

STRATEGY 2019–2025

DEPARTMENT OF ELECTRIC POWER ENGINEERING

The Norwegian University of Science and Technology – NTNU

Foreword

In 2018, NTNU and the Faculty of Information Technology and Electrical Engineering finalised their strategies for the period 2018–2025. This document presents the strategy of the Department of Electric Power Engineering (IEL) for the period 2019–2025, focusing on our specific mission. IEL has conducted an inclusive process involving all our employees, and the document is based both on ideas and knowledge gathered in the internal processes and on the overarching strategies. We share the overall visions and values of NTNU and the Faculty, and we have the same core tasks, cross-cutting areas of focus and development goals as the rest of the university, with the adaptations that are natural at the departmental level. We also share the same general challenges. We have tried to avoid repeating what has already been written in the overarching documents, and refer the reader to these instead.

NTNU's vision is *Knowledge for a Better World*, while the Faculty of Information Technology and Electrical Engineering (IE) specifies this as *We will Make the Future Smart, Safe and Sustainable*. The Department of Electric Power Engineering has chosen *At the Centre of the Digital, Green Shift* as its vision for the period. We believe that this fits in well with the overall visions, as well as with our specific social mission.

The Department's strategy has 3 parts. The first part, *About the Department of Electric Power Engineering*, is a description of the Department and our activities today combined with a scenario of the future. The second part, *Core Tasks*, describes our development goals within the 4 core tasks. The third part deals with the *Development of the Department and Action Plans*, addressing both the work environment and how we will develop a systematic structure in our activities, through approaches that include following up IEL's overall strategy with specific action plans with a shorter time horizon in all the Department's academic units.

A very brief description of our strategy

- IEL wants to make an even stronger impression. IEL aims to be an agenda-setter for the digital green shift, and its vision is therefore to be *At the Centre of the Digital, Green Shift*.
- IEL has high ambitions. By focusing on outstanding research, we will also succeed in national and international competition for research funds. We develop our research-based courses and study programmes in line with developments in the field.
- IEL is constantly developing. We are willing to change and to develop our organisation and personnel. We set the agenda for development in electric power engineering and at the same time we are responsive to the community around us. The strategy is a living document, and it is concretised in regular action plans.

The action plans provide further concretisation of this strategy document, which describes the overall policies and resolutions agreed upon by the Department. The strategy document is also a living document, and will be revised at least once during the strategy period.

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OUR VISION

OUR SOCIAL MISSION

OUR EMPLOYEES AND ORGANISATION OF THE DEPARTMENT

CHALLENGES IN THE CURRENT SITUATION

GOALS FOR 2025

01



OUR VISION:

AT THE CENTRE OF THE DIGITAL, GREEN SHIFT

This vision is our specific perspective of NTNU's vision of Knowledge for a Better World, based on our horizon scanning. The 3 Ds – decarbonisation, decentralisation and digitalisation – are drivers of sustainability, which will be achieved through innovations in the electricity sector. In short, the future is digital, renewable, and electric. We are proactive in defining and helping to solve the most important research challenges, as well as in developing our study programme portfolio so that we educate graduates with the best possible prospects for facing these challenges in their professional practice. We participate in the most important strategic forums, and our opinion makes a difference. We aim to be internationally leading in several subject areas, and a national leader in all of them.



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OUR SOCIAL MISSION

Our most important social mission is to educate engineers at bachelor's-, master's- and PhD- level with high relevance to the society around us. At the same time, through its research, the Department contributes to the development of technology and systems for planning, operation and maintenance of increasingly efficient, sustainable energy systems. We are also Norway's most important flag bearer in our discipline, as a steward of fundamental and applied knowledge of electric power engineering, producing graduates who have a sound foundation in the mathematics and natural science cornerstones of the electric power engineering discipline.



Photo: Colorbox

OUR **EMPLOYEES** AND **ORGANISATION** OF THE DEPARTMENT

The Head of Department, with executive responsibility for IEL, is employed for a fixed term in a 100% administrative position. The Head of Department must be a person with scientific qualifications at Associate Professor level or above in one of the Department's subject areas, and typically has leave of absence from their permanent position for the fixed-term period. As of October 2019, the Department had nearly 50 permanent employees, of whom about a third are employed as the administrative and technical staff. The Department also has many temporary academic employees, mainly PhD candidates and postdocs, but also some who have an additional post as Adjunct Professor or Adjunct Associate Professor. There are typically more temporary than permanent staff members, but this varies over time depending on our project portfolio.

As of October 2019, the Department is organised in 6 units: Administrative and technical staff as well as 5 research groups. Our scientific staff have expertise in a wide range of subdisciplines in electric power engineering, giving us unique opportunities for multidisciplinary research. The 5 research groups are responsible for both research and education in their areas, and also work together in projects across the research groups. Administrative and technical staff work across the entire organisation to support the research group activities. The 6 units of the Department are described below.



Photo: Kai Dragland/NTNU

Administrative and Technical staff

The Department's Head of Office leads the administrative and technical staff. The administrative duties cover a wide range, where the most important are in finance, administrative project tracking, HR, study programmes and management support. The most important technical duties are to operate, maintain and further develop our digital and physical laboratory infrastructure, service lab and mechanical engineering workshops, as well as to provide assistance to students working on projects and laboratory assignments, and to employees in connection with research and education.

The Electrical Machines and Electromagnetics (EME) research group

Development, design, optimisation and testing of electrical machinery are the group's main research activities, especially permanent magnet machines and hydropower generators. In addition, research is focused on advanced electromagnetic modelling and analysis of a variety of power apparatus and installations.

The High Voltage Technology (HVT) research group

Design, modelling and operation of electric power components are the main research activities of the group. Research into better insulation materials, for both AC and DC, also plays a key role.

The Power Electronic Systems and Components (PESC) research group

Development, design, optimisation and control of power electronic converters and systems are the group's most important research activities. Application areas include onshore power plants, marine, oil and gas, as well as transportation sectors.

The Electricity Markets and Energy System Planning (EMESP) research group

The main research activities of the group relate to the integration of renewable energy sources, energy storage and consumption in the electricity market, and how to optimise the integration of the power system with other parts of the energy system, such as heating and transport.

The Power System Operation and Analysis (PSOA) research group

The main research areas of the group relate to the planning, operation, control, and analysis of power systems, with applications in smart grids, transmission and distribution grids, microgrids, and High Voltage Direct Current (HVDC) systems.

In addition to the units mentioned above, the Department has committees that deal with specific tasks across the Department. These committees are currently: *EnergiKontakten* (a network of companies and organisations associated with areas of our education and research), the Education Committee, the Research Committee, the Laboratory Committee, the Data Committee, and the Committee on Diversity and Gender Equality.

CHALLENGES IN THE CURRENT SITUATION

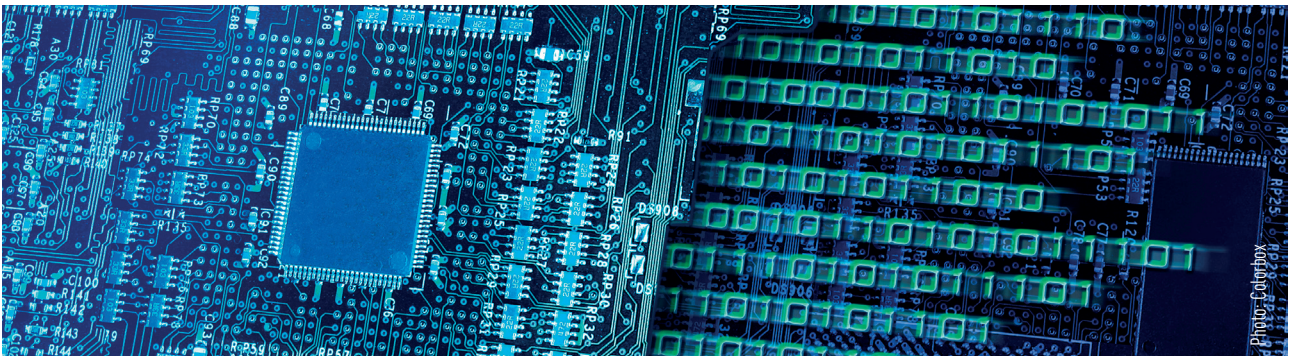
Accelerating technological development, specifically in the field of electric power engineering – linked, among others, to the green shift and climate challenges, as well as digitalisation and the new digital energy landscape, presents exciting challenges to the Department's disciplines. The Department must respond to this development, while maintaining the foundation of its disciplines.

It is demanding to find the right balance for the academic profile in new hirings, development of the academic portfolio, research areas to be prioritised, and the opportunities that we should seize.

Strategic initiatives

The 5 discipline-oriented research groups that are briefly described in the previous page also implicitly represent the Department's initiatives for the strategy period. During the strategy period, the research groups will work actively to define and establish their own strategic project portfolio in their disciplines and in interdisciplinary collaboration with the other research groups.

The Department as a whole will also have strategic areas of focus, including links with areas of focus at the Faculty and across NTNU. We want to highlight one area in particular that we believe will be important during the strategy period, and where we wish to have a special focus: Digital electrical energy. In this area, the Department's innovation manager works across the Faculty and the university. A tentative definition of digital electrical energy appears below. However, this is a new area, where our strategic work also involves clarifying the content of the term.



Digital electrical energy

Digital electrical energy is an emerging research field that deals with the revolutionary developments in renewable energy, especially wind and solar energy, energy storage, consumer flexibility and electrification of transport. This field is dedicated to improving efficiency and performance of electric power and energy systems for a sustainable future by embracing these developments with the innovative use of information technology, communication technology, computer science, power electronics, and cybernetics. The term “digital” is the common denominator in the interdisciplinary alliance that is required to realise the intelligent and sustainable electrical energy and electrical energy conversion sectors of the future.

Relevant research topics in this field include:

- The role of digitalisation in improving planning, control and operation of power systems, as well as in their flexibility, productivity and stability, and in sustainable energy conversion.
- The importance of technologies such as big data, artificial intelligence, machine learning and blockchain technology for the electric energy sector of the future.
- Emerging and new business models, open innovation and stimulation of entrepreneurship in electrical energy.
- Technologies such as wireless power transmission, microgrids and digital control of power electronics for cyber-physical systems.

GOALS 2025

In 2025, IEL will be internationally recognised for its research and study programmes. We aim to be world-leading in several of our research areas, and in Norway we aim to be at the forefront of our discipline in general. Our study programmes must be up to date and well-equipped to fulfil our social mission as we see it in 2025, while taking care of electric power engineering as a discipline. We will take advantage of the opportunities offered by new technology to give our students access to varied forms of learning and assessment, and will develop our study programmes to build innovation competence and skills among our students.

CORE TASKS

EDUCATION AND LEARNING ENVIRONMENT

RESEARCH AND ORGANISED RESEARCHER TRAINING

INNOVATION

DISSEMINATION AND OUTREACH

02

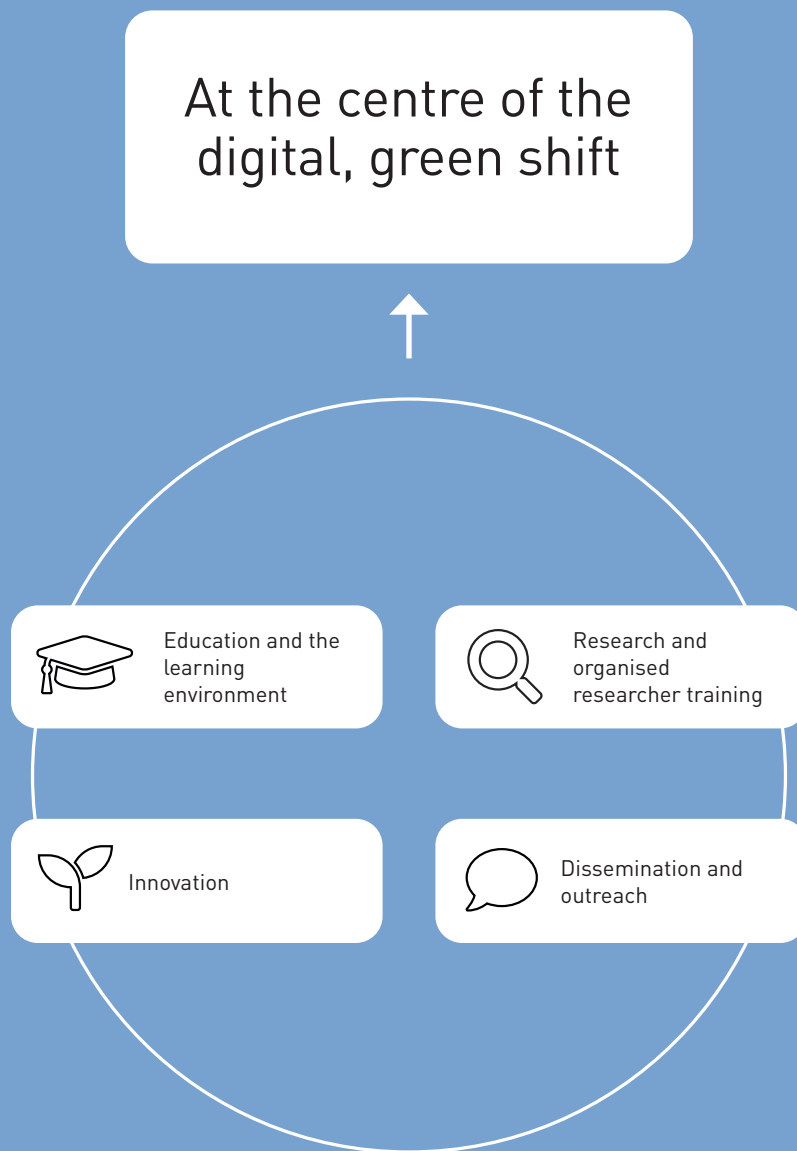


CORE TASKS

The Department has the same set of core tasks as the Faculty, which also reflects 4 of NTNU's 5 core tasks. The Department strives to ensure that our activities in each of the core tasks are consistent and interrelated, and that both the individual tasks and the interaction among them support our vision, as illustrated in the figure in the next page.

Illustration: Colorbox





EDUCATION AND THE LEARNING ENVIRONMENT



DEVELOPMENT GOALS

Effective operation of education activities as well as an **appropriate portfolio of courses and programmes** that ensures a good balance and coherence between research and education tasks. Where possible, there should be a suitable integration among the different study programmes. The Department has an overarching responsibility for all our courses and programmes, and all academic employees must have the opportunity to contribute to all our programmes

Continuing and further education (EVU) is seen in the context of our overall portfolio of courses. Here too, the principle of suitable integration is used whenever possible.

Study programmes must be clearly anchored in strategic considerations. The research groups are responsible for both research and education in their disciplines, and they will work to ensure that the **courses offered are research-based**, up to date and relevant to the study programmes in which they are situated.

The educational offering must address the challenges and trends in society, and include interdisciplinary cooperation where necessary. The study programmes must be **modern and forward-looking and must be developed dynamically in line with changes in society**. The Department wants to participate actively in NTNU's central development project "Technology Studies of the Future".

The Department's educational offerings must promote the discipline of electric power engineering, and ensure that the **foundation of the discipline is maintained**.

The research groups take **active responsibility for further development of the study programmes**.

Digital and physical laboratories must play a key role in all programmes. We will continue to further

improve the quality of the Department's laboratory activities.

Our programmes of study must be **internationally oriented**. The Department will facilitate both incoming and outgoing student exchange.

The Department uses varied forms of learning and assessment, **focusing on best pedagogical practices**, and has clear and unambiguous expectations of excellence from both students and members of the teaching staff.

The Department places emphasis on **delivering good laboratory training/education**, and that students perceive this as relevant.

The Department strives to ensure good physical settings, where students feel a sense of belonging and identity so that **the campus is an attractive workplace** for them as well.

Today, we educate graduates at bachelor's-, master's- and PhD- level in electric power engineering in study programmes described in more detail on our website: <https://www.ntnu.no/iel/studier>. Relevant specialisations currently include planning, design and operation of electrical energy systems, including renewable energy production and new smart energy grids, deregulated electricity markets, as well as the design and development of electric power engineering components for application in industry, energy supply, buildings and transport.

A goal of the Department is that the sectors we serve, whether private or public, will find the graduates we educate at all levels as relevant, creative, knowledgeable and innovative.

The Department aims to operate our portfolio of programmes and courses effectively with optimal use of resources.

The Department regards all students as equal regardless of their study programme affiliation or the level they are at in the course of their studies. All students at IEL therefore have the same right to the high quality of education that we offer. We offer research-based education at all levels.

RESEARCH AND ORGANISED RESEARCHER TRAINING



DEVELOPMENT GOALS

The Department works in close collaboration with industry partners in research on technology for the production of electric energy from renewable energy sources, and in research that leads to solutions for the future power grid, all the while with high relevance to society, addressing industrial needs and global challenges. Collaboration with SINTEF Energy Research is important to the Department, and will continue during the strategy period. The Department currently has a strong involvement in several major research centre initiatives and other research projects, and we are an attractive partner.

Our aim is to **be an initiator and have an active project management role** in externally funded projects and other larger initiatives to an even greater extent. The Department will realise this by:

- Having clear expectations for the research groups, while providing them with leeway for their own development.
- Creating a conducive environment for research in general, and specifically for individual researchers who take the responsibility for larger initiatives.
- Having an international focus and creating good networks, by setting ambitious goals for academic publication, through exchange of PhD candidates, systematic follow-up of research sabbaticals for tenured staff and active participation in important international arenas such as the European Energy Research Alliance (EERA).
- Developing best practices for project portfolio management

During the strategy period, the Department aims to **realise at least one major initiative** under the auspices of the Department, such as a Centre for Research-based Innovation (SFI), Centre of Excellence (SFF), Centre for Environment-friendly Energy Research (FME) or a large EU project. This also supports the Department's goal of **working across disciplines** and being internationally **leading** in at least one research area. A subgoal of the Department is to procure **international research projects** within Horizon Europe and other relevant EU programmes.

The Department aims to maintain **first-class digital and physical laboratories** and to develop them further, in order to support the plans and research projects of the research groups as well as education activities. Technical staff play an essential role in this work.

The Department aims to **increase the progression rate for PhD candidates** and to reduce dropouts. This will be achieved through:

- Quality in recruitment.
- Clear expectations to PhD candidates and supervisors in the start phase.
- Systematic follow-up along the way.
- Involving PhD students in the Department's activities as a whole.
- Identifying any problems early on and taking suitable measures



INNOVATION

design business
ideas operations motivation
communication operations management
original
success original
finance
vision
new
goals teamwork ideas strategy
strategy focus innovate
finance invention method creative
development
company
business
operations
design

DEVELOPMENT GOALS

NTNU has created the Strategic Programme for Knowledge-Based Innovation as a follow-up to its strategy. This programme is an initiative to increase the transformation of knowledge, technology, methods, results and ideas from research at NTNU into tangible innovations. The aim is to make it easier for society to access and use the knowledge and results from our research.

IEL participates in the programme and we have appointed an innovation manager for this purpose. During the strategy period, IEL will work towards the programme goals as described above, in general, and with a special focus on digital electrical energy. The Department aims to build a lasting culture of innovation and effective methodology contributing to continuous transformation of knowledge from IEL to the benefit and value for society and the digital green shift. IEL will work to increase innovation skills among our students and staff.

A further goal of the Department is to create effective procedures for identifying more ideas from research activities with potential for innovations. IEL aims to work actively to realise the ideas through cooperation with NTNU's ecosystem for innovation and/or in collaboration with existing or new employers / job markets. NTNU's ecosystem for innovation is the network of actors and services in innovation and business collaboration linked with NTNU, which together contribute to translating knowledge from NTNU into benefits and value for society.

In 2025, it will be possible to identify innovation in the society around us as a clear result of our activity.



■ DISSEMINATION AND OUTREACH



DEVELOPMENT GOALS

The Department must disseminate the results of its research to the research community. We aim to publish more of our research in high-level scientific channels, and everything that is published should be of high academic standards and language quality.

The Department's education is research-based. This means that our research results are not only disseminated to the research community, but also communicated to students, and influence our educational offer. A goal of the Department is that the educational offering is continuously developed in line with the ongoing production of new knowledge.

The Department works in close collaboration with industry and the public sector both directly through networks of individuals and through our centres, clusters, collaboration agreements, national and international committees for the development of standards, the *EnergiKontakten* network, and ongoing research projects. This collaboration is very important for the Department, and the Department wishes to strengthen these activities.

The Department's vision also requires us to be more visible to the public. We aim to increase our outreach to the public through popular science articles and participation in other popular science arenas. At a time when knowledge about energy and climate is being challenged from several quarters, it is especially important for us to be active in public discourse, and to promote our research and knowledge in a variety of media such as television, radio, newspapers, and social platforms.

The Department's visibility is also important in connection with our national and international reputation, as well as for recruitment of good candidates to both permanent and temporary positions, and for the recruitment of students. The Department aims to have up-to-date web pages of high quality that create a professional impression and effectively communicate our competence, achievements, results, and relevance to the outside world. A further goal is to use social media actively to convey relevant news from the Department to the outside world.



Photo: Kai Dragland/NTNU

DEVELOPMENT OF THE DEPARTMENT AND ACTION PLANS

The Department regards the development of the work environment as highly essential. Our aim is to maintain a good physical and psycho-social working environment, where people enjoy coming to work and contribute to collegial atmosphere. A culture of safety in all laboratories and workshops must be an area of focus throughout the Department. We must develop a culture where excellent performance is given due attention, both among the academic staff, and the administrative and technical staff. Quality must be a cornerstone of all our research and education activities, and in the support functions. We value diversity and we will continue to strive for good integration of all staff members in social and academic interaction at the Department. The Department strives to include all employees in the development of our academic strategy, and aims to have processes that allow everyone to be heard.

Our goal is that all employees, whether temporary or permanent, perceive themselves as an integral part of the Department as a whole. Everyone who is present at the workplace forms a part of the work environment, and we want to develop a culture in which every employee primarily performs their job in the workplace and thus also takes part in the day-to-day professional and social interaction with colleagues.

The Department must have a good correlation between work assignments and available resources, and as such the mapping of resources and work allocation for employees will be introduced. The key aspects are to create space for academic activity and research as well as to have a transparent and equitable distribution of work assignments among the permanent academic staff at the Department.

The management responsibilities and tasks of the heads of all the 6 units must be clearly defined, and strategic development of all the units is a goal for the Department. All the units must work systematically with their development and at the Department. A specific outcome of this will be that all units develop their own action plans, which are regularly followed up and updated, with a horizon of 1-2 years.

The management and administration of the Department will develop a strategic staffing plan and long-term budget. In addition, they will annually plan events and arenas for common team building, strategy development and organisational development, as well as be responsible for annual planning of resource and work allocation. The administration will follow up new employees, and ensure that the Department has effective routines in place that ensure predictability for and fair treatment of all employees.

The Department has a set-up of committees that deal with specific tasks across the Department. The Department will assess which committees are necessary, and will clearly define their roles.

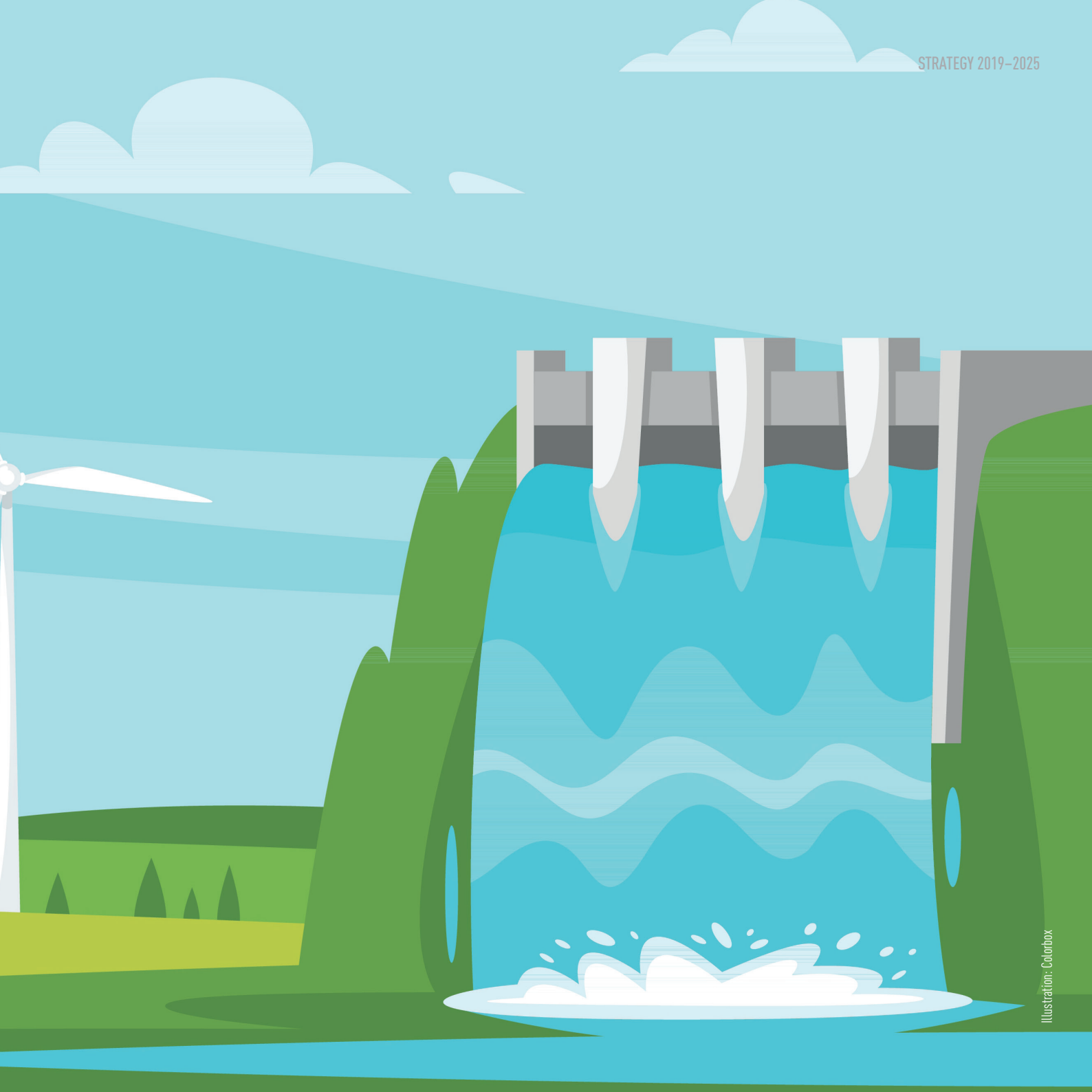
In their action plans, the administrative and technical staff must focus on how they can best support the primary activities of the Department, and how to develop the staff with this in mind.

In their action plans, the research groups must describe:

- Strategic research areas of the group.
- Research initiatives and project acquisition.
- Follow-up of activities in progress, including PhD candidates and postdocs.
- Publishing, dissemination and outreach.
- Development of the academic portfolio as well as learning and teaching methods.
- Organisational development initiatives in the group as well as the group's role and collaboration at the Department.
- How the group involves PhD candidates and postdocs in its activities







FROM VISION TO REALITY

2019–2025

“The secret of getting ahead is getting started. The secret of getting started is breaking your complex, overwhelming tasks into small manageable tasks, and then starting on the first one.”

-Unknown - attributed to Mark Twain