Curriculum 8th Semester
Energy, Technology and Management

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Aim and description: Energy – Technology and Management

The aim of the elective is to give the students an insight into and perspective on energy technologies and energy systems. The emphasis is on Danish energy policies and solutions, but these are also seen in an international context.

The international aspect of the semester is underlined by the fact that the programme is open to international as well as Danish students and an essential purpose of the course is to practice communication and cooperation between students from different countries and cultures. Therefore, all lectures, all educational material and all assignments will be in English.

Structure of the course

The course consists of two parts of a duration of approximately 8 weeks each, corresponding to 15 ECTS. Each part can be taken separately.

Part 1		Part 2	
Language & Culture 5 ECTS	Exam	Optimization of an Energy System 5 ECTS	Common Exam
Bioenergy 4 ECTS		Energy Efficiency and Power to X 4 ECTS	
Oil and Gas Production 4 ECTS		Renewable Energy Systems 4 ECTS	
Combined Heat and Power 2 ECTS		District Heating 2 ECTS	

All the subjects shown in a part are compulsory. For a more detailed description, see the curriculum for the specific part and subject.

The subject Culture substitutes the language and culture part of the cross-curricular element (document no. 1148-01) compulsory for Danish students (Current tilte of module is “Language & Culture”).

The subject Optimization of an Energy System substitutes the methodology part of the cross-curricular element (document no. 1148-01) compulsory for Danish students.

Content of Part 1

Part 1 of the elective Energy – Technology and Management at Aarhus School of Marine and Technical Engineering consists of the following 4 subjects:

Culture	5 ECTS
Bioenergy	4 ECTS
Oil and Gas Production	4 ECTS
Combined Heat and Power (CHP)	2 ECTS

Prerequisites

International students: High school diploma followed by at least one year of university studies in the natural sciences, engineering, management or economics.

Danish students: Passed 7th semester exam.

Credit

15 ECTS

Duration

8 - 9 weeks (Beginning February – End March or Mid-August – Mid October).

Aim

The student shall acquire fundamental knowledge of energy from oil, gas, and biomass and how these fuels are used in combined heat and power plants in a Danish as well as an international context. The student shall also acquire general knowledge of energy policies and strategies. Furthermore, the student shall acquire knowledge of cultural analysis and cross-cultural communication.

Learning Outcomes

The learning outcomes are divided between knowledge, skills and competencies.
Taxonomy: SOLO multistructural level unless otherwise stated.

Knowledge

Culture

The student has knowledge of:

- Different theories and models relating to cultural understanding and cultural analysis
- Intercultural communication and cooperation

Bioenergy

The student has knowledge of:

- Energy content of biomass as it relates to chemical composition
- Pre-treatment techniques of biomass
- Operating methods of different biogas reactor types
- Different biological processes and process kinetics
- Simple models to simulate anaerobic processes
- Technologies for purification and upgrading of biogas
- Basic principles of biodiesel and bioethanol production (SOLO unistructural level)

Oil and Gas Production

The student has knowledge of:

- Offshore oil exploration
- Offshore oil well drilling technology
- Oil and gas production from oil well to refinery

- Technologies for transportation of gas (LNG)

Combined Heat and Power

The student has knowledge of:

- Relevant thermodynamics, e.g. energy balances and work cycles
- Plant design and combustion techniques for solid biofuel and waste
- The volatile CO2 neutral energy system
- Different types of energy storage
- Energy quality (Exergy)
- Different types of combined heat and power

Skills

Culture and Energy Policy

The student can:

- Describe cultural aspects of an international work situation
- Analyze cultural aspects of an international work situation

Bioenergy

The student can:

- Calculate the dimensions of a biogas plant
- Calculate the impact on the greenhouse gas balance
- Quantify the energy production from a given amount of biomass

Oil and Gas Production

The student can:

- Read technical literature on oil and gas production
- Participate in discussions on related subjects

Combined Heat and Power

The student can:

- Calculate plant efficiencies
- Analyze the effect of adding heat pumps and heat storage to a CHP plant
- Discuss pros and cons of CHP plants and condensing power plants
- Discuss pros and cons of the absorbtion heat pump and the compressor heat pump

Competencies

Theoretical foundation for employment within energy production. The student can outline and discuss national strategies for energy supply. Furthermore, the student can relate in an analytical and critical way to the cultural differences present in an international work situation.

Exam

The subject Language & Culture is evaluated through an oral exam. The duration of the exam is 20 minutes including marking. Mark: One mark from the Danish scale (consisting of the marks -3, 00, 02, 4, 7, 10, 12, where 02 is the passing mark).

The subject Bio Energy is evaluated through a group project work. The group size is max 6 students. The group hands in a report of 8 standard pages. (A standard page is 2400 characters including blanks).

Additionally, the group in common makes an oral presentation of their project (10 minutes per participant) followed by an individual examination of approximately 10 minutes in total for the group. Mark: passed/failed.

The subject Oil and Gas Production is evaluated through a group project work. The group size is max 6 students. On the last day of the second last week of Part 1 the group hands in a report of 4 standard pages per student. (A standard page is 2400 characters including blanks). Additionally, each student writes a single page in which he describes his contribution to the report and his outcome of the project. Mark: passed/failed.

The subject Combined Heat and Power is evaluated through a number of individual compulsory assignments which must be approved to pass the course.

Content of Part 2

Part 2 of the elective Energy – Technology and Management at Aarhus School of Marine and Technical Engineering can be taken separately or in combination with part 1, to make up a full semester. Part two consists of the following 4 subjects:

Optimization of an Energy System	5 ECTS
Energy Efficiency and Power to X	4 ECTS
Renewable Energy Systems	4 ECTS
District Heating (DH)	2 ECTS

Prerequisites

International students: High school diploma followed by at least one year of university studies in the natural sciences, engineering, management or economics.

Danish students: Passed 7th semester exam.

Credit

15 ECTS.

Duration

8 - 9 weeks (Beginning Mid-April – End June or Mid-October – Mid December).

Aim

The students shall acquire a theoretical basis for optimizing energy systems towards a higher degree of sustainability, and be able to document their results in a professional report according to document no. 1148-02.

Learning Outcomes

Taxonomy: SOLO multistructural level unless otherwise stated.

Knowledge

Optimization of an Energy System

The student has knowledge of:

- Tools to balance energy systems (EnergyPlan)
- Excess electricity production
- Different technologies that can be used in the development of an energy system
- Scientific methodology in a project work

Energy Efficiency

The student has knowledge of:

- Tools for setting up a baseline for energy consumption
- Tools for calculations on heat loss from buildings
- Methods for calculating and assessing energy consumption in industrial processes
- Relevant legislation concerning energy consumption
- DS/EN ISO 50001, international standard for Energy Management Systems

Power to X

The student has knowledge of:

- Layout of a PtX system
- Hydrogen as energy carrier
- Water treatment
- Overall operation of the PtX plant

Renewable Energy Systems

The student has knowledge of:

- Tools for modeling and developing energy systems
- Mechanical and electrical components of wind turbines
- Principles of solar thermal and solar photovoltaic energy plants
- Energy content in solar radiation and wind
- Methods of energy storage

District Heating

The student has knowledge of:

- Layout of a district heating system
- Properties for efficient district heating supply and consumption
- General socioeconomic advantages of district heating

Skills

Optimization of an Energy System

The student can:

- Use the software tool EnergyPLAN to develop and balance a large scale energy system
- Use the software tool EnergyPLAN to calculate socioeconomic aspects of developing sustainable energy systems
- Discuss possibilities for development of energy systems towards a higher degree of sustainability
- Use correct methodology in a project work.

Energy Efficiency

The student can:

- Set up a baseline for energy consumption
- Identify and assess optimization actions in buildings and industrial processes

- Set up action plans for energy optimization activities
- Prepare procedures for an Energy Management System

Power to X

The student can:

- Identify and explain the various components in a PtX plant
- Plan maintenance of a PtX plant
- Trouble shooting in the PtX process.

Renewable Energy Systems

The student can:

- Conduct basic dimensioning of solar and wind energy plants
- Calculate the energy output from solar and wind based energy plants
- Plan maintenance routines for renewable plants

District Heating

The student can:

- Evaluate the function of a district heating consumer installation
- Discuss advantages and disadvantages of district heating compared to individually heated buildings

Competencies

The student can participate in teams working with energy savings or within sustainable energy technology and can take part in development of sustainable energy systems.

Exam

The subject Optimization of an Energy System is evaluated through a project work in which a future energy system of a limited area is modeled in the program EnergyPLAN. The project work must encompass all the other subjects of Energy – Technology and Management including methodology. The group size is max 6 students. On the last day of the course in the second to last week of the course, each group hands in a project report of max 20 (+1) standard pages. A standard page is 2400 characters including blanks.

In addition, each student writes a personal script of one page which comprises a description of the individual contribution to the project and the personal outcome hereof. The personal script does not count as a part of the 20 project pages.

The group projects are subsequently evaluated and graded by the OP teacher. Written feedback is given to each study group along with the corresponding grade.

Mark: One mark from the Danish scale (consisting of the marks -3, 00, 02, 4, 7, 10, 12, where 02 is the passing mark).

In the subjects Energy Efficiency, Power to X, Renewable Energy Systems and District Heating there will further be a number of compulsory assignments and exercises that must be handed in and approved in order to gain the corresponding ECTS points for each module.

In addition to the compulsory assignments mentioned above, a portfolio assignment must be provided in the modules:

EE – Energy Efficiency
P2X – Power 2 X
CHP – Combined Heat and Power
OG – Oil & Gas Production

RES WP – Wind Power
RES SP – Solar Power
DH – District Heating

On the basis of the handed in portfolio assignments each student is evaluated individually through an oral exam. The portfolio assignments in question are chosen by an algorithm in the Campus software. Four different portfolio subjects are chosen from the above six possibilities.

The number of students is thus divided into four segments in order to direct each fourth to the four chosen portfolio assignments as base for the oral exam.

The duration of the exam is 20 minutes including marking. Mark: One mark from the Danish scale (consisting of the marks -3, 00, 02, 4, 7, 10, 12, where 02 is the passing mark).

The oral portfolio exam is carried out during the second to last week of the course.

In the event that a student does not pass the portfolio exam, the student must resit the exam at a later date scheduled by the School Administration. The subject for the resitting of the exam is chosen randomly between the different exam subjects of the elective by the campus algorithm.

Overview of subject content, ECTS, form of evaluation and assessment

Part 1

Indhold	Skema	ECTS	Eva.	Eks.	Bedøm.	Navn DK/GB
198901 A	LC	5	MDT	IP	7TRIN	Language & Culture
198902 A	BIO	4	PRO	IP	BE/IB	Bioenergy
198902 B	OG	4	RAP	IP	BE/IB	Oil and Gas Production
198902 C	CHP	2	LB	IP	BE/IB	Combined Heat and Power

Part 2

Indhold	Skema	ECTS	Eva.	Eks.	Bedøm.	Navn DK/GB
198904 A	OP	5	RAP	IP	7TRIN	Optimization of an Energy System
198903 A	EE	4	LB	IP	BE/IB	Energy Efficiency
198903 B	RES	4	LB	IP	BE/IB	Renewable Energy Systems (Wind + Solar)
198903 C	DH	2	LB	IP	BE/IB	District Heating
198904 B			POR	IP	7TRIN	Energy Portfolio

Date	Overview of corrections, additions etc.
August 2023	– Minor linguistic corrections to the section on exam in part 2 – Learning outcome, skills under Combined Heat and Power removed (Initially use EnergyPlan for the modelling of energy flow scenarios) – Learning outcome, knowledge under Optimization of an energy system adjusted (before: Tools to balance energy systems, now: Tools to balance energy systems (EnergyPlan)) – Conditions for reexamination (oral portfolio exam) have been added – Curriculum and teaching plans have been updated with a new set-up and new layout – Document no. changed from 1148-21 to 1148B
January 2024	– The subject Power 2 X is integrated in the subject Energy Efficiency so that approximately 2 ECTS points are allocated to each subject.
August 2024	– Group size changed from max 5 to max 6