

AAU ENERGY

energy.aau.dk

- GREEN ENERGY FOR THE FUTURE



As the name implies, AAU Energy is fully dedicated to research, innovation, and education within the broad field of energy at our campuses in both Aalborg and Esbjerg. We strive for excellence and impact in what we do, through establishing strong, collaborative partnerships with industrial and academic stakeholders within the field and engaging in the public debate concerning one of the major challenges of our time: the green transition.

FACTS ABOUT THE DEPARTMENT

At the time of this brochure going to press (September 2021), we proudly host three Villum Investigator centres and one Poul Due Jensen Foundation centre. One of our research areas, power electronics, has consistently been rated in the global top 3 over the last three years. We have several researchers among the top 1% most cited, and many more in the top 2%. Within our staff and guests, we count 30 nationalities, and potential PhD students with prestigious scholarships from their home countries actively seek us as host institution.

We are engaged in approximately 213 research, innovation, and training projects funded by EU Horizon 2020, Innovation Fund Denmark and EUDP, the Danish Energy Development and

Demonstration Programme, among others – and we are PI in 112 of them. In fact, AAU has been the third most successful European university in the Horizon 2020 Energy Programme. Our external turnover on these activities is approximately DKK 93m per year, and – as one of our research KPIs – we publish more than 600 articles in high-impact factor journals within all areas of energy, but with a strong bias towards sustainable and renewable technologies. As another KPI, we actively commercialise research results with our partners and spin out new, innovative companies into the energy sector. All in all, we think that we are doing quite well.



HEAD OF DEPARTMENT
LASSE ROSENDAHL



SEVEN NEW MISSIONS

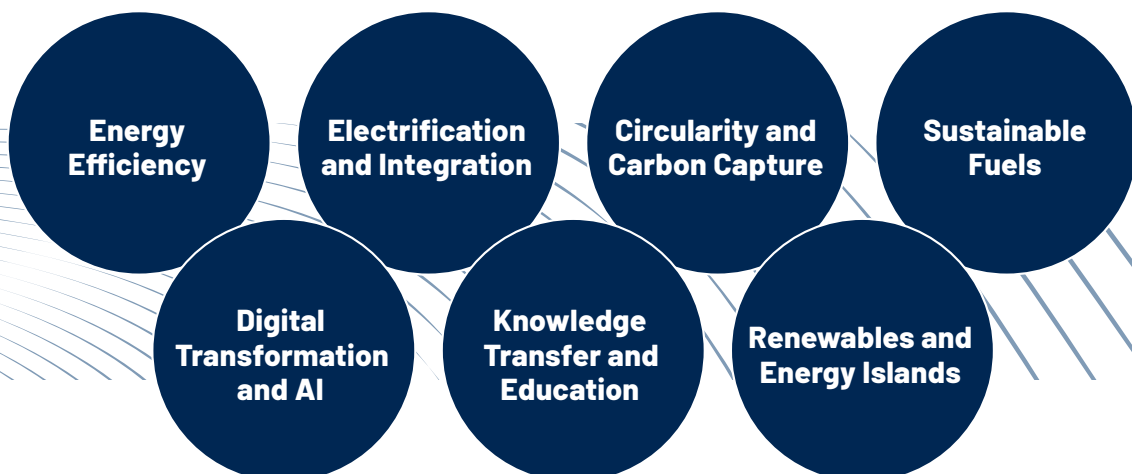
However, there is always room for improvement, and we have been looking into ways of improving on all parameters: excellence, collaboration, and impact. The result that we have come up with are our six technical research missions – and the seventh on education, knowledge transfer, and training – that we present in this brochure. These missions form a set of common overarching goals for our research groups, each with their different competences and areas that inspire to greater collaboration and synergy externally as well as internally for students and staff, as well as making it easier for external partners and stakeholders to engage with us in collaborative efforts. With our missions, it becomes clearer as to what parts of the green transition we can and want to have a positive impact upon, and how

the AAU Energy missions align themselves with Danish and European missions, as well as the UN Sustainable Development Goals.

By having a mission that explicitly focuses on education and training, we also make it clear that we are dedicated to educating new and training seasoned professionals to meet the requirements of the future – giving them the tools to have real impact in their time.

As we launch our missions, it is with the strong ambition and belief that they allow us to be an even stronger and better contributor to the green transition with the energy challenges that lie ahead, and a preferred partner for stakeholders within the field of energy in collaborative research and innovation.

OUR MISSIONS



THE GLOBAL GOALS
For Sustainable Development

ENERGY EFFICIENCY

This mission focuses on increasing energy efficiency in new technology and in the application of existing technology. Energy efficiency is a broad field within energy research. We have staff who work with electronics and power conversion in wind turbines, hydraulics in cars, harvesting energy from solar panels, heating in homes, cooling using heat pumps – you name it. The common theme is hunting the calories, the kilojoules – as the more we save by increasing efficiency, the less need for new energy production. As a rule of thumb, every 1 kW of electricity spared saves 3 kW in total, minimising energy needs and lowering emissions.

As we transition into a more electric-centric world and leaving behind fossil fuels, our electrical energy consumption will rise significantly. Our goal is to develop electric components that are as efficient as possible while also increasing durability – ultimately ensuring better safety in electronics, batteries, etc. At the same time, we consider the environmental consequences from cradle to grave. If, for instance, we double the lifespan of an improved component using the same materials, we contribute to both increased efficiency and less environmental impact.

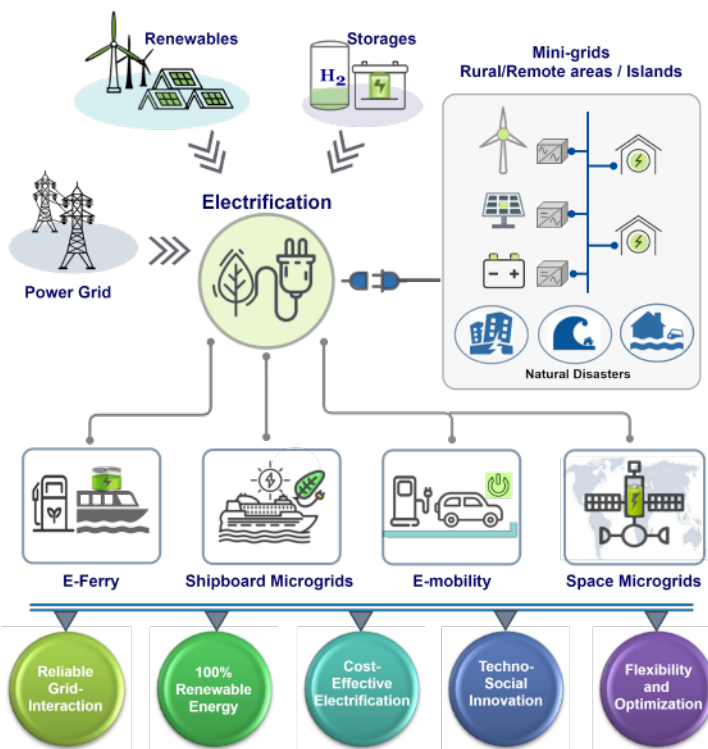
The field of energy efficiency requires inputs from a wide array of disciplines and industries. We have close collaboration with developers, manufacturers, suppliers, and fitters – to build better energy systems and contribute to a more energy efficient world of tomorrow.



HEAD OF MISSION
FREDE BLAABJERG



ELECTRIFICATION AND INTEGRATION



The Electrification and Integration mission is one of the building blocks towards the green transition, closely connected with and complementing the other missions in accelerating the expansion of the cross-border electricity grid to achieve the climate-neutral world and accelerate the electricity access process in developing and transition countries. It will also explore potential widespread electric technology advances in extending the electrification definition over myriad industries.

The mission's aim is to provide sustainable, cost-effective, resilient and scalable energy solutions to boost the integration of internal- and international-excellence for techno-social innovations in large-scale electrification sectors. The main targets are facilitating the decarbonisation of the energy system with alternative low-carbon and resource-efficient energy-coupling technologies, reducing emissions and creating possibilities and potential solutions for electrification in the transportation, building, and industrial sectors, as well as rural/remote regions, islands, and space applications.



HEAD OF MISSION
JOSEP M. GUERRERO



CIRCULARITY AND CARBON CAPTURE

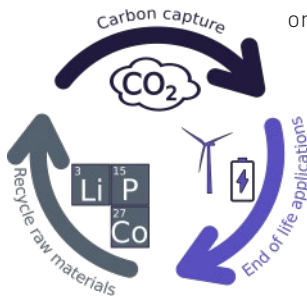
Our mission is focused on closing loops and closing the emission gap between renewable energy sources and the further needs for decarbonisation in the future. For far too long we have viewed our energy resources as inexhaustible, but that is not the reality.

By building new ecosystems, finding new energy sources, and converting energy, we help to boost the green transition. But these solutions create pressure on other resources and raw materials that are likewise finite. In essence, every time we solve one problem, we potentially create another.

Taking EVs as an example: If we introduce 1 million EVs to the streets, in 10 years we need to exchange 1 million battery packs.

With circularity, we might be able to give these batteries a second life rather than disposing them; both extending their life cycle and reducing demand on raw materials, many of which are mined in a very limited number of countries and thus create supply security issues. We aim to reduce, reuse,

and recycle – for instance by introducing urban mining/waste mining of everything from lithium-ion batteries to fuel cells, electrolysis cells, and biomass resources.



Another main concern is the gargantuan task of avoiding the global temperature tipping point. In essence, the green transition is unlikely to reach a sufficient pace in time, and all prognoses show we need to capture carbon from the atmosphere. Our research here is focused on CCS (carbon capture and storage), for instance capturing CO2 from industrial point sources or directly from the air and storing it underground, and CCU (carbon capture and utilisation), in which we utilise the captured CO2 to create fossil-equivalent fuels, chemicals, or materials. In essence, our mission is to push forward – and create a backup plan for – the green transition.



HEAD OF MISSION
THOMAS HELMER PEDERSEN



BALLARD

Power to change the world

We are Europe's leading fuel cell company focusing on R&D, engineering, manufacturing, sales and Customer Care. Ballard's zero-emission fuel cell products provide solutions to some of the world's most pressing environmental issues and enable electrification of mobility, including buses, commercial trucks, trains, marine vessels, passenger cars, forklift trucks, as well as reliable backup power.

From our European headquarters in Hobro, Denmark, our business activities focus on:

- **Marine Center of Excellence** - We design and build the fuel cell module FCwave™ for marine applications
- **Critical Infrastructure** - We build the FCgen® -H2PM fuel cell system specifically designed for backup power of critical infrastructure
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SUSTAINABLE FUELS

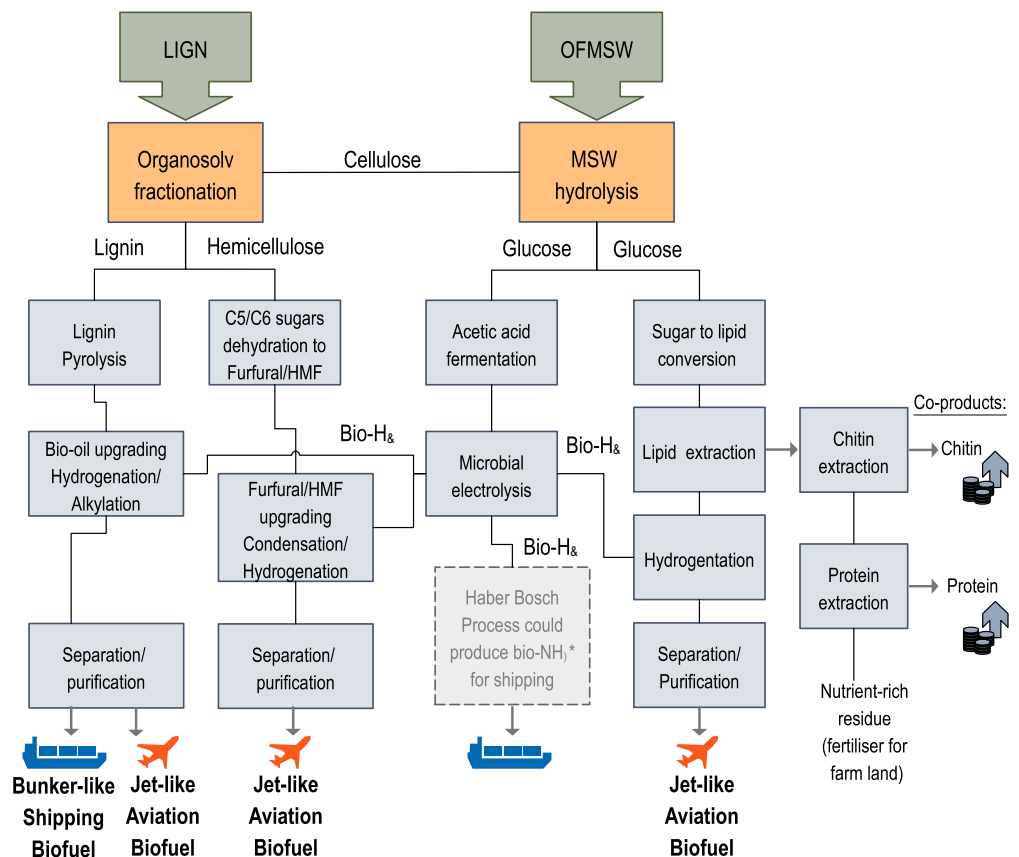
Our mission is simple - we aim to replace fossil fuels with sustainable fuels - but the paths to achieve it are everything but easy. For many years, biofuels have been researched as standalone components, but they have failed to gain a foothold in the field. One of the reasons for this is the difficulty with which biomass becomes biofuels. So a part of what we do is making biorefineries more efficient, allowing them to make not just one product from biomass, but extracting everything we can from the molecules and making value-added products *alongside* the biofuel.

Offshore process control and cybernetics: Researching systems control, digitization, optimization, process control, and monitoring.

Overall, our goal in integrating these research areas is to achieve more feasible and sustainable biofuels, better Power-to-X, combining biomass with electrofuel processes (e.g. storing wind energy), digitalising and controlling processes, ensuring we get the most out of our feed materials.

Lastly, and as part of the circular economy, we focus on recirculation of nutrients from biofuel processes. One of the most important things about our mission is being aware that we are not exclusively making fuel but that we are extracting and creating materials and chemicals.

We are extracting and creating materials and chemicals that add value to many processes, and in that sense, we still have a lot to learn from the petrochemical industry. Taking phosphor as an example: This is a limited resource and it is an essential nutrient that we can and must find better ways to recycle back into agriculture as part of the overall biofuel process.



HEAD OF MISSION
METTE HEDEGAARD THOMSEN



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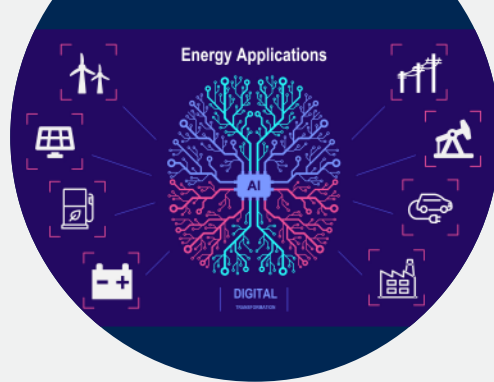
We have the solutions for a sustainable world. We invite you to join our strong and passionate team helping customers with energy efficient green products and services. We are engineering tomorrow for a better future and aim for climate neutrality in 2030.

Read more on [Danfoss.dk](https://www.danfoss.dk)

ENGINEERING
TOMORROW

Danfoss

DIGITAL TRANSFORMATION AND AI



We provide new ways to design, manufacture, and provide services to energy systems, making the process more time and resource efficient, and ultimately reducing time-to-market. We also enable connectivity, through connecting different products that can optimise the operation of entire systems. This is so that digital transformation can benefit the energy sector.

The more energy systems are developing, the more we need new tools. This is where AI comes in, as it lets us build optimised models based on observations and data. AI can be used for many things, but the energy sector requires something more tailored. Firstly, we need to define where AI can assist us within energy applications; then, we can work with different research groups, scientists, and industry to define and build the solutions. For instance, as privacy and security are always a concern when we talk about data and AI, one of our research groups is dedicated to cyber security and ensuring security through every application.

We aim to enable the next leap in transforming energy systems by bridging the research and innovation in energy, digitalisation, and AI, contributing to the green transition towards a climate-neutral society. We already collaborate internally across disciplines, but we also look for partnerships with other universities as well as companies in the energy sector – and the AI and data science industries – to reach our goals of developing autonomous, resilient, and reliable energy systems for the future.



HEAD OF MISSION
HUI WANG



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KNOWLEDGE TRANSFER AND EDUCATION



Our main focus is to disseminate novel knowledge to society and educate the energy engineers of tomorrow in an inspiring study environment, providing them the best research-based competencies for solving the complex interdisciplinary challenges of the green energy transition.

The mission outreach and our student ambassadors inspire and encourage future generations to take part in this work, informing about department achievements and through active collaborations with, for instance, primary and secondary schools.

Part of the mission's brand is our close collaboration and continuous interaction with industry and decision makers. We educate the future innovators and leaders, and we like to say that our students of today are the collaboration partners of tomorrow!

Through the inherent interdisciplinary nature of our Problem-Based Learning (PBL) educations, we constantly shape new digital and

hybrid learning environments and modes in a collaborative and research-supported effort among lecturers where teaching means learning for all.

We additionally aim to provide flexible life-long education in the rapidly evolving field of energy.



HEAD OF MISSION
MADS PAGH NIELSEN



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ENERGY
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RENEWABLES AND ENERGY ISLANDS

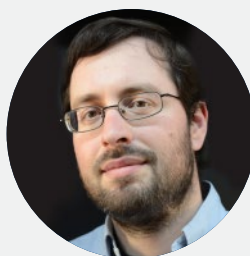
Denmark – and our department – is a world leader in renewable energy and respective grid integration. However, we are reaching a tipping point. The solutions, strategies, and principles of yesterday are no longer going to be enough if we want to avoid severe consequences. We need radical ideas to ensure better access to renewable energy, increasing outputs, efficiency, and grid integration.

We help develop these radical ideas. Ideas that help society reach its goals, that help maintain Denmark as a leader in renewable energy, and help create green jobs at the same time. Revolutionary designs are often unachievable because we don't – yet – have reliable technologies or ways to integrate them into the power system, so we also focus on improving the efficiency of existing solutions and integrating them into a complex electric grid, optimising through combination with multiple energy vectors, including Power-to-X, and making solutions that are both scalable and applicable.

One of the radical ideas that *is* achievable is energy islands, the first in the world, which will be constructed in Denmark as part of a broad effort. The energy islands will exploit our immense wind resources in the North and Baltic seas and serve as hubs that can create better connections between energy generated from offshore wind and the energy systems in the region around the two seas. The energy islands

are as radical as it gets, since nobody has attempted it before. If they are a success, everyone will want to emulate us, further improving Denmark's reputation and export of technology and knowledge related to renewable energy.

To achieve success in the mission's many goals, we group people from four areas: generation, storage, system integration, and reliability. Without a partnership of these four areas we risk insurmountable obstacles; but together, our often-radical approaches can benefit from the complementary nature of these multiple facets. In the end, our mission aims to reduce emissions while improving society's well-being.



HEAD OF MISSION
FILIPE MIGUEL FARIA DA SILVA



ENERGINET

HØJE AMBITIONER FOR EN BEDRE VERDEN

Tag del i den grønne omstilling. Se mere på www.energinet.dk/karriere



Jeg elsker udfordringerne med teoretiske elektrotekniske analyser. Jeg har stor indflydelse på, hvordan det endelige design af stationer og elnettet ser ud, så det virker uden fejl eller mangler.

Grønne energiteknologier er i en rivende udvikling, og jeg er med på rejsen!

Chris Skovgaard Hansen
Stærkstrømsingeniør, netanalytiker



LABORATORIES

AAU Energy hosts laboratories within all parts of the energy field; our state-of-the-art laboratories range from smart energy systems labs, medium and high voltage equipment, to a life-size Power-to-X facility. The AAU Energy laboratories are at the centre of some very exciting projects where we collaborate with the energy sector to bring new technologies and concepts, from lab-scale to life-size, into full-scale operation.

We have about 5,000 m² of indoor laboratories supplemented with outdoor platforms for large-scale setups and equipment, all supported by an extensive electrical, ventilation, and cooling infrastructure.

Our researchers, collaborators, and students can carry out fundamental experiments, reliability, and lifetime testing, as well as proof-of-concept tests in electrical, hydraulic, and thermo/electro-chemical equipment and systems; they can link up to and use in-house or live external experimental data through an advanced real-time simulation lab.



We are electrifying the future - wanna join us?



PowerCon is a Danish company founded in 2009 that has enjoyed a remarkable growth ever since

We develop and produce full-scale electric power converters for various applications within three business segments: Converter Development for Wind Turbines, Converter Drives for Test Equipment & Shore Power Solutions

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COLLABORATION

At AAU Energy, we collaborate extensively with private companies, research institutions, and public authorities in Denmark and abroad. Our ambition is to be an attractive collaboration partner and generate knowledge in mutually binding partnerships that benefit society.

WE OFFER A WIDE RANGE OF OPTIONS FOR COLLABORATION, SUCH AS:

- Research and innovation projects with or without third-party funding
- Student projects
- Industrial PhD or postdoc
- Consultancy on contractual basis
- Laboratory experiments, testing, and equipment rental

We participate in many different partnerships and are always ready to enter into new collaborations with institutions, clusters, SMEs, etc. We strongly believe that working together with the surrounding society enhances the possibility for making a difference and making contributions to solving the energy and climate challenges of the future.

If you are interested in discussing potential collaboration with us, please do not hesitate to contact us.



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