TEAMWORK
SERIOUSLY
AFFECTS
YOUR BRAIN

THE DEPARTMENT OF ENERGY TECHNOLOGY

AALBORG UNIVERSITY
DENMARK

CONTENTS

WELCOME

AT THE DEPARTMENT OF ENERGY TECHNOLOGY

The Department of Energy Technology operates with energy technologies and solutions with focus on sustainable energy, thus largely contributing to future energy and climate challenges.

The department was founded in 1987 and is located in Aalborg and Esbjerg, Denmark. Each campus offers both research and education.

THE MISSION

The department's mission is to teach and carry out research at the highest level within the field of energy engineering in order to produce new knowledge and candidates for the benefit of both companies and Danish society.

We produce graduates at Bachelor, Master and PhD levels at an internationally recognised standard.

Research and results are characterised by a comprehensive collaboration with both national and international companies and universities. The majority of our students, PhDs, employees and collaborations are international.

A UNIQUE ACADEMIC COMBINATION

Since the beginning in 1987, our focus has been on renewable energy and its integration in the complete energy system, combined with energy savings. The department has a unique academic combination, since competences in electric, thermal, fluid power and mechanical energy are placed within the same unit. This interdisciplinary approach benefits a number of research programmes with focus on current areas such as wind turbines, photovoltaics, biomass, smart grids, HVDC transmission, fuel cells, batteries, E-Mobility, reliable power components etc. In our research cooperation with internal as well as external partners we also focus on experimental verification of research results and as a result of that we have state-of-the-art laboratory facilities within all areas at our disposal.

IMMENSE GROWTH

In later years, energy and climate changes have drawn much attention in society. Therefore, the department has had a significant growth in many areas, as the number of PhD's has more than doubled, and we have had a massive growth in external research projects, which has increased the external turnover to constitute more than 60% of the total turnover. This has led to an increased number of employees as well as a demand for the department's candidates. We focus on educating a sufficient number of candidates and students with the right competences in cooperation with the industry, including the members of the Energy Sponsor Programme among others.

THE FUTURE

The Department of Energy Technology aims to continue seeking new energy challenges and finding solutions to these.

The department has a number of interesting and internationally recognised research activities in an exciting international environment, which both existing and future collaboration partners can read more about in this brochure. We are looking forward to dialogues and collaborations in the area of energy technology.

Head of Energy Department
John K. Pedersen

THE DEPARTMENT OF ENERGY TECHNOLOGY

The Department of Energy Technology focuses on a sustainable future, thus research is carried out in renewable energy, efficient energy consumption and distribution, conversion technologies and control of energy.

Hence, the department addresses the energy technological challenges, which are met on the path to a society free from fossils, based on a robust energy system with a high degree of supply security.

This is connected to a number of challenges within e.g. optimal consumption of biomass, integration of wind-, photovoltaic- and wave energy in the energy system and configuration of a future intelligent grid including, electricity, heat and gas. Furthermore, research is carried out with regards to challenges with transportation by electric cars and heavy traffic based on bio fuel as well as efficient and reliable conversion technologies and future houses, which contribute with net energy.

SECTIONS AND RESEARCH PROGRAMMES

To meet these challenges, the Department of Energy Technology is organised in seven sections and thirteen research programmes.

The seven sections make up the basic organisation of all scientific employees and reflect the primary core competences. The sections are presented on page 6.

The thirteen research programmes reflect the current research focus in technologies and applications. The programmes are dynamic and continuously adjusted to new possibilities. Each research programme contains a series of research-, PhD- and collaborations projects and has a programme leader, who is in charge of the programme and its development.

The programmes are presented from pages 8 to 20.

AIMS FOR THE DEPARTMENT OF ENERGY TECHNOLOGY

The department has three overall aims:

- to conduct definitive international leading edge research with strong industry interaction
- to educate highly qualified candidates at all levels from BSc to MSc and PhD
- to interact with peers in the industry and academia

CLOSE COLLABORATIONS

The Department of Energy Technology places great emphasis on being an international and collaboration oriented university with world class experimental facilities.

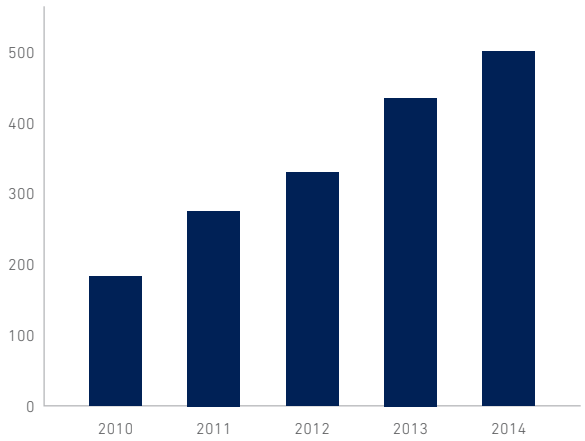
The department has a comprehensive collaboration with the industry in both research projects and consulting and is proud of the fact that numerous world renowned companies have chosen to have in-house divisions at the department, which contributes to ever closer collaborations.

Please find information about possibilities for cooperating with the Department of Energy Technology on page 26.

FACTS

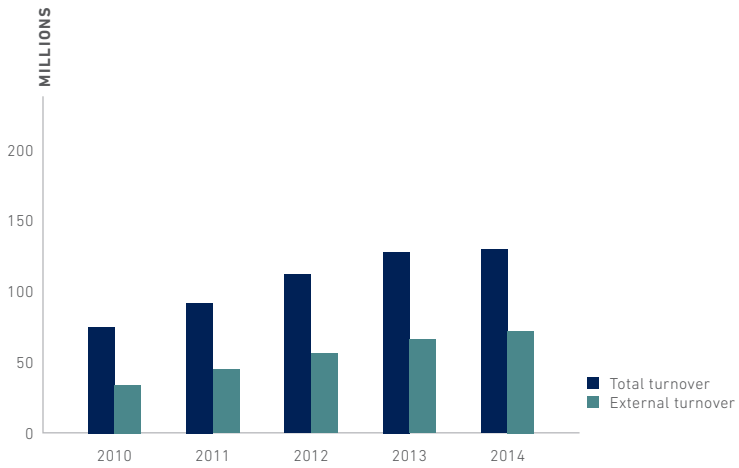
- App. 60 faculty members
- App. 100 PhD's
- More than 30 guest researchers
- App. 30 TAP (technical administrative employees)
- App. 360 students
- More than 75 ongoing collaboration projects
- App. 60% of the turnover comes from external projects
- Total turnover app. 140 Million

PUBLICATIONS

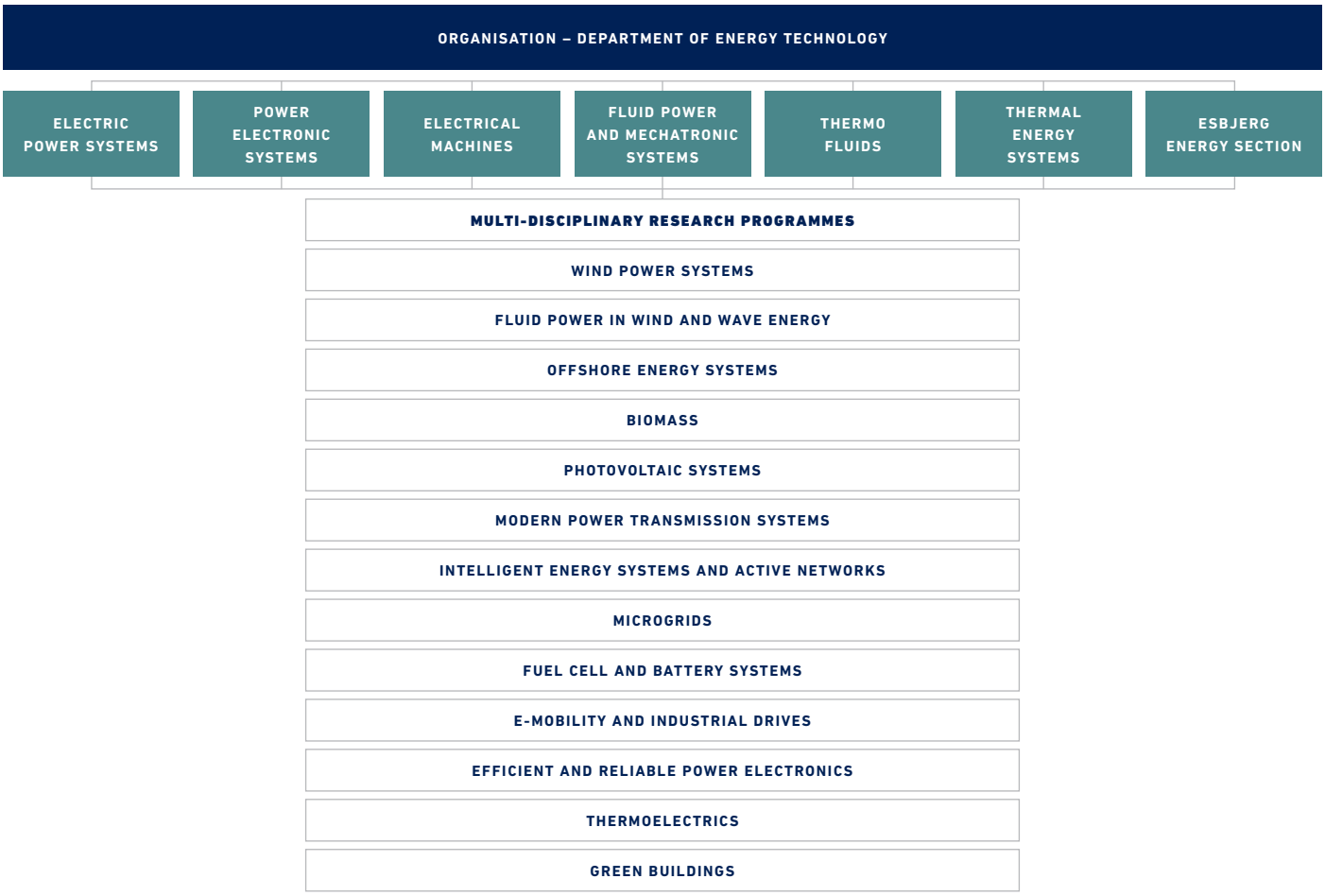


DEVELOPMENT IN PUBLICATIONS

TOTAL TURNOVER



DEVELOPMENT IN TURNOVER



DEPARTMENT ORGANISATION IN 7 SECTIONS AND 13 RESEARCH PROGRAMMES

SECTIONS AT THE DEPARTMENT

THE DEPARTMENT IS ORGANISED IN SEVEN SECTIONS. EACH SECTION REPRESENTS THE TECHNICAL BACKGROUND AND CORE COMPETENCE AREAS OF THE DEPARTMENT.

ELECTRIC POWER SYSTEMS

The section of Electric Power Systems focuses on integration and control of renewable dispersed fluctuating power sources and energy storages together with demand side response, HVAC, and HVDC interconnections as well as network grid layout and structures.

POWER ELECTRONIC SYSTEMS

The section of Power Electronic Systems works with power electronic components and construction of power electronic converters and systems with special focus on energy optimal design, reliability, integration, and optimization of system performance.

ELECTRICAL MACHINES

Focus within the section of Electrical Machines is on development and design of new types of electric motors, actuators, generators, and magnetic gears, applying modern technologies, topologies, and materials.

FLUID POWER AND MECHATRONIC SYSTEMS

The section of Fluid Power and Mechatronic Systems deals with challenges regarding design and control of fluid power as well as mechatronic components, and systems for optimization of system performance.

THERMO FLUIDS

Focus within the section of Thermo Fluids is on reacting and non-reacting flows, simulation of multiphase flow as well as emerging energy technologies including green gas, liquid energy carriers, electrochemical conversion, and storage systems.

THERMAL ENERGY SYSTEMS

The section of Thermal Energy Systems deals with heating and cooling, process integration and chemical conversion and works with applications like fuel cell systems, renewable energy supply, systems for buildings, CHP and waste heat recovery technologies.

ESBJERG ENERGY SECTION

The Esbjerg Energy Section is an interdisciplinary section and the core competence areas are primarily fluid mechanics and combustion for thermal energy systems and bioenergy systems. Power systems and electronic control for offshore energy systems are other core competence areas. In the future the Esbjerg Energy Section will cover all the core competence areas of the department.

SECTION LEADERS

ELECTRIC POWER SYSTEMS
PROFESSOR CLAUS LETH BAK
+45 9940 9281, CLB@ET.AAU.DK

POWER ELECTRONIC SYSTEMS
PROFESSOR STIG MUNK-NIELSEN
+45 9940 9242, SMN@ET.AAU.DK

ELECTRICAL MACHINES
ASSOCIATE PROFESSOR PETER OMAND RASMUSSEN
+45 9940 9244, POR@ET.AAU.DK

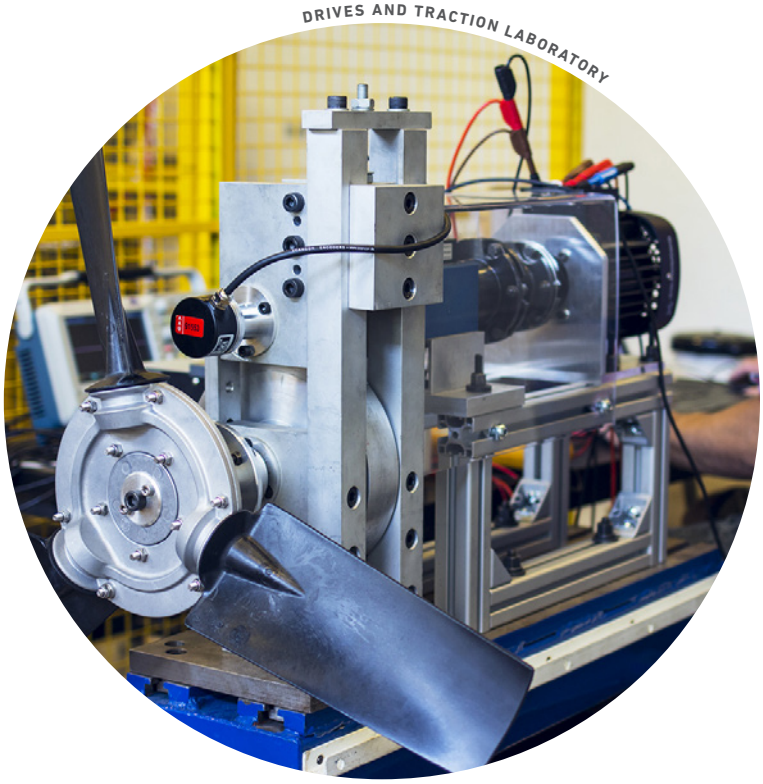
FLUID POWER AND MECHATRONIC SYSTEMS
PROFESSOR TORBEN O. ANDERSEN
+45 9940 9269, TOA@ET.AAU.DK

THERMO FLUIDS
ASSOCIATE PROFESSOR HENRIK SØRENSEN
+45 9940 3306, HS@ET.AAU.DK

THERMAL ENERGY SYSTEMS
ASSOCIATE PROFESSOR MADS PAGH NIELSEN
+45 9940 9259, MPN@ET.AAU.DK

ESBJERG ENERGY SECTION
ASSOCIATE PROFESSOR JENS BO HOLM-NIELSEN
+45 9940 3317, JHN@ET.AAU.DK

DRIVES AND TRACTION LABORATORY



GRADUATION CEREMONY

THE MINISTER FOR CLIMATE, ENERGY AND BUILDING VISITS THE DEPARTMENT

PHD RESEARCH DAY 2015

FUEL CELL AND BATTERY SYSTEMS LABORATORY

MV LABORATORY

SHELL ECO MARATHON 2015

PROTOTYPE WORKSHOP

WIND POWER SYSTEMS

EXAMPLES OF RESEARCH PROJECTS

THE NORWEGIAN CENTRE FOR OFFSHORE WIND ENERGY (NORCOWE)

INN WIND – INNOVATIVE WIND CONVERSION SYSTEMS (10-20MW) FOR OFFSHORE APPLICATIONS

RESEARCH ON DC NETWORK CONNECTION WITH A NOVEL WIND POWER GENERATION SYSTEM

HARMONIZED INTEGRATION OF GAS, DISTRICT HEATING AND ELECTRIC SYSTEMS (HIGHE)

FUTURE DEEP SEA WIND TURBINE TECHNOLOGIES (DEEPWIND)

CONTACT INFORMATION

PROGRAMME LEADER:
PROFESSOR
ZHE CHEN
+45 9940 9255
ZCH@ET.AAU.DK

VICE PROGRAMME LEADER:
ASSOCIATE PROFESSOR
WEIHAO HU
+45 9940 3336
WHU@ET.AAU.DK

WIND.ET.AAU.DK

PROGRAMME PURPOSE

The purpose of the programme is to conduct leading edge research in the field of the wind power systems, to improve reliability, energy efficiency and cost reduction for future wind power systems, to support the developments of the wind turbine technologies for the industry and to help the integration of wind power into future energy systems.

CORE CHALLENGES

The research programme includes many different subjects related to "Wind Power Systems". The core challenges are related to the following topics:

- Components in wind turbines/farms
- Control and monitoring of wind turbines/farms
- Planning, design and optimization of large scale wind farms
- Wind power integration into future energy systems.

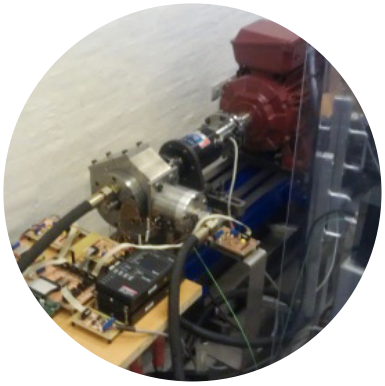
"We work on various main electrical components, such as generators, power electronic converters and other wind farm electrical systems, focusing on optimal design, operation and control. We also develop simulation and design tools for wind power conversion systems so as to integrate the power grid simulation and wind turbine system simulation to meet the grid code requirements and optimise the wind turbine system performance. Furthermore, we work on offshore wind power grids and optimisation of large-scale offshore wind farms." **Zhe Chen, programme leader.**

The programme is an active part of Wind Energy Structures and Technologies (WEST) at Aalborg University, Danish Academy of Wind Energy (DAWE) and is closely associated with the European Academy of Wind Energy (EAWE) and the European Wind Energy Association (EWEA). The programme is also actively related to Wind Energy of SDC (Sino-Danish Centre for Education and Research), for which Professor Zhe Chen is the principal investigator. SDC is a centre established between eight Danish universities and Graduate University of Chinese Academic of Science for developing research, education and collaboration with the industry.

LABORATORY FACILITIES

- Hardware-in-the-loop test platform including Real Time Digital Simulator (RTDS), OPAL-RT and dSPACE control system
- DFIG-based wind turbine system
- Modular Multilevel Converters (MMC) for wind power systems
- DC network test system for offshore wind power.

FLUID POWER IN WIND AND WAVE ENERGY



PROGRAMME PURPOSE

The overall mission of the Fluid Power in Wind and Wave Energy research programme is to conduct research to advance and develop new components and systems for wind and wave energy applications. The activities are concentrated around the three classes of core activities: development of new components, designing new and better systems and development of advanced control strategies. The research activities are based on a combination of theoretical work, modelling and simulation and experimental validation and uses a truly mechatronic design approach combining the key areas of fluid technology, electrical and mechanical engineering, control theory and optimization.

CORE CHALLENGES

The activities in the research programme are concentrated around the core challenges:

- Research and development in relation to high-efficient and reliable Discrete Displacement Technology (DDT) components and systems
- Designing control strategies for DDT components and systems
- Designing advanced control of wind turbines in relation to fluid power systems (pitch, yaw, etc.)
- Development of high-efficiency control strategies for wave energy converters.

"Fluid power is an often overlooked technology that is conceived as being inefficient and messy. However when dealing with extreme forces and torques, which is typically the case for wind turbines and wave energy converters, fluid power technology has the potential to overcome and solve many of the technical challenges, which are foreseen and which may otherwise be limiting factors for future development. New component types and systems based on digital displacement technology not only mean much higher efficiencies, but also better reliability and robustness, and are hence far from the general conception of fluid power as inefficient and messy." **Henrik C. Pedersen, programme leader.**

LABORATORY FACILITIES

The research programme benefits from world class laboratory facilities for testing both components and systems in full scale using state-of-the-art transducers and measurement equipment. The laboratory facilities include:

- Large scale hydraulic power supplies (325 kW and 110 kW and a range of medium size power units)
- Full scale wave simulator test bench
- Custom set-ups for testing components
- State of the art measurement equipment and transducers in all ranges.

EXAMPLES OF RESEARCH PROJECTS

HYDRIVE: HYDROSTATIC DRIVE TRAIN TRANSMISSION FOR RENEWABLE ENERGY APPLICATIONS

DIGITAL HYDRAULIC POWER TAKE OFF FOR WAVE ENERGY

FUTURE HYDRAULIC PITCH SYSTEMS

CONTACT INFORMATION

PROGRAMME LEADER:
ASSOCIATE PROFESSOR
HENRIK C. PEDERSEN
+45 9940 9275
HCP@ET.AAU.DK

VICE PROGRAMME LEADER:
PROFESSOR
TORBEN O. ANDERSEN
+45 9940 9269
TOA@ET.AAU.DK

FLUID-POWER.ET.AAU.DK

OFFSHORE ENERGY SYSTEMS

EXAMPLES OF RESEARCH PROJECTS

PLANT-WIDE DE-OILING OF PRODUCED WATER USING ADVANCED CONTROL (PDPWAC)

STABILIZATION AND CONTROL OF SATELLITE-TRACKING ANTENNAS FOR MARINE COMMUNICATION (STAR2 COM)

CONTACT INFORMATION

PROGRAMME LEADER:
ASSOCIATED PROFESSOR
ZHENYU YANG
+45 9940 7608
YANG@ET.AAU.DK

VICE PROGRAMME LEADER:
ASSOCIATE PROFESSOR
MOHSEN SOLTANI
+45 9940 8744
SMS@ET.AAU.DK

OFFSHORE-ENERGY.ET.AAU.DK

PROGRAMME PURPOSE

The purpose of the programme is to explore, research and develop innovative and breakthrough engineering methodology/methods and technology/techniques for harnessing different types of offshore energy in a reliable, sustainable, cost-effective and environmentally friendly manner.

CORE CHALLENGES

The programme especially focuses on the modeling, optimization, control and fault/failure diagnosis of offshore oil and gas production processes, offshore wind turbine/wind farm, marine communication and underwater robotics. Such as:

- Drilling automation for offshore oil and gas exploration
- Optimization of offshore oil and gas production systems and processes
- Cost-effective offshore energy harness analysis and design
- Oil spell/leakage inspection and diagnosis for pipelines, processes and utilities
- Zero-(pollutant)-discharge techniques for produced water treatment
- Technologies for underwater inspection and maintenance for offshore structures
- Optimization of offshore wind turbine and wind farm operation
- Research on new technologies and new components for offshore wind energy systems
- Offshore communication and telepresence, remote maintenance and operation
- Optimization of the operation and production of the offshore and floating wind turbines
- Specialized mechatronics for remotely operated drills and automated operations of robotic drills to improve time- and cost effectiveness and reduce risk of operating errors
- Advanced ROV technologies for inspection of FPSO risers, manifolds and flow-lines
- Development of algorithms and components for underwater vehicles (AUV/ROV).

"More than 71% of the earth surface is covered by water. There is limitless energy covered or held by water, such as oil and gas under the sea floor, ocean thermal energy, tidal energy, wave energy, offshore wind energy, as well as solar energy. However, to harness these energies is far beyond simple and straightforward, due to challenges of the complicated geology and harsh environment." **Zhenyu Yang, programme leader.**

LABORATORY FACILITIES

- PDPWAC Lab - Plant-wide De-oiling of Produced Water using Advanced Control (PDPWAC) laboratory
- GreenOil Lab – Green Produced Water Treatment for Offshore Oil and Gas Production laboratory
- Offshore Lab – test and analysis of the offshore structures and subsea devices in Wave basin/Water tank
- H2-LAB (Hydraulic and Hydrodynamic Laboratory) – test and analysis of subsea and hydraulic systems.

BIOMASS

PROGRAMME PURPOSE

The Biomass research programme has its main focus on thermo-chemical and bio-chemical conversion of biomass for the purposes of either energy or solid/liquid/gaseous biofuel production. Activities cover the full value chain from feedstocks through conversion to end use application for example in engines or power stations and further developments into fully equipped biorefinery platforms. Geographically, the Biomass research programme has activities at both Aalborg and Esbjerg campus.

CORE CHALLENGES

The research programme has activities directed toward a number of pertinent challenges concerning the use of biomass for energy purposes. These include:

- Quantification of 2. generation and uncompromised biomass resources using GIS based methods
- Quantification of biomass feedstocks as suitable candidates for different energy technologies
- Optimized production of green gas from agricultural and agroindustrial residues
- Drop-in liquid biofuels as a strategic pathway to green transport
- Sustainable production of liquid biocrude through thermochemical pathways.

"A major challenge for the European Union is to live up to the GHG reduction targets set up for 2020 and 2030. This requires a different approach to biofuel implementation than currently, In that focus should be on designing sustainable pathways to compatible liquid fuels – the drop-in paradigm – adding to the hydrocarbon pool rather than on complete pathways requiring new infrastructure and leading to incompatible final grade fuels." **Lasse Rosendahl, programme leader.**

LABORATORY FACILITIES

- Continuous Bench Scale 1 (CBS1) near-pilot scale hydrothermal liquefaction research facility
- Chemical analysis lab for biomass, bio-crude and transport grade fuel characterization
- Distillation and upgrading (hydrogen treatment) facilities for biocrude upgrading
- End use technology test facilities (diesel engines up to 1600HP, aeroengine (200HP), 400 kW combustion platform.

EXAMPLES OF RESEARCH PROJECTS

C3BO – CENTER FOR BIOOILS. RESEARCH INTO HYDROTHERMAL LIQUEFACTION PLATFORM FOR SUSTAINABLE FUEL PRODUCTION FROM LIGNOCELLULOSIC BIOMASSES

FLEXIFUEL. INVESTIGATING CATALYTIC PATHWAYS TO ENHANCED CONVERSION EFFICIENCY IN THE SUPERCRITICAL REGIME

SULPHUR-FREE MARINE BIOFUEL FROM WOOD

INBIOM 2.0 - INNOVATION NETWORK FOR BIOMASS

LARGE SCALE BIOENERGY LAB

CONTACT INFORMATION

PROGRAMME LEADER:
PROFESSOR
LASSE ROSENDAHL
+45 9940 9263
LAR@ET.AAU.DK

BIOMASS.ET.AAU.DK

PHOTOVOLTAIC SYSTEMS

EXAMPLES OF RESEARCH PROJECTS

SMART PHOTOVOLTAIC SYSTEMS

FULLY AUTOMATED SERVICE EXECUTION PLATFORM FOR PHOTOVOLTAIC POWER PLANTS – FASE

REMOTE MONITORING AND ANALYSIS OF PV SYSTEMS

CONTACT INFORMATION

PROGRAMME LEADER:
ASSOCIATE PROFESSOR
DEZSO SERA
+45 9940 3307
DES@ET.AAU.DK

VICE PROGRAMME LEADER:
PROFESSOR
REMUS TEODORESCU
+45 9940 9249
RET@ET.AAU.DK

PV-SYSTEMS.ET.AAU.DK

PROGRAMME PURPOSE

The primary focus of this programme is on grid connected photovoltaic systems. Research activities include characterisation and fault detection in PV panels and arrays, control and topologies of PV inverters, as well as grid integration issues in residential and large PV plants. The programme also engages in education activities at both MSc and PhD level.

The research programme offers high quality PV panel test and characterisation services for the industry.

CORE CHALLENGES

The programme focuses on a number of key challenges mostly related to the optimal operation of PV systems and integration of PV power into the electricity grid:

- Condition monitoring and automatic diagnostics for photovoltaic plants
- High sensitivity fault detection and identification in PV panels in laboratory and field environment
- Distributed control of module integrated converters (DC modules)
- Reliability issues of PV inverters and control for reliability
- PV power integration in the low voltage distribution grid
- Grid integration of large PV power plants.

"Photovoltaics is well on the way of becoming a major source of electricity worldwide. With the reduction of the investment cost for PV installations, operational costs become more significant in the total cost, calling for techniques to optimize system operation. The fast growth of PV capacity connected to the electricity grid makes the grid integration aspects of this intermittent source of energy increasingly important." **Dezso Sera, programme leader.**

LABORATORY FACILITIES

- PV inverter test setup: High bandwidth PV array simulator with linear post-processing unit (Regatron, 1000V- 40V), High Precision Power Analyser (Yokogawa WT3000), Fully programmable four quadrant grid simulator (California Instruments MX- 30)
- PV panels test and measurement setup: Flash Sun simulator (SPI-Sun 5600 SLP), Class A+ A+ A+, module size up to 2000mm X 1370mm, dark and light current-voltage curve measurement
- Optical PV module characterisation setup: InGaAs short-wave infrared (SWIR) camera for electroluminescence (EL) tests, with resolution 640x512 pixels, spectral range of 0.9 to 1.7 microns wavelengths, 25fps, IR camera for thermal imaging, resolution 320x240, spectral range of 7.5 to 13 micron, sensitivity 0.05°C @ 30°C
- Grid connected converter setups (five identical converter systems controlled by dSPACE system featuring four- quadrant operation capability) for control development and teaching purposes
- PV array diagnostic setup: 1kW dual-stage grid connected inverter controlled by dSPACE system
- PV plant monitoring and data acquisition system (PVDAAQ) featuring high sampling rate environmental data and remote I-V curve measurements.

MODERN POWER TRANSMISSION SYSTEMS

PROGRAMME PURPOSE

The mission of the research programme is to conduct research at the highest level, in order to allow a technically sound and long-term reliable transition of today's power transmission system into a modern transmission system capable of handling the demands of the future transmission system (e.g. dispersed generation, long HVAC cables, multiterminal HVDC, harmonic propagation). This is a huge and expensive task of a very high importance for modern society.

CORE CHALLENGES

- HVAC transmission cable technology, both equipment and system studies
- Operation of HVDC multiterminal transmission networks
- Offshore-to-onshore network connection
- Development of modern relay protection
- Load shedding for systems with a high penetration of renewable energies
- Network restoration in systems with few conventional power plants
- Propagation of harmonics in modern power systems (HVDC, cables, weak networks)
- High voltage issues and design of new composite transmission towers with less visual impact
- Electromagnetic transients studies and development of simulation models
- Insulation coordination issues
- Coordination between HV networks and electrified railways.

"Power systems are the backbone of our modern society. Just imagine how life would be without electricity – a scaring thought! The power system has evolved over the last century and today and in the future it faces tremendous challenges, because energy needs to be supplied in a more sustainable way in order to preserve our environment. It is quite a challenge to include renewable sources such as offshore wind and photovoltaics and at the same time avoid the visual impact of power transmission and be able to accommodate the demands of the expanding electricity market in Europe. That puts what is considered among the world's most complex human-made systems to something resembling a revolution." **Claus Leth Bak, programme leader.**

LABORATORY FACILITIES

- High-Voltage Laboratory with impulse generator up to 800 kV
- Medium-Voltage Laboratory with 2MVA/20 kV
- Diversified measuring and test equipment including portable impulse generators and GPS synchronised acquisition equipment
- Real time digital system (RTDS) and relay laboratories
- Software for power systems analysis like PSCAD, DigSilent, Matlab and Comsol.

EXAMPLES OF RESEARCH PROJECTS

DANPAC – HVAC CABLES TRANSMISSION NETWORKS

HARMONY – HARMONIC IDENTIFICATION, MITIGATION AND CONTROL IN POWER ELECTRONICS BASED POWER SYSTEMS

POPYFU – POWER PYLONS OF THE FUTURE

CONTACT INFORMATION

PROGRAMME LEADER:
PROFESSOR
CLAUS LETH BAK
+45 9940 9281
CLB@ET.AAU.DK

VICE PROGRAMME LEADER:
ASSOCIATE PROFESSOR
FILIPE FARIA DA SILVA
+45 9940 9280
FFS@ET.AAU.DK

POWER-SYSTEMS.ET.AAU.DK

INTELLIGENT ENERGY SYSTEMS AND ACTIVE NETWORKS

PROGRAMME PURPOSE

The purpose of the programme is to conduct research within coherent energy systems where the interaction between electricity, gas, heat, transport and energy storage systems applying ICT are the key research areas of the programme. Control, stability and reliability of the transmission and distribution systems with a large amount of renewable and dispersed generation as well as new controllable loads are in focus. The focus is also on providing coordinated control and operation, provision of ancillary services and the possibility to run a self-sustained renewable based energy system.

CORE CHALLENGES

The research programme includes many different subjects related to "Intelligent Energy Systems and Active Networks". The core challenges are related to the following topics:

- Grid integration of distributed generation (including wind power, PV-systems and combined heat and power plants) and flexible loads (heat pumps, electric vehicles, electric boilers, electrolysers, etc.)
- Smart metering, Demand Response and Demand Side Management
- Distribution system analysis
- Power to Heat (P2H), Power to Gas (P2G), Power to Storage and transportation systems (V2G)
- Energy storage technologies and energy management
- Stability and reliability of power systems
- Hierarchical and distributed control architectures including ICT
- Fault calculation, localisation and relay protection
- Power quality and power conditioning (including inter-harmonics and sub-harmonics)
- Optimal power flow (deterministic/probabilistic)
- Network planning including long term and short term forecast methods
- Power compensation devices and systems
- Efficient control and market based regulation of the power systems.

> The focus of the European Union is to redesign the entire architecture of the electricity network at both transmission level and at distribution level in order to accommodate Distributed Generation from renewable sources and to use intelligent methods for the control of the network grid." **Birgitte Bak-Jensen, programme leader.**

LABORATORY FACILITIES

- Real time digital system (RTDS) laboratory
- Smart grid laboratory with emulators for dispersed generation, storage facilities, loads, industrial controllers at different levels, communication network emulators, etc.
- Advanced computer simulation tools for power systems like DigSilent from Power Factory, PSCAD-EMTDC and Matlab with diverse toolboxes and libraries
- Cooperation with the utilities for verification and validation of developed benchmark models for networks and components.

EXAMPLES OF RESEARCH PROJECTS

SMART CONTROL OF ENERGY DISTRIBUTION GRIDS OVER HETEROGENEOUS COMMUNICATION NETWORKS

ARROWHEAD, WHICH LOOKS INTO COOPERATIVE AUTOMATION FOR DYNAMIC INTERACTION BETWEEN ENERGY PRODUCERS AND ENERGY CONSUMERS, MACHINES, AND BETWEEN PEOPLE AND SYSTEMS

TOTALFLEX, WHICH ACTIVATES ALL PIECES OF DEMAND RESPONSE FROM HOUSEHOLDS IN A FLEXIBLE MANNER

CONTROL, PROTECTION AND DEMAND RESPONSE IN LOW VOLTAGE GRIDS

EFFICIENT DISTRIBUTION OF GREEN ENERGY

DEVELOPMENT OF A SECURE, ECONOMIC AND ENVIRONMENTALLY FRIENDLY MODERN POWER SYSTEM

CONTACT INFORMATION

PROGRAMME LEADER:
ASSOCIATE PROFESSOR
BIRGITTE BAK-JENSEN
+45 9940 9274
BBJ@ET.AAU.DK

INTELLIGENT-ENERGY-SYSTEMS.ET.AAU.DK

MICROGRIDS

PROGRAMME PURPOSE

The Microgrids research programme provides control solutions and energy management of AC and DC Microgrids, involving centralized and distributed control architectures, power quality and protections, multi agent systems, standard-based information and communication technologies, online optimization techniques and supervisory systems. The research programme also focuses on sustainable solutions and optimal use of energy.

All of the foregoing can also be conceived within a problem based learning (PBL) education for Postgraduates, PhD students and industrial partners. The programme also promotes national and international cooperation with universities, institutions and companies.

CORE CHALLENGES

The research programme intends to conduct leading research at an international level which aims to achieve the following core challenges:

- Low and Medium Voltage microgrids
- AC and DC minigrids for ships and aircrafts
- Hybrid energy storage systems for islanded grids and multiple microgrid clusters
- Microgrids and minigrids in emergent countries and rural areas
- Advanced Metering Infrastructure for microgrids
- LVDC distribution architectures for residential applications (DC homes)
- DC Electrical Vehicle charging solutions
- Distributed active power filters for microgrid power quality improvement
- Provision of ancillary services.

"Today, by using Microgrids, energy is generated near to the consumer loads and thus part of losses due to electrical transmission in conventional electric grids is avoided. We can imagine that our houses can use Microgrids to store electricity when it is not needed and to use the electricity generated from the sun during the night. In that sense, Microgrids involve different technologies such as power electronics equipment, ICT, renewable generation, storage and loads. In order to coordinate these diverse elements, several layers of control are necessary. This will enhance energy efficiency, flexibility and independence from the electrical main grid, but also, it allows cost savings in the variable electricity price scenario." **Josep Guerrero, programme leader.**

LABORATORY FACILITIES

- Intelligent Microgrid Laboratory (iMGlab)
- Intelligent DC Microgrid Living Lab (iDClab)
- HighPower Microgrid Laboratory (HPMGlab)
- Flywheel/Supercap Integrated Platform for Microgrid Systems (FLYCAP) (envisioned).

EXAMPLES OF RESEARCH PROJECTS

INTELLIGENT DC MICROGRID LIVING LAB
– DSF SINODANISH

MICROGRID TECHNOLOGY RESEARCH AND DEMONSTRATION
- EUDP SINODANISH

FLEXIBLE ELECTRIC VEHICLE CHARGING INFRASTRUCTURE FLEX – CHEV
– ERANET

ACTIVE POWER FUNCTIONALITIES FOR POWER CONVERTERS IN WIND POWER PLANTS
– FORSKEL

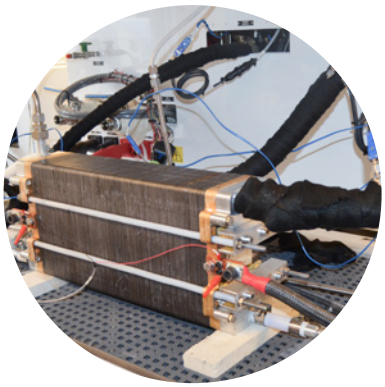
FUTURE RESIDENTIAL LVDC POWER DISTRIBUTION ARCHITECTURES
- DFF STARTING GRANT

CONTACT INFORMATION

PROGRAMME LEADER:
PROFESSOR
JOSEP GUERRERO
+45 9940 9726
JOZ@ET.AAU.DK

VICE PROGRAMME LEADER:
ASSOCIATE PROFESSOR
JUAN CARLOS VASQUEZ
+45 9940 9724
JUQ@ET.AAU.DK

MICROGRIDS.ET.AAU.DK



FUEL CELL AND BATTERY SYSTEMS

EXAMPLES OF RESEARCH PROJECTS

ALPBES, ADVANCED LIFETIME PREDICTION OF BATTERY ENERGY STORAGE

BATTERIES2020: TOWARDS REALISTIC EUROPEAN COMPETITIVE AUTOMOTIVE BATTERIES

4M, MECHANISMS, MATERIALS, MANUFACTURING AND MANAGEMENT – INTERDISCIPLINARY FUNDAMENTAL RESEARCH TO PROMOTE COMMERCIALIZATION OF HT-PEMFC

REST, RELIABILITY ESTIMATION AND TESTING IN HYDROGEN AND FUEL CELL SYSTEMS

E-STORE: FURTHER IMPROVEMENT OF PEM ELECTROLYSIS FOR FLEXIBLE ENERGY STORAGE, INNOVATION FUND DENMARK - ENERGY AND ENVIRONMENT

CONTACT INFORMATION

PROGRAMME LEADER:
PROFESSOR
SØREN KNUDSEN KÆR
+45 9940 3300
SKK@ET.AAU.DK

FUEL-CELLS.ET.AAU.DK

PROGRAMME PURPOSE

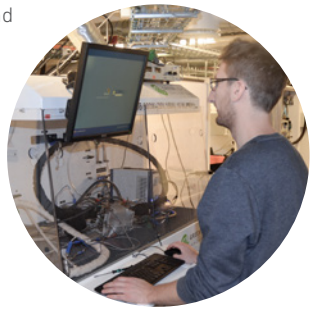
The Fuel Cell and Battery Systems research programme is centred on electrochemical conversion and storage of energy covering the entire chain from single fuel cell and battery cells to complete systems. Cell level activities focus on acquiring fundamental understanding of performance and durability of the technologies through advanced measurements coupled with comprehensive simulation models. At the stack/pack and system levels, performance optimisation, diagnostics, prognosis and control concept development are key activities.

CORE CHALLENGES

The research programme has activities directed toward a number of core challenges concerning the efficient conversion and storage of energy using electrochemical technologies. These include:

- Quantification of performance and performance degradation of fuel cells, electrolyzer cells and battery cells using advanced experimental techniques
- Optimization of core technologies through advanced 1-, 2- and 3-D multi-physics simulations coupling fluid mechanics, heat and mass transfer with electrochemistry
- Advanced management and monitoring systems with diagnostics and prognostics features such as State-of-Health and Remaining-Useful-Lifetime prediction
- Optimization of system performance and efficiency through advanced thermodynamic modelling
- Quantification of system reliability and failure mechanisms to predict cost of ownership
- Energy system balancing technologies including electrolysis, methanol synthesis and methanation based on for example upgrading of bio-derived syngas.

"Efficient conversion and storage of energy is a key challenge in the transition to a fossil-free energy system in 2050. Electrochemical devices such as fuel cells, electrolysis cells and batteries can help balance the energy systems and support the fuelling of the transport sector." **Søren Knudsen Kær, programme leader.**



LABORATORY FACILITIES

- A range of commercial (Greenlight Innovation) and in-house fuel cell test benches that include reformate simulation and electrochemical tests (EIS, CV, H2 crossover, etc.). From 20W to 12 kW electric power
- Climatic chambers up to 1200L that enable temperature and humidity control in a wide range
- A large number of ovens to characterize battery storage degradation and accelerated ageing tests
- A range of gas analysers to measure fuel cell exhaust and reformate gas composition
- Battery cell test stations from Fuelcon, Maccor and Digatron with a test capacity of around 100 cells simultaneously
- Battery module test station from Digatron
- Bi-directional power supplies/loads ranging from 1 kW to 50 kW
- dSpace battery simulator for battery management system development.

E-MOBILITY AND INDUSTRIAL DRIVES

PROGRAMME PURPOSE

The main purposes of the research carried out in this programme are to reduce the energy consumption and cost of industrial drives and to secure a clean, efficient, comfortable and cost-effective transport sector based on electric drive trains and intelligent integration with the grid.

CORE CHALLENGES

- Efficient, compact and cost effective electric machines and drives
- Grid integration of electric vehicles
- Energy storage devices
- Hybridization and energy management strategies
- Power electronic merging with multiple functionalities
- Comfortable and user friendly solutions
- Fast charging
- Energy harvesting in industrial and mobile applications
- Diagnostic and reduction of sensors
- Micro electromagnetic robots and generators.

"Each time the energy density of batteries are improved, there are new applications within the field of transport where an electric drive system can be used instead of the traditional propulsion system based on the combustion engine. However, in order to speed-up the process of electrifying the transport sector many other aspects should also be considered; for example hybridization and continuous loss reduction of all the components in the drive train." **Erik Schaltz, programme leader.**

LABORATORY FACILITIES

- Flexible Drive System Laboratory consisting of five dSpace-based 4-qudrant motor setups
- Advanced Electric Machine and Drive Laboratory with two test benches loaded by Siemens Drive Serving for smart load profile simulation
- Static electrical machine test system for fast characterization of electrical machine parameters
- Vehicle and HeavyLab with several bidirectional power supplies of up to 50 kW for Hardware-In-the-Loop (HIL) testing
- Lithium-Ion battery pack (40 kWh)
- Electric vehicle platform for field testing of various electric vehicle components
- Equipment for magnetic field measurement
- Various battery test equipment for cell, module and pack testing
- Various ad-hoc load systems for large machines, high speed machines, linear drives, etc.

EXAMPLES OF RESEARCH PROJECTS

ADVANCED COMPONENTS FOR ELECTRO-MOBILITY USAGE (ACEMU)

COMPACT INTELLIGENT POWERFUL ELECTRIC DRIVETRAIN (CIPED)

FUEL CELL SHAFT POWER PACK (FCSPP)

MAGNETIC LEAD SCREW BASED ACTUATOR

TOMORROW'S HIGH-EFFICIENCY ELECTRIC CAR INTEGRATED WITH THE POWER SUPPLY SYSTEM

VARIABLE-SPEED, ROBUST SYNCHRONOUS RELUCTANCE MACHINE DRIVE SYSTEMS

WIRELESS INDUCTIVE CHARGING TO INTEROPERATION TESTING (WIC2IT)

A HIGH EFFICIENCY FAN DRIVE SYSTEM (MAGFAN)

CONTACT INFORMATION

PROGRAMME LEADER:
ASSOCIATE PROFESSOR
ERIK SCHALTZ
+ 45 9240 3302
ESC@ET.AAU.DK

VICE PROGRAMME LEADER:
ASSOCIATE PROFESSOR
KAIYUAN LU
+45 9940 9288
KLU@ET.AAU.DK

DRIVES.ET.AAU.DK

EFFICIENT AND RELIABLE POWER ELECTRONICS

EXAMPLES OF RESEARCH PROJECTS

HARMONY - HARMONIC IDENTIFICATION, MITIGATION AND CONTROL IN POWER ELECTRONICS BASED POWER SYSTEMS

INTELLIGENT AND EFFICIENT POWER ELECTRONICS (IEPE)

CENTER OF RELIABLE POWER ELECTRONICS (CORPE)

RELIABILITY OF CAPACITORS IN POWER ELECTRONIC SYSTEMS (RELIACAP)

HIGHLY EFFICIENT, LOW-COST ENERGY GENERATION AND ACTUATION USING DISRUPTIVE DEAP TECHNOLOGY

SEMICONDUCTOR MATERIALS FOR POWER ELECTRONICS (SEMPEL)

POWER-2-ELECTROLYSERS

DSO CHALLENGES FROM INTRODUCTION OF HEAT PUMPS

CONTACT INFORMATION

PROGRAMME LEADER:
PROFESSOR
FREDE BLAABJERG
+45 9940 9254
FBL@ET.AAU.DK

VICE PROGRAMME LEADER:
PROFESSOR
STIG MUNK-NIELSEN
+45 9940 9242
SMN@ET.AAU.DK

POWER-ELECTRONICS.ET.AAU.DK

PROGRAMME PURPOSE

The purpose of this programme is to develop innovative power electronic converters and systems to all relevant applications, which are efficient, reliable and cost-competitive by means of reduction in manufacturing, maintenance and operational costs.

CORE CHALLENGES

- Future power electronics products target for ppm level of return rate, with optimized life-cycle performance in terms of energy efficiency and cost
- Undesirable harmonics and resonances in local electrical network and power systems
- Lack of design tools for efficiency, reliability and cost oriented power electronics design
- Emerging applications of power electronics under harsh environments and long operation hours
- Emerging active devices and passive components need paradigm shifts in packaging technology and power electronics design.

"70% of all electrical energy is processed by power electronics. Therefore our goal is to develop the future generation of power electronic converters, which are benchmarked to high efficiency, higher power density, low weight, low cost and at the same time focusing on the reliability in the power converters." **Frede Blaabjerg, programme leader.**

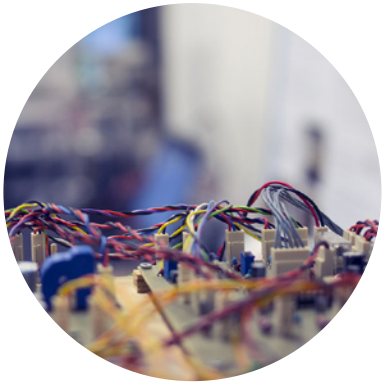
The applications are very wide as power electronics is used in production, transmission and consumption of energy in photovoltaics, wind turbines, refrigerators, pumps, computers, televisions or the like. The power range of applications is from W to MW. The group designs power electronics equipment with attention to apply the proper technology and control. The programme provides tools for optimization of efficiency and reliability as well as prototyping of the converters towards industrial application. It also addresses better understanding of how reliability of power electronic devices and systems is influenced by different stress factors and develops prognostic tools in the power electronic converter for predictive maintenance.

We strive for the highest excellence in research and education, and to be one of the top 10 research groups in power electronics in the world in terms of publications, impact (citations) and reputation.

LABORATORY FACILITIES

- High power semiconductor device electrical, thermal, and wear-out testing facilities
- Scanning Electron Microscope
- Advanced capacitor testing system
- Power converter prototypes in W, KW and MW levels and latest control and simulation software.

THERMOELECTRICS



PROGRAMME PURPOSE

The Thermoelectric research programme has its main focus on design of optimized thermoelectric energy systems through complete and detail modeling, multi-parameter optimization and hardware design. Activities in this research programme include multiphysics modeling based on computational fluid dynamics, control and electrical circuit modeling as well as experimental study involving individual thermoelectric modules and full thermoelectric systems.

CORE CHALLENGES

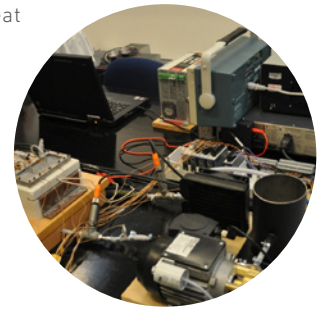
To develop innovative and efficient thermoelectric energy systems and to provide an internationally recognized comprehensive research platform, research in this programme is directed towards the following challenges:

- Development of advanced modeling and analysis tools for thermoelectrical energy systems and devices
- Development of advanced optimization procedures for thermoelectrical energy systems
- Development of state-of-the-art dedicated hardware for thermoelectric energy conversion, such as DC/DC inverters, micro-structured heat exchangers and module architectures
- Experimental facilities to test and analyze systems and devices in order to generate validation data
- A comprehensive formulation of concept of this technology applied to automotive heat recovery and hybrid photovoltaic-thermoelectric systems.

"The European Union targeted to decarbonize energy systems in a sustainable way and to complete the energy internal market, in line with the objectives of the Renewable Energy. Time is pressing to develop new technologies that are intended to shape energy market frameworks for 2030 and 2050. The thermoelectric technology employs a multidisciplinary system approach from elementary to system level that can enhance the competitiveness of research based innovation in Denmark and EU in time to play a role in this emerging market." **Alireza Rezaniakolaei, programme leader.**

LABORATORY FACILITIES

- Thermoelectric generator module characterization
- Measuring of heat transfer and flows in various types of heat exchangers integrated with thermoelectric device
- Load units and facilities for power electronic and control strategy of thermoelectric systems.



EXAMPLES OF RESEARCH PROJECTS

INTEGRATED PHOTOVOLTAICS WITH THERMOELECTRICS

CENTER FOR THERMOELECTRIC ENERGY CONVERSION

NANO-CARBONS FOR VERSATILE POWER SUPPLY MODULES

OXIDE THERMOELECTRICS FOR EFFECTIVE POWER GENERATION FROM WASTE HEAT

CENTER FOR ENERGY MATERIALS (CEM)

CO-SIMULATION AND CO-OPTIMIZATION OF THERMOELECTRIC GENERATION SYSTEM

CONTACT INFORMATION

PROGRAMME LEADER:
ASSISTANT PROFESSOR
ALIREZA REZANIAKOLAEI
+45 9940 9276
ALR@ET.AAU.DK

THERMOELECTRICS.ET.AAU.DK

GREEN BUILDINGS

EXAMPLES OF RESEARCH PROJECTS

4DH - 4TH GENERATION OF DISTRICT HEATING. A RESEARCH CENTRE FOR THE FUTURE DISTRICT HEATING CONCEPTS, SYSTEM AND COMPONENTS

HEAT PUMPS IN THE ENERGY SYSTEM. LARGE HEAT PUMPS IN THE DISTRICT HEATING GRID AND SMALLER HEAT PUMPS IN RESIDENTIAL BUILDINGS

CONTACT INFORMATION

PROGRAMME LEADER:
ASSOCIATE PROFESSOR
CARSTEN BOJESEN
+45 9940 3659
CBO@ET.AAU.DK

VICE PROGRAMME LEADER:
ASSOCIATE PROFESSOR
MADS PAGH NIELSEN
+45 9940 9259
MPN@ET.AAU.DK

GREEN-BUILDINGS.ET.AAU.DK

PROGRAMME PURPOSE

The Green Building research programme conducts research within energy supply of buildings based partly or entirely on sustainable sources. The programme focuses on the generation of space heating, space cooling, domestic hot water and local heat storage. Considered sources are local at the building site, centralized at off-site plants such as wind parks, combined heat and power plants, or combined systems at various levels.

The purpose of the programme is to explore the potential of each individual energy source as well as the interaction, integration and optimization of combined sources. The research outcome should provide technical solutions and guidelines for future energy supply strategies of buildings including the extraction, conversion, distribution and utilization of energy. Energy storage is investigated as a central part of such supply systems.

CORE CHALLENGES

In a transition period, where the supply sources of heat and electricity will change from fossil fuels and into often fluctuating and unstable sustainable sources, a main challenge will be to ensure a sufficient and stable energy supply to residential houses and other buildings. These include:

- Evaluation of individual sustainable energy sources and conversion technologies as contributors to the total energy supply
- Integration of multiple energy sources for levelling out discrepancies between the production and the consumption of heat and electricity
- Exploration and evaluation of the necessity and the technologies for energy storage
- Balancing and optimising the ratio of remote and local heat and electricity supply
- Energy management of buildings in a smart energy environment.

"During the conversion process from fossil fuels to sustainable energy sources, of which a major number of sources are fluctuating, it is vital that not only individual energy technologies for utilising renewable energy sources are exploited. A sufficient and stable supply of heat and electricity for buildings based on sustainable sources requires a close interaction and integration of the available sources as well as measures for balancing discrepancies between the energy consumption and the energy production/conversion." **Carsten Bojesen, programme leader.**

LABORATORY FACILITIES

- Green Building container equipped with thermal solar panels, photovoltaic panels, vertical axle wind turbine, air source heat pump and hot water storage tanks
- A separate Green Building lab for testing of a palette of energy sources, conversion and storage technologies will be established in the newly renovated lab building.

BACHELOR AND MASTER OF SCIENCE

ENERGY IN AALBORG

BACHELOR OF SCIENCE IN ENERGY

1ST-4TH SEMESTER

BASIC COURSES IN MATH, THERMAL, ELECTRICAL, MECHANICAL, THERMODYNAMIC AND CONTROL ENGINEERING

5TH-6TH SEMESTER

- SPECIALISATION IN ELECTRIC ENERGY ENGINEERING (EEE)
- MECHATRONIC CONTROL ENGINEERING (MCE)
- SPECIALISATION IN THERMAL ENGINEERING (TEE)

MASTER OF SCIENCE IN ENERGY ENGINEERING

1ST-4TH SEMESTER MSc

- POWER ELECTRONICS AND DRIVES (PED)
- ELECTRICAL POWER SYSTEMS AND HIGH VOLTAGE ENGINEERING (EPSH)
- WIND POWER SYSTEMS (WPS)
- MECHATRONIC CONTROL ENGINEERING (MCE)
- THERMAL ENERGY AND PROCESS ENGINEERING (TEPE)
- FUEL CELLS AND HYDROGEN TECHNOLOGY (HYTEC)

ENERGY IN ESBJERG

BACHELOR OF SCIENCE IN ENERGY

1ST-4TH SEMESTER

BASIC COURSES IN MATH, THERMAL, ELECTRICAL, MECHANICAL, THERMODYNAMIC AND CONTROL ENGINEERING

5TH-6TH SEMESTER

- SPECIALISATION IN THERMAL PROCESSES
- SPECIALISATION IN DYNAMIC SYSTEMS

MASTER OF SCIENCE IN ENERGY ENGINEERING

1ST-4TH SEMESTER MSc

- SPECIALISATION IN PROCESS ENGINEERING AND COMBUSTION TECHNOLOGY (PECT)
- SPECIALISATION IN OFFSHORE ENERGY SYSTEMS (OES)

BACHELOR AND MASTER OF SCIENCE

THE DEPARTMENT OF ENERGY TECHNOLOGY CONDUCTS TEACHING COVERING ALL ASPECTS OF ENERGY ENGINEERING FROM PRODUCTION OVER TRANSMISSION TO DISTRIBUTION AND EFFICIENT USE OF ENERGY. ALL TEACHING IS RESEARCH BASED WHICH MEANS THAT STUDENTS BENEFIT FROM THEIR TEACHERS AND PROFESSORS BEING RESEARCHERS THEMSELVES.

HENCE, ALL STUDENTS GAIN ACCESS TO THE NEWEST KNOWLEDGE WITHIN THEIR AREA. FURTHERMORE, THE COURSES ARE CONSTRUCTED FOR STUDENTS TO BE ABLE TO TEST AND TRY OUT THEIR THEORETICAL SKILLS PRACTICALLY IN WELL-EQUIPPED AND MODERN LABORATORIES.

FURTHER INFORMATION

HEAD OF BOARD OF STUDIES

ASSOCIATE PROFESSOR
BIRGITTE BAK-JENSEN
+45 9940 9274
BBJ@ET.AAU.DK

SES.AAU.DK

EDUCATION AND THE INDUSTRY

The study programmes are created in close collaboration with the industry in order to meet their demands. Every semester the students have possibilities to choose among a lot of project proposals suggested by the industry. Some students also take the opportunity to spend a semester in industry; this is a possibility for students at studies in Bachelor of Engineering in Sustainable Energy at the 6th semester and for master students in Energy at their 9th semester.

ADVISORY BOARD AND ADVISORY GROUP

A number of renowned Danish energy companies participate in an advisory board covering 6 different study boards. The advisory board is set down by the School of Engineering and Science. Further the Board of Studies in Energy has an advisory group with industrial members for the energy area only. Both boards meet once a year. The companies in these advisory panels help to develop the study programmes by sharing their points of view and every day challenges. The collaboration with the advisory board and advisory group continuously strengthens the relations between the industry and the Department of Energy Technology.

INTERNATIONAL STUDENTS

About 30 % of the students are international. Thus from the 5th semester and onwards all teaching is in English, partly in order to accommodate the numerous international students attending the courses, but also to prepare the Danish students to an international environment. There is strong student solidarity and students as well as teachers work closely together across the many specialisations.

PROBLEM BASED LEARNING

Problem based and project oriented learning is a large part of preparing the students for a carrier in the industry, giving them knowledge about working with realistic industrial projects and in teams. Further, practical tests are used to verify the theoretical methods used in the projects.

STUDENT INTAKE (FIRST YEAR STUDY - AALBORG AND ESBJERG)

	2010	2011	2012	2013	2014
AALBORG UNDERGRADUATE	37	39	58	51	52
AALBORG BACHELOR OF ENGINEERING	0	9	9	13	23
ESBJERG UNDERGRADUATE	0	18	26	36	31
TOTAL	37	66	93	100	106

STUDENT INTAKE (POSTGRADUATE)

	2010	2011	2012	2013	2014
AALBORG	70	62	59	40	58
ESBJERG	0	0	0	11	13

GRADUATED STUDENTS IN AALBORG

	2010	2011	2012	2013	2014
UNDERGRADUATE	33	16	30	18	28
BACHELOR OF ENGINEERING	0	0	0	6	5
POSTGRADUATE	20	22	49	36	42
TOTAL	53	38	79	60	75

GRADUATED STUDENTS IN ESBJERG (UNDERGRADUATE)

2010	2011	2012	2013	2014
0	0	0	11	6

Up to the 6th semester the students may change from bachelor of science to bachelor of engineering and vice versa.

PHD

THE DEPARTMENT OF ENERGY TECHNOLOGY AIMS TO CREATE A SOLID AND DYNAMIC ENVIRONMENT FOR PHD STUDENTS TO OBTAIN FUTURE INNOVATIVE SOLUTIONS FOR ENERGY TECHNOLOGIES. THE PROGRAMMES INITIATE ACTIVITIES LIKE ENERGY-RELATED COURSES FOR PHD STUDENTS, SEMINARS, RECRUITMENT MEETINGS, WORKING GROUPS, KEYNOTE LECTURES, PHD SUPERVISION MEETINGS AND SOME SOCIAL ACTIVITIES.

FURTHER INFORMATION

HEAD OF THE ENERGY TECHNOLOGY PROGRAMME

PROFESSOR
CLAUS LETH BAK
+45 9940 9281
CLB@ET.AAU.DK

ET.AAU.DK/PHD

THE DEPARTMENT HAS ONE MAIN STUDY PROGRAMME FOR PHD STUDENTS, WHICH BELONGS UNDER THE DOCTORAL SCHOOL OF ENGINEERING AND SCIENCE. THE RESEARCH ENVIRONMENT IS STRONGLY INTERNATIONAL AND AIMS TO PUBLISH RESEARCH RESULTS AT THE HIGHEST INTERNATIONAL LEVEL WITH IMPACT ON ACADEMIA AND INDUSTRY.

THE ENERGY TECHNOLOGY PROGRAMME

The programme is a cross-disciplinary PhD programme, which ranges between many basic engineering and science fields in order to solve the future challenges in the energy area by means of developing new energy technologies within the areas of electrical, thermal, and electromechanical engineering science.

The programme covers a broad range of energy-related topics like the energy conversion process itself as well as transmission, distribution and efficient use of energy (both thermal and electrical). The programme is experimental oriented and offers state of the art lab-facilities in all the disciplines. The PhD students work in a very close cooperation with industry both national and international as well as top-level research institutions worldwide.

The Energy Technology Programme has around 100 PhD students coming from all over the world. We enrol a great number of PhD students each year. They publish more than 150 publications in highly esteemed journals and conferences, such as IEEE, IET, Elsevier and Cigré.

The environment is characterised by a very innovative and positive spirit. The PhD students and their supervisors and industrial partners interact in an informal and close cooperation, which leads to world class research results.

NEW PHDS

2010	2011	2012	2013	2014
17	19	35	28	31

GRADUATED PHDS

2010	2011	2012	2013	2014
9	5	22	15	19

COLLABORATION

COLLABORATION

The department engages in strategic collaboration within all its areas of research, where mutual interests and individual competences can be brought together to create synergetic partnerships pushing the frontiers of science and applications. Collaboration partners comprise private enterprises, research and higher education institutions as well as public institutions and authorities from Denmark and abroad.

CONSULTANCY

- Knowledge building and training activities
- Test and laboratory facility rental
- Proof of concept, feasibility studies
- SME consultancy, direct or through "videnskupon" (knowledge coupon – government funded)

COLLABORATIVE PROJECTS

- Direct research collaboration
- Large research project, consortium or centre with third-party funding
- Direct co-financing of researcher positions
- Direct co-financing of PhD or postdoc positions
- Industrial PhD projects
- Co-financing of equipment or facilities

SPONSORSHIPS

- Equipment
- Buildings and facilities
- Student related activities through the Energy Sponsor Programme
  - Student trips and excursions
  - Prices and scholarships
  - Specific course topics

INDUSTRIAL COLLABORATION

In all research programmes, the department engages with industrial partners in specific projects typically involving PhD training, co-funded research positions and development of laboratory setups. Often, this type of collaboration is augmented by third-party funding from Government research councils (DSF, Innovation Fund, PSO, EUDP) or European (FP7, Horizon 2020, ERC) or international bodies, in some cases also from private foundations. This, however, is not a requirement, and specific projects involving only one or more industrial partners and the department also exist within the project portfolio. Consultancy work is also carried out on market terms.

INTERNATIONAL RELATIONS

The department strongly values and emphasizes its international relations, and continuously works to strengthen and expand these. International relations are very important in order to cross-fertilize knowledge and share with globally leading institutions, ensuring that the research and development activities undertaken at the department are at the forefront. Furthermore, it significantly enhances the learning environment for energy students as well as their teachers to be able to be inspired by, and even collaborate with the leading companies and institutions globally in energy technology and science.

COMPANIES ON CAMPUS

A number of companies are physically represented at the campus of the department, typically by placing part of an R&D department here. This provides contact with researchers and students on a daily basis, giving unique opportunities for collaboration and making the company very visible for students through student projects, scholarships and student jobs, as well as for identifying the strongest candidates for future jobs. It also provides a platform for long term co-development of large experimental facilities, valuable to both research and industrial development.

THE ENERGY SPONSOR PROGRAMME

The overall purpose of the Energy Sponsor Programme is to strengthen the energy engineering educations at the department in order to enhance the education of tomorrow's engineers. By being proactive, the Energy Sponsor Programmes, i.a. aims to:

- Ensure a sufficient number of energy engineers
- Enhance the academic profile and quality of MSc's
- Create synergy between students, student projects and the companies

BOARD

The Energy Sponsor Programme is organised by a board in which the department and six of the member companies are represented. Furthermore, the programme has a part time secretariat at the Department of Energy Technology that takes care of the organisation and administration of the programme. Members of the board naturally influence the Energy Sponsor Programme both with regards to management and decisions concerning e.g. activities, budget, and the annual Energy Seminar etc.

MEMBERSHIP

The Energy Sponsor Programme requires membership. As a member of the Energy Sponsor Programme, a company supports the overall aim, and acquires certain benefits in relation to the means of the Programme. Members must pay a yearly fee, and the size of the latter is determined according to the type of membership of which there are two: A "Basic Membership" and an "Extended Membership".

ADVANTAGES

Whichever membership is chosen it will give the company an increased exposure towards the students through events such as visits to the company, project proposals, scholarships, student jobs, and the presence at the yearly award presentation. In this way the students more than likely remember the company when they start to consider their future career.

You can read much more about the Energy Sponsor Programme at et.aau.dk/energy-sponsor-programme. If your company wants to be a member, please contact information officer Hanne Munk Madsen, hmm@et.aau.dk, 9940 3313 or Maria Hald Friis, mha@et.aau.dk, 9940 9238.

DEPARTMENT OF ENERGY TECHNOLOGY

AALBORG UNIVERSITY

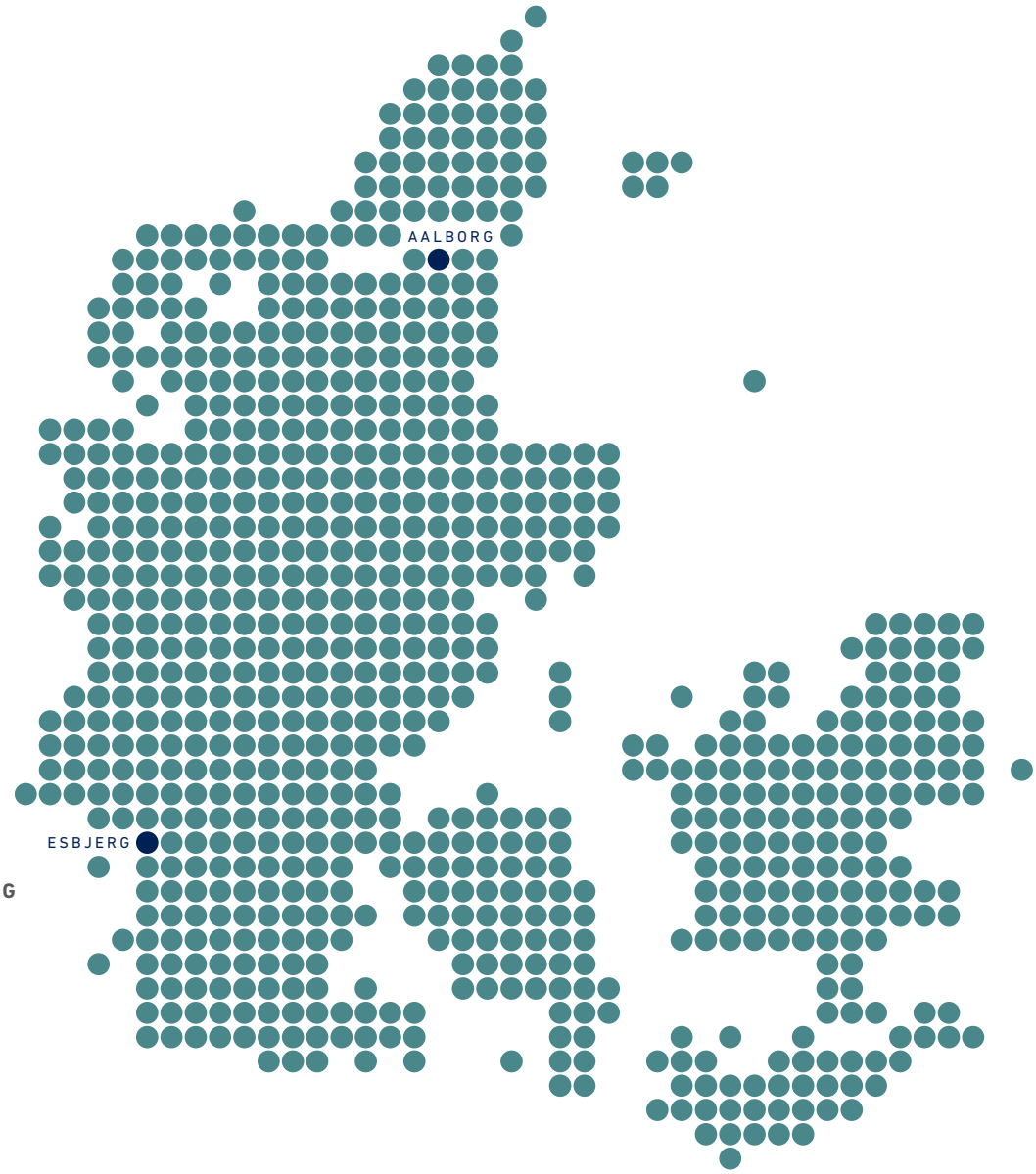
Pontoppidanstræde 101
9220 Aalborg East
Denmark

Phone +45 9940 9240
Fax +45 9815 1411

et.aau.dk

Head of Department
John K. Pedersen
+45 9940 9264
jkp@et.aau.dk

Department Secretary
Tina L. Larsen
+45 9940 9240
inst-sekr@et.aau.dk



AALBORG UNIVERSITY ESBJERG

Niels Bohrs Vej 8
6700 Esbjerg
Denmark

Section Leader
Jens Bo Holm-Nielsen
+45 9940 3317
jhn@et.aau.dk

AALBORG UNIVERSITY
DENMARK