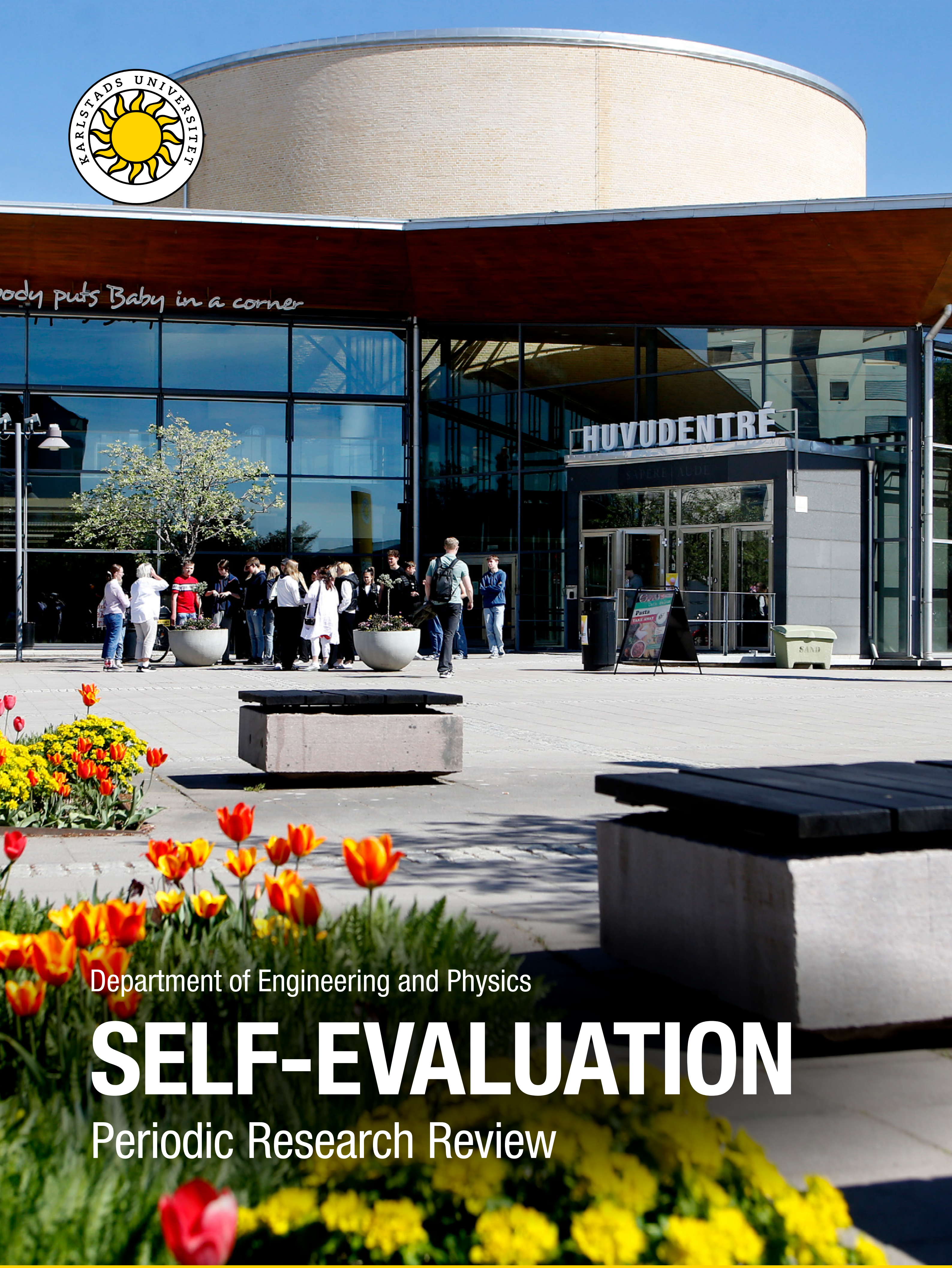
KARLSTADS UNIVERSITET



Department of Engineering and Physics

SELF-EVALUATION

Periodic Research Review

Self-evaluation of the research conducted at the Department of Engineering and Physics

Introduction

The Department of Engineering and Physics is one of five departments in the Faculty of Health, Science and Technology at Karlstad University. The Department consists of four subjects: Materials and Mechanical Engineering (MME), Physics, Electrical Engineering (EE), and Industrial Engineering and Management (IEM). The organizational structure of the department is shown in Figure 1. Three subjects; EE, Physics, and MME are part of this self-evaluation.

IEM was established at the end of 2024 and is therefore not included in this evaluation. The research in Physics Education is carried out under the umbrella of the Research Centre of Science, Mathematics and Engineering Education Research (SMEER). Since SMEER is a separate entity within the Faculty of Health, Science, and Technology, it will be evaluated separately and is not included in the present self-evaluation.

Two subjects, Materials Engineering and Physics, have examination rights for third cycle studies. Within MME, there is ongoing work to extend the examination rights from materials engineering to a combined discipline. EE lacks examination rights for doctoral students, and the four doctoral students associated with the subject are enrolled at the Department of Computer Science and Mathematics at KAU, and Energy and Environmental Technology, Dalarna University.

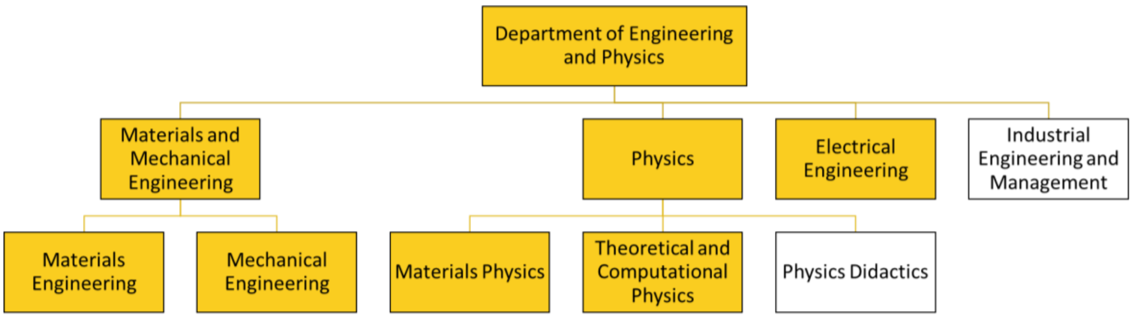


Figure 1. Organization scheme for the Department of Engineering and Physic. The non-colored boxes represent subjects that are not directly included in the evaluation.

The staff composition of the evaluated subjects is shown in Table 1. Physics has the highest number of professors. MME has the highest number of PhD students, where seven are industrial PhD students.

Table 1. The total number of employees in different subjects at the end of 2025.

Subject	Professors	Senior lecturers	Lecturers	Assistant lecturers	Research engineers	Doctoral students and Postdocs
EE		4	2	1		4+1
Physics	5	4	0	2	1	6+1
MME	3.3	5	4	1	1	11*

*Seven out of these are industrial doctoral students

The department has a steering board consisting of a Head of Department, a Deputy Head of Department, Directors of studies, and subject representatives. The department has a Department Council and an Education Council that serve as advisory bodies for the Head of Department. The Department Council consists of the management team as well as professors, selected research leaders, and student representatives. The council addresses issues of strategic importance in research and education, such as the development of research and educational programs, finances, research funding, competence supply, and doctoral education. The Department Council normally meets once every semester and is chaired by the Head of Department.

The Education Council consists of the management team, program coordinator, and student representatives. The Education Council deals with matters related to undergraduate education and student-related issues. This includes quality assurance in education, program and course development, syllabi and course evaluations, internationalization, operational planning, and more. The handling of syllabi and course evaluations is coordinated with the program councils. The Education Council normally meets once every semester and is chaired by the Deputy Head of Department.

This self-evaluation is organized in such a way that each of the three subjects has performed the evaluation separately, and the results are presented for each subject in turn, in the following order: EE, Physics, and MM.

Electrical engineering

1. Summary

The subject of EE is a part of the Department of Engineering and Physics, which carries out research in the field of intelligent electrical power, renewable energy systems, and automation. The EE subject has not yet been approved to provide third cycle studies. However, it is engaged in PhD students' supervision and high-quality research in collaboration with other research environments within KAU and other universities. The EE subject has leading roles in the research center SOLVE - Solar Electricity Research Centre, Sweden, specifically in the topic of "Planning of large scale expansion of solar energy,"[1] in DAMI, specifically in the topic of "Smart Energy Solutions (Renewables, SmartGrid),"[2] and projects supported by regional funding, such as LOKEN - Lokal energiledning Värmland, and Interreg- GränsEnergi,[3]. In addition, the EE group participates in the Swedish research center SESBC, Swedish Electricity Storage and Balancing Centre[4].

Strengths

The research environment demonstrates strong interdisciplinarity, encompassing several energy-related domains. This breadth of expertise enables collaboration across multiple research environments within KAU and with other universities, including computer science, mathematics, energy engineering, and physics. Furthermore, the group has developed an extensive network of industrial partners and public authorities at national and international levels. This wide collaborative ecosystem enhances the group's relevance, visibility, and potential for impactful applied research.

Weaknesses

A major limitation of the current research environment is the absence of structured second-cycle (Master) and third-cycle (Doctoral) education programs in the field. This restricts the development of a sustainable pipeline for early-stage research talent and limits the public and academic visibility of the group. Consequently, it becomes challenging to expand the human and infrastructural capacity of the research environment. Although the EE group maintains an extensive international network, the weak integration with research-related educational activities reduces its attractiveness for long-term collaborations beyond externally funded projects, such as exchange or joint PhD initiatives. In addition, the absence of a dedicated research engineer hinders the systematic improvement and maintenance of research facilities.

[1] https://www.uu.se/en/research/solve/projects/6.-planning-for-large-scale-expansion
[2] https://www.kau.se/en/dami/about-dami
[3] https://glavaenergycenter.se/sv/
[4] https://www.sesbc.se/

Opportunities

There is a high concentration of national and international funding opportunities in the research areas where the EE group is active. Their thematic focus aligns well with societal, industrial, and public interests, especially in the transition towards sustainable energy systems. This alignment creates a favorable environment for growth and expansion through interdisciplinary research, industrial partnerships, and increased participation in competitive research calls. These factors collectively form a strong foundation for further strengthening the position and impact of the EE research group within the broader research landscape.

Threats

The small size of the research group and its limited human resources, combined with substantial commitments in research, education, and administrative tasks, pose significant challenges. These pressures risk creating excessive workloads, internal stress, and potential strain on group dynamics. Moreover, the heavy administrative and management responsibilities placed on researchers limit time for recovery between tasks, threatening work–life balance. This imbalance is also reflected in staff well-being assessments, highlighting the need for careful monitoring and proactive management to ensure the sustainability of the research environment.

2. Organization and leadership

Organization

Most of the research organizational activities in EE are coordinated by the Head of Subject (ämnesföreträdare). Specifically, on department organization level, the head of subject together with the Director of studies represents the subject in the management team meetings. In addition, most of the EE members collaborate under the initiative of the research group CREATE (Intelligent eleCtrical and REnewAble energy sysTEms)[5]. The CREATE group coordinator organizes regular meetings with researchers who follow CREATE to discuss current trends and management decisions.

Recruitment, Competence development and career support for researchers

Recruitment in EE subject is organized according to KAU regulations. Since EE is traditionally male dominated, we always welcome highly competent female colleagues to join the subject.

[5] https://www.kau.se/en/electrical-engineering/research/research-electrical-engineering/create

Competence development and career support

Competence development and career support are organized at university level by the Centre for teaching and learning (UPE) and the Grants and Innovation Office (GIO). Courses in teaching, supervision in higher education, and research leadership are requested as an obligatory prerequisite for promotion. Members of EE can participate in such courses according to their interest and their availability in connection with departmental conditions. Now, there is one associate assistant professor supported by a KKS Recruitment Grant who is in close connection with GIO and UPE to attend courses needed for future employment and career development. The EE subject is planning to recruit/promote one professor in Electrical and Renewable Energy. The long-term goal is to obtain examination rights for third-cycle studies.

Other contextual aspects

The EE subject is working closely with industry, regional and national authorities to strengthen mutual interests regarding collaboration and to provide opportunities for research projects.

3. Scientific results and academic impact

The subject of EE carries out research in the field of intelligent electrical power, renewable energy systems, and automation. The EE subject has leading roles in two well-acknowledged research centers. First, we have the leading role in the research theme “Planning of large-scale expansion of solar energy” in SOLVE. Under this collaboration, we are engaged as co-supervisors for three PhD students and as the main supervisor for one PhD student. In the research center DAMI[6], the group has a key role in the topic of “Smart Energy Solutions (Renewables, SmartGrid)”. In addition, EE is collaborating in several interdisciplinary projects together with Glava Energy Center, where the most prominent are Kluster för innovationer och utbildning inom hållbara energisystem. Furthermore, the EE group participates in SESBC. Good examples of academic collaboration at the national level are joint efforts with Uppsala University and Dalarna University via shared PhD students.

The research infrastructure at EE is generally satisfactory. There are substantial software facilities that are used to conduct our research such as MATLAB and Simulink, Electromagnetic Transient Program (EMTP), Python-based web-based alternatives for components and systems modelling as well as energy management and optimization studies. Over the last few years, the EE subject has developed hardware facilities via both external and internal funding. A complete and modular physical system model of the electrical power grid

[6] https://www.kau.se/en/dami

that includes wind and solar power generation has been installed. The system is supported by SCADA, a parallel control and supervision system with data collection and logging. We are planning to expand the system with further storage and edge-devices such as NVIDIA Jetson nano devices for real time supervision, storage, and modelling.

The research in the EE subject is both theoretical and experimental and carried out in close collaboration with industrial partners, regionally, nationally, and internationally. Together with our collaborators, the EE group formulates joint projects in which several staff members from EE and surrounding research groups, for example from Computer Science and Mathematics, participate. The projects are led in most cases by the EE group. Representative funders of our research are KKS, Vinnova, Energimydigheten as well as international-type calls such as Interreg and CETP calls. Our scientific outcome is disseminated via national and international conferences and published in highly reputable international peer-reviewed journals. Over the past few years, the EE subject has substantially increased the research output in terms of journal and conference publications as well as external research funding and strategic collaborations. Most of the research in EE is funded from external sources. The EE subject continuously gains international visibility via key collaborations and publications. This is because of the initiatives of the members of the EE subject towards building a coherent research environment.

Strategically, the EE subject envisions involvement in joint international research schemes aiming to strengthen international visibility and to establish long-term international collaboration channels. Currently, several EE subject members are establishing key collaborations with universities from the UK, Germany, Denmark, Spain and Japan with which we have a number or running applications. International collaboration is mostly based on the individual collaboration of the EE subject members with academic and industrial partners in Germany and Austria to name a few. A good example of collaboration is a project with Deggendorf Institute of Technology about AI-based modelling and decision-making in relation to energy systems.

At this point, we must highlight that the research outcome depends on the stability of the senior staff group and the supervision of PhD students. During the last years there have been disturbances in the human resources of the EE subject, and in connection to that EE is not established as an official research subject. We would say that a strategic short-term plan is needed to support the subject in its ambition to expand towards the full spectrum of research and education practices.

4. Academic culture

Regarding research project applications and research collaboration, there are individual initiatives from the staff in the EE subject. However, over the last few years a new culture has been established in EE subject via the CREATE research group. The group has regular informative meetings at which all members in the CREATE group are engaged and in which running projects are discussed, opportunities for new applications are explored, expansion of research facilities are proposed and in general, all necessary topics related to the improvement of the quality and the expansion in research are examined. These meetings are led by the research group coordinator. The agenda is formulated by all members according to their needs for information and sharing. At these meetings, the researchers communicate their views about the projects, share networks and partners, express open and honest opinions about roles, tasks, duties and contributions, and create a solid background for future research collaboration. These meetings are valuable, but not everyone is able to participate. This is because senior researchers have secondary but urgent administration and management tasks that oblige them to re-schedule their calendar accordingly. Hence, it is of paramount importance to cope with this situation as described in the Threats section above.

Except for these informative meetings, dedicated meetings for each project are called according to the usual practice that follows the timeline of research projects. The project group meetings are important to discuss project goals, framework, roles and responsibilities, questions related to publications, knowledge dissemination, and co-authorship more generally, thus guaranteeing involvement and contribution in project decisions. In addition, supervisory and personal progression meetings are commonly organized between supervisors/mentors and PhD students/junior staff members.

The EE subject is regularly involved in several development practices and dissemination of results. For example, regarding our PhD students, we always recommend that they join the activities of the Faculty NT Research School. Additionally, EE is a part of the DAMI research environment, which organizes regular seminars and networking events. Via the Reseach school and DAMI events, the PhD students, the supervisors and others can exchange knowledge, discuss issues and present results. Open discussion and learning from each other are important factors in developing a creative research environment. In addition, the establishment of contacts with GIO via the CREATE research group and in parallel, the offer of pedagogical research courses via UPE, provides opportunities towards career and competence development.

4. Collaboration with the surrounding community

The development of the EE subject follows academic as well as social needs beyond academia. This means that the EE group aims to reflect and interact with real world problems as they

appear in the industrial sector, regional development necessities, targets on national level and opportunities via international themes. During the last few years, the EE subject has been working hard to increase the network with key industrial clusters, regional authorities and national and international environments.
The result of this strategic work has substantially increased the network, which has resulted in several new collaborations and projects. Specifically, regarding the surrounding community, we are engaged with regional industrial clusters like Compare and Paper Province, research centers like Glava Energy Center and RISE, the regional energy companies, and Region Värmland and the municipality of Karlstad. The research is related to energy transition, digitalization, and societal electrification, renewable energy systems, and new business models. The results are disseminated via articles in conferences and journals, seminars, invited talks and networking activities in regional, national and international forums.

6. Interaction between research and education

The EE subject hosts one educational program, a Bachelor of Science in EE (180 ECTS credits). The program profile is about electricity grids and renewable energy. In the labor market, there is a high demand for students with such backgrounds and nearly all of them are employed directly after graduation.
There are plans to develop a Master program in electrical engineering with a specialization on smart electrical grids. The Master program will offer a blend of electrical engineering and data science. This involves addressing grid control with computational tools, machine learning, and simulation technologies. The program will build on a strong background in EE and combine this knowledge with data-driven methods. This development is in line with a newly developed Master program in MME (data-driven mechanical engineering), and several generical courses are expected to be the same in the two Master programs. Further, there are discussions about developing Master courses in cooperation with subjects in engineering physics and environmental and energy systems at the Department of Engineering and Chemistry. The final stage of releasing the program Smart Electricity Grids is on hold due to departmental decisions. Teachers involved in the courses of that program are also involved in research projects and therefore know the state-of-the-art in areas of research. The core topic of the proposed Master in EE in Smart Electrical Grids is aligned to the Bachelor in electricity grids in the EE subject and our research as described above.
The strong connection between the research in the subject and the educational program is manifested by the fact that many of the theses are completed as part of the ongoing research projects conducted by researchers in the subject. As such, a Master program as the one mentioned above in Smart Electrical Grids constitutes an excellent opportunity for fruitful

interaction between research and education. To this end, because of the interdisciplinary nature of smart electricity and renewable energy research, several groups within the department and the faculty such as the EE subject, MME, Physics, Computer Science and Mathematics may collaborate in both research and education.

Physics

1. Summary

Researchers in Physics work in the fields of Materials Physics, Theoretical and Computational Physics, and Physics Education. The research is international, with an extensive network of shared projects and collaborations. Physics as a subject is generally successful in obtaining external research grants.

More specifically, some examples of research areas in Physics that are represented at Karlstad University are as follows:

- materials physics; solar energy materials, surface science, and nanomaterials,
- theoretical and computational physics; condensed matter theory and quantum many-body physics,
- physics education; which is not directly part of this review, but related (as discussed in other sections) research is about practical laboratory tasks, and concrete techniques like the use of infrared cameras in physics teaching.

Physics has leading roles in national collaborations such as the Swedish research consortium SOLVE (Solar Electricity Research Centre) for the topics *Advanced Photovoltaic Technology*[7] and *Economics and Business Models*, in the regional network LOKEN (Lokal energiledning Värmland) with Glava Energy Center, the Swedish research center SESBC (Swedish Electricity Storage and Balancing Centre)[8], and PRISMAS PhD Program[9]. Internationally the subject participates in MSCA cofund and Horizon Europe MSCA-doctoral network[10]. Other funding agencies are the Vetenskapsrådet, Wallenberg Foundation, and the Swedish Foundation for Strategic Research. The group is part of the Wallenberg Initiative Materials Science for Sustainability[11].

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[7] https://www.uu.se/en/research/solve/projects/1.-advanced-pv-technology
[8] https://www.sesbc.se/research/materials-and-devices-for-energy-storage
[9] https://www.maxiv.lu.se/education-outreach/programs-and-activities/prismas/
[10] https://www.tugraz.at/projekte/opvstability/home
[11] https://wise-materials.org/

Strengths

The Physics subject is involved in a wide variety of research areas, theoretical and experimental, and several that are very successful in attracting research funding. As mentioned above, it has a high degree of internationalization, both in the sense of research collaborations, and in terms of the places where the researchers themselves studied.

Very few of the senior researchers themselves have received their PhDs from Karlstad University, so this constitutes a good baseline for renewal. Conversely, at some other Swedish institutions, a significant fraction of researchers received their PhDs from the local institution itself, which is an obvious challenge for renewal.

There are clear connections in Physics at Karlstad University between research and teaching, which can be fruitful in both directions. The obvious example is the PhD program, but also at lower levels there is connection. Facilitating this synergy is the fact that the research in Physics Education is an integrated part of the subject, unlike at some other universities (see section 6).

Weaknesses

Physics is a very broad discipline, so inevitably there are major areas of physics that are not represented at all in research at Karlstad University, such as nuclear physics. Although lack of full coverage is to some extent unavoidable, it can be viewed as a weakness, since all physics is in a sense connected, and missing topics need to be addressed by research collaborations.

Opportunities

With imminent retirements at the time of writing, there is a generation of change. (Perhaps this change is in effect widely across the university, since it became a university in 1999.) Recent recruitments have led to further focus on the research profile of Physics at Karlstad University. This focus can be an opportunity to develop a research profile further for which Karlstad University can be recognized.

Threats

The generational change is an opportunity but can also be a threat. The focus of the recent recruitments inevitably leads to some other research topics in physics; some represented in the publication list of this review, no longer being carried out solely at Karlstad University. The judgement of the current Physics subject is that this is acceptable, but if one of these fields receives new and targeted funding (and some trends in physics do oscillate back and forth over time), any reduction in variety will become a threat to the ability of the department to apply for certain kinds of research funding.

On a different note, some researchers emphasize time-consuming administration for senior researchers as a threat to activities. This also means administration of teaching, so not in itself directly related to research, but still directly relevant for those researchers who teach. Again, this problem is of course not unique for Karlstad University, or for physics research. At one gathering, researchers identified the problem not as *lack* of time in total, but as the specific *use* of their time. There have been several efforts from the leadership to address this, but the results have not been evaluated yet. The recent employee surveys show positive results specifically for physics, so perhaps there is at least some improvement in this regard.

2. Organization and leadership

It is a general challenge for small universities that organizational units of reasonable size may not have leadership representing every specialty. Without specific subject competence, activities such as recruitment and competence development could potentially be less effective. For Physics at Karlstad University, the situation is good. The current Head of Department has a PhD in Materials Physics, and the Deputy Head is in Physics. The Head of Subject (Discipline) is by definition a physicist. In total, the organization has the competence to recruit in physics and has been successful in doing so.

Concerning gender balance, the Physics subject has historically had an under-representation of women, nationally and internationally. Recent recruitment has improved the situation at Karlstad University somewhat, as can be seen from the background information: out of the 21 listed employees in Physics, nine are women.

Competence development is systematically done by different courses. As an example, a current associate senior lecturer (*biträdande lektor*) in Physics is taking a course offered by the University Pedagogy Training Unit (UPE) as part of developing personal competence in connecting research and teaching.

As mentioned in the other sections, the various national and international research networks that Physics is part of provide an important context for the various researchers, in addition to the local-regional context.

Within the research field of Physics Education, research is conducted in relation to preschool, elementary school and university education in the subjects of physics and technology. The research in Physics Education is organized with subject-specific education research across departments in the research center Science, Mathematics, and Engineering Education Research (SMEER)[12], which was evaluated separately in 2023[13], and is therefore excluded from the current evaluation.

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[12] https://www.kau.se/en/smeer

[13] Registration number: LUN2023/26

3. Scientific results and academic impact

An important overall precondition for the ability of the Physics subject to maintain high quality of research output is the physical environment. The offices and laboratory spaces are located in a single building, which is relatively modern (2008). There are lists of infrastructure in the background information, but a few examples are extensive and advanced equipment for scanning probe microscopy, electron microscopy and spectroscopy, and laboratories for producing solar cells with electrical testing. One unique piece of equipment is the AFM-IR (combined atomic force microscope and IR spectroscopy). The Physics subject also uses X-ray-based methods at various synchrotron facilities, like MAXIV and SOLARIS. Since 2023, Karlstad University is part of the EU-MSCA-COFUND research school PRISMAS, at MAXIV.

Visibility can be important. At Karlstad University, one example of exceptionally high international visibility is prof. Ellen Moons, who as an internationally renowned researcher and serves on the Nobel Committee for Physics[14]. Her overall research interests are focused on the **relations between molecular structure, optical and electronic properties, and electrical performance in emerging solar cells.** The research group developed around experimental studies on solution-processed organic and halide perovskite materials for cost-effective solar cells, but grew in recent years, strengthened by computational physics and physical chemistry expertise, some with specific strength in AI and neural networks. The main research questions and contributions concern the understanding of underlying thermodynamic and kinetic mechanisms of structure formation, the energy level alignment at molecular semiconductor interfaces, and the unravelling of photodegradation mechanisms of conjugated organic molecules that make up the photoactive layer. The research is aimed at improving the power conversion efficiency, sustainable processing, and operational lifetime of emerging solar cells. The experimental techniques include scanning probe microscopy; optical and X-ray spectroscopy of solution-processed thin films used as solar energy materials, as well as fabrication and electrical characterization methods for organic and perovskite solar cells.

In the example of **surface science research**, the studies of semiconductor surfaces and nanostructures have recently been focused on quantum well states in ultrathin Pb films on Be and Ge surfaces, as well as topological effects in the metal-semiconductor interfaces. There has been a focus on materials and structures that are relevant for technological application such as spintronics. Researchers in the Physics subject carry out high-resolution electronic structure investigations of Pb quantum wells grown on surfaces, as a function of the Pb layer thickness. This research uses a combination of spectroscopy and microscopy methods: photoelectron spectroscopy, X-ray absorption, circular dichroism and scanning tunneling

[14] https://www.nobelprize.org/about/the-nobel-committee-for-physics

microscopy (STM), combined with ab initio density-functional theory (DFT) calculations to achieve complete understanding of the system under study. Synchrotron radiation at MAX IV in Sweden and ELETTRA in Italy is primarily used for the spectroscopy studies.

An example of research in theoretical physics is on symmetry structures in **quantum physics**, such as conformal and topological field theories (CFT/TFT). Traditional mathematical tools like group theory do not capture all aspects of these physical systems, which means that they require more sophisticated mathematical methods. Among them are symmetries resulting from the presence of topological defects or domain walls, symmetries that were co-discovered at Karlstad University by Jürgen Fuchs, and which are now known as categorical or non-invertible symmetries. Part of the motivation for this research comes from phenomena observed in condensed matter systems, such as fractional quantum Hall fluids. An example of novel tools involves Grothendieck-Verdier categories in the study of representations of vertex operator algebras. Conversely, some of these results have served to broaden the toolkit for the study of exotic states of matter, that is frequently used in recent literature on applications.

It is worth pointing out here that there was a *Vetenskapsrådet* (Swedish Research Council) review of the Physics research at Karlstad University in 2022, which will be mentioned again below.

4. Academic culture

The Faculty of Health, Science and Technology has an overall organization for PhD students: a *Forskarskola*, or Graduate school. This is a local organization that promotes good research practice, for example, through a compulsory course on research ethics. The Graduate school also organizes many forms of activities for PhD students and supervisors, for example last year they hosted the Nordic Conference on PhD supervision (CoPHS) at Karlstad University.

The local Graduate school is complemented by academic networks outside the university. For example, in the field of **organic solar cells**, PhD students participate in a national network for organic electronics

including annual network meetings. This network has an annual conference and PhD school organized among researchers that lead major projects: SOLA (K-A Wallenberg) in Karlstad, Chalmers, Lund and Linköping, and the OPV 2.0 project (*Vetenskapsrådet*) in Linköping. There is a general seminar series, where both senior researchers and PhD students can present local projects. The planning of individual projects is performed in project meetings.

SMEER is the node from which the science, mathematics, and engineering education research at KAU is coordinated. As a research center, it engages researchers in different departments, across the subjects of Biology, Chemistry, Physics, Mathematics, and Technology. In turn, SMEER researchers are engaged in the research environment Research on Subject-Specific Education (ROSE)[15], which has been identified as one of three profile areas for the research at KAU.

5. Collaboration with the surrounding community

Physics has several collaborations outside of academia. Some have already been mentioned elsewhere in this self-evaluation, such as solar cell research through SOLVE. Importantly, there was a *Vetenskapsrådet* (Swedish Research Council) review of the Physics research at Karlstad University in 2022[16]. Relevant to this section on collaborations with society in general is that some subfields at KAU were singled out to represent *Impact on Society*. There were case studies on:

- Artificial intelligence in simulations of quantum physics: examples with new materials for better future batteries
- New test system for solar panels (with silicon solar cells) specifically in Sweden
- In materials physics: how advanced microscopy can be used for fatigue tests of tool steel

In addition to examples such as these, the Physics subject has many contacts with local businesses and public institutions. For example, there is an ongoing collaboration with the medical physicists at Karlstad Central Hospital. One PhD medical physicist there was recently appointed *docent* at Karlstad University, on the topic of (nuclear) magnetic resonance imaging. The Physics subject is working actively to build and improve its industrial network. There are also ongoing, long-term partnerships with local schools, for example *Sundsta-Älvkulle-gymnasiet*, Sweden's third biggest high school. The Physics *Inspiration Days* take place every year: several hundred high school students come and visit lectures, laboratory demonstrations, and discussions with local university students. The visit is organized in close collaboration with high school teachers and is generally appreciated by both teachers and students.

6. Interaction between research and education

Research in Physics Education is an integrated part of Physics, unlike at some other universities. This has resulted in some joint publications in academic journals. To be clear: subject-specific education itself is not being reviewed here, the purpose of mentioning this connection is to highlight the relatively strong link at Karlstad University between research in Physics (e.g. quantum physics) and outreach (e.g. in high schools), and that Physics Education

[15] https://www.kau.se/en/rose
[16] https://www.vr.se/analys/rapporter/vara-rapporter/2023-04-18-quality-and-impact-of-research-in-physics-in-sweden.html

is part of this link. It has stimulated some researchers in Physics to connect aspects of their research to education.
Although not included in the evaluation, the research on Physics Education focuses explicitly on education in physics and in related areas such as technology. Research focused on education at preschool and school levels is primarily relevant for teacher education, in which several of the staff within the Physics subject are engaged. In addition, research in Physics Education also involves students' engagement in courses that are given within the subject, such as introductory mechanics for engineers and physics education within the teacher's education. A recent area of collaboration between researchers in Physics Education and Theoretical Physics has been the development of outreach activities for high school students on simulations of quantum entanglement[17] (not included in the publication list).
The recent evaluation of the Karlstad University PhD program in Physics (2023) found, among other things, that the PhD program is of "*very high quality*" (the highest level), and that Physics at KAU has "*succeeded very well in recruiting and keeping excellent researchers and supervisors*". It also mentioned that the infrastructure that PhD students have access to is of "*very high quality*". One challenge listed is that all supervisors should have taken the supervisor course, which is being implemented at the time of writing. There is also now a regular supervisor/PhD meeting in conjunction with the Physics meeting.

Mechanical and Materials Engineering

1. Summary

The MME group is part of the Department of Engineering and Physics and conducts research in core areas of fatigue, tribology, additive manufacturing, microstructure characterization, and applied mechanics. Starting from early 2000, Materials Engineering is a research subject approved to provide third-cycle education leading up to a doctoral degree. For decades, MME has been a part of material science initiatives at Kau, and now it is a part of Material Research at Karlstad University (MR@KAU), an interdisciplinary research environment consisting of about 40 scientists from MME, Materials Physics, and Physical Chemistry. MR@KAU conducts top-quality research in five key research areas: mechanical properties of high-performance materials, additive manufacturing and new materials, surface physics and nanomaterials, solar energy materials, and computational materials science.

[17] Solvang, L., Haglund, J., & Berg, M. (2025). Exploring entanglement using a hardware quantum computer simulation. *Physics Education*, *60*(3), 035027.

Strengths

Traditionally, research in mechanical and materials engineering is focused on applied science carried out in collaboration with regional, national and international industrial, and academic partners. This strength is, for example, reflected by a "m3c - Microstructure, Mechanical properties, Manufacturing processes, and Components" industrial PhD-student research school started in 2024.

In each of the above-mentioned core areas of expertise, MME has a professor or docent leading the research.

The MME group is multicultural and includes co-workers from many countries, making research collaboration diverse and international.

The research infrastructure at MME is excellent and provides research opportunities in all areas of expertise. Additionally, MME has a fully staffed workshop supporting both teaching and research needs. Historically, the subject has developed customized experimental equipment to refine the investigation of targeted wear and fatigue mechanisms.

Weaknesses

The research in MME is focused on applied science, missing opportunities, and development in fundamental and theoretical science.

The MME group has had a high staff turnover over the last few years. This has resulted in difficulties keeping a stable gender balance and building a stable research college. In its current form, the subject is understaffed for carrying out research and educational tasks and as a result it is dependent on external consultants for performing part of the teaching.

The extensive experimental equipment park demands maintenance and expertise to run the equipment. Currently only two research engineers are employed in the department, which is too few, in relation to the ambitions of continuing to develop experimental equipment in-house.

MME does not have very efficient channels for research results of dissemination for the public sector and is not very visible nationally and internationally.

Opportunities

There is ongoing work to define a new research subject for third cycle studies that would extend the examination of rights from materials engineering to a combined discipline in materials and mechanical engineering.

The MME group is aiming for a good balance between individual and "larger" research grants, national (like Vinnova Excellence center, KKS Profile) and EU, considering the latter as a tool to create a better research environment, consolidate researchers with combined materials and mechanical engineering research questions, thus supporting group stability and external financing of the group, and have an impact in terms of the international visibility of the MME group.

Threats

Due to high workload, administration responsibilities, and management activities put on researchers, MME staff members do not have time for rest between tasks, which poses an increasing danger to affect work-life balance, as reflected in the most recent Leadership and Employee Survey (LMU).

2. Organization and leadership

Organization

Research activities in Materials Engineering as a research subject are led by a research subject leader (Head of subject/*ämnesföreträdare*), who on a regular basis meets with other research subject leaders and the Head and Deputy Head of the department at management team meetings. Each research subject leader organizes a series of regular meetings with researchers in the group to discuss current trends and management decisions.

Recruitment, Competence development and career support for researchers

Recruitment in the MME group is organized according to KAU regulations, and a recruitment group consisting of people with the required competence is commonly organized. Since MME traditionally is under-represented with female staff, we always welcome highly competent female colleagues to join MME. During the last decade, MME employed three female PhD students, one female senior lecturer, one adjunct professor and one female guest researcher. Unfortunately, for different reasons, one female PhD student and one female senior lecturer left MME for other jobs.

Competence development and career support

Competence development and career support are organized at different levels. PhD students are a part of NT PhD Research school, a faculty-organized research school aiming to support knowledge exchange for PhD students and supervisors. PhD students are also provided opportunities to be involved in education, support seminars and laboratories, supervision of Master theses, and attend UPE (University Pedagogy Training unit) courses on teaching in higher education. This supports the development of teaching skills and expertise which are required if they decide to pursue an academic career (courses on teaching in higher education are requested as an obligatory prerequisite for lecturer or junior lecturer positions in many countries nowadays.) At the moment, there are two junior researchers working at MME, one supported by a KKS Avans project grant and one by a KKS Recruitment grant. Both are in close connection with the Grants and Innovation Office (GIO) and UPE to attend courses needed for future employment and career development. During the last few years, two senior lecturers were appointed docents, and the MME group also prepares promotion of two docents to professors in mechanical engineering (thus supporting competence development for a joint Materials and mechanical research subject application). Additionally, a promotion of a junior assistant lecturer to a senior lecturer position is planned for 2026-27.

Other contextual aspects

MME group is working closely with industry partners and to strengthen further collaboration, provide continuous communication, and initiate more research projects in the future, we plan to employ several adjunct lecturers and/or professors in different core expertise areas. The effort will be made with a focus on KKS Recruitment calls, and several applications are already under preparation.

3. Scientific results and academic impact

MME research is traditionally experimental and carried out in close collaboration with industrial partners. The research questions formulated in core research areas are normally combined in joint projects, and several companies participate. The projects are commonly led by research leaders participating in core areas, who, as mentioned, are professors or docents in the MME group. The projects are usually funded externally by various relevant KKS and Vinnova calls. During the last decade, these two funding agencies were the main ones for research carried out by the MME group. Scientific outcomes are traditionally presented at national and international conferences and published in highly reputable international peer-reviewed journals. Research outcomes are sensitive to the stability of the senior staff group and the number of PhD students. Since there were some disturbances in the research group and the number of PhD students decreased during the last few years (2022-2024), the number of published articles also decreased. But with respect to the start of KKS "m3c - Microstructure, Mechanical properties, Manufacturing processes, and Components" industrial doctoral research school (currently 8, a maximum of 20 industrial PhD students can be employed, with a possibility to apply for a prolongation of the duration of the doctoral studies) in 2024, the publication rate will increase. Other PhD students, for example one recently employed PhD student in collaboration with Uppsala University and AM4Life excellence center, will also contribute to academic production and impact. Strategically, the MME group sees a need to be involved in joint international research as a group, and in the near future it is a goal to achieve international visibility and establish long-term international collaboration. Currently, MME group members are discussing and searching for opportunities within Horizon and Marie Skłodowska-Curie Actions.

The research infrastructure at MME is excellent and supports research in all areas of expertise. MME has servohydraulic test machines, 20 kHz ultrasound instruments, an in-situ Scanning electron microscope (SEM) mechanical test rig, novel heat checking equipment, Slider On Flat Surface (SOFS) wear tester, flat on cylinder high-temperature wear tester, metallographic lab including light optical microscopy, and hardness tester. The FEG SEM is equipped with energy dispersive spectroscopy and Electron backscatter diffraction (EBSD), and FEG TEM has EDS and STEM detectors. In material and applied mechanics, the following software is used: Abaqus, Tosca and Thermocalc. To manufacture specimens and develop new materials, we have a Renishaw 400AM metal printer for laser bed fusion printing and developed in workshop WAAM robotized machine. To support machine building and sample preparation, KAU has a fully staffed workshop. We also plan several applications to large facilities, for instance the synchrotron facilities PETRA 3 at DESY in Hamburg, Germany.
International collaboration is mostly based on the individual collaboration of professors and docents in the MME group with academic and industrial partners in France, Germany, Poland and other countries. This is well reflected by a number of joint publications and presentations at international symposia and conferences. As mentioned above, MME sees EU projects as an opportunity to have international collaboration in research on a systematic basis. As good current examples to be expanded, there is a strongly established collaboration within mechanical engineering and Finite Element Modeling with Stuttgart University. Additionally, one MME member is a Mercator Fellow in FOR 5134 (https://www.for5134.science) DFG (German Research Foundation) nr.434946896 project. MME is represented on the scientific board of the international conferences Laser Assisted Net Shape Engineering - LANE, Lasers In Manufacturing – LIM, Swedish Production Symposium – SPS, International Tooling Conference, International Conference on VHCF, and members of MME are also working on the editorial boards of a number of Elsevier and MDPI journals (see background data appendix to this self-evaluation).

4. Academic culture

Internal meeting routines for research first of all include research subject and teaching collegium meetings, where current situations, strategic changes, needs, and issues are discussed. These meetings are valuable and informative, but are rarely attended by all available staff, mostly because seniors have secondary but urgent administration or management tasks. Additionally, MME organizes regular seminars inviting researchers from other universities and countries for academic presentations and knowledge exchange.

When it comes to research project applications, an initiative group is formed and meets on a regular basis to formulate project applications and finalize submission. These meetings are organized by the researchers with core expertise, in fatigue, tribology, additive manufacturing, microstructure characterization, and applied mechanics. MME has a professor or docent leading research in these areas. At these meetings, competence-based discussions guarantee involvement of all relevant researchers in the project discussion, who share networks and partners, engage in open and honest discussion of roles, tasks, duties, and contributions, and create a solid background for future research collaboration. In many cases, the same group then conducts the project, supporting collaboration and a good research environment. These project meetings are also very important for PhD students and supervisors. Supervisory meetings are commonly organized between supervisors and PhD students, but project group meetings are useful for discussing more precisely project goals, framework, roles and responsibilities, questions related to publications, knowledge dissemination, and co-authorship, thus guaranteeing involvement and contribution of all partners in the project decisions.

MME contributes to different good practices supporting staff development, mostly through the guidance of researchers, and the organization of supporting development events. For example, for PhD students, it is always recommended to join the NT PhD Research School. Additionally, MME is a part of MR@KAU PhD research environment, which organizes regular meetings for materials science researchers. Both NT Research school and MR@KAU provide opportunities for PhD students and supervisors to exchange knowledge, discuss issues and present results. Open discussion and learning from each other are important factors in developing a creative research environment. In KKS m3c Industrial PhD research school, we also organize seminars discussing career development in an industrial environment, supporting the employment of graduated industrial PhDs in a new, higher-level position. For junior researchers, MME always supports establishing contacts with GIO and UPE, who provide a list of courses and seminars directed towards career and competence development.

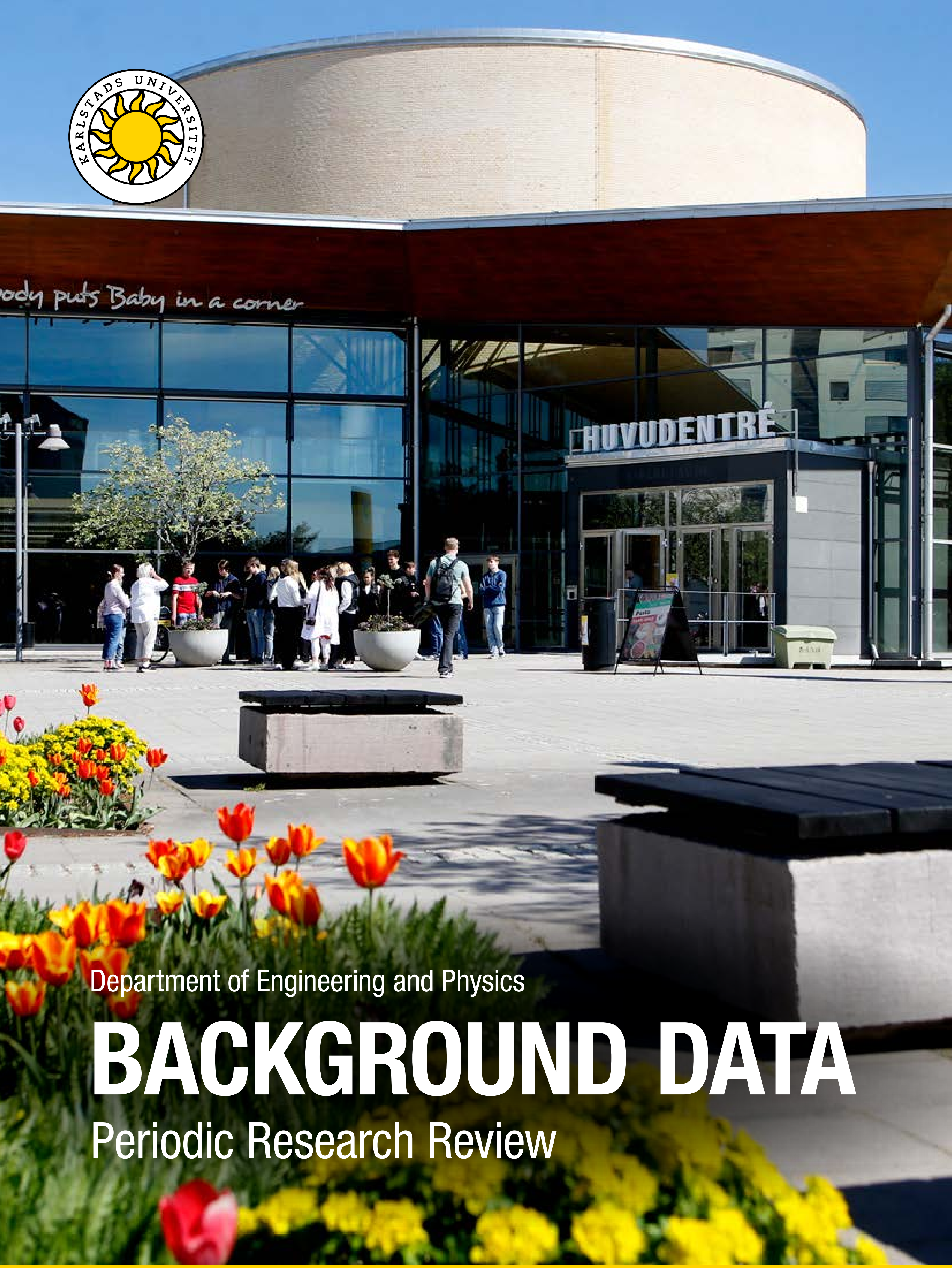
5. Collaboration with the surrounding community

The competence development and employment of new staff naturally result in the development of a network and partnership with academia and industry. Starting from projects with regional partners in the manufacturing of tool steel, MME developed other areas of expertise such as additive manufacturing, topology optimization, finite element simulation, fatigue, including very-high cycle fatigue, and tribology. This resulted in a larger interdisciplinary research project, often in collaboration with other universities. For example, in KKS m^3c research school, we collaborate with Jönköping University and the University of Gävle. The research carried out at MME is related to process and product development and material and component performance. Therefore, the step between academic articles and implementation of the results is normally short, so our research is close to industrial innovation and implementation.

Communication with the community and dissemination of knowledge and research results support the establishment of personal contacts, which are used to develop future project consortia and groups. This commonly takes place at conferences, meetings and seminars organized by regional and national organizations, for instance Jernkontoret (the Swedish iron and steel producers' association). The MME group is an active member in the national research network UTMIS - Utmattningsnätverket i Sverige (The Swedish Fatigue Network), SFMT - Svenska föreningen för materialteknik (Swedish Society for Materials Technology), and SPA - Svenska Produktion Akademi (Swedish Production Academy), where modern trends and possible collaborative projects are discussed. It is important to mention that for the international members of the MME group, to establish close collaboration with the public sector is sometimes challenging due to intercultural and language reasons.

6. Interaction between research and education

The MME group hosts a Master of Science in Mechanical Engineering (300 ECTS credits), a Study Program (HIng) in Innovation and Design Engineering (180 ECTS credits), a Study Program (HIng) in Mechanical Engineering (180 ECTS credits), and starting in 2026 a Master in Mechanical Engineering with a specialization in Data-driven Mechanical Engineering (120 ECTS credits). All contain several courses relevant to the core research expertise of the MME group (fatigue, additive manufacturing, tribology, and others). The majority of teachers involved in these courses are active researchers working in ongoing research projects. Therefore, new knowledge and state-of-the-art results obtained in relevant research areas are directly used for updating the courses. It is done individually and on a regular basis. In turn, students participate in projects as part of their thesis work, often performing tasks that belong to ongoing MME research projects. This connection is also expanded by the admission of Erasmus exchange students to summer placements or internships, where students from abroad contribute in current research.



Department of Engineering and Physics

BACKGROUND DATA

Periodic Research Review

KAU.SE/EN

INTRODUCTION

Background data covers a three-year period (2022-2024) and contains information about staff, third-cycle education, financial resources and research outputs. Data is collected from the university administrative systems to provide an overview and illustrate preconditions for research at the evaluation unit.

1. STAFF

1.1

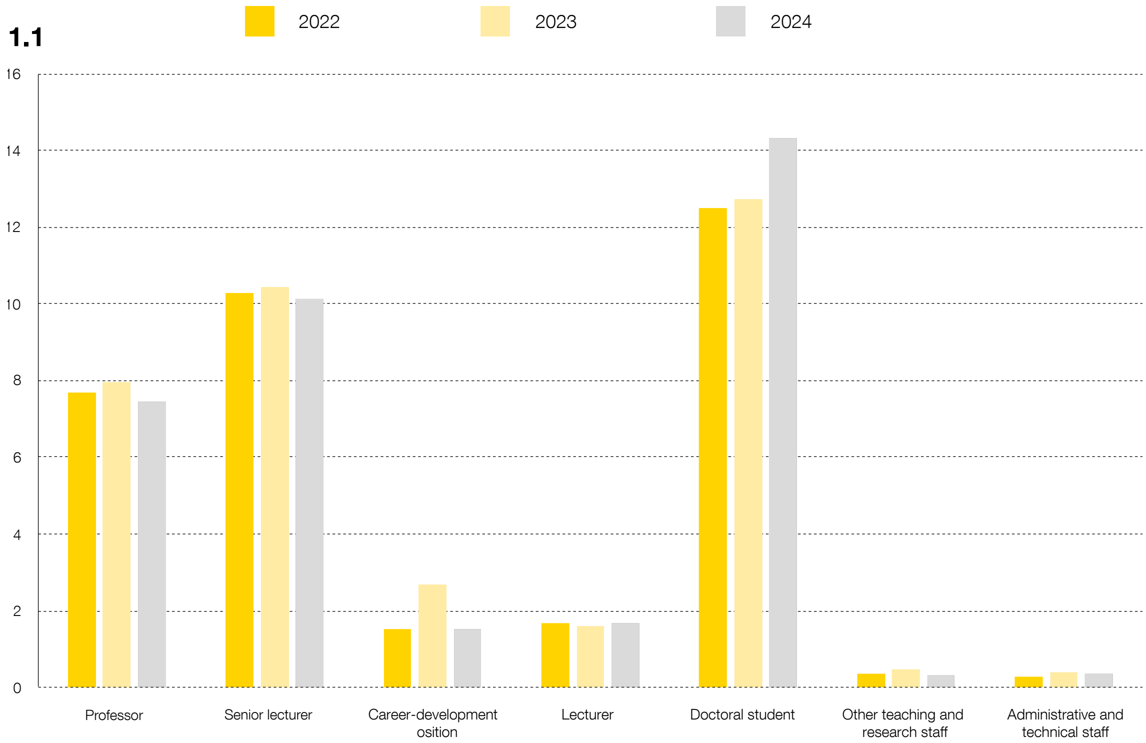


Figure 1.1 Workforce by staff category

The graph shows the workforce, full-time equivalents*, registered for research activity and connected to the evaluation unit over a three-year period. Staff categories are professor, senior lecturer, career development position, lecturer, doctoral student and other teaching and research staff. See table 1.2 for individuals in each category.

Source: Primula

1.2 Staff at the evaluation unit

Position	**Research Subject**
Professor	
Araujo, Moyses	Physics
Berg, Marcus	Physics
De Vin, Leonard Jacobus	Materials and mechanical Engineering
Ericson Öberg, Anna	Materials and mechanical Engineering
Fuchs, Jürgen	Physics
Grehk, Mikael	Materials and mechanical Engineering
Johansson, Lars	Physics
Krakhmalev, Pavel	Materials and mechanical Engineering
Magnusson, Kjell	Physics
Moons, Ellen	Physics
Rinio, Markus	Physics
Uggla, Claes	Physics

Senior lecturer

Biel, Anders	Materials and mechanical Engineering
Fallqvist, Mikael	Materials and mechanical Engineering
Haglund, Jesper	Physics
Holleboom, Thijs Jan	Physics
Lin, Fengxiang	Materials and mechanical Engineering
Moroz, Sergej	Physics
Mossberg, Magnus	Electrical Engineering
Muntean, Stela Andrea	Physics
Sirjani, Reza	Electrical Engineering
Solis Alfaro, Jorge	Electrical Engineering
Strömberg, Niclas	Materials and mechanical Engineering
Svensson, Krister	Physics
Theocharis, Andreas	Electrical Engineering
Tkachuk, Anton	Materials and mechanical Engineering
Tkachuk, Mykola	Materials and mechanical Engineering
Zhang, Hanmin	Physics

Career development position

Marchiori, Cleber	Physics
Pareek, Saurabh	Physics
Pinchuk, Nataliia	Materials and mechanical Engineering
Rathinavelu, Sokkalingam	Materials and mechanical Engineering
Rezende Franco, Leandro	Physics
Seema, Seema	Electrical Engineering
Spånslätt Rugarn, Christian	Physics

Lecturer

Flognman, Jeanni	Physics
Solvang, Lorena	Physics
Åsberg, Mikael	Materials and mechanical Engineering

Doctoral student

Chantziara, Aikaterini (Katerina)	Materials and mechanical Engineering
Christopholi, Leticia	Physics
Ebrahimijamal, Mohammad	Materials and mechanical Engineering
Graf, Juliane	Physics
Högberg, Filip	Materials and mechanical Engineering
Javadzadeh Kalahroudi, Faezeh	Materials and mechanical Engineering
Johansson, André	Physics
Kadakkotteeri, Shahna Mysin	Physics
Mayadevi, Athulya	Physics
Panahi, Negar	Materials and mechanical Engineering
Pandiyalakkal Musthafa, Asirin	Physics
Prasad, Suraj	Physics
Salari, Majid	Physics

Administrative staff

Ericsson, Leif Karl Enar	Physics
Nikas, Dimitrios	Materials and mechanical Engineering

1.3 Recruitment

Number of recruited staff, total/women during 2022-2024. Year of employment certificate.

	2022	2023	2024
Recruitments with doctoral degree from another Swedish university	0	0	3
Recruitments with a doctoral degree from outside Sweden	6(1)	2(1)	3
Recruitment with doctoral degree from own university	0	1	0
International guest researchers	2(1)	0	0
Adjungations - fellowship	0	0	0
Shared positions	2(1)	0	0

Source: Varbi/evaluation unit

1.4 Promotion

Number of promoted staff, total/women, during 2022-2024. Year of employment certificate.

	2022	2023	2024
Docent promotions	0	1	2(1)
Professor promotions	0	0	1
Total	**0**	**1**	**3**

Source: Primula

THIRD CYCLE STUDIES

2.1 Doctoral students

Doctoral students by discipline, year of admission and degree of activity during 2024.

Name	Admission subject	Year of admission	Degree of activity 2024
Faezeh Javadzadeh Kalahroudi	Materials Engineering	2021	74
Negar Panahi	Materials Engineering	2020	16
Aikaterini Chantziara	Materials Engineering	2020	80
Mikael Åsberg	Materials Engineering	2000	19
Mohammad Ebrahimijamal	Materials Engineering	2021	72
Suraj Prasad	Physics	2021	80
Athulya Mayadevi	Physics	2024	100
André Johansson	Physics	2024	80
Leticia Patricio Christopholi	Physics	2021	80
Juliane Graf	Physics	2023	80
Majid Salari	Physics	2023	80
Asirin Pandiyalakkal Musthafa	Physics	2024	63
Shahna Mysin Kadakkotteeri	Physics	2024	100
Lorena Solvang	Physics	2017	50

Source: Ladok

2.2 Completed a Degree of Licentiate or Doctor

Number of students that have completed a Degree of Licentiate and Doctor over the past three years.

Name	Research Education Subjects	Degree (L/D)	2022	2023	2024
Mattias Flygare	Physics	D	1		
Aikaterini Chantziara	Materials Engineering	L			1
Faezeh Javadzadeh Kalahroudi	Materials Engineering	L			1
Abdulbaset Mussa	Materials Engineering	D	1		
Total			**2**	**0**	**2**

Source: Ladok

3.1 Research funding

Research funds spent at the evaluation unit for the period of 2022 - 2024. Amounts in SEK 1 000

	2022	2023	2024
Faculty funding[1]	21 033	23 622	25 388
External funding[2]	19 802	17 931	17 613
Total	**40 835**	**41 553**	**43 001**
Percentage external funding	48%	43%	41%

Source: KULI/Raindance

[1] Faculty funding: Includes revenue from governmental funding and other internal incomes that includes, for example, grants and/or compensations from other parts of the University.

[2] External funding: Includes revenue from fees, other reimbursements and funing. Funding which can include grants from Councils, other public research funding agencies, municipalities, regions and research foundations.

3.2 External research funding

Distribution of external research funds spent during the period of 2022 - 2024. Amounts i SEK 1000.

Funding source	2022	2023	2024
EU and Foreign organisations	501	-	1 114
Swedish research councils[1]	2 480	4 359	3 913
Other Swedish government foundations	6 751	4 720	6 956
Country councils and municipalities	643	612	626
Private foundations, industry, company etc.	9 428	8 240	5 005
Total	**19 802**	**17 931**	**17 613**

Source: KULI/Raindance

[1] Research Councils include the Swedish Research Council (Vetenskapsrådet), the Swedish Research Council for Health, Working Life and Welfare (Forte), the Swedish Research Council for Sustainable Development

(Formas) and the Swedish Institute for Educational Research (Skolforskningsinstitutet).

3.3 External research funding

Number of grant applications submitted to external funding bodies, number of granted applications, amount applied for and granted refers to Karlstad University´s share. Amounts in SEK 1000.

	2022	2023	2024
Number of grant applications	28	20	34
Number of granted applications	10	9	13
Amount applied	108 115	87 595	172 855
Amount granted	21 208	14 456	24 795
Success rate[1]	35,7 %	45 %	38,2 %

Source: KULI/Raindance

[1] Success rate is calculated on the number of granted applications in relation to those submitted.

5. EXTERNAL COLLABORATION AND ACADEMIC ENGAGEMENT

5.1 Engagement in the scientific community.

The table shows the number of individual peer-review assignments within the evaluation unit during 2024.

Assignment	Total numbers
Plenary or keynote talk at international conferences	1
Assignment as expert evaluator in research councils and foundations	7
Assignment as expert evaluator for position of professor, associate professor (docent) and/or senior lecturer	3
Assignment as opponent for PhD thesis	
Assignment as member of examination board for PhD thesis	6
Assignment as editor or member of editorial board for journal	13
Assignment as reviewer for international journal	73
Assignment for national scientific councils	
Assignment for international scientific councils	1

Source: Evaluation unit

5.2 Collaborative partners

Collaborative partners, reported by the name of organization, for the period 2022-2024. Research collaborations given here are limited to those with joint research grants and/or joint publications with the evaluation unit.

	Regional	National	International
Academic	Lillerudsgymnasiet	Chalmers University of Technology,	KU Leuven, Belgium
		Karolinska Institutet,	Aalborg University, Denmark
		KTH Royal Institute of Technology,	Addis Ababa University, Ethiopia
		Lund University, Dalarna University, University of Gävle,	AGH University of Science & Technology, Poland
		Mid Sweden University,	AGH University of Science & Technology, Poland
		Uppsala University,	Aichi Center for Industry and Science Technology, Japan
		Örebro University,	American University of Beirut, LBN
			Argonne National Laboratory, USA
			Aristotle University of Thessaloniki, Greece
			Belgorod State National Research University, Russian Federation
			Brazilian Synchrotron Light Laboratory (LNLS), Brazilian Center for Research in Energy and Materials (CNPEM), BRA
			Center for Advances in Reliability and Safety, Hong Kong, China
			Center for Digital Technology and Innovation, Munich, Germany
			Center for Information Technology Renato Archer, BRA
			Central University of Technology, South Africa
			Central University of Technology, ZAF
			Chinese University of Hong Kong, China
			Chongqing University, China
			Cidade Universitária, Brazil
			Colorado School of Mines, USA
			Comillas Pontifical University, Spain
			Comillas Pontifical University, Spain

Regional	National	International
		Deggendorf Institute of Technology, Germany
		Department of Theory and Computer-Aided Design of Mechanisms and Machines, Ukraine; National Technical University “Kharkiv Polytechnic Institute”, Ukraine
		Die Technische Universität München, Deutchland
		Dmytro Motornyi Tavria State Agrotechnological University, Ukraine
		Eastern Mediterranean University, Turkey
		Ecole Polytechnique Fédérale de Lausanne (EPFL), Switzerland
		Eindhoven University of Technology, Netherlands
		Erwin Schrödinger International Institute for Mathematics and Physics, Austria; Max-Planck-Institut für Mathematik in den Naturwissenschaften, Germany
		Federal University of Paraná (UFPR), Brazil
		Federal University of Pernambuco, BRA
		Federal University of Rio de Janeiro (UFRJ), Brazil
		Forschungszentrum Jülich GmbH and RWTH Aachen University, Germany
		French National Centre for Scientific Research (CNRS), France; Sorbonne Universités, France
		Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany
		Fudan University, China
		Graz Centre for Electron Microscopy, AUT
		Graz University of Technology, AUT
		Guangzhou University, China
		Hamburg University of Technology, Germany
		Hasselt University, Belgium
		Hasselt University, Belgium
		Hokkaido University, JPN
		Huazhong University of Science and Technology, China
		Huazhong University of Science and Technology, China
		Humboldt-Universität zu Berlin, DEU
		Indian Institute of Science, IND; University of Maryland, USA
		Institut de Recherche sur les Céramiques, France
		Institut Hospital del Mar d’Investigacions Mèdiques, Spain
		Institute for Basic Science (IBS), South Korea
		Institute for Condensed Matter Physics and Complex Systems, DISAT, Italy
		Institute for Energy Technology, Norway
		Institute of Nanotechnology of Microelectronics of Russian Academy of Science, Russian Federation
		Instituto de Ciencia Molecular Universidad de Valencia, ESP
		Islamic Azad University, Iran
		Jagiellonian Univ, Poland
		Jianghan University, China
		Kharkiv Polytechnic Institute, Ukraine
		King Abdullah University of Science & Technology, Saudi Arabia
		Konya Technical University, Turky

Regional	National	International
		Korea Advanced Institute of Science and Technology, South Korea
		Korea University of Science and Technology, South Korea
		Korea University, South Korea
		Kuwait University, Kuwait
		Leiden University, Netherlands
		Ludwig-Maximilians-Universität München, Germany
		Madurai Kamaraj University, India
		Max-Planck Institute of Quantum Optics, Germany
		Monash University, Australia
		Nagoya University, Japan
		National Institute for Materials Science, Japan
		National Institute of Standards and Technology, USA
		National Synchrotron Light Source II, USA
		National Technical University “Kharkiv Polytechnic Institute”, Ukraine
		National Technical University “Kharkiv Polytechnic Institute”, Ukraine
		Osaka University, Japan
		Oslo Metropolitan University, Norway
		Pontifícia Universidade Católica do Rio de Janeiro, Brazil
		Rensselaer Polytechnic Institute, USA
		Ritsumeikan University, Japan
		RWTH Aachen University, Germany
		Saga University, Japan
		Sandia National Laboratories, USA
		Sapienza Università di Roma, Italy
		Shandong University, China
		Shanghai Jiao Tong University, China
		Sichuan University, China
		Siyuan Laboratory, Guangzhou Key Laboratory of Vacuum Coating Technologies and New Energy Materials, China
		Skolkovo Institute of Science and Technology, Russian Federation
		Sorbonne Université, France
		State Marine Technical University, Russian Federation
		Tallinn University of Technology, Estonia
		Technical University of Denmark
		Technical University of Denmark
		Technical University of Munich, Germany
		Technische Hochschule Mittelhessen, Germany
		Technische Universität Dortmund, Germany
		Technische Universität München, DEU
		The Chinese University of Hong Kong, China
		The Hebrew University of Jerusalem, Israel
		The Hong Kong Polytechnic University, China
		Tokyo University of Science, Japan
		Transilvania University of Braso, Romania

	Regional	National	International
			Tsinghua University, China
			TU Dresden, Germany
			UC Santa Barbara, USA
			Universidade de Lisboa, Portugal
			Universidade de São Paulo, Brazil
			Universidade de São Paulo, Brazil
			Universidade Federal de Goiás, Brazil
			Universidade Federal de Goiás, Brazil
			Universidade Federal do Pará, Brazil
			Università degli Studi dell'Aquila, Italy
			Universita di Roma, Italy
			Universitat de Barcelona, ESP
			Universite Catholique Louvain, Belgium
			Universiti Tenaga Nasional, Malaysia
			Universiti Tenaga Nasional, Malaysia
			University College Absalon, DNK
			University of Applied Sciences Mittelhessen, Germany
			University of Atlantic, COL
			University of California, USA
			University of Cambridge, GBR; Technische Universität München, Germany
			University of Campinas (UNICAMP), BRA
			University of Chicago, United States
			University of Colorado, USA
			University of Copenhagen, DNK
			University of Hamburg, Germany
			University of Jaén, Spain
			University of Jyväskylä, Finland
			University of L'Aquila, Italy
			University of Málaga, Spain
			University of New South Wales, Australia
			University of Rome, Italy
			University of São Paulo, Brazil
			University of Southern Denmark, Denmark
			University of Stuttgart, Germany
			University of Surrey, United Kingdom; The Faraday Institution, United Kingdom
			University of Waikato, New Zealand
			University of Waterloo, CAN
			University Wurzburg, Germany
			Ural Federal University, Russia
			Weizmann Institute of Science, Israel
			Xiamen University, China
			Xi'an Jiaotong University, China
			Zhengzhou University, China
Industry	BAE systems AB, Karlskoga	Billerud AB,	German Pool Limited Engineering, China
	Data Advantage CGI, Karlstad	CheckWatt AB, Sweden	Ivaldi Norway AS, Norway
	E&G Kraft AB, Karlstad	Chemtron AB, Sweden	Klabin, Brasilien Amazemet, Poland International Additive Manufacturing Group Sp. z o.o., Poland

	Regional	National	International
	Lasertech LSH AB, Karlskoga	Curtiss-Wright Surface Technologies AB,	MME - Smurfit Westrock, USA
	SAAB Dynamics AB, Karlskoga	Ellevio AB,	Panasonic Corporation, Japan
	Triton Valsteknik AB, Grums	Endre technologies AB,	State Enterprize “V. A. Malyshev Plan”, Ukraine
	Bharat Forge Kilsta AB, Karlskoga	FBT Bredaryd,	Tesa SE, Germany
	Bofors Test Center AB, Karlskoga	Gestamp AB	TNO, The Netherlands.
	Uddeholms AB, Hagfors	GKN Aerospace Sweden AB	Toyota Central R&D Labs, Japan
	Voestalpine precision strip AB, Munkfors	Goodtech Solutions AB	
	Volvo CE, Arvika	H2 Green Steel	
	CGI, Karlstad	Holmen AB,	
	Glava Energy Center, Arvika	Hydroc Energy AB,	
		Kongsberg Maritime AB	
		Lamera AB, Sweden	
		MTC Powder Solution AB	
		Norgald AB	
		Northvolt AB	
		Quintus Technol AB	
		Ringhals AB	
		RISE Research Institutes of Sweden	
		Sandvik AB	
		Sandvik Materials Technology	
		SC Burman AB	
		Seco Tools AB	
		Sticky Solar Power AB	
		Stora Enso AB	
		Swedish Association of Engineering Industries	
		Swerim AB	
		Tetra Pak AB	
		Uddeholms AB	
		Viking Analytics AB, Comptech AB,	
		Viking Analytics AB, Göteborg, Sweden	
		Volvo Construction Equipment	
Public sector	Region Värmland,	Region Dalarna,	Fornybar Norge Norway,
		Region Gävleborg,	Klosser Innovasjon AS Norway
		Sustainable Steel Region,	
Other	IUC Stål o Verkstad Värmland,	IUC Stål o Verkstad-Dalarna,	DESY Hamburg Germany
	Glava Energy Center Arvika,	Swerim AB,	
	Paper Province Värmland,	SOLVE - Solar Electricity Research Centre,	
	Stiftelsen Compare Karlstad.	MAX IV Laboratory	
		Nordita, Sweden	

Source: Evaluation unit

6. SCIENTIFIC PRODUCTION

The research activity at Karlstad University is expressed, among other things, in scientific publications. This report aims to map the publishing activity and its development over time for Department of Engineering and Physics. The report also shows the proportion of internationally co-authored publications where at least one of the authors is affiliated with a university outside Sweden as well as the proportion of publications that are open access, i.e. freely available online.

METHOD

To get a complete coverage of what is published within the unit, the following tables are based on registered publications in DiVA (Digital Scientific Archive), the local publication repository where researchers, teachers and students register their research publications and essays. It covers all subject areas and publication types.

Publication extraction for the years 2022-2024 has been based on the researchers individual Kau: ID, which links them with their respective publications. The list of researchers that are included in the analyses was provided by the HR department at KAU and includes also researchers that are no longer part of the unit but were employed during 2022-2024.

The analysis includes all publications where at least one of the authors is affiliated with Karlstad University. The publication types included in the report consist of article in journal, article review, book review, book, chapter in book, conference paper, collection (editor), proceedings (editor), and report. The publication subcategories presentation, poster, abstracts and “other” have been omitted from the analysis because these entries are registered to a very varying extent by the researchers. Doctoral dissertations and licentiate theses are reported in detail in other parts of the evaluation and have therefore also been omitted here.

PUBLISHING OUTPUT

Counting the total number of publications is the simplest bibliometric measure for reporting publications over a period of time for a research-producing unit. The evaluation unit Department of Engineering and Physics, shows that the 80 people connected to the unit, have published 165 publications between 2022-2024 (for full publication list see appendix 1). Figure 6.1 shows publication volume changes between 2022 and 2024. Figure 6.3 shows the number of publications for each publication and content type during the investigated period.

Figure 6.1 The annual total number of publications during 2022-2024.

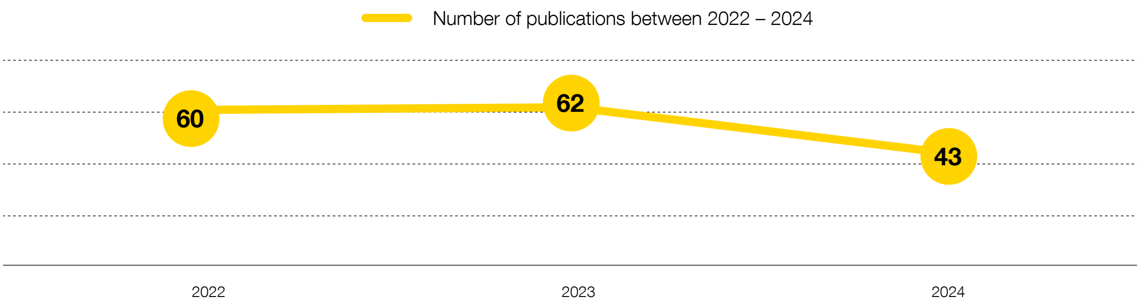


Figure 6.2 Number of peer-reviewed publications per year for the unit (bars). Percentage of peer-reviewed unit publications out of the total annual number of publications (line).

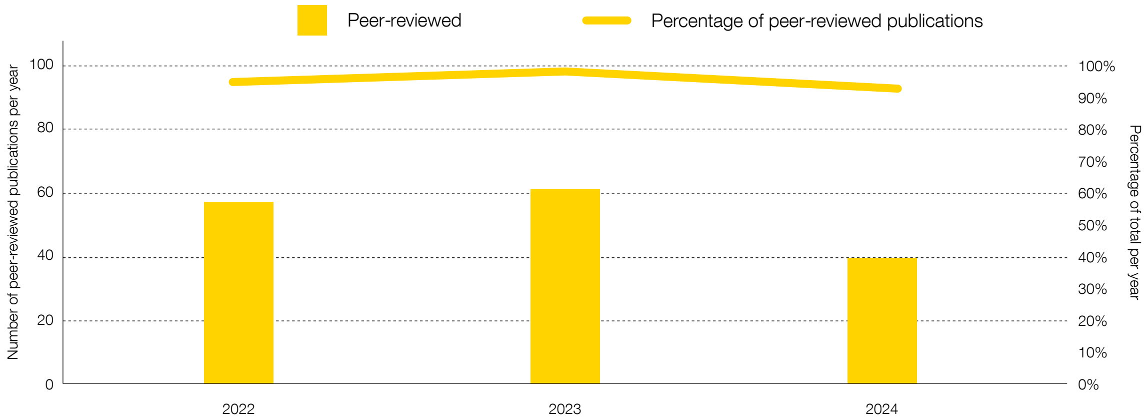


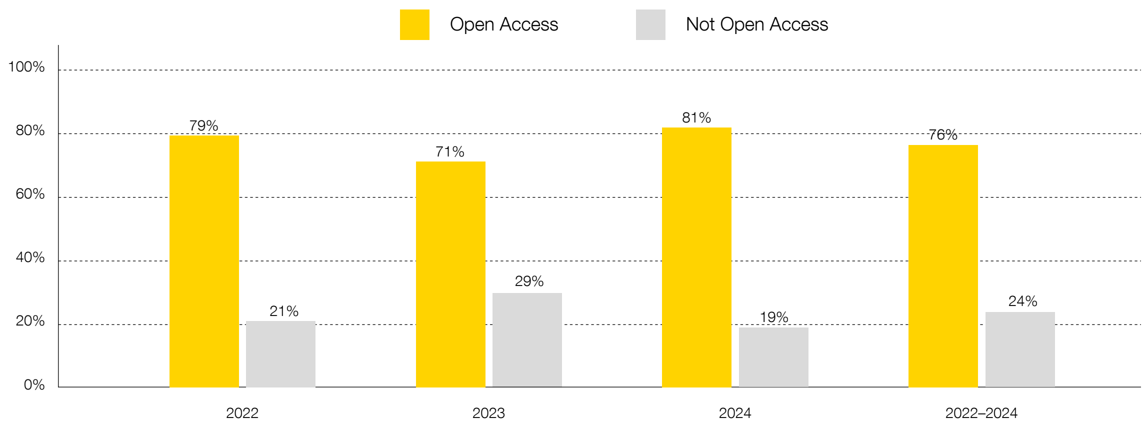
Table 6.3 The unit´s publications sorted by publication and content type for the years 2022-2024.

	Peer-reviewed	Scientific but not peer- reviewed	Other (popular scientific, debate)
Article in journal	119	1	
Article, review/survey	2		
Book chapter	14	1	
Conference paper	22	3	
Report		2	
Collection (Editor)	1		

OPEN ACCESS

The Swedish government and many research funders demand that research that is financed with public funds needs to be published open access to make it more accessible for anyone who is interested. So far, this requirement has been applied predominantly to scientific publications in journals, which is why this report focuses on the proportions of open and closed access for scientific articles.

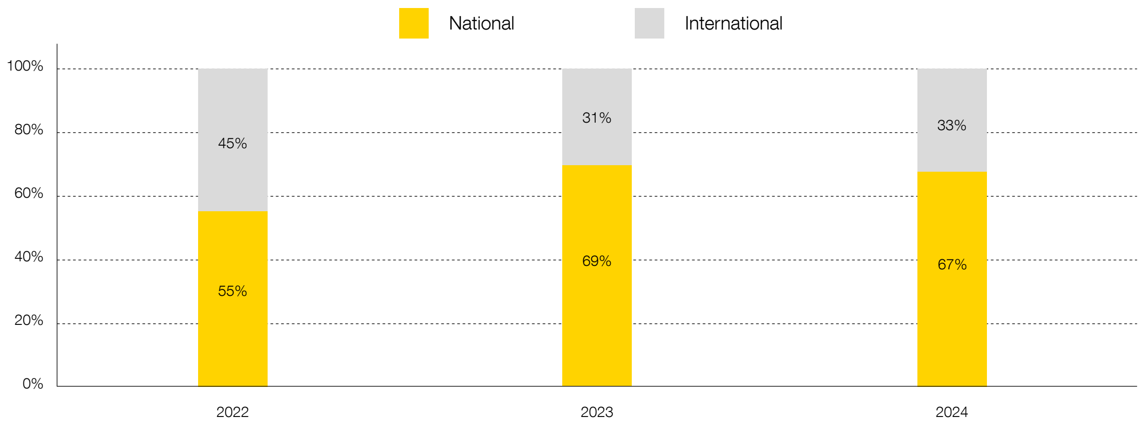
Figure 6.4 Comparison of the percentage of peer-reviewed articles that are open access and the percentage that are not.



NATIONAL AND INTERNATIONAL CO-AUTHORSHIP

International cooperation in R&D is assumed to increase the quality of research and strengthen the country's competitiveness and attractiveness. One way to measure international research collaboration is to measure the proportion of publications that are co-authored with researchers from other countries. As a double affiliation of Kau researchers to both Kau and an organization abroad also indicates an ongoing international collaboration, these publications have been counted as publications with an international profile as well.

Figure 6.5 Proportion of the unit´s publications with an international profile and publications where all authors were affiliated to Swedish organizations.



7. RESEARCH INFRASTRUCTURE

If applicable, specify the most significant research infrastructure available.

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KAU.SE/EN

Appendix 1.
Publication list

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Publication list

Article in journal

Aderne, R. E., Borges, B. G. A. L., Avila, H. C., von Kieseritzky, F., Hellberg, J., Koehler, M., Cremona, M., Roman, L. S., Araujo, M. C., Rocco, M. L. M., & Marchiori, C. (2022). On the energy gap determination of organic optoelectronic materials : the case of porphyrin derivatives. *Materials Advances*(3), 1791-1803. https://doi.org/10.1039/d1ma00652e

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Appendix 1.
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Appendix 1.
Publication list

Evaluation report March 23, 2026

Karlstad University

Institutionen för ingenjörsvetenskap och fysik

Department of Engineering and Physics

Evaluation panel

Professor Edvin Lundgren, Lund University, Sweden

Professor Ulrich Krupp, Aachen University, Germany

Professor Amin Hajizadeh, Aalborg University, Denmark

1) Summary

The evaluation committee congratulates the Department of Engineering and Physics for its excellent research and research organization. The department has shown determination and flexibility over the last decade, as external and internal conditions has changed, an impressive task. Further the research environment has improved with an increasing amount of internal and external research networks. The evaluation committee finds nevertheless areas of improvements leading to some recommendations. This includes establishing a sufficient and stable staff situation, promoting the grant application environment at the department, facilitating teaching and administration duties, and ensure that new and promising recruitments stay at the department. The evaluation committee also recommend to strengthen and expand the existing internal collaborations, to inspire innovative research and grant opportunities. The committee also strongly recommend to promote a proactive EU Horizon culture, by strengthening the application support in various EU Horizon funding schemes. Finally, the committee recommends to promote and strengthen the initiative to allow for a PhD education at the EE subject, since this would increase the subject's ability for success in competitive national and international grant applications and networks.

The evaluation committee would like to thank the organisers for the excellent organisation of this evaluation, and to thank all the staff at the Department of Engineering and Physics for their relaxed and informative interaction with the evaluation committee.

2) Scientific results and academic impact

The Department of Engineering and Physics demonstrates a strong and steadily developing scientific profile, supported by high-quality research activities, visible academic contributions, and increasing engagement with national and international partners. Although the maturity and scale of research differ across subjects, the overall trajectory is positive. The department is increasingly recognised for its interdisciplinary strengths, strategic relevance, and ability to contribute to pressing societal challenges—particularly in materials science, renewable energy, digitalisation, and sustainable engineering.

2.1 National and International Positioning

The department holds a solid position within Sweden's scientific landscape. Its contributions are particularly visible in materials science, mechanical engineering, and physics, where established research groups have cultivated long-term partnerships with national laboratories, strategic research environments, and industry actors. These interactions strengthen both scientific output and societal relevance.

International visibility is strongest in Physics and MME, where researchers publish in wellregarded journals, participate actively in European collaborations, and engage in longstanding partnerships with universities such as Stuttgart, Erlangen-Nürnberg (FAU), and SaintÉtienne. The MR@KAU (Materials Research at Karlstad University) initiative has become an important internal driver of internationalization by providing a collaborative platform spanning materials engineering, physics, and chemistry. This platform has already begun to elevate the department's international presence and is likely to support future participation in large coordinated calls.

Electrical Engineering (EE), while younger and smaller, is also strengthening its international outlook. Its growing focus on digitalized energy systems, integration of renewables, and intelligent grid management aligns closely with global research priorities, and the group is increasingly involved in networks and joint explorations - particularly through collaborations with Computer Science and Mathematics.

Overall, the department is positioned to enhance its international footprint further, particularly if structural bottlenecks—such as limited PhD capacity in EE and heavy teaching workloads—are addressed.

2.2 Scientific Output and Subject-Level Achievements

Physics (PHY)

Physics remains one of the department's scientifically strongest subjects, with internationally recognised work in solar energy materials, thin-film technologies, surface science, and theoretical physics. The group consistently produces high-impact publications, contributes to scientific conferences, and maintains a strong academic reputation. Recent recruitments have injected new energy and expertise into the subject, and these new research lines are expected to enhance visibility and improve competitiveness in large national and international applications, including the planned WISE–WASP (NEST) initiative.

Materials and Mechanical Engineering (MME)

MME demonstrates substantial scientific depth and coherence. Its work links mechanical performance with material microstructure and integrates modelling, predictive analytics, topology optimisation, and advanced characterization. The group's collaborations with European partners contribute to a continuous flow of high-quality publications and externally funded projects. MME also plays a central role in MR@KAU and contributes significantly to the department's experimental ecosystem. The subject benefits from productive cross-disciplinary interactions, particularly with Physics, and is well positioned to drive future multi-partner proposals.

Electrical Engineering (EE)

Despite being the youngest subject and facing structural limitations, EE has carved out a promising and strategically important research profile. The group's scientific contributions address highly relevant themes:

- Energy transition and large-scale electrification
- Energy security and resilience
- Battery systems and energy storage
- Digitalisation of power systems and AI-based analytics
- Future electricity markets and energy communities
- Emerging investigations into quantum technologies for grid applications

EE's research productivity is commendable considering the exceptionally high teaching load (30–40%) and the lack of third-cycle (PhD) examination rights, which restricts long-term planning and reduces competitiveness in major calls. Nevertheless, the subject is investing actively in experimental facilities, strengthening collaborations with industry (notably Vattenfall and regional energy companies), and forming new academic connections through the CREATE initiative. These combined efforts support a steadily improving scientific output and a clear upward trajectory.

Industrial Engineering and Management (IEM)

Although smaller and more applied, IEM contributes to the department's scientific ecosystem through work related to innovation processes, project management, and industrial collaboration. Its integration with engineering subjects supports interdisciplinary student projects and strengthens links with regional industry.

2.3 Research Funding, Collaborations, and Contribution to the Research Community

The department secures funding from a wide range of Swedish research bodies, including Energimyndigheten, Vinnova, KKS, and industry partners. A notable strength is the strong industrial engagement: 7 of 11 PhD students are industryf unded, reflecting trust from external partners and the department's relevance to real world challenges.

However, the culture around European funding—particularly Horizon Europe, MSCA, and ERC—remains limited. Junior researchers show a growing interest, but structural and cultural barriers persist, including the perceived complexity of EU proposals and limited internal experience. The Grant and Innovation Office (GIO) provides helpful support, yet increased training and capacity-building would significantly strengthen the department's competitiveness.

The department contributes actively to the scientific community through conference organisation, peer reviewing, participation in networks, and interdisciplinary seminars. New initiatives such as CREATE (in EE) and the strengthening of MR@KAU exemplify a positive shift toward collaborative and outward-facing research culture.

2.4 Research Infrastructure, Support, and Sustainability

The department benefits from excellent laboratory infrastructure, supported through departmental, university, and external project funding. The equipment base enables high-quality experimental research in materials science, mechanics, physics, and electrical engineering. However, the long-term sustainability of this infrastructure is challenged by the limited number of research engineers—only two are shared across all subjects. This constrains data production, equipment maintenance, and experimental continuity. Expanding this support function would directly improve scientific productivity and free researchers to focus more on publications and proposal preparation.

2.5 Challenges Affecting Scientific Performance

A major concern raised across subjects is the heavy administrative and teaching load. In several cases, overloads of 30–40% reduce researchers' ability to pursue long-term research agendas, prepare competitive proposals, or supervise at the doctoral level. EE is particularly affected due to its lack of PhD rights, making it dependent on external enrolment and placing additional administrative burdens on staff.

Despite these challenges, the department continues to deliver high-quality scientific results. Addressing workload imbalances and strengthening structural support - especially related to doctoral education, EU funding, and research engineering - will be essential to sustaining and amplifying the department's scientific impact.

3) Organization and leadership

Department Overview

The Department of Engineering and Physics is one of five departments in the Faculty of Health, Science and Technology at Karlstad University. The Department consists of four subjects: Materials and Mechanical Engineering (MME), Physics, Electrical Engineering (EE), and Industrial Engineering and Management (IEM). Only Physics and MME have third-cycle (doctoral) examination rights; EE doctoral students are enrolled elsewhere. The department has a steering board, Department Council, and Education Council overseeing research, education, and strategic planning.

The evaluation committee appreciates the reported and detailed organization and leadership description found in the self-evaluation. From this, the evaluation committee finds that teaching duties are extensively shared in a positive collegial fashion, yet workload overload due to teaching is around 30-40%, reducing time for research and proposal preparation. In fact, strong concerns were raised on that newly successfully recruited scientific staff may resign due to teaching or administration (funding application) overload. The current teaching overload is likely due to retirement or staff resigning from their work due to professional or personal reasons. The lack of teaching staff has in part been solved by new recruitments, and new recruitments are underway. The issue here is that recruitments take a long time, and newly recruited staff also need a long time to become familiar with the department, subject and the teaching topic. The committee understands that recruiting additional qualified teaching staff at the same time is a financial issue for the department, the faculty and the university. We provide some recommendations on how to mitigate the teaching overload in chapter 7.

The committee also finds that the EU Horizon culture is weak at the department, and only a few EU funded application grants are submitted. From the interviews, the research evaluation committee finds the junior researchers/staff express a more positive aptitude to EU related funding applications compared to senior staff, the latter most likely being burdened by other responsibilities. It would be very much appreciated by the evaluation committee if the existing relatively negative funding culture could be mitigated. Therefore, more increased systematic support and internal incentives for EU proposals would be beneficial, to promote a culture which naturally and with no hesitation due to fears of complicated application procedures or grant administration, leading to an increased number of EU-funded grant applications. While researchers appreciate the existing internal support mechanisms for external funding applications, the department would benefit from additional training, guidance, and incentives that can help build confidence and competence in applying for Horizon Europe, MSCA, and ERC programs. Strengthening the internal departmental capacity and culture around EU funding would support increased participation in international research collaboration. This could promote the funding situation for the department, and at the same time result in a significant increase in international visibility and novel research opportunities.

The evaluation committee agrees that the infrastructure at the department is very good, and there are no major challenges with laboratory equipment. The equipment is financed through a combination of departmental, university, and external project funding, and this model currently works well. The evaluation committee finds an excellent and successful shared operation between the sub-projects of large-scale instrumentation. However, the committee also finds a lack of dedicated research engineers; there are currently two research engineers shared by the subjects across the department. The lack of research engineers may put long term continuity at risk, since research engineers are critical for lab operations, data production and equipment maintenance. Therefore, additional support from a research engineer or part of a research engineer would enable scientists to focus on proposal writing and publications.

Administrative duties - particularly around proposal preparation - consume significant time and reduce researchers' capacity for scientific output. Work–life balance is generally acceptable, but administrative burden remains a major challenge.

4) Academic culture

The evaluation committee was impressed by the dedicated work by the current Head and deputy Head of Department to promote a collegial academic culture at the Department of Engineering and Physics. This is done in a collaboration with the Department council, composed by researchers, students and managers. It is clear from the self-evaluation that an increase in research visibility on a national as well as on an international level is highly appreciated, and efforts in participating in national and international research networks are being taken.

The evaluation committee specially appreciate the various excellent individual research networks, which currently dominates collaborations, internally or externally. These activities certainly increase the quality of the performed research and enhances the visibility for the individual and in the long term, for the department. However, the evaluation committee believes that the presently rather dispersed networks and collaborations could be brought together, a boost in the national and international visibility can be predicted. Such a joint effort between the subjects would allow for potentially successful proposals on large, coordinated programs and networks.

One excellent example in this direction can be found in the so-called MR@KAU, materials research at Karlstad University. The MR@KAU is a collaboration between Materials Engineering, Materials Physics, Physical Chemistry and Mechanical Engineering, and includes a very broad range of research related to materials science. This collaboration should certainly be promoted, so that regular meetings and presentations within the group continues and is strengthened to ensure an exchange of information and research. The initiative certainly increases the national and international visibility, and clear indications for this can be found in the increased number of national and international networks and programs that researchers within MR@KAU participate in. The managers of MR@KAU should seek internally at the department to expand the number of members in the MR@KAU collaboration. It would also be beneficial to look for other potential members at KAU. The manager of the Department of Engineering and Physics should seek support from the faculty of Faculty of Health, Science and Technology, and Karlstad University to promote the successful MR@KAU collaboration.

In the subject EE, informal meetings between the research groups has been established recently, under the collaboration CREATE. In addition, a collaboration between Smart and Resilient Electricity Grids (EE) and Computer Science and Mathematics, has recently been established. This collaboration is in its beginning, and should be promoted, especially internally at Department of Engineering and Physics, but also externally at KaU, to establish a larger experimental and theoretical joint research group, with a focus on electrical power, renewable energy systems and automation. Here there is a good opportunity to harvest “low hanging fruit” to enhance national and international visibility.

5) Collaboration and societal impact of research

The Department of Engineering and Physics demonstrates a strong and evolving commitment to collaboration and societal impact, grounded in long-term partnerships with regional industries, national actors, and international academic institutions. The unit’s research activities address pressing societal challenges—renewable energy integration, digitalisation, sustainable materials development, and advanced manufacturing—which positions the department as an important contributor to both regional development and broader national innovation agendas.

5.1 Collaboration with Industry and External Stakeholders

Industry collaboration is one of the department’s most significant strengths. The subjects engage actively with companies across the energy, materials, and manufacturing sectors, offering mutual benefits in terms of research relevance, access to real-world data, and long-term funding stability.

Electrical Engineering (EE) stands out for its direct societal relevance. The group maintains deep collaboration with major utilities and energy companies, including Vattenfall, the Glava Energy Center, and several regional energy providers. These partnerships give researchers access to real operational environments, field measurements, and data streams that are essential for studying modern power systems. Projects in areas such as energy storage, grid flexibility, smart grids, digitalisation, and intelligent energy devices contribute directly to improving energy security and accelerating the energy transition.

In Physics, collaboration with the Karlstad Central Hospital in areas such as magnetic resonance imaging and medical physics represents an important societal contribution. These collaborations strengthen the link between fundamental science and health applications, while contributing to diagnostics and clinical research.

Materials and Mechanical Engineering (MME) also maintains strong connections with industry through partnerships with European universities and companies dealing with materials development, structural performance, and advanced manufacturing. These collaborations ensure that scientific advances—such as microstructural optimisation, fatigue modelling, and predictive digital tools—are translated into improved industrial processes and more sustainable material solutions.

The high number of **industry-funded doctoral students (7 out of 11)** across subjects further underscores the trust external partners place in the department and illustrates a healthy interaction between academic research and industrial needs.

5.2 Societal Value and Impact Areas

The department's work contributes to society in several high-impact domains:

Energy Transition and Security

The EE group's work on electrification, renewable energy integration, energy markets, and storage technologies addresses national and global strategic priorities. Research outputs contribute to more resilient energy systems, improved flexibility in local grids, and better tools for analysing the behaviour of future electricity markets. The department's focus on energy communities and user-oriented energy systems further enhances social sustainability and local engagement.

Digitalisation and AI in Engineering Systems

Digitalisation is a cross-cutting theme with substantial societal relevance. The integration of **AI, Python-based analytics, modelling, and smart-grid algorithms** into both teaching and research supports the shift toward data-driven engineering solutions. These developments prepare students for emerging demands in industry and equip local companies with modern analytical methods.

Advanced Materials and Sustainable Manufacturing

Research in materials science and mechanical engineering contributes to more durable, efficient, and sustainable industrial solutions. Work on corrosion, fatigue, predictive modelling, and microstructure optimisation directly benefits sectors such as automotive, energy technology, aerospace, and manufacturing. Through MR@KAU, the department helps drive regional competitiveness in advanced materials.

Health and Medical Technology

Physics contributes societal value through collaborations in medical imaging and radiation physics, demonstrating the department's interdisciplinary reach beyond conventional engineering.

5.3 Contribution to Innovation, Knowledge Transfer, and Skills Development

The department plays a significant role in regional innovation ecosystems. Collaboration agreements enable the co-creation of courses, MSc thesis topics, and doctoral projects that reflect real societal needs. Interaction with companies supports continuous competency development, with researchers frequently participating in industrial workshops, seminars, and knowledge-exchange events.

The close link between research and education also serves societal needs. The integration of modern topics—such as AI for power systems, data-driven mechanical engineering, and smart-grid simulation—ensures that graduates enter the workforce equipped with cutting-edge skills. This strengthens industry's capacity for innovation and supports the long-term development of the regional labour market.

5.4 Outreach, Dissemination, and Public Engagement

The department disseminates its research through numerous channels, including academic publications, conference contributions, industrial meetings, open seminars, and collaborative networks. Informal research groups—such as **CREATE** in Electrical Engineering—show a positive cultural shift toward interdisciplinary dialogue and public-facing engagement. The department's participation in MR@KAU further amplifies its visibility by creating shared events, internal seminars, and collaborative activities that highlight scientific achievements.

Although not the primary focus of all subjects, several researchers participate in public outreach, such as presentations at community events, media engagement, and expert advisory roles. These activities help build public understanding of energy systems, materials science, and technological developments.

5.5 Challenges and Opportunities for Enhancing Societal Impact

While collaboration is a clear strength, several structural challenges reduce the department's ability to fully leverage its societal relevance:

- Heavy teaching loads limit the time available for nurturing long-term partnerships and participating in interdisciplinary projects.
- Limited experience with EU-level programs such as Horizon Europe, MSCA, and ERC constrains the department's ability to join large research consortia that often produce the most significant societal impact.
- The lack of PhD rights in EE restricts the capacity to attract doctoral candidates and secure long-term, industry-linked research projects.

- A shortage of dedicated research engineers slows down the development of experimental infrastructures that support industrial collaboration and knowledge transfer.

Despite these challenges, the underlying potential is strong. The department has the expertise, networks, and societal relevance to significantly increase its visibility and impact in coming years. With strategic support—particularly in EU funding culture, doctoral-level capacity, and research engineering—its contribution to societal challenges can grow substantially.

6) Relationship between education and research

Research and teaching are closely linked, with many programmes benefiting from current research results and industry needs. EE has modernised its curriculum significantly by incorporating new courses in AI for power systems, Python-based data analysis, and smart-grid modelling, driven by collaboration with both industry and the Department Computer Science. MME spends much effort in the development of the Master program in Data-Driven Mechanical Engineering again benefitting from synergies with the department Computer Science. Engineering design is considered from the materials engineering point of view. Highlighting topology optimization and materials science and engineering has been the research nucleus for promoting teaching in Mechanical Engineering from bachelor to master level. MME is aiming to optimize coherency between their research focus in materials engineering and general mechanical engineering. To the committee, this appears challenging to since the latter one includes a variety of subjects that are obviously away from the department's fields of research, e.g., fluid dynamics, robotics etc. This issue has been tackled by hiring lecturers who represent these subjects.

In Electrical Engineering (EE), the lack of third cycle education rights limits the ability to attract PhD related funding and stabilise long-term projects.

7) Recommendations for further development

The department has successfully developed overarching research areas in materials science and electric grid management that will address most striking future and applied application in collaboration with regional and national enterprises. This development needs highly qualified researchers at all levels, efficient administrative support and an inspiring infrastructure.

7.1 Staff To safeguard the further exploitation of synergies between the subjects of the department and to motivate grant applications in various directions, the department needs a stable and sufficient staff situation. Accordingly, it is recommended to recruit additional lecturers, postdocs, and PhD students to reduce teaching-related overload and provide free time for research and elaborate grant applications. To ensure optimum training and usage of state-of-the-art equipment, to avoid any loss of specialized know-how, and to minimize off-times of important equipment, the recruitment of at least one additional research engineer should be considered. Here, it is recommended to invest in strategic hires that reinforce specialization in bridging Electrical Engineering (EE), Computer Science (CS), and Mechanical and Materials Engineering (MME).

In addition, reducing administrative burden and optimizing task distribution will improve work-life balance and give more time for developing new research ideas and exploring alternative funding schemes, e.g., those of the EU Horizon Europe porgram. The subject Physics has concern about recent recruitments and the potential that these recruitments will not stay due to vast teaching load. This situation might be mitigated by the pending and upcoming recruitments mentioned in section 3 in this review. Recruitment processes require timely initiation to avoid overloads in administration and teaching.

7.2 Cross-subject collaboration and research

Further integration of the department is highly recommended. That should focus on specific niche areas to build pioneering strength, e.g., digitalised energy systems & AI for smart grids and solar cells, where the complementarity of the subjects yields added value. As it is already done with the department Computer Science, further linkages across the University should be identified. Being already nuclei of international collaboration, research on biomedical applications and corrosion in MME could find linkages with Life Sciences (As mentioned by Jayaraj Jayamani during the interview with respect to collaboration with Estonia). The department should strengthen and encourage interdisciplinary meetings and discussions, that were already initiated, e.g., journal club, MR@KAU meetings. Such meetings will inspire for innovative research ideas and the formation of cross-subject consortia (EE–CS–Physics–MME) to jointly apply for large, coordinated national and EU grants. Such grants can build on the strong industrial and academic network of the department. We strongly recommend a more proactive EU Horizon culture including training, mentorship, and protected proposal-writing time for researchers. Expanding researchers' access to training, mentorship, and protected proposal writing time related to Horizon Europe, MSCA, and ERC schemes would improve the department's competitiveness in large international calls. The strong industrial network should allow for expanding opportunities for industry-linked MSc theses and courses, as well as externally funded PhD positions.

7.3 Strengthening EE with second and third cycle program

It is recommended to strengthen EE in such a way that PhD candidates can be supervised independently. This would improve competitiveness in national and international calls. At the same time, strong research programs should increase the attractiveness of the EE to potential students. Strengthening EE would also contribute to position the department as a regional leader in digitalised energy systems and sustainable materials research.