LUT University

LUT RIA 2024

Assessment report

CONTENT

PREFACE

Pursuant to the national Universities Act, LUT University regularly evaluates its research through international peer reviews.

LUT's latest Research and Impact Assessment (RIA) was conducted in autumn 2024. A review panel of twelve international academic members assessed the university's performance over the past five years.

The assessment was carried out for all departments individually and for the university as a whole. The assessment was based on a written self-evaluation report, site visits at the Lappeenranta campus, and on-site interviews with LUT researchers.

According to the report, LUT has made remarkable progress since 2019, resulting in high positions in global university rankings. Risks and uncertainties have been mitigated successfully. The panel considers that to be an outcome of strategic thinking, inclusive leadership, and dynamic and lean management, resulting in a research environment where scientists thrive and deliver.

This publication contains the university-level report, which presents the university and its departments, as well as the assessment report compiled by the review panel.

The report was presented to LUT's board on 3 December 2024.

Jari Hämäläinen
Vice Rector for Research and Innovation
LUT University

UNIVERSITY-LEVEL REPORT

1. Background and objectives of RIA 2024 from 2019 to 2023

An external research assessment – the Research and Impact Assessment or RIA – was conducted at LUT in 2019. The assessment was a development-oriented evaluation of LUT's research in relation to the international level and practices of each field of science. The aim was to analyse the quality profile of our university by identifying our existing strengths and potential. Our first research assessment, the Research Assessment Exercise (RAE), took place in 2012 and focused only on research.

The most recent assessment, however, also brought our university's impact into focus. The RIA 2019 examined the entire university, and its evaluations leaned on self-assessments written by our schools (note that the schools were the Units of Assessment in 2019) including impact cases, bibliometric data, other indicators of the quality and impact of research, and interviews by an expert panel during a site visit. The RIA was a peer-review process conducted by an external, international, independent panel of high-level experts. The RIA 2019 was vital to our university, revealing the strengths, potential, and challenges in our research and impact on society. Its results and recommendations as well as the material collected during the process laid the foundation for our university's 2025 strategy.

Our university's strategy work, international and national profile building, and overall development to meet the challenges of tomorrow's high-quality science are the main drivers for the RIA 2024. We are starting preparations for the new 2030 strategy, and the RIA 2024 is planned to reveal LUT's state of the art in research and impact with respect to international standards. Instead of the schools, now we selected the departments as the Units of Assessment.

2. LUT University in brief

LUT University (Lappeenranta–Lahti University of Technology LUT) is a public science university in Finland. Clean energy, water and air are life-giving resources for which LUT University seeks new solutions with its expertise in technology, business and social sciences. LUT helps society and businesses in their sustainable renewal. LUT's international community consists of nearly 8,000 members, and its campuses are in Lappeenranta and Lahti. LUT also has regional units in Mikkeli and Kouvola and a representative in Brussels.

Originally, LUT was stablished as a technical university in 1969. It branched out to economics and business administration in 1991 and recently to social sciences in 2023. Finnish universities were government agencies until the new Universities Act made them independent legal entities in 2010. Professors, for example, are no longer public officials – their position is based on an employment contract.

LUT Universities is a university group consisting of the science university LUT and the LAB University of Applied Sciences. In essence, LUT owns LAB and chairs LAB's board, but LUT and LAB operate under different laws and have their own study programmes. However, they have joint university services and both operate on the Lappeenranta and Lahti campuses.

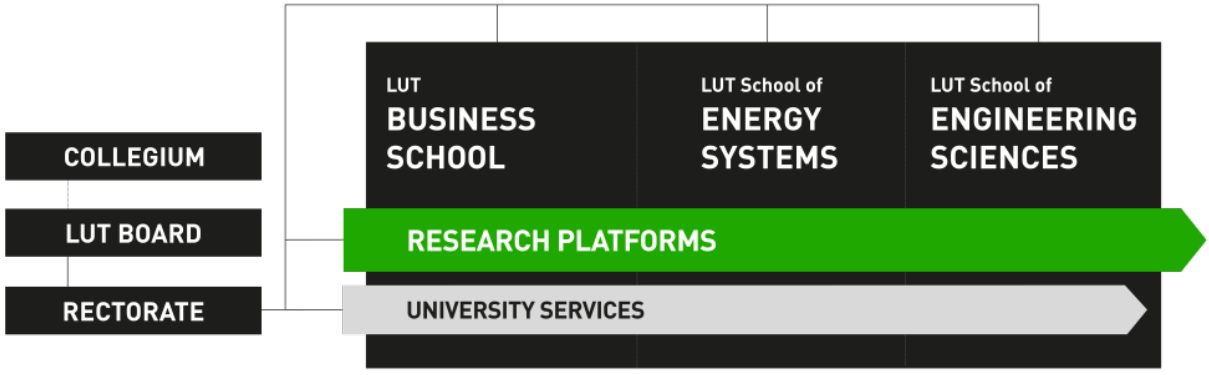


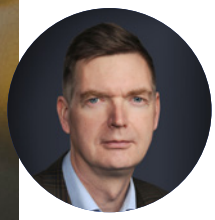
Figure 1. Organisation chart of LUT University.

As a public university, the supreme decision-making body of the university is the board, which is responsible for matters such as determining the university's operations, key financial objectives, and overall strategy and management principles. The board has nine members, five of whom are external to the university community and four of whom have been elected from different groupings within the university. The collegium decides on the number of members on the board and their terms of office and chooses the members. The current members have been elected for a four-year term from 2022 to 2025. The university also has an advisory board, which has a consulting role.

The four-year term also applies to the positions of rector, vice rectors, deans, and heads of departments. Their current term is 2023–2026, which means it is only partly aligned with that of the board. Rector *Juha-Matti Saksa* heads the activity of the university and is responsible for the effective fulfilment of the university's mission. In addition to the rector, there are three vice rectors: *Jaana Sandström* is responsible for education, *Jari Hämäläinen* for research and innovation, and *Truus Poels* for human resource development. Our university has a management committee, which meets once a month to discuss ongoing operational matters but is not an official decision-making body.

Our university has three schools: the LUT School of Energy Systems (LES), the LUT School of Engineering Sciences (LENS), and LUT Business School (LBS).

The LUT School of Energy Systems (LES), led by Dean *Olli Pyrhönen*, is divided into four departments: the Department of Energy Technology, the Department of Mechanical Engineering, the Department of Electrical Engineering, and the Department of Sustainability Science. The energy technology department specialises in technology and systems needed in the production, transfer, distribution, and use of energy. The mechanical engineering department is a hub of high-quality competence, experts, and research in the field of engineering and metal technology, catering to the needs of science, business and society. The electrical engineering department's education and research cover the conversion, use and transmission of electrical energy, the control of electric systems, and the electricity market. The sustainability science department represents an important multidisciplinary area of basic and applied research at the university ranging from natural sciences to social sciences and legislation related to technology and economics.



LES looks for solutions to mitigate climate change, promote wind and solar power, recycle nutrients and waste, provide continuous access to clean water and energy, and conduct business sustainably. Finding new energy-efficient solutions requires extensive research. The goal is a deep system-level understanding of the transition to a carbon-neutral energy system and its economic, environmental, technical and competitiveness factors. The school's research covers the technologies and systems required for the production, transmission, distribution, and use of energy, from equipment manufacturing and fuels to energy end-use. The school's strengths are its understanding of energy systems, the digital design and production of machines and equipment, and demanding welded metal structures.

The LUT School of Engineering Sciences (LENS), led by Dean *Mari Kallioinen-Mänttäri,* is divided into six departments: computational engineering, industrial engineering and management, physics, separation science, social sciences, and software engineering. Applied mathematics, computer vision and pattern recognition are the core areas of our university's computational engineering research. The Department of Industrial Engineering and Management is an integrative, solution-oriented unit that addresses organisations and their networks as technological, economic and social systems with the objective of enabling innovations and making businesses more efficient, economical and sustainable. The Department of Physics has strong expertise in material physics and optical measurement technologies. Its research primarily focuses on semiconductor and supraconductor physics and nanophysics. The Department of Separation Science conducts research on areas such as molecular interaction, unit operations, and process concepts. Research at the Department of Social Sciences is based on understanding society and human activities in relation to global sustainability problems and engaging people and communities more strongly at the very start of problem-solving.

The Department of Software Engineering is a major research organisation and educator in its field in Finland. It concentrates on supporting software development, digital transformation, and user-centred design.

LENS works for a sustainable future in a world where climate change and dwindling natural resources, access to clean water, the use of materials and environmental problems are significant challenges. The school provides international-level expertise in separation, purification and process technologies, green chemistry, machine vision and pattern recognition, industrial mathematics, different branches of physics, industrial engineering and management, and software engineering. The school's studies combine natural sciences and engineering with numerous practical applications. Studies are based on the needs of industry and address current global challenges by educating sustainability experts catering to different branches of business and industry. LUT's social scientists solve problems of the future and the sustainability crisis at the interface of people and technology.

LUT Business School (LBS), led by Dean *Sami Saarenketo*, educates problem-solvers of the future and promotes sustainable business. The school's education and research focus on sustainable business renewal. The school supports companies and the public sector by means of scientific research, producing knowledge and solutions and arranging academic forums for business development and societal decision-making. The school's strategic research area relates to the current sustainable business revolution: driving sustainable growth and creating value in a digital economy. The school's research aims for a better understanding of the factors that lead to sustainable value creation – that is, approaches that ensure that companies are successful in international competition while operating in a way that is economically, ecologically, and socially sustainable.

Our university's research platforms enhance multi-disciplinary research collaboration between our schools. We funded our first set of research platforms during our previous strategy period 2016–2020, and our second group of the platforms will be operating from 2021 to 2025. The platforms and the schools form a matrix organisation (Figure 1): researchers recruited to the platforms are also members of a school. In addition, the academic outputs of the platforms are attributed to the relevant schools.

3. Funding of higher education institutions in Finland

The Finnish higher education system consists of science universities and universities of applied sciences funded by the Ministry of Education and Culture (MEC). All Finnish higher education institutions are essentially public. Basic funding by the ministry to science universities was €1.999 billion in 2023. Funding is allocated based on a funding scheme that takes into consideration educational and research performance indicators (Figure 2), strategic development goals, and so-called national roles. For example, one of our university's national roles relates to nuclear engineering. The funding scheme implies a zero-sum game between the universities since the funding per indicator is fixed. The research-based indicators are doctorates (8%), scientific publications (14%), and research funding (12%). Values of publications have strong weighting between 0.1 and 4.0 based on the national Publication Forum ranking (so-called JUFO).

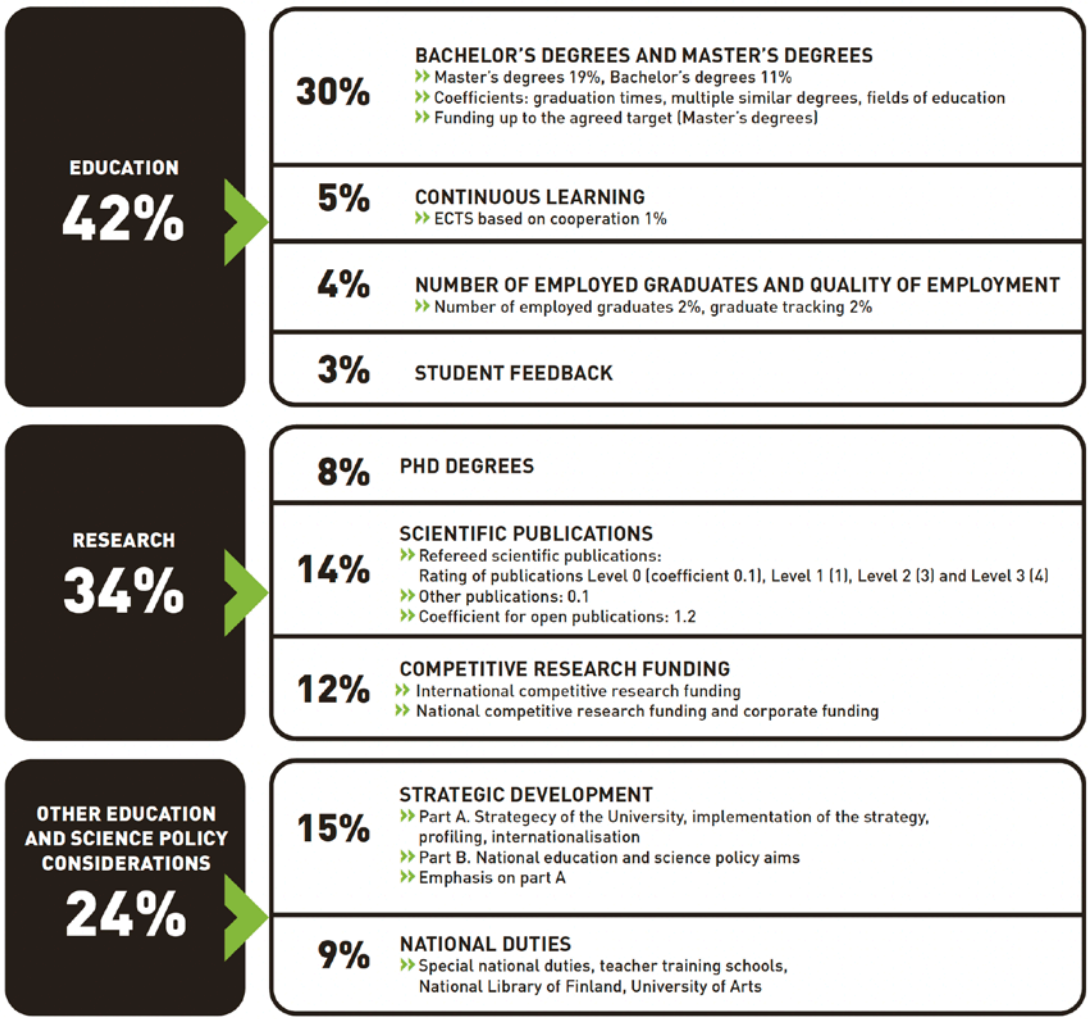


Figure 2. The core funding model of the Finnish science universities from 2021.

Table 1. Funding and expenses of LUT University in 2023:

FUNDING	€1000	%	EXPENSES	€1000	%
MEC	60,755	51	Staff expenses	77,826	66
Research Council of Finland	5,804	5	Depreciation	3,180	3
Business Finland	7,230	6	Rents	11,654	10
Companies	4,647	4	Other	25,250	21
European Commission	5,368	5			
Other domestic	28,616	24			
Other international	6,324	5			
TOTAL	**118,744**	**100**	**TOTAL**	**117,911**	**100**

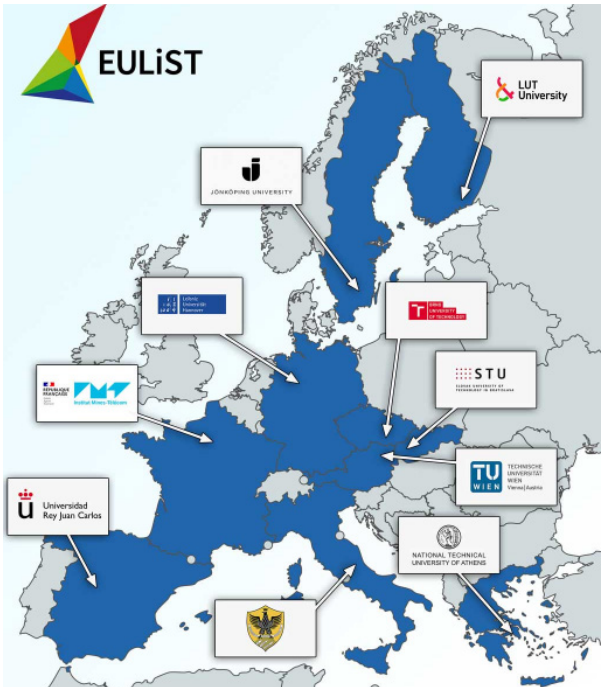
Basic funding from the MEC was almost €61 million (51%) in 2023, and all the other supplementary funding amounted to a total of €58 million (49%) (see Table 1). Other domestic funding includes foundations, cities, and services sold to LAB, for example. The largest costs are salaries with overheads (66%). Universities do not typically own their buildings but rent from the University Properties of Finland Ltd., and the rents are as high as 10% of annual costs. Other costs include, for example, travel, services, software licenses, laboratory materials, electricity, and cleaning.

Since 2015, the Finnish Government has moved €50 million annually from its core funding to so-called profiling funding (PROFI) granted by the Research Council of Finland to enhance universities' strategic development in scientific research. PROFI began with the "deselection" of research fields where a university was not nationally strong enough. Later, it has had a more collaborative nature, aiming to intensify strategic cooperation between Finnish universities and universities of applied sciences and research institutes and to distinguish the responsibilities between them. Compared to the core funding of €1.999 billion, €50 million does not sound huge, but it has been an effective incentive for Finnish universities in defining their research profiles.

The Research Council of Finland is the major national funding agency for scientific research in Finland. It has a range of funding instruments from person-related funding (academy research fellows and academy professors) to large research consortia and research infrastructures. Business Finland funds university research mainly in collaboration with companies. Our university has been relatively strong in research-to-business funding. Naturally, funding instruments of the European Commission are of the utmost importance to us, ranging from Marie Skłodowska-Curie doctoral networks and COST Actions to Horizon Europe research projects.

4. International partnerships

Naturally, our departments, research groups and individual schools have their own networks, and they have academic freedom to collaborate within their networks as reported in the self-assessment reports of the UoAs. In addition, our university has been developing institutional partnerships with both universities and enterprises.



We are a member of the EULiST (European Universities Linking Society and Technology) alliance. EULiST is one of the fifty universities involved in the European Universities Initiative (EUI). Typically, EUI alliances are teaching-oriented, but the funded EULIST project has a work package for research and innovations including, for instance, joint utilisation of research infrastructures and supporting early-career researchers from doctoral to postdoctoral researchers. The ten EULiST members are LUT, Jönköping University, Leibniz University Hannover, Brno University of Technology, Slovak University of Technology, Institut Mines-Télécom, TU Wien, Rey Juan Carlos University, University L'Aquila, and the National Technical University of Athens. EULiST is not only an EUI project, but the member universities have signed a strategic partnership agreement.

Our schools have their own priority partner universities, meaning that there might not be any official strategic partnership agreements, but the priority partner collaboration may include mutual research visits, joint supervision of doctoral students, double-degree programmes and joint European research projects.

5. LUT in the world university rankings

Our goal is to continually boost the quality, impact, and visibility of our research and the amount of our competitive research funding, and in that way, to solidify our position internationally. We are already among the best universities in the world. Our university's special strengths are our research, citations to our scientific publications, and our industry collaboration and the funding it yields.

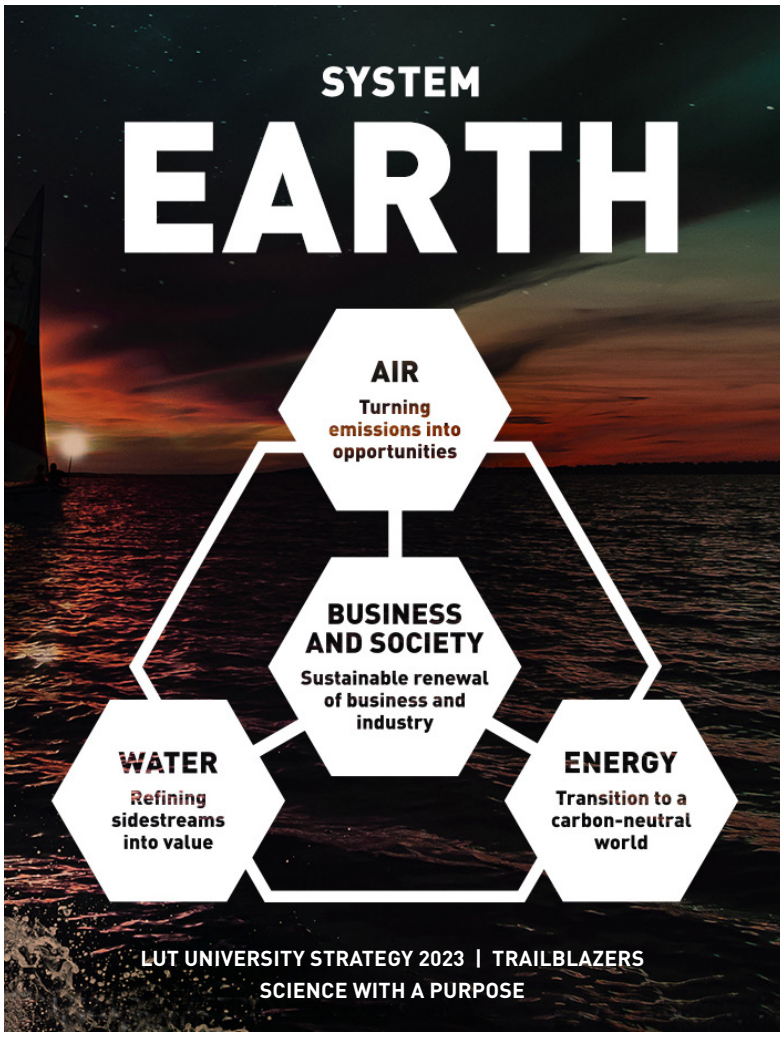
We constantly take part in university rankings to compare our university's research performance, education quality and international relations with those of other universities. The Times Higher Education (THE) World University Rankings are among the world's most highly regarded university ranking systems. The latest list included 1906 universities, and we reached the top 300. Nationally, we shared third position after the University of Helsinki and Aalto University. In the most recent QS rankings published in June 2023, our position was 351st among the 1503 universities listed.

We have also succeeded globally in the THE 2024 subject rankings: top 150 in business and economics (second in Finland after Aalto), top 200 in physical sciences (second in Finland after the University of Helsinki), top 300 in engineering (third in Finland), and top 400 in computer science (fifth in Finland).

The Sustainable Development Goals (SDGs) set by the United Nations are the basis for the THE Impact Rankings. Our highest rankings globally have been ninth in SDG 13 in 2022 and fifteenth in SDG 12 in 2023. LUT has been in the top 200 globally and the best university nationally several years in a row.

6. Strategic focus areas and the UN's Sustainable Development Goals

Our strategic choices, scientific research, academic education and social interaction are all guided by the principles of ecological, economic and social sustainability. Many of the UN's SDGs have strong connections to LUT's strategic research focus areas: **WATER** – Complex water adequacy and water treatment needs; **ENERGY** – Transition to carbon neutrality; **BUSINESS and SOCIETY** – Sustainable renewal of business, industry and society; **AIR** – From emissions to opportunities. Specifically, we are focusing on SDG 6 (Clean water and sanitation), SDG 7 (Affordable and clean energy), SDG 8 (Decent work and economic growth), SDG 9 (Industry, innovation and infrastructure), SDG 12 (Responsible consumption and production), SDG 13 (Climate action), and SDG 17 (Partnerships for the goals).



Our most recent Report on Sustainability and Climate Action Plan are available on our website. We are committed to becoming carbon neutral in the GHG Protocol scopes 1 and 2 by the end of 2024. We also continue to reduce our scope 3 emissions in line with our Climate Action Plan.

7. LUT strategies 2020 and 2025

We briefly introduce our strategies for both 2020 and 2025 because they overlap with the RIA reporting period 2019–2023 and their fruits are collected in the following period.

The board confirmed the **Trailblazer Strategy 2020** in 2014. Its core consisted of four key global questions which LUT sought to answer: *Are we going to burn up everything? Is humanity condemned to suffer from the water it has polluted? Will waste be the grave of our future? Will we let Europe degenerate to the world's backyard?* The answer was simply: **No**, we will not, we will influence the world in new ways and lead the way with a trailblazer spirit.

Our scientific solutions to the key questions led to following three strategic focus areas: CLEAN ENERGY (Energy markets and solar economy, Energy conversion and storage technologies, Sustainability science); CIRCULAR ECONOMY (Water purification and reuse, Processing of secondary and renewable raw materials, Products and life cycle assessment); SUSTAINABLE BUSINESS AND ENTREPRENEURSHIP (Innovation and sustainable value creation, SMEs and international entrepreneurship, Business analytics and decision-making, Digitalisation of businesses). All three areas were linked to our CROSS-CUTTING THEMES (Digitalisation and data science, Focus area research in the Russian context and with the best Russian partners).

Research-related key performance indicators included, for example, 50 doctorates and 400 scientific publications with a JUFO rating of 2 or 3 by the year 2020, supported by the action plan focusing mostly on a) establishing the cross-disciplinary research platforms, b) placing all new professorships on the tenure track, c) internationalising doctoral training, d) increasing competitive research funding, and d) adopting open access research practices.

We did not set the goal of 50 doctorates to increase the number of doctorates but to keep close to the goals set by the MEC. Our official goal was 42–45 doctorates. It meant that our focus was more on postdoctoral researchers recruited by, for example, the research platforms, not on increasing the number of doctoral students. Furthermore, we reached our goal of 400 high-level publications in 2019.

Our current strategy, [Trailblazers – Science with a Purpose], is a continuation and updated version of our previous one. We use the term "strategy 2030" on our web pages and in some documents, but the period 2021–2030 is actually divided into two strategy periods: 2021–2025 and 2026–2030.

The latter period's goals and activities will be updated based on our achievements in 2021–2025. The focus areas ENERGY and BUSINESS AND SOCIETY are continuations of the previous strategy. The former circular economy has found more concrete focuses in AIR and WATER.

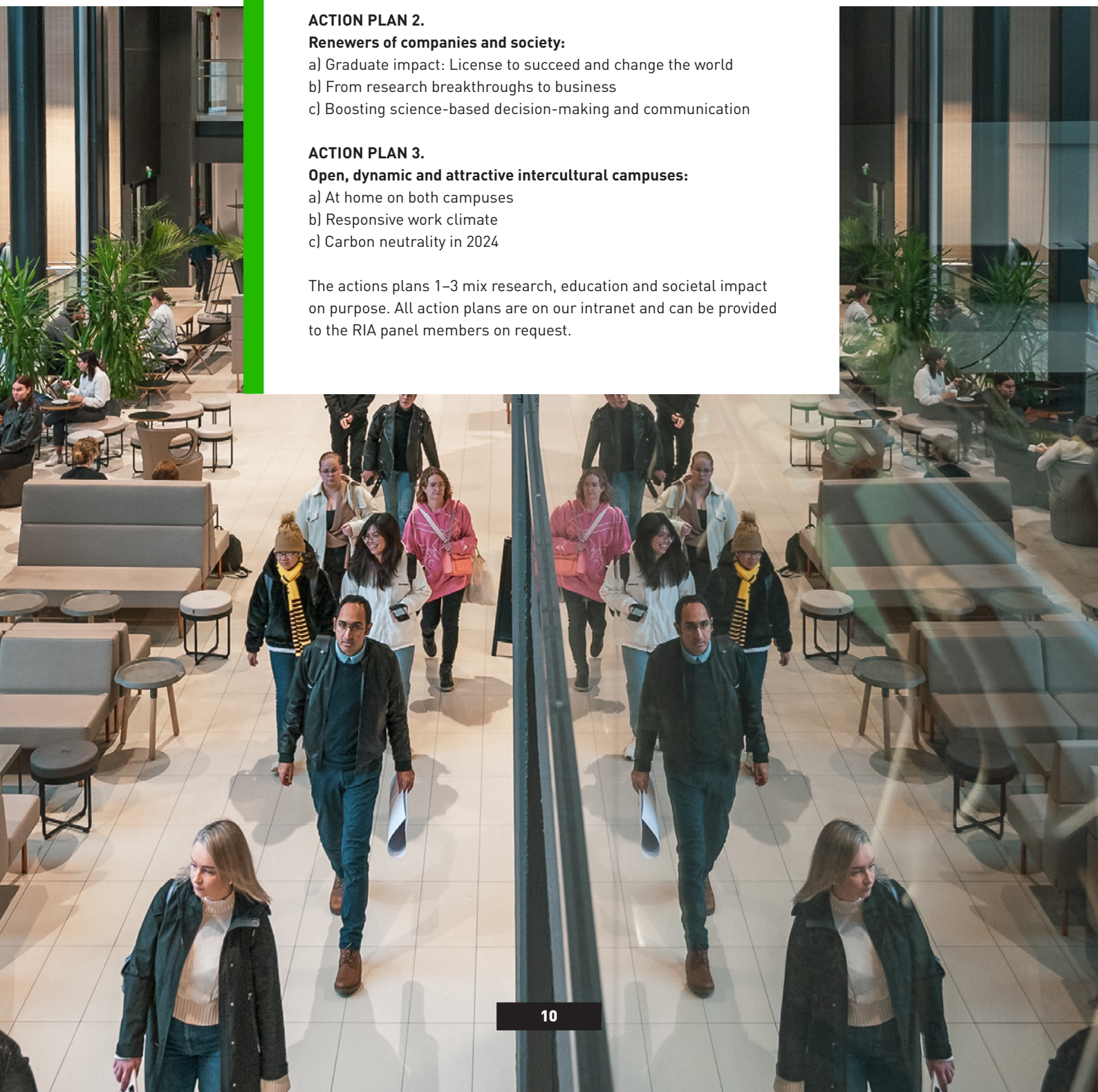
We carried out an interim review of the 2025 strategy in autumn 2022. As a result, we decided to strengthen our international reputation and internationalisation. The updated strategy includes the following actions plans:

ACTION PLAN 1.
Significant research player in Europe:
a) Promoting an international academic reputation (focus on Europe)
b) Excellence in research
c) Strategic partnerships in research and education
d) Disseminating open science practices

ACTION PLAN 2.
Renewers of companies and society:
a) Graduate impact: License to succeed and change the world
b) From research breakthroughs to business
c) Boosting science-based decision-making and communication

ACTION PLAN 3.
Open, dynamic and attractive intercultural campuses:
a) At home on both campuses
b) Responsive work climate
c) Carbon neutrality in 2024

The actions plans 1–3 mix research, education and societal impact on purpose. All action plans are on our intranet and can be provided to the RIA panel members on request.



8. University-level research support activities

8.1. Doctoral education

Most of our doctoral students are employed by the university as junior researchers with full-time contracts, which is typical at technical universities. A minority of them are working in industry, research institutes or other organisation, or have their own scholarship. All our doctoral students belong to the LUT Doctoral School (LUT DS), which coordinates doctoral education at LUT. The LUT DS is headed by the vice rector for research and innovation together with the DS steering group. The steering group consists of the heads of the doctoral programmes and of three doctoral students.

Doctoral programmes operating in schools are responsible for education and supervision. The study affairs team of the LUT DS advises all doctoral students and applicants on study administration matters from application to graduation.

We offer doctoral education in the following research fields:

- Energy technology, energy market and solar economy, electrical engineering, mechanical engineering, and sustainability science (Doctoral Programme in Energy Systems)
- Computational science, green chemical technology, industrial engineering and management, software engineering, technical physics, social sciences (Doctoral Programme in Engineering Science)
- Economics and business administration (Doctoral Programme in Business and Management)

A doctoral degree requires approximately four years of full-time studies. In addition to doctoral studies (min. 40 ECTS credits), a doctoral degree also includes writing a dissertation that the student defends in a public examination. There are no tuition fees for doctoral education.

Our university has dissertation regulations that apply to all of its schools. A university-level dissertation committee handles all dissertation manuscripts and decides on starting examination processes and appointing preliminary examiners according to the university's criteria. The quality assessment of doctoral education is part of our university's external quality system audit.

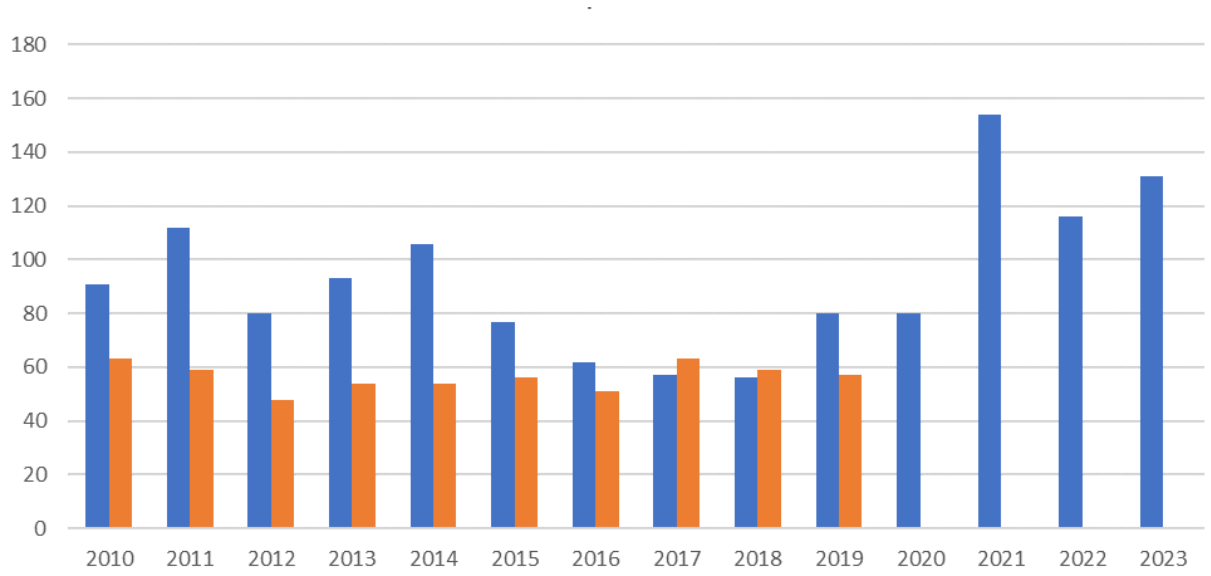


Figure 3. Doctoral student intake (blue bars) and doctoral graduates four years later (orange bars). This statistic does not follow individual students, but numbers per year.

The number of doctoral graduates per year was quite constant during the years 2014–2023 regardless of variations in the intake in 2010–2019. This reflects the goal of 42–45 doctorates set by the MEC. In addition, the doctoral student admission criteria were probably too low and many doctoral students never graduated. Only recently has the MEC raised the goal to 66 doctorates a year, which has clearly influenced our intake of doctoral candidates. The average intake was about 120 new doctoral students a year in 2020–2023, and we expect the number of doctoral graduates to approach 100 per year in 2024–2027.

The graduation rate has been high for those who started their studies in 2015–2019 and graduated four years later in 2019–2023 – that is, during the RIA 2024 reporting period – and that is why it is emphasised here.

It is noteworthy that the Finnish Government decided in 2023 to invest €255 million in doctoral education in 2024–2027, and the MEC expects universities to hire 1,000 additional doctoral researchers, who should graduate after three years of doctoral studies. We received funding for 44 researchers, which will influence our output in 2027 and 2028.

8.2 Tenure track

Researchers and teachers are employed either in tenure track positions or non-tenure track positions. Tenure-track positions aim to advance to the level of tenured professor based on achievements and qualifications. Job applicants can be appointed to the positions of assistant professor, associate professor, or full, tenured professor. Assistant and associate professor positions have a fixed term of four years, but full professors have tenure. Tenured professorships can be filled by invitation only in exceptional circumstances. Promotions from assistant to associate professor and further to full professor are based on general tenure criteria set by a supervisor and the school's dean and accepted by the university-level tenure-track committee. Advancement to full professor is always based on external expert evaluations. Associate professors who fail to obtain a tenured professorship can be offered a permanent non-tenure track associate professor position.

So far, 11 assistant or associate professors have been promoted on the tenure track to full professors. The tables below show the gender balance and origin of all the recruited tenure-track professors since the introduction of the tenure track at LUT.

Table 2. Gender of the appointed persons

TENURE TRACK	2016	2017	2018	2019	2020	2021	2022	2023	TOTAL
FULL									
male		3	3		2	2	2	2	14
female	1	2	2	1	2	2	1	2	13
ASSOCIATE									
male	1	2	4	3	5	5	3	3	26
female		3				2	2	2	9
ASSISTANT									
male		1	5	1	4	2	3	3	19
female			1		2	1	1		5
TOTAL	2	11	15	5	15	14	12	12	86

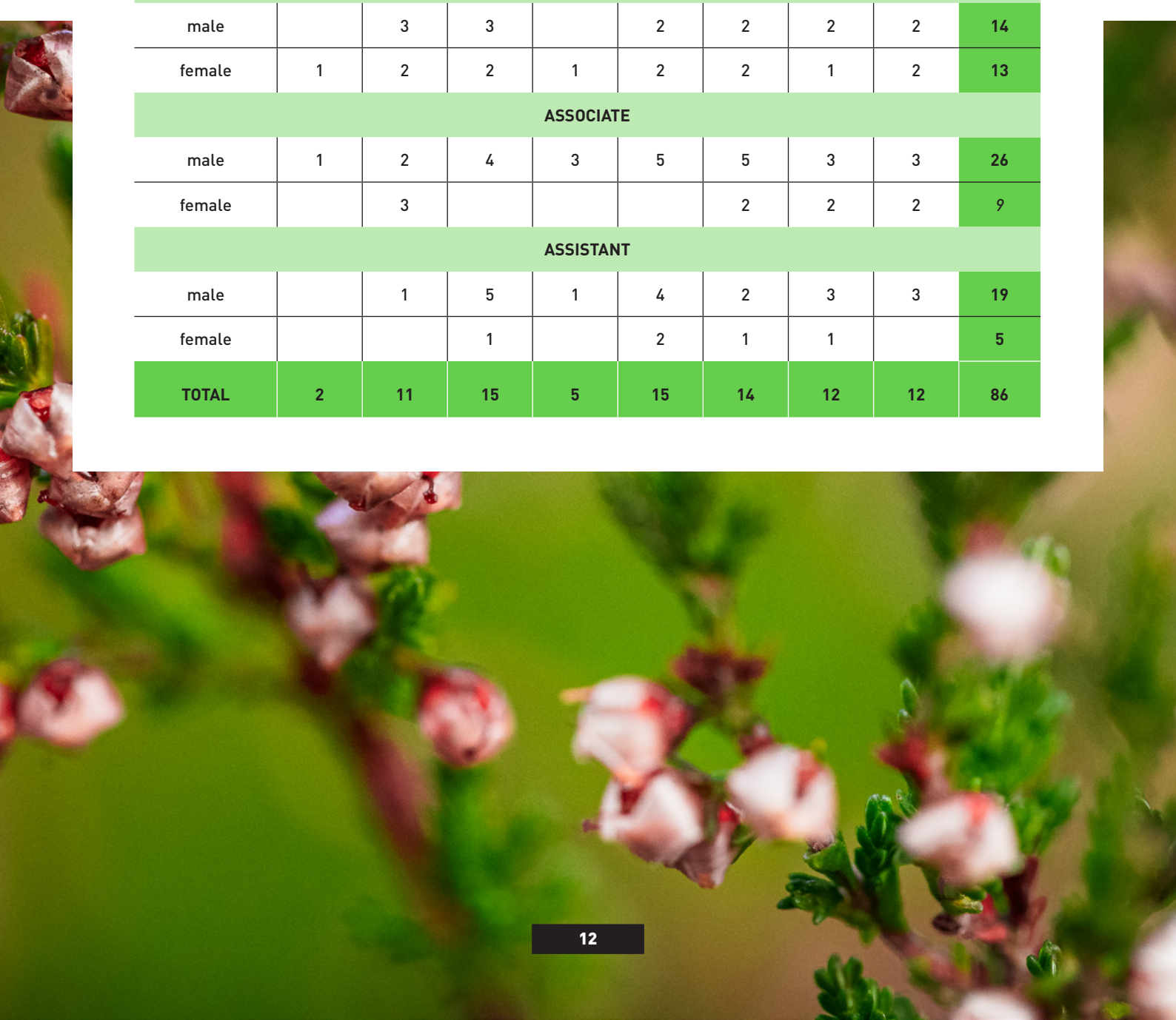


Table 3. Origin of the appointed persons

TENURE TRACK	2016	2017	2018	2019	2020	2021	2022	2023	
FULL									
LUT	1	4	5		3	1	2	1	17
Finland				1		2		2	5
Other country		1			1	1	1	1	5
ASSOCIATE									
LUT	1	3	3	1	4	5	4	2	23
Finland		1	1	2				3	7
Other country		1			1	2	1		5
ASSISTANT									
LUT		1	2		2		2	2	9
Finland			1	1	2	1	2		7
Other country			3		2	2		1	8
TOTAL	2	11	15	5	15	14	12	12	

The schools can recruit researchers and teachers for fixed-term non-tenure track positions independently. Junior researchers (i.e., salary-based doctoral students), assistants, post-doctoral researchers and university lecturers are typically non-tenure track positions. The tenure-track committee intervenes only when fixed-term contracts are made permanent.

The Equality and Non-Discrimination Plan helps to keep LUT Universities on a path where all members of the community are treated with respect. Our community does not accept inappropriate treatment, discrimination or harassment. Equal treatment is actualised in interactive situations and in personnel management, recruitment, working conditions, salaries, and career development. The plan aims to engage all employees of LUT Universities in the promotion of equality and non-discrimination.

HR EXCELLENCE IN RESEARCH

Our university offers a sustainable and attractive working environment for researchers. We strive to improve it further through the European Commission initiative HRS4R: we received the Commission's HR Excellence in Research award in 2013 and last passed the renewal assessment in 2023. We continue to pursue the renewal of the HR Excellence in Research award and apply the regulated HRS4R process for continuous improvement.

8.3 Research ethics and responsible conduct of research

We offer training in research integrity for both students and supervisors. The principles of the responsible conduct of research and of dealing with conflicts of interest must be followed at all stages of the doctoral dissertation process. In handling alleged violations of the responsible conduct of research, we observe the guidelines prepared by the Finnish Advisory Board on Research Integrity (RCR guidelines: Responsible conduct of research and procedures for handling allegations of misconduct in Finland). Our university has appointed a research integrity advisor, who may also be asked to conduct ethical reviews or provide statements.

8.4 Open science and research

Our university has signed and thus committed to the national Declaration for Open Science and Research (Finland) 2020–2025 and complies with the Horizon 2020 Guidelines for open access to publication, data, and other research outputs. Following LUT recommendations, all research articles and publications are parallel-published (self-archived) in the LUTPub repository following the publishers' requirements for, e.g., licences, embargo periods or manuscript versions. LUT pays researchers an internal publication bonus as an incentive for open access publishing. As a rule, research data produced at LUT is always open and available for shared use unless there are justified reasons for restricting access to the data in question. LUT provides support for press releases and other ways of popularising published research.

8.5 Funding for research environments – research platforms and experimental laboratories

One of our main forms of support for research is funding for our multidisciplinary research platforms, which enhance research collaboration between the schools and human capacity building at LUT. The funding amounted to €2.7 million a year for the six platforms in 2016–2020, and it is currently €2.0 million a year for our five platforms for 2021–2025. We evaluated the previous research platforms in 2022 and prepared a final report on them in 2023. To summarise their scientific impact, the research platforms produced more than 20% of LUT's publications with JUFO 1, 2 and 3 ratings, and they raised a total of €15.3 million in supplementary external funding.

The other major investments are the physical laboratories, as we are a technical university. We grant investment funding based on applications. Investment proposals are submitted once a year. The application process and schedule are published on our intranet. Deans and directors prioritise their unit's applications and inform the chief financial officer of the order of priority. Based on prioritised proposals by deans and directors, the management committee decides on the overall level of investments. The board makes final approvals on investment projects. The typical level of our internal laboratory investments is about €3 million. In some cases, we get external funding from, for instance, the European Regional Development Fund.

Joint research laboratories:

Our university has several research laboratories in the School of Energy Systems and the School of Engineering Sciences. In addition, LUT Business School manages the J. Hyneman Center. Laboratories are offered for industrial collaboration and introduced on our website under the title "Industrial product development". There is also a more detailed site on our research infrastructures: https://infra.lut.fi/

8.6 Research services

The Research Services unit under University Services plays a crucial role in assisting researchers in applying for research and development funding. From initial planning to funding decisions, Research Services provides targeted support to its primary customer group: researchers. The services are continually refined based on feedback and aligned with our university's objectives. Researchers benefit from the expertise of three specialised teams: the Excellent Science, EU, and National Funding teams. Research Services offers:

1. **Information and communication on applications and deadlines:**
   - Research Services provides comprehensive information about funding opportunities, application deadlines, and the Funding mail service.
   - Research Services' intranet maintains the Funding Calls calendar, ensuring researchers stay informed.
   - Targeted communications are sent to potential applicants.

2. **Support for funding applications:**
   - Research Services guides researchers in securing funding from diverse sources.
   - Assistance includes preparing funding applications, understanding partnering requirements, and building consortia.

3. **Cooperation agreements and partner identification:**
   - Research Services assists in drafting research project agreements and collaborates with legal services during contract negotiations.
   - Research Services identifies suitable partners, considering factors like sanctions regulations.

4. **Contract research and service sales support:**
   - Research Services actively engages in business cooperation, managing the preparation of offers and contracts for contract research and service sales.

5. **Ethics and research integrity guidance:**
   - Research Services provides advice and training on good scientific practices and research ethics.
   - Services include the management of research permits and the preparation of ethical reviews.

6. **EU representation in Brussels:**
   - Member of the Research Services team Dr Anne Vuorema is LUT's Brussels representative.
   - During theme weeks and other significant events, she represents our university's interests in Brussels.
   - The Brussels representative alone or together with other institutes organises events and meetings to promote LUT views, research and researchers.

7. **Training:**
   - Research Services offers a **Grant Writing as a Skill** training programme and provides an **Ethics and Research Integrity** course.
   - The grant writing course covers both individual

funding applications for researchers and collaborative consortium funding.
- Additionally, Research Services provides specialised training related to specific calls, such as those by the Research Council of Finland and Marie Skłodowska Curie Actions. Research Services also provides instruction in the annual Grant Writing for Supervisors course.

Other Support Services for Researchers:
Project Services: The Project Services team under the University Services' Finance Service provides support for projects that are underway.

Procurement Services: The Procurement Services team helps with procurement for research projects.

Management Services: Management Services offers support in fostering strategic partnerships, facilitating networking opportunities, and addressing international matters.

Library Services: For matters related to open science, researchers can turn to Library Services.

Commercialisation Services: The Green Campus Open team specialises in commercialisation services.

Research Communication: The Communications and Marketing team is in charge of the brand, communications, and marketing at LUT.

8.7 IPR policy and commercialisation

We encourage our researchers and staff to make inventions and commercialise them. From the university's point of view, turning research results into new business through protected IPR is part of the university's societal impact. The processing, assessment, and protection of inventions by patenting is led by the vice rector for research and innovations.

Operational activities are the responsibility of the IP and innovation specialist of Green Campus Open (LUT's innovation services unit), which also coordinates the operational management of the patent portfolio and transfer of rights. Green Campus Open reports directly to the rector. It coordinates the university's research commercialisation and boosts innovation by means such as the LUT Storming programme, developing young researchers' innovation capabilities, and Research to Business funding allocated to universities by Business Finland. The terms of transfers of rights to startup companies or existing companies are based on university guidelines and decided by our IPR Management Team, which consists of the vice rector for research and innovations, the strategy director, and the director of governance and risk management. The principles related to business operations are available to researchers and staff on the our intranet.

To strengthen researchers' commercialisation capabilities, Green Campus Open together with the vice rector for research and innovations launched a new course, Introduction to LUT Innovation Processes, for postgraduate students in spring 2022. The course is held annually and includes an introduction to the university's innovation system, commercialisation, and pitching business ideas.

For patenting decisions, our university assesses the novelty value of the invention, its differentiation from the previous state of the art, and its alignment with our strategy and values.

When we have determined the invention's commercial potential and path to commercialisation and the funding and other resources required for further processing exist, we will still assess whether the patenting project is worth continuing at various checkpoints.

In connection with each interim decision issued by the Patent Office, we will assess the possibility of obtaining a patent and, on the other hand, the strength of the scope of protection remaining after the limitations of possible claims. Before a priority year, we will evaluate the need for international protection. If the utilization is not progressed, then university may decide not to continue to the international phase. In connection with the annual fee payment for a patent application or a patent, we always assess the situation and prospects for utilising the invention. The invention can be exploited through a licensing agreement, or the patent may be part of the background material of a research or business cooperation project that promotes the commercialisation of the invention. If the invention does not have a utilisation path, we may decide to stop maintaining the patent. The aim is to avoid passive patents in our patent portfolio. According to the annual planning cycle, our IPR Management Team monitors patenting and commercialisation activities regularly four times a year regarding finances, the content of the patent portfolio, strategy implementation and reporting to the university's management and board.

To commercialise an invention, inventors and the LUT unit they work for often apply for Business Finland's Research to Business funding. The aim is to create a new research-based startup company to commercialise the research result that is the subject of the invention or to transfer the invention by licensing or selling the patent to an existing company as part of the new business. More information about our Research to Business projects and the companies created on the basis of them is available on our website. When applying for Research to Business funding, patents owned by the university play an important role, because one of the core funding criteria is that the university must own the IPR of the background material for the project. In 2019–2023, 22 of our projects received €7.6 million in funding from Business Finland for the commercialisation

of research results. During the review period, eight new research-based companies emerged as a result of Research to Business projects.

Green Campus Open launches a call for new ideas for Research to Business funding twice a year. Green Campus Open's innovation experts spar research teams seeking funding by helping them clarify and pitch their business ideas. A mentor group consisting of external business experts participates in the process. At the end of the process, the teams pitch their business ideas to Business Finland's funders, who give feedback on the suitability of the idea for funding.

In 2022, we began marketing our patents and Research to Business projects on the international technology marketing platform Inpart. The global marketplace includes the most significant international R&D companies from several industrial sectors and more than 2,600 universities conducting top research. The benefits of the platform include targeted technology offers to companies through identified contacts and feedback from these companies' experts on the suitability of the inventions or research projects for them. In this way, Inpart can also be used as a feedback channel for market research purposes.

8.8 Science communication relies on content strategy: LUT communicates about science that matters

LUT's Communications and Marketing team is in charge of the university's brand, communications, and marketing. The goal of communications is to build and strengthen the university's reputation, increase external target groups' awareness of the university's expertise, and influence how the university's brand is perceived. The university communicates especially about research that is linked to the university's strategy and is found newsworthy by communications experts.

One of the key objectives of our communications is to increase the university's attractiveness to potential students and the scientific community. Another goal is to enhance our university's visibility to and impact on companies, the media, and decision-makers on topics related to our strategy. The third goal is to influence how our university's brand is perceived.

Our Communications applies a content strategy to steer external communications. The content strategy was developed in collaboration with our university administration during our website redesign in 2022. The content strategy ensures that communications focus on our strategy and support it.

Our science communication adheres to the key message of the content strategy, which serves as a foundation for all external communication: "We communicate about science that matters: Clean energy, water and air are life-giving resources for which we seek new solutions with our expertise in technology, business and social sciences. We help society and businesses in their sustainable renewal. We face the world with curiosity and boldly communicate our successes."

In our content strategy, researchers and members of the scientific community are identified as one of the key target groups for our science communication. Researchers interviewed during the content strategy work expressed their particular interest in university rankings and well-made popularised science content, which was also found important by other target groups. This is one of the reasons why the role of research is emphasised throughout communications.

One of our communications' key target groups and vehicles is the media. We inform and interact with journalists, so they can disseminate our university's expertise through their work. We use digital tools for media distribution and monitoring, covering also international media outlets.

Currently, our media communication emphasises national and regional media. Regional visibility also enhances our university's impact locally. The next major step is to reach out more to international media and further establish the university in the European scope. To achieve this goal, we have started to create an international communication plan and content strategy. Almost all our science communication is published in both Finnish and English in all channels, including our intranet. Social media plays an especially significant role in reaching our international target groups.

Our communications team increasingly analyses data from websites, social media, media monitoring, and newsletter analytics to steer its work. However, the primary driver is to highlight research that has the most powerful impact on the big picture.

LUT RIA 2024 ASSESSMENT REPORT

Background

LUT University evaluates its research through international peer reviews at regular intervals based on the national Universities Act. LUT University's previous Research and Impact Assessment (RIA) was conducted in 2019, and a new review panel of 11 international academic members assessed the university's performance during the last five years (2019–2023). The Assessment Panel was requested to assess and give numeric and written feedback on the following aspects:

1. A written statement on the research profile and how the activities relate to the LUT strategy
2. To rate numerically, from an international perspective, the quality, academic impact, societal impact, research environment and potential of the research and of the Units of Assessment
3. The scientific quality and the extent and impact of multidisciplinary collaboration of the research
4. Academic impact (impact of the research on the research community)
5. Societal impact and entrepreneurial and innovative capacity
6. Strengths and weaknesses of the research environment
7. Future potential
8. Recommendations for the future

The assessment was requested for all departments, henceforth called Units of Assessment (UoAs), and for the university as a whole. The assessment was based on a written self-evaluation report, site visits at the Lappeenranta campus and on-site interviews with LUT researchers (2–6 Sept. 2024).

Assessment and recommendations for LUT University as a whole

The university has made remarkable progress since 2019, making LUT not only one of the best universities in Finland but also landing it high positions in global rankings (where it often outperforms much better established, larger and better financed universities). Moreover, it has so far also managed to mitigate risks and uncertainties (a pandemic, an economic recession, the Russian invasion of Ukraine and the rapidly changing geopolitical situation). We recognize that it has been the result of strategic thinking, inclusive leadership, and dynamic and lean management. This has resulted in a research environment where researchers thrive and deliver.

The next ambitious goal for LUT could be to become internationally excellent, and we think it is achievable if strategic decisions are right and well implemented at all levels of management in a well-coordinated manner.

In university leadership and management, LUT has also been a forerunner: a good example of innovative thinking and risk-taking is focusing on research impact instead of (mostly) focusing on standard academic bibliometric results (publications, citations). LUT's strong focus on impact is well understood and well perceived among its researchers. The incentives system created by the management is truly functioning (e.g., creates strong motivation to publish in JUFO 2 and JUFO 3 journals). However, we observed that researchers sometimes struggle to define what impact is: they have difficulties differentiating between the results, impact and expected impact of their research or between research results and academic impact. The definition of impact can be discussed among the academic staff and explained better. Also, when appropriate, impact can be measured quantitatively (e.g., how many people have been reached or how much revenue was produced). To achieve its ambitions and increase impact, LUT might want to strengthen its communication services, focusing more on international visibility.

We also want to emphasize that technical inventions can take a long time to make an impact (from a laboratory prototype to a patent to a product to a change in peoples' lives or economy). The name LUT reflects a university "of technology". It is important that the focus on fast impact and applied science do not result in a gradual weakening of the technological focus of the university. The panel found that the most impactful cases were from creating and applying new technologies.

The university is a very good example of a collaborative and supportive environment where the managers largely have succeeded to avoid silos, mutual competition and isolation. All faculty members interviewed by us confirmed

feeling supported, welcomed and encouraged. The research platforms greatly help integrate different teams across schools and disciplines. However, younger members of the academic family sometimes mentioned that they can feel isolated.

The research topics at the university are well aligned with the aims of a university of technology; strong strategic management seems to be behind guiding the research towards the focus areas and the Trailblazer strategy. Social sciences are remarkably well embedded into the university structure and collaborate with technical teams. However, too many research problems are approached from the perspective of social sciences rather than through technical research, and those social studies do not necessarily all meet the international quality standards. For a university of technology, we would expect more focus on technology.

LUT has good industrial collaboration locally and nationally. It is significant that it has avoided the trade-off between high-quality research and applied research for industry, being able to excel by both measures. The number of startups created by university staff and alumni is outstanding. The university could explore the ambition to create more international industrial collaboration.

The university career model and tenure track system are largely appropriate, and with small variations, they are similar to the career models of other universities where the top academic jobs are also highly competitive. It was interesting to see that people leaving the tenure track do not necessarily have to leave the university: they still have academic career options, and this could contribute to creating a less stressful environment. However, for tenure track professors, the requirements for promotion were not always clear (does a person who moves to LUT from another country still have to get more international experience, are all the requirements in the career model mandatory or are some optional, etc.). This should be clarified for new employees to allay their fears and allow them to better focus on their targets.

The general impression was that the teaching load of the academic staff is not too high (although there might be exceptions we did not notice). Still, the university would benefit from a better formalized workload model (even if it is only used as a guideline or a best practice). As it is common in all universities, management, administrative and leadership roles often come at the expense of research achievement. LUT is encouraged to experiment with creating incentives for academic staff who fill administrative positions. It would also help to better define the expectations for mid-level managers.

The university has very ambitious growth targets, so the concern is that the growth should not come at the expense of quality. There is a risk that fast growth leads to many new activities that remain subcritical, unsustainable and of moderate quality because of a lack of critical mass. Maintaining the strong university spirit and tight connections across departments and schools could also be a concern in a sharply growing university. This concern of too rapid growth is general, it applies to the growing number of bachelor's, master's, and doctoral students, new tenures and new research areas (e.g., civil engineering, social sciences). The roles and exact responsibilities of the strategy director and chief growth officer within LUT were not entirely clear, and thus, we were unable to determine if these posts were adding value to the organization. LUT might also want to reconsider whether its current administrative structure (schools, departments, support services) is optimal, in accordance with the principle of lean management and whether it adequately supports the university's ambitions to grow and to stay connected at the same time. In addition, LUT may want to consider a more diverse Advisory Board with a large variety of stakeholders (e.g., including leading scientists who can help to define research topics of the future).

LUT Doctoral School

Doctoral programmes in general appear to function well and in line with international standards. Most doctoral students have work contracts (1+3 years), they belong to research teams and are part of one of the three doctoral programmes. The students need to take courses that amount to a total of 30–40 ETCS credits, which can be freely chosen from LUT or other universities from Finland or abroad.

We got the impression that the heads of the doctoral programmes manage too small details; for example, confirming what courses individual students take could, instead, be left to be decided by the student and the supervisor. Alternatively, some well taught, broad courses could be set as a requirement for all students (e.g., philosophy of science, scientific methods, academic writing). It is important for the heads of doctoral programmes to guarantee the quality of the supervision, monitoring the progress of the students and quality of the newly admitted students. We recommend analysing where and how the doctoral programmes are exactly adding value to doctoral studies.

The doctoral study administration can be better coordinated and simplified; for example, now, the approval of a doctoral thesis can take half a year. It is advised to define a maximum time from submission to defense (e.g., max. 3 months) and change the process management to reach that target. The risk of a student submitting a low-quality thesis can be mitigated and study time further shortened if the progress of the student is monitored regularly during the studies (e.g., thorough and informative yearly assessments or external mid-term reviews). The admission of new students could also be better organized

and streamlined (e.g., by aligning processes in Human Resources, Study Affairs and the Doctoral School and creating electronic submission systems).

Generally, doctoral students were satisfied with the supervision and working environment. Students from abroad were supported in moving to Finland and adjusting smoothly to the local environment. However, the job satisfaction of doctoral students seems to be lower than among the senior academic staff (based on the selection of students interviewed by the RIA panel). There were indications of lack of supervision and lack of support (intellectual, legal and emotional). The variations seemed to be largely attributed to the local culture in research teams and departments. Especially students who self-finance their studies, industrial doctoral students and international students coming from very different cultural backgrounds seem to be the most vulnerable. The university should make sure that no student "falls between the gaps". Mostly, it is the responsibility of supervisors, department heads and heads of doctoral programmes.

The recently established doctoral student association of LUT (a bottom-up initiative supported by university management) is a very welcome development, and, if carefully supported and nurtured, it can significantly contribute to doctoral students' well-being and job satisfaction. It can also boost the quality of doctoral studies, because the students get a forum where to exchange ideas and solve problems, supported by their peers. In addition, the university could consider appointing a person of trust who is independent and placed outside of the management hierarchy (student ombudsman).

Support Services

The research support services have been mostly perceived as supportive and competent by those using the services. Intranet pages have good guidelines for academic staff about upcoming calls along with contact people for the specific financing instruments. However, this does not necessarily help a completely unexperienced person starting an independent career in academia. There is also no detailed written information about what support could be expected from the research services (e.g., does it help with budgeting or also defining the social impact of a proposal). Clearly defined service standards would help to better manage workloads in the unit and researchers' expectations.

Post-award grant management support (e.g., budget reports, procurements, hiring, deliverables reporting, timesheets) is largely missing in the entire university. We heard numerous times that those tasks are the responsibility of younger academic staff (mostly post-doctoral researchers). This practice is not helping younger academics in their career and is not the best way of using the time of highly educated expert researchers. Moreover, it introduces risks that may be expensive to correct (e.g., mistakes in public procurements or hires made because of a lack of experience and knowledge of Finnish laws). In the long term, it would be more profitable to build up a system of either central or school/department level project management support, where the experience and knowledge accumulates and can be reused.

Currently, there are no tracking systems or statistics on project proposals. The university has no overview of who applies for funding, how often, and how successfully. Therefore, there is also no knowledge of how large the differences between individual units and individual professors/teams are when it comes to applying for competitive funding. Therefore, it is difficult for the university to take corrective actions by either creating incentives for those not applying or rewarding those who do.

LUT is successful in applying for research funding. The project portfolio, however, reveals a large share of small short-term projects. Focusing more on large long-term projects (e.g., Research Council of Finland, EU) would help to increase research quality and reduce project management overload.

The success rate of grant writing can be improved by creating a culture of sharing successful (funded) proposals and proposal writing workshops for academics from all walks of academic life and for various instruments.

The research support services could also measure the quality of their services (customer satisfaction) after every interaction with academic staff (not only once a year). The number of staff members (ca. 20 people) seems to be quite high even if they also serve the LAB University of Applied Sciences, especially taking into account that they are not providing post-award support. Analysing and streamlining processes and workloads could lead to better service without additional resources.

There seemed to be some unaligned processes, broken information flows and lack of communication between various support units (e.g., HR, Research Services, Academic Affairs). Analysing their responsibilities and streamlining processes can save resources and promote the work satisfaction of both academic and support staff.

Communication services do an excellent job with respect to marketing and branding (pamphlets, layouts, slogans, photography, central banner with SDGs). It could be strengthened to create more visibility for LUT in media in Finland and internationally, to support LUT's goal to become a leading university on a world scale.

Industry relations are handled centrally and through the innovation specialist of the university. Direct industry relations between researchers and companies are common, but an innovation officer can facilitate cooperation centrally. It is unclear how to measure the

success and extent of this effort. There is probably room to improve the processes and incentives for filing patents and supporting patent writing (either by third parties or internal staff). LUT may want to stimulate creating spin-offs and filing patents by introducing related KPIs and support measures.LUT could consider differentiating between types of third party funded research, such as applied research (where LUT retains the IPR), consulting research (where the IPR transfers to the partner), and basic research (LUT retains the IPR).

Research platforms

Cooperation on research platforms helps LUT to improve its research quality and achieve its strategic goals. They are a great tool for stimulating interdisciplinary research. Their impact is visible and measurable first and foremost through external funding secured by the platforms. It is strongly recommended that the platforms be continued.

More frequent calls (e.g., every two or three years) while keeping the same number of funded platforms but staggering the start and end dates could be considered. More attention could be paid to actual collaboration between research teams (e.g., monitoring and awarding joint publications). Midterm targets could be useful for evaluation. It was great to find out how the existence of the platforms was helpful to young professors in getting started/integrated.

It is suggested that the leadership explore having an "Emerging Technologies" platform allowing the faculty to propose new directions that are not necessarily tied to the existing research directions. This would enable some level of coverage of new areas that are not yet part of LUT's strategy and vision but could become very critical in the near future. Also, some external agency, such as industry, can help define the platforms.

General Recommendations for LUT University

- Keep up the ambition to be an excellent research university with high impact and a spirit of collaboration.
- Manage growth carefully, without compromising quality and impact.
- Strengthen technology research in well-targeted promising areas supported by good social science research.
- Keep management lean but reduce the administrative load of researchers by hiring competent dedicated administrative staff for well-defined purposes.
- Better define and communicate the LUT career model among tenure track researchers.
- Take care that all doctoral students get high-quality supervision and are part of research teams and the academic family.
- Increase the job satisfaction of early-career researchers (doctoral students and post-doctoral researchers).
- Streamline client-centred support services while also taking care of the job satisfaction of administrative personnel.
- Create professional project management services.
- Continue investing in platforms.
- Increase the international visibility of LUT as a leading and innovative university of technology.

ASSESSMENT OF THE UNITS

UoA1 | DEPARTMENT OF ELECTRICAL ENGINEERING

Research profile

Unlike a typically broad electrical engineering department, LUT has focused on a select set of topics aligned with the university's strategic mission areas. As such, the electrical engineering department focuses on three core areas: Renewable Power-to-X Economy, Smart Grids and Electricity Markets, and Electric Power Conversion. When new areas and opportunities arise, the department addresses them through partnerships. One example of this is semiconductor chips and corrosion reliability.

The department is well organized and positioned to excel in these research areas through research groups and laboratories. The panel noted the impactful work of several faculty members, including Professor Christian Breyer, leader in energy system modelling, with 259 Power-to-X (PtX) publications and over 14,000 citations, Professor Jero Ahola, with significant work in energy efficiency and electrochemical energy storage, and Professor Behnam Mohammadi-Ivatloo, with expertise in electricity markets and grid integration. The department consistently publishes around 110–150 papers annually, with a focus on JUFO 2 and JUFO 3 journals.

The department aims to increase its external research funding steadily from €6 million to €9 million by 2028. However, the panel felt that this would be a challenge, given the intense focus on the existing areas. The department may think about diversifying beyond Power-to-X and energy systems to stay competitive in other emerging fields, such as AI in energy or advanced semiconductor technologies.

Scientific quality

Many of the publications by the faculty have garnered significant citations. Professor Christian Breyer (highly cited in 2022 and 2023) and Professor Behnam Mohammadi-Ivatloo (highly cited in 2022) have significantly boosted the department's international reputation.

The department has produced 626 publications in JUFO 1–3 journals between 2019 and 2023, with 61 JUFO 2+3 publications in 2023. This brings the percentage of JUFO 2–3 publications to 49%. Notable contributions include work on global energy transition modelling, smart grid technologies, and power-to-fuels research.

However, there are some existing gaps in the research that, if overcome, could significantly increase the impact of this work.

- Firstly, experimental verification of the photovoltaic modelling effort is still lacking and, if performed, would demonstrate the real-world impact of this pioneering work.
- Further details on the scalability and real-world application of some of the proposed technologies, such as CO_2-to-X synthesis, would provide additional clarity on their practical implementation.
- The Electric Power Conversion area covers critical processes in transmitting and converting electricity, with notable attention to power electronics and control systems. The research team is well-positioned to advance this field. However, a more explicit linkage between these technical developments and their broader impact on energy system efficiency would enhance the narrative.
- Finally, in the Smart Grids and Electricity Markets area, attention to microgrid technologies for developing countries and underserved regions is also a strong component, as it addresses global energy equity. The research could benefit from a more detailed exploration of potential barriers to adoption in these regions, such as regulatory challenges and infrastructure limitations.

Academic impact

The department has been consistent in producing graduates, with 11 doctoral graduates in 2023. Doctoral students make up 42% of the staff (61 students), contributing significantly to the research output. Their interdisciplinary and collaborative environment fosters doctoral research with applications in energy systems, renewable energy, and electrification.

The department has set a goal of one doctoral degree per professor per year and is now at 0.78. To meet that goal, significant attention is needed to improve recruitment, particularly of doctoral students. The department leadership identified post-graduate recruiting as one of its biggest challenges. This is in major part due to the pipeline of Russian and Iranian students being blocked for geopolitical reasons. The department is now exploring double degree programmes with different universities to overcome the remote location challenge that they

claim as the biggest reason for recruiting challenges. International research visits of three to six months for doctoral students, while encouraged, need to be more systematically implemented.

Finally, the recruitment process of doctoral students could also be more efficient. Today, it may take six months to recruit doctoral students, and it is difficult to assess quality if recruited from outside.

Societal impact and entrepreneurial and innovative capacity

The department has made significant contributions to society by founding nine start-ups between 2015 and 2023, including Solar Foods Oy (microbial protein production from hydrogen and CO_2) and Spindrive Oy (active magnetic bearing solutions). Societal impact is also evident in their research into microgrids for developing countries, improving energy access. Researchers such as Professor Samuli Honkapuro and Associate Professor Jukka Lassila frequently contribute to public discourse on energy transitions and energy crises. The organization of the EEM2023 conference by this department was considered strong.

The impact cases presented also attest to the societal impact that the faculty are making in P2X as well as Neo-Carbon Food.

Research environment

The department has invested in world-class and unique research infrastructure, such as the High-Speed Electrical Machine Testing Laboratory (up to 2 MW and 16,000 rpm capacity) and the PtX Hydrogen Laboratory. The plans to scale the PtX laboratory to 10 electrolyser stations are impressive.

There are many staff members (154, including 14 tenure track professors) who support the research environment. The department's funding mix is 40% from LUT and 60% from external sources, showcasing its ability to secure competitive funding.

There are six research laboratories (Table 4). However, we noted that two of the laboratories did not have any associate or assistant professors listed. It is also commendable that the department found endowment funding to bring on four new tenure track faculty members.

The challenge the department faces is the large budget: 85% of the department's budget is spent on staff salaries, and there are significant expenses for space rental and laboratory operations. This may pose challenges for sustaining and expanding research activities.

In addition, the department is seeking a goal of one doctoral student per professor. To address the teaching load challenges, the department has reduced the number of courses on offer while still providing a robust degree. In the meantime, new courses have been added to align with the doctoral student research needs. Just like at other departments, the recruitment of women is a challenge at the electrical engineering department (EE). However, the department is trying and has started a dedicated post-doctoral fellowship on gender issues. In addition, the department has sent one of its female doctoral students to DTU for mentoring from female faculty there.

The team finds the platforms useful for training doctoral students and growing and sustaining core research programmes. Publications have increased. Previously, they were more focused on technology but now much more on research and studies on changes in society. A strong desire was expressed for these platforms to continue. On the other hand, we heard concerns about the lack of funding available for risky new ideas. It is recommended that the university leadership explore the platform to include high-risk/high-reward ideas.

At the same time, business most often studies data from the past while engineering works with scenarios and new technologies for the future. This is a challenge. Doctoral and post-doctoral involvement gives more opportunities. The next generation can probably win even more. It takes time, but publications, funding and citations go up when we do not live in silos.

In general, there were several concerns:
i) lack of support from communications/marketing on research accomplishments,
ii) lack of support for grant writing, and
iii) rental space funding.

Department staff also mentioned that they do not entirely feel they receive the best customer service from the university's administrative services.

The KPIs are working well, and doctoral students and faculty are clear on what is expected for them to get bonuses and salary increases. However, the societal impact – a key goal for the university – has been hard to measure. In this regard, communications/marketing is even more critical to ensure that maximum impact is achieved.

Future potential

The future potential of EE is strong. The department leadership has created a strategic plan for 2028. The department is well-positioned to lead in the global energy transition and green electrification. With the right

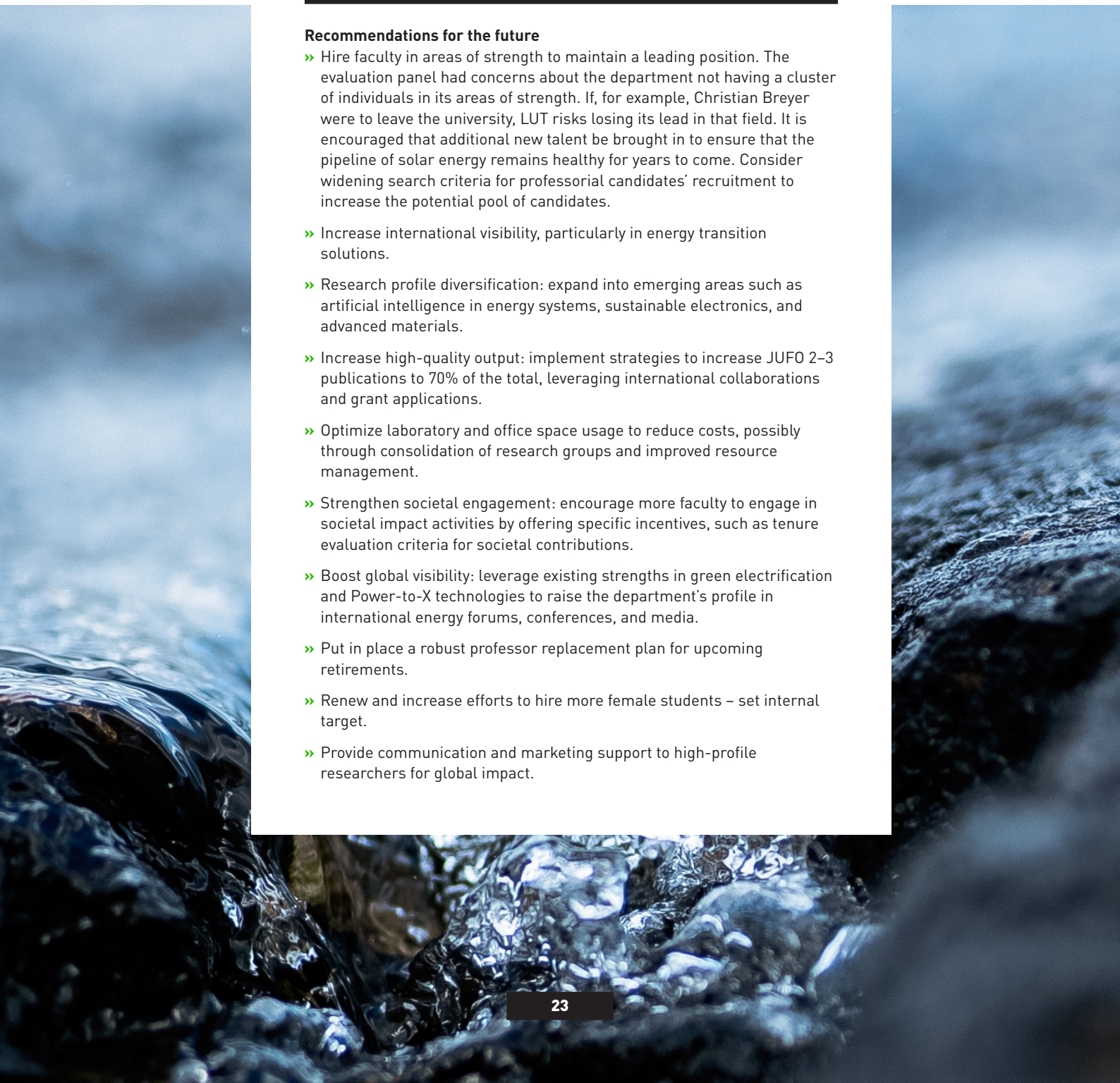
strategies, it could steadily expand external funding from €6 million to €9 million by 2028 and increase its staff by 30 new members. Expansion in areas such as green hydrogen production and high-speed electrical machines for heavy-duty vehicles and aviation presents strong growth opportunities.

The recruitment of talented doctoral students is a recurring issue. A clearer international recruitment strategy, particularly for doctoral candidates, is essential. Efforts to improve international visibility and collaboration are needed, with a focus on securing ERC grants and increasing international mobility.

Recommendations

Recommendations for the future

- Hire faculty in areas of strength to maintain a leading position. The evaluation panel had concerns about the department not having a cluster of individuals in its areas of strength. If, for example, Christian Breyer were to leave the university, LUT risks losing its lead in that field. It is encouraged that additional new talent be brought in to ensure that the pipeline of solar energy remains healthy for years to come. Consider widening search criteria for professorial candidates' recruitment to increase the potential pool of candidates.
- Increase international visibility, particularly in energy transition solutions.
- Research profile diversification: expand into emerging areas such as artificial intelligence in energy systems, sustainable electronics, and advanced materials.
- Increase high-quality output: implement strategies to increase JUFO 2–3 publications to 70% of the total, leveraging international collaborations and grant applications.
- Optimize laboratory and office space usage to reduce costs, possibly through consolidation of research groups and improved resource management.
- Strengthen societal engagement: encourage more faculty to engage in societal impact activities by offering specific incentives, such as tenure evaluation criteria for societal contributions.
- Boost global visibility: leverage existing strengths in green electrification and Power-to-X technologies to raise the department's profile in international energy forums, conferences, and media.
- Put in place a robust professor replacement plan for upcoming retirements.
- Renew and increase efforts to hire more female students – set internal target.
- Provide communication and marketing support to high-profile researchers for global impact.



UoA2 | DEPARTMENT OF ENERGY TECHNOLOGY

Research profile

The Department of Energy Technology primarily focuses on areas which are relevant to Finland. These include nuclear energy, bioenergy and sustainable energy systems. It also performs modelling on fluid dynamics and thermal engineering in relation to carbon capture. The focused approach is good, given the size of the department. The nuclear team has been involved in several industry collaborations, including helping to solve industry problems. There is also a strong focus on biomass production and use in the Finnish economy. Recently, the department has created the Energy and Society group focusing on the Finnish energy landscape.

All activities underway in the department seem to fall squarely in line with LUT's mission, with 76% of publications, for example, aligning with SDGs.

Scientific quality

The work performed by the nuclear energy group is clearly very relevant and important to the Finnish nuclear industry, which supplies over a third of Finland's electricity. Of particular significance are industry collaborations and the help the department has supplied in solving real industry problems and the work on the passive safety systems. Fluidized bed modelling, CO_2 capture, and work on supercritical flows in energy conversion processes are also done in collaboration with local and international partners and are producing fruitful results. The Energy and Society group, set up in 2023, has produced the Energy Outlook report and should also increase its impact in the coming years.

Academic impact

The research produced is of a good quality. Some of the work is particularly relevant and impactful. The number of publications produced over the period is good but can be improved. The number of high-impact JUFO 2–3 publications has increased to 96, and the department is making efforts to ensure public access to its publications. JUFO 2–3 publications represented 36% of all the department's publications, which, while good, can be improved. The number of publications shows a modest increase in recent years. Published papers had an average of 8.5 citations per paper published, which is good, and 43% of the publications scored in the top 10%.

Societal impact and entrepreneurial and innovative capacity

Most of the research of the group focuses on areas relevant to Finland. Highlighted papers included subjects such as biomass and waste characterization, exhaust gas recovery, and modelling and simulation related to real-world conditions and areas related to nuclear energy. All these areas are particularly relevant to local industry. Many of the master's and doctoral graduates end up in local industry. In fact, a large portion of theses are commissioned by local companies.

There are several ongoing collaborations with many companies and a healthy participation in EU projects. LUT's Energy and Society research group's two-year research report Energy Outlook, which showcases the expertise of researchers at the School of Energy Systems in key research areas, is also a useful and worthwhile contribution to the community.

Research environment

The research groups within the department appear to work well, but it is not entirely clear how much synergy there is between them. Also, the head of department is not given dedicated time to manage the team. The number of women especially among junior researchers was highlighted as being low, but no strategy was being prepared to increase it.

Three new positions were filled recently to cover strategic areas and an upcoming retirement. The number of doctoral students has not increased, while the number of post-doctoral researchers has doubled. The increase in post-doctoral researchers is positive and can result in higher research output. Many of the doctoral students come from countries from which it might be more difficult to recruit in the near future, so efforts are needed to compensate for that from elsewhere.

Concern was expressed about the department's ability to recruit high-quality individuals. The remote location was identified as a drawback. While this may be true, widening the call language to increase the pool of potential applicants and more outreach and PR would help. The group has strengths and some impressive infrastructure, which can be advertised more to also help with recruitment.

Future potential

Several groups within this department work very closely with industry and have the potential to continue influencing and supporting industry. By exploring potential collaboration with other groups, the department could be very impactful. The groups expressed frustration with the available funding, which is sometimes too targeted and therefore does not often match the groups' research

interests. However, the groups could try to be more creative in expanding and stretching their research areas so as to better fit into current mainstream research calls.

The department plans to grow by 50%, which should strengthen its research, increase its depth, and open new opportunities. The areas chosen for growth should be evaluated carefully to make sure the groups are sustainable. At the same time, widening calls will increase the likelihood of attracting high-quality individuals, who might not be a perfect fit as, for example, a replacement but will probably have better long-term outcomes.

The Energy and Society group can widen its area of research and pick areas particularly relevant and of interest to the Finnish and European community. The Industrial Energy Systems group should also offer new opportunities for growth and collaboration.

Recommendations

- If new areas of research are investigated, an obvious one to consider is wind research. Wind contributes 17 TWh to Finland's grid and is forecasted to grow to 33 TWh by 2030 (Finland's Integrated National Energy and Climate Plan: Update 2024).
- The work on nuclear energy appears to have been extremely valuable and should continue and possibly be expanded by the addition of an academic member of staff. While nuclear is not a renewable energy, it is an important bridging technology to reach the 2050 CO_2 goals. The work on small modular reactors shows particular promise. Efforts should be made to look for patent/spinoff opportunities.
- The department should seek more dialogue with other departments, particularly LUT Business School, to explore new avenues within the current research areas.
- It is noteworthy that a large portion of current students are from countries from which it might be more difficult to recruit students in the near future, so the numbers need to be monitored carefully and efforts made to recruit students from other regions.
- While research calls are not always directly linked to the research areas of this department, more efforts can be made to creatively fit the department's research into existing calls. More effort could also be dedicated to lobbying at the pre-call stage, also with the help of LUT administration, so more calls are issued in areas of interest.
- The expected growth of the department by 50% and the need to replace several retiring academics in the next cycle presents both a challenge and an opportunity. Care needs to be taken to ensure the proper depth of personnel in key areas and proper succession plans.

UoA3 | DEPARTMENT OF MECHANICAL ENGINEERING

Research profile

The research focuses on understanding the principles of physics and material science to improve the effective and efficient design and analysis of mechanical systems and to design, improve, and implement integrated and efficient production systems to produce products or services.

There are ten research groups that have been grouped into the five areas:

- digital product processes,
- high-speed rotating machines,
- advanced materials with difficult applications,
- paperboard conversion,
- human–machine interaction.

This has resulted in synergies and collaborations within the department.

In the LUT strategy, the groups mainly contribute to the energy industry, but they are actively choosing applications to be relevant also in other areas. About 40% of their publications per year are related to the SDGs.

Scientific quality

The department produced 444 articles from 2019 to 2023. They have been cited 3700 times, resulting in a citation count of 8.3 per publication. Despite an ambition to produce more JUFO 2–3 papers, 63% of the papers are published at JUFO 1 level, 30% at JUFO 2 level, and 6% at JUFO 3 level. During the period from 2019 to 2023, there has not been significant change in these proportions. Even if the numbers are good, they can be improved.

The department is very active in the LUT platforms, where the researchers are involved in three and leading two. They have contributed with competitive research, also leading to additional project funding. The extent of multidisciplinary collaboration is difficult to quantify, but more than 50% of the publications are characterized by internal collaborations. Also, it is observed that the impact from this multidisciplinary collaboration is substantial.

Academic impact

The professors are active and known internationally within their subject fields, being, for example, editors for international journals or involved in EU projects. Examples of scientific achievements are the novel fatigue assessment approach, the real-time multibody simulator and software for heavy mobile machinery, the reality-driven simulation methodology, as well as contributions to high-speed electrical machinery and recycling of composites. The scientific publications show good quality.

The department has succeeded in becoming more international during this period by, for example, collaborating with 91 international universities and institutes. The department also shows high impact by producing a large number of doctoral and master's degrees.

Societal impact and entrepreneurial and innovative capacity

The most impressive thing about the department is the large number of patents and startups. During the period, 26 invention disclosures and 49 patent applications were submitted, and 28 patents were granted. Startups from the department have now over 60 employees. The greatest strength of the department in this respect appears to be the Laboratory of Intelligent Machines.

The whole department shows evidence of substantial contributions to industry in heavy machinery, big mobile machinery, papermaking, etc. For example, 170 companies contributed with project funding during the period. Many of the doctoral and master's graduates are getting employed by industry.

Research environment

The department has a very collegial, agile, and innovative team and has adopted innovative approaches to faculty hiring, faculty assessment, and teaching impact, including mentoring. During the period, they have succeeded in hiring five new academic staff members, which indicates high potential for the future. There is an ambition to change the staff from dominating post-doctoral researchers to more doctoral students. This requires more supervisors, which are now in place with the new hires.

During the period, the department succeeded in getting more joint projects, becoming more international (staff, students, funding, mobility), as well as being involved in LUT platforms and a national centre of excellence.

Research group leaders have traditionally been largely independent, but the department is currently working towards larger groups with several professors. The reason is the pressure for more research funding, more multi-disciplinary research questions, and increased critical mass.

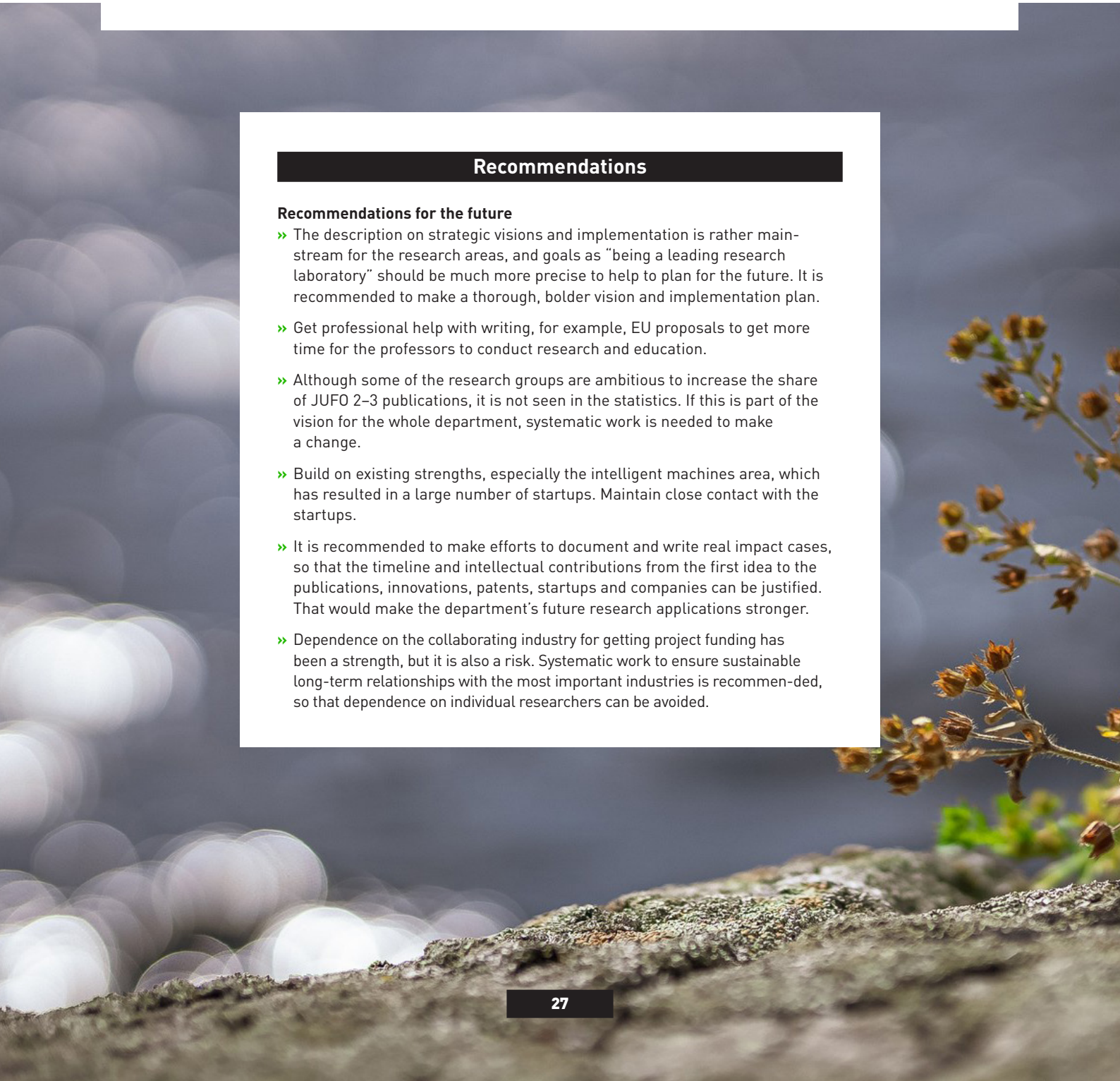
A main challenge for the future is the anticipated large increase in the number of students. This will put stress on the existing staff and requires changes in how the education is delivered. The role of department head was not presented as very attractive, since they appear to still have to match their KPIs as a regular professor.

The department has good experimental facilities and shows evidence of good collaborations both within and outside LUT. Approximately half of the funding comes from LUT, and half is external funding received through competition. About half of the research falls into the basic and applied research categories, and the other half targets commercialization. This illustrates the close collaboration with industry and startups, which is important for societal impact. This large share also risks that the research will not be ground-braking. The external research funding has increased modestly over the five-year period.

Future potential

The future potential is strong. The department has well-positioned research areas, and new tenure track associate professors are building their research groups, which gives good potential for increasing the research funding, number of doctoral students, and output for the department.

The digital twin work offers great potential in the areas in which it is being applied but also in other new areas.



Recommendations

Recommendations for the future

- The description on strategic visions and implementation is rather main-stream for the research areas, and goals as "being a leading research laboratory" should be much more precise to help to plan for the future. It is recommended to make a thorough, bolder vision and implementation plan.
- Get professional help with writing, for example, EU proposals to get more time for the professors to conduct research and education.
- Although some of the research groups are ambitious to increase the share of JUFO 2–3 publications, it is not seen in the statistics. If this is part of the vision for the whole department, systematic work is needed to make a change.
- Build on existing strengths, especially the intelligent machines area, which has resulted in a large number of startups. Maintain close contact with the startups.
- It is recommended to make efforts to document and write real impact cases, so that the timeline and intellectual contributions from the first idea to the publications, innovations, patents, startups and companies can be justified. That would make the department's future research applications stronger.
- Dependence on the collaborating industry for getting project funding has been a strength, but it is also a risk. Systematic work to ensure sustainable long-term relationships with the most important industries is recommen-ded, so that dependence on individual researchers can be avoided.

UoA4 | DEPARTMENT OF SUSTAINABILITY SCIENCE

Research profile

In a strategic focus, sustainability issues are integrated across all of LUT's strategic topics: energy, air, water, business and society. The Department of Sustainability Science (SuSci) finds collaboration partners in different departments and schools of LUT and broadens the scope of its research work in the sustainability framework: waste management, circular economy and life cycle assessment with the development of the handprint concept.

Almost all SuSci publications in 2019–2024 are linked to one or more of the UN Sustainable Development Goals (SDG).

The self-assessment report identifies three research teams:
1) Life Cycle Management (on the Lappeenranta campus),
2) Waste Management Technology (on the Lappeenranta campus), and
3) Sustainability Change (on the Lahti campus).

The multidisciplinary approach of SuSci researchers is proven by participation in two of LUT's research platforms: Green Hydrogen and CO2 for Industry Renewal Overall, and Sustainable Circularity of Inorganic Materials.

During interviews, SuSci researchers emphasized the need to split both platforms in two parts.

Scientific quality

The department has published about 30–50 publications each year in journals included in the JUFO classification system. Of these, 44% are published at the JUFO 2 level and 8% in the highest JUFO 3 level journals, and the quality of the journals in which research has been published has increased over time. The Unit's Field Weighted Citation Impact (FWCI) is 117% higher than the world average. However, the number of publications has decreased significantly: by 40% from 55 in 2022 to 33 in 2023.

The SuSci department is pursuing international cooperation through external projects, joint publications, and international research mobility. As LUT is a member of the EULIST alliance, the SuSci department has taken part in tasks concerning the strategy for Sustainable Development Goals across Europe since 2023.

Multidisciplinary collaboration happens as part of different activities and research by recruiting specialists in various fields and participating in two research platforms at the LUT level. SuSci has applied for externally funded projects jointly with scientists from other departments or schools. Overall, the scientific quality is robust and is improving.

Academic impact

A journal article published in the *Journal of Cleaner Production* in 2024 has already nearly 100 Google Scholar citations, and another one published in the *Journal of Environmental Management* has nearly 200 citations. These examples indicate and exemplify the academic impact and reach of the SuSci researchers at their best. The number of citations to publications indicates that the department's research is relevant and reputable to the international research community, although the department does not hold a leading position. The number of publications has declined substantially in the recent past.

The SuSci department has long-standing cooperation with the Lahti and Lappeenranta municipalities. Its professors have been invited to visible national roles in their area of expertise. For example, Professor Soukka has been appointed to the Finnish Climate Change Panel, and Professor Linnanen is an expert in the Panel for Sustainable Development.

Overall, the academic impact of the unit is very good, but it does not match that of the very best international departments in the field.

Societal impact and entrepreneurial and innovative capacity

SuSci is involved in many externally funded projects in which it engages and interacts with stakeholders, evidencing the relevance of its research to non-academic partners. Its research addresses the thematic area of circular economy which is of interest to communities, businesses and the public sector. Much of this research has applied a multidisciplinary approach with a focus on social sustainability and an emphasis on issues of particular importance and interest to municipalities.

We consider societal impact to be a clear strength of SuSci.

Research environment

SuSci has three research teams – two in Lappeenranta and one in Lahti. There is a good balance of staff at different career stages: three full professors lead the research teams, and there are three tenure-track associate professors. Post-doctoral researchers make up nearly a quarter (23%) of the research staff. The research staff consists of a diverse mix of people in terms of nationalities and backgrounds.

Established collaborations take place both within and outside of LUT, and access to external research funding is also established. The three key sources of external funding

are Business Finland, the EU, and the Research Council of Finland.

The research teams function rather autonomously based on rather balanced funding from the Ministry of Education and Culture and external funding sources. However, there are questions related to the cooperation between the research teams and the role of the teams in the department. It is important to foster a departmental culture, for example with research seminars and internal research discussions involving all teams.

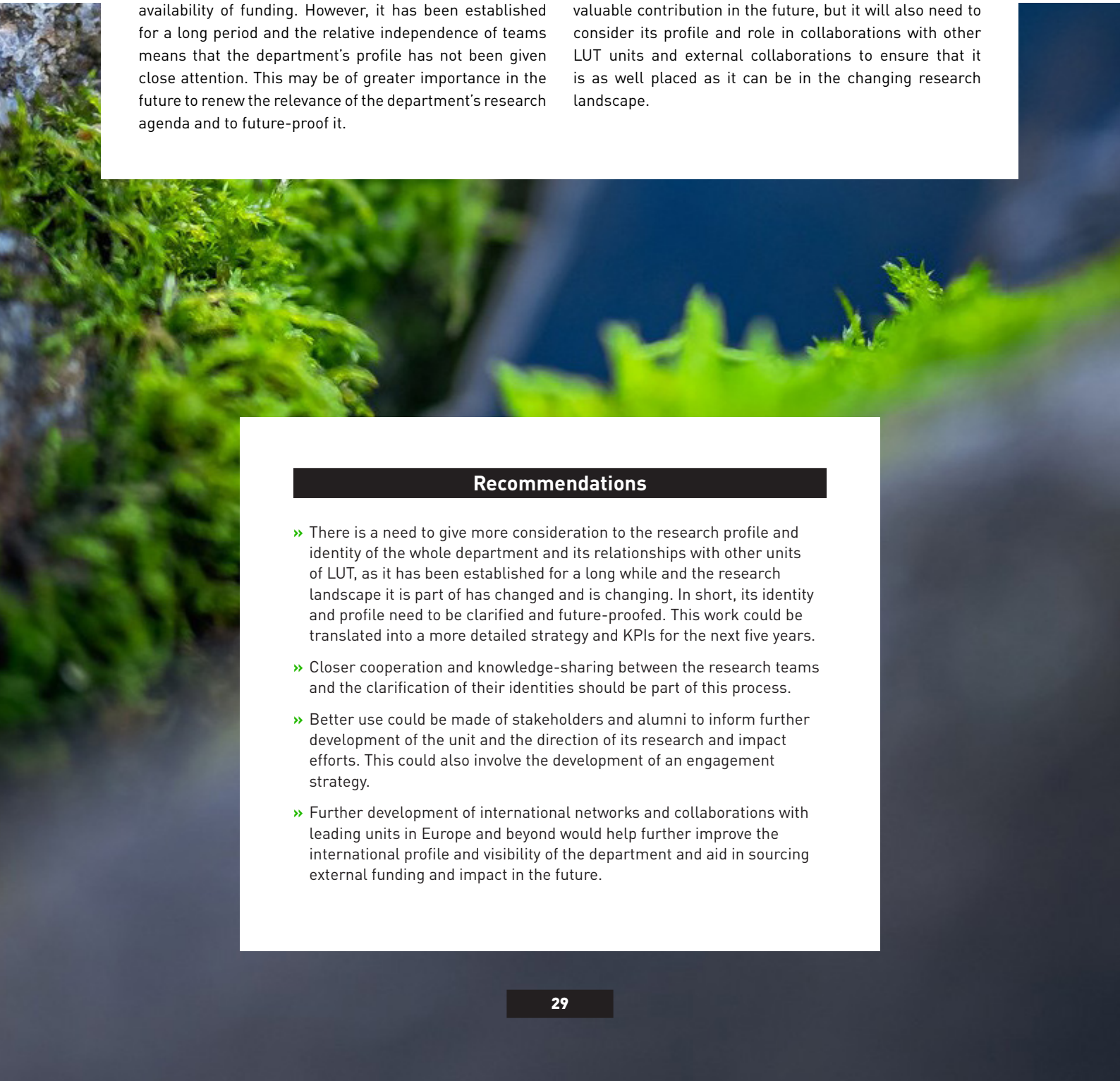
Future potential

The profile of SuSci aligns well with the LUT strategy and to a degree also with the external demand for expertise and availability of funding. However, it has been established for a long period and the relative independence of teams means that the department's profile has not been given close attention. This may be of greater importance in the future to renew the relevance of the department's research agenda and to future-proof it.

This will need to involve closer cooperation between the teams in Lahti and Lappeenranta, both at academic and research levels, to clarify and update the profile of the department as a whole and in its role and identity as part of the wider LUT environment and to better and more clearly establish its distinct identity.

The SuSci implementation plan for 2024–2030 includes the recruitment of four new tenure track professors, depending on the funding situation and opportunities, to respond to the retirement of existing full professors. These appointments need to be carefully considered as strategic investments that will shape the unit's future research capacity and expertise.

To conclude, the unit has clear continued potential for a valuable contribution in the future, but it will also need to consider its profile and role in collaborations with other LUT units and external collaborations to ensure that it is as well placed as it can be in the changing research landscape.



Recommendations

- There is a need to give more consideration to the research profile and identity of the whole department and its relationships with other units of LUT, as it has been established for a long while and the research landscape it is part of has changed and is changing. In short, its identity and profile need to be clarified and future-proofed. This work could be translated into a more detailed strategy and KPIs for the next five years.
- Closer cooperation and knowledge-sharing between the research teams and the clarification of their identities should be part of this process.
- Better use could be made of stakeholders and alumni to inform further development of the unit and the direction of its research and impact efforts. This could also involve the development of an engagement strategy.
- Further development of international networks and collaborations with leading units in Europe and beyond would help further improve the international profile and visibility of the department and aid in sourcing external funding and impact in the future.

UoA5 | DEPARTMENT OF COMPUTATIONAL ENGINEERING

Research profile

The Department of Computational Engineering (CopE) conducts a broad range of research on
(1) applied mathematics,
(2) computer vision and pattern recognition,
(3) atmospheric sciences, and
(4) computational spectroscopy.

Across this landscape, there is a broad focus on computational science and engineering, informed with data-centric learning, whether in the context of statistical inversion and Bayesian inference, or covering various angles on machine learning. Core competencies in terms of applied mathematics and numerical methods are combined with strong application drivers from atmospheric sciences and environmental remote sensing spectroscopy. Further, machine learning is a cross-cutting theme across the board, spanning computer vision as well as atmospheric and spectroscopy applications.

The range of work under CopE involves both national and international collaborations as well as synergistic teaming with other research teams under the LUT School of Energy Systems and LUT Business School. There is overlap with the physics department in research, and some overlap with software engineering in teaching. Broadly, the work of the department is very well aligned with the LUT Trailblazer Strategy, spanning various areas under *clean energy* (energy conversion and energy markets), *circular economy* (water purification and reuse), and *sustainable business and entrepreneurship* (digitalization of businesses).

Scientific quality

The scientific output of CopE is well documented in the technical literature. This includes 381 journal publications during the assessment period, or an average of 76 papers per year, which have garnered 3930 citations over this period, averaging 10 citations per paper. As a clear measure of high quality, we note that 70% of these publications are in the JUFO 2–3 categories, and 55% of them are in the top 10% journals. Further, the number of JUFO 3 papers has been rising over the past five-year period. A sampling of the journals the department has published in (and their two-year Impact Factors) includes: Bernoulli (1.7), Journal of Physical Chemistry B (2.8), Geoscientific Model Development (4.1), SIAM Journal on Scientific Computing (3.1), Applied Energy (11.5), and the IEEE Transactions on Image Processing (10.7).

The high quality of the CopE research is also attested by the extent of the collaboration network involved in co-authoring joint publications. In fact, 90% of publications have involved co-authors from organizations outside of LUT, with 74% involving international collaborations. Collaborating organizations include several leading national (U. Helsinki) and international (MIT, Caltech, CERN) institutions.

The scientific quality of the department's publications is clearly high. However, given that this high JUFO-rated picture has been dominated by the now lost CERN collaboration on the Large Hadron Collider experiment CMS through the computer vision area, there needs to be a concerted effort to elevate the quality of the publications uniformly across the department to retain the high-level rating going forward.

Academic impact

The department has a range of academic strengths combining senior faculty with a well-established reputation in the research community and junior faculty with good academic output and potential. Overall, the academic impact is strong, including well-cited journal publications as well as open-source online datasets and software. The faculty have been active in international collaborations and have served as organizers and co-chairs of leading conferences in the Bayesian and uncertainty quantification landscape. They have also nearly doubled the fraction of their research portfolio corresponding to EU-funded research over the assessment period.

At the same time, there is room for improvement in terms of the academic output when considering the department overall in comparison to high-performing international institutions. In particular, the current level of the CERN collaboration, using FPGAs for the level 1 trigger in CMS, involves a single post-doctoral researcher and may thus have a small impact in such a large international project.

Societal impact and entrepreneurial and innovative capacity

The department has a strong impact outside of academia. Its work has impacted environmental and natural resources in terms of the monitoring and filtration of runoff water with local municipalities, biodiversity in the Baltic Sea and regional lake systems, and adaptation to climate change. The department also has connections with industry on several fronts and has worked with several companies, including one founded by CopE alumni, on collaborative projects. These have broadly focused on multiple aspects of digitalization, involving the

use of multimodal measurements, computer vision, and data analysis, with application of artificial intelligence and machine learning, targeting the improvement of industrial process performance and enhancement of transportation infrastructure safety.

Research environment

The department head focuses on financial administration and management as well as research. The department has weekly meetings of a steering group composed of professors and associate professors, which has an advisory role in both research and education. Principal investigators of projects have a considerable degree of autonomy in hiring post-doctoral researchers, doctoral students and research assistants. The department has a high degree of diversity, with 42% being native Finns and 29% female.

The department has 14 faculty members, including seven professors and seven associate/assistant professors, divided among the four research focus areas of the department, although faculty also contribute to multiple focus areas. CopE has 25 active doctoral students and seven post-doctoral researchers. The department has research and educational activities on both the Lappeenranta and Lahti campuses. However, there is evidently insufficient administrative support for grants. Further, communication is somewhat difficult because the faculty occupy different floors. There is also a need for meeting rooms for the group.

The unfortunate passing away in 2021 of one faculty member who had a long-term joint research role in CERN has had an impact on the department output. The remedy of this loss by collaboration with the physics department, which currently includes only one post-doctoral researcher, is unlikely to lead CopE to regain its former role in CERN unless it is strengthened significantly.

Over this assessment period, CopE faculty have led one research platform and are participants in three others. Thus, they are quite active in multidisciplinary teams. They have participated in numerous multidisciplinary research projects in collaboration with external partners, including academic and industrial, national and international teams.

While CopE currently has 25 doctoral students, the number of doctoral graduates per professor per year, currently at 0.86, has been on the low side but increasing in recent years. It does need to increase further to at least meet the school requirement of one doctoral graduate per professor per year but should also be higher considering international practice. The current enrolment of doctoral students, each in a four-year contract, is expected to show a healthy increase in 2024 and should lead to a higher number of annual doctoral graduates in the near future. Students get joint supervision by two supervisors: several are co-supervised by faculty at other universities, both within and outside of Finland. The low number of graduates per professor is particularly concerning, given the co-supervision.

CopE has facilities on both LUT campuses. The CopE laboratory includes optical sources, digital imaging, spectroscopy, edge and embedded computing hardware as well as CPU/GPU computational servers. The department also makes use of national supercomputer resources.

External research funding is about 30% of the department budget and is 80% academic governmental funding, with 20% associated with industry. There is a need to increase industrial funding to reach target levels.

The interview highlighted challenges with the environment in the department. The panel was left with the impression that there is a significant lack of dynamism, enthusiasm and ambition. Further, there was no clear overall strategy for the department. In fact, it was mentioned during the interviews that the departmental strategy has not been finalized yet. Moreover, links to SDGs from the departmental output (as reflected in the table provided in the self-assessment report) were not followed up properly by the management.

Future potential

CopE targets increasing the number of doctoral graduates to 1.5 per full professor by 2030 and the range of recruitments of professors at all levels across the four focus areas. This is expected to lead to 20 new staff members overall. Goals also include improvement of the departmental space utilization rate.

Research and publication goals target increasing the high-level JUFO rating of publications in the four core areas. This is an important goal, as the current 70% JUFO 2–3 picture is dominated by joint-CERN publications, which are phasing out. The plan is to do this by increasing team sizes and international collaborations as well as focusing on high-quality journals.

Strategic goals also include an increase in external funding, currently at €1.5 million a year, by more than €1 million a year by 2030, with an associated Ministry of Education and Culture funding target of €0.7 million a year. This is planned to be achieved by targeting multidisciplinary research proposals to both government and industry. Further, the department aims to increase its societal impact by planning for LUT to host at least one international conference or seminar per year and by recruiting visible researchers focusing on societally impactful research.

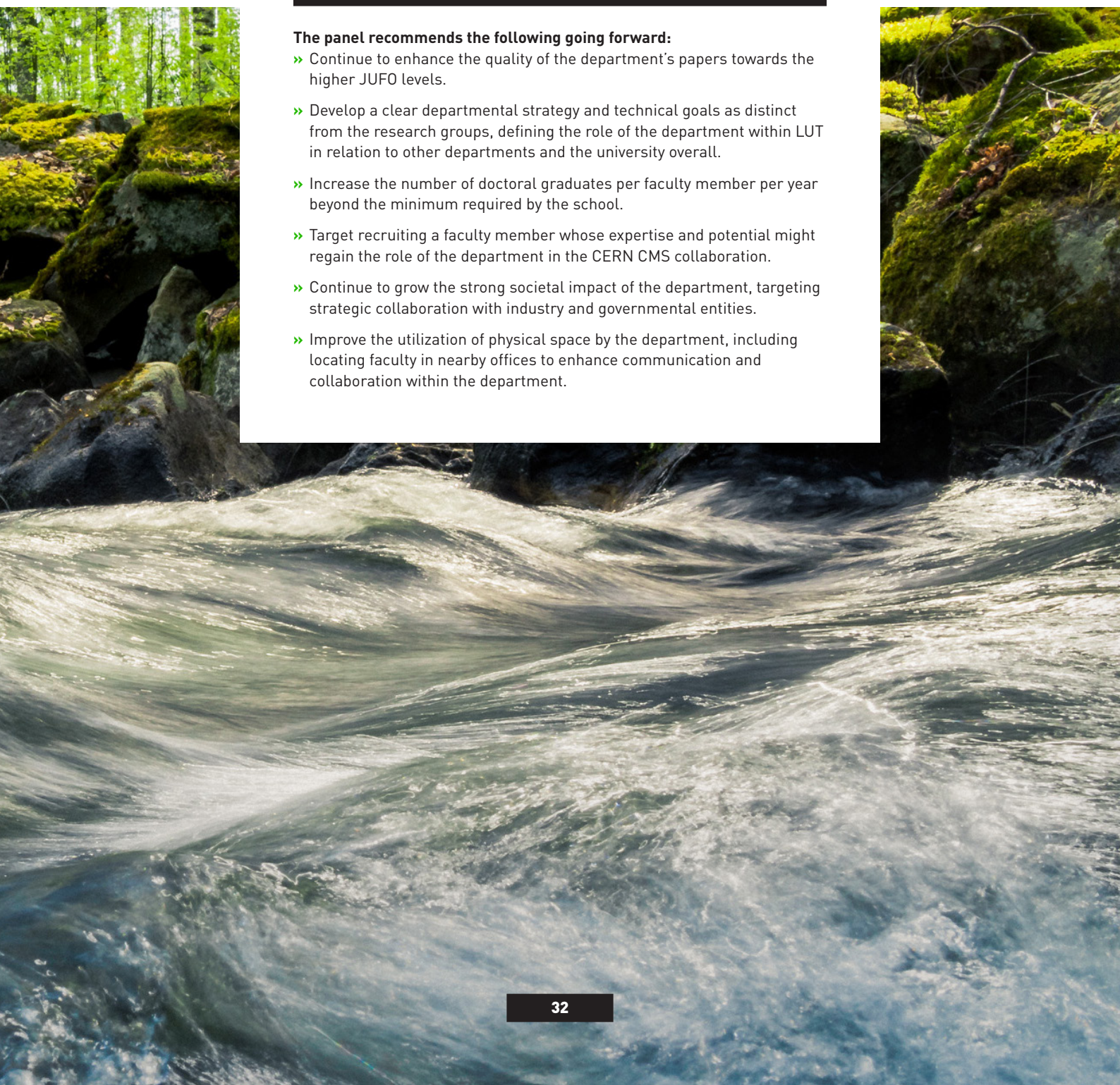
CopE's strategic goals are largely dictated by the plans of the faculty leading the four research focus areas. The plans include relevant growth targets in each of these areas. However, there is no explicit indication of strategic planning for specific growth targets in collaborative ventures among these areas or for envisioning new research focus areas driven by national/regional needs.

In verbal discussions, there were indications of targeting growing connections among the focus areas, work on trustworthiness and explainability in machine learning, and CERN collaboration. However, it would have been better to see all this laid out explicitly with meaningful plans and targets.

Recommendations

The panel recommends the following going forward:

- Continue to enhance the quality of the department's papers towards the higher JUFO levels.
- Develop a clear departmental strategy and technical goals as distinct from the research groups, defining the role of the department within LUT in relation to other departments and the university overall.
- Increase the number of doctoral graduates per faculty member per year beyond the minimum required by the school.
- Target recruiting a faculty member whose expertise and potential might regain the role of the department in the CERN CMS collaboration.
- Continue to grow the strong societal impact of the department, targeting strategic collaboration with industry and governmental entities.
- Improve the utilization of physical space by the department, including locating faculty in nearby offices to enhance communication and collaboration within the department.



UoA6 | DEPARTMENT OF INDUSTRIAL ENGINEERING AND MANAGEMENT

Research profile

From an international perspective, engineering faculties often have departments dedicated to "value creation," emphasizing the integration of technology with various business disciplines. Examples of universities in the Nordic countries with such departments include DTU, KTH, Chalmers University of Technology, and NTNU. These departments are typically characterized by extensive collaboration with industry, applied research, and cooperation with engineering disciplines. LUT's Department of Industrial Engineering and Management (IEM) is part of this tradition, as illustrated by its membership in the Scandinavian Academy of Industrial Engineering and Management (ScAIEM).

Describing the research profile of IEM is challenging. The self-assessment report identifies eight research teams:

1) Innovation and Technology Management
2) Innovative Organisations and Sustainable Societies
3) Innovations and Logistics
4) Supply Chains and Operations Management,
5) Cost Management and Data Analytics
6) Performance Management
7) Entrepreneurship
8) Systems Engineering

Overall, based on the self-assessment report and interviews, IEM addresses a wide range of issues and themes, often incorporating elements of digitalization and sustainability. Research projects include topics such as the entrepreneurial potential of ninth-grade students, citizen participation in decision-making processes, and digital integration in companies.

In relation to the LUT research strategies, particularly the "Business and Society – Sustainable Renewal of Business, Industry and Society" initiative, IEM's profile aligns well, and the department is well-positioned to contribute to the strategy.

The research profile of IEM can be described as broad rather than focused, influenced by the study programme portfolio and funding opportunities.

Scientific quality

On average, the department achieves about 120 publications each year in the JUFO classification system. Of these, 20% are published in top 10% journals, and there is a positive trend in the quality of the journals. Journal examples include *Technovation, Technology Forecasting and Social Change, Journal of Cleaner Production, Long Range Planning, and Journal of Operations & Production Management.*

The department has an extensive international cooperation network, both through external projects and joint publications. Multidisciplinary collaboration is a key characteristic of IEM's activities and research.

The number of external projects with diverse partners reflects a broad interest in IEM's activities, but it also presents challenges in terms of long-term focus and systematic knowledge building. Overall, the scientific quality is robust and showing positive development.

Academic impact

A journal paper published in the *Journal of Cleaner Production* in 2019 has nearly 700 Google Scholar citations. Additionally, two doctoral students, Dr. Jyri Hanski and Dr. Hanna Sievinen, have won international research awards. The SIM platform Routledge book is another notable example of collaboration with potential academic impact.

On average, the number of citations indicates that the department's research is relevant within the international research community, although the department does not hold a leading position. This may be influenced by the previously mentioned variation in research focus.

Overall, the academic impact is reasonable but not comparable to the very best international departments.

Societal impact and entrepreneurial and innovative capacity

IEM is involved in numerous projects with external funding and stakeholders, reflecting its relevance and ability to address thematic areas of interest for businesses, communities, and the public sector. The long-term ability to attract funding from various sources is a strong indication of impact. Examining the content of these projects reveals a focus on "real-world" challenges, often reflecting an applied and multidisciplinary research orientation. We assess this as a major strength of IEM.

Research environment

IEM does have a well-established structure and activity, also with a head of doctoral studies. The balance between different position types seems to be reasonable; a relatively

high number of post-doctoral researchers has been noted. The IEM staff has variation regarding nationalities and backgrounds, creating a heterogenous working environment.

Collaboration within and outside of LUT has been established, and access to research funding is evident. Most of the projects originate from Business Finland, the EU or other sources. Funding from the Research Council of Finland seems to be an exception; consequently, many projects have a short time span and limited budgets. One question is the ability to establish larger and long-term external projects. Industrial doctoral students contribute to networks and represent a possibility for partnership development.

The eight research teams seem to be structurally important, but there are questions related to the cooperation between them and the role of the teams in the overall activity of the department. The department could benefit from having a more active, forward-thinking leadership at the department and team levels. It is important to foster a culture with, for example, research seminars and internal research discussions involving several teams.

The master's students are connected to the research activity and often work in collaboration with external partners. This may be regarded as a long-term asset in the form of possible relationship development and cooperation opportunities.

Future potential

The implementation plan of IEM focuses on new recruitment, internal information sharing, well-being at work and alumni relations. We specifically support the attentions towards information sharing also between the teams.

Considering the future potential, there is no doubt that the IEM profile meets both the LUT strategy and external demand. However, we point towards the need for discussion about the interfaces between departments, as IEM has several areas also touched upon in other parts of the university. It is important that IEM systematically discuss and develop the department's profile in the wider LUT environment. As part of such a discussion, the possible narrowing down with more focus on selected areas should be considered to reach critical mass. It should also be considered if there exist project opportunities that should be defined as outside the scope of IEM.

Overall, there is a lot of future potential, but it will require internal discussions and deliberate actions to develop a more distinct profile and further develop the department's role within LUT.

Recommendations

- Initiate an open discussion with LUT Business School (as well as the social science and sustainability science departments) about the role differentiation and how you may develop distinct profiles.
- Work towards greater research focus; the level of fragmentation seems to be relatively high.
- Evaluate the project portfolio:
  - Is it possible to target larger external projects with a longer time span?
  - Are the smallest external projects worth the time and effort?
  - Is it realistic to receive more funding from the Research Council of Finland?
- Enforce more cooperation and more systematic knowledge sharing within the department and between the research teams.
- Involvement of master's students in projects and research is already important. Explore how this may be further developed, as it fits nicely with the IEM profile and traditions.
- Use the alumni opportunities more actively and potentially also interact with other stakeholders in a more structured way. This may also help to shape the profile of the department.
- Further develop the international networks and relationships.
- Consider more effort in communicating/"marketing" the research activity and results more broadly in Finland, as it will increase visibility and may be a positive long-term investment.

UoA7 | DEPARTMENT OF PHYSICS

Research profile

Physics is a new and currently small department with aspirations to grow significantly in the next period. Physics is a more fundamental science subject than those of many other departments at LUT, and it could thus be expected to be further from applications. The LUT physics department is, however, far more involved in the applied physics area than is typical for a physics department: this is an appropriate choice for the LUT research portfolio.

The department has a good proportion of international members and a reasonable gender balance for physics.

The department has a set of distinct research topics (material physics, computational materials science group, experimental physics instrumentation, solid state physics), but there are clear links between them. This is a good balance.

Scientific quality

The research groups all have strong publication records and have demonstrated clear current research programmes. The highlighted papers include those in the very top world journals (PNAS, Nature, Phys. Lett B).

There are international collaborations in all areas. The existing research groups would all be welcome in any high-ranked international department, although they do not have the group size and thus corresponding depth in expertise of the world-leading groups in these fields.

There are some clear examples of multidisciplinary research, with the application of techniques to other fields. However, multidisciplinary research should not always be the goal. Making breakthroughs in our fundamental knowledge requires a strong commitment to basic research. This will always be a tension in any university. In LUT, with its strong applied aims, room should still be made for more basic research, which will enhance the international reputation, high-impact publications and attractiveness for students.

Academic impact

The physics department has a significant academic impact for its small size, with only four professors at the time of the report (now growing to five). However, there is no doubt that for many internationally competitive technical fields, there is strength in numbers. It is this small size which limits the department's academic impact, and growth will be welcomed. Consequently, it will also be very important for the group to continue to work with national and international partners. The continued formation of and participation in consortia will be necessary to have high academic impact.

This is particularly true in the areas of particle physics (or nuclear or astro-particle physics), where work is carried out in large international teams. The newly appointed academics in data analysis (discussed below) will make an important contribution here. Looking beyond the construction of the CMS tracking detector, it will be good to identify in the coming years the international instrumentation programmes (at CERN, PSI or elsewhere) in which the group wishes to participate in the 2030s, as these programmes have very long lead times. This is best done in consultation with the other universities active in this area in Finland to provide critical mass.

Some group members have had national and international leadership positions; this increases the impact of the group by raising its visibility.

Societal impact and entrepreneurial and innovative capacity

The presented impact case from physics was impressive. An impact case of the application of particle physics instrumentation to nuclear security, soil monitoring, was described. Future work in this area has potential for other fields, such as medical imaging. The work shows significant potential and is already highly advanced. The impact of the work on society is, however, not yet demonstrated: that will require the use of the produced prototypes in real-world applications. There is a clear link to the basic research for the LHC CMS experiment conducted by members of the group. Research funding has been obtained for this work, and we would consider the prospects of obtaining further funding for this area very high. It is important to work closely with industry, as clearly identified by the group, in order for the potential benefits of this work to be realized. This was amongst the impact cases presented that have the strongest future potential.

The impact of the basic research carried out in the department should not be discounted. Several areas have the potential for long-term transformative impacts. While the path for some of these research areas to direct applications may be long, their societal impacts can be much wider than any specific application-oriented programme.

Research environment

The department has clearly created a lively and dynamic environment. The spirit of the researchers was very positive.

The impression of the group leadership and of the culture and communication it has set up in the department across groups was extremely positive. This is an important point, as with the group being distributed (as it is active on both LUT campuses, at the Helsinki Institute of Physics, and at CERN) close contact is needed. As the group will hopefully grow in the future, it will be necessary to pay attention to preserving this culture.

All groups have strong collaborative links.

The cessation of links with Russia following the Russian invasion of Ukraine has had a negative effect on some collaborations, for example closing long-standing links with Ioffe Institute, St. Petersburg.

The group has laboratory facilities suitable for carrying out its research programmes. We saw only part of these facilities, and they were clearly well operated and offered some relatively unique capacities (such as the 45T magnetic system) along with the more standard tools required. The impression was given that good use of the available infrastructure funds is being made. Naturally, given the small size of the group, the facilities are at a lower level than those available in the world-leading physics departments, which again emphasizes the need for continued strong collaborations.

Future potential

A new academic has just been hired (since the report) with expertise in experimental particle physics data analysis and the use of machine learning. We commend you on this choice. This area will complement the instrumentation work and the work of the computer vision group in computational engineering. This should attract doctoral students to combined projects.

The areas for new academic hires must be carefully considered, especially here, given the small department size. There is a clear synergy in activities related to semiconductors across the department, and strengthening this area could be one possible direction. Given the strengths in all groups in the department, succession planning should be considered where department members may be expected to retire within the next five-year period. It will be an important decision if expertise in these areas is to be retained or new areas pursued.

The sanctions against Russia have provided the need, but also the opportunity, to rethink the master's programme. The previous programme has been closed and a new programme is being planned for launch in 2025 with the working title of Applied Physics. The group is encouraged to continue its current discussions to determine the unique selling point of this master's programme – a more distinctly specialized programme might be more successful in student recruitment than a general programme. The department's strength in semiconductors, new materials, and their applications in radiation detectors may allow an interesting and cohesive programme to be identified. The department's strong international links could be leveraged, for example, in teaching, by adding guest lecture elements to a course where in-house expertise is not available and in student recruitment.

The department has clear and strong leadership. Given the strong growth potential and lively atmosphere in the group, we are optimistic about the significant further development of the group and assign a rating of 4.5.

Recommendations

Reiterating some of the key suggestions given above, we propose the following:

- Further growth of the department and continuing and establishing strong collaborative links with other groups are needed to maximize the department's impact, given the small department size.
- The benefits of the impact case that we were shown can only be realized by working closely with industry.
- The international target programmes of the 2030s for which the construction of semiconductor trackers will be carried out need to be identified in the coming years, in discussion with national partners.
- Identifying a distinct USP and title for the new master's programme is recommended.

UoA8 | DEPARTMENT OF SEPARATION SCIENCE

Research profile

The department covers a broad field of engineering solutions for industrially relevant streams and processes. It thus surely has an impact on Finnish industry, but in the global academic impact and the impact at the entrepreneurial level, there is room for improvement. The cohesion and spirit in the department seems fine, and the contribution to the SDGs is excellent and very clear for the department. The department seems very well organized and properly managed.

The department is large. The strategic vision might need more attention. The recent hiring of a specialist in gas separation and micro-algae is generally evaluated positively. The latter research field was unexpected in a Nordic setting and seemed to be more the consequence of an opportunity than of a clear strategic decision. The recent expansion towards food technology is clearly driven by the needs of local industry. There is a risk of limited academic impact in this research field if it remains too oriented in that highly applied direction, especially when only combining food technology with separation technologies that are already existing and/or studied in the department, as was mentioned. The processing of novel food applications (e.g., alternative protein sources) could be considered. It is recommended to look for competitive advantages worldwide, not only at the Finnish level.

Scientific quality

The team is very good at the level of process development and seems to give great support to (local) industries, is well organized and delivers decent work.

Academic impact

The academic output, when reflected in the impact of publications, might require more attention both in the number and JUFO ranking of papers. As in the previous report, the advice remains to keep focusing on publications in higher-impact journals to further increase (inter) national recognition and enhance societal and scientific impact. That shift was clearly not made yet over the past five years.

Even though it is realized that EU funding is very competitive and hence maybe not considered efficient to apply for, the contribution from global research funding is very small.

Societal impact and entrepreneurial and innovative capacity

The service to (local) industry is very clear. For a department that works so closely with industry, however, the number of patents and spin-offs is considered small. It is realized that the incentives in this direction (e.g., absent in university KPIs) and support in patent writing by LUT are relatively limited. A stronger focus on the development of novel, scientifically groundbreaking approaches in the different research teams could open new avenues here.

The presented impact case was surely a very solid piece of relevant work, but it did not reflect a unique breakthrough that had been realized by the department.

It was unusual to see a separate sub-unit for company collaboration, but as long as there are no conflicts of interest with the industrial liaisons of the individual professors and with the executive growth manager at university level, this is surely acceptable. It was hard to judge the real added value.

Research environment

The evaluation committee was impressed by the available laboratories and the wide range of high-quality equipment. Especially the pilot hall was impressive and seemed to be well used. This strong set of equipment is recognized as being financially very challenging to maintain.

The existence of a large technical support team of 11 people is highly appreciated and recommended to remain very well supported in the future.

The 'team sport' session in the self-assessment is highly appreciated, even though it was not straightforward to probe this during the RIA. In this respect, allowing people to work two days per week remotely is ok, but it might be on the high side, especially for people that are supposed to do laboratory work.

The reported confidential development discussions are highly appreciated and even motivated to become better exploited, especially after considering remarks by the doctoral students. It was not clear whether this was working equally well in all the research teams. It is suggested to follow up on this more closely.

The gender balance and diversity are excellent.

The participation in research platforms and the multi-disciplinary approach of the department is highly appreciated.

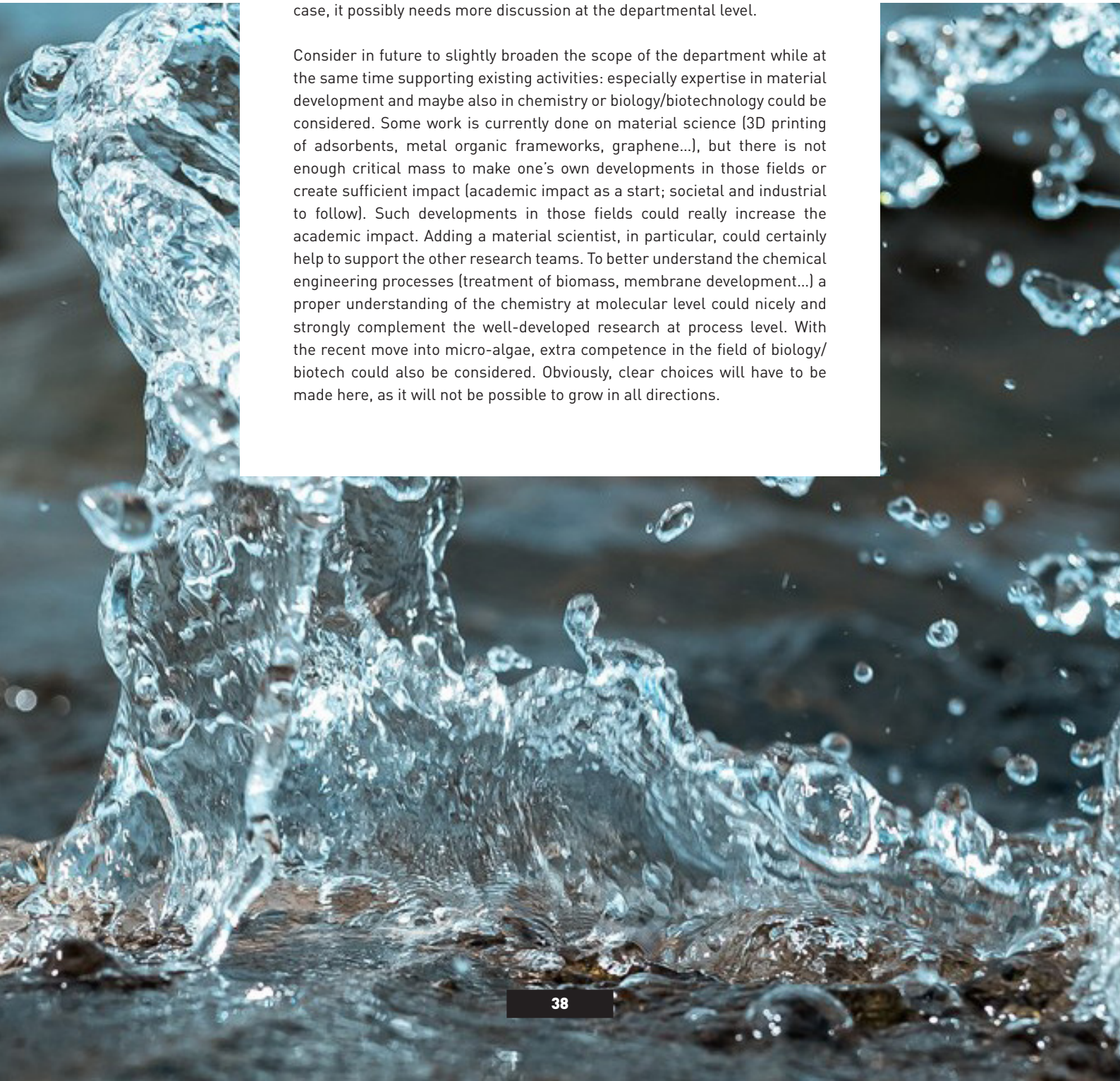
Future potential

The strategic vision in the self-assessment could have been worked out better. During the discussion, more details were revealed. Still, no clear groundbreaking approaches were announced or potential big scientific leaps made clear. Maybe a bit too much of the same (partly explained by a very strong link with existing industry)?

Recommendations

The strategic vision in the self-assessment report was very general. In any case, it possibly needs more discussion at the departmental level.

Consider in future to slightly broaden the scope of the department while at the same time supporting existing activities: especially expertise in material development and maybe also in chemistry or biology/biotechnology could be considered. Some work is currently done on material science (3D printing of adsorbents, metal organic frameworks, graphene…), but there is not enough critical mass to make one's own developments in those fields or create sufficient impact (academic impact as a start; societal and industrial to follow). Such developments in those fields could really increase the academic impact. Adding a material scientist, in particular, could certainly help to support the other research teams. To better understand the chemical engineering processes (treatment of biomass, membrane development…) a proper understanding of the chemistry at molecular level could nicely and strongly complement the well-developed research at process level. With the recent move into micro-algae, extra competence in the field of biology/biotech could also be considered. Obviously, clear choices will have to be made here, as it will not be possible to grow in all directions.



UoA9 | DEPARTMENT OF SOCIAL SCIENCES

Research profile

The research at the Department of Social Sciences focuses on sustainable citizenship, enabling renewable societies and the connections of people and technology, because understanding sociotechnical change, communication, and how these interact with societal power structures is essential when promoting systemic change and sustainable growth in, for example, existing energy, food, and water systems. Research themes have included strengthening civic capacities for participating in decision-making; resisting disinformation and propaganda; natural resource governance in relation to sustainability transformations; energy transition management; digital economies; social sustainability in relation to work, retirement and welfare; organizational and global communications and management; consumption and social change; and energy systems integration.

The emerging research profile of the UoA9 aligns rather well with the strategy of LUT. Its research profile is interdisciplinary within the social sciences, and it is challenge-led and impact-oriented. While the unit is very recently established, its members are reaching out to other departments and schools and are adapting to the collaborative ethos. The unit can also extend LUT collaborations with non-academic partners from industry and business towards local governments and non-governmental and civic organizations.

However, the research profile of the UoA is and will be evolving as the staff grows from the current below 40 to around 100 by 2030. This may involve strengthening the originally adopted themes or broadening the focus to new themes whilst maintaining the entrepreneurial spirit. There is a need to reflect on the developing research profile and ongoingly manage it.

Scientific quality

Because the unit of assessment was established very recently, it has not reported on its publications or research funding, and for this reason, it is not possible or it would be ill advised to assess the quality of its scientific output.

Academic impact

Because the unit of assessment was established very recently, it is not possible to assess the quality of its scientific output. However, given its timely and relevant research themes, its potential to have academic impact is good and credible.

Societal impact and entrepreneurial and innovative capacity

Because the unit of assessment was established very recently, it is too early to assess the scientific output and its societal impact. However, given its timely and relevant research themes, challenge-led and impact-oriented approach and interfacing with a new set of stakeholders for LUT, its potential to have societal impact is deemed to be good and credible.

However, to further enhance the impact potential, the unit should conduct an assessment to identify its key collaborators and stakeholders from time to time and to develop a strategy for interacting and engaging with them so as to use stakeholder views and priorities to inform its further development.

Research environment

The unit was established and is currently embedded in the School of Engineering Sciences. The choice may not look obvious at first, but it will help establish the challenge-led, impact-oriented approach in the developing unit which is envisaged to become a school of its own in about five years' time. The unit considers itself to be very well supported in the school and in particular by the dean of the school.

The unit plans for a research group structure based on a single professor surrounded by earlier-career academics, post-doctoral researchers and doctoral students. This solution is pursued to facilitate the ambitious goal of growing the unit from its current 40 members to around 100 by 2030. The solution may indeed facilitate growth in the early period, but it may also lead to fragmentation and an inability to communicate the expertise and profile of the unit after it has gained size. Therefore, it is important to revisit the structuring of the unit and adapt from time to time if need arises.

The members of the unit have already pursued collaboration across campus, and some of them have joined platforms. They have also brought with them existing links and collaborations, which can serve as the starting point for external collaborations. However, additional attention is needed to develop further international collaborations to enhance the visibility and profile of the unit internationally. The first doctoral students started their studies in the unit around the time of its formal establishment, which is a good achievement. It was not possible to deem how well existing doctoral training programmes, which are not actually social scientific in nature, are ready to support the training of the

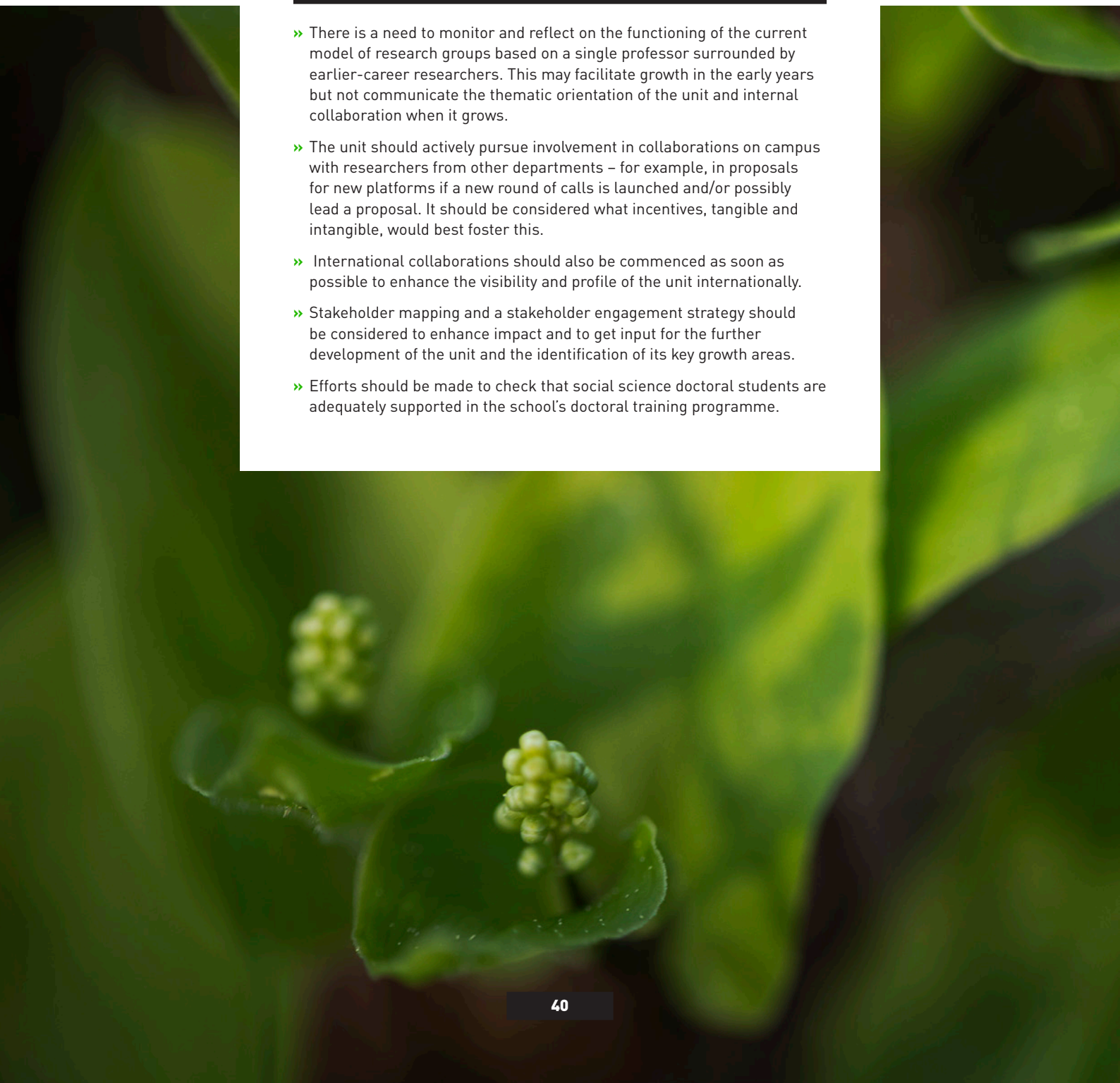
social science doctoral students, and a priority should be to ensure their training needs can be met.

Future potential

The future potential of the unit is convincing, considering its sound alignment with LUT's strategic priorities and orientation. The unit is also aware of the key challenges it faces when seeking rapid growth in the coming years. That said, in the near-term, the focus should increasingly be on the strategies, actions and measures to address the challenges and to realize the potential that the unit has. Attention to the establishment of further international collaborations should be a key part of this too.

Recommendations

- There is a need to monitor and reflect on the functioning of the current model of research groups based on a single professor surrounded by earlier-career researchers. This may facilitate growth in the early years but not communicate the thematic orientation of the unit and internal collaboration when it grows.
- The unit should actively pursue involvement in collaborations on campus with researchers from other departments – for example, in proposals for new platforms if a new round of calls is launched and/or possibly lead a proposal. It should be considered what incentives, tangible and intangible, would best foster this.
- International collaborations should also be commenced as soon as possible to enhance the visibility and profile of the unit internationally.
- Stakeholder mapping and a stakeholder engagement strategy should be considered to enhance impact and to get input for the further development of the unit and the identification of its key growth areas.
- Efforts should be made to check that social science doctoral students are adequately supported in the school's doctoral training programme.



UoA10 | DEPARTMENT OF SOFTWARE ENGINEERING

Research profile

From an international perspective, software engineering typically covers a wide range of competences: software development technologies and tools, software architectures, the software development life cycle, and corresponding competencies in programming languages and software development platforms and their applications to the production of functioning, correct, and sometimes certified software systems that are effective and efficient. This is often combined with departments of computer science, where the foundational competence is located. At LUT, the situation is remarkably different: there is no identifiable computer science, and the software engineering department concentrates on human-computer interaction, digital transformation, and software engineering, where software is not a produced output itself, but which rather concentrates on the study of the adoption, enactment and evaluation of IT technologies and systems in companies and for the production of products. This department studies the "business" of software, software ecosystems and the software-driven economy. This is traditionally a part of the information systems complex and quite frequently located in a business school.

Accordingly, this department has a very clear and well-defined research profile that is much narrower than the customary span of software engineering.

According to the self-assessment report, the department refers to itself as "LUT Software", and it declares LUT Software research to target the three focus areas of
1) software development
2) digital transformation
3) user-centred design

It is challenging to evaluate the department in several respects:

- concerning scope, universities such as Chalmers and NTNU have a much wider coverage of the software engineering spectrum and would additionally have strong computer science that provides opportunities for complementation and collaboration not present in LUT;
- concerning uniqueness of the profile within LUT, there are significant apparent overlaps with competences with IEM, the sustainability science department and the business school, which creates potential for collaboration but also presents a risk for duplication;
- concerning the fit with the LUT strategy, the current profile aligns with the "Business and Society – Sustainable Renewal of Business, Industry and Society" initiative, especially concerning studies on how to "create value in the digital economy" and "drive sustainable growth". It does not, however, cover aspects of hands-on software development; that is, it risks not to be able to provide concrete (advanced, high-end) software development to the platforms, projects and applied initiatives in LUT.

The research profile of the department can be described as narrowly focused within the software engineering denomination.

Scientific quality

The department is laser-focused on its objectives and strengths and very successful within this scope.

The department was formed from the IEM department in 2020. It has grown in five years from ca. 50 to ca. 170 publications per year, with a clearly international and collaborative strategy that has led the group and LUT to be considered a leader in Europe and likely also a global top player in software business, and since the arrival of Najmul Islam, also in digital transformation. In the JUFO classification system, most of the publications are at level 1. This is possibly because these topics are not trendy in higher-rated journals (therefore, there is little opportunity at levels 2 and 3), although there are also good level 2 and 3 publications.

The department has an extensive international cooperation network, both through external projects and joint publications. It hosts several international conferences and events, such as ICSOB 2023 in Lahti, and its members are leaders in a number of communities within the covered scope.

Multidisciplinary collaboration is a key characteristic of the department's activities and research.

The number of external projects with diverse partners reflects a broad interest in the department's activities, but it also presents challenges in terms of restricting the long-term focus on the human and decision aspects of ICT.

Academic impact

The top-cited papers are literature reviews (two papers with over 300 citations), frameworks (over 200 citations) and studies of human behaviour, for example, during COVID. One of these latter works, published in Elsevier's Journal of Retailing and Consumer Services, has received over 1000 citations since 2020. One professor has received over 2500 citations annually, two others are around the 600–800 marks, and some younger members of the team are at the 400–600 level. This indicates that the department's research is relevant within the international research

community, with a leading position in selected topics. This, in spite of the previously mentioned prevalence of JUFO 1 forums, justifies a combined score of 4 arising from a significant component at level 5 of clear international recognition but also a great deal of level 3 elements in need of further development.

Societal impact and entrepreneurial and innovative capacity

The team is very successful in acquiring projects, reflecting their generally high drive for outward engagement and their excellent communication abilities. This results in an entrepreneurial and holistic approach to all of the team's activities: they are essentially practicing within the department what they preach to others as consultants. The department has an outstanding record of EU engagement and financial success – much higher than the LUT average – and the majority of the funding is external, which is unique at LUT. The department's number of students has grown tenfold (25 to 250), with a corresponding enlarged footprint in the education landscape and a unique amount of international tuition income. The department is very active in conference organization (e.g., ICSOB 2023 in Lahti) and collaboration with companies and within the Finnish software engineering landscape. The policy report by Kari Smolander is a commendable output, and Jari Porras is a highly visible and influential researcher in ICT.

The contribution to the SDGs is very clear for this department and excellent for its profile.

In spite of the content of the projects being dominated by the human aspects in and around ICT, which is a small fraction of the general software engineering field, and by studies (i.e., with few IT development projects), the impact is very significant, with a score of 5.

Research environment

Strengths and weaknesses of the research environment and operational conditions:

The department has doubled in five years, based on their own funding successes rather than on institutional investments. This is both a strength, due to the demonstrated success and excellent international networks, and a weakness: Will such growth continue and will it be sustainable? The managerial procedures and leadership are successful: they seem to be very organized, very engaged, full of initiative, and determined to grow and establish the subject and competences even further. The existing laboratories are good, but the lack of investment funding (or similar) for cloud-based services is a problem that will only grow with new hires, and the growing body of research students will require such external commercial services. With the fast pace of change in hardware and technologies, this is indeed the best option to not waste capital on soon outdated machines that lack tending staff. If the issue remains unresolved, it could escalate from a practical problem to a limiting factor when hiring new staff who expect extensive ICT of this kind.

The balance between different position types seems to be reasonable for a department in strong growth, with a high number of post-doctoral and tenure track members. The balance of provenance and genders is such that the department is a heterogeneous environment.

Many collaborations exist both within and outside of Finland, with excellent success in funding acquisition, especially from the EU. Many projects have a short time span and limited budgets, thus generating a higher management overhead than longer and larger projects. The unsuccessful research platform proposal shows that this has been recognized and acted upon using this LUT instrument.

The specificity of the department's research topics raises questions related to the ability to cooperate with the other departments in software development roles and the potential overlaps and competition with other departments for the business of IT and IT management competences. It was palpable that the culture in the department is to foster the growth and independence of everyone, including research seminars, meetings and initiatives that go beyond the usual practice in the doctoral school and in the university. It is an almost ideal environment for team members and new hires – very attractive for acquiring further high-potential members.

Future potential

The implementation plan focuses on new recruitments, recognizes that startups and commercialization are areas to be developed, and increases the external perception of the department's competence as a leader in its field.

Considering the future potential, the current profile both aligns with the LUT strategy and meets external demands. However, there is a need for discussion about the interfaces between departments and systematic discussion on and development of the profile of the department in the wider LUT environment, maybe adding competences in more technical, software-producing topics in order to further develop the department's role and centrality within LUT.

The Lahti campus is growing further as an industry location, which is an advantage, as it is closer to the capital city region.

Recommendations

Recommendations for the future

- Reconsider the profile in the context of not losing current excellence, but also not missing opportunities of being relevant to a wider set of LUT collaborators, by building more technology competence.
- Consider in particular the risk of a further diverging scope with regard to computational engineering with regard to general excellence in software development competences, which is central also for many technical projects.
- Further develop the activities and opportunities on the Lahti campus, as both an industry and education location.
- LUT: look into the possibility to support greater use of commercial XaaS, including cloud computing services, but also working tools such as Overleaf Git licenses for the entire campus.
- Prioritize excellence initiatives, such as ERC proposals.
- Provide communication and marketing support to high-profile researchers so that impact is viewed globally.

UoA11 | LUT BUSINESS SCHOOL

Research profile

LUT Business School is the youngest of the three schools at LUT and is organized as a single department. The school is one out of currently eight business schools in Finland that hold AACSB (Association to Advance Collegiate Schools of Business) accreditation. It has a strong focus on international recognition and the visibility of its research.

The school's profile addresses most areas that are usually part of business schools, with a research focus on international entrepreneurship, purchasing and supply management, and knowledge management. In addition, a significant amount of high-level research is conducted outside of these areas. Across all topics and research fields, LUT Business School aims to specifically focus on sustainable growth and the digital economy – both topics well aligned with the LUT strategy, specifically the "Business and Society – Sustainable Renewal of Business, Industry and Society" initiative. All research foci also match well with the specific position of being a business school in a technical university and allow for relevant collaborations with other departments and schools of the university. The very proactive approach of the school to engage in such multidisciplinary research projects has been positively noted.

Scientific quality

On average, the department achieved between 160 and 190 publications each year in the JUFO classification system over the relevant period. Based on the Clarivate analysis provided, 50% of these were published in top 10% journals, an outstanding performance in comparison to other business schools in Finland. Examples include *Journal of the Academy of Marketing Science, Journal of Management, Journal of Management Studies, Journal of International Business Studies, or International Journal of Production Research.* Almost 50% of all publications have been developed in collaboration with international researchers, highlighting the strong embeddedness of the school in the international research community. We feel that this intense collaboration of the school with international faculty represents a core strength of the school and a key lever for future development.

Moving from the JUFO assessment to a more internationally oriented scale, we would rank the school as a unit where most researchers are quite consistently able to publish their research in good B or lower A journals. While strong A publications do exist, publications in such journals happen even more frequently in top international business schools. Overall, the scientific quality is very strong, with some potential to reach even higher international standards.

Academic impact

Research by members of LUT Business School created relevant impact in the international scientific community. Citations of publications are very strong compared to other schools in Finland (but not outstanding in international comparison), with notable positive exceptions for some faculty members. The substantial number of international awards and recognitions for researchers and their research provides further evidence of academic impact. The academic impact (as measured by H indices) varies across faculty members, but variation is rather small within the different faculty groups. Overall, academic impact is outstanding for Finland and very good from the international perspective.

Societal impact and entrepreneurial and innovative capacity

LUT Business School has presented several cases that showcase the societal impact of its research, largely well aligned with the topical strategy of the school, and the special position of the school in a technical university. The school interacts intensely with a variety of stakeholders and actively supports its faculty in creating impact beyond the academic community, for example with interview and media training. The school attracts around €2–3 million in external funding annually, and many of these projects have (potentially) strong impact for society and appear to be both applied and multidisciplinary. While the overall impact beyond academia is strong, we feel that it can still be further improved, specifically with regard to the quantity of impact cases and the distribution of impact cases across faculty.

Research environment

LUT Business School has made substantial efforts to create a research environment that allows to
a) address the university-level focus,
b) engage in multidisciplinary collaboration with other LUT units, and
c) increase the international research footprint of the department.

The faculty structure of the department represents a fitting structure in terms of the distribution of positions across career levels, gender balance, and age. As the report already describes, we agree that internal internationalization through more international faculty recruitment (at all levels) appears to be an important focus for the future. The amount of third-party funding in the department is reasonable, given the size of the

school. A highlight are the funded doctoral education projects that provide direct positive impact for the research environment. The department provides additional tacit measures to further improve the research environment of the school, such as research seminars, personal development workshops for faculty, and intense interaction with the international research community via visiting professorships and feedback from international faculty on doctoral work. In addition, the school operates three different 'laboratories', but their relevance for research could be more explicitly explained. With regard to the informal environment, the department tries to create a supportive culture through internal celebrations of top-level international publications, specific communication of international impact success, and international awards. Overall, we feel that the school offers a great environment for research and very actively and continuously develops it.

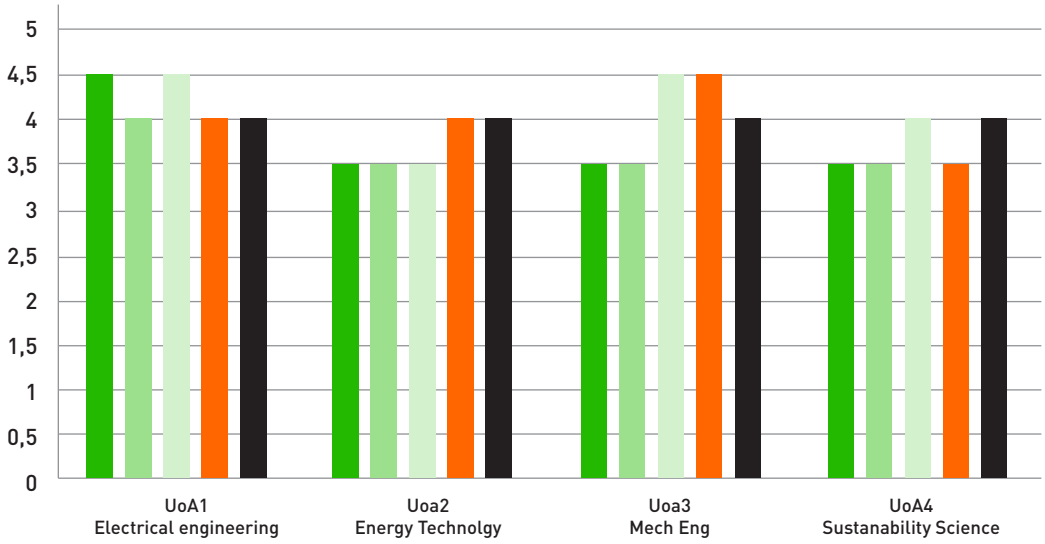
Future potential

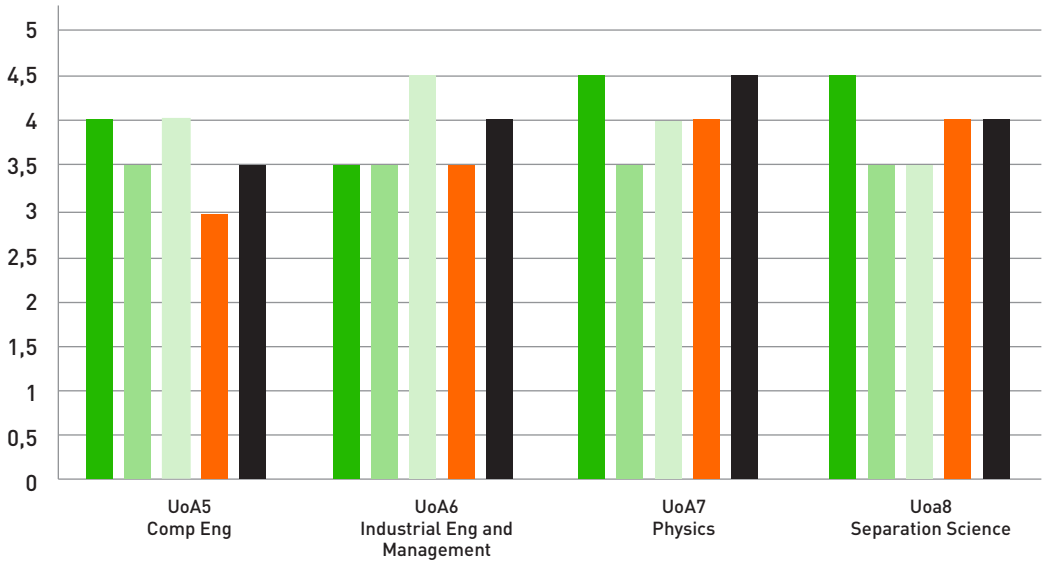
The school has three objectives for the next strategy period – top-level research, an outstanding learning environment, and strong impact beyond academia – and has developed a detailed implementation plan to reach them. We feel strongly that the future objectives and the topical focus match the university-level strategy very well and that the department has strong potential to continue to have significant impact at the university level. We also feel that the school has already reached a comparably high level of research output and impact within Finland and that strong focus for the next period has to lean on the further development of international impact (e.g., more consistently publishing in the most recognized international journals). We feel strongly that the school is well prepared for that and plans to align resources accordingly. At the same time, we feel that small further improvements are possible.

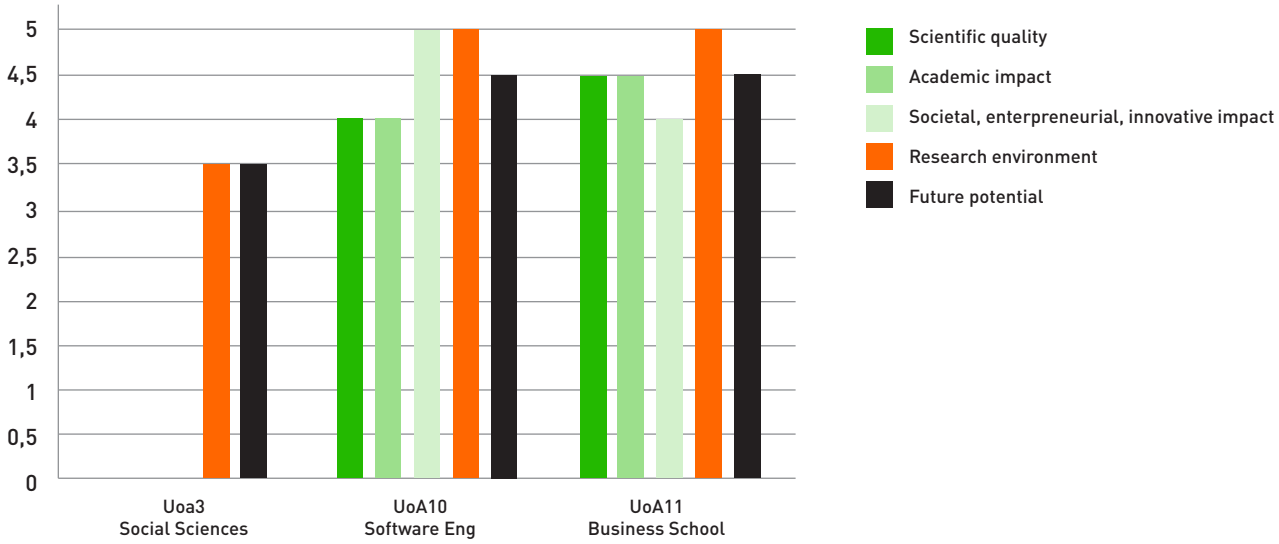
Recommendations

- Initiate an open discussion with the industrial engineering and management department (as well as, e.g., the social science and sustainability science departments) about the role differentiation and how you may develop distinct profiles. The department or at the university level; this would reduce the administrative burden for junior faculty/post-doctoral researchers.The school appears to provide some administrative support that is also provided at the university level or that could be provided at the university level, as demand from departments/the school should be somewhat uniform. In collaboration with the university level, we recommend assuring the clear distribution and execution of tasks (e.g., media officers).
- Consider formal mentoring as a tool to further develop younger faculty. This can help to leverage the research competencies of top scholars in the whole school.
- Consider more consistent integration of methodological courses in the development process of young faculty and doctoral students.
- The school conducts much research with international collaborators, but the selection of collaborators could be more strategic and supportive of research output. For example, maybe consider collaborating more intensely with young top researchers from international schools that are under publishing pressure. This may also allow you to avoid competing with all other schools in Europe for collaboration with publication-experienced senior faculty.
- Some of the recent research successes of the school are a consequence of the very early recognition of future-proof topics (e.g., AI/ML). If possible, try developing a structured process (e.g., in collaboration with alumni and other stakeholders) to discover such topics to stay topically 'ahead of the curve'.
- Some of the activities of the school can be considered best practices that may also be interesting for other schools/departments (e.g., the formal and informal structures in the research environment). Find a structured way for best practice sharing.

LUT RIA 2024 – Numerical assessment







RIA 2024 panelists

Chair:
MAARJA KRUUSMAA
is a board member of the Estonian Academy of Science and has held several positions and commissions of trust in science administration and science policy, including vice-rector for research at Tallinn University of Technology (TalTech), president-elect of the Network of Nordic Universities of Technologies (NORDTEK), member of the Estonian Research and Development Council, and member of the Future Emerging Technologies Advisory Board with the European Commission. She is also a member of the Group of Chief Scientific Advisors for the European Commission.

UoA1 Electrical Engineering:
VEENA MISRA
is the MC Dean Distinguished University Professor and the Interim Department Head of Electrical and Computer Engineering at North Carolina State University. She is the Co-Director of the National Science Foundation-funded Center for Advanced Self-Powered Systems of Integrated Sensors and Technologies (ASSIST). She is an IEEE fellow and a distinguished lecturer for IEEE Sensors. After working at the Advanced Products Research and Development Laboratories, Motorola Inc., Austin, TX, she joined the faculty of North Carolina State University in 1998. Dr Misra is the recipient of the 2001 National Science Foundation Presidential Early Career Award, the 2011 Alcoa Distinguished Engineering Research Award, the 2007 Outstanding Alumni Research Award, and the 2016 R.J. Reynolds Award. In 2022, she received the Alexander Holladay Medal, considered to be the highest honour bestowed by NC State University and its Board of Trustees.

UoA2 Energy Technology:
LUCIANO MULE'STAGNO
is the Director of the Institute for Sustainable Energy at the University of Malta and holds a PhD degree in physics from the Missouri University of Science and Technology. He spent 12 years in the US as the Director of Worldwide Labs at MEMC Electronic Materials. His major expertise is the characterization, engineering, and synthesis of semiconductor and solar materials. Over the past 10 years, he has also worked on offshore solar and solar systems. He has a passion for heritage and environmental issues, was the CEO of Heritage Malta (2007–2009) and is currently a council member of Din L-Art Helwa (National Trust of Malta). He is also Chairman of the European Cooperation in Science and Technology (COST) scientific committee and has served on the boards of several local companies.

UoA3 Mechanical Engineering:
ANNIKA STENSSON TRIGELl
has been Professor in Vehicle Dynamics at the School of Engineering Sciences at the KTH Royal Institute of Technology, Sweden, since 2000. She was Vice President for Research at KTH from 2017 to 2022 and responsible for the KTH Research Assessment Exercise (RAE 2021), which included the evaluation of all research groups at KTH and involved 90 external evaluators. Professor Trigell has extensive experience in managing about 20 multidisciplinary research centres in engineering and is engaged in about 20 committees for evaluating research funding. For example, she has been a member of expert panels in mechanical and electrical engineering for the Research Council of Finland and an external evaluator for automotive research at HAN University of Applied Sciences, the Netherlands.

UoA4 Sustainability Science:
Dagnija Blumberga
Heads the Institute of Energy Systems and Environment at Riga Technical University. She has a doctoral degree in energy engineering. Her main research areas are energy policy, renewable energy resources, and energy efficiency, including climate technologies. However, her work over the past 20 years has related to the integration of environmental problems into engineering science through the creation of environmental engineering bachelor's, master's and doctoral study programmes at Riga Technical University. She has supervised 46 doctoral theses during the past 20 years. She is the author of close to 500 research papers and 15 scientific monographies. She has participated in different local and international projects of FP5, FP6, FP7, HORIZON 2020 and HORIZON Europe.

UoA5 Computational Engineering:
HABIB N. NAJM
is a Senior Scientist at the Chemistry, Combustion, and Materials Science Center at Sandia National Laboratories in Livermore, CA, USA. He works on research in computational science, uncertainty quantification, statistical inference, data science, and machine learning as applied to physical systems. His work, documented in the open literature, spans the development of numerical methods and software across this landscape, with application in computational studies and analysis of reacting flow, chemistry, catalysis, and materials.

UoA6 Industrial Engineering and Management:
ØYSTEIN MOEN
is a professor at the Norwegian University of Science and Technology (NTNU), the Department of Industrial Economics and Technology Management. He has published in journals such as the International Business Review, Journal of International Marketing, and Journal of Small Business Management. Earlier, he has been the head of department, and he has been in charge of several research projects often focusing on the maritime sector or the energy sector. He is a member of a working group defining the NTNU budget allocation principles and has been strongly involved in university management recruitment processes. He was also part of the previous LUT RIA evaluation panel.

UoA7 Physics:
CHRIS PARKES
is an experimental particle physicist working at the University of Manchester. He was the leader of the Large Hadron Collider Beauty (LHCb) experiment from 2020 to 2023. LHCb is one of the world's largest scientific projects with around 1500 members from nearly 100 institutes in 21 countries. He was the LHCb Vertex Locator (VELO) Project Leader during the first LHC physics period (2010–2012). He led the W Mass measurement group on the DELPHI experiment at the previous CERN collider, LEP, and was a member of the LEP W working group. He was head of the Accelerator, Nuclear and Particle Physics Division in Manchester (2016–2017). He has been a member of the UK particle physics funding council panel for new projects (STFC PPRP) and its grants panel (STFC PPGP). He was a CERN Guest Professor 2020–2023 and a scientific associate with CERN in 2010–2012 and 2018–2019.

UoA8 Separation Science:
IVO VANKELECOM
studied bioscience engineering at KU Leuven and obtained his PhD degree on membrane development in 1994. Since 2002, he has been a professor at KU Leuven. He is the author of around 400 peer-reviewed papers with an H-index of 75, has collaborated with more than 50 companies, and has 30 patents. His main research areas include the development of membranes for (solvent-tolerant and solvent-resistant) nanofiltration, RO, gas separations, membrane bioreactors, flow batteries, and water electrolysis.

UoA9 Social Sciences:
JOUNI PAAVOLA
is Professor of Environmental Social Science and Co-Director of the ESRC Centre for Climate Change Economics and Policy (CCCEP) in the School of Earth and Environment at the University of Leeds. His research examines environmental governance institutions and their environmental, economic, and social justice implications around climate change adaptation and biodiversity conservation. He has published over 100 articles in journals such as Science, Nature Climate Change, Ecology and Society and Ecological Economics. Paavola was a member of the Scientific Committee of the European Environment Agency (EEA) in 2008–16. He was a member of international teams which evaluated the University of Hamburg and the University of Eastern Finland, and he has substantial experience in the evaluation of research programmes and projects for the European Commission and research councils of the EU member states.

UoA10 Software Engineering:
TIZIANA MARGARIA
is Chair of Software Systems at the Department of Computer Science and Information Systems at the University of Limerick. She has broad experience in the use of formal methods for high assurance systems, in particular concerning functional verification, reliability, and compliance of complex heterogeneous systems. Current application domains are to embedded systems, health care, and smart advanced manufacturing. She is Vice-President of the Irish Computer Society and of IFIP WG10.5. She is a principal investigator of Lero, the Science Foundation Ireland (SFI) Research Centre for Software, Confirm, the SFI Research Centre for Smart Manufacturing, and LDCRC, the Limerick Digital Cancer Research Centre. She is also Co-Director of the SFI Centre of Research Training in Artificial Intelligence. Her most recent achievement is the Immersive Software Engineering integrated BSc/MSc programme, which is a tightly knit ecosystem spanning education, industrial practice, and research.

UoA11 Business School:
JONAS PUCK
is Dean for International Relations (starting March 2024) and Full Professor at the WU Vienna University of Economics and Business. He was the founding Head of WU's Institute for International Business. In addition, he is Academic Director of the MBA in Energy Management at the WU Executive Academy and Co-Director of WU's Research Initiative in Sports and Management. Previously, he held the position of Academic Director of WU's CEMS programme and was Head of the Department of Global Business and Trade. Jonas is a Fellow of the European International Business Academy and currently acts as the elected Vice-Chair of the organization.