DEPARTMENT OF ENERGY
AND PROCESS ENGINEERING

NTNU

ANNUAL REPORT 2024

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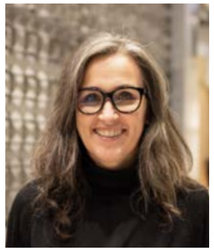


Terese Løvås
HEAD OF DEPARTMENT

Photo: Maren Agdestein / NTNU

The Department of Energy and Process Engineering (EPT) is one of 55 departments at NTNU and one of 8 at the Faculty of Engineering. Our department operates at the forefront of research excellence, focusing on a broad scope of disciplines, including sustainable energy systems, process optimization, thermos-fluid engineering, and industrial ecology.

2024 marked a year where EPT manifested its position in research, both nationally and internationally. The department now has four active European Research Council (ERC) grants for pioneering research, and we are involved in six new research centers for renewable energy (FME) co-funded by the Norwegian Research Council and industry, whereof two of them are in leading roles. In addition, a wide range of theoretical and experimental research is conducted across the entire breadth of topics within the department, including multidisciplinary research on different methods and tools for addressing sustainability challenges.

EPT shares the mission that, as part of a university, we deliver basic and applied research and educate outstanding graduates. EPT has a strong profile towards science and technology development within the energy and process sector and strives to have a significant impact internationally. Education remains at the core of our mission. We are proud of our students, whose enthusiasm and dedication inspire us daily. Our programs are designed to equip them with the knowledge and skills needed to excel in the rapidly evolving energy sector, ensuring they are well-prepared to make meaningful contributions to society.

Moreover, we place great emphasis on workplace ethics, nurturing an inclusive and respectful environment for all. Upholding these values is crucial, as they shape the foundation of our community and guide our interactions with one another and our external partners.

It is with pride that we present this yearbook, highlighting achievements from a remarkable year at the Department of Energy and Process Engineering.

I would like to thank all our employees for their continued aspiration to ensure that EPT still impacts NTNU on all key performance factors. The joint effort by our scientific, technical and administrative staff is key to achieving this. I hope that this annual report brings back good memories of proud moments in 2024. I would also like to thank all our research partners for the many ongoing and new projects. We look forward to continuing this path in 2025!

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

To the left:

Energized Aurora's on Classic NTNU
Photo: Meng Jiang / NTNU

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.

Illustration: SINTEF / NTNU / Oxygen

To the left:

Light trails in front of EPT
Photo: Meng Jiang / NTNU

OUR **MISSION**

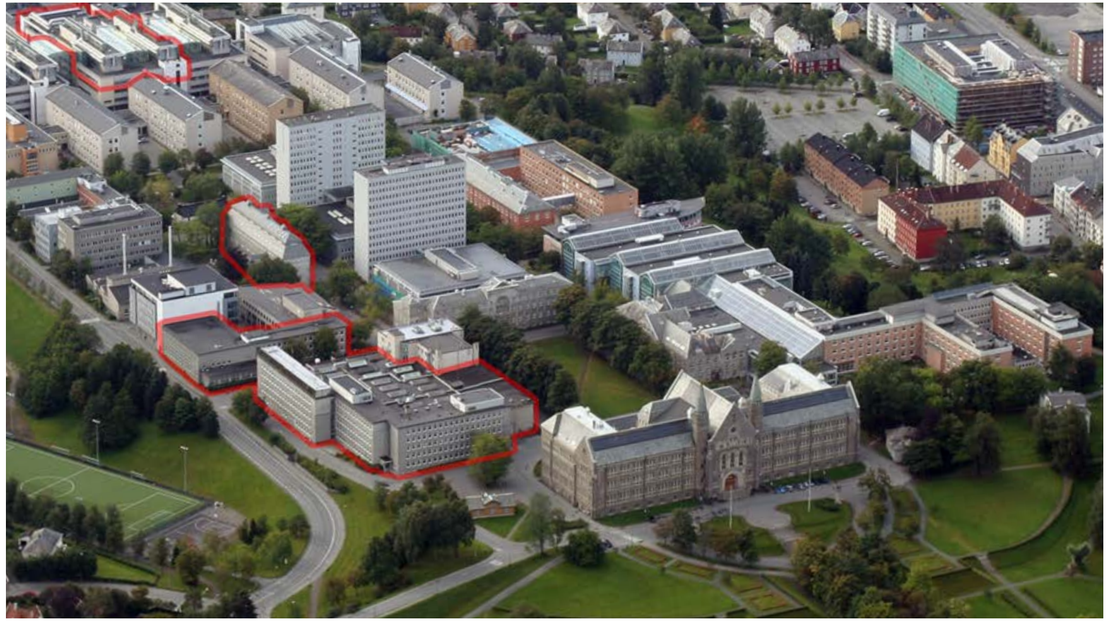
Our institute shares the mission of NTNU as part of the university, we educate outstanding graduates with strong analytical and practical abilities, and our research focuses on expanding knowledge in science and technology for a better world. Furthermore, EPT's mission is to contribute to Norway's role 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) that are relevant based on the research and educational activity at the Department: 2, 3, 6, 7, 8, 9, 11, 12, 13 and 15.

SUSTAINABLE DEVELOPMENT GOALS

EPT AT **NTNU**

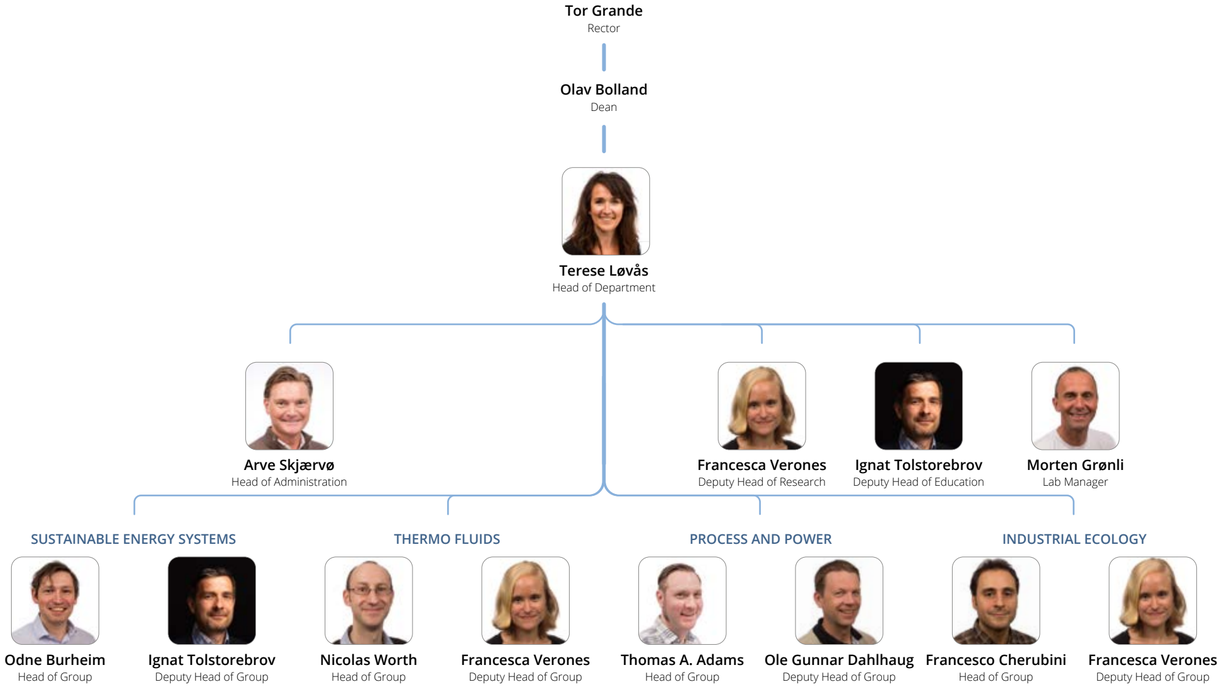
EPT is one of eight Departments at the Faculty of Engineering. There are eight Faculties at NTNU – Norwegian University of Science and Technology.



EPT is located in four different buildings across NTNU Gløshaugen campus

Original photo: Lars Strømmen / NTNU

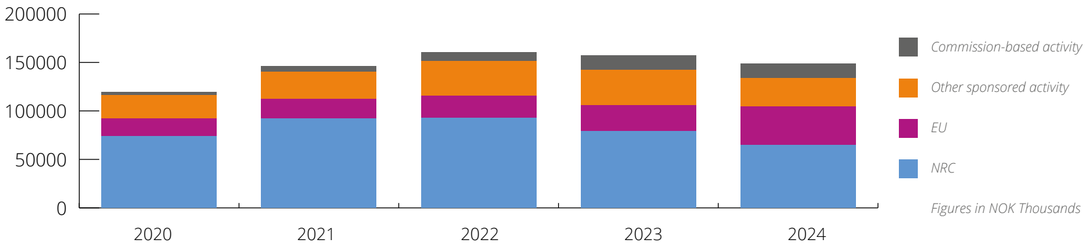
DEPARTMENT **ORGANIZATION**



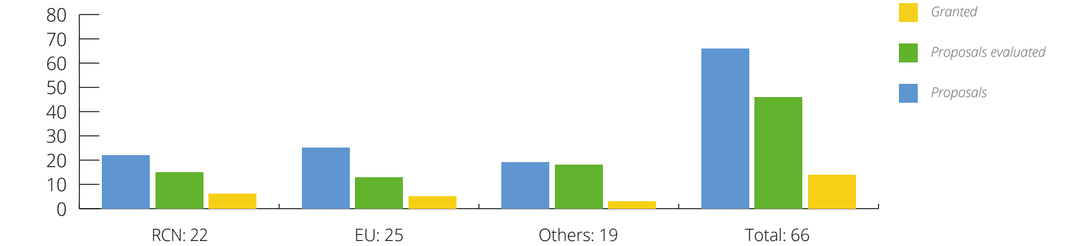
2024 IN NUMBERS

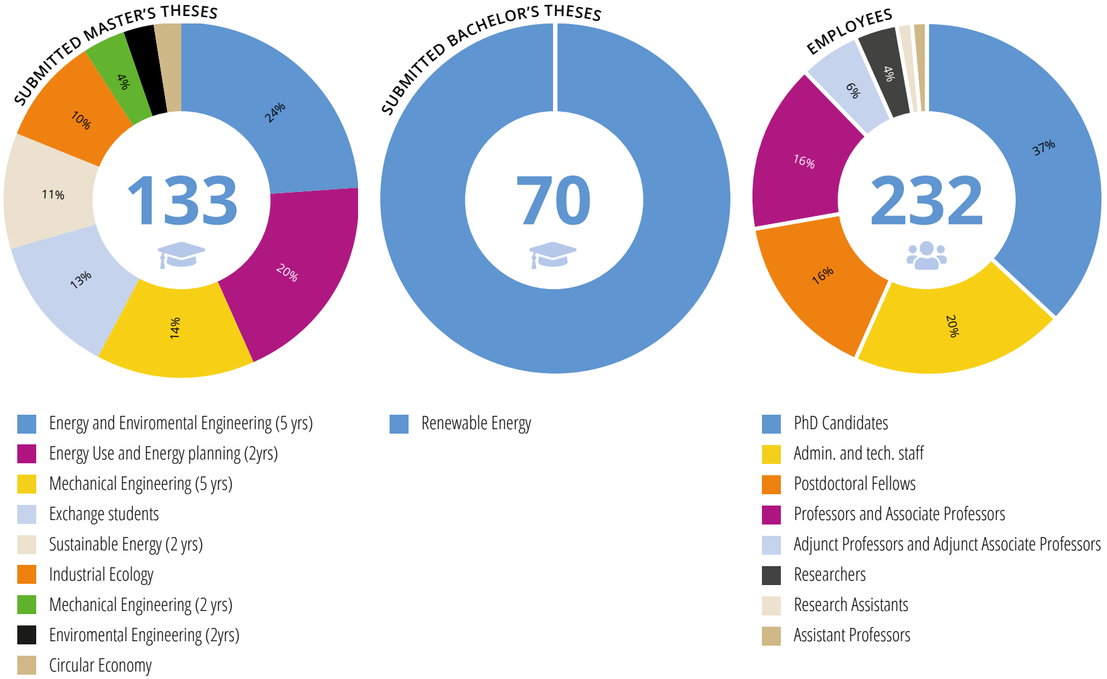
Projects where EPT receives funding from sources other than the grant from the Ministry of Education and Research will normally be defined as either sponsored or commission-based activities.

SPONSORED AND COMMISSION-BASED ACTIVITY – BOA (2020– 2024)



RESEARCH APPLICATIONS IN 2024:



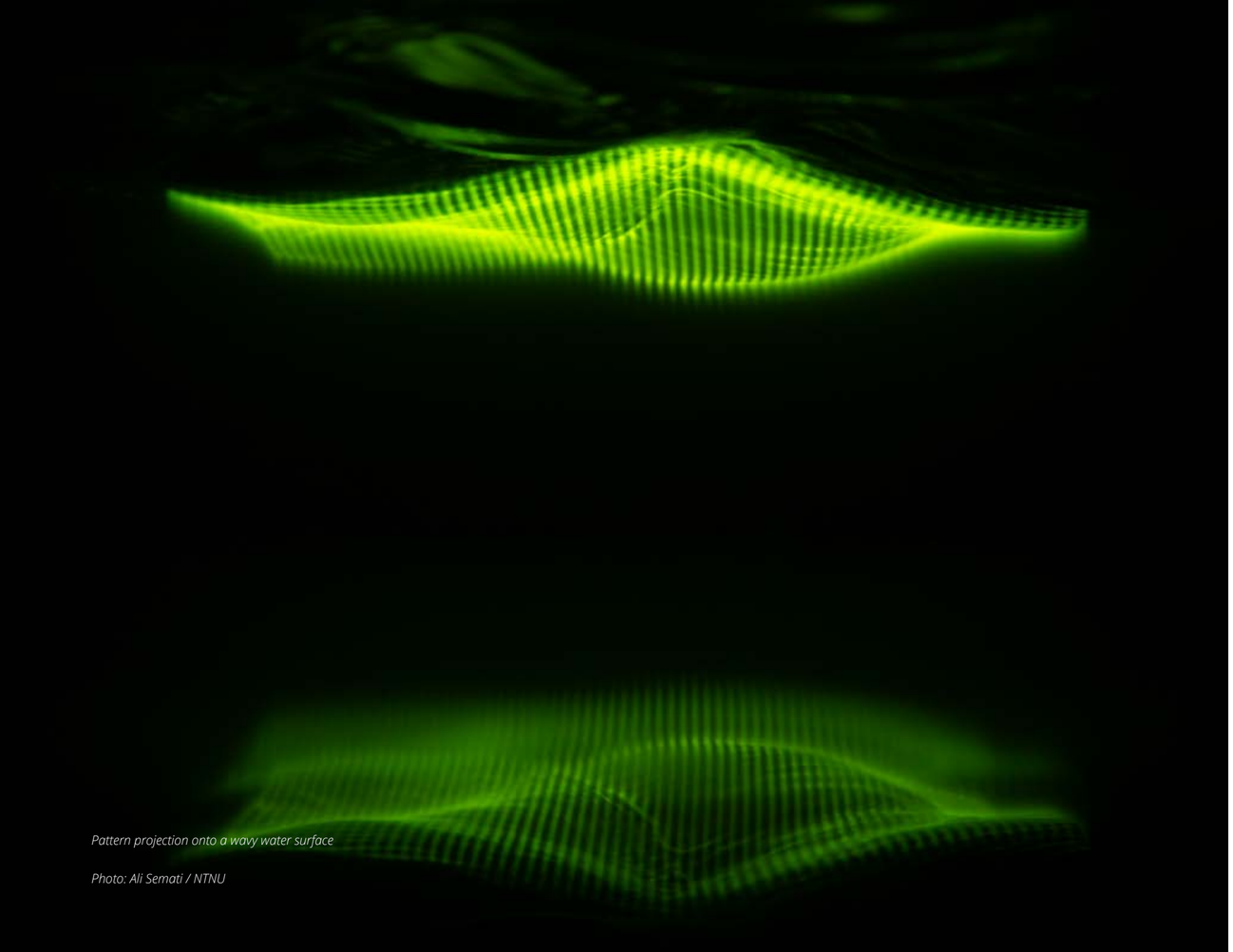


SUBMITTED AND DEFENDED **PHD THESES**

Number of defended PhD theses: 28

Research Group	Name	Title of Thesis	Supervisor
Industrial Ecology	Rasul, Kajwan	Energy in input-output modelling and its application to metals and food production	Hertwich, Edgar
IndEcol	Gilad, Dafna	Modelling biodiversity Impacts of renewable energy systems in Norway	Verones, Francesca
IndEcol	Klenner, Jan	Combating climate impacts and air pollution from the aviation sector: Advancing the understanding of the spatial distribution of present-day and future emissions	Strømman, Anders Hammer
IndEcol	Høiberg, Marthe Alnes	Towards inclusion of plastic pollution in Life Cycle Assessments: Impacts of entanglement from species to ecosystem quality level	Verones, Francesca
IndEcol	Kramel, Diogo	An integrated analysis of climate change mitigation strategies for the maritime sector	Strømman, Anders Hammer
IndEcol	Manjong, Nelson Bunyui	Sustainability Assessments of Battery Supply Chains Methodological Contributions and Application of Environmental. Footprint and Raw Material Criticality	Strømman, Anders Hammer
IndEcol	Akin, Sahin	Resource Use and Greenhouse Gas Emissions in Residential Buildings: Insights from Local Archetypes and Mitigation Scenarios in Western Asia and Northern Africa	Edgar Hertwich
IndEcol	Simoni, Mark Uwe	Monitoring the Physical Economy: Integrating Geological and Anthropogenic Systems	Daniel Beat Müller
Processes and Power	Gans, Luiz Henrique Accorsi	Design study of a reversible lobe pump turbine for low-head seawater pumped hydro storage applications	Trivedi, Chirag
PP	Motamed, Mohammad Ali	Assessment of alternative concepts for improved gas turbine operation under varying loads in decarbonized energy systems	Nord, Lars
PP	Skjervold, Vidar Torarin	Flexible Operation of Thermal Power Plants With Moving Bed Temperature Swing Adsorption Post Combustion CO2 Capture	Nord, Lars
PP	Dagsvik, Helene Njølstad	Transforming conventional hydropower plants into pumped storage by turbine replacement	Storli, Pål-Tore og Lamb, Jacob
PP	Saeed, Muhammad Zahid	Development and validation of CO2 cooling systems with expansion work recovery	Hafner Armin
PP	Auliano, Damiano	Heat and flow mechanisms in a passive geometrical cooling device	Erling Næss
PP	Kelele, Hailay Kiros	Aerodynamic and Structural Analysis of Wind Turbine Blade: Mitigation Extreme Wind Loads and Applying Single-Blade Design Concept for Structural Integrity Enhanced Performance and Cost Efficiency	Torbjørn Nielsen
Sustainable Energy Systems	Annaqeeb, Masab Khalid	Energy-related occupant behavior in buildings: Approaches for monitoring and modelling	Novacovic, Vojislav
SES	Heide, Vegard	Towards Simpler and More Affordable Heating and Ventilation Systems for Deep Energy Retrofit of Norwegian Detached Houses	Georges, Laurent
SES	Solberg, Simon Birger Byremo	Understanding Transport Phenomena in Membrane Systems for Waste Utilisation: Electrodialysis Concepts for Waste Heat to Hydrogen and Lithium-Ion Battery Recycling	Burheim, Odne
SES	Zimmermann, Pauline	Electrodialysis for Resource Recovery and Removal of Impurities in Hydrometallurgical Processes	Burheim, Odne
SES	Larkermani, Elyas	Development of a Framework using Orthogonal Grids and Immersed Boundary Methods for Large Eddy Simulation of Indoor Airflows	Georges, Laurent
SES	Bi, Yang	Energy efficient airflow distribution methods for surgical microenvironment control in operating rooms	Cao, Guangyu
Thermo Fluids	Asadi, Masoud	Exploring Turbulence - Turbulence Interactions: Impacts of Incoming Turbulence on Wall-Bounded Flows	Hearst, Jason
TF	Zheng, Zibo	Weakly nonlinear surface waves on vertically sheared currents	Ellingsen, Simen Ådnøy
TF	Weichert, Stefan	Error Sources in Wave-Based Remote Sensing and Free-Surface Synthetic Schlieren	Ellingsen, Simen Ådnøy
TF	Yahou, Tarik*	On the Effect of H2-enrichment on the ignition dynamics of lean premixed flames	Dawson, James
TF	Aligolzadeh, Farid	Studies of turbulence in a von Kármán swirling flow	Dawson, James
TF	Zhang, Wenjing	Droplet mobility and impacting dynamics on superhydrophobic surfaces	Fernandino, Maria
TF	Alvarez, Gonzalo Almanza	Cell Lysis via Surface Acoustic Waves (SAW)	Carlos Dorao

**cotutelle, defence in Toulouse.*



Pattern projection onto a wavy water surface

Photo: Ali Semati / NTNU

THERMAL **ENERGY** AND FLUID MECHANICS

RESEARCH GROUP THERMO FLUIDS (TF)

"The Thermo Fluids group performs fundamental and applied research in a range of topics within the fields of fluid dynamics and thermal energy", says Nicholas Worth, Head of Research Group. *"The research is both theoretical, computational and experimental, and the group has state-of-the-art laboratory facilities in fluid mechanics, aerodynamics and combustion. Our research helps address major societal challenges in energy, sustainability, transport, health and the environment."*

Ongoing major research projects and affiliated centres	Responsible
AMAZE	Terese Løvås
Climit Demo project BigH2 phase 4	Dawson, James Richard
FME Bio4Fuels – Norwegian Centre for Sustainable Bio-based Fuels and Energy	Terese Løvås
FRIC	Ivar Ståle Ertesvåg
FRIPRO Toppforsk: Unraveling the mechanisms controlling droplet growth dynamics during condensation on micro-patterned surfaces	Maria Fernandino
GLITR	Jason Hearst
HighRec_High-Temperature Gasification for Material Recycling of Municipal Plastic Wastes	Corinna Schulze-Netzer
HYROPE	Dawson, James Richard
InMyWaves	Jason Hearst
InsigH2T	Dawson, James Richard
Low Emission Research Center	James Dawson
Reheat2	Jonas Moeck
reSail	Jason Hearst
PUSCO	Maria Fernandino
STA Stability through asymmetry Frinatek	Nicholas Worth
WaTurSheD	Simen Ellingsen

Nicholas Worth
HEAD OF RESEARCH GROUP

Photo: Thor Nielsen / NTNU

STUDENTS ARE CURIOUS ON NUCLEAR ENGINEERING

Students at EPT are asking more and more for specializations and courses on nuclear engineering.

By the end of 2024, 4 master students were working on their thesis on topics of nuclear engineering, and 7 bachelor students were ready to start their thesis on the same area at our department.

"For this, the students learn during dedicated seminars the fundamentals of nuclear physics, neutron physics, nuclear reactor physics and nuclear thermohydraulic, in addition to research methodologies for dealing with multidisciplinary work", tells Carlos Alberto Dorao, Professor at EPT who teaches the subjects.

The theses focus on the design of nuclear reactors from the neutronics and thermohydraulic point of view, and for this, the students also need to learn the use of special software packages.

DANCING PLASTICS AT SCIENCE IS WONDERFUL! PUBLIC FAIR

Demonstrating the critical issue of plastic pollution in our oceans

Dr. Yi Hui Tee and Professor R. Jason Hearst in the Thermo-fluids group were highlighting the issue of plastic pollution in our oceans with an engaging booth at Science is Wonderful! public fair (Belgium, April 2024).

They demonstrated their work on how turbulence affects the transport of plastics across our oceans, tracking the motion of plastic particles in ocean-like flows. Their booth attracted more than 100 school groups and other visitors, sparking curiosity and raising awareness about this environmental challenge. The science booth was also presented to the public in Trondheim during the Forskningstorget in September 2024, with the help from Dr. Olav Rømcke, Dr. Håkon Tormodsen Nygård, Petter Rikheim Benonisen and Emilie Hjorth.

Tee's Marie Skłodowska Curie Actions (MSCA) post-doctoral fellowship project, InMyWaves was selected to be presented to the general public, thanks to funding from the European Commission.

On the left:

MSc and Bachelor students attending the nuclear engineering training.

Photo: Carlos Alberto Dorao / NTNU.

On the right:

Dancing plastics with Yi Hui Tee and Jason Hearst.

Photo: The Science is Wonderful! team

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."*

Ongoing major research projects and affiliated centres	Responsible
BAMBOO – Biodiversity and trade: mitigating the impacts of non-food biomass global supply chains	Francesca Verones
CircEUlar – Developing Circular Pathways for an EU Low-Carbon Transition	Anders Hammer Strømman
FME NTRANS – Norwegian Centre for Energy Transition Strategies	Edgar Hertwich
HiTEA – High Throughput Environmental Assessment Pipeline	Konstantin Stadler
ICARUS – International cooperation for sustainable aviation biofuels	Francesco Cherubini
LASTING – Sustainable prosperity through product durability	Johan Berg Pettersen
WOODSTOCK	Daniel Beat Müller

Francesco Cherubini
HEAD OF INDUSTRIAL ECOLOGY PROGRAMME

Photo: Titt Melhuus / NTNU

ARE WE MOVING IN THE RIGHT DIRECTION?

Research from EPT shows that we are throwing away and burning more waste that could easily be recycled.

After over two years of research on the Norwegian waste management system for households, researchers managed to quantify the flow of around 93% of the municipal solid waste in 2009 and 2019. During this period, new regulations and policies at national and EU levels aimed to shift waste management towards a circular economy.

THE GOAL OF CIRCULARITY

The basic idea of circular economy is to use resources efficiently - getting the same or more service with less resource input and redirecting waste back into material production. Or, if the material is too degraded or contaminated, we can recover the energy through incineration.
Waste management is a key part of the circular economy, so to what extent does our current system succeed in providing circularity? Also, what are the environmental impacts of the waste system and its development?

INCINERATION RATHER THAN RECYCLING

Researchers used material flow analysis and life cycle assessment to examine changes in the main types of waste and their treatment. They studied the flow and impact of incineration, transportation, material processing, and landfilling of waste.

The results show that the system has changed to comply landfilling bans introduced in 2009. However, the change is not towards more material recovery but rather towards waste incineration.

"While incineration is better than landfilling, we found that 50-55% of the waste going to incineration could potentially be recycled. In terms of transitioning towards a circular economy, we see that the recycling rate has not really changed, while the incineration of waste has increased from 49% to 65%", explains Kim Rainer Mattson, researcher at EPT.

THE NEED FOR TRANSPARENCY AND ACTION

The researchers emphasize the need for more transparency in the sector regarding treatments, consistent emission accounting, balanced waste flows, and the tracking of critical minerals such as phosphorus. These points did not enjoy as much media attention as the always engaging question 'Does recycling even work?'.

"This is a problem we have created and for which we must take responsibility. We also need to consume less and recycle more", concludes Mattson.

Mattson is researching what happens to our trash after we dispose of it.

Photo: Sølvi W. Normannsen, Gemini, NTNU

THE WORLD'S FIRST MOOC ON ALUMINIUM

What role did aluminum play throughout human history, and what role could, and should it play in the future?

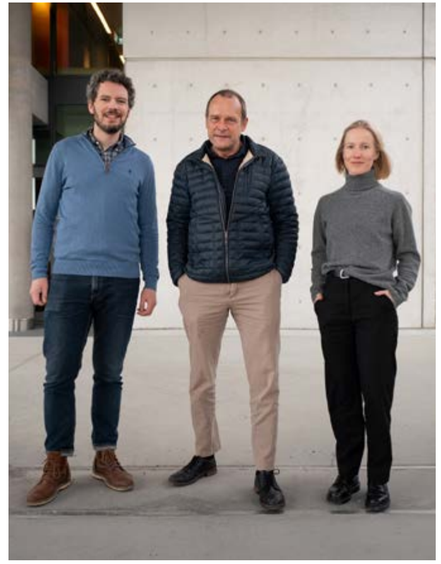
Answering these questions is essential for sustainable development, but it requires knowledge and skills on different aspects of the aluminum value chain and society. A new MOOC, or online course, aims to address this.

"To make knowledge about aluminum easily accessible, we have developed the world's first MOOC on aluminum: "Aluminum Unveiled: A Comprehensive Journey from History to Sustainability", together with Padua University and coordinated by the European Aluminum Association (EEA). The course provides the knowledge and tools to inspire and prepare learners to contribute to a greener, more innovative future for aluminum", says Daniel Beat Müller, Professor at the Industrial Ecology Programme (IndEcol).

The five-week course combines academic expertise with real-world insights. It features engaging content such as exercises, articles, video lectures, and interviews with industry experts. The course provides participants with a thorough understanding of aluminum's history, properties, production processes, and applications across key sectors such as automotive and mobility, building and construction, packaging, and engineering.

The course also explores aluminum's role in sustainability, examining challenges in decarbonizing its production process and its contribution to reducing emissions in other sectors. Participants will learn about the importance of recycling, the potential of urban mining, and the technologies driving efficiency and innovation across the aluminum value chain.

The MOOC is designed to cater to a wide audience interested in aluminum and is since December 2024 available for free on FutureLearn.



People who worked on the MOOC, f.l. Romain G. Billy, Daniel B.Müller and Jonna Ljunge.

Photo: Nils Maximilian Dittrich / NTNU.

BOARDGAME: WHO IS BEST AT SOLVING THE ENERGY ISSUE?

Step into the shoes of an environmental engineer with "Wildlife, Watts & Wires", a captivating board game developed by the Industrial Ecology Programme in Professor Francesca Verones' group. Your mission is to generate enough electricity for a bustling city while minimizing climate and biodiversity impacts.

WHO'S UP TO THE CHALLENGE?

The board game features a city and 99 landscape tiles, representing diverse ecosystems like forests, mountains, meadows and water. These tiles are home to various species, ranging from least concerned to critically endangered.

Each round, you'll strategically build power infrastructure, consisting of wind power plants, hydropower plants, solar power plants and fossil power plants, as well as powerlines to ensure the city stays powered up.

The idea was born within the CONSENSE project (led by Dafna Gilad) and expanded to the FIREPLUG (Jan Borgelt), SusHydro (Sif De Visser) and ATLANTIS (Philip Gjedde, Martin Dorber) projects for NTNUs Researchers night in 2023, to have a tangible product to showcase the effect of energy on the environment. Encouraged by the feedback of the Researchers night and winning the creative abstract competition at the 2023 conference of the International Society for Industrial Ecology, we decided to print the boardgame in 2024.

Developers of the boardgame f.l. Jan Borgelt, Martin Dorber, Dafna Gilad and Philip Gjedde. Missing are Sif de Visser and Francesca Verones.

Photo: Francesca Verones / NTNU.

FROM HYDROGEN AND BATTERIES TO BUILDINGS

RESEARCH GROUP SUSTAINABLE ENERGY SYSTEMS (SES)

The Sustainable Energy Systems group works on integration of energy systems.

"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", says Odne Burheim, Head of Research Group.

"I'm very proud of a major achievement for our group in 2024, as the Research Council of Norway awarded us with FME Battery for eight years together with IFE. This is a new centre for environment-friendly energy research, where we will seek to bring together Norway's battery environment, both in research, education and industry", Burheim explains.

Ongoing major research projects and affiliated centres	Responsible
CellMap	Odne Stokke Burheim
ChinoZen	Vojislav Novakovic
DIGG MIN SKOLE	Guangyu Cao
DREAMS	Odne Stokke Burheim
FME Battery	Odne Stokke Burheim
FME ZEN	Laurent Georges, Hans Martin Mathisen
ENTRANCE	Natasa Nord
HeaLiSelf	Steven Tyler Bones
HumanIC	Guangyu Cao
KeyTech-NeVe-ChiNo	Odne Stokke Burheim
More is Less	Odne Stokke Burheim
NorGiBatF	Odne Stokke Burheim
POSIred	Guangyu Cao, Hans Martin Mathisen
TRAINING (CET)	Natasa Nord

Odne Burheim
HEAD OF RESEARCH GROUP

Photo: Thor Nielsen / NTNU

SUSTAINABLE ENERGY TRANSISTION OF BUILDINGS

Enabling smart-grid ready building through integrated solutions and digital technologies: ENTRANCE

This summer, July 2024, we got the excellent news that we are funded a Horizon Europe project, ENTRANCE. The project will work to advance sustainable solutions for the built environment through cutting-edge research and innovation. Buildings are at the heart of the energy transition, and ENTRANCE is set to redefine their role in the energy system!

WHAT MAKES ENTRANCE UNIQUE?

- Smart-grid ready buildings that interact with the energy system in real time
- Digital solutions to optimize energy use and flexibility
- End-user engagement for a more active role in the energy market
- Sustainability and efficiency at the core of our approach

The aim of ENTRANCE is to enable smart-grid-ready and decarbonized buildings through the integration of energy efficiency, flexibility, on-site renewables, mobility, empowerment of end-users, and interoperability between buildings and district heating and electricity grids.

The ambition of ENTRANCE is to develop and demonstrate solutions that promote building integration and active participation in the energy system and market through guaranteeing end-users' comfort and empowerment while creating value for the economic actors of the energy landscape.

ENTRANCE is bringing together a strong and diverse consortium of leading universities, research centers, and industry experts from across Europe. The total project budget is about 5 mil EUR. Professor Natasa Nord from EPT is the scientific coordinator.

The illustration shows energy interaction among new and existing buildings to enable the sustainable energy transition.

Illustration: REHVA for the ENTRANCE project

EPT AT RESEARCHERS' NIGHT

Researchers' Night at NTNU had its 20th anniversary this year and was a success with around 1,000 young people at Realfagsbygget.

GOOD CLIMATE AT EPTS OPERATING ROOM

A good indoor climate in an operating room is critically important for achieving good results during demanding interventions. Indoor climate is a collective term to explain how air quality, temperature and humidity contribute to human health. In EPTs operating room, we test various ventilation solutions to obtain optimal air flow and temperature distribution, to achieve the best possible conditions for surgery.

"We had six groups of young people attending our presentation of EPTs operating room at Researchers' Night. I shared an engaging simulation video, including results related to the implementation of extended reality (XR) and the ventilation systems. VR is used as a tool for analyzing airflow and temperature distribution", says Mohammad Shakerin, Assistant Professor at EPT.

"A big thank you to Guangyu, Tomas, and Hans Martin for assisting in preparing for the demonstration, and Elyas and Thomas for their contribution to the demonstration of EPT's operating room".

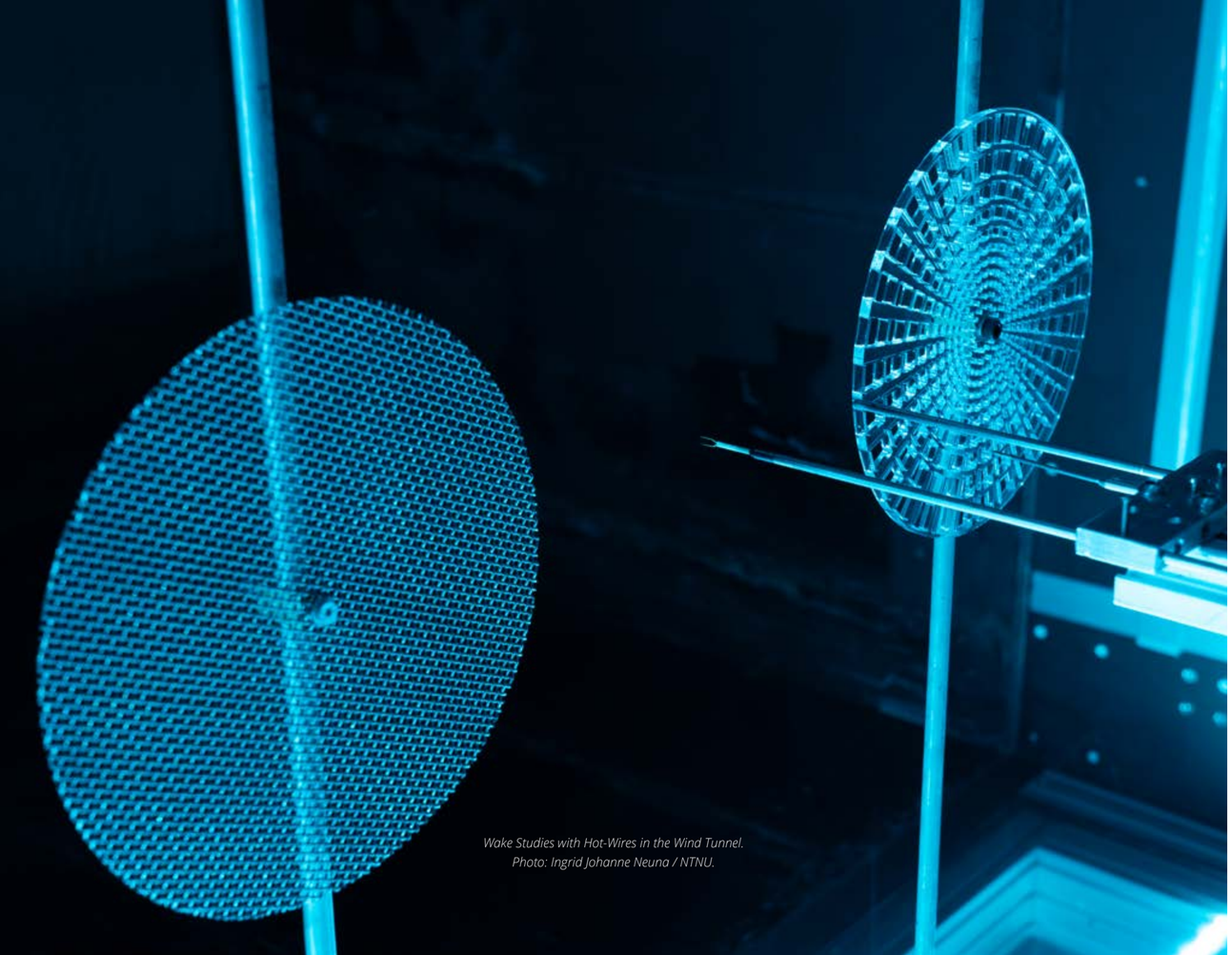
"This is the second year I have participated at Researchers' Night, and it was a fantastic experience", says Elyas Larkermani, PhD candidate at EPT.

Mohammad demonstrating EPTs operation room at Researchers' Night.

Photo: Elyas Larkermani / NTNU

F. l. Mohammad Shakerin and Elyas Larkermani.

Photo: Khalid Hamid / NTNU.



Wake Studies with Hot-Wires in the Wind Tunnel.
Photo: Ingrid Johanne Neuna / NTNU.

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."*

Ongoing major research projects and affiliated centres	Responsible
ALPHEUS	Chirag Trivedi
CO2FFER	Armin Hafner
Digital Twin	Lars Eirik Bakken
EnergyNet (NORHED II)	Ole Jørgen Nydal
FME HighEFF – Centre for an Energy Efficient and Competitive Industry for the Future	Truls Gundersen
FME HydroCen	Liv Randi Hultgreen
FME RenewHydro	Liv Randi Hultgreen
NTNU-MIT_Equinor Energy Research Programme	Thomas A. Adams II

Thomas Alan Adams
HEAD OF RESEARCH GROUP

Photo: Maren Agdestein / NTNU

ACADEMIC LECTURES IN JAPAN

EPT was invited to give academic lectures at the Nagoya Institute of Technology (NIT) in December, as a part of an ongoing collaboration with the research group of Professor Iwamoto and development of academic mobility between NTNU and NIT.

Dmytro Konovalov, post doc. at EPT, held a lecture about hydrogen technology, modern trends, strategic insights, and the path to a sustainable future. Ignat Tolstorebrov, Associate Professor at EPT, lectured about integration of high-temperature heat pumps in the industrial processes. Both in the framework within the research projects: "IntER-Cold project: Interdisciplinary Education and Research Platform (Norway-Japan)" and "Liquid Hydrogen: Eco-techno-economic analysis and optimization of liquid hydrogen value chains".

During the stay at NIT, there were also meetings with local researchers and students and several tours of the labs, including the lab of hydrodynamics and fluid mechanics and the lab of hydrogen technologies. It was agreed on a continued collaboration with the research group of Professor Iwamoto among others.

Professor Iwamoto, his daughter Nino and PhD candidate Argeena Agao-Agao together with Dmytro and Ignat. Photo: Yuhiro Iwamoto

WORKING WITH AFRICAN UNIVERSITIES ON ENERGY TECHNOLOGY

EPT has been the driver for the collaboration with a group of African universities on renewable energy technology through a series of NORAD, NFR and EU funded projects since 2007.

The collaboration has resulted in 5 new master programs, many MSc, more than 30 PhD graduates and the exploration of a number of small-scale renewable energy components for Distributed Energy Systems. Our focus has been on solar thermal (heat storage for cooking, frying and baking), hydropower (pumps as turbines), wind power (wind to heat) and solar refrigeration (adsorption systems).

In May 2024 we organized a workshop with the 10 partner universities in Ethiopia, Tanzania, Uganda, South Sudan, Malawi and Mozambique. The weeklong event was coordinated with 3 projects and with a 3-month research visit of 6 PhDs to NTNU.

THE THREE PROJECTS

- **Erasmus+**: University Network on PhD Programs in Energy Technology (2021-2024, Ethiopia, Tanzania, Uganda, Mozambique, Italy). Joint development of PhD courses relevant for Energy Technology.
- **NORHED II**: Energy Technology Network (2021-2026, Ethiopia, Tanzania, Uganda, Mozambique, Malawi, South Sudan) Small scale renewable energy technology development and implementation.
- **NORPART**: UDSM-NTNU Mobility Program in Energy Technology (2019-2024, Tanzania). Exchange of students and staff at UDSM and 4 departments at NTNU.

PhD students and staff gathered during the workshop at Varmeteknisk laboratories, NTNU in May 2024.

Photo: Nice colleague.

A SUSTAINABLE COLLABORATION BETWEEN NTNU AND KATHMANDU UNIVERSITY

The collaboration between NTNU and Kathmandu University (KU) has developed significantly over the years, particularly in the fields of engineering and hydropower technology, with support from Norad and the Norwegian Embassy in Nepal. Initiated in the early 1990s by Rector Inge Johansen, this partnership has led to the creation of numerous educational programs, research projects, and laboratories. Today, it is a sustainable collaboration with multiple ongoing research projects.

TURBINE TESTING LABORATORY IN KATHMANDU

EPT's collaboration started with Professor Arne Kjølle in 1999. He initiated the idea that KU should develop a Turbine Laboratory on their campus in Dhulikhel, and he motivated young teachers at KU to study at NTNU.

The first PhD-graduate, Bhola Thapa was supervised by Professor Hermod Brekke and defended his PhD in 2004. Bhola Thapa's research during his PhD-study was sediment erosion in hydro turbines, a critical issue for the operation and maintenance of hydro power plants in the Himalayas. Thus, this became the main topic for the collaboration with EPT and the planning of the Turbine Testing Laboratory (TTL) at KU.

DEVELOPMENT OF TURBINE DESIGN

The development of hydro turbines that can withstand sediment erosion has been the main topic of research since Professor Ole Gunnar Dahlhaug started his collaboration with KU in 2003. Over the years, many different designs and innovations have been tested at TTL, and in 2024, KU's own turbine-design was finalized. A high-quality model-turbine was manufactured, and laboratory testing at TTL will commence in spring 2025, marking a milestone that we are very proud of!

These turbines will have 5 times longer lifetime than today's turbines. The aim is to produce these turbines in a spin-out company from KU.

A VERY GOOD PARTNERSHIP FOR YEARS TO COME

TTL was finalized in 2011, and today 5 professors at KU have been given their PhD-degree from EPT. Bhola Thapa has been the vice chancellor of KU for 4 years, and he has been a good ambassador for NTNU who always promotes collaboration. KU was a research partner in FME HydroCen, and is now a partner in RenewHydro. A partnership that started in 1999 will continue for many more years to come.

On the left:

Students and staff at TTL.

Photo: Unknown for Ole G. Dahlhaug / NTNU

On the right:

Professor Chirag Trivedi in the Waterpower Laboratory at NTNU.

Photo: Maren Agdestein / NTNU

ORGANISATIONAL **STORIES** & **MOMENTS**

TIME TO CELEBRATE NEW FME CENTRES

It was time to celebrate when the Research Council of Norway awarded new Centres for Environment-friendly Energy Research (FME) in April 2024.

EPT will host and coordinate FME Battery and FME RenewHydro and be involved in as many as four others of the new research centres: FME ZeMe (Zero Emissions Metal Production), FME MarTrans (Norwegian R&D centre for Maritime Energy Transition), FME gigaCCS (Norwegian Research Centre of Excellence for Carbon Capture and Storage) and FME Interplay (Integrated Hub for Energy System Analyses).

NEW RESEARCH AND NEW SOLUTIONS FOR A BETTER WORLD

"We are incredibly proud to be involved in so much of what is happening around these FMEs! The activity will be stepped up with many new PhDs, representing the broad spectrum of research in our department", says Terese Løvås, Head of Department

The FMEs ensure funding for long-term research into environmentally friendly energy, and a close and direct collaboration between research institutions and the working world that will put the knowledge to use. The centres will solve key challenges in the energy and climate area and strengthen the innovation capacity of Norwegian business by providing new knowledge, new technology and new solutions, so that we can realize a low-emission society.

FME RenewHydro and FME Battery at the official marking of the new FMEs.

Photos: Thomas Keilman / The Research Council of Norway.

FME Battery

FME Battery will conduct research, technological innovation and education for the next generation and improved circular sustainable battery technology value chain.

"Gathering Norwegian research and education institutions from west to east, north to south, alongside 35 different enterprises, and for NTNU to host such a center is remarkable and valuable. As deputy head of the centre, I am of course very proud of this achievement, as well as very grateful for the opportunities it provides for the next 8 years", says Professor Odne S. Burheim at EPT.

FME RenewHydro

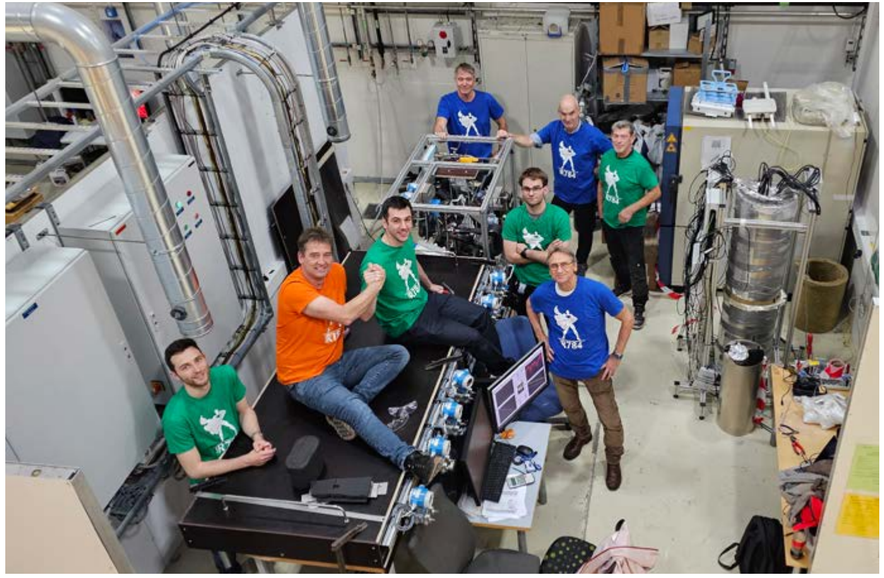
RenewHydro aims to develop knowledge and solutions that enable flexible hydropower to support the realization of energy transition and achieve national energy, climate, and environmental goals.

The new centre combines cutting-edge science with deep insight provided by user partners as we develop Norwegian hydropower and contribute to more sustainable renewable energy!

RenewHydro continues and expands the research efforts from FME HydroCen (2017-2024).

WORLD NEWS AT EPT, -82°C COOLING WITH KRYPTON (R784)

After several years of theoretical calculations and the construction of the world's first cooling system using Krypton as the working fluid, researchers at EPT managed to conduct laboratory experiments. With only the noble gas krypton in a customized vapor compression process, we can demonstrate how future cooling systems at CERN can be designed and operated at temperatures around -82°C.



On the picture from right to left (clockwise):

Lukas Köster (NTNU), Bart Verlaat (CERN), Luca Contiero (NTNU / CERN), Håvard Rekstad (NTNU), Armin Hafner (NTNU), Reidar Tellebon (NTNU), Marius Døllner, and Paolo Petanga (CERN).

Photo: Unknown student / NTNU

STUDENT EXCURSIONS TO ITALY

The main student excursions of the year were trips to Italy in March, featuring a blend of academic content and cultural experiences.

"Excursions like this are meant to broaden the academic horizon and may create memories that last", says Bjørn Austbø, Associate Professor at EPT.

We had one excursion with 97 students from the Energy and Environmental program, visiting among other places, the waste management company Herambiente, the Ferrari Museum, Politecnico di Milano, and the railway company Alstom.

We also had a trip of 68 students from 3rd year Mechanical engineering program together with Associate Professor Ignat Tolstorebrov. The students visited Polytechnic University of Turin and Joint Research Centre of European Commission where they observed green and energy efficient technologies for the building sector.

The visit to the research facilities was supported by industrial excursions to: Hexagon company, specialized in the construction of industrial systems usually based on the use of lasers for engraving, welding and measurement, Petronas Global research and Technology Centre - a world-class facility, equipped with advanced laboratories, equipment and facilities to develop lubricants for both the domestic car and motor racing, and LU-VE Group, the third largest operator in the world and second largest in Europe in the production of air heat exchangers.

Top:

From the tour of the Ferrari Museum in Modena.

Bottom:

The students visited Herambiente, an Italian waste management company.

Photos: Bjørn Austbø

GEORGES AND MOECK PROMOTED TO FULL PROFESSOR POSITIONS

We congratulate Professor Laurent Georges and Professor Jonas Moeck on their promotion to full professor positions at EPT.

WORLD MENTAL HEALTH DAY WITH EPT

We need to talk more, spend eight minutes each day talking to someone to combat loneliness and exclusion was the campaign's theme for 2024.

At EPT we invited employees and guests for a walk around Campus followed by a gathering inside at Navier & Strokes to eat and listen to a speech by Arve Skjærvø, our head of administration. Skjærvø highlighted the important message of the campaign throughout his speech: Take the time to care about your colleagues – you matter and can do a difference!

World Mental Health Day is a nationwide campaign that aims to raise awareness about mental health.

Left:

Professor Laurent Georges at EPT Day 2024.

Photo: Per Henning / NTNU.

Right:

Walk around Gløshaugen in lovely autumn colors.

Photo: Pia Johansen / NTNU.

LIVE FROM THE CLIMATE NEGOTIATIONS IN BAKU

This year, the UN Climate Conference, COP29, felt much closer. Professor Anders H. Strømman from EPT reported directly from Baku during EPT Day and he also participated in virtual meetings with several high schools in Trondheim.

Strømman explained to the students what COP29 is, what has happened at the meetings this year, what is being discussed, and what agreements are being sought. The students asked a lot of questions both during and after the sessions.

"It is important to engage people in what happens at the climate summit", says Anders Hammer Strømman.

The feedback from the schools was overwhelmingly positive, praising it as a brilliant initiative! We hope this also reflects their environmental commitment in general.

Strømman also contributed articles in both Gemini and Adresseavisen about COP29. COP29 was primarily about financing so that poor countries can get financial help to switch to renewable energy.

Left photo:

Anders H. Strømman talking with Thora Storm in Trondheim by Teams.

Photo: Annika Bremvåg / NTNU.

Right photo:

Head of Department Terese Løvås is having a good time with Yuhiro Iwamoto, keynote speaker at EPT Day 2024.

Photo: Per Henning / NTNU.

EPT DAY - ANNUAL TRADITION

EPT Day has evolved into an annual tradition with a seminar on future-focused research, education and green career paths gathering employees, students and alumni at Kjelhuset, NTNU.

It is a good place to learn what is going on in the Department and get to know each other!

Professor Yuhiro Iwamoto from the Nagoya Institute of Technology (NIT) in Japan was the keynote speaker of EPT Day 2024.

GENDER AND EQUALITY AT EPT

EPT Woman in Science (WiS) iniative creates opportunities for networking and professional development at the department.

2024 saw the WiS mentoring programme running for the third time, where colleagues are paired up to share experiences of working in academia. WiS also organized lunch seminars with topics ranging from NTNU LGBTQ+ community, menstrual cycle, research grant application, career path in academia and a workshop on mental fitness.

This year WiS invited to our first department level event, EPT Roundtable - Diversity, Equity and Inclusion with external guest speakers and discussions with the audience.

During the Have Fun and Help the Planet clothing swap event in August, we learnt about sustainable fashion from Kamila Krych (IndEcol) while getting some new old clothes.

REPORT ON GENDER AND DIVERSITY

"WiS had a fruitful and fun year of 2024, and we ended the year with a Christmas get-together party where games, food and drinks were enjoyed", says Qiaoqiao Wang, WiS organizing committee.

The Department also got a report on Gender Balance and Diversity at EPT, that aims to assess the current state of diversity and inclusion at EPT and to identify the areas and strategies for improvement. The report is written by PhD candidate Martine Sletten from Department of Interdisciplinary Studies of Culture (KULT) at NTNU.

WiS at Xmas get together 2024

Photo: Unknown student / NTNU.

DANCING PLASTICS AND CLEAN ENERGY AT FORSKNINGSTORGET

EPT was excited to contribute to the science fair and showcase two great stands at Kalvskinnet in September.

Stand no. 6: Clean energy for your future

90% of our electricity in Norway comes from hydropower. At EPTs stand you could test how hydropower plant works and see how water is turned into energy. You could experience that reservoirs are lakes that act as natural batteries, so that water can be used to create energy just when we need it.

Stand no.10 Dancing plastics

At EPTs stand you could explore the dance between plastic particles and turbulence motions in the ocean and understand how ocean turbulence transports plastics across our seas. Forskningstorget is part of the national festival Forskningsdagene (18 – 29 September) under the auspices of the Research Council of Norway.

EPT's HydroCen team ready for visitors at Forskningstorget 2024. This stand was also voted the best!

Photo: Juliet Landrø / NTNU.

Vibrant Energy Flow of Aurora.
Photo: Meng Jiang / NTNU

EPTRAINING

EPTraining is great for meeting up and having fun with colleagues while training and beeing healty. In the winter season, we had ski training, which is very popular, and also monthly refreshing Sauna & Dip. Running sessions, football, basketball, tabata and hike to Lade or Bymarka among other activities keep us active in the summertime.

SUMMER TABATA

SAUNA & DIP AT HAVET ARENA

Left:

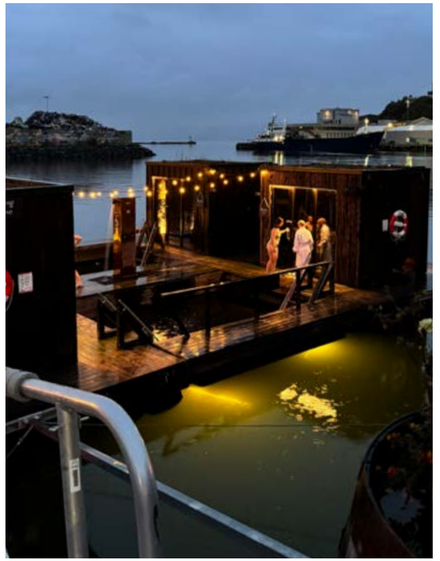
Outside session of tabata in the summer.

Photo: Nice Stranger

Right:

Monthly refreshment with Sauna & Dip at Havet Arena.

Photo: Renate Fjellheim / NTNU.



BASKETBALL TOURNAMENT

Basketball tournament, February 2024.

Photo: Candy Deck / NTNU.

FOOTBALL INDOOR AND OUTDOORS

"A ton of fun" at the indoor football tournament, April 2024.
Photo: Candy Deck / NTNU.

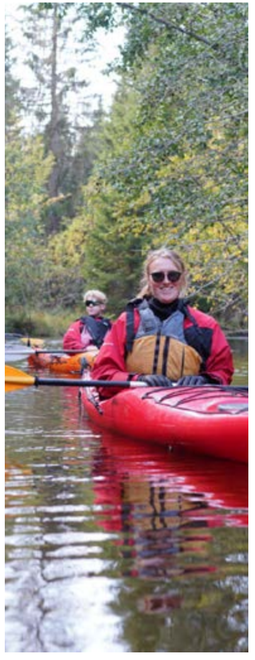
Many gathered on the green field in Dødens dal, May 2024.
Photo: Maren Agdestein / NTNU

WALK TO LADE

Walk and barbeque at Lade in June.
Photo: Unknown

Walk and barbeque at Lade in June.
Photo: Bjørn Austbø

KAYAK COURSE



Kayak course in August / September.
Photo: PadleNorge

EPT AT SINTEF-STAFETTEN

Stronger than ever before! EPTraining-WIS, EPTraining-Sunny Office, EPTraining-Bretzel+Baguette, and EPTraining-RaskeBriller.

Photo: Martin Dorber / NTNU

HIKE AND MUSHROOM PICKING IN BYMARKA

Hike and mushroom picking in Bymarka, September 2024.

Top photo: Bjørn Austbø / NTNU.
Bottom photo: Patrick Christian Bösch.

EPT TOWARDS 2026

Arve Skjærvø
HEAD OF ADMINISTRATION

Photo: Maren Agdestein

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 2026. These are tightly linked to the development goals of NTNU, which we have set out in the agreement with the Ministry of Education. The NTNU strategy is under revision, and this also means that the Departments strategy is too. It is, however, not likely that the new strategy will bring about huge alterations to the way the Department is run on a short-term basis, nor the long-term basis.

Simultaneously with the strategy process, the Department will define a strategic personnel plan for the period until 2035. This personnel plan will be closely linked to the strategy process and of course the final new strategy.

The current Head of Department is in her last leadership period, and the Department will get a new Head of Department during 2025. The Department is rigging up the support functions to be able to give the new Head of Department the best possible grounds for his or her first period in the leader position.
We are looking forward to an exciting and eventful upcoming period.

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 prosessteknikk

Department of Energy and Process Engineering

Annual Report 2024

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