Research Assessment Dalarna University
RADU 2023

Self-evaluation of research activities at:

School of Information and Engineering (IIT)

Based on the years 2018-2022

HÖGSKOLAN
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Self-Evaluation for the School of Information and Engineering (IIT)

The self-evaluation has been written by four authors: one senior researcher from each of the three main research environments and the deputy Head of School (*proprefekt*). The latter also led the writing process. The intention has been to give all researchers at the School the opportunity to follow and contribute to the self-evaluation work. Researchers within each research environment were invited by their respective representative author to participate in two seminars, as the self-evaluation was being written, to discuss the draft texts for their own environment. After that all senior researchers, the Head of School (*prefekt*) and Department Directors (*avdelningschefer*) were invited to two seminars to discuss the entire self-evaluation draft, specifically focusing on the last section containing the summary and SWOT analysis. Three collegial members of the School's Steering Council (*institutionsledningsråd*) made a final revision of the self-evaluation before the Head of School approved it for submission.

The self-evaluation is supported with the following appendices:

1) Publication lists [please see the complementary evaluation material from the central administration].
2) Bibliometrics both on School and department levels: some graphs have been used in the report to illustrate points considered important for characterization of the different research environments [please see the complementary evaluation material from the central administration].
3) A previous university-wide research evaluation from 2015 (DURE) [appendix 1]. In Fall 2022 a university-wide investigation was conducted by an external consultant, DAMVAD, based on bibliometrics from 2017–2021 [appendix 2]. Some graphs from the resultant report are incorporated into this self-evaluation.
4) One common table for the School listing external academic commitments (2021 and 2022) [appendix 3].
5) One publication for the micro-data analysis (MDA) research environment: "The emergence of Microdata Analysis and its intellectual history over the past two decades" (Carling 2018) [appendix 4].

The first five sections mainly describe the research, following the guidelines in the self-evaluation template. Each section ends with a short summary which evaluates the main matters and which are then included in the SWOT analysis in Section 6.

The Swedish employment positions and academic roles are translated into American English and are given as a list at the end of the report, together with organizational abbreviations that we use throughout the report.

1. Area of research

Before the reorganization of Dalarna University into five Schools defined as coherent academic environments for research and education, research and education were organized as separate parts. The research was established in six research profiles given internal research funding and a mandate to decide on the distribution of these resources to the profile's researchers.

In the new organization three of the previous research profiles are located within the School of Information and Engineering (IIT): Complex Systems – Microdata Analysis, Energy and Built Environment, and Steel Forming and Surface Engineering. Each of them is located in one of the three departments. Hence the Information and Data Management Department (*Data och informationshantering, DIH*) includes the Complex systems – microdata analysis researchers; the Energy and Construction Engineering Department (*Energi- och byggteknik, EBT*), the Energy and Built

Environment researchers; and the Industrial Engineering Department (*Industriell teknik och ekonomi, ITE*), the from Steel Forming and Surface Engineering researchers. After the reorganization, the ITE department also has researchers in the department within Industrial Engineering & Management and Entrepreneurship which moved from another department now placed in another School.

The report which follows is, in the main parts (i.e. Sections 1, 3 – 5), written from the research environments' perspectives to best describe and evaluate "from the inside" the ongoing research and path forward. Two larger research environments coincide with the departments where they are located and involve all research active staff in those departments. The subsections in the report are therefore titled with the name of the research environments: Microdata Analysis (MDA) and Resource Efficient Built Environment (*resurseffektiv byggd miljö*, REBM) respectively. In the ITE department the research is organized into four separate groups: Materials Technology, Mechanical Engineering, Industrial Engineering and Management, and Entrepreneurship; the sub-sections are therefore titled with the department name instead. Figure 1 illustrates the School's organization into three departments and their respective research environments. Section 2 is written from the School's perspective describing the decision-making for resource allocation for research such as funding and staffing.

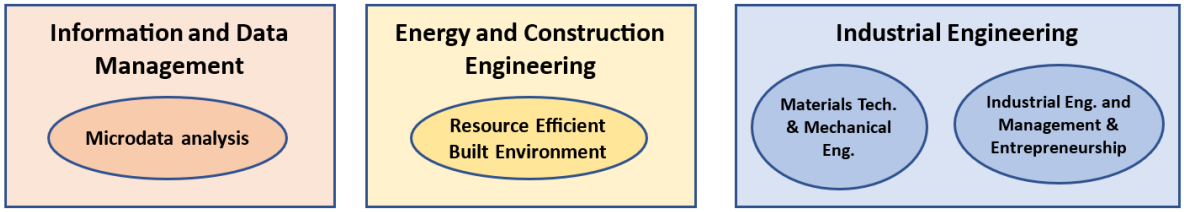

Figure 1: Research environments (ellipses) located in the departments (rectangles) of the School of Information and Engineering. The total number of staff in each department is: DIH ca 50, EBT ca 40 and ITE ca 20. The research active staff in each environment is mentioned in Sections 1.1 – 1.3.

1.1 Microdata analysis (MDA)

For the evolution of the MDA research see "The emergence of Microdata Analysis and its intellectual history over the past two decades" (Carling 2018). However, in recent times and as is stated in the DURE (2015) report the main focus of MDA research is the study of complex processes both in business and in industry as well as in social constructs. The main thematic focus was on transport, infrastructure and retail. This has been complemented by energy consumption, intelligent healthcare, building/construction materials, animal welfare, neuro evolution, and evolutionary game theory. Note that currently many of the published articles have an environmental angle as a co-focus in the areas mentioned above. Moreover, central in MDA research is the creation and adaption of tools which can be used when collecting, processing, analyzing data, and decision making. Part of the research is engaged in analyzing existing decision systems and developing new ones. The research is transdisciplinary in its character and includes a mix of established subjects such as Computer Science, Information Science, Management Science, Statistics, Mathematics and Human Geography. Some of the important scientific communities which MDA researchers frequently interact with include INFORMS, EURO (The Association of European Operational Research Society), WISE (Web Information Systems Engineering), ACM SIGSPATIAL, ISD (Information Systems Development, World Meteorological Organization (WMO), and the Global Atmosphere Watch Programme (GAW).

From a methodological point of view the MDA researchers have been involved in developing advanced statistical methods, improving algorithms in various application areas often in a real-world context; creating methods for the capturing and modelling of real-world knowledge and experiences, methods to solve highly complex optimization which works with massive data sets, methods to collect and process highly complex spatial data, and modeling and prediction of dynamic systems.

In the past five years the main development in the applied research is the inclusion of urban analysis of air quality, new aspects of intelligent healthcare, neuro evolution, and evolutionary game theory. Development in methodological research includes synthetical data analysis methods and logic (knowledge) reasoning methods. This development has been possible with the recruitment of two new professors in MDA with AI orientation in their approaches.

The research network in MDA is shown in Figure 2 which illustrates that the senior researchers have an important position as gravity points in the conducted research. The senior researchers are Rybarczyk, Hintze, Westin, Alam, Dougherty, Fleyeh, Håkansson, Rudholm, Carling, Song, Han, Rönnegård and Zhao. Around them they have a network of Junior PhDs and PhD students to conduct the research. Note that some of the researchers in this network have left the environment and some have been added since 2018. Currently there are 34 researchers in the MDA environment: 11 are seniors, 11 junior researchers and 12 PhD students.

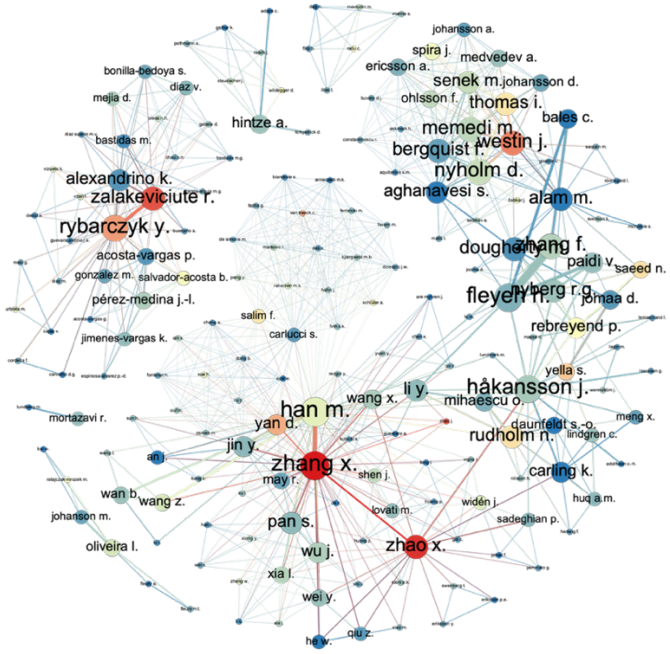

Figure 2: Research network in Microdata analysis. (Sources: Damvad Analytics, Scopus, DiVA)

Another major cornerstone in the MDA research is the PhD program in MDA. Currently there are 12 PhD students in the program, which is a bit low. The students are mostly supervised by 2-3 supervisors, where the senior supervisors are the main supervisors. In practice, a lot of the research is conducted within these supervisory groups. The PhD students mostly write a compilation thesis and, so far, most of the papers in these theses have been published in international peer-reviewed journals. Normally the PhD students receive a lot of help in the beginning of his/her article writing. The help tails off as their studies proceed and usually ends with the PhD student as the leading author or the single author in the last articles added to their thesis.

Figure 3 complements Figure 2 by showing how many authors there are in the scientific publications produced. Out of 234 publications during the period a typical publication has 3-4 authors. This is considered satisfactory since we believe that collaborations between researchers will improve research quality. The collaboration is not limited to within MDA collaborations, according to Scopus and Diva. Some 40 % of the publications are in collaboration with other Swedish institution researchers; the main ones being Uppsala University, Örebro University, University of Gothenburg, and HUI Research. Further, about 44 % of the publications are joint publications with co-authors from other countries than Sweden.

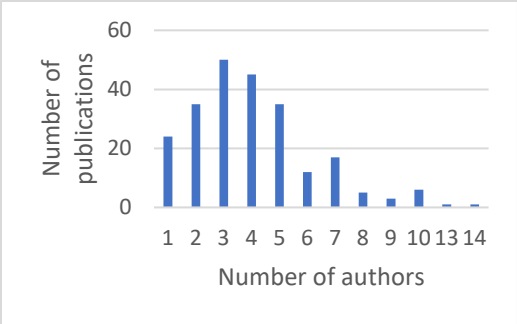

Figure 3: Number of authors per scientific publication in Microdata analysis 2018-2022. (Source: DiVA)

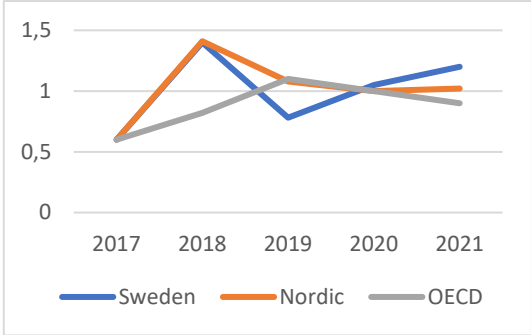

Figure 4: Scientific impact in 2017-2021 compared by region. (Sources: Damvad Analytics, Scopus, DiVA)

Figure 4 shows the scientific impact of MDA research. The scientific impact is defined as the average number of citations in the sample divided by the average number of citations within the same research field and publication year. As can be seen, the impact varies around an average (score 1) for the compared regions.

For the future plans, we want to continue to establish our MDA research in the surrounding research community. Important means to achieve this is via joint publications with researchers at other universities. Although it is somewhat difficult to achieve high scientific impact when the research is transdisciplinary rather than with a certain traditional subject area, there is a publication focus in the environment striving to publish in the most high ranking journals. It is a learning process to have the articles published in those journals and the goal is to attain better scores in publishing in such journals. This would help to improve the scientific impact of the MDA research.

1.2 Resource efficient built environment (REBM)

There are 23 active researchers in REBM including 6 professors (5 of them full-time), 2 associate professors, 6 lecturers and 7 PhD students. However, three professors will retire in 3 to 5 years and the environment has therefore been strengthened with two new professors, one recruited and one promoted during the last year. The research environment consists of two main research focus areas:

- **Energy systems in the built environment:** the focus is on single and aggregates of buildings, as well as district and urban scale. It includes the development of different technologies within energy systems such as demand response, heat pump, solar, battery/thermal storage, district control, mobility, and socio-economic study for both heating and electricity purposes. The department, which is specialized in solar technology, started as the Center for Solar Energy Research (SERC) in 1984. The research is interdisciplinary and multidisciplinary. The energy systems research is done in collaboration with the Department of Data and Information Management using machine learning algorithms to optimize the system design and operation. The socio-economic research is done in collaboration with the social and economic research groups.
- **Energy efficiency in the built environment**: the focus is on new/renovation technologies of buildings for improved resource and energy efficiency as well as improved indoor climate and life-cycle analysis. The research in this direction is interdisciplinary, multidisciplinary, and often applied in collaboration with local industries. The social science research on energy efficiency in buildings is primarily focusing on social engagement and has involved researchers from Political Science and Social Anthropology. Collaboration is now also starting up with the Industrial Engineering and Management group for circular economy.

There is a large overlap between these two focus areas. In addition, there are other small research

areas such as sustainable urban planning and social science for energy and building renovation. Research on forest resources was included in the beginning of the period but has been phased out due to staff retirements. Figure 5 illustrates words from the key areas from publications during the past five years and confirms the spread of subtopics which have engaged the researchers.

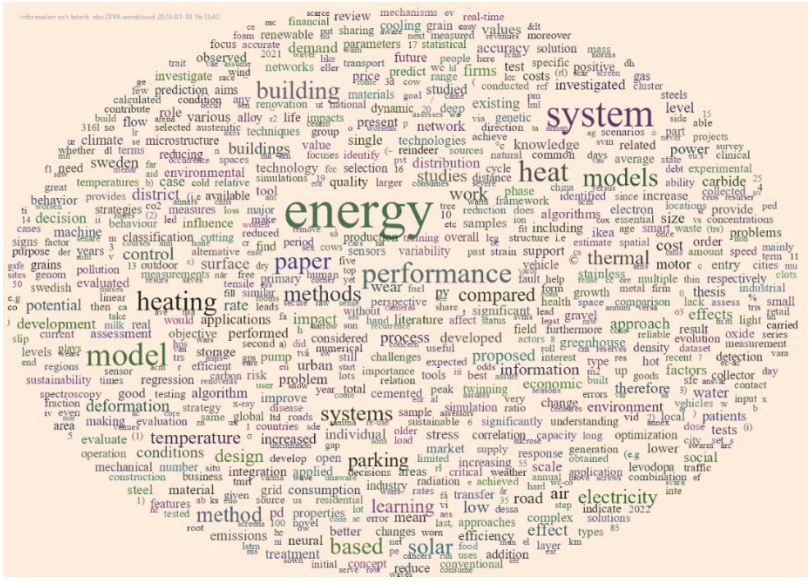

Figure 5: Cloud information for the key areas. (Source: DiVA 2018 – 2022.)

The REBM environment assesses its research activities within three aspects: existing competence, current research projects, and collaboration as shown in Figure 6. It has, as shown in Figure 6 a, strong activities in the areas of renewable energy supply, co-generation/district heating, flexibility (including digitalization), energy storage, and electrified transport infrastructure and load. The department is less active in energy (resource) efficiency for buildings, sustainable urban planning, pro-active grid improvement and knowledge transfer on energy transition. There has been no activity related to hydrogen in the past 5 years.

The REBM environment has an initial plan to further strengthen all research areas, indicated in Figure 6 b, to couple with the regionally prioritized activity areas (launched by the Dalarna regional office in terms of future prioritized directions for general energy systems). More specifically, four main themes within the research environment emerge: energy efficiency in buildings, solar energy systems, flexibility in energy systems, and sustainable transportation. These areas are prioritized by the surrounding society and they will strengthen the regional energy systems.

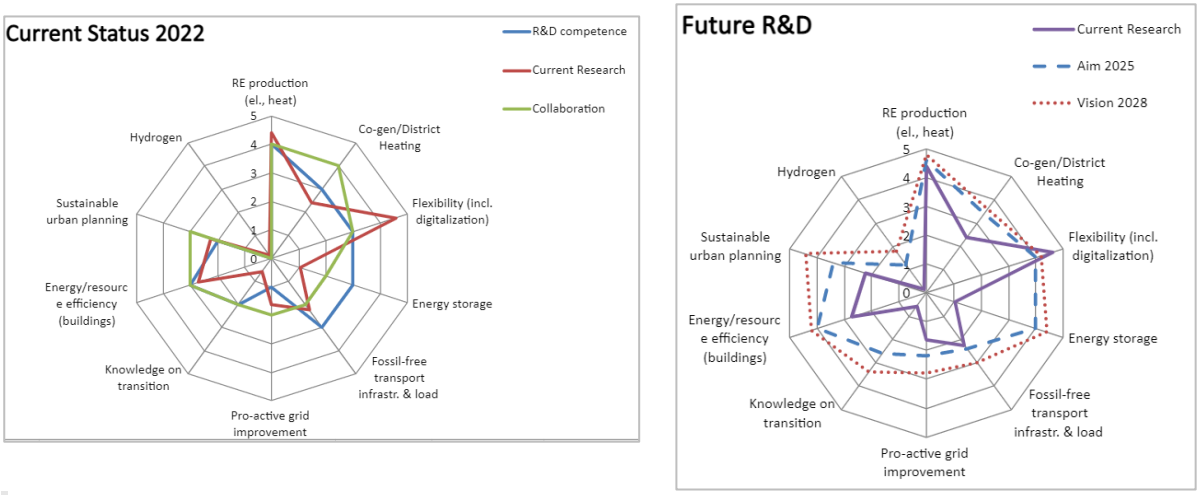

Figure 6: Current (a) and future (b) research activities of REBM.

In the distribution of internal research funding, PhD projects as well as senior research to qualify as an associate professor has been prioritized, as well as a few post doc positions for researchers recruited from outside the university. This has been according to the plan to become a stable research environment to attain the right to have doctoral education, something which was achieved in 2022. Many of the PhD students have become connected to companies since they have been within the Research Schools. The PhD students' research areas have been formulated together with the companies and the academic supervisors. However, we see that the final research questions are often formulated by the PhD students themselves, indicating that the environment's ability to create researchers with academic freedom works. The post doc and aspirants to become associate professors (*docents*) have been chosen based on their academic field, skills and ambitions, and they have been free to choose their research subject. However, the publications are often in collaboration with other researchers and/or linked to ongoing externally funded projects, but not always.

Since a generation shift will take place in the coming decade, the new professors and associate professors, as well as new researchers who will be recruited to higher academic positions, will have an important influence on the direction of future research.

The REBM's publications stand on the frontier on both national and international levels. The REBM environment is the third largest research area at Dalarna University in terms of publications. REBM produced only 27 publications in 2018, but the numbers increased to 40-50 from 2019 to 2022, see Figure 7. Most of the publications are peer-reviewed articles with either national or international collaborations. Over 80 % of the peer-reviewed articles are visible in JCR, Scopus and Web of Science (WoS) databases and are listed on Norwegian level 1 and level 2. Half of the peer-reviewed articles are in the top 25 % cited in the field of energy and construction engineering.

The field-adjusted Journal Citation frequency is for 57 % of the articles larger than 1.0, which means 57 % of REBM's articles were cited more than other articles published within the same field. The 10 most productive researchers share about 73 % of peer-reviewed articles and contribute 82 % of total citations. However, about 15 articles do not have any citations as of the end of 2022, while most of the remaining articles have less than 30 citations. Only two articles are cited more than 100 times. In 2018, about 43 % of the articles had a female as first author; however, this ratio dropped to only 5 % in 2022. To a large extent this was due to previous female PhD students finishing their work during the first part of the period, while new female PhD students began their work later into the period.

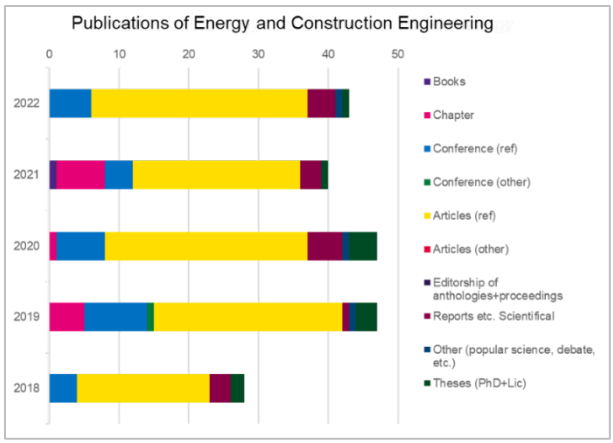

Figure 7: Publications of REBM from 2018-2022. (Sources: DiVA 221231)

1.3 Industrial Engineering

The Industrial Engineering department consists of Physics, Mathematics, Materials Technology, Mechanical Engineering, Industrial Engineering and Management, and Entrepreneurship subjects. Research within the Industrial Engineering department is mainly within the Materials Technology subject with some contributions from the Mechanical Engineering, Industrial Engineering and Management, and Entrepreneurship subjects.

Materials Technology

The research within Materials Technology focuses on steel forming and tribology. Steel forming research focuses on developing physically based models to predict mechanical behavior and microstructural evolution during plastic deformation in carbon and stainless steels. Tribology focuses on investigating the mechanisms of friction and wear. The research mainly explores how the microstructural design of materials and surface engineering can be utilized to enhance performance in various applications including metal cutting, wire drawing, and rock drilling. In addition, research has been carried out to study the microstructural and mechanical properties including tribological and corrosion behavior of samples produced by different additive manufacturing processes. The research is performed in close collaboration with Swedish manufacturing and steel industries. The group today has one professor, one senior professor (10 %), two associate professors, and a research engineer.

Mechanical Engineering

The research within Mechanical Engineering focuses on the methods and tools used for an efficient and customer-oriented process and product development process, particularly the decision-making during the early stages of the development process. The research is conducted by one assistant professor.

Industrial Engineering and Management

The research aims to enhance efficiency, customization, and sustainability in industrial applications. It has focused on developing sustainable last-mile logistics business models in grocery retailing. In addition, research has been carried out in collaboration with the REBM environment to evaluate and develop business models and investments for small local networks of renewable energy micro-producers. The research is conducted by one associate professor and one PhD student.

Entrepreneurship

The research within the Entrepreneurship subject focuses mainly on different forms of entrepreneurship (such as social, hybrid, micro, rural, and urban entrepreneurs) where different

entrepreneurial factors are used to create positive social and environmental impact, while also generating financial sustainability, regional development, and growth. The research is conducted by one assistant professor and one PhD student.

Currently, the subjects within the Department of Industrial Engineering have individual research goals and do not interlink with each other. For a better and more cohesive research environment within the department, a common research goal needs to be identified. This future research direction has not yet been decided and it is important to build a suitable education portfolio so that a research environment connecting all subjects within a department can be developed. This will also help to strengthen the education within the Industrial Engineering department and build a strong collaboration with regional and national industries. Thus, the immediate goal (within the next 5 years) is to develop the basic level education (Bachelor engineering program) in all subjects or at least in Mechanical Engineering and Industrial Engineering and Management subjects. To create this common research environment within the department, plans and strategies need to be discussed within the subjects and also with different levels of management and relevant committees.

1.4 Summary

The research environment at the School started relatively early at Dalarna University (founded 1977). Solar energy and material research started in the 1980s and data science in the 1990s. Hence a long practice of research, and the need to fund research with external grants, has resulted in research contributing to a larger share of the core activities (education and research) compared to the university as a whole. Two of the environments have succeeded to grow and become academically mature enough to attain doctoral programs. The environments have grown independently of each other from the start, developing more interdisciplinary collaboration in the past five years. There is a strength in being self-sufficient and independent although it can also constrain further research development, specifically multi or interdisciplinary research.

There is collaboration between the three environments and also with other environments within the university. One collaboration which has evolved over time and is now a research group with two senior researchers (one each from MDA and REBM respectively) and a few doctoral students is in the field of energy systems modelling. There are also other examples of collaboration on project level, in KK-funded doctoral schools (*KK Stiftelsen*, the Knowledge Foundation), and manifested in a number of external project applications (some granted and others not). Figure 8 illustrates the internal collaboration between the School's researchers. The collaboration between researchers from MDA (blue) and REBM (yellow and red) is strongest as manifested in the shorter connections (lines) between the researchers (circles).

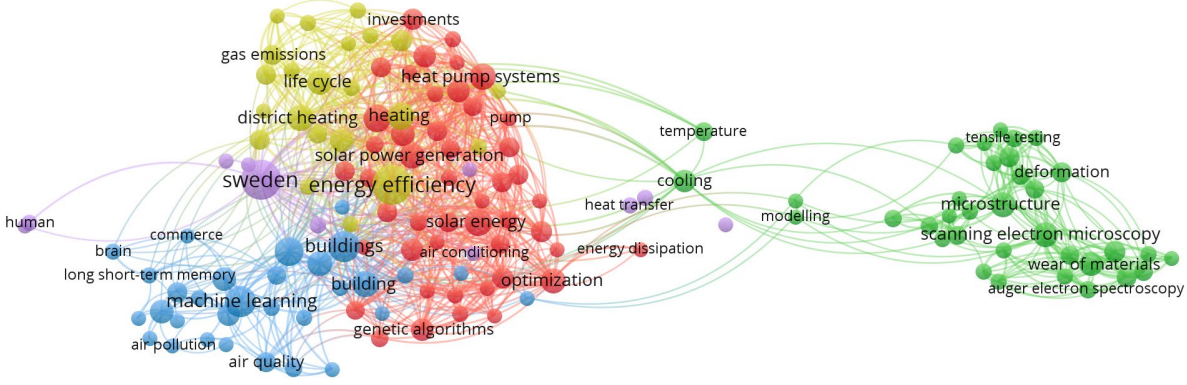

Figure 8. Keyword net connecting authors School of Information and Engineering 2018 – 2022. The colors indicate researchers in the different subjects and the size of points the presence of a keyword. Blue: MDA; red: Energy Engineering, yellow: Construction Engineering, green: Materials Technology. (Source: DiVA)

External collaboration plays a vital role in the research, illustrated in Figure 9 which shows co-authoring with academic institutions worldwide.

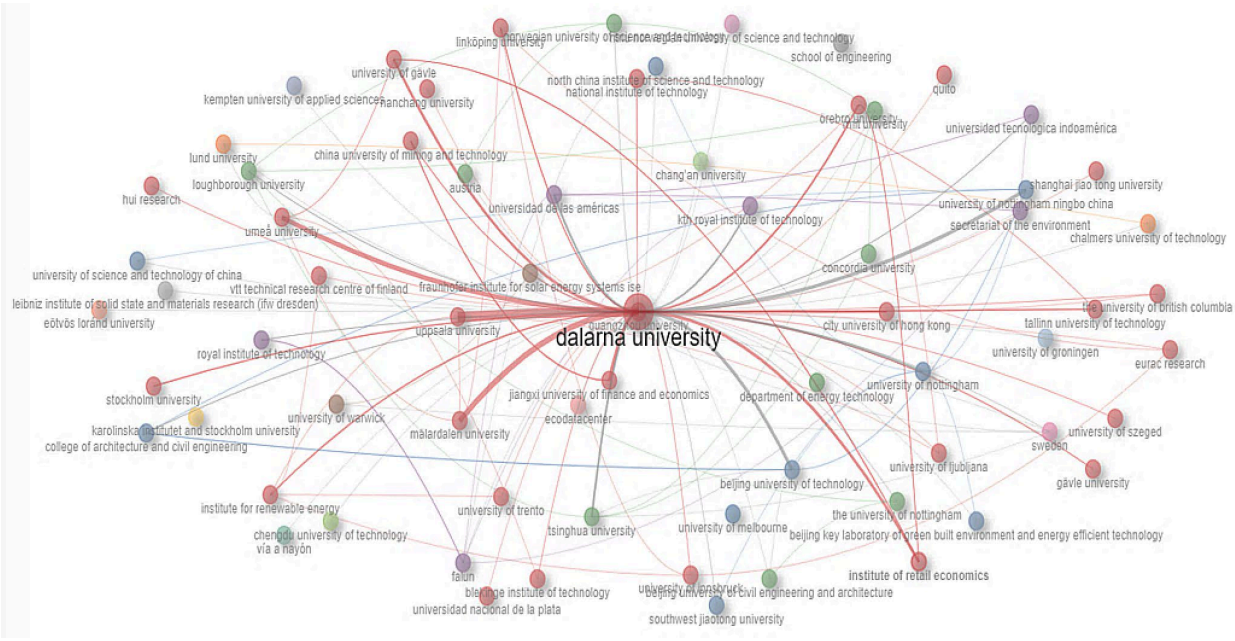

Figure 9. Collaboration network for co-authoring with academic institutions 2018 – 2022 for the whole School of Information and Engineering. (Source DiVA).

2. Preconditions: organization and resources in the School

Departments as units have been used instead of research environments in this section to describe the allocation of research funding and research staff. The reason is that these are organizational units used for finance and staffing.

2.1 Research organization and management

Each of the three departments at the School are led by a Department Director. There are no academic requirements for this position and none at present has a PhD, although one has a licentiate degree. Each director is appointed by the Head of School.

As a complement to the Department Director, a Research Coordinator (*forskningssamordnare*) is appointed by the Head of School to coordinate research and to assist with staff planning, budget issues, etc. The academic requirement for this post is at least associate professor. The Research Coordinator is appointed by the Head of School based on suggestions from the Department Director, who in turn has given the department staff the opportunity to suggest suitable persons.

The Director for a doctoral program (*studierektor*) is chosen through a similar process to that of the Research Coordinator and formally appointed by the Head of School. There is no formal academic requirement but of tradition at least associate professor is required.

The Head of doctoral subjects (*ämnesföreträdare*) have a central position in the PhD education, and by tradition the incumbent is at least associate professor.

The current Research Coordinator, Director of doctoral program and Head of subject are all associate professors in DIH and professors at EBT, and the Research Coordinator at ITE is associate professor. The senior staff are called to seminars and meetings to give their feedback and suggestions on important research activities whenever necessary. There is also a Doctoral Student Council for each

of the two doctoral programs. Approval of research application submissions is formally made by Head of School or the Vice-Chancellor after consultations with the Department Director, Research Coordinator, and Finance Department staff. Decisions related to research education are made either by the Head of School or the Doctoral Education Committee (*forskarutbildningsnämnd, FUN*) after consultations with the Director of the doctoral program.

The School is led by the Head of School. The formal requirement for this position is at least a doctoral degree. There is a School Steering Council which consists of the three Department Directors and three collegial members, one from each department. The collegial members are appointed after collegial election where the teaching staff in the School vote. The formal requirement to become a Steering Council collegial member is a permanent teaching position, however the practice at the School is to require at least PhD degree. A deputy Head of School (*proprefekt*) is appointed on the decision of the Vice-Chancellor, after consultation with the collegial Steering Council members and proposal by the Head of School. The deputy Head of School must be at least associate professor if the Head of School has a lower grade than associate professor. At the moment the Head of School has a doctoral degree, the deputy Head of School is professor, one Steering Council collegial member is professor, one is associate professor, and one is a PhD.

The decisions which have to be taken by the Head of School follow the university delegation order (*delegationsordning*). A decision is made after a process where relevant staff groups are heard (*beredning*). For the moment, it is a work in progress to formalize staff fora for different types of preparation processes. One managerial group which has been established is the monthly meetings the deputy Head of School has with the Research Coordinators to prepare in common School research matters and activities before the Head of School makes any decisions. This group also serves to create a common ground for research questions raised by the departments. In more principle matters, this group also calls consultant meetings with the so-called senior reference group which constitutes all senior researchers at the School. This usually happens 2–3 times a year. There is also a forum for doctoral education preparation (*beredning forskarutbildning, BFU*).

2.2 Research funding

The university distributes internal research funds to the Schools based on five key indicators compiled for each School with weight factor: amount of external research funding (10 %), number of publications (20 %), number of employees with PhD (30 %), number of PhD students (20 %), number of full-year students (*helårsstudenter, HST*) (20 %). The indicators have been calculated on data from the three preceding years, 2018 – 2020, for 2021 and 2019 – 2021 for 2022. In the years 2018 – 2020, before the re-organization, the distribution of funding was based on other not so transparent criteria. The Head of School decided after consultation with the School Steering Council to use the same model to distribute internal funding to the three departments. To use the same distribution model internally in the School was originally proposed by a group of six senior researchers as representatives from the three departments and it was well anchored among the researchers within the three departments as being the best way to give transparency and predictable conditions which are the same for all researchers.

Ten percent of the internal funding to the School is kept at School level for common research activities. The deputy Head of School and the Research Coordinators arrange an annual *Research Day* event and other common activities in workshop format to promote more collaboration between researchers from the different departments. Part of this 10 % is also used to promote more specific research activities such as co-funding common PhD students to build up research with broader competences. It is also used for course fee payments for junior researchers attending supervision courses. The budget for the 10 % common fund is prepared by the deputy Head of School together with the Research Coordinators. It is presented to the Steering Council before a decision by the Head of School is made.

The university allocates funding specifically for doctoral programs to cover the costs of doctoral courses, doctoral and licentiate examination, and other expenses. This funding is distributed directly from the School to the two departments which host doctoral programs, 1.8 MSEK each.

To have transparency and equal rules for allocating internal funding in a similar way at the three Departments, the School has a policy which recommends the level of support to individual researchers. The recommendation is that all research active staff with a PhD degree have 5-10 % of their full-time post (85-170 hrs annually) for participation in research meetings and research seminars (5 %) and to participate in writing research applications (5 %). This is a basic affordable level considering the number of researchers in relation to the internal funding. Doctoral student salaries, supervision time, infrastructure and co-funding of external projects for PhDs are also equally prioritized. Figure 10 shows the use of funds (as costs for 2022) for the different main categories of PhD students (in DIH and EBT), PhDs for research, and laboratories (at EBT and ITE). The two larger departments (DIH with ca 50 employees and EBT with ca 40 employees) are given higher shares than ITE (ca 20 employees) as an outcome of the distribution model. As seen in Figure 10, the PhD students account for the larger part in DIH and EBT and the laboratories account for the largest share in ITE.

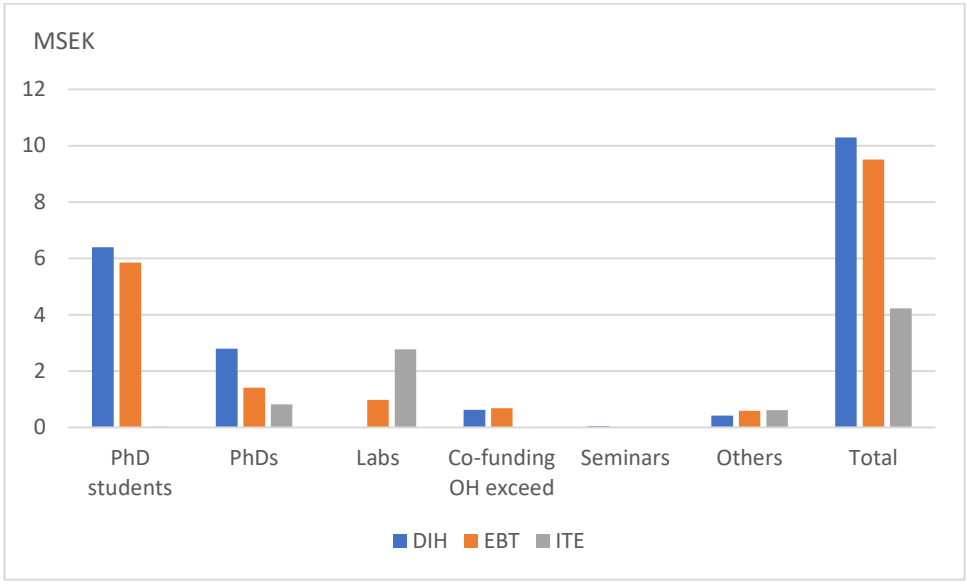

Figure 10: Internal research funding at the School *2022 distributed by main research activities.*

Since a large portion of the funding is allocated to conduct the doctoral programs, a large part of the research takes place through doctoral projects. One guiding factor here is that external funding also plays a role in the financing of PhD students. One principle is that when a PhD student is in part externally funded, the remaining part will be provided from the internal fund. Further, when internal funding is required in an external project this is prioritized according to the School's policy referred to above.

In general, the research is funded from internal and external resources. External funding comes mainly from various research foundations but also from other organizations. The annual funding for the last five years is shown in Figure 11, divided into department level, internal and external funding. The research part is about 30 % of the sum of research and education funding at the School (Annual Report 2022). This is 10 % higher than for the university as a whole. The goal set in the School´s business plan for the period up to 2026 is to reach 40 % for research. This is only achievable by increasing external funding.

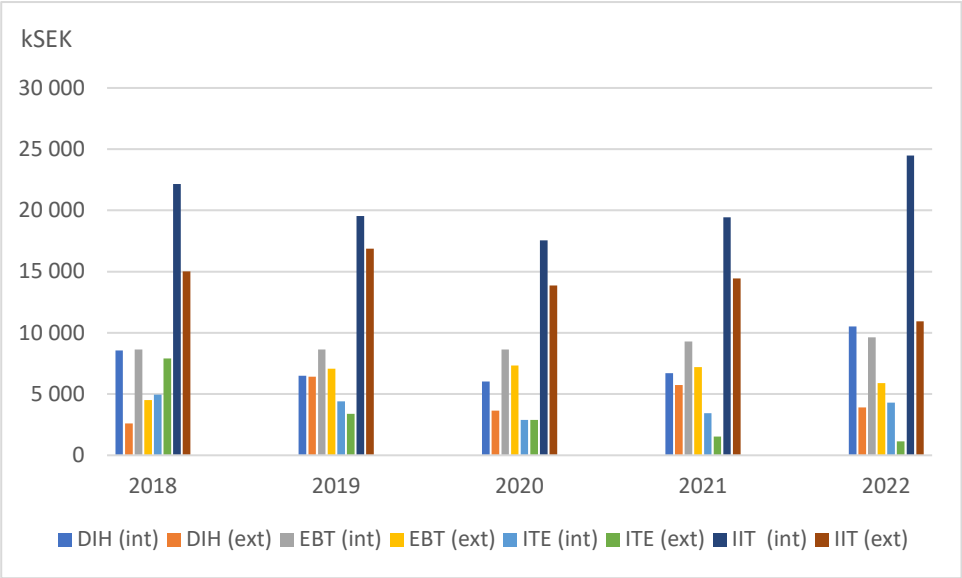

Figure 11: The internal and external research funds (as costs) on department level and total.

All research active PhDs are encouraged to apply for external funding and, as mentioned above, a base funding of 5 % is allocated for writing applications. For larger applications planned in advance, these can be budgeted for from the department's allocation or the School's common 10 % share to allow more time to be spent on strategically important applications.

The approved external funding in total in 2021 and 2022 was 15 MSEK and 21 MSEK respectively. This corresponds to 19 % in approval rate in 2021 and 17 % in 2022 (so far). The sources of funding for 2018 - 2022 are shown in Figure 12.

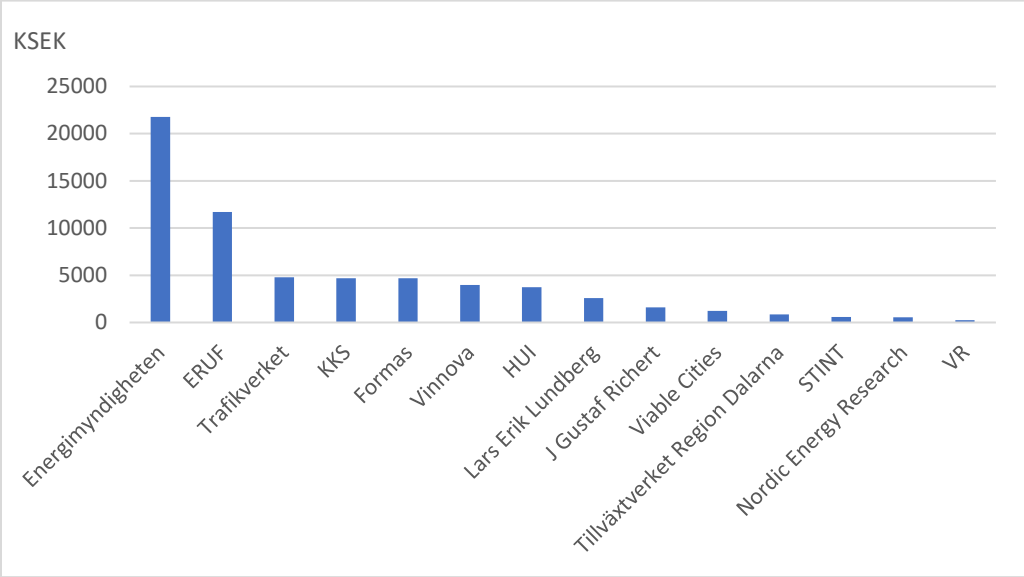

Figure 12: Research funding in total for 2018 - 2022.

As mentioned in Section 2.1, all external research applications need approval by the Head of School before submission. If co-funding from the university in total exceeds 0.5 MSEK, this requires approval from the Vice-Chancellor as well. The applicant presents the application in a decision meeting to the Head of School where the deputy Head of School is also present. The Research Coordinator and Director of the applicant´s department also participate in the meeting to confirm that resources from

the Department´s internal research funding can be used (if co-funding is needed) and time can be planned for conducting the project (e.g. removal from teaching duties might be a consequence). Before starting to write the application, the researcher needs to inform the Research Coordinator and receive confirmation that co-funding (if needed) is available. The Department Director must be informed and needs to approve that time is available for the planned participants in the project. Hence a budget plan is in focus early in the plans and needs to be approved by Financial Department staff before the application is presented to the Head of School.

The research at the School is mostly applied and therefore focuses on research questions with societal relevance. The research development aims to be flexible to take new directions based on societal changes and challenges. It is a balance between depth and width, continuation in "old" tracks and shifts to new tracks to build up a solid research capacity and robust research environment.

The quality of each research application is assured via a team of application authors. The majority of applications are made in collaboration with researchers at other universities and partners from industry or other organizations. Younger researchers receive support from senior researchers (acting as mentors) and have their application reviewed before submission. The university offers a workshop for researchers to develop their application writing skills. Such a workshop was held for the first time in Fall 2022 with 6 PhDs participating from each School. There is, at the moment, no direct grant office support for the actual writing of applications at either central university or School level. Granted external funding for 2018-2022, distributed as seen in Figure 12, totaled 63 MSEK.

In addition to external research resources given as grants, there are a number of industrial PhD students who contribute to the research in a similar manner to internally employed PhD students. During the period 2018–2022 there has been two PhD students employed at The Swedish Transport Administration (*Trafikverket*), seven employed in companies within the KK-funded industrial doctoral School REESBE (Resource-Efficient Energy Systems in the Built Environment), and three in the KK-funded industrial doctoral school Future Proof Cities (more about the doctoral schools in Section 3.2).

2.3 Professional competence

The staff list as of December 2022 comprised 119 employees, with 112 in full-time employment. The research time in total is 24.34 in person/year which means that 22 % of time is spent on research on average. This is a smaller number than when counting the total spending on research contra education, but the research has also other costs in terms of infrastructure, travel, etc. Research staff compared to total School staff (management and administrative staff not included) is visualized in Figure 13 dispersed over different employment categories.

The senior researchers, associate professors and professors, are 11 in each category, in total 22. The time devoted to research is, for this group, on average 34 %. The junior PhDs holding an assistant lecturer position (*lektor*) is a smaller group, 16 persons. The majority are research active but on average only 12.5 % of their time is used for research which is notably lower than in the senior group. The largest teaching category is lecturers (*adjunkt*) without a PhD. This reflects that a large part of the teaching duties is dedicated to three-year bachelor and engineering programs as well as two-year programs where competence from professional sectors other than academia is also needed. Participation in research is very low in this group and only 6 out of 37 have some research activities, mainly conducted as R&D in external projects.

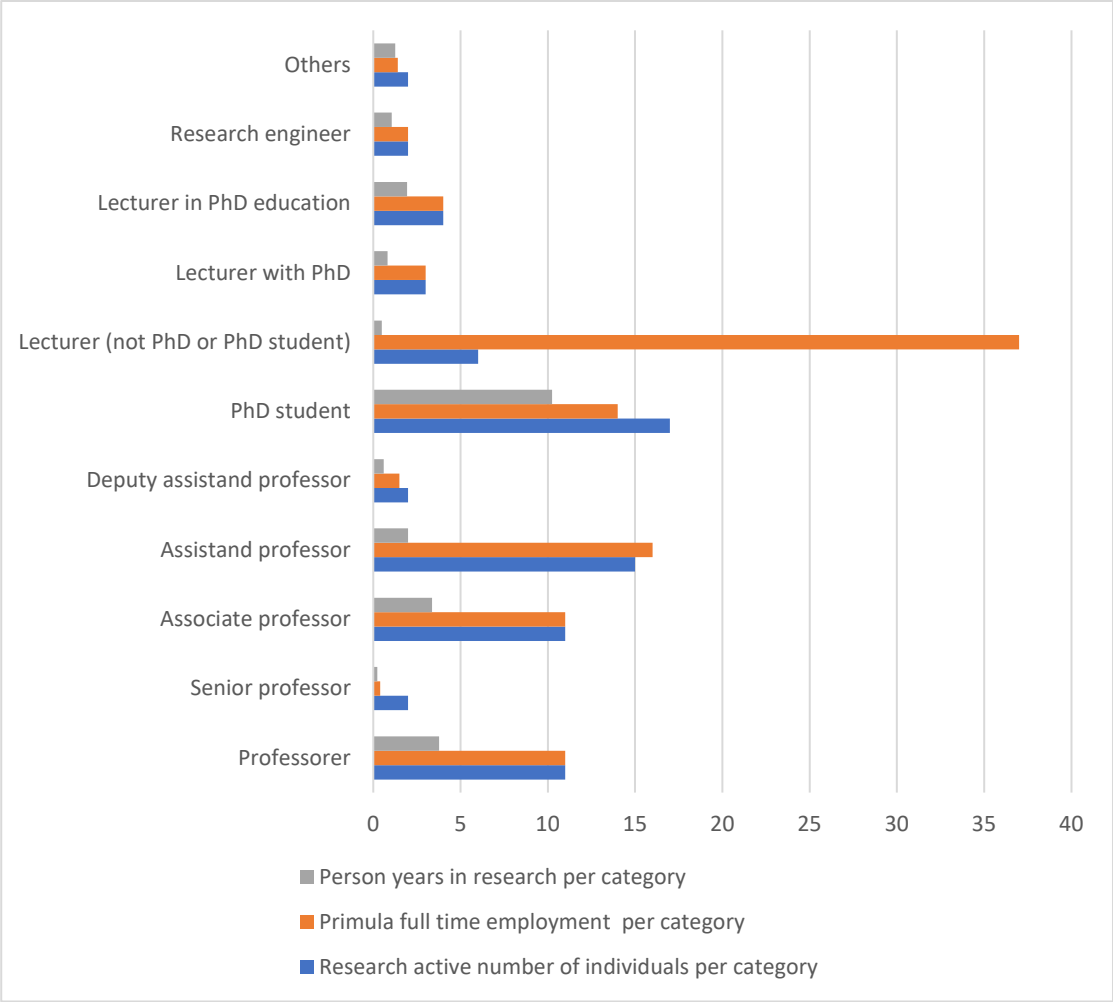

Figure 13: The School staff in December 2022.

The university strategy for 2021–2026 explicitly states the goals to increase the number of assistant professors and have a larger share of staff with competence to conduct research. This is also the goal of the School and is in line with the goal to increase external research funding (40/60 in percentage between research and education) as described above. Professors usually do less teaching but have instead other commitments within the university such as members of collegial committees or academic leaders. There is also a competence need for lecturers to be, to some extent, involved in research. A goal could be to have on average 10 % of a full-time post for this group to participate in R&D in external projects.

A larger competence lift for lecturers without a PhD (*adjunkter*) is to enroll as PhD students and be promoted to senior lecturers (*lektorer*) after receiving their degree. At the moment, there are two such PhD students (as shown in Figure 13). This route entails, in accordance with present university regulations, that the person must take leave from their permanent lecturer position and be employed as PhD student, a step which considerably lowers their salary.

2.4 Recruitment strategies

Recruitment needs are identified and details prepared at department level with decisions on recruitment at School (lecturer posts) or Vice-Chancellor (assistant professor and professor posts) level. The School has a preparation meeting before decisions are taken regarding recruitment. The three Department Directors, Head of School, deputy Head of School and the School´s HR specialist participate in these preparatory meetings. The Department Directors present their recruitment needs and motivate why a specific teaching position is suggested for recruitment. The needs (many

times acute) for most of recruitment is for a lecturer to fill a vacancy where 100 % of teaching is needed in undergraduate programs. Even though the School management is aware that a shift must be taken to enroll more senior competence, it is difficult in an acute situation. Skills lift through replacing retiring/resigning lecturers with assistant professors is applied to some extent but not in very urgent cases when courses in the short term lack teachers.

Most recruitment for positions offering research as part of the duties (PhD students, post doc, associate professors and professors) are international, which means that research staff have backgrounds from varying university systems. This makes the research environment robust with respect to gaining widespread international networks, as well as gaining a broadening of perspectives and backgrounds. A challenge for internationally recruited researchers is to adapt to the Swedish system which to a high degree depends on external research funding and collaboration with Swedish partners in industry/organizations. There are good examples of researchers who, after 2-3 years, have been self-supported via external funding. As a bridge, externally recruited assistant professors and professors have a larger share of internal research funding in their first years until they manage to obtain external funding. This share is in the range 30–50 % of a full-time post. Post-docs and deputy assistant professors will also have a larger share of internal funding during their period of employment but often there is already partial external funding which supports their recruitment in these cases.

Gender balance is important and is part of the recruitment strategy to build a coherent academic environment. At present, the balance is poor in the senior group (1 out of 11 is female in each of the associate professor and professor categories). In the assistant professor group, the ratio is 7 out of 15, i.e. almost half. The reason for having such a large portion of females in this group is that they have been identified (internally or externally) and encouraged to apply for positions. Females are usually well represented among applicants for PhD positions, and this is reflected in that the fact that ca 30 % are females in this group (7 out of 17). When it comes to external recruitment of assistant professors and professors, female applicants are in the minority and the chances to have females highly ranked then becomes lower if it has not been identified candidates encouraged to apply for the position.

2.5 Career support

The tenure track after attaining a PhD degree is either a post-doctoral position or deputy assistant professor at Dalarna University. The planning of such positions is, at the moment, done at department level when internal or external funding and teaching opportunities allow. All positions must be open for internal and external applicants which means that there is no guaranteed position for an internal applicant. Career planning often starts in the last 1-1.5 years before completion of the doctoral degree and the main support is the supervisors.

Junior researchers normally become associate professors ca 5 years after their doctoral degree. A course in supervision training is mandatory before applying to become an associate professor. Dalarna University has an agreement with Örebro University giving access to their training course. Time for course participation, 130 hrs, is given from the internal research funding. In the last five years, six assistant professors have become associate professors.

2.6 Research infrastructure

Research within the REBM environment includes innovative experimental studies and many senior researchers do experimental research during their PhD or postdoc work.

The oldest laboratory is the system and combustion lab which can be used for accelerated dynamic testing of small-scale household heating systems with solar thermal, photovoltaics, heat pumps or

combustion boilers. The objective of system testing is fault-finding within the systems and evaluation of annual energy performance and, in case of the boilers, also evaluation of flue gas emissions. Research which focuses on the development of dynamic test sequences for heating systems originated 30 years ago and has been continuing until recently throughout several projects. Recently, a test method has been developed to test photovoltaic (PV) and heat pump systems with electric and thermal storage. This experimental work is also strongly linked to modelling and simulation, where the measurements serve as a basis for modelling and model validation.

In 2018 our own research home “Dalarna’s villa” was designed by students, funded by Dalarna’s insurance company, and built together with local companies. The project acted as an arena for testing innovative and smart solutions with the aim to create a sustainable home with a healthy indoor climate and a low carbon footprint. The project ended in 2023 after years of testing different systems and strategies with a real family living in the house. Two PhD students and many thesis projects have contributed to the project.

A collector test rig and a climate chamber for U-value testing of walls, door and windows has also been acquired. The latter has been used for product development together with local industries. One project enabled evaluation of a novel low-energy greenhouse structure and development of a simulation model. In 2021, a test setup was built for conducted and radiated electromagnetic emissions from PV systems with up to 14 PV modules. As part of a PhD project, a method was developed to measure and analyze radiated electromagnetic emissions from PV systems. The labs are also used for experimental master and bachelor thesis work.

The preferred focus of the research within Materials Technology is on applied research which caters to the Swedish steel and manufacturing industry. The research heavily relies on a well-equipped materials technology laboratory situated in Borlänge, which offers mechanical, corrosion, and tribological testing facilities, as well as the capability to characterize the microstructure and composition of materials and surfaces.

Among these facilities, a field emission gun scanning Auger electron spectroscopy (AES), field emission gun scanning electron microscope (FEG-SEM) equipped with detectors for energy-dispersive X-ray spectroscopy (EDX), electron backscatter diffraction (EBSD) and a high-temperature pin-on-disc tribometer, scratch tester, micro-/nano-indenter, interference surface profilometer are the most used equipment for the research.

Part of the research in Materials Technology is currently conducted in the form of commissioned research assignments from various companies where the expertise of the materials researchers and our laboratory resources contribute to characterizing and evaluating materials intended for certain applications.

A research engineer within the Materials Technology group manages the laboratory operations and the instruments, with the research staff also playing a role in supporting these efforts.

2.7 Administrative support

The researchers have support from the IT, library, HR and legal departments for questions which arise during the research process. However, we lack the support from a qualified central research department which can help and guide researchers, especially for navigating the sometimes complicated research funding systems such as those for EU funding and KKS. The research environments are highly international with more than 10 nationalities represented which can make it difficult to be a successful researcher and to successfully navigate the Swedish and European administrative systems.

2.8 Summary

The research environments rely on reasonably good internal and external funding; the internal funding is predictable and stable from year to year while external funding is more unpredictable and fluctuates from year to year, as seen in Figure 11. A risk to be is that a higher share of external funding which is the goal could lead to even larger fluctuations. As described above, the research active staff is in general quite low regarding research activity (Figure 13) and there is, thus, the potential to increase research time overall to strengthen the research. To achieve this, the success rate of external applications needs to be improved from the present level of ca 20 %.

3. Research outcomes and impact

The research outcome and impact are, in this section, written from the research environments' individual perspectives. Graphs from bibliometrics and funding have been used to illustrate the impact from publications in the way which each environment finds suitable. The purpose has not been to make a comparison between the environments but to compare within their own field of research from an international perspective. The appended documents include the same type of bibliometrics for all three departments and also aggregated for the entire School.

3.1 Microdata analysis (MDA)

The publication history of MDA is shown in Figure 14. According to DiVA, there were 234 publications in the period 2018-2022. Of those, 193 were referee reviewed publications (mostly conference papers) and 149 were published articles in journals. All publications are peer reviewed except for the reports. Recently, the publishing has shown an increasing trend, especially due to the increase in peer reviewed articles. It is to be noted, however, that the status for such publications, conference papers and reports has diminished during 2020 and 2021, which means that in the short term we cannot expect more article publications. However, conference paper production has increased during 2022 so in a few years we can expect an increase in the number of journal articles. The visibility of articles in peer review journals is shown in Figure 15. It is somewhat on the low side and there is clearly a potential to increase the visibility. However, it should be noted that the inclusion in Scopus and WoS is better for engineering, medical science and computer science, compared to economics and social science. A fairly large proportion of the published articles is within the economics and social science fields.

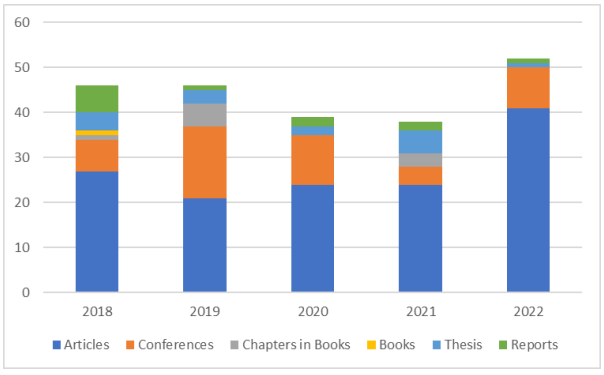

Figure 14. MDA Publications.

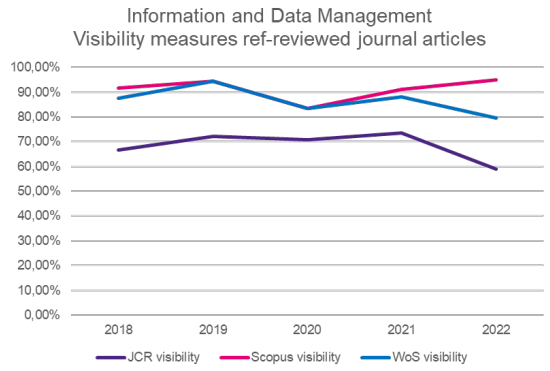

Figure 15. Visibility of publications.

With regard to the impact, the focus is on the citations of publications within Scopus and WoS. In total between 71 (WoS) and 101 (Scopus) of the articles have been cited. The distribution is shown in Figure 16 and, as can be seen, it is very skewed. The median article has six citations according to Scopus and four according to WoS. Some 20 articles are published in the 25 % top ranked journals. When compared to the journal rankings, it is clear that the most cited articles are also published earlier in the period and in high ranked journals. Figure 17 shows the field-adjusted Journal Citation frequency (JCf). This illustrates that the citation of publications from the environment is around

average.

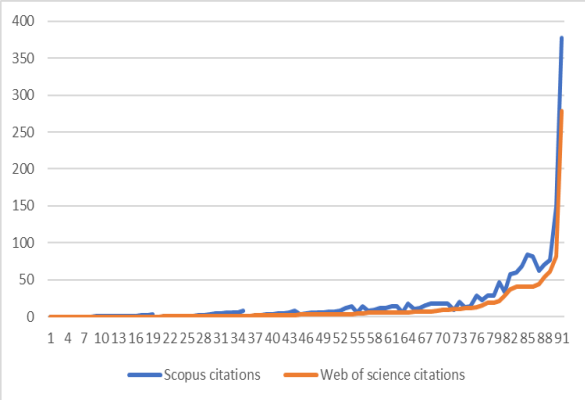

Figure 16. Citations according to Web of Science and Scopus by publication 2018-2022.

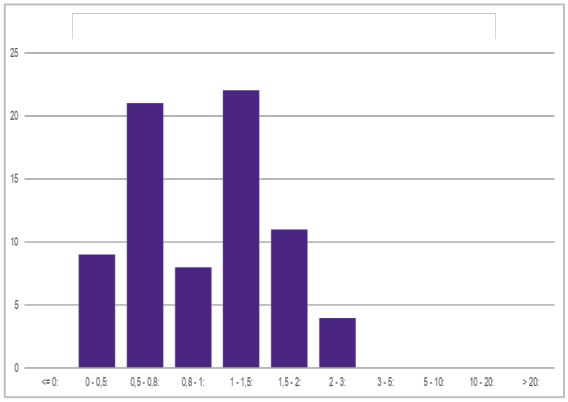

Figure 17. Field-adjusted Journal Citation frequency (JCf) between 2018 and 2022.

As a complement, Figure 18 shows the citation history of the 11 senior researchers currently working with MDA research. It is apparent that the senior staff have an upward trend when it comes to citations. On average the citations have increased from 100 per year to 200 per year during the period. The seniors can be grouped into two groups: those mostly publishing within the engineering, medical science, or computer sciences fields, and those mostly publishing in the economics and social science fields. The difference in citations is correlated with those seniors mostly publishing within engineering and computer science, which have more citations, and those seniors mostly publishing in economics and other social sciences. Further, the h-index for the senior staff varies between 6 and 19, where the variation to a large extent is related to which areas the seniors mostly publish in (social science, technology, natural science).

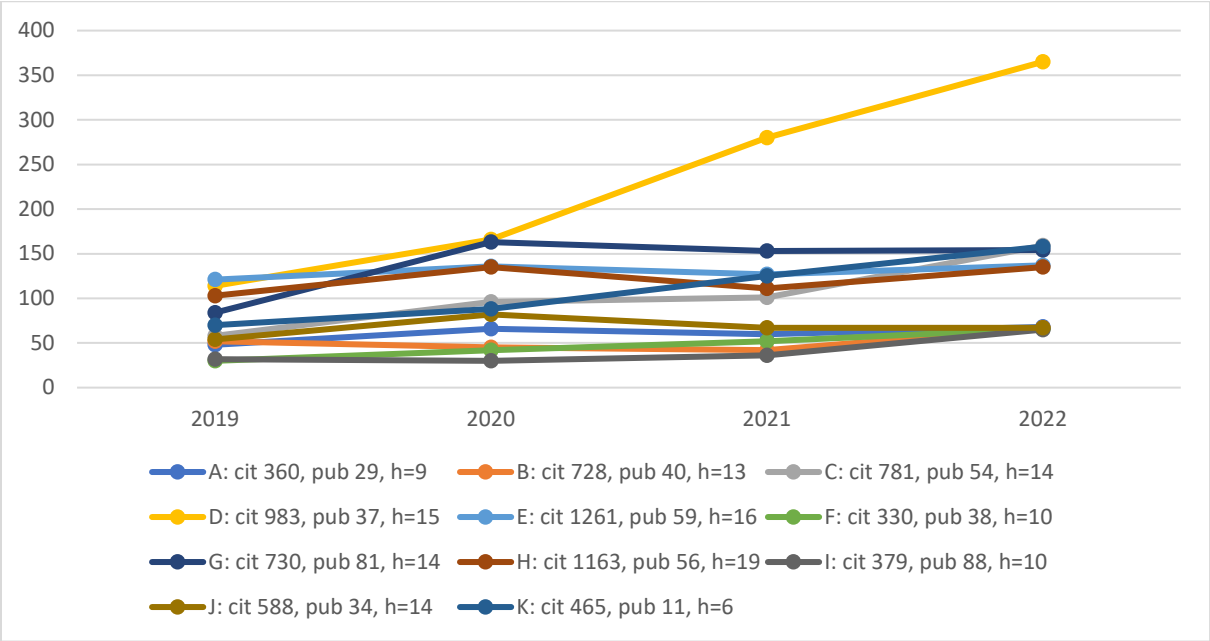

Figure 18: Number of citations per year in Scopus regardless of publication year and affiliation, self-citations included. Number of all time: citations, publications, and h-index for each researcher presented after A-K.

The ongoing research can be arranged into the areas mentioned in Section 1. The areas are basically the evolution of a combination of research interests among the staff and the ability to attract

external funding. The researchers in the environment are actively applying for new research grants with applications for 43.4 MSEK (2021) and 40.1 MSEK (2022). The applications were made by 11 different principal investigators (PIs). However, the hit rate is low, below 10 %. One problem is that the large applications were not that successful and so it is obvious that the track record for granted external applications needs to be improved. The research conducted by MDA researchers is ca 30 % financed by external grants (see Table 1). External funding can be expected to fluctuate somewhat over time. However, when the internal funding also fluctuates a lot, the financing of current and future financing of the research becomes very uncertain. This is a situation which is far from optimal for the research and there needs to be as much stability as possible over time.

Table 1: Research funding of the MDA research 2018-2022.

	Funding			**Ext. Share**
Year	**Internal**	**Exernal**	**Total**	**In %**
2018	8 573	2 614	11 187	23
2019	6 493	6 408	12 901	50
2020	6 038	3 658	9 696	38
2021	6 714	5 742	12 456	46
2022	10 528	3 917	14 445	27

For us the current focus in research is just a state in a very dynamic process. Therefore, the future areas of the research are dependent on the stream of external money which comes into the research. However, a not so wild guess is that most research will continue to have an environmental focus, since many of the funding calls have that emphasis.

The MDA researchers are participating in joint research projects with other researchers in other departments within the School, with other researchers at other Schools at the university as well as with other researchers at other universities in Sweden and internationally. It is a natural thing to exploit such opportunities when they arise.

At the core of the research is a higher seminar in MDA. At this seminar all ongoing research activities are presented and discussed. During the Covid-19 pandemic period, it was hard to maintain these activities, but now post-corona it is continuing as it should. The participation among the PhD students and most of the senior staff is satisfying. Less satisfying is the participation by junior staff and so this is an area for improvement. Moreover, as well as presenting the research at the MDA seminars, we are also keen to participate in relevant international conferences. Most of the PhD students and other researchers in the environment participate by presenting their research at such conferences. Further, it is also positive that staff encourage PhD students to take some relevant PhD courses at another university in Sweden or abroad.

As for dissemination of the research, we have a focus on writing articles published in international well-established peer-reviewed journals. A common strategy for publication is to start submitting the manuscript to the top journals and, if not accepted, submit to the 2nd ranked journals and so on until the paper is accepted. This means that the publication process will extend somewhat in time but in the end, we will gain quality and impact. Another dissemination activity is related to externally funded research. Such research normally has a specific targeted industry where dissemination activities also take place (e.g. seminars, guidelines). A third means of dissemination is by being invited by organizations to talk about a topic they are interested in.

With regard to wider academic contributions, researchers are involved as journal editors, reviewers of papers and research applications, members of grading committees, opponents and so on (see Appendix “External academic commitments”).

3.2 Resource efficient built environment (REBM)

Figure 19 summarizes the REBM's external research applications from 2018 to 2022. The number of external research applications varies from 10 to 18 annually from 2018 to 2021, with a peak at 30 in 2022. The number of successful applications changes from 3 to 6 annually from 2018 to 2021, while 10 applications were granted in 2022 (as of 28 February 2023). As a result, the success ratio is in the range of 27 % to 33 %. The total granted budget changes from the lowest value (7.5 MSEK) in 2019 to the highest (24.1 MSEK) in 2021. It needs to be clarified that there was one major research funded in 2021 (SOLVE, the solar electricity competence center) and this resulted in a larger granted amount in 2021, although there were actually more funded projects in number in 2022. The number of total external research applications has tended to increase annually, and the same increasing trend applies to the number of granted projects and the related granted amount.

These research applications include both projects led by REBM and other universities or research institutions such as the doctoral schools REESBE and Future Proof Cities (FPC) led by the University of Gävle; researchers from Dalarna University have been very active in leading these schools. The list also contains research cooperation projects at national level (e.g. SOLVE) and regional level such as Energiinnovation 1.0 and 2.0.

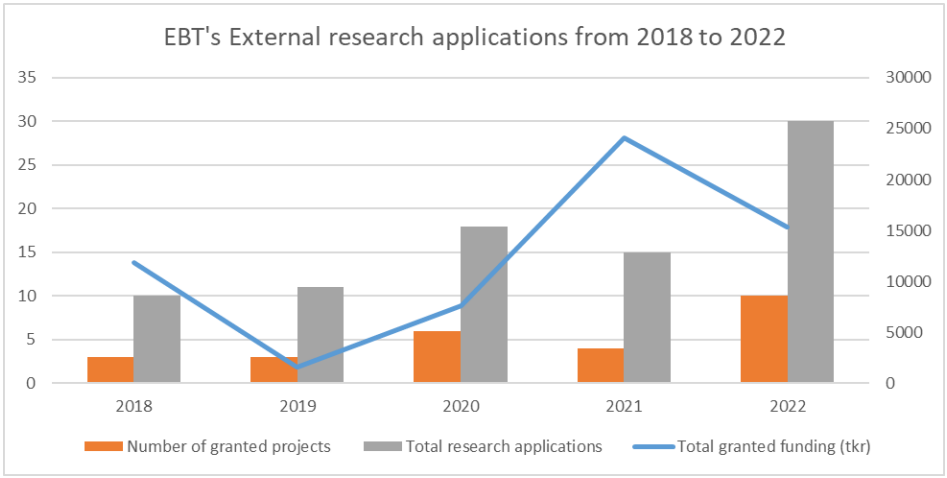

Figure 19. REBM's external research applications from 2018 to 2022.

Research conducted by doctoral students is a substantial part of the total research. In the period 2018 to 2022, 21 PhD students in total were employed (or still are) in the Energy and Construction Engineering department. Among them, 20 PhD students have been registered (or still are) at another university or another Dalarna University department. Dalarna university attained examination rights in REBM in 2022 and has so far one PhD student admitted in its own doctoral program Energy Systems in the Built Environment. For the PhD students admitted at other universities, REBM´s colleagues are normally secondary supervisors but, in practice, they work very closely with the PhDs students and cover most of the supervision done by a main supervisor. Among the 21 PhD students, 8 of them have completed their doctoral dissertation and attained PhD degrees; an additional 7 of them have achieved licentiate degrees.

REBM promotes and maintains the quality of the research through seminars, conferences, international exchanges, workshops, participation in IEA tasks and cost actions, and publications. Figure 20 shows an example of the countries where the presenters for the research seminars come from (marked in purple). As can be seen, most of the seminar presenters came from Sweden, Norway, Denmark, Germany, China, Italy and Austria. In the past 5 years, REBM has held 72 seminars in total, which is ca 14 seminars per year. These seminars are a mixture of academic and industrial seminars, covering most of the research areas in REBM. Researchers attended ca 25 different conferences in the past 5 years (5 conferences per year). For some conferences, several researchers

attended together and presented several papers. In Figure 20, the countries of the conferences REBM colleagues attended in the past 5 years are marked in deep blue. The researchers attended conferences mostly in Demark, Sweden, China, Germany and Italy as most research projects and IEA tasks hold meetings and conferences in these countries.

Figure 20. Countries of research seminars presenters and conference countries (2018-2022)

In addition, REBM is active in IEA tasks and EU cost actions. For instance, the researchers joined IEA EBC Annex 83 as subtask A leader, and as participants at IEA EBC Annex 79, IEA EBC Annex 66, IEA SHC Tasks 53, 56, 60 and 68, and IEA HPT Annex 55/ECES 34. One researcher is working on the Management Committee for Cost Action CA19126 - Positive Energy Districts (PED) European Network. Further, REBM also hosted the 1st training school for PED. There were about 34 participants who joined this training school on the Borlänge campus. In addition, REBM invited Borlänge Municipality, Borlänge Energi, Dalarna Science Park, Research Institutes of Sweden (RISE) and other municipalities to a workshop to discuss with PED experts during this training school.

REBM is carrying on an international exchange project funded by The Swedish Foundation for International Cooperation in Research and Higher Education (STINT), which facilitates exchange of researchers and teaching with Xi'an University of Architecture & Technology, China in the field of wood building and the related energy technologies. REBM also has regular researcher exchanges through the research schools at both national and international level such as REESBE, SHINE (Solar Heat Integration Network), and FPC.

When a research application is made by researchers in REBM, there is no formal procedure for how the new research fits into the overall research environment, or how the application should be written. However, there is an informal tradition where we share experience and ask each other when desirable; the high success rate of our application shows that this has been working well.

In addition to the publications described in Section 1.2, one researcher has published a book: “Data-driven Analytics for Sustainable Buildings and Cities: From Theory to Application”. This book is a collection of recent research outcomes from REBM, covering both energy systems and energy-efficient built environments. REBM has also initiated a poster and research day, thus making the research accessible to the general public. These two events have been approved and promoted at the School level.

Since most PhD projects are connected to companies, there is a tradition that the PhD students regularly present their research to the company and their partners. During the period, several so-called Energy cafes have been organized where researchers have the opportunity to present their research to invited participants from companies and the general society.

A few years ago the Energy Competence Center (*Energi kompetens centrum*, EKC) was set up at Dalarna University with the task to create contacts and activities between the university's energy operations and the surrounding community. Among other things, as mentioned above, ca 20 energy cafes have been implemented in 2019-2022 with a large number of external visitors. The department's researchers have often participated in these and thus been able to spread knowledge about our research. The EKC has also worked with gender issues and the energy industry, which has received international attention. For example, we have been able to present the activities via international forums such as in the workshop "Policies, women and climate change" in Brussels 2019 arranged by, among others, the European Committee of Regions; and, in the final conference of the international project Femina in Italy in spring 2023.

Healthy homes (559090-7365), Sustainable Prosumer Solutions Sweden AB (559253-5685' and Klaus Lorenz Konsult AB (556842-3858) are three spin-off companies funded by the researchers from REBM. Within the cooperation project Energiinnovation, a mentor program for students interested in starting companies has been set up. From 2020-2021, six new companies (AB) were set up primarily offering solar energy related services and products. Some of them have been shown to be very successful with several employees already. In addition, researchers from REBM actively join the knowledge transfer partnerships program (KTP) and act as academic mentors for several project leaders working with energy and building related projects within regional companies.

REBM researchers have been engaged in formulating the regional energy and climate strategy signed in 2019. As an outcome, the EKC has been engaged by municipality energy companies in the region to lead their work by formulating a road map for future energy systems in Dalarna. This was presented in Fall 2022 and highlights nine prioritized areas which the energy sector in the region needs to work with in order to fulfill future climate goals. REBM has an ambition to strengthen collaboration with the municipality energy companies in the future and has used the road map as a foundation when discussing future research directions (summarized in Section 1).

3.3 Industrial engineering

The publication data during 2018-2022 with Dalarna University affiliation with at least one co-author from the Industrial Engineering department was collected and analyzed from the data posted in DiVA as of the end of 2022. According to the bibliometric data for that period, the Industrial Engineering department produced a total of 91 scientific publications comprising books, book chapters, conference proceedings, journal articles, scientific reports, popular science articles or debates, and PhD/Licentiate theses as shown in Figure 21a. Most of the publications were peer-reviewed journal articles with a high Scopus and WoS visibility (see Figure 21b).

The number of publications was 35 in 2018 and gradually decreased to 10 in 2022. This was due to the tenure of Steel Industry Graduate School project coming to a close in 2019 and the fraction of research contribution from the researchers within materials research was reduced due to their education and administrative duties. The majority of scientific publications are from the Materials Technology subject which has produced nearly 71 scientific contributions where 15 % of the articles are in top 25 % in their respective field. There is one publication from Mechanical Engineering, 15 from Industrial Engineering and Management, and four from Entrepreneurship. Of the 71 articles, 34 have received citations.

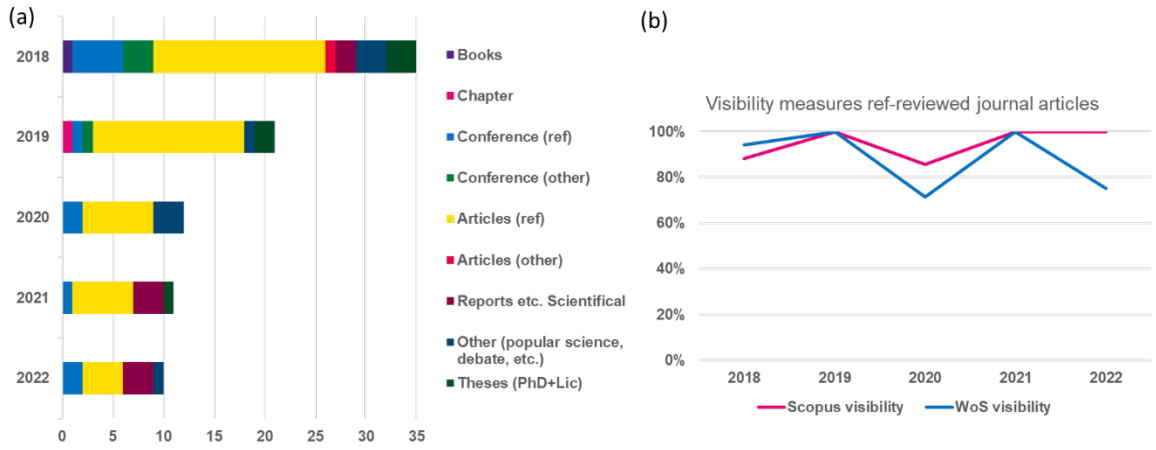

Figure 21. Overview of Publications in Industrial Engineering Department

Figure 22a shows the number of citations per publication with mean citations per article in WoS data as 5.7 and in Scopus 6.6 citations per article. Figure 22b shows the field-normalized citations for the 34 articles with a mean value of 0.8 and there are 13 articles beyond this value. This shows that these articles are beyond the expected citations of the journal.

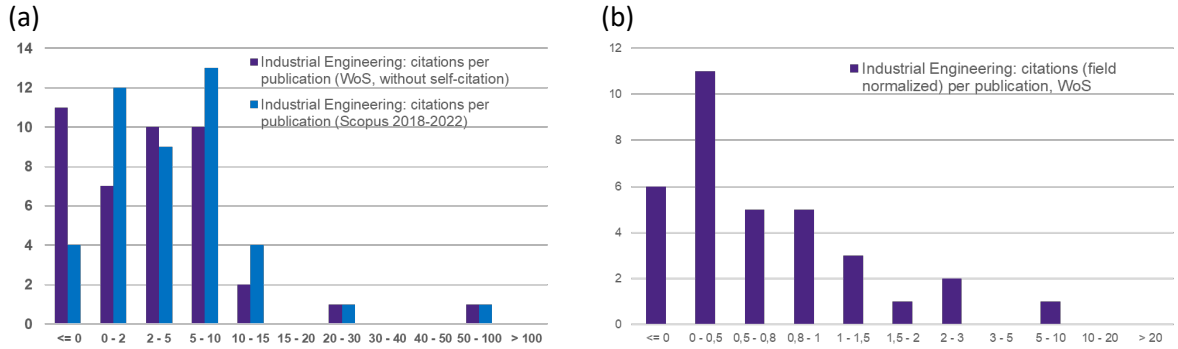

Figure 22 (a). Number of citations per publication and (b). Field-normalized citation for articles

The list of research projects for Materials Technology during 2018-2022 are given below. Some projects, which were started before 2018, continued and were finalized during 2018 – 2022:

- The Steel Industry Graduate School – 2015-2019
- The *DEFMOD II – Software for modelling the effect of deformation on mechanical properties II* project – 2015-2018
- The Knowledge Foundation project *Microstructural Design of Cemented Carbides for Rock Drilling Applications* – 2016-2018
- The Knowledge Foundation project *Surface engineering of steel wire drawing tools for improved performance and lifetime* – 2017-2019

Here is the list of the projects which were initiated and finished during 2018-2022:

- Full-scale project on integrated modelling of metal working processes (FINBEAM) - July 2018 – Jun 2022
- VV-kontroll: Robust processes for reheating and rolling by controlling oxidation - Nov 2018 – Oct 2021

- YTFEL: Fewer surface defects on hot-rolled products - Oct 2019 – Mar 2021
- Feasibility study Center for industrial development - Feb 2020 – Oct 2020

At present, three active research projects are going on within the Materials Technology group:

- WOLS: Wire drawing optimization with resource-efficient lubrication - Jan 2022 - Dec 2023
- FINBEAM2: Full-scale integrated modelling of metal working - Oct 2022 - Sep 2025
- YTFEL2: Innovative surface inspection with multispectral technology and artificial intelligence - Oct 2022 - Sep 2025

The Industrial Engineering and Management group has mainly been involved in projects coordinated by other research groups from other departments at the School. Business model aspects have been addressed for renewable energy solutions in the Energy Matching project coordinated by REBM, and last mile logistics business models issues have been dealt within the SAILOR project for smart last mile solutions coordinated by MDA. In addition, several popular science contributions have been made mainly in logistics-related areas.

The research projects from the Entrepreneurship group during 2018-2022 are listed below:

- Working with Swedes (2017-2018), County Administrative Board (Länsstyrelsen, Dalarnas Län)
- *Dalakassen* – Pilot study
- Research & Charity – Easy life (2018-2020), The Kamprad Family Foundation for Entrepreneurship
- Social entrepreneurship (2019-2020), EU structural funds from County Dalarna

Working with Swedes has a popular science approach and the book was printed by the Mondå Förlag in 2018. Dalakassen was a pilot study for a larger application to the Kamprad Family Foundation, Easy life. The research project Easy life's focus was on last mile logistics and initially the case, Dalakassen, was to be used to test a route optimizing program developed in an earlier project, SAILOR. The project Social Entrepreneurship was a collaboration with different organizations which work with social entrepreneurs.

The internal and external research funding of the ITE department obtained during 2018-2022 is shown in Table 2. The percentage of external share has continuously decreased from 62 % to 21 %. The ongoing research activities were considerably supported by internal research funding.

Table 2. Research finding of ITE during 2018-2022

Year	Funding (KSEK)			Ext. Share in %
	Internal	External	Total	
2018	4954	7912	12866	61.5
2019	4401	3395	7796	43.5
2020	2880	2894	5774	50.1
2021	3435	1519	4954	30.7
2022	4301	1132	5433	20.8

In the Materials Technology group, there were 5 PhD students in 2018 and 1 PhD student in 2019 belonging to the Steel Industry Graduate School which ended in 2019. Since 2020, there have been no active PhD students in the Materials Technology group. Three PhD and licentiate theses were completed in 2018, two PhD and licentiate theses in 2019, and one licentiate thesis was completed in 2021. The contribution to scientific publications by doctoral students during the years 2018-2019 was

very high as compared to 2020-2022.

The outcome from the research projects from Materials Technology resulted in increased resource efficiency through improved yield, better quality, and fewer rejections, and also contributed to a sustainable production process for Swedish steel and manufacturing industries. The research outcome from the above projects and Steel Industry Graduate School yields several scientific publications in terms of journal articles, conference proceedings, and scientific reports.

The researchers at ITE are participating in joint research projects with researchers at other universities in Sweden and internationally as well as with researchers from other departments at our university. Researchers and doctoral students have actively participated in several national and international conferences and presented their research findings. This has also led to several peer-reviewed conference articles.

In addition to external and internal research funds, several commissioned research assignments (*uppdragsforskning*) were carried out in the department which created a win-win situation for the researchers and for several small and medium-sized companies.

3.4 Summary

Overall, the research outcomes as publications are quite large and the majority of publications are peer-reviewed articles as seen in Figure 23a. These are mostly published in acceptable/good-impact peer-review journals. Figure 23b shows that the top-ten most productive authors of peer-reviewed articles participate in about 40 % of these articles and the top-one in about 10 %. This is in many ways positive but there can be a risk to lose research activity if a few of the key researchers leave the university.

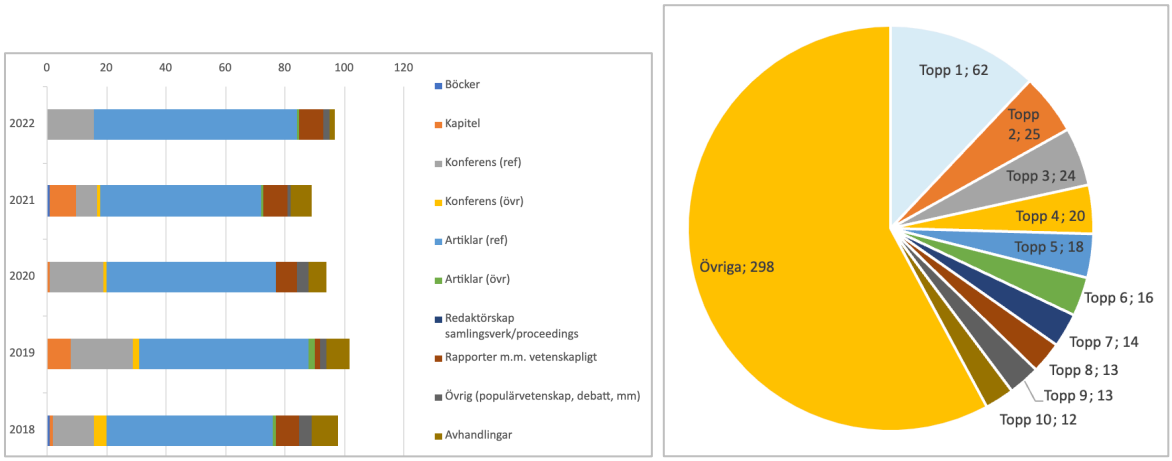

Figure 23a. Total amount of publications School of Information and Engineering. b. The share of authoring of the ten most productive researchers at the School in peer review articles.

4. Relationship between research and teaching

The School offers 11 education for the academic year 2023-2024: 4 two-year (120 credits), 4 bachelor, 2 bachelor engineering, 2 one-year master, 2 two-year master and 2 doctoral programs. The responsibility for conducting the programs and assigning teachers to the courses is managed on department level which, in this section, motivates that the relationship between research and education, and progression between the programs on different levels, is best described in a departmental context.

4.1 Microdata analysis

The research time for professors in 2022 is on average 38 % of full-time. For junior researchers 21 % on average is allocated to research and for the PhD students 60 % is allocated to research on average. The time allocated to research is somewhat low. However, the figures vary over time and there are several reasons behind this. For instance, some are highly involved in administration, and other are on partial leave. All the MDA researchers are also involved in teaching at all levels. Several of the educational programs fostered by the MDA department have an MDA researcher as program manager (see Figure 24). The figure shows the yearly student intake and how the programs are connected. The blue color shows programs with MDA as the degree subject and yellow programs for Information Science as the degree subject. The blue and yellow frames show the teaching resources connected with PhD and higher connected to the two subjects. The background profile of the students entering the programs are given by CS (Computer Science), Eng (Engineering) and business (Business Studies and Economics). At the department there is a PhD program with 11 PhD students currently, with a yearly intake of 5. Further, two master programs (Data Science, DS, a two-year master and Business intelligence, BI, a one-year master) with around 80 students are run by the department (yearly intake 30 students). Some 10 students on average change from BI to DS during their education, which is possible since the program courses are synchronized. At the basic level the department fosters the System Science (SY), IT Security and Software Testing (IT) and Graphical Design and Web Development (GDW) programs. The yearly intake is 180 students jointly. The number of students on these programs amounts to some 350 students. Students from bachelor level have a progression in their studies up to PhD level. As mentioned above, the MDA researchers are involved in teaching courses at all levels on these programs. One especially important part of the teaching is the supervision of master and bachelor theses. The master student theses are often connected to the MDA research and theses are frequently transformed into journal articles. Several master students have applied for positions on the PhD program and some of them have also started as PhD students. Bachelor level theses are often made in cooperation with companies, functioning therefore as a means for reaching out to industry.

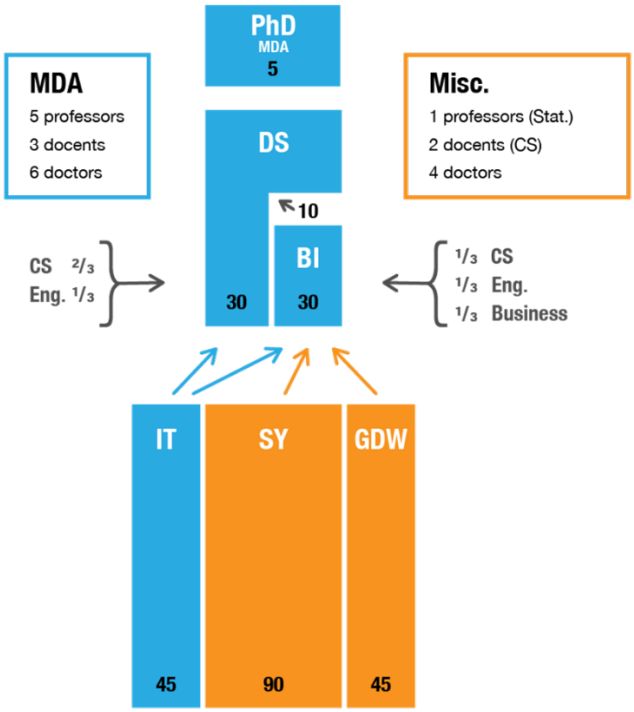

Figure 24. Schedule showing the various educational programs, their connections and number of yearly new students in MDA.

4.2 Resource efficient built environment

The EBT department offers several courses from undergraduate to master and doctoral levels, as shown in Figure 25 which are closely connected to the REBM research environment. The engineering program Sustainable Energy Systems is broad in terms of content and deals with various aspects of thermal and electrical energy systems, and energy use. The program trains energy engineers who can be active in both traditional energy industries (e.g. energy companies, manufacturers of technical equipment in energy facilities, etc.) as well as property management, authorities and organizations which also need a broad and system-oriented energy competence. The engineering program in Construction Engineering contains mandatory courses in energy technology which give access to the master's program in Energy-efficient Construction. The bachelor's program in Building and Community Planning provides eligibility for the master's program in Energy-efficient Buildings if the education is supplemented with basic courses in mathematics and energy theory. The one-year master's program in Solar Energy Engineering has been running for over 20 years and applicants are largely international students. Since 2015, a two-years master's program in Solar Energy Engineering has been offered. These two master programs contain the same courses during the three initial study periods of the first academic year. Both programs have courses in solar radiation, solar electricity and solar thermal with the aim of training engineers for a broad international solar energy market. The master's program in Energy-efficient Buildings also has a focus on energy and resource efficiency in built environment and so has joint courses on solar radiation with the Solar Energy master program.

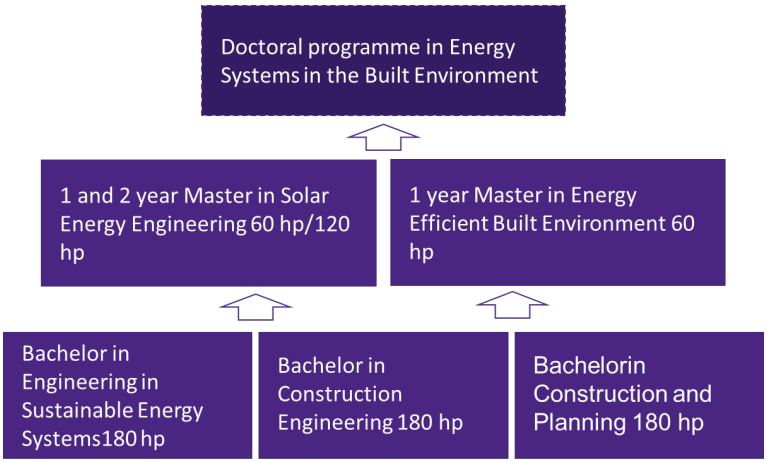

Figure 25. Education structure of EBT

The REBM doctoral program focuses on research which deals with energy systems with application (primarily) in the built environment. In addition to energy systems, this doctoral program includes research on resources, materials in the built environment, resource-efficient use of materials in construction, operation and demolition, indoor climates, and low environmental impact from a life-cycle perspective. Buildings are also spatial structures with infrastructure and functions for people's lives and activities in an area. So, this doctoral program also includes basis research on spatial planning. The whole research area aims to build knowledge to develop sustainable civil planning and construction and therefore has an interdisciplinary character where doctoral studies can include elements of a socio-technical or techno-economic nature in projects in collaboration with social planners, social scientists and economists.

By referring to the two main research areas of REBM described in Section 1.2, the education at different levels is linked well with research in the EBT department.

In addition, REBM emphasizes the involvement of students in research projects including lab testing, model development, IEA tasks and cost action task. In addition, several students have also attended international conferences together with their supervisors, and published conference papers. A few

students have even published high-quality journal papers together with REBM colleagues by extending their thesis work.

4.3 Industrial engineering

Apart from the senior professor (10 % tenure), all researchers within the department are active teachers in the education programs which provide courses in their respective subjects of Materials Technology, Mechanical Engineering, Industrial Engineering and Management, and Entrepreneurship. No PhD students were employed in Materials Technology subject during 2018-2022. However, a few researchers were actively engaged in the supervision of doctoral students within the Steel Industry Research School which generated 6 theses (PhD and licentiate) during this period.

Figure 26a shows the education structure during 2018-2022. Figure 26b shows the future planning for a new education portfolio towards sustainable production. Figure 26a shows that education at the advanced and research levels was only within the Materials Technology subject, whereas the contribution from the other subjects was only at the basic level. Unfortunately, the advanced and basic level education within the Materials Technology and Mechanical Engineering subjects were discontinued in 2022. As a long-term goal (within the next 5 to 10 years), there is a possibility to expand the independent research groups into one research environment in the direction of 'Sustainable products and production' as shown in Figure 26b. As a first step, a basic level technical two-year education, Production Technician (*Produktionstekniker*) program, has been developed and is expected to start in Fall 2023.

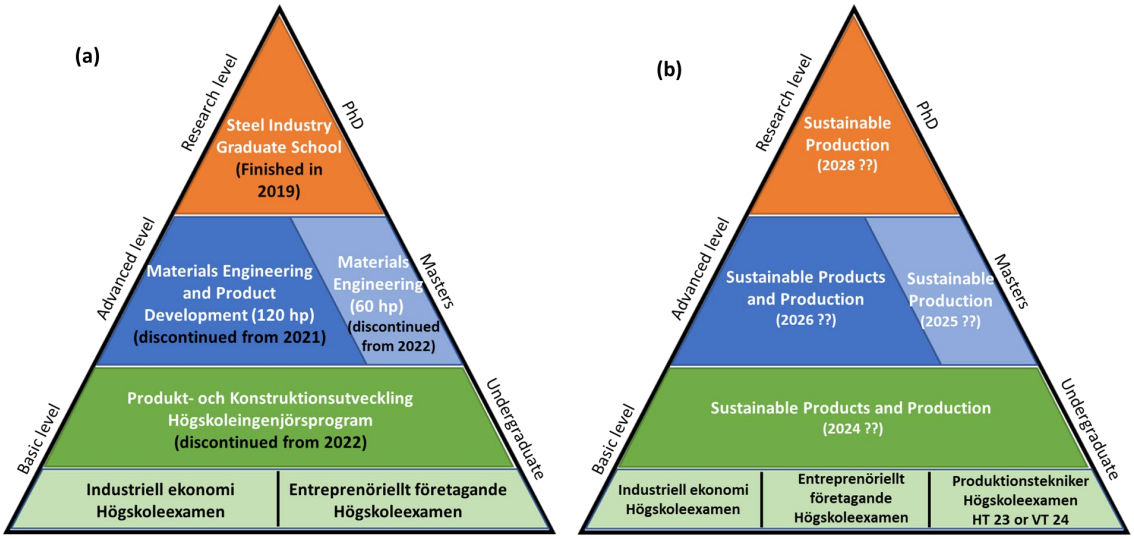

Figure 26 (a). Education structure (2018-2022) and (b). Future plan for education.

A two-year master's program in materials engineering and product development was conducted in the years 2019-2021 and 2020-2022. The main area of this master's program was Materials Technology. A one-year magister program in Materials Engineering was run 2018-2019 and 2021-2022. All researchers within the Materials Technology group actively engaged in teaching materials science related courses as well as supervision of thesis work from the magister and masters programs. All master and magister thesis work can be categorized into the tribology, surface engineering, additive manufacturing, and steel forming research fields. A researcher from Materials Technology is co-supervising two doctoral students who are registered at Tallinn University of Technology, Estonia within the additive manufacturing field.

A doctoral project has been initiated and planned within Industrial Engineering and Management, which focuses on circular logistics and business models in the construction sector. A doctoral student

has been recruited from among internal staff and the project started in March 2023. The value chain including clients, architects, designers, manufacturers, and contractors to build up and demolish and recycle the construction material will be investigated in terms of obstacles and possibilities related to recycling and re-use in circular business models. This takes place in collaboration with the University of Gävle. Student thesis writers can benefit from the doctoral student's supervision and vice versa where data and results from doctoral theses can be used in the research. Logistics-related research results are to some extent used within courses in the 2-year Industrial Engineering and Management program.

A researcher from Entrepreneurship is involved in the co-supervision of an industrial doctoral student and two doctoral students. The industrial doctoral student, connected to this subject and the research school FPC, is currently researching public and private partnership collaborations in the housing development industry with an emphasis on sustainability and resilience. One PhD student defended his thesis in January 2023 with the title *Decision-making strategies of internationalization under challenging times: lessons from SMEs*. The last PhD student is studying entrepreneurs at a macroeconomic level. Once published, some of the research findings will be incorporated into different programs both at Dalarna University and also in courses at all levels at Mälardalen University.

4.4 Summary

The number of students differs considerably in the different programs. In general the programs in Data Science and IT (connected to MDA) and the programs in Entrepreneurship and Industrial Engineering and Management have enough students for a balanced budget. Programs in engineering and technology are presently less attractive and have too few students to bear the costs. This also impacts the research since the researchers must also have a substantial part of their duties within education. Thus, if teaching opportunities disappear the research environment cannot survive.

5. External collaboration and other outreach activities

The School have extensive collaboration at regional, national and international levels. Specifically, the regional cooperation is important for knowledge transfer to businesses, public and private organizations. The societal oriented research conducted gives opportunities to collaborate with municipalities which is shown in the following sub-sections. Regional funding from Region Dalarna is important in the European Regional Development Fund (ERUF) funded projects. KKS-funded projects require co-financing from companies, as does most of the projects funded from Energy Agency. These are just a few of the main funding sources which were illustrated in Figure 12. Collaboration by having industrial PhD students is important for more long-term collaboration (4 - 5 years). There are at the moment six industrial PhD students at the School in this form and a further two will start this year.

On a joint level, the School is engaged in an annual public outreach event called Forskarfredag (Research Friday). Researchers are invited to give talks as part of the National Science Festival arranged in many Swedish cities on the same date every year, the last Friday in September.

Dalarna 24 hr Innovation Challenge 2023 was run for the first time as an event and there are plans that this will become an annual event. This was arranged by EKC (described in Section 3.2) with participating master students from DIH and EBT.

High school students in 3-year science and engineering programs can apply for a 2-week course to undertake projects related to the research and education we have at the School. This is offered twice a year and has been running for about 15 years.

Most of the collaboration and outreach activities are conducted on department level and described in the following sub-sections.

5.1 Microdata analysis (MDA)

Over the years, external collaboration has been well developed at the MDA subject and the external partners include industries, the public sector, other universities, and regional organizations. The collaboration forms include joint programs, contracted researchers, and co-organized events. The above-mentioned collaborative activities bring in e.g. seminar speakers, PhD grading committee members and opponents, joint projects and research students to help with the dissemination of our research achievements and MDA influences.

Further, it is common for the MDA researchers to collaborate with external partners both in Sweden and internationally in their scientific work. In Table 3 some of the strongest relations in research with external partners are shown. As can be seen, it is quite a heterogenous range of collaborations which is natural due to the wide range of suitable application areas for MDA and scientific backgrounds among the senior MDA staff.

Table 3: A selection of important external collaborations in MDA research

Company/organization	**Connected projects**
Trafikverket	Several projects. Currently two PhD students are financed by *Trafikverket*. The projects have a wide range from developing standards for data sharing to estimating need for repairs on roads and railway.
HUI Research	Several projects have been co-founded with them mainly focused on various aspects of retailing and retail markets.
Borlänge kommun (local council)	The organization has for a long time financed transport- oriented research and retail-oriented research
Clinitrac (patient diary apps), Neopharma, Solvay, Abbott, and AbbVie (intestinal levodopa pump treatments), Nordforce (mobile communication), Cenvigo (medical measurement technology), Global Kinetics (wearable sensors) and Sensidose (micro-tablet dispensing devices).	Several research projects with a focus on developing methods including video and sound processing, signal processing, including wavelet transforms and entropy, machine learning, such as support vector machine regression, mathematical modelling and simulation of drug transport and effect, optimization methods, man-machine interfaces and gamification and clinimetric test evaluation methods.
Various European stakeholders	In a Horizon 2020 project we were the PIs in a joint European collaboration project where we developed an IT decision support system for improved efficiency in the last mile deliveries. Stakeholders (both academic and companies) from 4 European countries were involved in the project.
Rättviks Kommun Th1ng (IoT Platform)	Collaboration on a research project on Digital Twin for assistive living (funded by FORTE) which involves 1 PhD student in MDA.
RISE, SLU, Sami Reindeer Herding Community, Växa Sverige (regarding animal genetics, and animal welfare), Sony Nordic (with automatic animal welfare evaluation using GRB and ToF images).	Several projects focused on animal behavior and welfare.
BEACON Center for the Study of Evolution in Action, Michigan State University	Connected Project: continued Membership in PhD committees, joint research publications in neuro-evolution, evolutionary game theory, and mental representations in deep learning and other cognitive substrates.
Region Dalarna	Innovation Project – pre-study
Dalarna Science Park, *Byggdialog* Dalarna, *Arvika Kommun*	EU Interreg EcoInside 2

5.2 Resource efficient built environment (REBM)

Table 4 lists the main non-academic REBM collaborators. As the threshold is set, only the co-funding from companies/organizations or external funding of a project ≥ 0.5 MSEK or project time ≥ 1 year and during the last 5-year period is listed. Most non-academic collaborators are from the Dalarna region, while the remainder are representative industries in Sweden within the areas of solar energy, heat pump, thermal storage and micro-grids, etc.

Table 4: The main non-academic REBM collaborators

Company/organization	**Connected projects**
Borlänge Municipality	Borlänge Municipality is involved in two on-going projects (*Klimatneutralt Borlänge* 2030 and PED-ACT project). It is an essential partner for EBT to collaborate with to achieve the climate-neutrality goal for Borlänge by 2030.
RISE	RISE is an important partner involving several projects such as the center of excellence SOLVE, *när elbilen flyttar in*, Comfort and climate box, REESBE industrial doctoral school.
Absolicon Solar Collector AB	Solar district heating with pit storage for Swedish conditions
Borlänge Energi, *Kopparstaden*, *Tunabyggen*, Borlänge municipality	FPC doctoral school and *Total hållbarhet vid renovering* project
Region Dalarna	*Energiinovation* and *Energiinnovation 2.0* working with smart specialization in energy systems.
Borlänge Energi and *Falu Energi & Vatten*	Participating in the project *Jämställdhetsintegrering I Dalarnas Näringsliv*
Länsstyrelsen Dalarna	Development of road maps for the regional energy and climate strategy (within *Energiinnovation* and *Energiinnovation 2.0*)
Byggdialog Dalarna, High Voltage Valley and IUC Dalarna	Extensive cooperation within the projects *Energiinnovation* and Ener*giinnovation 2.0*
Dalarna Science Park	Development of the regional innovation process, innovation challenges, support to potential entrepreneurs within the energy field
RISE, Dalarnas insurance company, SaltX, *Tunabyggen, Borlänge energi*, PPAM, *Byggpartner*	REESBE industrial doctoral school
Ferroamp and Nibe	National project TESHP and EU project Energy Matching
LudvikaHem (housing company)	EU Project Energy Matching

Within the framework of Energiinnovation and Energiinnovation 2.0 projects, EBT's colleagues have helped more than 30 companies with consultation of minor work (typically a value of 40-100 KSEK). EBT colleagues helped to start up at least 6 companies (AB) within the Energiinnovation and Energiinnovation 2.0 projects during the last few years, and about 100 companies have participated in our energy seminars and Energy cafes (for industrial partners).

Over the period 2018-2020, eight of the PhD students in the research environment have been industrial PhDs in the doctoral schools REESBE and FPC. These PhD students spend approximately half their time in the company where they are employed and half at Dalarna University; in addition, they participate in courses and seminars at the university at which they are registered. These projects are a result of the specific collaboration projects that we have had, but also lead to new projects resulting in long term collaboration.

The research area is active in dissemination of the research activities outside the pure research community. We regularly participate in Research Friday organized every Fall when we describe our research results for the public sector. We also used to present our research for special interest groups such as Sveriges ingenjörer i Dalarna, Västerbergslagens Ingenjörsklubb and others. During recent years we have also participated in several presentations for Rotary clubs in Dalarna and

company breakfast meetings (organized by the local community business offices in Dalarna). For the most part, the presentations have focused on energy research, but construction has also been represented, e.g. presentations at Dalarna Science Park during Research Friday and a lecture on the connection between sustainable buildings and building maintenance at Dalarna's Museum. Researchers at the department have been appeared both in the daily and trade media such as Svensk Solenergi (Swedish Solar Energy). Before the 2022 election, researchers from the department participated in a Swedish Television program talking about the importance of politicians listening to the scientists and taking climate change seriously. We have also participated in public debates organized by Svenska naturskyddsföreningen (Swedish Society for Nature Conservation) and researchers from the department have led discussions about the energy transition in local associations such as Kulturföreningen Vargen (Cultural Association Vargen) in Hedemora. A short video [https://www.youtube.com/watch?v=0g0o_y8osHc] has also been produced by EBT in collaboration with the Media subject from Dalarna University to introduce the research results of a demonstration site in Ludvika to the regional industries within the H2020 Energy Matching project.

5.3 Industrial engineering

The Material Technology research group works closely with the Swedish steel and manufacturing industry to conduct applied research. Typically, their research projects involve collaborations with multiple companies, institutes, and universities, see Table 5. The group joined the AM Arena network (Swedish Arena for Additive Manufacturing of Metals) in 2020, where they actively collaborate with national universities and companies within the field. Some researchers are involved in solving research questions related to Materials Science posed by industry at the AIM (Academic Industry Meeting) Day organized by Uppsala University. This increases the network between industry and the university which can lead to larger future projects. One researcher is involved in the Corrosion Awareness Day which is an initiation to increase awareness of corrosion within the academic and industrial community.

Table 5: External contracts/research collaborations during 2018-2022

Educational institutions	**Sweden:** Chalmers University of Technology, University West, KTH Royal Institute of Technology, Luleå University of Technology, Lund University, Uppsala University, Örebro University **Germany:** Leibniz Institute of Solid State and Materials Research, Dresden **Estonia:** Tallinn University of Technology in Estonia.
Organizations	SWERIM (AM Arena), *Jernkontoret* (technical areas; TO31, TO33 and TO41), Triple Steelix, IUC Dalarna, Region Dalarna, European Spallation Source,
Businesses	Alleima (previously Sandvik Materials Technology), Calamo, Epiroc Drilling Tools AB, Erasteel Kloster, Fagersta Stainless, Gestamp Hard Tech, GKN Aerospace, Gränges Sweden, Hjulsbro Steel, Hyperion, IMPETUS Afea, Ionbond Sweden, Kanthal, Morgårdshammar, Outokumpu Stainless, Ovako, Sandvik Coromant, Scania CV AB, SSAB EMEA Borlänge, SSAB EMEA Oxelösund, and Suzuki Garphyttan

The senior professor and professor from the Materials Technology subject are involved in two technical areas (TO31 – Strip and plate, TO33 - Wire) in the Swedish iron and steel producers' association, *Jernkontoret*. The objective of this research within the technical areas is to enhance the competitiveness of the steel industry in its respective technical areas. The research is primarily driven by the needs of the industry and is centered around enabling practical applications in various companies.

In addition, the research group collaborates with regional and national companies to offer commissioned training and research. These collaborations focus on developing competencies, as well as conducting material testing and characterization, to meet the needs of these companies. Most of these commissioned research assignments are important to support regional and national

educational institutes, organizations, and industries with the research expertise to contribute to society. These assignments also can lead to larger research projects as well as help researchers engage with contemporary materials and technology issues. Some of the research work was used for student thesis work.

The researchers within the department are actively involved in the scientific community with additional research activities such as an opponent for a PhD student at another university or members of the PhD examination board at other Swedish universities.

The Entrepreneurship researcher collaborates with several Swedish universities such as Södertörn University, Mälardalen University, Umeå University, and Mid Sweden University. The researcher has also collaborated with Dalarna Science Park, Young Entrepreneurship (UF), and also belongs to the EKC, and is involved with innovation projects with partners from industry and public services. Academic supervision of KTP projects provides a good framework to bring research results into action at the regional level.

5.4 Summary

The research environments have extensive research collaboration with external non-academic partners as seen in Tables 3–5. This is an opportunity to strengthen the research funding from e.g. KK Foundation where in most calls 50 % funding is needed from companies. Industrial PhD students are also a good example of having long-lasting (4–5 years) and deep collaborations, something which can be further explored.

6. Development opportunities and other comments or conclusions

The SWOT below relates in many parts to aspects introduced in the summaries that ends each section above. To keep this section as condensed as possible we have tried to avoid repeating too much from these summaries. The SWOT has been developed during separate meetings with the senior reference group, collegial members of the School's Steering Council, and finally in a joint meeting with the senior reference group, all Steering Council members and the Head of School. The focus has been on matters of dignity for the whole School. In relation to this, each department is actually at the moment in the process of making their own SWOT. However, given this purpose, the scope below is on a School level.

Strengths

As strengths, five basic conditions (underscored below) can be highlighted which we see as necessary to obtain and sustain vital research environments. The School has two doctoral programs with in total about 20 PhD students and five masters programs with clear research connections acting as a base to recruit PhD students. What is also necessary to play a part in novel research is the extensive national and international research collaborations which the School's researchers have. Another important part is research funding, where the School has a fair enough amount of external grants to sustain current research activities. With low fixed research costs there is a possibility to be flexible in research development 2–3 years ahead. Given these conditions we consider the large number of publications and citations in acceptable/good-impact peer-review journals as being a confirmation that we have vital research environments within the School.

Weaknesses

Although we see the research at the School has strengths to sustain ongoing research activities, there are weaknesses which might hinder the further development of the research. We highlight the following five matters (underscored below). The base of PhD students and master programs is lacking in one of the departments (ITE) and is a limiting factor in capacity building as a first step towards sustainable research groups. Even though researchers at the School obtain enough external funding, the low hit-rate in grant approval (on average 20 %). The reason for having fairly good external funding is that a lot of applications are written each year. Although the School's researchers are successful in

publishing and being cited, these are within rather narrow research domains which means that in comparison and competition with the larger universities we cannot offer the same width in external collaboration. It is sometimes expected from external actors, especially regional, that we can cover more than we actually can do. The productivity in gaining funding, publishing and supervising PhD students must be seen in the light of the number of active researchers and their research activity. Both the small number of staff with PhDs (ca 45 out of in total 120) and their low research activity in time funded from internal and external funding (about 11 full-time) can be considered as weaknesses which limit research development. Another aspect we want to highlight is the gender imbalance. The current situation is comparable to similar research fields, but this is not an excuse and we need to work progressively towards a more equal balance.

Opportunities

There is potential to improve aspects which today are functioning optimally via structured and systematic work. We highlight four points (underscored below) which should contribute to the development of the research environments at the School. Most of these points highlight an increase of external funding as being the most important matter to develop research at the School. First, a systematic follow-up of rejected applications and support to junior researchers in grant application writing so that a larger number of submitted external applications will generate a higher hit-rate. To match a larger amount of external funding the research activity has a potential to increase from today´s 25 % on average to an individual range of 40–60 %. The unique applied research competence in trending domains such as sustainability perspectives on energy, transport, construction, management, industry has the potential to attract collaboration with companies and regional authorities and so can be used to raise more funding from e.g. KK Foundation. Many ongoing collaborations have the potential to work as a base for this. More internal collaboration can boost external funding further by combining the different competences to study and contribute to the solution of societal challenges within joint expert areas.

Threats

As threats we consider external factors which we have no or low control over. Five (underscored below) points are highlighted which we see as the most vulnerable areas when maintaining the research at the School. These relate to losing or not gaining vital resources such as competent staff, external funding, and teaching as part of the duties. The most vulnerable factor is losing key researchers to other universities offering better academic conditions such as career tracks or funding. It follows that another threat is not being able to attract competent researchers due to poorer academic or other conditions than elsewhere. If we succeed in gaining larger amounts of external funding, this makes us more vulnerable to the intrinsic volatility in the Swedish funding system and the consequence is that teaching planning for the research active staff fluctuates more from year to year. The need to have teaching as part of a post is fundamental at the smaller universities as we do not obtain (internal) research funding independent from educational funding. This implies that the teaching staff needs to engage in teaching and the research environment cannot survive without being part of an educational environment. A further threat is that there are few students within engineering and technology which undermines the research environments within EBT and ITE. Finally, low scientific competence among many decision-makers is problematic since the likelihood for poor decisions increases.

List of Swedish to English translations and abbreviations

Adjunkt – Lecturer
Lektor – Assistant professor
Biträdande lektor – deputy Assistant Professor
Docent – Associate professor

Prefekt – Head of School
Proprefekt – deputy Head of School
Avdelningschef – Department Director

Studierektor forskarutbildning – Director for a Doctoral Program
Forskningssamordnare – Research Coordinator
Ämnesföreträdare forskarutbildningsämne – Head of Doctoral Subject

Forskarutbildningsnämnd – Doctoral Education Committee
Institutionsledningsråd – Shool´s Steering Council

Institutionen för information och teknik (IIT) – School of Information and Engineering
Avdelningen för data och informationshantering (DIH) – Data Management and Information Department
Avdelningen för energi och byggteknik (EBT) – Energy and Construction Engineering Department
Avdelningen för industriell Teknik (ITE) – Industrial Engineering Department

Mikrodata-analys (MDA) – Microdata Analysis
Resurseffektiv byggd miljö (REBM) – Resource Efficient Built Environment

HÖGSKOLAN
DALARNA