



DEPARTMENT OF ENERGY
AND PROCESS ENGINEERING

 NTNU

ANNUAL
REPORT 2023

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From a department lunch at Kvilhaugen Gård, Wednesday 29 March 2023.
Photo: Kim L'Orange Sørensen/NTNU

LOOKING BACK AT 2023



REFLECTING ON A YEAR OF CONTRASTS

As we summarise yet another year for EPT, I take a moment to contemplate the triumphs and challenges that have shaped our journey at the Department of Engineering and Process Technology (EPT) in 2023. This year, much like the one before, has tested our resilience, yet I am proud to witness the unwavering commitment that defines our department. Despite the more limited and unpredictable conditions related to the adoption of a new finance model for higher education, EPT remains steadfast against the waves of challenges.

FIRST YEAR OF TEACHING FOR MTEK

Our pursuit of constant development is evident in the successful revision of the Mechanical Engineering study programme together with the Department of Mechanical and Industrial Engineering and the Department of Structural Engineering. We introduced TEP4111 – Energy and Sustainability, a pivotal course laying the foundation for students to delve into the academic challenges our department champions. My heartfelt thanks go to all involved for their dedication.

ACKNOWLEDGING PROFESSORS AND ITVS

I extend gratitude to our professors for their tireless efforts in the lecture halls, and I appreciate the feedback from our department-elected student representatives (ITVs). Their affirmation of student satisfaction with EPT's instructors is heartening.

CONTINUING TO HARVEST NEW PROJECTS

EPT proudly reflects on a successful year securing new and substantial research projects. Notably, our younger permanent academic staff members have excelled in obtaining funding for their projects, attesting to the high scientific caliber within our ranks. Furthermore, the department will host yet another ERC grant. This year, the department became host for the first time of an ERC Synergy grant. Thus, we currently have four ongoing ERC grants. As we await the results of the Centers for Environment-Friendly Energy Research (FME) application round, the prospect of new opportunities is exhilarating.

ADAPTING TO THE NEW SYSTEM

The implementation of the new digital system for finance and payroll, a recurring theme in 2023, demanded considerable effort and adaptation. Despite the unforeseen challenges, we are closing in on our goals. I appreciate everyone's patience and commend our economists for their remarkable effort and resilience in navigating this transition.

GRATITUDE TOWARDS OUR COLLABORATORS

Our partnership with both academic and industrial collaborators has been strengthened by our shared commitment to bring forward the research frontier for sustainable energy and process solutions. Furthermore, this year was an all-time high for industrial involvement in bachelor's and master's thesis work. This collaboration exemplifies our shared values and commitment to making a positive impact on societal development and the environment.

Here's to a year of resilience, achievements, and the promise of new horizons in the coming year.

A handwritten signature in black ink that reads "Terese Løvås". The signature is fluid and cursive, with a large initial "T".

Warm regards,
Terese Løvås
Head of Department
Department of Energy and Process Engineering

THE ENERGY LANDSCAPE

The Energy Landscape spans the entire scope of energy research and competence development conducted at NTNU - Department of Energy and Process Engineering and SINTEF Energy.





OUR MISSION

EPT shares the mission that as part of a university, we educate outstanding graduates with strong analytical and practical abilities, and our research focuses on expanding knowledge in science and technology for a better world. Furthermore, EPT's mission is to contribute to Norway's role in developing a viable foundation for society at regional, national and global levels.

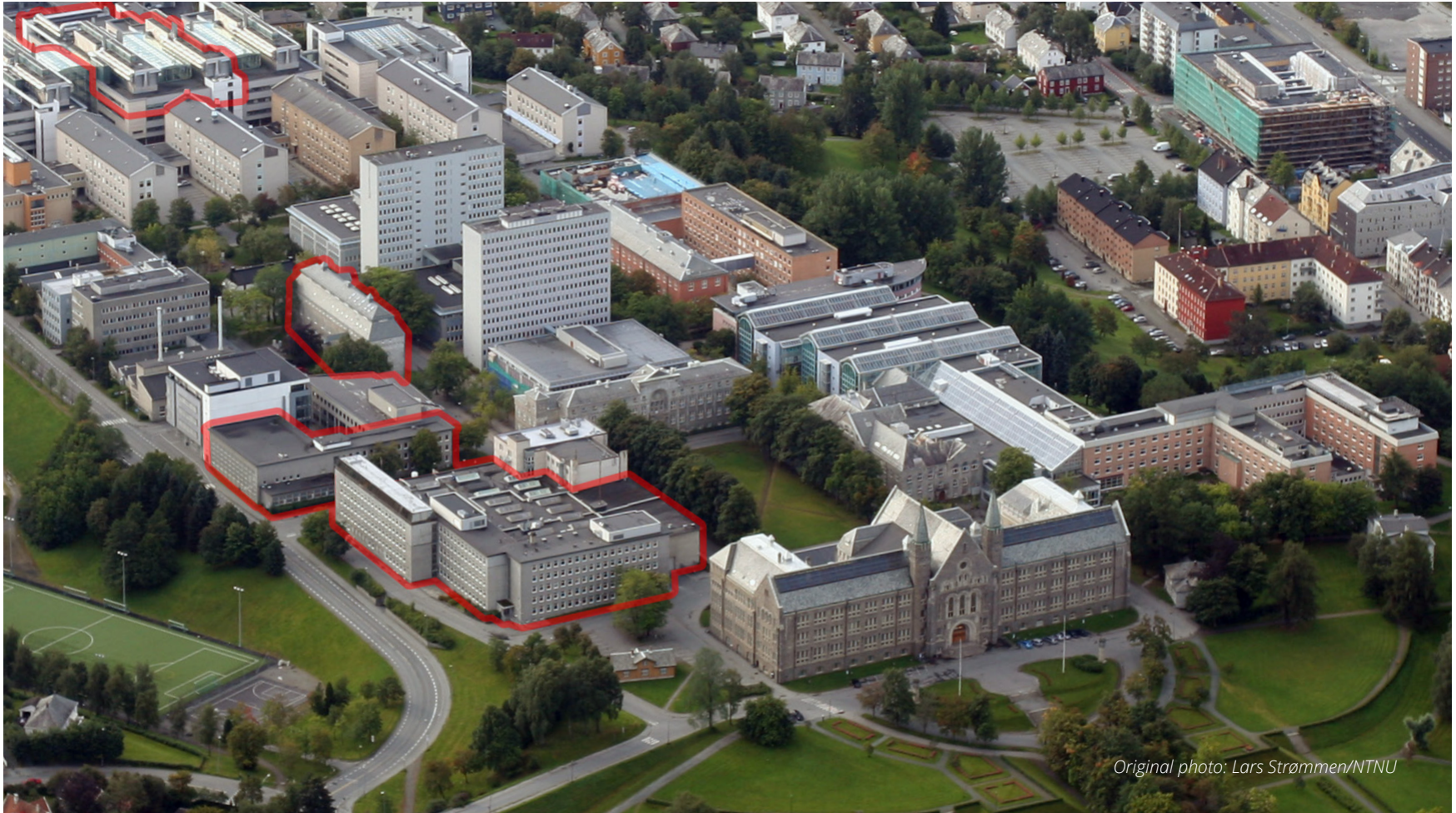
Through research and education, the department shall contribute to the understanding of sustainable solutions, helping to solve complex problems and global challenges to ensure effective resource utilisation. In line with NTNU's goal to move from mission to action, we address the UN Sustainable Development Goals (SDG's) (ntnu.no/baerekraftmaal) that are relevant based on the research and educational activity at the Department: 2, 3, 6, 7, 8, 9, 11, 12, 13, 15.

SUSTAINABLE DEVELOPMENT GOALS



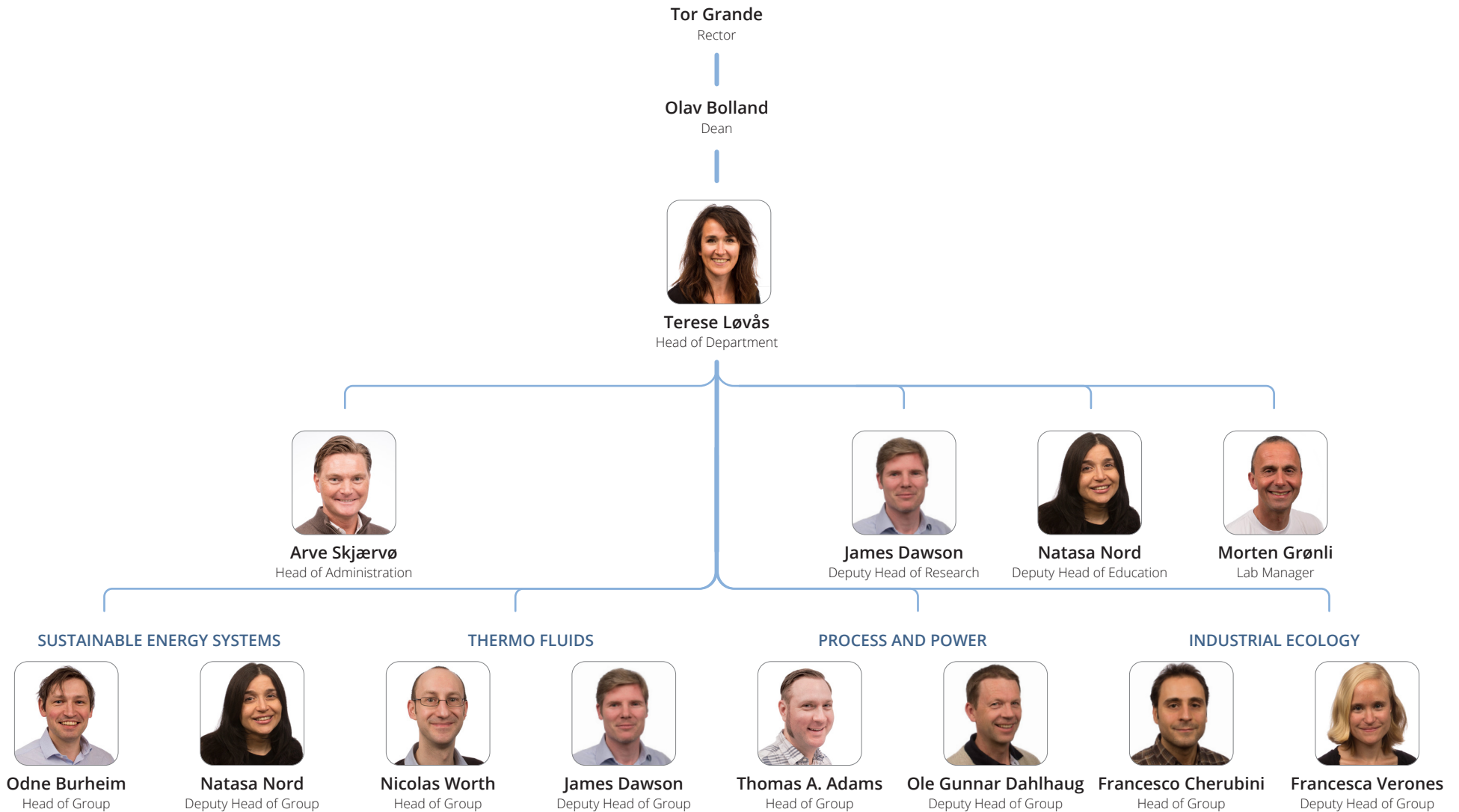
EPT AT NTNU

EPT is one of eight Departments at the Faculty of Engineering. There are nine Faculties at NTNU – Norwegian University of Science and Technology.



EPT is located in four different buildings across NTNU Gløshaugen campus.

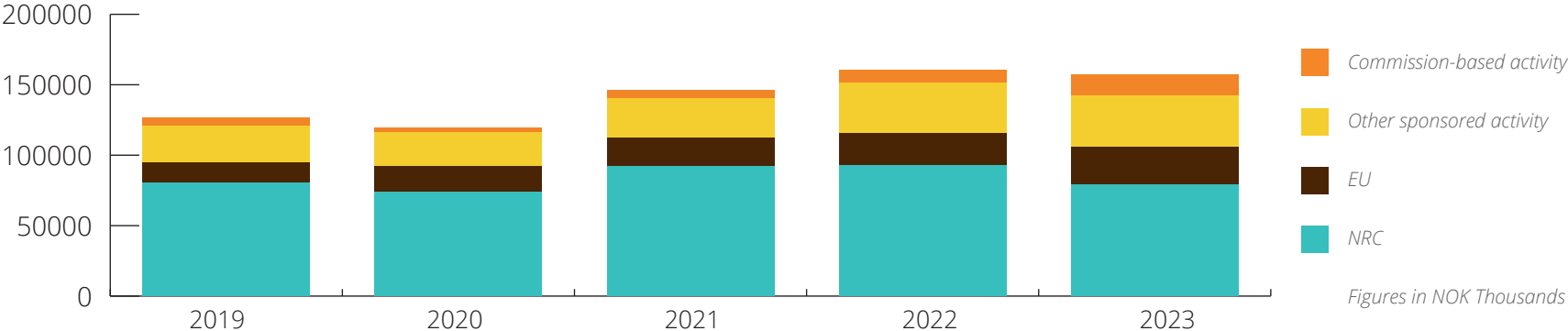
DEPARTMENT ORGANIZATION



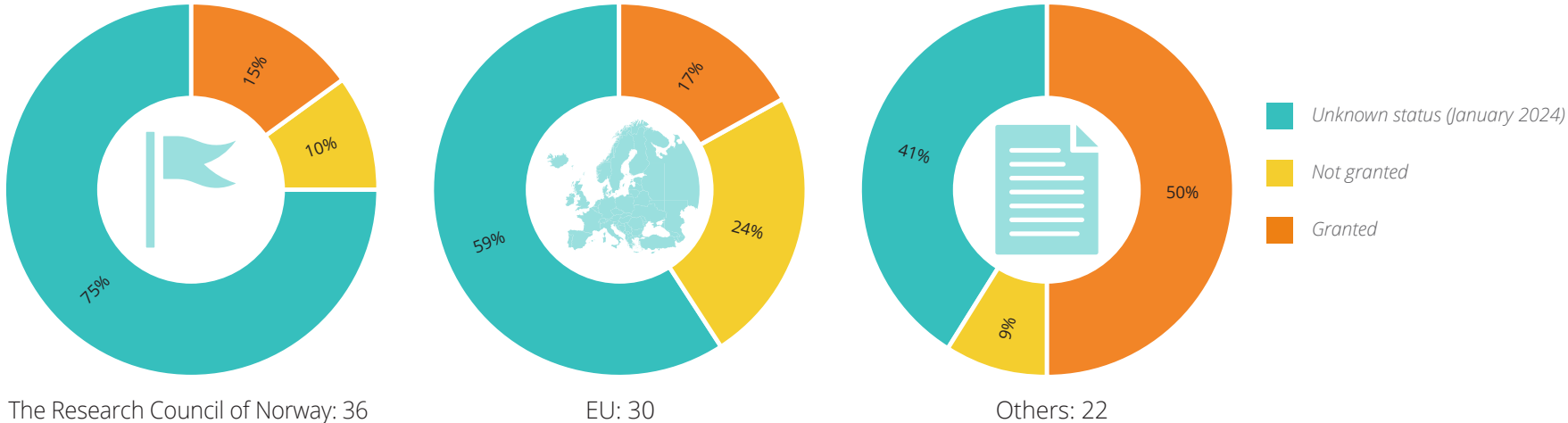
2023 IN NUMBERS

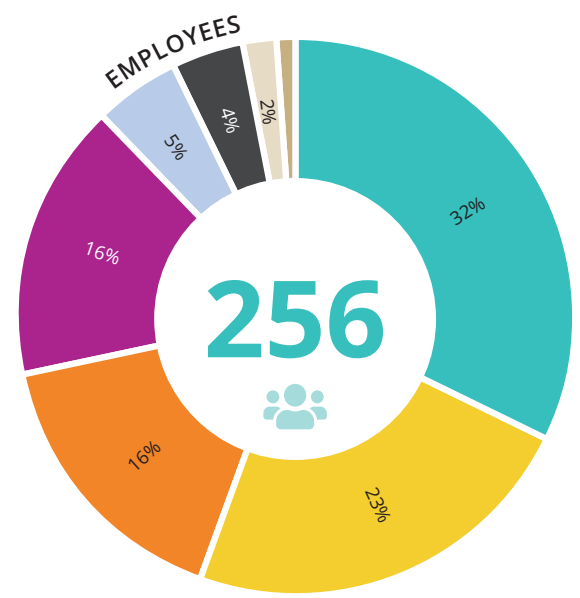
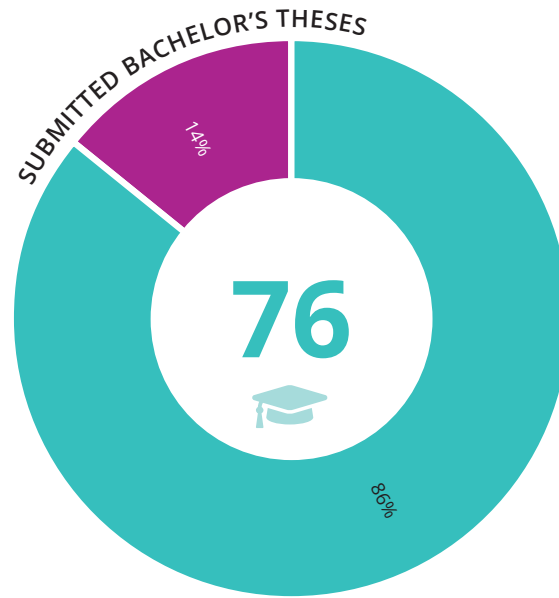
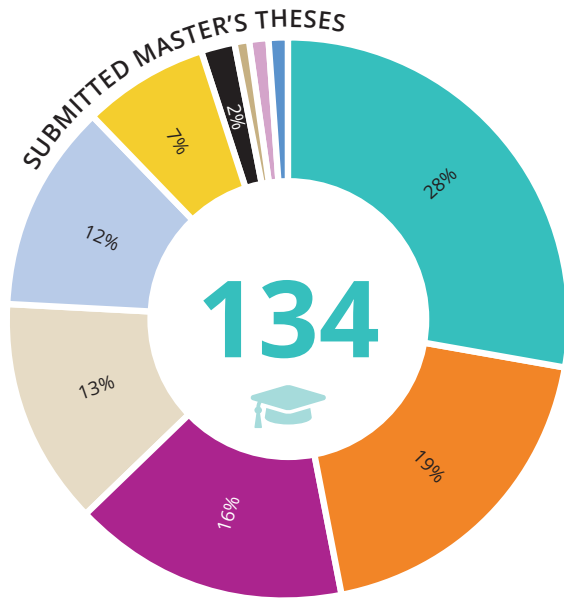
Projects where EPT receives funding from sources other than the grant from the Ministry of Education and Research will normally be defined as either sponsored activities or commission-based activities.

SPONSORED AND COMMISSION-BASED ACTIVITY - BOA (2019- 2023)



RESEARCH APPLICATIONS IN 2023:





- Energy and Environmental Engineering (5 yrs)
- Mechanical Engineering (5 yrs)
- Industrial Ecology
- Energy Use and Energy planning (2yrs)
- Exchange students
- Mechanical Engineering (2 yrs)
- Sustainable Energy (2 yrs)
- Natural Gas Technology (2 yrs)
- Circular Economy
- Environmental Engineering (2yrs)

- Renewable Energy
- Mechanical Engineering

- PhD Candidates
- Admin. and tech. staff
- Postdoctoral Fellows
- Professors and Associate Professors
- Adjunct Professors and Adjunct Associate Professors
- Researchers
- Research Assistants
- Assistant Professors

SUBMITTED AND DEFENDED PHD THESES

Number of defended PhD theses: 16

Research Group	Name	Title of Thesis	Supervisor
Industrial Ecology (IndEcol)	Hung, Christine	Beyond life cycle assessment: building a methods extension ecosystem for the environmental assessment of emerging technologies	Strømman, Anders H
IndEcol	Aguilar Lopez, Fernando	Lithium-ion Batteries – Norwegian opportunities within sustainable end-of-life management, reuse, and new material streams	Müller, Daniel B
Processes and Power (PP)	Ahrens, Marcel	Development of an ammoniawater absorption-compression heat pump at high temperature operation	Eikevik, Trygve
PP	Ringstad, Knut Emil	CFD Modelling for Improved Components in CO2 and Ammonia Vapour Compression Systems	Hafner, Armin
PP	Kverno, Johannes Opedal	Experimental investigation of flexible operation of Francis turbines	Dahlhaug, Ole Gunnar
PP	Log, Alexandra Metallinou	Depressurization of CO2 in pipes: Analysis of experiments and non-equilibrium flashing flow models	Hafner, Armin
PP	Kuhn, Wolf Ludwig	Evaluation of ultrasonic degasification as a tool to mitigate total dissolved gas supersaturation downstream hydropower plants	Dahlhaug, Ole Gunnar
Sustainable Energy Systems (SES)	Ding, Yiyu	Trends in Urban Building Stock Energy Use - from Large to Small Scale	Natasa Nord
SES	Hashemi, Seyedbehnam	Energy Efficiency in Biogas Production: Dealing with Bottlenecks for Improved Methane Production	Lien, Kristian M
SES	Bryntesen, Silje Nornes	Production Strategies for Sustainable LIB Cathodes with Enhanced Energy Density and Rate Capability	Lamb, Jacob
SES	Spithoff, Lena	Investigating the Interaction between Degradation and Thermal Behaviour in Lithium-Ion Batteries.	Burheim, Odne Stokke
Thermo Fluids (TF)	Vinnes, Magnus Kyrkjebø	The actuator disk as a wind turbine model: An experimental assessment of the fluid dynamics	Hearst, Jason
TF	Govender, Dirren	Three-Dimensional Measurement of Azimuthally Forced Flames in an Annular Combustor	Worth, Nicholas

Research Group	Name	Title of Thesis	Supervisor
TF	Tomasch, Stefanie	Application and development of dissipation-based combustion models for conventional and unconventional combustion processes	Ertesvåg, Ivar
TF	Kwah, Yi Hao	Ignition and lean blowoff dynamics of turbulent flames in annular combustors	Dawson, James
TF	Gaucherand, Jessica	Direct Numerical Simulation of premixed ammonia/hydrogen flames: the effects of thermo-diffusive instabilities	Schulze-Netzer, Corinna



Photo: Geir Mogen/NTNU



Photo: Khalid Hamid/NTNU

THERMAL ENERGY AND FLUID MECHANICS

RESEARCH GROUP THERMO FLUIDS (TF)

“Our research group focuses on both fundamental and applied research in the general areas of thermal energy and fluid mechanics,” says Nicholas Worth, Head of Research Group. “We develop and use cutting-edge theoretical, experimental and numerical methods to help address major societal challenges in energy, sustainability, transport, health and the environment.”



Nicholas Worth
HEAD OF RESEARCH GROUP

Photo: Thor Nielsen/NTNU

Ongoing major research projects and affiliated centres	Responsible
LowEmission – Research Centre for a Low-Emission Petroleum Industry on the Norwegian Continental Shelf	James Richard Dawson, Terese Løvås, Nicholas Worth, Andrea Gruber, Jonas Moeck
FME Bio4Fuels – Norwegian Centre for Sustainable Bio-based Fuels and Energy	Terese Løvås
Breaking through: The Impact of Turbulence on the Gas-Liquid Interface (GLITR)	Jason Hearst
Hyrope – Hydrogen Under Pressure	James Dawson
WaTurSheD – Small Flows with Big Consequences: Wave-, Turbulence- and Shear current-Driven mixing under a water surface	Simen Ellingsen
High-Temperature Gasification for Material Recycling of Municipal Plastic Wastes	Corinna Schulze-Netzer
AmmoniA Zero Emission (AMAZE)	Terese Løvås
Cardio Exosomes - Biomedical engineering platform for cardio exosomes	Carlos Dorao
Dyndrops - Mechanisms controlling droplet growth dynamics during condensation on micro-patterned surfaces	Maria Fernandino
Fire Research and Innovation Centre (FRIC)	Ivar Ståle Ertesvåg
Reheat2H2 - Towards clean and stable hydrogen reheat combustion in gas turbines	Jonas Moeck
Stability Through Asymmetry: Breaking vortical symmetry to enable zero-carbon combustion	Nicholas Worth



RESEARCH INTO ZERO CARBON GAS TURBINES RECEIVED 12.7 MILLION EUROS

How can we decarbonise large-scale power generation and aviation as quickly as possible? The European Research Council awarded a substantial grant to a team of researchers who will explore this.

A potential game changing pathway to decarbonise large-scale power generation and aviation is to develop gas turbines that can burn zero carbon fuels such as hydrogen or ammonia. But how do we accelerate this development?

A team of researchers from NTNU, ETH Zurich in Switzerland, TU Darmstadt in Germany, and CNRS in France aims to accelerate the development of new gas turbines by understanding the combustion science of hydrogen and ammonia. The European Research Council (ERC) has awarded their project – Hyrope – a Synergy grant of 12.7 million euros (145 million Norwegian kroner).

PINNACLE OF TECHNOLOGY

“Gas turbines are a pinnacle of technology and are a corner stone of our energy system. It is a common misunderstanding that combustion engines are “dirty” when in fact it is the fuel,” says Professor James Dawson.

He is the Deputy Head of Research at the Department of Energy and Process Engineering at NTNU.

Hyrope brings together four European laboratories that will work together in close collaboration to conduct atmospheric and high-pressure experiments as well as large scale computations to understand how hydrogen and ammonia fuels burn safely and with minimal pollutants.

GAS TURBINES HAVE IMMENSE POTENTIAL

Despite their historical association with fossil fuels, there is immense potential in adapting gas turbines to burn zero-carbon alternatives such as hydrogen or ammonia.

However, this transition raises several scientific and technical issues since these fuels have very different combustion and emission characteristics compared to fossil fuels, especially under high-pressure conditions.

“The effect of pressure on the combustion properties of hydrogen and ammonia is the main problem that Hyrope aims to solve,” says Professor Dawson, “Without understanding the pressure dependence we cannot develop the models and simulation tools needed for the rapid development of new gas turbines – and time is of the essence”.

The funding from ERC will last 6 years and provide the Hyrope team with over 20 PhDs and Postdocs at NTNU, ETH, TU Darmstadt and CNRS.



Professor James Dawson is the lead Principal Investigator of the Hyrope team, which received EU support to develop gas turbines that operate on zero carbon fuels.

FINALLY NORDIC FLAME DAYS

The Nordic Flame Days is the Nordic meeting point for everybody involved in combustion or combustion-related processes.

Several employees from EPT were part of the organising committee for this conference in November, which finally took place four years after the last time. The Nordic Flame Days conference is usually held every other year, but had been postponed due to COVID-19.



The 2023 version of the Nordic Flame Days was held at NTNU's Gløshaugen campus.



Photo: Geir Mogen/NTNU

BRIDGING TECHNOLOGY AND SCIENCE

- THE INDUSTRIAL ECOLOGY PROGRAMME (INDECOL)

“Industrial ecology is the study of the energy and material side of the economy and society and investigates how resource management contributes to welfare, where environmental impacts occur, and the strategies for the transition to more sustainable systems,” says Francesco Cherubini, Head of the Industrial Ecology Programme. “Our teaching and research activities bridge technology, the environment, and the social sciences.”



Francesco Cherubini

HEAD OF INDUSTRIAL ECOLOGY PROGRAMME

Photo: Titt Melhuus/NTNU

Ongoing major research projects and affiliated centres	Responsible
FME NTRANS – Norwegian Centre for Energy Transition Strategies	Edgar Hertwich
CircEULAR – Developing Circular Pathways for a EU Low-Carbon Transition	Anders Hammer Strømman
BAMBOO – Biodiversity and trade: mitigating the impacts of non-food biomass global supply chains	Francesca Verones
LASTING – Sustainable prosperity through product durability	Johan Berg Pettersen
Mind-P – opportunities and barriers to how the Norwegian bioeconomy can be transformed to achieve direct independence from imported mineral phosphorus by 2030	Daniel Beat Müller
ICARUS – International cooperation for sustainable aviation biofuels	Francesco Cherubini
HiTEA – High Throughput Environmental Assessment Pipeline	Konstantin Stadler



PROFESSOR VERONES TO INTERNATIONAL NATURE PANEL

Professor Francesca Verones will assess how businesses impact the state of nature on a global nature panel.

Francesca Verones from the Industrial Ecology Programme (IndEcol) has been selected as a lead author for an upcoming assessment by an international nature panel. The panel is known as The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). Verones will be responsible for Chapter 4 in the IPBES report on biodiversity and business, titled “Approaches to measuring business dependence on and impact on biodiversity.”

CREATING A PLATFORM OF KNOWLEDGE FOR POLICYMAKERS

“It is an incredibly exciting opportunity to contribute to this report, and I am really looking forward to it,” says Verones. “The report aims to provide an assessment of the business sector’s effects on and dependence on biodiversity. The goal is to identify methods and indicators that can quantify these effects, along with other sustainability aspects. Ultimately, this will serve as a platform of knowledge for policymakers and authorities internationally.”



Professor Francesca Verones contributes with vital knowledge about natural diversity.

Verones has extensive experience in nature and climate-related research and coordinates three major EU projects: BAMBOO and RAINFOREST on biodiversity and trade, and ATLANTIS on marine plastic.

The IPBES report on business and biodiversity is scheduled to be completed by 2025-2026.

OUTSTANDING RESEARCH AND ARTISTIC ACTIVITY AWARD TO EDGAR HERTWICH

The NTNU employee award for outstanding research and artistic activities in 2023 was awarded to Professor Edgar Hertwich.

Previous awardees are the Nobel laureates May-Britt and Edvard Moser, centre-of-excellence leader Bengt-Erik Sæther, and the founder of a logistics company, Kristin Ytterstad Pettersen. The jury emphasized the international contributions of Hertwich to the work of policy interface organisation, including the International Resource Panel, the Intergovernmental Panel on Climate Change, and his recent appointment to the European Scientific Advisory Board on Climate Change.



Tor Grande, Pro-Rector for Research and Dissemination, presented the award to Professor Edgar Hertwich.

Photo: Thor Nielsen/NTNU.

FROM HYDROGEN AND BATTERIES TO BUILDINGS

RESEARCH GROUP SUSTAINABLE ENERGY SYSTEMS (SES)

“The Sustainable Energy Systems group works on integration of energy systems”, says Odne Burheim, Head of Research Group. “Our aim is to increase sustainability. We use diverse technologies such as hydrogen and batteries, and applications such as energy supply and energy efficiency for good indoor environments in buildings.”

Furthermore, Burheim explains that within this context, the group has obtained new battery projects in 2023. “For instance, we secured three distinct RCN projects covering digitalisation, new sensor methods, and production development within batteries, along with the funding for four new PhD Candidates.”

Furthermore, Professor Natasa Nord, Deputy Head of Research Group, explains that the group was very successful in securing EU projects in 2023. “One EU project within innovation action and two highly competitive and prestigious projects under the Marie Curie programme were obtained. These projects will bring one postdoctoral fellow and two PhD candidates to our group.”



Oodne Burheim

HEAD OF RESEARCH GROUP

Photo: Thor Nielsen/NTNU

Ongoing major research projects and affiliated centres	Responsible
FME ZEN – The Research Centre on Zero Emission Neighbourhoods in Smart Cities	Laurent Georges, Hans Martin Mathisen
ExPOSe - Transparent Energy Planning	Natasa Nord
NorGiBatF – Norwegian Giga Battery Factories	Oodne Burheim
POSired - Reduction of Post operative surgical site infections through development of XR tools	Guangyu Cao, Hans Martin Mathisen
UnDID – Understanding behaviour of District heating systems Integrating Distributed Stocks	Natasa Nord



HEALTH MINISTER INAUGURATED THE OPERATING ROOM OF THE FUTURE

Norconsult, NTNU, and St. Olavs Hospital have joined forces to combat dangerous infections resulting from airborne and contact-based transmission during surgical procedures in hospitals. In August, Health Minister Ingvild Kjerkol inaugurated what could become the operating room of the future.

“Hospital-acquired infections are the most common complications in healthcare, occurring all too frequently. I am pleased that Norconsult, St. Olavs Hospital, NTNU, and their collaborators aim to contribute to reducing these types of infections. It is also incredibly exciting and important to explore how we can use new technologies such as XR and machine learning to develop and enhance our healthcare system, addressing specific challenges we face as a community. I applaud initiatives like this,” said Ingvild Kjerkol, Minister of Health and Care Services.

The operating lab will be utilised to research how the risk of such infections can be minimised through the POSI-red project.

AUGMENTED REALITY

The laboratory used in the project is designed as an operating room, equipped with technology and devices that make it possible to visualise ventilation flows and airborne particles. Stereoscopic cameras record the movement patterns of healthcare personnel. An XR tool (extended reality) is being developed to capture the interaction between the movements of healthcare professionals, virtual airflow, and particle distribution in the room.



Rector Anne Borg handed over the scissors to the Minister of Health and Care Services Ingvild Kjerkol, who declared the lab officially open.

Photo: Lars B. Aarset/NTNU



From the mock operation during the inauguration of the Operation Room Lab.

Photo: Lars B. Aarset/NTNU

BREAKTHROUGHS IN BATTERY TECHNOLOGY AND INNOVATIVE PROJECTS

Prominent battery publications and grants characterise 2023.

The past year has been marked by significant strides in the field of battery technology at the department, with three papers published under the prestigious Nature journal umbrella. Additionally, the successful acquisition of five project grants further underscore our commitment to fostering innovation and pushing the boundaries of scientific discovery.

The papers and grants in question are listed below:



From the left: two cylindrical cells (one open and one closed), two pouch cells, a coin cell and a large pouch cell.

PAPER IN NATURE COMMUNICATIONS:

1. Liu, F., Lu, W., Huang, J., Pimenta, V., Boles, S., Demir-Cakan, R & Tarascon, J-M. Detangling electrolyte chemical dynamics in lithium sulfur batteries by operando monitoring with optical resonance combs. Nat Commun 14, 7350 (2023). <https://doi.org/10.1038/s41467-023-43110-8>

PAPERS IN NATURE SCIENTIFIC REPORTS:

1. Hansen, H.E., Seland, F., Sunde, S. Burheim & G. Pollet, B. Optimum scavenger concentrations for sonochemical nanoparticle synthesis. Sci Rep 13, 6183 (2023). <https://doi.org/10.1038/s41598-023-33243-7>
2. Moradi-Alavian, S., Kazempour, A., Mirzaei-Saatlo, M., Ashassi-Sorkhabi, H., Mehrdad, A., Asghari, E., J. Lamb, J., & G. Pollet, B. Promotion of hydrogen evolution from seawater via poly(aniline-co-4-nitroaniline) combined with 3D nickel nanoparticles. Sci Rep 13, 21486 (2023). <https://doi.org/10.1038/s41598-023-48355-3>

PROJECT GRANTS:

1. HeaLiSelf - Self-healing lithium-ion batteries enabled by fiber/nano optic sensing and convergent data-driven analytics, led by NTNU and funded by the RCN. Contact persons: Steven Boles and Jacob J. Lamb
2. CellMap: How different parameters influence cost and performance of battery cells from material to the final cell, led by IFE and funded by the RCN.
3. Platform for computational battery design, led by Freyr Battery Norway AS and funded by the RCN. Contact persons: Odne S. Burheim and Jacob J. Lamb
4. Rethinking zinc-air flow batteries for stationary energy storage (ReZinc), led by SINTEF and funded by the RCN. Contact persons: Odne Burheim and Jacob J. Lamb.
5. Computational studies on the impact of electrochemical pre-lithiation process on cell production, led by Beyonder AS and funded by the RCN. Contact person at EPT: Jacob J. Lamb.

MARIA JUSTO ALONSO AWARDED FOR HER PHD WORK

Maria Justo Alonso received the Crown Prince Haakon's Research Award on April 19, 2023, for her PhD work on indoor climate, energy use and health.

Justo Alonso defended her thesis in December, and her work has focused on measuring, monitoring and controlling several indoor climate parameters that are important for asthma and allergy diseases. Her project was affiliated with FME ZEN.



Maria Justo Alonso and Anne Elisabeth Eriksrud, the Secretary General of the Norwegian Asthma and Allergy Association (NAAF), during the award ceremony at the Allergy Risk Conference in Oslo in April.

Photo: Beate Sloreby/NAAF.

FROM HEATING AND COOLING TO **HYDROPOWER AND ENERGY EFFICIENCY**

- RESEARCH GROUP PROCESSES AND POWER (PP)

“The Processes and Power group is best characterised as generally providing EPT’s expertise in process systems engineering and specifically providing the underlying technologies that comprise them, including but not limited to power generation of many kinds,” explains Thomas Alan Adams II, Head of Research Group. “PnP has a strong industrial focus. Although we have curiosity-driven and fundamental research, the majority of PnP projects are directly informed by industrial collaborations with an aim toward education of experts, technology transfer, implementation, and commercialisation.”



Thomas Alan Adams
HEAD OF RESEARCH GROUP

Ongoing major research projects and affiliated centres	Responsible
FME HydroCen – Norwegian Research Centre for Hydropower Technology	Liv Randi Hultgreen
FME HighEFF – Centre for an Energy Efficient and Competitive Industry for the Future	Truls Gundersen
Wet Gas Compression Fundamentals	Lars Eirik Bakken
NTNU-MIT_Equinor Energy Research Programme	Thomas A. Adams II
The Future Refrigeration India: INDEE+	Armin Hafner
European Energy Research Alliance Joint Programme Hydropower	Ole Gunnar Dahlhaug
HydroFlex – Increasing the value of Hydropower through increased Flexibility (H2020)	Ole Gunnar Dahlhaug
TRI-HP – Trigenation systems based on heat pumps with natural refrigerants and multiple renewable sources	Armin Hafner
Small Scale energy renewable technology	Ole Jørgen Nydal



FLEXIBLE HYDROPOWER

The research project Store2Hydro will work with innovative energy storage solutions for hydropower, with emphasis on reversible pump-turbines.

Wind and solar energies are variable in nature, and they do not provide continuous electricity. Therefore, other energy sources must handle the variability and provide uninterrupted electricity supply.

“Exponential use of wind and solar energies to mitigate global warming related challenges has surpassed the smooth operational limit of the hydropower in recent years,” says Professor Chirag Trivedi. “Hydropower experiences significant challenges in providing society with the necessary stable electricity supply.”

REVERSIBLE PUMP-TURBINES

The Store2Hydro project aims to provide technological solutions to improve the limit and to optimise the energy storage in reversible pump-turbine type hydropower plants. Lulea University of Technology coordinates the project, while EPT at NTNU is a key partner for developing and validating the technologies. The project also collaborates with nine other partners across Europe.

RESHAPING THE FRANCIS TEST FACILITY IN THE WATERPOWER LABORATORY

The aim of the NTNU part of Store2Hydro is to design and develop a rim-driven booster pump and integrate it into the existing test facility of the reversible pump-turbine. On the NTNU side, a PhD candidate, a postdoctoral fellow and six master’s students will carry out the planned research.

Store2Hydro is financed by the European Commission under the Horizon Europe Research and Innovation Action programme. The total budget of the project is EUR 4.3 million over four years.



Professor Chirag Trivedi inspects the available state-of-the-art test facility of the reversible pump-turbine, which will be adapted for the new research project.

VISIT FROM INDIA'S AMBASSADOR TO NORWAY

In July, we were honoured to welcome India's new ambassador to Norway, H.E. Dr. Aquino Vimal, to NTNU at the Department of Energy and Process Engineering, along with representatives from the Ministry of Foreign Affairs. This delegation also met with the university's Rector, Vice Rector, and various academic communities here at the Norwegian University of Science and Technology (NTNU).

Professor Armin Hafner spoke at EPT about the project Future Refrigeration India: INDEE+ and the Edu-Cool project.

Professor Armin Hafner in discussion with India's new ambassador to Norway, H.E. Dr. Aquino Vimal.



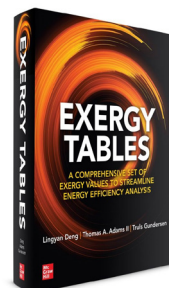
VISIT FROM THE MINISTER OF ENERGY

Terje Aasland, the Norwegian Minister of Energy, visited FME Hydrocen and the Waterpower Lab in October.

There were good discussions about pump hydropower, flood control, biodiversity, more power from the same water (efficiency), and collaboration with developing countries, and of course, the importance of research and knowledge in society.



Discussions in the Waterpower Lab with Terje Aasland, the Norwegian Minister of Energy (to the right), Liv Randi Hultgreen, Ole Gunnar Dahlhaug, Arne Nysveen and Ludvik Kuhn. Photo: Juliet Landrø/FME Hydrocen



NEW BOOK FOR THE PRACTICING ENGINEER

Exergy Tables, co-authored by EPT professors Thomas A. Adams II and Truls Gundersen, teaches how to use thermo-mechanical and chemical exergy to analyse industrial and chemical process systems. Made for the practicing engineer, this book makes it easy with 3 simple chapters introducing the topic, and then 7 chapters packed full of tables and charts for thousands of chemicals, mixtures, fuels, and common process streams.

ORGANISATIONAL **STORIES & MOMENTS**

100 YEARS OF TECHNICAL HVAC EDUCATION

During the HVAC Days on October 24th and 25th, a hundred years of education in the field of heating, ventilation, and sanitary engineering are celebrated. Natasa Nord guided the audience through the programme on the first day, and Head of Department, Terese Løvås, began with a retrospective on the roots of the profession. Vojislav Novakovich gave the first presentation of the day, focusing on institutional history and key researchers.



VISIT BY ITALIAN PRESIDENT AND THE CROWN PRINCE COUPLE

Media followed the VIPs in the lab this May. Photo: Ned Alley/NTNU. When the Italian President and the Norwegian Crown Prince couple visited NTNU, they stopped by the Turbulent Combustion lab.



Left:

Natasa Nord introduced the HVAC Days.

Right:

Media followed the VIPs in the lab this May.

Photo: Ned Alley/NTNU.

EPT WOMEN IN SCIENCE: TIME MANAGEMENT AND NETWORKING

The initiative EPT Women in Science creates opportunities for networking, professional development, and mentoring. One of several events was a time management and networking course provided by Catherine Lemaréchal.



Course instructor Catherine Lemaréchal gives a thumbs up along with the course participants at the department.

Photo: Kamila Krych

APPRENTICES AS PART OF OUR SOCIAL MISSION

Apprentices welcome: while our department is well used to taking on apprentices, this year broke the record with six apprentices in all. Four work in the lab and two with IT.



From the left: Marcus Klemetsen, Erik Larsen, Christer Schjølberg, Mikal Selbekk and Fredrik Fløttum. Not present: Hans Greger Lund.

Photo: Lars Konrad Sørensen

NEW MEMBERS OF PERMANENT ACADEMIC STAFF

During 2023, we welcomed two new members of our permanent academic staff at EPT: Ignat Tolstorebrov, Associate Professor in the Sustainable Energy Systems Group, and Corinna Schulze-Netzer, Associate Professor in the Thermo Fluids Group.



ENERGY WAS THE MAIN TOPIC OF THE NATIONAL SCIENCE WEEK

The National Science Week is a nationwide event held every year to make science and research available to the public.

During the National Science Week in October, FME HydroCen won the price for best stand at the Science Fair (Forskningstorget) in the city centre. The stand was titled “Where does the electricity come from”, and displayed both a miniature hydropower plant and different living organisms from typical rivers. On Researchers’ Night for secondary school students, EPT organised a tour in the Operation Room Lab and a board game playing event. Researchers affiliated with IndEcol had developed a board game to illustrate the trade-offs between renewable energy, power lines and local biodiversity.



Right photo:

Jonas Bergmann-Paulsen, Nils Solheim Smith, Vebjørn Opsanger (NINA), Olivia Simmons (NINA).

Photo: Juliet Landrø/FME HydroCen

Left photos:

Ignat Tolstorebrov and Corinna Schulze-Netzer on stage at EPT Day in November.

DEVELOPING AN INNOVATION CULTURE

Carlos Dorao, Professor and Head of the initiative Let's invent at EPT, explains the objectives of the initiative.

WHAT IS LET'S INVENT AT EPT, AND WHO IS IT FOR?

"Let's invent at EPT is a pilot project focused on the inventor's role for innovation and how to develop an innovation culture within the department. The first objective of the pilot project is to map the existing awareness, interest, and needs regarding invention, innovation, and entrepreneurship among PhD candidates and postdocs at EPT. Based on the response and identified needs, the second objective is to establish an Inventor-Innovation-Entrepreneurship community and provide them the elements to enable the community to grow."



Professor Carlos Dorao in the new social room in Strømningsteknisk: Navier & Stokes.

WHAT HAS HAPPENED SO FAR?

"During 2023, a series of lunch seminars were organised. During the seminars, Jonas Bergmann-Paulsen, Innovation Manager at FME HydroCen (hosted by NTNU), discussed different topics related to the innovation."

WHY IS THIS IMPORTANT?

"Part of our work is to seek new knowledge or to address a specific problem. Sometimes the progress is incremental, and a small step is followed by another one slowly addressing a large problem. However, sometimes a great leap can be achieved through an unexpected discovery or idea. This idea can be something that no one could have predicted or considered before. This pilot project focuses on this idea or discovery and the role of the inventor. The pilot aims to trigger awareness about potential discoveries or ideas in our everyday work and the steps and possibilities of such new ideas."

WHAT WILL BE THE NEXT STEP OF LET'S INVENT AT EPT?

"The next step for Let's invent at EPT has not yet been decided by the management. However, the idea is to organise a new series of seminars and visits from NTNU Technology Transfer AS (TTO) to the department."

EPTRAINING

MUSHROOM PICKING AND HIKE

EPTraining is great for meeting up and having fun with colleagues while training and being healthy. In the winter, we normally have ski training sessions, which are very popular. Running sessions, the St. Olavsloppet relay race from Österstund in Sweden to Trondheim and kayak courses keep us active in the Summer.



Photos by Bjørn Austbø, Jørgen Røst/PadleNorge, Hamed Pahlavan, Candy Deck.

HIKE TO ESTENSTADHYTTA CABIN



ST. OLAVSLOPPET RELAY RACE



SKIING



HANDBALL



KAYAKING



EPT TOWARDS 2025

EPT believes that the ongoing transition in society towards a sustainable future requires constant renewal of engineering knowledge, combined with interdisciplinarity, based on fundamental disciplines. To succeed in being relevant for research partners and students, we must continue to improve and develop our core activities and support functions.

We are striving to reach our goals put forward in EPT's Strategy towards 2025. These are tightly linked to the development goals of NTNU, which we have set out in the agreement with the Ministry of Education. The agreement outlines three main areas of development, under which 12 specific goals are defined. I am very pleased to see that EPT addresses all of these specific goals and that they are "in the green". For those marked in orange we still are in process to achieve our goals, and we have ongoing and specific measures to reach them within the timeframe.

While the traffic light status of the goals below says NTNU, we report for EPT's contributions:

NTNU WILL DEVELOP ITS ROLE AS A DRIVER AND PARTNER FOR SUSTAINABLE SOCIAL DEVELOPMENT

- 1. NTNU uses its main profile and academic breadth to train candidates with resilience and restructuring skills
- 2. NTNU strengthens the offer of lifelong learning
- 3. NTNU implements future technology studies and future HUMSAM studies
- 4. NTNU creates innovation, development and change through the use of research-based knowledge and new technology
- 5. NTNU will be a leading university for sustainability in its own operations

NTNU WILL DEVELOP ITS EMPLOYEES' SKILLS AND STRENGTHEN THE WORKING AND LEARNING ENVIRONMENT

- 6. NTNU works systematically to develop employees' skills and careers
- 7. NTNU strengthens the learning environment for students to facilitate increased learning and well-being
- 8. NTNU develops attractive campuses and infrastructure that contribute to an excellent learning and working environment and high academic quality

NTNU WILL DEVELOP AS A LEADING INTERNATIONAL UNIVERSITY

- 9. NTNU makes it possible for substantially more groups to establish themselves at a documented high international level
- 10. NTNU develops and strengthens collaboration and partnerships with internationally leading academic circles
- 11. NTNU develops and shares knowledge and technology to help meet global challenges
- 12. NTNU stimulates international mobility and recruitment that ensure diversity and quality

Read EPT's strategy for 2020 - 2025 here:



EPT's management group adopted a strategy for 2025, in 2020. It is based on NTNU's overall strategy.

Photo: Lars R. Bang/NTNU



NTNU

Institutt for energi- og
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