students who may pursue PhD studies.

The average duration of a PhD at ENTEG is 57 months, which is 9 months too long, although this can be partly assigned to the effect of the pandemic. ENTEG has taken measures such as bootcamps, writing skills training, third-year presentations, and an ENTEG PhD monitoring committee to help reduce this further, which are good initiatives.

The committee finds it surprising that nearly half of the ENTEG PhD graduates move on to a next job in academia. Career perspectives in academia are very limited and ENTEG-trained staff should be in particularly high demand in industry; yet only 25% of the mainly international PhD graduates directly find a job in industry. The committee wonders if ENTEG does all it can to inform its PhD candidates on the many exciting career opportunities in industry.

5.3. Research quality

ENTEG aims its research programmes at Technology Readiness Levels (TRL) in the range 1-5. TRL 5 is defined as "technology validated in an industrially relevant environment" (EU definition for key enabling technologies). This implies that such research is carried out in close collaboration with industrial users. The committee notes that many private-public partnership programmes, e.g., those funded by NWO, cover the TRL 1-3 or 1-4 range, and there are many opportunities for relevant engineering research there too, with less stringent requirements on the achievement of technological targets. Such programmes provide a means for more blue skies (engineering) research that can later develop into TRL 4-5 programmes. The committee recommends reserving the TRL 4-5 type research to projects that have a well-defined impact pathway to applications by external partners, so that the engineering work is not carried out without an application perspective.

An open question is how to make sure that the insights developed in ENTEG research create the targeted impact. This requires an analysis of the impact pathways from research output (papers, patents, recipes) to outcomes: the take-up of these results by an (often industry) partner that then brings it further and creates impact with it. The committee thinks that the ENTEG staff can train itself further to develop, for each of its research programmes, effective impact plans, defining the chain from output to outcome to impact. It can then also develop metrics to measure success in knowledge transfer to users and longer-term impact creation. As an engineering-focused institute, ENTEG should be able to define key performance indicators that help drive the transition from the institute's output to applications that create impact. For example, what products are further developed by companies, based on TRL 1-5 research at ENTEG? What is the strategy to create value with patents and how much value is created in the longer term? Successes in these categories make an engineering programme successful. The committee recommends that ENTEG develops metrics for engineering success and use them in the annual development meetings with the PIs to help further guide the research to the highest possible relevance.

ENTEG has developed high-standard infrastructure and facilities. The practice of sharing equipment contributes to a collaborative environment. Notably, the institute also shares facilities with other FSE institutes, fostering cross-collaboration.

ENTEG has developed a multidisciplinary research portfolio spanning both fundamental and applied engineering sciences and its journal publications cover a wide range of disciplines and sectors. The bibliometric analysis reveals increasing productivity and high-quality scientific output, with a FWCI=1.60, comparable to other Dutch engineering departments (TU Delft, TU Eindhoven). The committee assesses the scientific quality of ENTEG's papers as very high. ENTEG staff is very well represented in (inter-) national committees and has won several awards.

5.4. Societal relevance

ENTEG's research programmes address key topics that are of high relevance for a wide range of applications in high-tech design and manufacturing, sustainable chemistry and biotechnology. In general, engineering forms the basis of many aspects of a sustainable society. ENTEG aims to achieve its societal impact first of all by collaboration with industry partners. The institute participates in several private-public partnership programmes and contract research activities that generated €17.8M in third-stream funding between 2017 and 2022. Aided by regional funding, ENTEG set up the Groningen Engineering Business Centre (GEBC) as a first point of contact for potential industrial partners. Strategic collaborations with industry involve the appointment of externally financed honorary professorships and the impending launch of two post-master's Engineering Doctorate programmes in 2024, aiming to bridge the gap between fundamental research and technology R&D in enterprises. Furthermore, ENTEG leveraged its research findings by the filing of 16 patents, two of which have been licensed to companies. The institute's success in creating spin-offs also underscores its capability to translate fundamental research into practical applications. The committee highly values all these initiatives.

Another key pathway for ENTEG to achieve societal impact is through education in engineering, training students with knowledge that meets the future needs of society in the transition to renewable energy, a sustainable & circular economy and smart industry. A noteworthy achievement is the initiation of a regional Mechanical Engineering master's degree in 2019, conducted jointly with Innovation Cluster Drachten. ENTEG staff members are actively encouraged to engage in UG outreach events and

contribute to knowledge dissemination through various media channels, enhancing the institute's visibility. Open Science requirements are well addressed.

5.5. Viability

ENTEG's mission to contribute to sustainable and smart products and processes for society and, in general, the strong focus on contributing to a more sustainable society is highly relevant. Over the past six years, ENTEG has demonstrated significant vitality, marked by a strong strategy, strong leadership, and substantial growth. Notably, ENTEG has significantly contributed to elevating the status of engineering in Groningen and establishing connections with the regional engineering community. The future of ENTEG is bright.

The previous committee's recommendation (2017) to establish a scientific advisory board has not yet been followed up, and the current committee emphasises that such a board would be a valuable addition to a rapidly expanding institute, providing guidance in navigating challenges, identifying opportunities, and aligning research focus with current trends and future needs. The advisory board could be tasked with guiding ENTEG in the implementation of the recommendations made in this report.

5.6. Conclusion and recommendations

ENTEG is a strong institute in engineering research and education. It combines top-quality engineering research with an open eye for applications in a broad range of highly relevant fields. ENTEG is an effective breeding ground for young starting PIs that develop the technologies of the future, and it creates a diverse base for education programmes for master and PhD candidates in highly relevant fields. The previous management should be complemented for successfully developing and growing ENTEG over the years, which was a very strategic development for the UG as a whole. ENTEG has developed balanced internal and external strategies for the years to come and the new leadership under Prof. Jayawardhana is well on its way to continue these successes and expand them further. ENTEG has a bright future ahead.

To continue and further increase the impact of ENTEG's research the committee has the following recommendations:

- Explore opportunities for collaboration between ENTEG and the humanities and social sciences at UG, for example in ethics and AI, human perception in robotics, consumer behaviour in energy transitions and climate resilience.
- Make better use of opportunities in the NWO and EU funding system to start projects with national of European industrial and societal users.
- Initiate and develop further collaborative European research programmes and focus on individual ERC grants.
- Create a better-balanced distribution of nationalities in the PhD research staff. Reduce the dependency on fellowship grants and increase the number of research projects with industrial partners using Dutch and EU funds.
- Develop a strategy to attract more Dutch PhD candidates to ENTEG's programme.
- Keep the focus on TRL 1-5, with TRL 4-5 reserved for projects that have a well-defined impact pathway to applications by external partners, for instance in combination with EngD positions.
- Develop metrics for engineering successes and use them in the annual development meetings with the PIs to help further guide the research to the highest possible relevance.

ENTEG asked the opinion of the committee on the following questions:

1. *How can our institute find a balance between collaborating with international partners and the likely limitations caused by political concerns surrounding knowledge security, without being discriminatory towards research units which may be affected by governmental regulations?* ***This is addressed in Section 5.2.5***
2. *Over the past 10 years, a major goal has been to form a coherent institute where people know each other, collaborate together and enjoy a pleasant working environment. We had the prospect of finally being housed close together in the new Feringa building which would make achieving this goal easier. We have recently learned that, due to decisions at the faculty level, part of the institute will not be moving to the new building, and, as a result, our Institute will be housed in two different locations. Can the committee advise us on how we can continue to operate as a solid team despite being split across two locations?* ***This is addressed in Section 5.2.5****.*

6. Stratingh Institute for Chemistry (Stratingh)

6.1. Introduction

The Stratingh Institute for Chemistry ("Stratingh") is a leading research institute in the area of (molecular) chemistry. The institute conducts research in three main areas: chemistry of life, chemical conversion and chemistry of materials. The institute is discipline-oriented with the molecular component uniting the research. Making molecules and studying their properties is at the core of the institute's research activities. The institute houses 18 PIs, 118 PhD candidates, 29 postdocs, and has an administrative or technical support staff of 21.

6.2. Organisation, internal and external strategy

6.2.1. Organisation

In the past years, the governance of the institute consisted of a scientific director (Prof. Adriaan Minnaard, 2017-2022; Prof. Gerard Roelfes, 2022-2023), an education director (Prof. Wesley Browne) and an institute board chaired by Prof. Nathalie Katsonis. The 18 PIs are embedded in 8 base units with related research topics, which are each chaired by an associate or full professor. Within each base unit, each PI is scientifically independent. Based on the interviews the committee thinks the institute is well organised, with excellent leadership.

6.2.2. Internal strategy

The mission of Stratingh is to perform excellent research and provide excellent education in molecular and supramolecular chemistry. By placing emphasis on obtaining fundamental insights into molecular processes, the institute strives to (1) develop efficient and sustainable synthetic methods toward (bioactive) molecules and versatile building blocks, (2) realise new materials for energy storage and conversion, and (3) pursue innovative approaches to study, control, and mimic the processes that govern life.

In the past period, Stratingh has redirected and expanded some of its activities to address key questions regarding the energy transition (e.g. research on batteries and molecular energy), accelerating circular and sustainable chemistry (ARC CBBC) the digital transformation (AI & automation in chemistry), health challenges (e.g. photo-pharmacology, research on tuberculosis) and it has further expanded its research on the creation of systems that mimic living systems (e.g. oLIFE).

The committee thinks Stratingh has a very strong and well-balanced mission that enables the acquisition of deep fundamental insight in complex molecular systems that are relevant for the development of sustainable chemistry, the energy transition, and healthcare.

Stratingh is well recognised as an internationally leading centre for molecular chemistry and has maintained and strengthened that position in the past period. The research topics form an effective cluster for PhD candidates, postdocs, and master's students to receive training in relevant fields of molecular science.

Stratingh has been exceptionally successful in acquiring research grants from a wide variety of funding sources, acquiring 45 M€ over the past period to create a total budget of €12.5M/year. This includes ERC grants for 9 PIs, participation in several National Growth Fund and NWO-Gravitation programmes, and ARC-CBBC. The collaborative and collegial approach among PIs in preparing grant applications contributes significantly to the high success rate.

In the past period, Stratingh strengthened itself with several young PIs that brought in creative new ideas that further fortified the institute's research portfolio. The committee feels there is a good strategic internal process among the PIs regarding the desired profile of new PI hires and for the hiring process itself. The tenure-track process has worked well, with all PIs having been promoted in the past 15 years. The research infrastructure of Stratingh is state-of-the-art, mostly funded by externally acquired grants supplemented by investments from the institute and FSE. The committee evaluated Stratingh' s data use and open access policies and found them well in order.

The public presence of the PIs is exceptional. Prof. Ben Feringa, the Nobel laureate, is a highly visible representative of Stratingh and actively exploits many opportunities to promote the importance of science in society, e.g., in the media, on schools, and much more. He serves as an enthusiastic and

effective ambassador for scientific research and is a role model for many. Many other Stratingh PIs also play very visible roles in outreach and other connections to society. The committee thinks that Stratingh' s strategic goals to attract and develop excellent research staff (eight new appointments in the reporting period), to recruit outstanding PhD candidates and postdoc researchers and to actively disseminate the acquired knowledge in the scientific community and in societal organisations are excellently fulfilled.

Stratingh has well-developed onboarding procedures. New PIs receive extensive support from colleagues, for example with the recruitment of PhD candidates and post-docs, or by receiving feedback on grant applications. Another notable fact is that laboratories are often shared between research groups. All groups that the committee met during the site visit explicitly mentioned collegiality as a strength of the institute. This is clearly a very strong aspect of Stratingh.

From the interviews it was clear that overall, the PIs feel well supported by the institute management, and that new PIs are actively and effectively mentored by more senior PIs. Young PIs feel that they are given ample freedom to develop their own research, with independence on the one hand and the advantage of collaboration within Stratingh on the other hand. Internal communication at the PI-level is well-organised and the committee thinks PIs feel they have impact on decision-making at the institute level. In the interviews several PIs indicated that they struggle with a high teaching load, and it was mentioned that increased support by teaching assistants is desired. The institute has a well-developed strategy to deal with integrity issues. Altogether, the committee is of the opinion that Stratingh radiates a thriving, creative, and supportive work atmosphere, which is an achievement of all staff and management together.

The committee appreciates that many of the UG master's graduates continue to pursue a PhD at Stratingh. PhD candidates are funded from multiple sources, with 15% supported by scholarships, which the committee sees as a healthy proportion. It is notable that many PhD candidates and postdocs from Stratingh have found academic positions elsewhere after their stay at Stratingh. The committee noted that, as in all FSE institutes, the duration of PhD trajectories at Stratingh is too long, although this can be partly assigned to the effect of the pandemic: of the PhD candidates starting 2014-2017 only 61% finished within 5 years. Stratingh should develop measures to reduce the PhD duration. As described in Chapter 2, the committee recommends this is done through an FSE-wide initiative, with support of GSSE.

A major point of attention is the gender imbalance amongst the institute's PIs. The management is well aware that action is needed, and the committee highly recommends the institute to actively learn from experiences and initiatives at for example ENTEG and GELIFES that have effectively addressed this issue, even in fields that are generally less popular with women (ENTEG).

With many aspects of Stratingh' s research addressing (aspects of) sustainability, it is interesting to notice that the institute took the initiative to enhance and certify the sustainability of its own laboratories (Green Labs and LEAF Initiatives). This initiative aims at minimising waste and the consumption of energy and water, for example, and to train the researchers in a sustainable mode of working. The initiative has been followed by other institutes and advice is given to institutions abroad.

The committee also notes that Stratingh carries out a highly original and world-class programme regarding the creation of artificial systems that mimic (aspects of) living systems. The committee encourages the institute to be prepared for ethical discussions that can come up in this field and warns that it is best to actively initiate such discussions at an early stage from within the institute. Stratingh benefits from advice from the international advisory boards of many large collaborative initiatives in which it participates. Nonetheless, and also recommended in the previous SEP evaluation, the committee thinks that Stratingh can benefit from having its own advisory board that focuses on internal and external strategic issues like the ones reviewed in this evaluation.

In the interviews, Stratingh expressed a strong desire to further strengthen its technical staff. This came up for several institutes and in Chapter 2 the committee has devoted a segment to this issue, also touching upon how FSE distributes funding to the institutes. Overall, the committee recommends Stratingh to consolidate its size and research focus and create a centralised budget (such as the suggested mission budget) which can be used to increase the organisational and technical/ administrative support

after the rapid growth of the research programme over the last couple of years.

6.2.3. External strategy

Stratingh collaborates with several institutes within FSE, e.g., in the ALERT programmes with ZIAM, GBB, GRIP and UMCG, and the NWO energy focus group NGOP with ZIAM. Its research programme connects to the Aletta Jacobs School for Public Health, new UG-wide Wubbo Ockels School for Energy and Climate and the Jantina Tammes School of Digital Society, Technology and AI. Furthermore, there are collaborations with the UMCG. This shows Stratingh is well connected within the UG. Parallel to these top-down initiatives, the PIs and the self-evaluation report express that most strategic choices that are relevant for Stratingh and its research fields originate from bottom-up initiatives. The committee thinks this bottom-up approach should be cherished.

Outside FSE and the Groningen region, Stratingh is part of, and in many cases (co-)leading, national collaborations, such as ARC-CBBC, Origins Centre, oLife, and the NWO-Gravitation programme FMS. It is (co)-leading an NWO SUMMIT application with partners outside UG. A major new programme is the National Growth Fund programme "The revolution of self-thinking molecules" that will give a very strong boost to Stratingh' s research programme in the coming years.

Stratingh directly collaborates with several industrial companies. Given the importance of its research for solving key societal questions, and hence technologies, the committee expects these interactions to grow in the future. The innovation and industrial-development programmes of National Growth Fund in which Stratingh participates will be natural vehicles for this, as are several other collaborative programmes. Other opportunities for smaller projects (with one or a few PIs) within NWO programmes (OTP, KIC, Perspectief-grants, etc.) are also logical to be explored further. For comments on entrepreneurship and startups see Chapter 2 for FSE in general. Overall, Stratingh has a very well-developed and highly relevant external strategy for the future.

6.3. Research quality

Stratingh is an outstanding institute with excellent PIs and worldwide visibility. The institute performs cutting edge research in each of its research areas. The molecular component in the research unites Stratingh' s staff members and allows them to speak the same language, inspire each other, and make progress together. This is partly due the strong bottom-up culture in which all PIs explore their talents and exploit them to create strong output and impact.

Bibliometric data shows the leading role of many researchers in their respective fields. An impressive number of Stratingh' s papers is published in leading journals such as Science, Nature, and sub-journals, JACS, Angewandte Chemie International Edition (161 papers in the reporting period). The consistent publication in these journals is a strong indication of the superb quality of Stratingh' s research. The impact analysis shows that the institute operates within the top-30 of chemistry institutes worldwide.

Many (inter)national awards also show the high visibility and success of PIs and other staff. Another strong mark of recognition is the success in grant applications, including personal grants (ERC, VIDI, VICI). The quality of Stratingh is also reflected by the fact that the PIs are regularly recruited by other universities, in the Netherlands and abroad. Stratingh has high-quality, state-of-the-art research infrastructure that is continuously being updated and renewed.

6.4. Societal relevance

Stratingh defines its paths towards societal relevance in four pathways: 1) research impact with fundamental research fuelling innovations in applied sciences, 2) human capital development by training undergraduate, graduate and postdoctoral candidates, 3) outreach activities in order to engage and inform the wider public and disseminate knowledge to society at large, and 4) sustainability in research with a focus on reducing the ecological and climate footprint of the research and its consequences, and to train the next generation of chemists in a way that makes sustainability part of their mindset.

Regarding the first, and most important pathway, the committee notes that neither the self-evaluation report nor the interviews gave much insight in how Stratingh stimulates the important "fuelling innovations" aspect. This aspect often is the key bottleneck in the impact pathway from fundamental scientific research to applications, and the committee devoted a section in Chapter 2 on this issue, as it is relevant for all FSE institutes. Fuelling innovations requires an effective impact plan that

transfers research output (papers, patents, recipes), to outcome: the taking-up of these results by an (often industrial) partner that then develops them further and uses them to create impact. The committee thinks that the Stratingh staff should examine the development, for each of its research programmes, of effective impact plans, defining the chain from output to outcome to impact. Stratingh can then also develop metrics to measure successes in knowledge transfer to users and the creation, in the longer term, of impact.

The committee sees that Stratingh effectively carries out mission pathways 2, 3 and 4 with great success. It trains a large cohort of molecular chemists that are in high demand by the chemical industry and high-tech companies. It is highly effective and successful in its outreach, and it has taken initiatives to increase sustainable procedures in its own research (Green Labs and LEAF initiatives). The latter can become impactful if it is followed by others and the committee strongly suggests that Stratingh actively advertise this initiative on a worldwide scale, e.g., through the American Chemical Society and other networks. This would constitute one example of an impact plan activity, following the methodology mentioned above.

6.5. Viability

The committee thinks that Stratingh has a strong future ahead. It has world-class research programmes that focus on key fundamental questions in in fields of (molecular) chemistry that are highly relevant. Stratingh has a balanced group of very talented PIs at different levels of seniority, making the institute well prepared for the future. It trains bachelor's and master's students with knowledge that prepares them well for careers in areas where they are highly desired. The trained PhD candidates and postdocs are strongly needed in many areas of society. Stratingh' s participation in collaborative programmes with industrial participants guarantees the flow of research results to users.

The future research strategy for Stratingh does not represent a major redirection; it follows the strong ongoing research portfolio. Upcoming new directions that Stratingh has already identified are the further use of automation in research and further advanced use of artificial intelligence in data collection and analysis. The funding situation of Stratingh for the coming years is bright, with a large number of projects funded, in addition to participation in major ongoing grant applications for NWO-Gravitation, and co-lead of an NWO SUMMIT proposal. Stratingh could further expand its efforts to enhance knowledge transfer to users in industry and society at large by expanding its collaborations with industrial partners through NWO OTP, KIC and Perspectief-grants, for example.

6.6. Conclusion and recommendations

The Stratingh Institute is outstanding, with excellent scientists and worldwide visibility. The quality of the research is impressive, and the collegiality and collaborative nature of the researchers should be cherished. Management should be complimented for everything they have achieved. Stratingh's management has developed balanced internal and external strategies for the years to come and the leadership is well on its way to continue these successes and expand them further. Stratingh has a bright future ahead.

To continue and further increase the impact of Stratingh' s research, the committee has the following recommendations:

- Develop effective strategies to increase impact of research projects using the impact plan methodology, develop metrics to measure success in knowledge transfer to users.
- Continue initiatives to improve the gender balance using the three PI vacancies that can be filled as a start.
- Implement an international advisory board to advise on the internal and external strategy of Stratingh.

Stratingh asked the opinion of the committee on the following question:

1. *We would like advice from the committee on whether we should focus on further growth of the institute (in terms of scientific staff) or try to consolidate the current size and focus on optimising the organisation and technical/ administrative support after the rapid growth over the last couple of years.* This is addressed in **Section 6.2.2.**

7. Groningen Biomolecular Sciences and Biotechnology Institute (GBB)

7.1. Introduction

The Groningen Biomolecular Sciences and Biotechnology Institute (GBB) combines research in chemistry and (molecular) biology, encompassing the subdisciplines of biochemistry, biophysical chemistry, cell biology, chemical biology, computational biology/chemistry, enzymology, genetics, microbiology, systems biology, synthetic biology, and structural biology. It hosts 28 Principal Investigators, overseeing 135 PhD candidates, 35 postdocs and 33 support staff. GBB is actively involved in various FSE degree programmes with curricula that are closely aligned with its research.

7.2. Organisation, internal and external strategy

7.2.1. Organisation

The governance of GBB is composed of a scientific director (Prof. Dirk Slotboom), an education director (Prof. Dirk-Jan Scheffers) and a board chaired by Prof. Siewert-Jan Marrink. Each member of the GBB board has a specific portfolio of responsibilities. The institute consists of thirteen basic units, six of which are dedicated to chemistry and seven to biology. Each basic unit comprises 1-4 PIs, one of whom is chairing the unit. The units serve mostly as administrative layers and PIs can operate independently. New PIs have the flexibility to either join an existing unit or establish their own unit. According to the committee, the institute is very well organised with strong and effective leadership.

7.2.2. Internal strategy

GBB develops fundamental insights into complex molecular systems that are relevant for the development of, for example, biotechnology and biomedicine. In the review period, GBB has focused on the broad areas of molecular mechanisms of biological processes and physiology & systems biology. Cross-connections within the key areas have facilitated progress in the redesign and engineering of complex molecular and cellular systems, including designed cell factories and synthetic cells. While many research areas are covered by GBB, the overarching themes and structure seem well chosen and effective.

GBB's strategy is very well described. Starting from a clear vision, its mission is defined as "to conduct exceptional biomolecular research, train future scientists, foster transdisciplinary collaboration, and drive practical applications". The institute then defines clear ambitions, and a strategy to reach these: (1) attract a diverse, talented and dedicated team of staff members, postdocs and (PhD) candidates; (2) consolidate an optimal institute size that accommodates teaching requirements, utilises available space, and provides adequate support for starting PIs, (3) ensure a state-of-the-art infrastructure to support advanced research and training, and (4) foster a collaborative and inclusive environment that encourages and challenges each other to excel, creating a vibrant and collegial atmosphere.

The committee thinks GBB has a very strong and well-balanced mission and strategy and has formulated excellent resource strategies to meet its objectives. GBB has made strong progress in all four strategic lines listed above. That said, with biology being a rapidly advancing area of science at present, it can consider expanding its research programme in, for example, cell biology, genome engineering, advances in structural biology (e.g., cryo-electron tomography), or machine learning for structure prediction.

In the review period, GBB has seen a large turnover in its PI staff, with seven professors and one associate professor retired. GBB has followed an effective hiring strategy that enabled further strengthening of the coherence in its research programme and teaching needs. The institute engages renowned (inter)national advisors in its recruitment efforts and makes extensive efforts to learn to know candidates for PI appointments, a good model for other FSE institutes.

Annual meetings are held with all research staff to monitor progress and identify where assistance is required. The institute provides strong coaching and mentoring to its junior staff, that who are effectively aided to develop research proposals, optimising their success in securing grants. GBB also initiated its own postdoc community. A substantial portion of the PhD candidates (on average 25 per year) originates

from the Biomolecular Sciences master's programme coordinated by GBB staff. Compared to some other FSE institutes, GBB relies less on PhD candidates with scholarships (on average 20%), which the committee sees as healthy. GBB actively optimises the transfer for PhD candidates to their next job, while minimising the use of the Dutch social welfare system.

From the interviews the committee concludes that GBB fosters an outstanding academic culture characterised by a collegial atmosphere. The institute's commitment to regular interactions between staff members is evident through monthly staff lunches, annual retreats, a yearly symposium, and quarterly newsletters. All are fostering a sense of community and information exchange. Weekly unit meetings further enhance communication and collaboration between staff. GBB demonstrates a proactive problem-solving attitude in many respects, at the institute, FSE or UG level. This approach reflects the institute's excellent leadership and its unity in solving challenges for the institute.

Approximately 80% of PIs and researchers are international, highlighting the institute's diverse composition. The institute acknowledges the need for further improving gender balance, with 27% of current PIs being female. GBB actively addresses this issue with an action plan; five out of ten recent hires are female. As only one out of 11 full professors is female, promoting successful new female staff and retaining them will be crucial in the coming period.

The average duration of a PhD at GBB is much too long, although this can be partly assigned to the effect of the pandemic: in the period 2014-2017 only 63% graduated within 5 years. In the interviews it was once said that biology PhD projects would inherently require more than four years to complete. This requires a redefinition of what a biology project is, as the PhD contract at UG is for four years. The committee strongly recommends SBB to take action to address this.

GBB is very successful in attracting external funding, with its total annual income fluctuating around 17 M€/year. A major fraction of the annual budget comes from external sources (NWO, EU, etc.). GBB has managed to create internal funding budgets and mechanisms that enable it to create its own internal strategic steering. For example, it provides a top-up for the start-up packages for new PIs, which strongly enhances their effectiveness to build up their own research line and reputation. GBB also awards funds for the fourth year for ITN/ETN PhD candidates and some contract extensions for some unforeseen circumstances.

These and other internal measures give GBB a high degree of independence in how it manages its research. Many of the successes of GBB seem to be rooted in this independence. In the interviews, GBB expressed it would like to have more freedom in the internal allocation of the financial means it receives from FSE. The committee recommends FSE to install a separate mission budget for each institute through which it could distribute budget funds e.g., for support personnel. The committee recommends that GBB leads a discussion with FSE on this topic, together with the other institutes.

GBB generally has state-of-the-art research infrastructure based on well-established long-term planning and strategic vision. Most of the equipment is obtained from individual grants and subsequently opened to other users. The committee recommends that GBB appoints a dedicated staff member to run equipment in a shared GBB facility. The committee sees this as a worthwhile investment, even if it goes at the expense of hiring another PI. As cryo-electron microscopy is a key technique for GBB's programme, the institute should pursue its plans to acquire the next-generation instrument, to create an internationally leading position in this area.

Overall, GBB is an exemplary institute within FSE for the many internal initiatives, which have been systematically developed to create the best environment for GBB personnel to carry out their work at the highest possible level and in a collaborative manner.

7.2.3. External strategy

GBB has several collaborations within FSE (Stratingh, ZIAM, GELIFES) and with the UMCG, and PIs are leading several local centres and collaborative networks. GBBs research fits within the FSE themes Molecular Life and Health, Advanced Materials, and Adaptive Life; the detailed strategic choices in GBBs research programme are predominantly determined by GBB management and staff, as well as the funding opportunities. From the interviews (and a separate question to the committee, see below) it appears that GBB is concerned that some university-wide strategic choices that are relevant for GBB do not match with the institute's own strengths and future research directions. The committee agrees

with the GBB management that the selection of faculty-wide strategic scientific choices must be strongly connected to bottom-up directives. This was also brought up by other FSE institutes.

Outside the Groningen region, GBB is part of, and in several cases (co-)leading, national collaborations, such as NWA, NWO-LIFT, National Growth Fund, and participation in SUMMIT proposals. GBB also has an extensive list of international collaborators. GBB PIs have led or participated in many H2020 and Horizon Europe projects, indicating GBB is closely connected to key international groups in its research fields. GBB PIs are members of many national committees aiming to contribute to and steering of research agendas.

GBB has a strong strategy for collaboration with industrial companies (e.g., DSM-Firmenich, Corbion, Avebe, BASF, FrieslandCampina, Enzypep, Winclove), which is natural given the importance of its research for solution of key societal questions, and hence technologies. The innovation and industrial-development programmes of National Growth Fund in which GBB participates will also be natural vehicles for effective knowledge transfer, as are several other collaborative industrial partnership programmes. Overall, the committee is of the opinion that GBB has a very well developed and highly relevant external strategy for the future.

7.3. Research quality

GBBs scientific output is excellent. The detailed description of research results and highlights in the report is impressive. A large fraction of its publications is in top-tier peer-reviewed journals, in addition to many other highly relevant published papers. The institute's overall academic impact compares favourably with that of other top institutions worldwide.

The quality of GBB's research is also apparent from many national and international awards, KNAW memberships (5 KNAW members) as well as many successes in the highly competitive ERC grant rounds and other prestigious funding schemes (VIDI, VICI, etc.). The international reputation of GBB PIs is also reflected in the leading roles of PIs in coordinating national and international research projects.

7.4. Societal relevance

GBB focuses on curiosity-driven fundamental science with research lines in cell biology, membrane biology, microbiology, protein biochemistry and engineering, synthetic biology, and structural biology. These are all highly relevant research topics with potential for scientific breakthroughs in areas such as molecular immunology, cell biology, host-microbe biology, RNA biology, systems biology, and more research fields with high potential for societal impact. The institute has many public-private partnerships with a wide range of companies that can help make the transfer from research findings to impact.

GBB's research can create value in the development of biobased chemicals, more sustainable biosynthesis routes, biocatalysts, and in general microbial biotechnology which is highly relevant for a green processing economy. GBB leads the academic part of the NGF programme FutureCarbonNL and can achieve impact by direct connection with the industrial partners in this programme. Also, in healthcare GBB research provides important insights and collaborates with pharmaceutical companies, for example. GBB research can also help create innovations though collaborations with the food industry.

GBB actively engages in patent applications, with on average four patents awarded annually during the review period which is high. The institute has licensed eight patents to start-ups. Four start-up companies were founded in the review period. Computational tools developed by GBB are provided as open-source resources and have benefited researchers all over the world.

Overall, the valorisation strategy (past and future) of GBB is impressive. A key question then is whether this strategy creates the targeted impact and to what extent. Collaborating with companies is an important first step, but what prototypes or products were brought on the market as a result of the collaborations: What is the value to the Dutch economy, to sustainability, and other impactful fields. The committee recommends GBB to develop metrics to measure its successes in knowledge transfer to users. Such metrics, that likely will be positive, can be very useful to use in future research applications and will underline the importance of fundamental research for societally relevant applications. Assistance from an external consulting company in such an exercise would be helpful and GBB could set an example with this for FSE.

Another way GBB makes an impact is through education and training, producing highly skilled researchers for both academic and non-academic sectors. Staff members play an active role in policy bodies, contributing to national and regional research strategies, and several of them serve as advisors to several companies. Furthermore, staff are actively encouraged to engage with the public and media, sharing – for instance – expertise on biosafety related to synthetic biology. The committee judged GBBs data use and open access policies and found them well in order.

7.5. Viability

The future for GBB is bright. The institute has world-class research programmes that is highly relevant and has a clear strategy and its research objectives are highly relevant. The institute defined a set of clear guiding aims to reach its ambitions. Its research topics connect well to international trends. GBB has a balanced group of highly talented PIs at different levels of seniority, making the institute well prepared for the future. It trains bachelor's and master's students with knowledge that prepares them well for careers in areas where they are highly desired. The trained PhD candidates and postdocs are highly needed in many areas of our society. The participation of GBB in several collaborative programmes with industrial participants can enable the flow of research results to external users and create impact. The funding situation of GBB for the coming years is bright, with many grants funded, in addition to participation in major ongoing grant applications.

GBB's strength in fundamental and curiosity-driven research is highly valued by private partners (e.g., DSM-Firmenich, Corbion, Avebe, BASF, Friesland-Campina, Enzypep, Winclove, and many others). These partners recognise the importance of GBB's research in, for example, the engineering of industrial enzymes, the development of therapeutics, industrial processing of fine chemicals or dairy products, enabling pharmaceutical companies to develop improved drugs and working with clinicians to establish novel (personalised) drug administration strategies, or provide valuable insights for early diagnosis, monitoring, and potentially the prevention of disease processes. All these testify to the viability of GBBs research plans.

7.6. Conclusion and recommendations

The committee is of the opinion that the GBB Institute is outstanding, with excellent scientists and worldwide visibility. The quality of the research is impressive, and the collegiality and collaborative nature of the researchers should be cherished. GBB has developed balanced internal and external strategies for the years to come and the management under the excellent leadership of Prof. Dirk Slotboom is well on its way to continue these successes and expand them further. GBB has a bright future ahead. To continue and further increase the impact of GBB's research the committee has the following recommendations:

- Appoint a scientist (group leader) to run GBB's facilities as a shared facility, if needed funded at the expense of a new tenure track position.
- Lead a dedicated discussion with FSE to establish the "rules of independence" (financial, strategic) within which GBB (and other FSE institutes) can operate in a way that is best for all.
- Develop a culture of timely PhD completion.
- Develop metrics to measure successes in knowledge transfer to users and exploit them as successes in future research applications motivating the importance of fundamental research.

GBB asked the opinion of the committee on the following questions:

1. *GBB contributes substantially to start-up packages for new staff, in addition to the start-up package offered by the faculty. In order to fund this, the institute choses to free up budget by leaving some of our vacancies unfilled, which at the moment occurs on an ad hoc basis. Does the committee think that the Institute should reserve a structural budget for start-up packages for its new staff members (via agreements with Faculty Board)? (SEP criteria: Viability). This is addressed in Section 7.2.2.*
2. *GBB manages a lot of equipment (usually obtained from individual grants). Should we appoint a scientist (group leader) to run this equipment in a shared facility? If so, should this be at the expense of a standard tenure track position? Should budget be made available for this? (SEP criteria: Viability). This is addressed in* ***Section 7.2.2.***
3. *The connection between GBB strongholds (e.g., from sector plans) and the university's investment agenda (i.e., the 'schools') is poor. What can/should GBB do to also be credited for its own strengths within university policies. (SEP criteria: Viability). This is addressed in* ***Section 7.2.3****.*

8. Groningen Institute for Evolutionary Life Sciences (GELIFES)

8.1. Introduction

The Groningen Institute for Evolutionary Life Sciences (GELIFES) was founded in 2015 as a merger between the Centre for Ecological and Evolutionary Studies (CEES) and the Centre for Behavioural and Neurobiological Research (CBN). The research in GELIFES is organised in seven interdisciplinary expertise groups, assemblies of scientists with similar and/or complementary expertise around core research topics. The institute houses 45 PIs, 26 postdoctoral researchers, nearly 200 PhD candidates and 63 support staff corresponding to 45.6 FTE, of which 23 are temporary and funded through grants awarded to PIs (14.1 FTE).

8.2. Organisation, internal and external strategy

8.2.1. Organisation

The GELIFES management is under the responsibility of the Scientific Director (Prof. Rampal Etienne), supported by a five-member board. The board is supported by seven advisory committees, providing recommendations on specific topics. Research is organised within expertise groups that each have a coordinator. Within the expertise groups, each PI has an independent position in terms of research and budget and receives support from technicians and administrative staff. Altogether the GELIFES has a flat organisational structure with consultation and participation opportunities for all research staff.

According to the committee, the institute is well-organised, with strong, dynamic, and proactive leadership. Throughout the review period, GELIFES stimulated collaboration and integration across the institute, leading to some joint PhD projects and connections between PIs. Despite the wide range of research topics, the committee generally felt a collaborative atmosphere. From the interviews, the committee concludes that GELIFES forms a relatively egalitarian community in which researchers feel well involved in decision-making processes. The governance was mentioned to be transparent, and researchers feel heard.

8.2.2. Internal strategy

The mission of GELIFES is to enhance the understanding of adaptive processes, including their causes and consequences and their maladaptive costs, across all levels of biological organisation (from molecules and genes to individuals, populations and ecosystems), to inform society of its findings and contribute with (tangible) solutions to urgent societal problems.

The fundamental insights in adaptive processes that GELIFES develops are of high relevance at all levels of biological research, from the molecular level to the whole organism and ecosystems. They are grouped in three overarching themes: Adaptive Ecosystem, Adaptive Organism, and Adaptive Brain. Firstly, GELIFES integrates ecology with evolution, using mechanistic models for evolution to bridge theory with experimental work on real organisms. Secondly, it addresses behavioural biology and neuroscience, in particular on animal and human personality and social behaviour. Thirdly, it studies (conservation) ecology of terrestrial and marine ecosystems in relation to global change, including long-term studies on avian biology and research on the Wadden Sea. Fourthly, it covers ecology, physiology, and neurobiology of behaviour in captive and free-living animals, with connections to biomedical research through translational studies on neurobiological mechanisms of brain disorders. And fifthly, it addresses biological rhythms and sleep, combining animal and human studies.

Overall, the committee thinks GELIFES has a balanced mission and that there is added value in bringing together such a wide range of related research topics within a single institute. GELIFES is the largest institute in the Netherlands that covers all these topics. The research topics form an effective breeding ground for PhD candidates, postdocs and master students to become trained in relevant fields of biological and evolutionary science.

GELIFES aims to reach its strategic goals by following five parallel routes: 1) Perform frontline research by integrative approaches to short- and long-term adaptive processes from individual to ecosystem level, from a proximate and ultimate perspective; 2)

Provide high-level education to researchers and educators in this integrative way of thinking; 3) To inform the public at large of GELIFES' research, and engage with stakeholders to facilitate knowledge-based solutions for societal challenges; 4) Contribute with solutions to global challenges by tailoring GELIFES' fundamental and applied research to societal demands; 5) Create a balanced and stimulating atmosphere for the GELIFES community of staff and students.

The committee thinks GELIFES made significant progress along all these five lines. It is impressed by the way the staff is aware of the commonality despite differences in research directions and interests. Some of the expertise groups seem to be integrated and work well cross-disciplinary.

With such a very large research staff (45 PIs, nearly 200 PhD candidates) it is a major challenge to obtain sufficient research grants to fund the research. GELIFES has a broad range of funding sources; next to the regular NWO and EU funds it also attracts significant funds from charities, foundations and other societal organisations. According to the report, in the past period, it received nine grants from NWO/EU and 28 grants from a total of 46 donors (charities and foundations). The total income from external funding was in the range 5-7 M€/year. In addition, GELIFES has a significant number of PhD candidates with scholarships.

The committee is surprised by the relatively small amount of research grants from NWO and EU and recommends the institute to develop an action plan to be more active to acquire these. In more applied research, NWO offers OTP, Perspectief, and LTP programmes that can be considered. It should be not too difficult for GELIFES to become successful here given its strong reputation in working with industrial partners. Given its multidisciplinary profile with strong societal links GELIFES can easily take the lead in grant applications for the NWA.

The report also mentioned the existence of "self-paying students". The committee does not know the details, but generally does not support assigning tasks to unpaid personnel.

GELIFES has an effective onboarding process. Researchers perceive a high workload, in particular in combining teaching and research. Tenure-track PIs feel independence in their research and appreciate the support provided by expertise groups. The starting package allows them to start building their own research group while being included by senior PIs in larger network developments and consortia, for example participating in joint proposals.

The average number of PhD candidates per PI is appropriate (4 per research PI), given the teaching load for each PI, if the duration of PhD trajectories would be within four years. The committee also notes that the distribution is skewed. Some PIs supervise only one or two PhD candidates while others have over ten, in which case supervision may be spread thin.

In the self-evaluation report, GELIFES writes that one of its weaknesses is the "scarce overview on the levels of inclusivity, equity, and safety, amplified by a poor understanding of cross-cultural differences". The committee is pleased to learn that a survey will be set up to gauge possible issues on safety and inclusion and that the institute is making efforts to further improve its orientation & onboarding processes and mentoring programmes.

The hiring policy includes procedures to ensure fair and transparent recruitment. GELIFES has taken effective measures to improve the gender balance in the scientific staff, which now has 52% females. GELIFES attracts a large number of PhD candidates from its master programme and 60% of the PhD candidates are women. The committee recommends that the institute continue its efforts in order to also improve gender balance at the most senior level, which is lagging behind with only 11% female full professors.

The average duration of a PhD project at GELIFES is over 5.5 years, which is much too long, although this can be partly assigned to the effect of the pandemic. From the interviews the committee did not always sense a feeling of urgency with the staff that this should be fixed. For example, it was mentioned that such a long duration is not uncommon within GELIFES' research field. Moreover, PhD candidates mentioned the lack of incentive to finish the project within the set amount of time. It is both the staff's and student's responsibility to ensure the PhD trajectory is completed in time. Notably, in its SWOT analysis GELIFES seems to put much of the blame with the PhD candidates; "W5: PhD candidates take too long to finish", while this is obviously also the staff's responsibility. The committee strongly recommends this is fixed. See also the general section on this topic in Chapter 2

8.2.3. External Strategy

GELIFES has many connections with other institutes within FSE; an impressive table was provided in the report that gives an overview of many topical connections that benefit multiple institutes. GELIFES also has an extensive network of external strategic partners, including non-profit organisations and industrial partners. It has connections with many Dutch and international universities, and a strong connection with NWO institute NIOZ. The unique position close to the Wadden Sea allows for state-of-the-art research programmes there.

GELIFES' PIs participate on a regular basis in advisory boards of patient organisations (Diabetes, Hersenstichting) and other health-related organisations, in advisory panels of nature conservation agencies (e.g., WWF, Natuurmonumenten, SOVON, Convention on the Conservation of Migratory Species of Wild Animals, IWC), governmental boards (SNN-PAS, land restructuring, nature conservation), and are invited as experts to national and regional parliaments on nature conservation and management issues. GELIFES played an active role in the establishment of the Dutch Sectorplan for biology.

GELIFES' neurobiology programme has many connections with industrial partners, in the fields of nutrition, exercise and motion, brain disorders, biological rhythms & sleep, and neurodegenerative diseases, showing the relevance of its research in these areas.

Overall, the committee sees that GELIFES is well connected with external partners in many of its research fields. The committee recommends GELIFES to work further to enhance its visibility and the branding of the institute (see also chapter 8.5), as that will further assist in finding and building new collaborations through which funding can be achieved. To assist the GELIFES management in these efforts, the committee recommends GELIFES to regularly consult the scientific advisory board.

8.3. Research quality

GELIFES carries out innovative research of high quality in all its disciplines of neurobiology, behaviour, ecology, and evolution. At the neurobiology and behaviour level a key strength is the cross-species approach that few institutes worldwide have, from birds to humans. Examining the biological basis of cognition, sociability, ageing, and sleep using different systems makes GELIFES a unique entity globally and the potential to leverage this will increase with new interdisciplinary recruits. The use of novel technological approaches was particularly obvious from both plant biology and brain analysis. GELIFES houses facilities for in vivo animal and plant experimentation under semi-natural conditions and for ecological fieldwork. The facilities in general were excellent and custom designed with the type of research in mind.

The research products for peers and marks of recognition show a steady increase over the past years. The publication citation statistics of GELIFES are on the low side. Six PIs received international and national academic prizes. It is notable that GELIFES was awarded only one ERC Advanced Grant in the past period, which is surprising for such a large high-level institute and raises questions about the international standing. The committee recommends that GELIFES develops a strategy to increase success in the competition for personal grants. The quality of the paper output varies between PIs and groups, with a significant number of papers in top journals. According to the committee, GELIFES should follow a more aggressive and ambitious publication strategy to increase the visibility of the institute nationally and globally to reflect the high potential of the GELIFES research staff.

8.4. Societal relevance

The research programme of GELIFES is highly relevant. It addresses key issues related to the development of natural species, human evolution, the human brain, and natural ecosystems. It is essential for the faculty of FSE to have such an institute that can contribute to social progress, improving the well-being of individuals, communities, and the planet. GELIFES helps lay a foundation for informing policy and decision makers and society at large. A number of highly relevant and visible products have been developed with, and are being used by, societal partners, e.g., restoration of seagrass in the Dutch Wadden Sea, artificial reefs, and a smartphone app to assess dietary interventions and social functioning. In general, GELIFES makes impact in nature conservation, mitigating climate change, understanding sleep-wake rhythms, pest control, the relation between food and health, psychiatric, behaviour and neurological pathologies. This is an impressive list of highly relevant contributions to global and regional

challenges. All these research topics also present excellent career perspectives for PhD candidates.

Several of GELIFES' PIs actively participate in societal debates, e.g. by appearing on regional and national TV and radio, as well as in interviews in newspapers. An Outreach and Communication Committee has been set up to further work on the societal impact.

8.5. Viability

GELIFES strives for academic excellence, increasing its visibility and recognition as an interdisciplinary institute. An explicit question to the committee was if the institute is functioning well as a single cohesive unit, and what the committee can recommend exploiting diversity in the best possible way and prevent it from becoming a weakness. The committee sees the diversity as a main strength of the institute and concludes that the integration into one broad and multidisciplinary institute is a success. During the site visit, the representatives were very positive about the merger, the diversity and the integrated research direction of the institute.

The committee recommends that GELIFES does more on the messaging of its uniqueness on the global stage. The Adaptive Life theme offers unique opportunities to combine and integrate different disciplines and approaches. According to the committee, given the large societal importance of research and the further potential for synergy, GELIFES could become a flagship research institute in Europe.

To increase the visibility committee recommends a larger focus on achieving impactful publications, including a clear publication strategy. Organising major international workshops and conferences on the intersection between ecology/evolution and neurobiology/behaviour can further increase visibility. Acquiring further major transdisciplinary research grants will also strengthen the institute.

The committee has confidence in the future of GELIFES. The structure in place is solid and a good basis to continue integration and increase visibility. The institute's research agenda is widely focusing on global challenges, providing it with good perspectives for funding. The flat structure of the institute gives all research staff - in particular, the talented young PIs - a key role in the future direction of the institute.

As the potential societal impact of GELIFES' research programme is clear, and its performance very strong, the committee recommends the institute to develop further metrics to measure successes in the flow of knowledge to users, as that can strengthen the visibility of the institute. As an example, the committee mentions the explicit notion of 650 ha of seagrass in the Wadden Sea that was restored. Similarly, it will be interesting to gauge the impact on the policy measures that were achieved by advice given by GELIFES' staff. And for the Adaptive Brain Theme, what was the impact of the human sleep deprivation studies? And what was the impact of Adaptive Organism studies on treatment of diseases, health, and welfare? Making all these results (even) more explicit can further improve the impact and international standing of GELIFES.

A point of concern is the external funding that is required to maintain a staff of some 200 PhD students. This requires a dedicated action plan of the PIs and the exploration of new funding opportunities.

8.6. Conclusion and recommendations

GELIFES is an excellent institute that covers a wide range of highly relevant topics. It was created as the merger of the CEES and CBN institutes with the aim to strengthen its profile, boost its visibility, and to strengthen its position in the national and international science landscape, as well as to engage in large funding initiatives and strategic input to policy makers. Now, after eight years it can be concluded that achievements within these goals are well on their way. At the same time, there is much work to do to further take advantage and exploit the unique collection of top-quality expertise of PI staff. To continue and further increase the impact of GELIFES' research, the committee has the following recommendations:

- Work towards the situations that the duration of PhD trajectories does not overshoot the normal project duration of 4 years.
- Continue efforts to improve the gender balance for senior staff.
- Develop an action plan increase the number of grant proposals to NWO, EU and other funding sources.
- Develop a strategy to increase success in the competition for personal grants (VIDI, VICI, ERC).
- Develop quantitative metrics to measure successes in the flow of knowledge to users, as that can strengthen the visibility of the institute.
- Develop a publication strategy that reinforces the unique, interdisciplinary nature of GELIFES,

and allows for a focus on impactful publications.
- Better message the uniqueness of GELIFES on a global scale and improve visibility and branding of the institute. Increasing the number of top journal papers is an important part of this.
- Establish an international advisory board.

GELIFES asked the opinion of the committee on the following questions:

1. *GELIFES is the result of a merger of two Institutes (CEES and CBN) which took place in 2015. We would like to ask the committee to see if the Institute is functioning well as a single cohesive unit, and does the committee have any recommendations on how our diversity, seen as our main strength, can be exploited in the best possible way, and how we can prevent it to become a weakness (dilution). This is addressed in* ***Sections 8.2.3 and 8.5****.*
2. *GELIFES is working on building up a network of strategic partners. Does the committee have any recommendations for the Institute for building a strategic partners network, and how to make the best use of this network in building collaborations, such as in large grant/consortia proposals or other forms of societal impact?* This is addressed in **Sections 8.2.2 and 8.2.3.**

9. Energy and Sustainability Research Institute Groningen (ESRIG)

9.1. Introduction

The Energy and Sustainability Research Institute Groningen (ESRIG) was established in 2009 as the result of the merger of the Centre for Isotope Research and the Centre for Energy and Environmental Sciences. The institute is dedicated to addressing challenges in the shift towards circular resource systems. ESRIG is one of the smaller FSE institutes, with 20 PIs, seven postdocs and approximately 80 PhD candidates. Research and education are connected through the Energy and Environmental Sciences (EES) MSc programme, which attracts around 50 students annually.

9.2. Organisation and strategy

9.2.1. Organisation

ESRIG is organised in six interdisciplinary units: Biomimetics, Centre for Isotope Research and CIO Oceans, Geo-Energy, Integrated Research on Energy, Environment and Society, Hydrogen and Energy Conversion, and Nuclear Energy. The institute is led by a scientific director (Prof. Nasser Kalantar-Nayestanaki), who is supported by the ESRIG Board, consisting of a research coordinator, a director of education, and the six unit-heads.

Decisions taken by the board are communicated to the staff via monthly meetings. From the interviews, it appeared to the committee that ESRIG has organised responsibilities in quite a hierarchical manner. By including unit heads in the board, the management structure gives a siloed impression. This does not seem conducive to creating strong interactions and synergies between the six units. Early and mid-career staff are not optimally represented in decision-making processes and female staff is not represented in management. The committee recommends that ESRIG transforms its management structure to address these issues, so that all staff feel included in strategy and policy development.

ESRIG's six units contribute to three overarching research themes: Energy systems, Bio-based economy & circular resource systems, and Carbon cycle & climate. These are all highly relevant topics in a time of climate change and growing importance of sustainable materials use. Within three overarching themes, approximately 20 PIs each pursue their respective projects, collectively amounting to 25 topics in total. According to the committee, this structure of three themes and a rather large number of sub-themes seems too scattered an institute with approximately 20 PIs. The organisational structure adds to the overall perception that ESRIG consists of a collection of individual researchers who are rather loosely bound by a very broad sustainability theme.

9.2.2. Internal strategy

ESRIG's mission is to contribute to sustainable energy utilisation and resource exploitation in the coming century for more people. As such, ESRIG's research domain aligns closely with key missions of UG and FSE.

ESRIG's report mentions (often loosely) its relation to solar technology, batteries, hydrogen economy, nuclear technology, carbon cycle, the "water nexus", etc. However, it is impossible for an institute with only 20 PIs to be recognised as an important partner in all these fields. It would require, for example, to have (co-)leading roles in each of the National Growth Fund programmes for photovoltaics, battery technology, and hydrogen, on top of connections to the new wave of nuclear technology that is appearing in our country. This is not possible for such a small institute. It is clear that the individual PIs are well-recognised specialists in their field, and the committee has seen research activities of world class at ESRIG. However, in the committee's experience, the best impact is nearly always created with research groups that collaborate and inspire each other within a well-defined focused theme. This is lacking in ESRIG. We will discuss this further in Section 9.5 Viability.

The committee found that in some cases progress in the past period was difficult to assess, as ESRIG's report was lacking detailed information on some topics. One example is that the committee found it difficult to judge the nature of the collaborations with companies and governmental organisations on major projects. What projects are funded, what budget, what was the outcome, which results are

transferred, with what impact? Several PIs are successfully doing this but a complete overview for all staff was lacking. Overall, the information given in the report by ESRIG was scarce compared to what the other institutes delivered. It was not easy to get an overview of the staff, individual or collaborative grants, the research laboratories and infrastructure; the ESRIG website also provides limited information.

Research staff receive their own budgets and facilities and operate with sufficient autonomy. ESRIG adheres to the Faculty's Career Path in Science policy, including an internal system for mentoring tenure track staff and guiding them through the initial stages of their career. The committee has the impression that ESRIG uses the traditional research quality indicators as a basis for advancing the careers of its researchers and has not made as much progress as the other FSE institutes in implementing new recognition and rewards systematics. The committee recommends that ESRIG strongly increases its efforts in this respect.

ESRIG has a substantial number of international staff, contributing to the cultural diversity within the institute. Furthermore, ESRIG has successfully attracted young talent. In the committee's opinion, it now has the opportunity to invest time and resources into actively nurturing and developing this talent, thereby fostering long-term success. The committee recommends that ESRIG further improves its onboarding procedures and proactively assists staff members in network building.

The institute reports difficulties with respect to the recruitment and retention of female talent. With a current male-female ratio of 80:20 and an all-male leadership, the committee recommends addressing this issue with urgency. ESRIG management should seek assistance within FSE to revise hiring practices, for example on coaching and raising awareness amongst current leadership, proactive scouting of female talent, tailoring advertisement texts and requirements, and reconsidering the composition and practices of selection committees. To retain female talent, a more lenient approach to the requirement for postdocs to leave the university for two years to acquire external experience seems desired. Here, a dialogue with FSE and UG needs to be established.

ESRIG has an annual turnover of €5M, implying that the funding per PI is on the low side. Roughly 50-60% of the annual budget comes from external funding sources such as NWA, NWO, and the Netherlands Polar Programme (NPP). Additionally, the institute has secured international grants from the ERC, Horizon Europe programme, and Marie Curie ITN.

ESRIG hosts around 80 PhD candidates of which more than half are scholarship students, many of whom from China. As also discussed in Chapter 2, FSE will soon become less dependent on scholarship candidates. The committee recommends that ESRIG develops as soon as possible an active strategy for grant writing to make sure that it can sustain its significant number of PhD candidates from regular funds and minimise its dependence on scholarships and double-degree candidates. Novel external grants from e.g., NWO and the EU will also provide an opportunity for ESRIG to enhance its connections with relevant external partners. ESRIG's active involvement in the EES MSc programme, with growing student numbers, provides the institute with an excellent pool of potential high-quality PhD applicants.

ESRIG has a substantial number (20%) of self-funded PhD candidates. The committee does not know the details, but generally does not support assigning tasks to personnel that does not receive a salary.

The average duration of a PhD project at ESRIG, 5.7 years, is much too long. The institute took several measures to try to improve this, but these were only partially successful. The committee strongly recommends that this is fixed. See also the general section on this topic in Chapter 2.

In the interviews, staff described a culture of internal collaboration and regular informal exchange, particularly within ESRIG's units. The general atmosphere amongst most colleagues was described as open and supportive. The institute organises annual staff retreats, newsletters, and semi-annual symposia. Yet, the committee thinks that because of the very broad and scattered research strategy of ESRIG it is difficult to create a strong and effective culture of internal collaboration.

In light of remarks made about hierarchical management structures and gender imbalances, the committee strongly recommends close monitoring of social safety and inclusion, and consideration of implementing best practices from other institutes. Research integrity seems adequately addressed. It is part of PhD training, and also discussed with PhD candidates in the context of the research units. The open access policies are well in order.

9.2.3. External strategy

ESRIG has connections with several other institutes, within FSE and also through the Wubbo Ockels School for Energy and Climate and its predecessor, the Groningen Energy and Sustainability Programme (GESP) of which it was one of the main founding members.

Overall, the report gives a limited insight on the nature of the external collaborations (although some case studies gave excellent examples). The committee finds it surprising that despite its strong relevance in sustainability, ESRIG has only limited participation in the major sustainability-related National Growth Fund programmes. Regionally, ESRIG participates in the New Energy Coalition (NEC) and nationally it is involved in the hydrogen fuel cells growth fund. ESRIG also has links with NIOZ, KNMI, WUR, and UU.

9.3. Research quality

While the section above is very critical on ESRIG's scattered strategy, several PIs and their corresponding research demonstrate high quality, evident from publication metrics; the citation scores of ESRIG are very high (FWCI=2.56). This excellence has resulted in several of the ESRIG members receiving many prestigious prizes and awards. This is a clear strength of ESRIG.

ESRIG has state-of-the art lab facilities, for example the world-class facility for isotope analysis using mass spectrometry. This also serves as a facility for radiocarbon dating which is an excellent example of world-class fundamental science providing a direct service to society. Other examples are the ESRIG WindTunnel, which it has for example used to optimise wind turbine blades, and the Lutjewad greenhouse gas and aerosol measurement station that ESRIG maintains. In addition to experimental work in these facilities, ESRIG furthermore develops powerful simulation tools and interdisciplinary models, used for example to plan future continent-wide power systems, or to investigate the impact which COVID-19 has had on the energy transition. These are all examples of excellent research, which has led to many high-profile publications.

However, a truly integrated multi-/interdisciplinary approach, combining technical and assessment perspectives, is lacking while this could be a major strength for both research quality and societal relevance if further developed strategically.

9.4. Societal relevance

ESRIG's core research themes address urgent societal needs, and the institute thus has many opportunities to create societal and economic impact. That said, for some parts of ESRIG's research it is not easy to derive from ESRIG's report what impact it has created.

The report states that ESRIG supports the regional hydrogen valley development, but lacks clarity on the methods employed, specific research programmes and valorisation strategies. Similarly for the programmes on nuclear energy, the committee wonders how the research connects to national initiatives and what impact is created. The report also mentions impact in the "water-food-nexus", but it Is not clear what is meant or achieved. These examples all indicate that it is difficult to make strong impact when a small institute is working on so many topics. At the same time, as said, the presented case studies are relevant. The report indicates that working with industrial partners is one of the key elements of the research. The committee lacked a clear full overview of who these partners are, which programmes have been funded, and what research is carried out.

ESRIG has an active outreach policy, and its PIs contribute to the public debates on sustainability and the challenge of the energy transition. Some ESRIG PIs are members of high-level (IPCC, EERA, NERA, KNMI and NIOZ) policy-making committees and institutions, and thus in a position to influence policy.

9.5. Viability

The mission of ESRIG addresses an important topic, but it is very broad ("contribute to sustainable energy utilisation and resource exploitation in the coming century for more people"). ESRIG contributes to this mission with a wide range of activities, each at a relatively small scale. As written above, it is not possible for such a small institute to be recognised as an important partner in all these fields. In the committee's experience, the best impact is nearly always created with research groups that collaborate and inspire each other within a well-defined focused theme. This is lacking in ESRIG.

At least two units of ESRIG can be considered to be of subcritical size, which raises questions on the viability of their research topics on a short to medium (five-year) term. These units are Geo-Energy

with one relatively young assistant professor, and Nuclear Energy with one experienced professor who will retire in the upcoming review period. Both units have few PhD candidates. Two other units are somewhat larger, with one full professor and one associate professor (Biomimetics) or a total of three researchers/lecturers (Energy conversion). Despite the sizable number of PhD candidates in these units, the committee still considers these rather small. These concerns are aggravated by the modus operandi of ESRIG, i.e., working as a collection of individual researchers rather than trying to overcome sub-criticality of specific research themes by bundling them in larger, truly integrated activities.

In the report, ESRIG writes it has a "central position in energy and environmental research". That is fair, but because of its very broad research programme it is difficult for ESRIG to take up FSE-wide leadership in the sustainability field. Of course, taking new initiatives requires leaders that are willing and capable. The committee thinks ESRIG certainly hosts talents that can help make the necessary change, together with the present management. At the same time, FSE institutes like ZIAM, ENTEG and others also are very active in energy research, and often play (inter-)nationally leading roles in this field. As an energy institute, ESRIG could also co-lead initiatives to discuss the wanted or unwanted role of fossil-fuel companies in the energy transition, or the management of nuclear waste in nuclear energy technology.

The committee recommends that, taking advantage of the strongest elements in its research programme, ESRIG develops a coordinated future vision to improve cohesion and enhance the visibility and impact of the institute. In doing so, it should critically assess whether each research unit possesses the critical mass necessary for making impactful scientific contributions and societal advancements. The committee lacks sufficient insights to make a recommendation on what topics ESRIG should increase its focus on, and which ones it should abandon in the future, also because this may strongly impact the PIs.

9.6. Conclusion and recommendations

ESRIG is an institute that delivers high-quality research. Several of its activities are world-class. The institute, however, has various challenges such as the scattered portfolio of activities, sub-critical units, lack of strategic vision on integration, limited improvement of the gender balance. The lack of progress on these issues is somewhat surprising. For reference, the committee judged that GELIFES, which resulted from a merger 8 years ago, now is operating as a well-integrated institute. During the site visit, the committee did not get the impression that the management felt a sense of urgency to pro-actively address certain issues. To continue and further increase the impact of ESRIG's research, the committee has the following recommendations:

- Develop a more active and strategic vision to reach the full potential for both scientific and societal impact, carried by clusters or units with critical mass, overcoming the viability problems of some units that currently seem sub-critical. Enhancing the visibility and impact of the institute, taking advantage of the strongest elements in the research programme.
- Take initiatives to become a (co-)leader in sustainable energy research programming within FSE.
- Transform the management structure of ESRIG so that staff is more included in strategy and policy development, making the structure more conducive to truly integrate research across units. This can help solving the issue of sub-criticality in some units. One suggestion is to have the management team managing ESRIG wide portfolios, instead of representing their own unit.
- Take initiatives, with assistance from FSE, to increase the hiring and retention of female staff.
- Implement the new recognition and reward systematics to the full extent.
- Develop an active strategy for grant writing to raise the number of external grants.
- Reduce the average duration of the PhD projects.
- Closely monitor social safety and inclusion and consider implementing best practices from other institutes.

ESRIG asked the opinion of the committee on the following questions:

1. *How is ESRIG as an Institute doing in terms of interdisciplinarity and how can the Institute strengthen interdisciplinary research across the University? This is addressed in* ***Section 9.2, 9.4 and 9.5****.*
2. *How is ESRIG doing in terms of its research growth areas? Are we flexible enough to respond to new initiatives, and should we?* This is addressed in **Section 9.2, 9.4 and 9.5**.

10. Van Swinderen Institute for Particle Physics and Gravity (VSI)

10.1. Introduction

The Van Swinderen Institute for Particle Physics and Gravity (VSI) focuses on fundamental research in particle physics and gravity. The research is mainly curiosity driven and is performed in close internal and international collaboration between theory and experiment. The institute was formed in 2014 as a merger of the former Centre of Theoretical Physics and two research groups of the Kernfysisch Versneller Instituut. In the review period, scientific staff has grown from 11 to 14 members, with three honorary/special appointment professors, an average of 35 PhD candidates and 5-8 postdocs.

10.2. Organisation and strategy

10.2.1. Organisation

The research in VSI is part of the FSE research theme Fundamentals of the Universe and is divided over three basic research units, corresponding to three interconnected research lines: the Cosmic Frontier, the High Energy Frontier and the Precision Frontier. The institute develops understanding of the world at the smallest and the largest distance scales, and how these are connected. Since 2016, VSI has been a partner of Nikhef, the Dutch National Institute for Subatomic Physics, a partnership between NWO and six Dutch universities. Through Nikhef, VSI participates in the LHCb experiment at CERN. The main local experiment at VSI, the NL-eEDM collaboration, is an integral part of the Nikhef research portfolio.

The management of VSI consists of the scientific director (Prof. Daniël Boer) and the board of the institute composed of Prof. Steven Hoekstra (chair), Prof. Anastasia Borschevsky and Prof. Diederik Roest. Biweekly meetings are organised to jointly reach decisions on the management of the institute. In research lines, the PIs are organised in groups of 4-6 PIs. The committee thinks this management and organisational structure is working well. The institute has a balanced approach between the three research lines, all covering areas with much focus in fundamental physics on a worldwide scale.

In the interviews the committee heard that it is sometimes difficult for the relatively small institute to fill all management roles. Associate professors are not eligible for management roles, like directorship of VSI, which results in a lot of managerial tasks for the small group of full professors.

At the time of the site visit, the labs of the institute were all located in a rather outdated building at the Zernike campus. During the lab tour, the committee was impressed by the institute's ability to nonetheless present a laboratory with a modern look. The lab-tour highlighted the impressive large-scale instrument and enthusiastic explanations by the institutes junior staff. A large part of the institute, including most of the experiments, will move to the new Feringa building in 2024.

VSI aligns its strategy with that of Nikhef, which is natural given the large-scale collaborative efforts of the research, which is embedded in large (inter) national activities, including those at CERN. For this reason, VSI does not have a separate advisory board, but instead relies mostly on advice that is obtained through the participation in Nikhef.

Overall, the committee thinks VSI has an excellent organisational structure.

10.2.2. Internal strategy

The mission of VSI is “to advance the understanding of nature at its most fundamental level, through the theoretical and experimental investigation of Nature’s fundamental forces and building blocks of matter, and their symmetries, over a wide range of distance scales. In this way, the VSI aims to connect the physics at the smallest distances scales (from molecules, atoms, and elementary particles down to the Planck scale of quantum gravity) to astrophysical observations at cosmic distance scales” .

According to the committee, VSI has a very strong mission with the frontiers well-chosen and each with sufficient critical mass, with experimental and theoretical components, ensuring good coherence, and good overlap between the frontiers. The close alignment to the Nikhef strategy gives VSI critical mass and allows it to act at world stage.

To carry out its mission, VSI followed a strategy along four lines: 1) to perform and stimulate theoretical

and experimental research done in close collaboration along three research lines (frontiers); 2) to create stronger ties with related research groups in the astronomy, mathematics and physics institutes; 3) to take part in the NWA route "Building blocks of matter and the fundamentals of space and time"; and 4) to maintain and develop the strong connection of the research with the educational programme through the very successful 'Quantum Universe' master track.

According to the committee, VSI has successfully followed these strategic aims: it made strong progress along all three frontiers, it established further links with neighbouring disciplines, it joined the NWA route, and its Quantum Universe master track continues to attract a large number of students.

VSI defined three additional specific strategic aims for the past evaluation: 1) a research portfolio that is well-aligned with that of Nikhef; 2) strong connections and strong coherence within the institute in the future and 3) making "Fundamentals of the Universe" a faculty research priority.

The committee thinks that these strategic paths too were successfully followed in the review period: the connection with Nikhef was strengthened further, the coherence in the institute has grown, and the desired faculty theme has been established. Several implicit strategic aims, as listed in the report, were also followed up on.

VSI plays an exceptional role in the teaching programmes of FSE: it supervises a very large part of the bachelor's students and several VSI staff members hold key positions in education. The VSI staff was strengthened with several teaching fellows and an assistant professor.

As written in the self-evaluation report, the institute considers its financial situation sound; it raised €12M in external funds over the review period. While this amount is in line with acquired funding in the field, e.g., comparable to that of the Nikhef collaboration as a whole, the number of PhD candidates is small in relation to the number of PIs. In the interview, VSI stated that while theorists usually have smaller groups and fewer PhD candidates, it would like to increase the number of PhD candidates per PI. The committee supports this; of course this will require a higher level of grant acquisitions.

VSI is successful in acquiring funding at the national level, both at the individual and consortium level, such as NWO XL and individual grants, and an NWA start-impulse grant. It is expected VSI will remain able to receive funds through these channels in the future. Within the newly structured NWO, with PIs from many disciplines together competing for the same grants, acquiring funding for VSI-type research is more challenging and requires the collaborative national approach which VSI already pursues.

VSI had only limited success in acquiring ERC and Horizon grants. The committee recommends exploring collaborative (national and EU) grants together with industrial partners such as ASML or VDL on specific topics. These may not be at the heart of the mission of VSI but could strengthen the research and create further critical mass for VSI. For increasing ERC grant success rates, the committee can only advise the obvious approach of using external advice of non-specialists on how to find the best strategic pitch for the fundamental questions that VSI addresses.

From the external grants VSI creates an internal mission budget in which part of the funding is assigned within the institute to help make strategic choices. This methodology seems to be well supported by the PIs. Overall, the committee thinks VSI has a sound funding strategy with a good perspective to maintain or even expand its activities.

10.2.3. External strategy

The external strategy of VSI is largely determined through its partnership with Nikhef, that generally runs long-term and large-scale projects. Nikhef assists VSI's experiments through specialised technical workshops. VSI contributes to theory, eEDM and LHCb programmes, and co-determines the general future directions of Nikhef. VSI receives funding through large consortium programmes that are coordinated by or within the Nikhef partnership. The committee recommends that VSI takes full advantage of what Nikhef can offer.

VSI also partners with the VU LaserLab for precision spectroscopy and with several international research institutions, most notably CERN. VSI staff members are embedded in (larger) international partnerships which gives the institute a voice in international strategies.

Overall, the committee thinks that VSI has an excellent external strategy that matches the nature of its research.

10.2.4. HR policy

VSI has a relatively small PI staff that has slightly grown in the past period. In hiring, the institute has carefully tried to keep a balance to cover its three research frontiers, the interface between the three research lines, and the combination of theory and experiment. The committee noticed somewhat of a balancing act between creating synergy through strategic consolidation of resources and giving (young) PIs independence. It is advantageous for new tenure trackers to have freedom to create a separate experimental setup, while at the same time the institute may risk some loss of synergy. It is good that a broad research coverage is sought, but in relation to the size of the staff, the research portfolio is at the edge of being overly diluted. The committee recommends to VSI to guard against this dilution in future appointments, in order to retain the high level of impact.

From the interviews, it appeared to the committee that VSI is an inclusive institute that welcomes diversity in staff in terms of age and career phase, gender, nationality, and cultural background. It also increasingly pays attention to new forms of recognition and rewards. Good care is given to onboarding. Overall, the committee got the impression from the interviews that VSI is a very pleasant place to work, where people care for each other and move their research forward in a very collaborative fashion.

10.2.5. PhD policy and training

In the review period, VSI has graduated 55 PhD candidates, of which 45% were Dutch. The committee considers this a very good proportion. VSI follows the “C3” PhD monitoring system of Nikhef, in which a committee evaluates the supervision with the PhD candidate and assesses what is required to ensure timely graduation, with focus on the wellbeing of the candidate. The committee is very positive about this policy. The time to completion for PhD candidates dropped in recent years and is below the FSE average, but still too long (55 months), although this can be partly assigned to the effect of the pandemic. VSI is in the good position of having 11 PhD vacancies to fill.

10.3. Research quality

The research quality of VSI is excellent. Following the indicators provided in the self-evaluation report, VSI scores very high on all aspects. This is very well described in section 5.1.1. of VSI’s report that extensively describes how the institute has consistently produced new fundamental insights that advance the understanding of nature at its most fundamental level. This is the heart of the mission of the institute. The quality of the work is reflected in the journal publications. VSI also creates new experimental protocols and new instruments that form the basis for novel fundamental insights that may be achieved in the future. Recognition of VSI through awards, memberships of societies and in boards, etc. is excellent. The quality of the work is also reflected by the success in acquiring funding.

The committee likes to stress the importance of the flagship experimental eEDM project. This is a unique programme within the VSI and FSE that can create true breakthrough results which will further lift its international reputation, and which is also highly important for Nikhef. Making progress with this instrument is very complex and the committee recommends VSI to do everything it can to speed up progress on this important experiment. If this requires more support staff to run the experiments, this should be given the attention of both institute and FSE. The committee notes that the special eEDM Nikhef committee has visited less than yearly (2019, January 2022). The committee recommends that the frequency increases to yearly visits.

10.4. Societal relevance

VSI’s foremost societal relevance is the fact that the institute advances our understanding of nature at its most fundamental level. As a modern society, we fund fundamental research to gain insight in the origin, structure and future of the world around us, and by developing such knowledge VSI creates strong societal relevance. To reveal the new fundamental insights to the general public, VSI carries out an effective outreach programme.

VSI develops high-tech instruments at a superb level. This can provide unique opportunities for interaction with industrial high-tech partners such as VDL and ASML. The committee recommends to further explore these opportunities in both directions, to transfer knowledge and to benefit from it. These companies can offer technical insights and facilities complementary to those of Nikhef. The existing

connection with ARCNL is one natural way to facilitate this.

A key relevance to society also lies in the education and training of highly qualified scientists with unique technical expertise. This is reflected by the fact that, as written in the report, VSI alumni generally land high-level jobs after their term at VSI is finished.

The committee found the open science policies of VSI well in order; the field of high-energy physics has been exemplary in this respect.

10.5. Viability

VSI has a clear strategy for the future, focusing on further development of key fundamental insights in the origin of the universe. New hires were made within this strategy, providing a long-term perspective. VSI is well-structured and well-connected to external partners and the committee supports the strategy for the upcoming period. By being a partner in Nikhef, the institute has sufficient critical mass to make impact. The institute has a good age diversity which contributes to its viability.

One potential risk the committee sees, is that VSI may cover too many complex research projects at once. While the visit of the committee was too short to get sufficient insight into this, the committee recommends that VSI carefully considers the number of experiments it runs and participates in, to have critical mass in each. It may be that carrying out a smaller number of activities with more people for each, creates higher overall impact.

10.6. Conclusions and recommendations

VSI is an excellent institute that delivers excellent quality, addressing fundamental research questions. With its focus on understanding of nature at its most fundamental level it forms an essential part of FSE and UG. It connects FSE and UG to research within Nikhef, CERN and other key international organisations. It creates an outstanding base for education programmes for master's and PhD candidates and trains them in a broad range from high-tech instrumentation to fundamental theory at the highest level which prepares them for a wide variety of jobs after their time at the VSI.

To continue and further increase the impact of VSI research, the committee has the following recommendations:

- Expand the links with Nikhef that has much to offer from which VSI could benefit. Hold yearly meetings with the Nikhef eEDM committee.
- Consider focusing on fewer (large-scale) experiments.
- Increase the focus and effort for the eEDM experiment that has world-level potential if successful, while maintaining a good balance between the frontiers.
- Create (further) links with high-tech equipment companies such as ASML and VDL and benefit from each other's technology.
- Consider allowing associate professors in management positions, like the directorship of VSI, to reduce the managerial workload for the small group of full professors and to allow associate professors to gain experience in management positions.

VSI asked the opinion of the committee on the following question:

1. *Does the committee have any recommendations on what the Institute could do to enhance earning power, such as increasing our chances of success in obtaining EU or other types of funding?* ***This is addressed in Section 10.2.2****.*

Appendices

Appendix A: Review Committee

The Executive Board of UG appointed a core review committee of external peers, including a mid-career researcher and a PhD candidate.

- Prof. Albert Polman (chair), Scientific Programme Leader at NWO Institute AMOLF, professor at the Faculty of Science at University of Amsterdam, the Netherlands.
- Prof. Gerrit van Meer (vice-chair), emeritus dean, Faculty of Science, Utrecht University, the Netherlands.
- Prof. Katharina Al-Shamery, full professor of Physical Chemistry, University of Oldenburg, Germany.
- Dr. Ruben de Groote, assistant professor in Nuclear and Atomic Physics, KU Leuven, Belgium.
- Sofie Kölling MSc, PhD candidate Interfaces and Correlated Electron Systems, University of Twente, the Netherlands.
- Prof. Maarten Steinbuch, University Professor in Systems and Control, Eindhoven University of Technology, the Netherlands.

In addition, the Executive Board of UG appointed one or more additional sub-committee members to provide input for the review of particular institutes. This way, there was sufficient substantive expertise for each institute within the committee.

- Prof. Hagan Bayley (ZIAM, Stratingh, GBB), professor of Chemical Biology, University of Oxford, UK.
- Prof. Eric Laenen (VSI), director Institute of Physics, University of Amsterdam, the Netherlands.
- Prof. Armand Leroi (GELIFES), professor of Evolutionary Developmental Biology, Imperial College London, UK.
- Prof. Jacob Moulijn (ENTEG), Emeritus Professor of Catalysis Engineering, Technical University Delft, the Netherlands.
- Prof. Arnold Tukker (ESRIG; GELIFES), professor of Industrial Ecology, Leiden University, the Netherlands.
- Prof. Matthias Wilmanns (GBB), head of EMBL Hamburg, Germany.
- Prof. Herre van der Zant (ZIAM), professor at the Kavli Institute of Nanoscience, Technical University Delft, the Netherlands.

Due to personal circumstances, Professor Moulijn could not participate in the site visit.

The UG Executive Board appointed dr. Meg van Bogaert and dr. Floor Meijer as independent secretaries to the committee.

Appendix B Procedures followed by the committee

The committee received the following documents:

- Self-evaluation report FSE-GSSE
- Self-evaluation reports for the seven institutes
- Committee report previous review
- Strategy Evaluation Protocol 2021-2027

Furthermore, the committee received Terms of Reference with a request to answer certain specific questions concerning FSE, GSSE, and each of the institutes. These questions are listed in the corresponding chapters of this report.

Members of the committees signed a declaration stating they would evaluate without bias, personal preference, or personal interest. Their judgment is made without undue influence from the institution, the programmes, or other stakeholders. Any existing professional relationships between committee members and programmes under review were disclosed. The committee concluded that there was no risk in terms of bias or undue influence.

All committee members received an introduction to the SEP and specifics about the Dutch research landscape. On June 19, 2023, the core committee had an online introductory meeting in which it discussed the SEP, working methods and procedural matters. Two core committee members each were assigned to FSE, GSSE and the institutes as the first responsible reviewers. They would take the lead during the discussions. After studying the self-evaluation reports, the committee filled out Preliminary Assessment Forms (PAFs) with initial findings. The completed PAFs were discussed during an online meeting of the core committee on October 18, 2023, and topics for discussion during the site visit were determined.

The site visit took place from October 29 - November 2, 2023, in Groningen. During the site visit, the committee held interviews with the chair of the Executive Board of UG, the Faculty Board, the Boards of the institutes and the GSSE, senior and junior PIs, and external stakeholders. The committee also made lab visits at each institute. In addition, the committee met informally with various FSE communities, including postdocs and PhD candidates. To conclude the site visit, the committee chair presented the main preliminary conclusions to the institutes, faculty, and the university.

After the site visit, the committee chair took the lead in composing this report, aided by input provided by (sub) committee members. An online meeting of the committee was held on February 2, 2024, in which conclusions and recommendations were discussed. All committee members agree with the conclusions in this report.

The draft version of the report was presented to the Faculty Board with a request for identification of factual errors and comments. Subsequently the report was finalised and offered to the Board of the University on May 24, 2024. The schedule for the site visit is included in Appendix D.

Appendix C: Site visit schedule

For each institute, the schedule consisted of

- Meeting with management
- Meeting with senior research staff
- Meeting with mid-career research staff
- Lab visit

		Day 1		Day 2		Day 3		Day 4	
Start Time	Sunday 29 Oct	Start Time	Monday 30 Oct	Start Time	Tuesday 31 Oct	Start Time	Wednesday 1 Nov	Start Time	Thursday 2 Nov
		8:30	taxis to Bernoulliborg	8:30	taxis to Bernoulliborg	8:30	taxis to Bernoulliborg	8:30	taxis to KVI - Zernikelaan
		9:00	PRC Closed Session (15 min)	9:00	PRC Meeting and Check-in with organisation (30min)	9:00	PRC Meeting and Check-in with organisation (30min)	9:00	**VSI Site tour at KVI Building (1 hr)**
		9:15	Meeting with FSE Faculty Board (45 min)	9:30	**Stratingh (3hr)**	9:30	**GELIFES (3hr)**	10:15	PRC Meeting and Check-in with organisation (30min)
		10:00	**ZIAM (3hr)**					10:45	**VSI (2hr)**
		13:00	PRC Closed Session and Lunch (60 min)	12:30	PRC Closed Session and Lunch (60 min)	12:30	PRC Closed Session and Lunch (60 min)	12:30	PRC Closed Session and Lunch (45 min)
14:00	Arrival Hotel Prinsenhof	14:00	**ENTEG (3hr)**	13:30	**GBB (3hr)**	13:30	**ESRIG (3hr)**	13:15	Meeting with Faculty Board, Directors and Coordinators (45 min)
								14:00	PRC Closed Session (90 min)
				16:30	PRC Closed Session (45 min)	16:30	PRC Closed Session (45 min)	15:30	Preliminary Feedback Session (30 min)
17:00	Welcome and Introduction Drinks	17:00	PRC Closed Session (45 min)	17:15	Meeting with Graduate School (30 min)	17:15	Stakeholders Meeting (30 min)	16:00	Networking Drinks End of programme 17:00
		17:45	Meetings with FSE Communities: WISE, YSEN and Postdocs (45 min)	17:45	Meetings with PhD Students, FSE PhD Council (45 min)	17:45	Meeting with Jouke de Vries (30 min)		
18:00	PRC Dinner in Hotel Prinsenhof Tuinkamer	18:30	PRC Closed Session (30 min)	18:30	PRC Closed Session (30 min)	18:15	PRC Closed Session (45 min)		
		19:00	PRC Dinner Het Feithuis (19:30 - 21:30)	19:00	PRC Dinner Schimmelpennink Huis (19:30 - 21:30)	19:00	PRC Dinner Viva la Vie (19:30 - 21:30)		

Appendix D: Quantitative information

Quantitative information on research staff and funding is provided according to SEP for all institutes.

Zernike Institute for Advanced Materials (ZIAM)

	2017			2018			2019			2020			2021			2022		
Scientific Staff (#/OZ fte)*	# (a)	%F	OZ fte (b)	#	%F	OZ fte	#	%F	OZ fte	#	%F	OZ fte	#	%F	OZ fte	#	%F	OZ fte
Assistant Professor Research	6	0%	3,7	6	0%	2,4	6	33% (2)	2,9	7	43% (3)	3,7	6	50% (3)	3	7	57% (4)	3,3
Assistant Professor Education																1	100%	0,3
Associate Professor	9	33% (3)	3,5	8	25% (2)	3,5	9	11% (1)	3,5	7	14% (1)	2,8	11	18% (2)	3,6	9	22% (2)	3,4
Full professor	14	21% (3)	4,5	15	27% (4)	5,4	20	40% (8)	6,2	21	43% (9)	6,6	21	43% (9)	6,6	24	38% (9)	6,8
Postdocs	29	28% (8)	23,9	34	29% (10)	25,3	29	31% (9)	22,6	40	28% (11)	27,6	37	32% (12)	30,9	31	32% (10)	29
external (NWO funded) PhD candidates	16	38% (6)	-	21	33% (7)	-	12	17% (2)	-	5	20% (1)	-	3	0%	-	1	0%	-
Regular PhD Candidates	166	27%	-	163	28%	-	180	29%	-	202	30%	-	210	29%	-	204	28%	-
Total research staff	**240**		**-**	**247**		**-**	**256**		**-**	**282**		**-**	**288**		**-**	**277**		
	# (a)		fte (b)	#		fte	#		fte	#		fte	#		fte	#		fte
Support staff	41		30,1	41		27	41		28	38		28,2	35		28,4	45		30,7
Visiting fellows	36			44			35			25			40			43		
Total staff	**317**			**332**			**332**			**345**			**363**			**365**		

Research Unit: Zernike	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Funding						
Direct Funding (1) Total	€ 10.758.917	€ 9.921.331	€ 9.454.210	€ 10.780.413	€ 11.969.557	€ 12.651.206
Direct Funding(1)	€ 6.859.242	€ 6.633.639	€ 6.018.234	€ 8.036.874	€ 8.404.327	€ 8.405.121
Direct Funding(1) BIS	2.701.620	2.034.601	3.501.575	1.461.930,80	2.015.920,22	2.182.933,82
Direct Funding(1) CogniGron	1.198.056	1.253.092	-65.598	1.281.608,48	1.549.309,36	2.063.150,98
Research grants (2)	€ 2.369.020	€ 2.490.126	€ 3.275.490	€ 3.004.036	€ 2.891.090	€ 2.750.388
Contract Research EU-ERC (3)	€ 1.815.474	€ 325.761	€ 593.182	€ 146.222	€ 324.349	€ 442.347
Contract Research EU-other (3)	€ 1.103.739	€ 1.148.253	€ 1.122.166	€ 825.313	€ 1.054.516	€ 1.054.604
Contract Research other (3)	€ 956.918	€ 452.364	€ 813.140	€ 877.273	€ 938.362	€ 1.793.999
Other (4)						
Total Funding	**€ 17.004.068**	**€ 14.337.836**	**€ 15.258.187**	**€ 15.633.258**	**€ 17.177.873**	**€ 18.692.545**
Expenditure						
Personell costs	€ 9.985.314	€ 9.838.521	€ 10.063.895	€ 11.756.601	€ 13.331.290	€ 14.384.761
Material Costs						
Other costs	€ 7.018.754	€ 4.499.315	€ 5.194.292	€ 3.876.658	€ 3.846.583	€ 4.307.784
Total expenditure	**€ 17.004.068**	**€ 14.337.836**	**€ 15.258.187**	**€ 15.633.258**	**€ 17.177.873**	**€ 18.692.545**

Engineering and Technology Institute Groningen (ENTEG)

	2017			2018			2019			2020			2021			2022		
Scientific Staff (#/OZ fte)*	#[1]	%F	fte[2]	#	%F	fte	#	%F	fte	#	%F	fte	#	%F	fte	#	%F	fte
Assistant Professor (TT research)	6	17 (1)	3,3	7	14 (1)	4,3	10	40 (4)	5,8	13	46 (6)	6,4	14	43 (6)	7,6	13	54 (7)	7,8
Assistant Professor (TT education)																3	33 (1)	0,6
Associate Professor	2	0	0,5	2	0	0,7	3	0	0,9	3	0	1,2	4	0	1,2	5	20 (1)	1,7
Full professor	14	7 (1)	3,5	14	7 (1)	3,6	16	6 (1)	3,8	13	8 (1)	3,7	14	14 (3)	4	17	13 (2)	4,3
Postdocs	15	0	10,6	17	0	16,4	29	14 (4)	24,4	26	15 (4)	21,5	23	17 (4)	20,2	15	13 (2)	16
PhD Candidates**	90	26		95	28		110	31		127	32		145	34		153	36	
Total research staff	**127**		-	**135**		-	**168**		-	**182**		-	**200**		-	**206**		
	#		fte	#		fte	#		fte	#		fte	#		fte	#		fte
Support staff	15		12,7	15		12,2	19		15,7	19		15,7	21		18,7	21		17,9
Visiting fellows	13			18			25			15			33			31		
Total staff	**155**			**168**			**212**			**216**			**254**			**258**		

	2017	2018	2019	2020	2021	2022	total	%
Direct Funding (1)	4,178,006	4,526,870	5,362,087	4,673,162	6,419,083	6,419,083	31,578,291	57
Research grants (2) other	636,071	1,022,112	1,011,578	760,459	1,180,977	1,117,202	5,728,399	10
Contract Research EU-ERC (3)	226,102	141,114	351,489	481,543	461,537	422,141	2,083,926	4
Contract Research EU-other (3)	45,171	427,266	745,908	821,416	547,403	432,444	3,019,608	5
Contract Research other (3)	1,387,963	1,435,043	1,639,331	2,726,512	2,755,587	2,732,865	12,677,301	23
Total Funding	**6,473,313**	**7,552,404**	**9,110,394**	**9,463,093**	**11,364,586**	**11,123,734**	**55,087,524**	
Expenditure								
Personnel costs	4,738,855	5,359,899	6,422,009	7,039,680	8,314,453	9,183,802		
Other costs	1,734,458	2,192,506	2,688,385	2,423,413	2,409,811	1,939,932		
Total expenditure	**6,473,313**	**7,552,404**	**9,110,394**	**9,463,093**	**10,724,264**	**11,123,734**		

(1) Direct funding by the University

(2) Research grants obtained in national scientific competition (e.g. grants from NWO, KNAW)

(3) Research grants obtained in international scientific competition (e.g. grants from the European Research Council)

Stratingh Institute for Chemistry (Stratingh)

Research Unit **Stratingh**																		
	2017			**2018**			**2019**			**2020**			**2021**			**2022**		
Scientific Staff (#/OZ fte)*	*# (a)*	*%F*	*OZ fte (b)*	*#*	*%F*	*OZ fte*	*#*	*%F*	*OZ fte*	*#*	*%F*	*OZ fte*	*#*	*%F*	*OZ fte*	*#*	*%F*	*OZ fte*
Assistant Professor	4	25% (1)	2.1	4	25% (1)	2.2	5	20% (1)	2	4	25% (1)	2.2	5	0%	2.2	6	0%	2.8
TT education																		
Associate Professor	5	40% (2)	2	5	40% (2)	2	3	0%	1.6	4	0%	1.5	4	25% (1)	1.8	4	25% (1)	1.6
Full professor	7	14% (1)	2	7	14% (1)	2.3	9	22% (2)	2.8	8	25% (2)	2.9	8	25% (2)	2.7	8	25% (2)	2.8
Postdocs	17	18% (3)	18.4	20	20% (4)	20.6	28	25% (7)	25.8	27	15% (4)	19.7	27	19% (5)	22.2	29	31% (9)	24.2
PhD Candidates **	98	32% (31)		109	34% (37)		102	37% (38)		121	36% (44)		121	39% (47)		118	38% (45)	
Total research staff	**131**		-	**145**		-	**147**		-	**164**		-	**165**		-	**165**		
	# (a)		*fte (b)*	*#*		*fte*	*#*		*fte*	*#*		*fte*	*#*		*fte*	*#*		*fte*
Support staff	25		18.4	27		17.9	26		18.9	26		20.2	23		16.3	21		14.8
Visiting fellows	18			21			27			15			21			24		
Total staff	**174**			**193**			**200**			**205**			**209**			**210**		

Research Unit: Stratingh	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Funding						
Drect Funding	€ 4.071.071,82	€ 3.646.231,23	€ 4.029.617,10	€ 3.374.246,45	€ 3.839.416,62	€ 4.853.549,41
Research grants other	€ 3.533.570,52	€ 4.263.735,66	€ 3.501.662,22	€ 3.293.462,99	€ 2.597.116,88	€ 1.815.092,64
Contract Research EU-ERC	€ 1.115.950,65	€ 1.857.617,27	€ 1.832.844,48	€ 2.402.540,31	€ 2.598.449,65	€ 1.908.257,27
Contract Research EU-other	€ 632.373,44	€ 681.046,76	€ 592.494,38	€ 916.141,37	€ 1.076.982,08	€ 930.342,52
Contract Research other	€ 310.241,01	€ 458.214,16	€ 1.070.360,53	€ 1.492.905,45	€ 2.447.002,83	€ 2.990.997,09
Other						
Total Funding	**€ 9.663.207,44**	**€ 10.906.845,08**	**€ 11.026.978,71**	**€ 11.479.296,57**	**€ 12.558.968,06**	**€ 12.498.238,93**
Expenditure						
Personell costs	€ 6.397.404,01	€ 7.187.008,60	€ 7.937.298,00	€ 8.507.645,61	€ 9.435.959,78	€ 9.453.022,96
Material Costs						
Other costs	€ 3.265.803,43	€ 3.719.836,48	€ 3.089.680,71	€ 2.971.650,96	€ 3.123.008,28	€ 3.045.215,97
Total expenditure	**€ 9.663.207,44**	**€ 10.906.845,08**	**€ 11.026.978,71**	**€ 11.479.296,57**	**€ 12.558.968,06**	**€ 12.498.238,93**

Groningen Biomolecular Sciences and Biotechnology Institute (GBB)

	2017		2018		2019		2020		2021		2022	
Research staff	**#[1]**	**Fte[2]**	**#**	**fte**	**#**	**fte**	**#**	**fte**	**#**	**fte**	**#**	**fte**
Full professor[3]	15	5.2	14	4.8	14	4.8	12	4.7	12	4.2	12	4
Associate professor	5	2.0	5	2.2	5	2	7	2.8	7	2.8	9	2.9
Assistant professor	6	2.6	6	2.6	7	3.1	7	3.1	8	4.1	7	3,9
Assistant professor with education profile	-	-	-	-	-	-	-	-	1	0.3	1	0.3
Postdocs	43	41.4	43	37.1	50	37	48	39.3	31	33.4	24	22.3
PhD students[4]	144	129.6	155	139.5	162	145.2	146	130.5	153	137.7	152	136.8
Total research	**193**	**180.8**	**204**	**186.2**	**219**	**192.1**	**201**	**180.4**	**193**	**182.5**	**184**	**170.2**
Support staff	**#**	**fte**	**#**	**fte**	**#**	**fte**	**#**	**fte**	**#**	**fte**	**#**	**fte**
Technicians[5]	26	21.8	26	21.0	26	20.8	23	19.6	22	18.0	25	21.9
Other support staff[6]	12	8.2	12	8.2	13	9.3	8	7.3	8	7.1	8	6.9
Visiting fellows[7]	38		55		32		34		59		63	
Total support	**76**	**30**	**103**	**29.2**	**71**	**30.1**	**69**	**26.9**	**89**	**25.1**	**96**	**28.8**
Grand total GBB	**269**	**210.8**	**307**	**215.4**	**290**	**222.2**	**270**	**207.3**	**282**	**207.6**	**280**	**199.0**

1 Individuals involved per staff level or category.
2 Average fte (research) input per given year according to the fraction appropriate for the level as researcher (top rows) and/or the (part-time) appointment for each given year.
3 Staff with dedicated tasks (e.g., institute director) have a smaller fraction (0.2 fte) of their appointment for teaching duties.
4 PhD trajectories as per December 31 of each given year, but excluding PhD candidates appointed for external organizations (e.g., R&D scien tists at companies who obtain their PhD degree being (co-)supervised by GBB staff.
5 Including dedicated support staff with specific scientific expertise (bioinformatics, molecular dynamics simulations, compu tional protein engineering) and/or use of GBB facilities (e.g., cryo- and normal EM; mass spectrometry).
6 Secretaries, general support staf and GBB Office.
7 Including a fraction of alumni (PhD) researchers who have access to data and facilities for completing analyses, data storage and submission of manuscripts.

Funding source	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**Total**	**Average**
University (personnel & research)[1]	9642	8300	10031	8122	8221	9019	**53336**	**8889** (56%)
National research grants [2]	3453	2334	2067	2893	3093	2746	**16587**	**2765** (18%)
ERC grants [3]	241	168	20	1008	895	479	**2810**	**468** (3%)
EU contract research [4]	2766	3426	2717	1296	904	734	**11843**	**1974** (13%)
Contract research other [5]	2554	1480	1402	1073	1237	1213	**8960**	**1493** (10%)
Total funding	**17049**	**16394**	**19160**	**16825**	**16886**	**14191**	**93536**	**15589**
Expenditure	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**Total**	**Average**
Personnel costs	12544	11324	11341	11850	12188	11348	**70594**	**11766** (75%)
Other costs [7]	6112	4384	4897	2543	2163	2843	**22942**	**3824** (25%)
Total expenditure	**18656**	**15708**	**16238**	**14393**	**14351**	**14191**	**93536**	**15589**

1 Expenses for direct funding by the University ('Eerstegeldstroom') for salaries of tenure-track and tenured research and support staff, starting packages, Covid compensation budget, and reserves (~1500k€ per December 2022) realised by GBB research group (mostly revenues from larger PPP and EU programs);
2 Research grants obtained in national scientific competition such as grants from NWO (incl. ZonMW; "Tweede geldstroom");
3 Individual research grants obtained in international scientific competition (i.e., ERC Starting, Consolidator, Advanced and Proof of Concept grants)
4 Any EU project grant other than ERC grants; e.g., H2020 and Horizon Europe grants for Research Cooperation, EIC, and Marie Curie instruments (ITN, COST, PF, Cofund);
5 Research contracts for specific research projects obtained from external organisations, such as industry, Top Sectors, Public-Private Partnership programs, charity organisations, etc;
7 All costs related to running the institute and particularly to conduct experimental and computational research in terms of consumables, investments in equipment, maintenance, etc.

Groningen Institute for Evolutionary Life Sciences

	2017			2018			2019			2020			2021			2022		
Scientific Staff (#/OZ fte)*	#[1]	%F	OZ fte[2]	#	%F	OZ fte	#	%F	OZ fte	#	%F	OZ fte	#	%F	OZ fte	#	%F	OZ fte
Assistant Professor	8	38% (3)	3.2	9	44% (4)	4.7	8	38% (3)	4.2	8	38% (3)	4.3	6	50% (3)	3.4	7	57% (4)	3.1
TT education													2	100% (2)	0.1	6	67% (4)	4.1
Associate Professor	13	15% (2)	5.7	13	15% (2)	5.2	14	36% (5)	5.6	13	38% (5)	5.1	13	31% (4)	5.5	10	30% (3)	4.3
Full professor	21	9,5% (2)	6.2	21	9,5% (2)	6.8	26	7,7% (2)	7.1	26	11,5% (3)	7.5	26	11,5% (3)	7.2	27	11,1% (3)	7.4
Postdocs	26	38% (10)	21.1	27	41% (11)	21.8	34	53% (18)	22.6	30	63% (19)	18.3	32	56% (18)	22.2	31	55% (17)	22.4
PhD Candidates **				192		-	208		-	218		-	216		-	205		
Total research staff	**68**		**-**	**262**		**-**	**290**		**-**	**295**		**-**	**295**		**-**	**286**		
	#[1]		fte[2]	#		fte	#		fte	#		fte	#		fte	#		fte
Support staff	71		49.3	77		46.8	69		50	62		41.6	72		44.8			45.6
Visiting fellows	65			71			89			64			78					
Total staff	**204**			**410**			**448**			**421**			**445**					

Note 1: number of staff as of 31-12 (avoids duplication of people who changed function during the year in the system)

Note 2: OZ fte is average over the year

* source: Peoplesoft up to and including 2019, AFAS as of 2020

** source: Hora Finita (regular PhD candidates trajectories as of 31-12 of given year registered as either GELIFES, CBN or CEES, excludes type 4 buitenprompvendi)

Funding	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Direct Funding (1)	€ 9,107,909	€ 9,444,614	€ 8,260,515	€ 8,923,236	€ 8,928,161	€ 10,074,769
Research grants (2)	€ 2,604,098	€ 2,644,460	€ 2,580,945	€ 2,372,159	€ 1,607,245	€ 1,737,139
Contract Research EU-ERC (3)				€ 487,568	€ 613,126	€ 344,093
Contract Research EU-other (3)	€ 1,144,346	€ 1,481,691	€ 2,151,742	€ 762,626	€ 1,254,722	€ 1,632,241
Contract Research other (3)	€ 1,123,363	€ 1,151,893	€ 2,596,393	€ 1,966,229	€ 1,807,881	€ 2,985,321
Other (4)						
Total funding	**€ 13,979,716**	**€ 14,722,657**	**€ 15,589,595**	**€ 14,511,818**	**€ 14,211,134**	**€ 16,773,563**
Expenditure						
Personnel costs	€ 10,333,177	€ 10,731,228	€ 11,749,775	€ 11,426,149	€ 11,029,389	€ 13,309,413
Material costs						
Other costs	€ 3,646,539	€ 3,991,429	€ 3,839,821	€ 3,085,669	€ 3,181,745	€ 3,464,150
Total expenditure	**€ 13,979,716**	**€ 14,722,657**	**€ 15,589,595**	**€ 14,511,818**	**€ 14,211,134**	**€ 16,773,563**

Energy and Sustainability Research Institute Groningen (ESRIG)

	Academic staff		Postdocs & Research staff		PhD candidates
	FTE	No. *)	FTE	No.	No.
2017	12.6	19	10.6	15	70
2018	11.2	18	9.1	12	74
2019	12.2	19	6.4	8	71
2020	16.9	20	9.8	11	71
2021	16.7	21	8.4	9	77
2022	15.9	20	6.6	7	79

*) Including honorary professors. Academic staff also have teaching duties.

	2017	2018	2019	2020	2021	2022	Total
Permanent staff	2,347,481	1,969,015	2,160,789	2,187,643	2,630,080	2,504,783	13,799,790
Running costs (OZI)	104,945	115,217	126,295	116,085	144,045	150,834	757,421
Individual Training Budget PhDs (ITB)	29,700	32,400	8,145	19,761	33,139	20,291	143,436
Total funding	**2,482,126**	**2,116,632**	**2,295,229**	**2,323,489**	**2,807,264**	**2,675,907**	**14,700,647**

	2017	2018	2019	2020	2021	2022	Total
GS1 (Sectorplan)			2,742,000				2,742,000
GS2 (NWO)	8,560	2,500,000	40,000	1,270,658			3,819,218
GS3 (EU)	2,157,816		408,110	261,094			2,827,020
GS3 (EU-ERC)	1,494,041					1,635,000	3,129,041
GS3 (Industry)					237,500	479,345	716,845
GS3 (Nat. Governm.)	1,308,939	59,319	330,720	144,726	504,961	1,912,640	4,261,305
GS3 (Non-profit)		77,822			162,474		240,296
GS3 Other)		77,443	27,831	75,000	979,000		1,159,274
Service-based activities	458,614	974,186	543,920	601,899	837,582	713,989	4,130,190
Total grants	**5,427,970**	**3,688,770**	**4,092,581**	**2,353,377**	**2,721,517**	**4,740,974**	**23,025,189**

GS1-3 stand for the three money streams. Note that the numbers present the total amount of a project, and are placed under the year in which the project was approved. Of course, the actual allocation of the grants spreads over several years after the grant approval.

Van Swinderen Institute for Particle Physics and Gravity (VSI)

	2017			2018			2019		
Scientific Staff (#/OZ fte)*	*# (a)*	*%F*	*OZ fte (b)*	*#*	*%F*	*OZ fte*	*#*	*%F*	*OZ fte*
Full professor	6	17%	1,7	6	17%	1,6	8	13%	1,9
Associate Professor	6	0%	3,1	5	0%	3,2	4	0%	2,9
Assistant Professor	1	100%	0,6	1	100%	0,6	2	50%	1,1
Postdocs	2	0%	0,5	3	0%	0,3	5	20%	3,2
PhD Candidates **	36	20%		43	23%		37	28%	
Total research staff	**51**		**-**	**58**		**-**	**56**		**-**
	# (a)		*fte (b)*	*#*		*fte*	*#*		*fte*
Support staff	7		6,4	7		6	6		6,2
Visiting fellows	9			9			12		

	2020			2021			2022		
Scientific Staff (#/OZ fte)*	*#*	*%F*	*OZ fte (b)*	*#*	*%F*	*OZ fte*	*#*	*%F*	*OZ fte*
Full professor	8	13%	2,4	7	14%	2,1	6	17%	1,5
Associate Professor	5	20%	1,6	6	33%	1,8	6	33%	2
Assistant Professor	4	50%	1,6	3	33%	2,1	4	25%	1,9
Postdocs	5	20%	4,6	6	17%	4,4	7	0%	4,5
PhD Candidates **	37	33%		34	36%		33	38%	
Total research staff	**59**		**-**	**56**		**-**	**56**		
	#		*fte*	*#*		*fte*	*#*		*fte*
Support staff	6		4,1	7		4,4	10		4,5
Visiting fellows	4			4			5		

Research Unit: VSI	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Funding						
Direct Funding (1)	€ 1.580.110	€ 1.743.884	€ 1.680.212	€ 1.765.879	€ 2.209.903	€ 1.929.819
	76%	83%	69%	68%	70%	66%
Research grants (2) FOM	€ 176.167	€ 121.256	€ 240.775	€ 116.337	€ 145.509	€ 756.137
	9%	6%	10%	4%	5%	26%
Research grants (2) other	€ 312.425	€ 235.870	€ 500.285	€ 560.145	€ 596.825	€ -119.235
	15%	11%	21%	22%	19%	-4%
Contract Research EU-ERC (3)				*€ 140.018*	*€ 148.020*	*€ 250.851*
				5%	5%	9%
Contract Research EU-other (3)				€ 20.477	€ 66.225	€ 93.822
				1%	2%	3%
Total Funding	**€ 2.068.703**	**€ 2.101.011**	**€ 2.421.274**	**€ 2.602.857**	**€ 3.166.483**	**€ 2.911.394**
	100%	**100%**	**100%**	**100%**	**100%**	**100%**
Expenditure						
Personnel costs	€ 1.679.822	€ 1.829.130	€ 1.920.286	€ 2.354.694	€ 2.802.121	€ 2.789.006
	81%	87%	79%	90%	88%	96%
Other costs	€ 388.880	€ 271.879	€ 500.987	€ 248.162	€ 364.361	€ 122.387
	19%	13%	21%	10%	12%	4%
Total expenditure	**€ 2.068.703**	**€ 2.101.011**	**€ 2.421.274**	**€ 2.602.856**	**€ 3.166.483**	**€ 2.911.394**
	100%	**100%**	**100%**	**100%**	**100%**	**100%**