Development goals and measures (UMV) 2019-22

DTU Civil Engineering

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1. Academic profile and expected performance goals of the Department

DTU Civil Engineering develops and utilizes science and technical knowledge for the benefit of society and the sustainable development of construction and the built environment. DTU Civil Engineering will be known and respected as one of Europe's leading construction engineering research and education environments. DTU Civil Engineering will be an international centre for building research, a preffered provider of civil engineering education and will reflect the great importance of the built environment and the construction sector to society. DTU Civil Engineering has a special role in researching, educating and developing new construction engineering solutions for Arctic regions, for the benefit of society in Denmark and Greenland.

The activities at DTU Civil Engineering are organised in sections following classic civil engineering disciplines:

- Design and Processes, addressing building and construction technology, building and infrastruce design, building information systems, design and construction processes, fire safety and Arctic housing.
- Materials and Durability, addressing concrete, corrosion, new and printed construction materials, reuse and upgrade of materials, building physics, moisture in materials and building envelope as well as materials and durability in Arctic construction
- Energy and Services, addressing building energy technology, building utilities and services, solar energy in housing, smart cities and energy and utilities in Arctic housing.
- Structures and Safety addressing design and analysis of structures, structural safety and loads, structural dynamics, integral structural and material modelling and structures in the Arctic.
- Geotechnics and Geology, addressing geotechnics, geology, geophysics, pavement engineering, rock mechanics as well as permafrost and geotechnical engineering in the Arctic.
- Indoor Environment , addressing comfort and health in buildings in terms of thermal, acustic and lightning conditions, impact of indoor climate on productivity and human beings, efficient indoor air distribution and air cleaning, user/occupant behaviour and indoor climate in Arctic housing.

Furthermore, the Department hosts three centres for co-operation across DTU:

- Arctic DTU, Centre for Arctic Technology coordinating and communicating DTU's Arctic strategy, network and activities including the development and operation of an Arctic DTU campus in Sisimiut.
- ICIEE, the International Centre for Indoor Environment and Energy, identifying and providing solutions to ensure healthy, comfortable and productive indoor environments with minimal energy consumption.
- CASMaT, Villum Center for Advanced Structural and Material Testing, bringing infrastructural lab facilities for multi-scale structural experiments to an international top level cross-departmental alliance at DTU.

In the UMV-period 2019-2022, the Department is expected to increase the intake of students to meet societal needs, and to increase the number of scientific personnel to ensure a creative scientific environment as basis for research of excellent quality and fabulous teaching.

The Department has defined '*DTU Civil Engineering Strategy 2025'*. The strategy comprises a general strategy, an overall research strategy and selected strategic goals for 2025 on the following areas: top 5 research, deliverables to society, external research funding, e-learning for better and more flexible educations, digital modelling and research-based consultancy. To achieve this, we will pursue the following overall strategic actions as the backbone and the recurring themes of the formulation of development goals and measures (UMV):

1. consolidate cohesion in the Department athrough trust and dialogue based work and practices;

2. continuously develop research strategy, publication strategy, education strategy and policies to guide the Department's activities;
3. improve applications for research funding and establish at least one large research programme in all sections;
4. strengthen external funding and the Department's research support;
5. strengthen publication — both scientific and application-oriented — and establish and consolidate at least one new channel of communication for the construction industry;
6. review and showcase teaching activities and develop didactics for e-learning;
7. strengthen the management of the Department at all levels, and equip line managers, project managers and heads of studies with the necessary and sufficient management information and management tools to perform the leadership task;
8. strengthen the academic environment at the Department through professional dialogue and collaboration;
9. develop and establish a common ICT platform for digital modelling of construction engineering phenomena, including the link between simulation and experiments and simulation and the real world;
10. develop recruitment methods, talent management and 'own food chain' as a basis for realising the strategy;
11. enter into strategic alliances with the building research departments of other universities on study programmes, research and utilization of laboratories;
12. enter into strategic partnerships with construction and built environment 'problem owners' for long-term and coherent research and innovation programmes.

The Department will front DTU's activities in Civil Engineering towards society and the construction industry.

The Department will encourage and broaden involvement from different DTU departments in activities in the Arctic through Arctic DTU.

2. Education and teaching

2.1 Education and teaching (BEng, BSc and MSc programmes)

DTU Civil Engineering educates engineers for the building sector in both Denmark and Greenland and strives to improve the quality and at the same time increase the number of graduates, as the demand by large numbers exceeds the numbers produced.

DTU Civil Engineering will develop an education strategy to ensure the relevans of our graduates in future construction industry and labour market. Following this, we will launch several initiatives to enhance excellence and efficiency of teaching activities, reduce drop-out rates and increase the number of graduates with a focus on:

1. Educating smarter
2. Functional bilingualism
3. E-learning and digital competences
4. New teaching activities

2.1.1. Educating smarter

The education and teaching development aim at creating an inspiriring educational environment, where both the students and the Department can work smarter and achieve better results, while using less resources. Specifically, the Department will:

- Share educational activities with other universities, e.g. with Nordic Five Tech as in the Nordic Master in Cold Climate Engineering.
- Organize project families to train peer-review, peer-instruction, peer presentations, the ability to collaborate and communicate, and increase the R&D impact of the projects through industry involvement during the project period.
- Ensure that the Department's educational effort is efficient by performing an analysis of the economy and ressources underlying the educational activities and identify target areas for improvement.
- Establish an overview of the distribution of supervision on projects and courses to ensure a more uniform distribution of the supervisions load and incorporating non-Danish speaking staff in basic courses.
- Reduce and rationalise the number of courses at DTU Civil Engineering with 10% without reducing the students' possibilities for a deeper specialisation, while at the same time increasing the number of faculty by 20%.
- Establish a more rational use of the laboratories to increase the students experimental activities in courses and projects through use of project families, introduction to safety through interactive e-learning, and by increasing laboratory capacity to handle experimental activities in courses with 90+ students. Use of laboratories outside normal working hours will be investigated in order to increase the capacities.
- Develop teaching and learning concepts to facilitate a more flexible use of lecture halls, group rooms and laboratories, thus increasing the effective number of students in these areas. A best practice manual will be developed to support these options.

2.1.2 Functional bilingualism

Preparing students for international co-operation and employability via functional bilingualism (Danish and English) will be secured for the BEng and BSc students by introducing teaching activities in basic courses taught by English speaking personnel and by establishing study plans, which incorporate courses taught in English. Thus, the students will expand their professional vocabulary in English. To prevent drop-outs due to language barriers, the students will be able to get key points in both Danish and English

The functional bilingualism will be supported by new Danish-English (both ways) dictionaries of civil engineering glossary, which are to be developed at the departement.

2.1.3 E-learning and digital competences

The Department will innovate the teaching and learning activities by incorporating e-learning and LearningLab to achieve the overarching goals outlined in DTU's e-learning policy and the elaborated goals in the Department's e-learning policy.

The Department will contribute to developing best practice for DTU Learn by transferring current courses to the new platform. Teamwork with other departments will be increased to facilitate effective learning through the use of e-learning. These activities will facilitate the learning process, increase student engagement and agency, enable a deeper learning, and create a more efficient use of the resources. Thus, transforming the educational environment and decrease drop-out rates by increased use of:

- Blended e-learning techniques in more courses, preferably in combination with the flipped classroom, or in combination with distance teaching (e.g. Arctic courses, educations shared with other universities, Massive Open Online Courses (MOOC), continued education).

- Self-assessment tests and e-quizzes for testing at the beginning of and throughout a course in combination with digital lectures and exercises to increase the level, while the weaker students have an efficient way to catch up.
- E-quizzes, e-peer-review and e-grading activities to facilitate the work for improvement of the student's feedback preparing them for evaluating both their own work and the work of others. This will be combined with the traditional, individual exam to secure the individual testing, only this exam and the grading will use the digital possibilities to a larger extend.
- Experimental possibilities for the students through instruction videos, which are either prepared by the staff or the students. This will both improve the learning and increase the capacity of the lab, which will result in improved access for the students.
- Involvement of students in the development of e-learning materials (e.g. The Open and Intelligent Laboratory).
- Establishment of an annual seminar for best practise in teaching as well as ongoing workshops, knowledge sharing and teaching support.
- Presenting experiences and documentations of the most effective means for teaching and learning, which also improve the quality of the learning.
- Developing a strategy and handbook for the use of e-learning possibilities as well as e-learning supports.
- Introducing e-tools for following the performance of courses and teacher over time and initiate dialogues with teachers and sections for changes to optimize feedback and evaluations.

These activities will be used as a part of the branding of DTU Civil Engineering, especially of the Department's international and continued teaching activities. The e-learning facilities will form a strong and efficient support for project based activities, especially in cross-disciplinary problems. The e-learning facilities will also contribute to the reduction of the time it takes students to complete their studies, as they efficiently support the students' chances to catch up with delays and succeed at reexaminations.

2.1.4 New teaching activities
The Department aims at establishing or expanding several new teaching activities:

- Increase the capacity for the BSc Civil Engineering students to facilitate 90 in annual uptake, including an increase of laboratory capacities to accommodate 90+ students at the same time.
- Review learning goals and studyplans on Civil Engineering topics in all study programmes to update the profile for future engineers in building technology and building design as well as design and technology in infrastructures, both in general and in relation to certification schemes in the industry.
- Increase the experimental activities for students in courses and in projects based on new and planned laboratory facilities in B128, B129 and B130.
- Maintain and improve the contribution to the Innovation Pilot in the BEng Building and Infrastructure. Develop a support for BEng thesis activities through the use of project families.
- Upgrade and profile the teaching and learning in Structural Engineering in different educations through dialogue with students, Study Board and Heads of Studies.
- Develop a master education study line focused on geotechnical engineering and technical geology in view of observed and upcoming changes in climate in alignment with the needs of society in Denmark and Greenland.
- Support the different aims of BEng and BSc educations with separate courses, while at the same time providing the students maximal support for specialisations within the educations rules.
- Further development of the Danish Building Academy as a CDIO based, innovative learning activity in order to provide both a hub for external stakeholders to students and an improved learning platform; e.g.

student driven participation in the competition ‘Solar Decathlon 2019’ in Hungary emphasizing rehabilitation of existing buildings.
- Support the development and implementation of a new BEng education in Fishing Technology headed by DTU Aqua and a new MSc education in Mineral Ressource Management in partnership with Luleå University; both educations are to be based in Greenland within the framework of Arctic DTU.
- Outline detailed plans for the realization of educations at an Arctic Technical University Center in Sisimiut under the auspices of Arctic DTU along the lines of Vision 125.

2.2 PhD programme

The PhD School at DTU Civil Engineering wants to offer a unique academic platform for PhD students, to graduate excellent PhD students and to be recognized as one of the best among peers.

The PhD School management will continue its focus on improving academic identity and promoting and supporting stays abroad; e.g. by framework agreements with universities in EuroTech and Nordic Five Tech. Furthermore, it will facilitate incitements for PhD students to value and produce high quality research publications, such as the DTU Civil Engineering PhD School Best Paper Award and mutual peer reviews of drafts for research publications among PhD students.

The PhD School will take initiatives to ensure that supervisors has the necessary knowledge, tools and competencies to support PhD students properly.

DTU Civil Engineering aims at increasing the number of PhD students with 50 % as well as the ratio of industrial PhD students in collaboration with not only the industry, but also regions, cities, suppliers and ministries. This will also enhance the innovation activities for PhD students. The PhD development will be improved through co-operation with DTU’s alliance partners.

2.3 Continuing education

In order to support engineering competencies among practitioneers in the construction industry and elsewhere, DTU Civil Engineering will strive to increase the activities in the field of continuing education in alliance with the industry and other educational institutions. Specifically, the Department will:
- Review current activities and ensure that both current and future activities in continued education employs a more flexible learning that takes into account the specific needs of working students through the use of digital learning.
- Develop new continued education programmes and courses in collaboration with various authorities nationally and abroad including offerings fulfilling requirements in certification schemes as defined in the Danish Building Regulations
- Seek possibilities to develop more continued education within the framework of Open Education as well as through joint efforts with other Departments at DTU.
- Seek possibilities to develop continued education targeting Greenlandic/Arctic engineers.
- Strengthen the focus on streamlined administrative processes and a high service level for students in continuing education.
- Develop partnership with other providers of continuing educations and courses to obtain economy of scale and enhanced quality.

3. Research

3.1 Research strategy

DTU Civil Engineering is based on a polytechnical concept of creating building and construction techniques based on a deep understanding of underlying physical phenomena combined with forefront experimental investigations. The Department's research strategy comprises general priorities, selected strategic research themes and research strategies for the classic basic disciplines and areas.

The research at DTU Civil Engineering will in general give priority to:

- Experimentally based research, where development, access to and use of unique research facilities in all disciplines of civil engineering is the key - either in-house or through strong strategic collaborations.
- Digital research that leverages digital technologies to create new knowledge, including digital twins, hybrid test technologies, big data and digital research data management.
- Innovative construction, where DTU Civil Engineering will challenge the civil engineering profession and expand its scope—e.g. by developing new design and construction methods and expanding technical horizons on sustainability.
- Selected strategic research themes: (1) Digitalization of built environment (2) Circular Construction, (3) Arctic built environment and a fourth theme to be openly identified within the Department in close co-operation with the Advisory Board.

The Department will revise and update its research strategy continously, and selected specific research areas will be prioritized to ensure a strong future-oriented research profile of the Department. The priotorization in 2018/2019 will be based on an international external research evaluation as well as the ongoing strategic process.

3.2 Research Areas

The Department is organised in six sections, three centres and three strategic themes, whereas both the centres and the themes are interdisciplinary and draw on research resources from the sections. The research profile of DTU Civil Engineering is continuously adapted to ensure development of knowledge in the classic disciplines of civil engineering, identify novel means to provide innovative solutions to problems and to facilitate solutions to major societal challenges. Research activities may be identified in teamwork between researchers, external stakeholders and students, and will be reviewed and clarified.

Current research activities within the Department include e.g.:

- Design and processes: (1) Holistic design of buildings and infrastructure, components and joints for simultaneous fulfilling of requirements of structures, acoustics, indoor and outdoor climate, buildability, application, aesthetics, and environment; (2) Interaction between construction technologies and building design; (3) Building Information Modeling (BIM); (4) Use of linked data technology and digitals twins in the lifecycle of buildings.; (5) Robust technical solutions for renovation of housing; (6) Establishment of design fire scenarios; (7) Systems for super-light building structures; (8) Value of Information analyses for efficient building design and integrity; (8) Arctic housing – functionality and durability.
- Materials and durability: (1) Characterization and durability of porous construction materials; e.g. concrete; (2) New construction materials based on new lab facilities, e.g. composites, fiber materials, printed materials and bio-based materials; (3) Thermodynamics in the building envelope; (4) Moisture and durability of building materials; (5) Reuse of construction/demolition waste in new building materials

supporting circular economy; (6) Ashes as cement substitute in concrete for optimal resource efficiency; (7) Moisture in buildings in the Arctic.

- Energy andServices: (1) Transfer of surplus heat between rooms and flexibility in drawing energy from thermal and electrical grids; (2) Low temperature district heating systems for nearly zero energy buildings; (3) Solar energy systems in buildings including energy storage for the future energy systems; (4) Smart cities activities including technical and financial models ; (5) Composition of high performance building facades; (6) Development and integration of innovative, easily operable, maintainable and efficient building services for lighting, heating, cooling and ventilation; (7) Model predictive control and continuous commissioning of building services; (8) Energy efficient buildings in the Arctic.
- Indoor Environment: (1) Relationship between exposures in the indoor environment through various pathways and human comfort, health and performance; (2) chemistry of indoor environments especially in relation to human occupants; (3) Air distribution and dispersion/containment of pollutants and contageons; (4) Natural/artificial light and comfort in housing and offices; (5) Effect of occupant behavior in buildings on indoor environmental quality and energy consumption including methods to integrate the user/occupant in the control of buildings; (6) Occupant interaction with new systems for ventilation and climatization of buildings; (7)Indoor environment in Arctic housing and offices
- Structures and safety: (1) Material specific design and analysis methods for concrete, steel and glass structures; (2) Numerical methods for predicting structural behaviour and material response; (3) Modelling and classifying capacity and remaining service life and safety of existing structures; (4) Structural monitoring; (5) Structural response and long-term behaviour to dynamic, stochastic and impact loading; (6) Simulation and prediction of complex load processes including wind loads; (7) Optimal structures under arctic conditions.
- Geotechnics and geology: (1) Characterization of soils and rocks, with special emphasis on mechanical properties and permeability, e.g. Paleogene clay (Femern belt), impure chalk (petroleum reservoirs), sandstones (geothermal reservoirs); (2) Development of pavement engineering, e.g. by promoting the use of advanced material and structural models as well as utilization of modern sensing techniques; (3) Geotechnical centrifuge testing and modelling of soil structure interaction; (4) Mapping and characterization of permafrost soils to infrastructure development in a warming climate in the Arctic.

In addition hereto, a number of inter-disciplinary research projects are conducted across the different sections. Most of these research areas are dealt with in the aforementioned strategic themes.

3.3 Research collaboration

The Department will emphasise an expansion of external co-operation with stakeholders in the construction industry and academia, e.g. engineering consultants and contractors, consortia partners in *INNO-Byg,* strategical DTU partners like *EuroTech* and *Nordic Five Tech* and other Danish universities. The attitude will be *'better share than protect'*.

Contributions from the Department to research collaboration both internally and externally in the hosted centres will include, but are not confined to:

- Arctic DTU, Centre for Arctic technology
  - Development of a research plan regarding Arctic technology as outlined in Vision 125.
  - New Arctic Building Practice end evaluation of housing in an Arctic environment;
  - Need and models for transport infrastructure in the Arctic island operated communities.

- ICIEE, International Centre for Indoor Environment and Energy
  - Occupants' reactions to and control of indoor environment for prediction of the indoor environment and energy use in buildings.
  - Internet of Things (IoT) and sensor systems for control of the indoor environment.
- CASMaT, Villum Center for Advanced Structural and Material Testing
  - Understanding fatigue through multi-scale testing and modelling
  - Large scale testing of structural elements and joints

The Department will develop internal research co-operation among others with the following DTU Departments and centres:

- CERE on geotechnic and geophysics.
- Arctic DTU on Arctic technology.
- Center for Oil and Gas on structural dynamics in offshore environment and geology/rock mechanics.
- DTU Electrical Eng. on building acoustics in general and for super-light structures.
- DTU Compute on smart buildings, smart cities and probabilistic based engineering.
- DTU Management Eng. on construction management and sustainable buildings.
- DTU Mechanical Eng. on structural fatigue and structural dynamics
- DTU Wind Energy on fatigue and wind load on structures.
- DTU Bioengineering on mould in buildings and bio-based construction materials.
- DTU Energy and Solar DTU on test facilities for large scale solar energy systems including a solar collector field on the ground and a long term water pit test heat storage that will be established at DTU Risø Campus. The test facilities will be established in alliance with DTU Fotonik and DTU Elektro.

To ensure the highest possible quality and impact based on critical mass of all activities, the Department will continue to focus on increasing its research activities and on concentrating civil engineering research at DTU at the Department.

3.4 Research Funding

The Department will increase the external funding of research and innovation during the UMV period by 25%, and by including more VIP employees in externally funded research projects release resources for strategic research investments and strengthen core research areas. Our extensive research infrastructure will be used as a discriminator in funding processes. The aim is to both increase the number of applications and strive to improve the quality of applications by peer-to-peer processes and departemental support to applicants thus increasing our success rate.

The senior researchers will increasingly be encouraged to take the lead in research programmes funded by the European Commission, whereas our young researchers are encouraged to link up to research projects led by other institutions. All sections at the Department will aim at receiving at least one high profiled voluminous grant in the UMV period.

The Department will focus on funding through the following specific programmes and partners:

- Programmes under the auspices of EIT, including Horizon 2020, ERC and Climate KIC.
- Marie-Curie Programme for PostDocs and PhD students.
- Innovation Fund Denmark.
- Stakeholders in the construction industry; e.g. private companies and large building/infrastructure owners
- INNObyg and Innovationsnetværket Smart Energy (Inno- SE).
- Private foundations; e.g. Villum, Højgaard, RealDania, Mærsk and public/non-profit foundations.

– Danish and Greenlandic authorities, e.g. Danish Energy Agency, Danish transport, construction and housing authorities and the Government of Greenland.

3.5 Research Dissemination

DTU Civil Engineering will develop a dissemination and publication policy based on recommendations from external evaluation covering both the need for scientific publication and the industry need for better communication of research and innovation results.

We will increase our scientific publication in recognized scientific journals and monographs emphazising the impact by incorporating af communication plan as an integral part of every research and innovation project.

We will develop communication products to fulfill the needs of the industry to get closer to our research and innovation environment by offering usable and 'digested' information; e.g. DTU Civil Engineering analysis on current issues, resumes of journal papers and education materials and textbooks. The specific formats and contents will be clarified through communication with external stakeholders.

4. Scientific advice

The in-house competencies as well as developed techniques, methodologies and lab facilities of the Department will be brought into play for the benefit of both private and public sector enterprises, nationally as well as internationally. This will happen not least through development of lab. facilities on Lyngby Campus.

The focus areas are closely linked to current major challenges for the built environment:

- New requirements on sustainability of the building sector with respect to environmental issues, resource consumption and re-use, economics, social and health issues.
- New requirements to the effectiveness and industrialization of the building sector.
- Upgrading and renovation of existing central elements in the aging built environment including the infrastructure.
- Utilization of possibilities for more efficient capacity building and operation of the use of embedded ICT (information and communication technology); e.g. sensing and active structures, intelligent materials and dynamic human-system interaction.

Furthermore, the following areas are expected to be potentially central in national and international research-based consultancy activities within the UMV period: mould in renovated buildings, indoor climate implications of a society with circular economy, condition assessment, maintenance scheduling and remaining service life prediction of the existing infrastructure, estimation of capacity of existing structures, foundations and constructions in permafrost areas, quality assurance and documentation of safety in buildings and finally performance specifications and quality assurance on scientific issues for future large infrastructure projects. All will be major challenges, not only for the society but also for owners, consultants and contractors.

In Greenland – as envisioned in Vision 125 – the establishment of a new university centre for research and education related to Arctic technology is foreseen in collaboration between DTU and the Greenlandic authorities to be fully developed over the next 8-10 years – provided that the necessary funding can be obtained – thus creating a stronghold for research based consultancy in Greenland and for a circumpolar market.

The Department will:

- Prepare analysis of selected parts of the construction sector activities including mapping of needs for scientific advice services among stakeholders; e.g. construction materials and/or digitalisation 4.0.
- Prepare and identify consultancy relations with governmental institutions as scientific advice areas or tasks are put out to tender.
- Develop a business case for scientific advice services and strengthen the administration by standard list prices for department staff and use of lab facilities.
- Develop and market a business model for offerings based on testfacilities in laboratories.
- Ensure impartiality and independency as a strong basis for trustworthy advice.
- Develop scientific advice services for major building and infrastructure owners.
- Increase participation in national and international standardization.
- Seek long term service agreements with selected stakeholders, e.g. public or semi-public organisations.
- Develop scientific advice services based on lab testing facilities, optionally with university partners.

Finally, the ongoing construction and renovation activities at DTU Lyngby Campus offers possibilities for establishing building and infrastructure monitoring activities, which can strengthen the consultancy competences in the area of renovation, maintenance and facility management.

5. Innovation

DTU Civil Engineering strives to integrate innovation in all its activities, including its core activities: education and research. The Department encourages its researchers to make use of individual networks and engage in those innovation activities that may arise from such teamwork. The Department has compiled the following three strategic goals for innovation in the UMV period:

- Improving the innovation environments
- Facilitating student innovation and entrepreneurship
- Increasing innovation collaboration

Improving the innovation environments

To obtain the goal of improving the innovation environment, the Department will:

- Make use of the new laboratory facilities: CASMaT and the new laboratory buildings 128 and 129.
- Carry out planning and building of a new building 130 as a new innovation and research environment for civil engineering materials, e.g. biomaterials, ZeroWaste materials and concrete.
- Increase the capacity of student workshops in buildings 117 and 127 and the Department's laboratories by combining "The open and intelligent laboratory"-concept (blended E-learning and access 24/7) provided necessary funding is obtained.

Facilitating student innovation and entrepreneurship

The Department will strengthen the innovation activities of all bachelor educations, where the Department contributes and use these as a starting point for further co-operation with external partners. To obtain this goal, the Department will:

- Increase the number of student projects in conjunction with external partners, in order to encourage innovation and learning, e.g. by using Project Family concept and the Danish Building Academy concept.
- Make innovation and entrepreneurship part of selected courses.
- Create innovation and entrepreneurship activities for BEng students as part of their mandatory semester in practice and later as a part of the Innovation Pilot course.

- Develop the concept of innovation immersion or research immersion in the summer period; among other things to be used for new concepts, project ideas or development of recruiting activities.
- Participate in Science Camps and Innovation Camps.

Strengthening and increase innovation collaboration

The Department wishes to strengthen the inter-disciplinary research in order to increase the innovation alliances with other DTU departments as well as the industry. To obtain this goal, the Department will:

- Strengthen innovation through the interdisciplinary development areas, Danish Building Academy/Campus Village and selected project areas e.g. SmartCities.
- Increase the collaboration with external partners, networks and organizations (e.g. Krüger, Saint Gobain, Velux, The Capital Region of Denmark, Lyngby, Ballerup and Albertslund, The Landowners' Investment Foundation, Confederation of Danish Industry, The Danish Construction Assocation and InnoByg.
- Increase co-operation with other DTU departments and international universities.
- Refine the Department's Innovation Day by inviting more external participants, selected persons from other DTU departments.

6. Partnerships

DTU Civil Engineering's partnerships are fundamental platforms in order to reach the Department's goals at both strategic and operational levels. Our identification and engagement with partners is based on a strategic consideration on how partnerships best support activities related to our core activities on research, education, innovation and research-based consultancy.

During the UMV period, the Department will further develop partnerships with - present and future - partners including: EuroTech and Nordic Five Tech alliance universities, Harvard, Stanford, BAM, the buildingSMART consortium, the INNObyg consortium, Climate KIC, Raw Materials KIC, LTH, KTH, TU Delft, Danish universities and large engineering corporations.

Furthermore, the Department will strengthen partnerships with transport infrastructure owners suchs as Femern Belt, Danish Road Directorate and Sund & Bælt through the use of the Deparment's excellent experimental facilities allowing for a broad range of issues to be analysed and understood.

In the UMV period, the Department will specifically develop partnerships with:

- Danish Engieering companies, authorities and universities to develop continuing education programmes.
- Leading technical universities in Europe for mutual sharing of lab facilities and experiences on testing activities; e.g. within large scale structural testing.
- Leading construction material laboratories in Europe and China and leading organisations in the Scandinavian construction industry in preparation of the New Concrete and Material Lab in Building 130; e.g. study tour to selected labs.

The Department's engagement in Arctic DTU calls for partnerships with technical universities in Arctic and Nordic countries for collaboration on research and combined educations, e.g. through UArctic and Nordic Five Tech as well as the Government of Greenland and Greenland Institute of Natural Resources.

7. Human resources

7.1 Organisation

DTU Civil Engineering has approximately 200 employees and is organized in six sections, three research centres and central support units comprising IT, workshop and a departmental secretariat including building services and laboratory services, as shown in the figure below. A virtual centre for DTU's Arctic related activities was opened in January 2018 and is anchored at DTU Civil Engineering , along with ICIEE and CASMaT.

The department will aim to foster a lively and vibrant academic environment as basis for motivated employees to contribute to the strategic goals; e.g by sharing project ideas, inspire teamwork and engage in debate on actual themes in society and the construction industry.

DTU Civil Engineering wants to develop an agile organisation that supports the necessary processes for successful delivery of our strategic goals. The overall aim of the supporting units is to support the teachers, scientists and research groups in the best possible way, thus ensuring the best terms and conditions to conduct excellent education and research. A high standard and precision within fundraising and research support will be given special attention.

As contribution to this, the Department wants to strengthen the administrative resources, competencies and working culture enabling the employees to offer a wide range of specialized support across the Department within the areas as project support, administrative support, laboratory support, management and communication. This support will in combination with services from the various DTU corporate units focus on agility and response time.

7.2 Leader and leadership development

DTU Civil Engineering applies to the DTU Leadership Role and recognizes management development as an integral part of the activities at strategic and operational levels. The Department aims for a clear understanding of individual roles and responsibilities in the overall functionality of the Department.

Strategic leadership is of key importance to DTU Civil Engeneering. All members of the management team are expected to participate actively in leading the strategic development of the Department, in the day-to-day management activities in their sections and teams and to develop as leaders. The Department will strengthen the management of the department at all levels, and equip line managers, project managers and heads of study with the necessary and sufficient management information and management tools to perform the leadership task

7.3 Employee development

Development of the employees at DTU Civil Engineering is a focus point in the daily operation but also at a strategic level. The process is rooted in the annual employee development interviews conducted between the individual employees and their immediate manager. The annual employee development interviews are a crucial leadership tool to show recognition, set up goals and be clear on expectations and development potentials. Sabaticals is a natural part of carrier development at DTU Civil Engineering and will be integrated in the planning of teaching and PhD supervision.

As stated in the DTU competence strategy, the aim is a clear link between the strategic goals at the Department and the individual employee competence development, in order to develop the highest potential possible. Initiatives like implementing the Code of Conduct and the development of new laboratory facilities will need a strategic competence development plan, and an analysis of what kind of skills and competences is needed in order to fulfill the potentials in such initiatives.

DTU Civil Engineering has a continuous focus on improving the Department as a workplace where issues as recognition and appraisal, constructive and respectful co-operation based on trust and dialogue is pursued. Dedicated staff is fundamental to reach the Department's goals and there will be an increased attention on our ability to accomodate diversity among staff, i.e. gender, nationality and social background.

DTU Civil Engineering focuses on job satisfaction, in particular through the regular job satisfaction surveys, where critical points are identified through an involving process including the local Collaboration Committee and action plans are developed at all levels . The action plan from the job satisfaction survey 2017 identifieda greater focus on stress management particularly among younger research staff, interdisciplinary teamwork, zero tolerance towards unwanted behavior and self-management.

In order to further develop a productive work environment, the Department will:

- Develop performance targets for all scientific staff, including education, external funding and publication.
- Arrange an annual DTU Civil Engineering educational seminar, presenting best practice "from teachers to teachers".
- Maintain a strong focus on continuous development of our lecturers – primarily via Learning Lab, e-learning and by integrating our young faculty members as PhD supervisors.
- Pay special and continuous attention to the administrative procedures towards obtaining an optimal organizational structure, enhanced efficiency in processes, clear co-operation structures, preparation of job and task descriptions and high quality knowledge sharing.
- Enhance the cohesion between strategic goals and competence development through partnership between the management and the Collaboration Committee.
- Introduce a mentoring programme for young scientists at the Department.
- Integrate sabaticals in the planning of teaching and research as a natural part of carrier development.

7.4 Attracting and recruiting

Developing and recruiting talent is crucial for increasing expertise within DTU Civil Engineering's scientific fields, and therefore the Department is fully committed to formulating and executing a collective initiative with HR that enables the Department to develop talent and recruit appropriate scientific personnel, including exploration of whether other personnel categories could be developed to increase attention; e.g. for industry experts to enter academia.

In order to further develop the potentials and talents of the Department, the Department will look for possible professorships in relation to the strategic initiatives. In the UMV period, the Department will establish three professorships in strategic selected research areas, e.g. architectural engineering, fire safety, rehabilitation of buildings, building information modelling, structural safety or civil engineering materials. Furthermore, the Department will continue to improve start-up conditions and support for new employees acknowledging that more possibilities for permanent employments for younger research staff will ultimately be a win-win for both parties. Finally, DTU Civil Engineering will investigate national and international funding mechanisms that can support the Department in attracting and developing talented researchers.

7.5 HR key figures

DTU Civil Engineering wants to obtain and maintain a sound scientific balance for the activities of each individual VIP, e.g. between education and research. In general, the educational part of VIP activities is high. At the same time, the Department wants to maintain a critical mass in the research groups in order to ensure scientific quality and development.

In the UMV period, an 20% increase in permanently employed research staff and an 50% increase in PhD students will be pursued reflecting the required growth in teaching activities, external funded projects as well as the research-based consultancy venture. Consequently, faculty members will be asked to engage in external funded activities on a regular basis and all other scientific staff to engage in educational activities based on tuned expectations.

8. Material resources

8.1 IT

The Department provides a solid IT platform available for daily work and supports the transition and digitalisation of professional activities,including e-learning and knowledge sharing.

Computers are central components in all experimental activities, making the activities depend on secure and flexible IT environment, where security threats should not result in compromised data and loss of valuable experimental knowledge. Data Management procedures will be reviewed to ensure alignment with Code of Conduct. A special focus point is the IT infrastructure in the laboratories where higher security will be planned, established and adjusted .

On-site measurements conducted by Internet-of-things-devices will increase dramatically. To help researchers use this technology it will be investigated if the Department should host a common platform covering a selected choice of IoT-technologies.

Due to the implementation of EU’s General Data Protection Regulation (GDPR) at national and DTU level, local procedures for data and file handling will need adjustments. The Departmental IT security committee will also be part of that work.

The Internet at Campus Sisimiut will be updated to the highest possible standard, provided the necessary funding can be obtained.

Enhancement of internal knowledge sharing at the Department will be planned and implemented by means of common data structure, knowledge sharing systems and a 'sharing work culture’.

8.2 Laboratory equipment and scientific infrastructure

Experimental facilities of high quality are key components for a long range of the activities of the Department. It is thus our strategy to maintain and further develop these to a high international level. The funding requirement for this is significant and should be reflected in both the basic funding and external research funding.

At present, several laboratory units are undergoing or finishing a major transformation both in terms of the building infrastructure and the experimental facilities. Moreover, procedures are established to ensure

professional operation and maintenance of the Department's experimental infrastructure. These will be further expanded and developed in the UMV-period; including further implementation in most laboratory units of the Equipment Information System (EIS) platform,

DTU funding allocated to a new concrete and construction material laboratory form the basis of a dedicated effort to rise external funding for equipment with new research possibilities; e.g. intelligent materials, composites, fiber-based materials or reuse of materials for a circular economy. These facilities will be included in the new Building 130 and rehabilitated areas in the basement of Building 119. The equipment funding effort will be done in close collaboration with industrial partners, private foundations and possibly other DTU departments. This laboratory is expected to open officially in 2020.

Facilities for experimental pavement engineering for use in both education and research activities are highly needed as a consequence of the ongoing capacity building within geotechnical engineering.

The significant increase in experimental facilities as well as student uptake in the UMV-period will inevitable require more supportting personel in the workshop; e.g. measurement technicians and laboratory engineers, thus calling for more funding both form external sources and from DTU.

It is envisaged to establish a boundary-layer wind tunnel to perform studies on individual buildings and on the urban built environment at suitable geometric scale. The available and future facilities at DTU MEK and DTU Wind – including the National Windtunnel - are not suitable for this type of simulation, and the use of commercial wind tunnels comes with heavy time restrictions.This wind tunnel is envisioned to be the main instrument for research in wind load on structures and dynamic response, verification of numerical simulation as well as for research on urban microclimate. In this connection, formation of a 'wind tunnel center' across DTU should be considered.

New research and technological challenges and possiblities dictates a new look at the indoor climate lab facilities. A major update is required and at the same time the current placement far from the main premises of DTU Civil Engineering is a barrier for a better integration of the Section for Indoor Environment and Comfort in the Department. Hence, the Department will seek to attract funding for new research facilities to be located into the 1st quadrant. The funding comprises both external funding of lab facilities and DTU funding for a new building or alternatively reuse and rehabilitation of an existing building. In this connection, formation of aliances across DTU or reaching outside DTU should be considered.

With the help of a new financial laboratory structure, the need for allocation of funds for laboratory use, maintenance and upgrading is clarified and made transparent, whereEIS will be an important instrument in this effort.

During the UMV period, safety in lab units and workshops will be structured and enhanced in parallel with the increase in capacity and facilities including physical access control and laboratory specific user safety clearance. Safety on experimental works in the field at and around Campus in Sisimiut will have special attention.

8.3 Premises

The comprehensive renovation plan for DTU Civil Engineerings premises in the 1st quadrant is expected to be finalized in the planning periode. This effort is expected to give the built environment in 1st quadrant a

major upgrade both functionally, environmentally and visually. The plan is effectuated in close dialog between CAS and the Department – a process which will be ongoing throughout the UMV period.

However, the plan does not foresee the envisioned relocation of Indoor Environment staff from building 402. Those issues will be addressed during the first years of the UMV period, involving relocation of Indoor Environment staff to Building 118/119 along with the envisioned indoor climate lab renewal.

Furthermore, the Department will need an upgraded outdoor lab-environment 'terra lab', estimated to 24.000 sqm north of Nordvej for outdoor experiments; supporting activites including – but not limited to – geotechnical research, pavement engineering, solar systems enginnering, 1:1 prototyping in connection with Danish Building Academy, Solar Decathlon and test houses for Greenland and storeage facilities. Finally, attention on upgrading/rehabilitation of education facilities in B116 incl its east-wing is important to support education activities.

As predicted in ARTEK Vision 125 Business Plan, new campus facilities are needed in Sisimiut before the end of the Vision-period; year 2025. The Department will, in collaboration with Greenlandic Self-Rule, seek funding for premises facilitating office work, educational activities, arctic laboratories and accommodation for scientific personel in Sisimiut. Support from central DTU services is essential in these matters.

DTU's low-energy house in Sisimiut is expected to be renovated in the UMV-period and instrumented for monitoring of various technical parameters during operation; e.g. new facades.

9. Communication

In the UMV period, DTU Civil Engineering will focus on aligning the communication with the strategic goals of the Department to a higher degree. As part of DTU Civil Engineering Strategy 2025, a communication strategy/policy will be determined in order to support the Department's strategic goal to be seen as a significant contributor to both the public debate as well as in the industry. It is envisioned that this communication strategy/policy amongst other activities will enable the Department to:

- Engage proactively in external relations.
- Deliver specific, useful results for practical construction, including e.g. reports, analyses, textbooks and models.
- Prepare a range of products that can be of use for colleagues in academia as well as practioners.
- Produce significant contributions to the public debate on construction matters.
- Strengthen the number of publications — both scientific and application-oriented — and establish and consolidate at least one new channel of communication for the construction industry.

Furthermore, the communication activities will bring the many new laboratory facilities at the Department into focus, emphasizing the the opportunities the facilities provide for education, research, innovation and research-based consultancy.

With the establishment of Arctic DTU in 2018, the Department has a particular communication task involving Arctic research and education activities across DTU and to be a 'communication hub' between DTU and external stakeholders, policymakers, networks and other universities in the Arctic.

10. Process and employee involvement

The UMV process was initiated in March 2018 in the management group of the Department, followed by discussions within the individual organisational units and at staff meetings. Staff members have been given the opportunity to contribute to this UMV, however bearing in mind that in parallel with the making of this UMV, the Department is also close to finalising its strategic process. Consequently, several elements from the process leading to DTU Civil Engineering Strategy 2025 bears a natural resemblance to the UMV. Also, in the final phase of the writing of the UMV report, the actual organisation in sections and developmental areas is being reorganised meaning that the Department has a different set-up to the one that was in place when the process for this UMV was initiated.