

## **Energy technology**

The subject of energy technology covers energy technology components, and how systems work and are constructed. The subject is partly based on scientific principles implemented at energy technology facilities. An environmental perspective is covered in the subject since energy technology systems have a considerable impact on the environment.

### **Aim of the subject**

Teaching in the subject of energy technology should aim at helping students develop knowledge of carrying out operations, maintenance and service of energy technology facilities, and the ability to solve practical problems in the area. It should also help students develop knowledge of basic physical quantities, the mathematics required and basic chemistry. In addition, students should be given the opportunity to develop knowledge of treating, sampling and analysing different kinds of water used in the processing industry and in energy, environmental and hydro technologies. Teaching should also help students develop a theoretical foundation in the area of energy.

Teaching should give students the opportunity to develop understanding of efficient and sustainable use of energy and recycling systems. Students should also be given opportunities to develop a knowledge of both conventional and alternative energy systems, and to develop safety awareness, professional identity and a professional and ethical approach.

Through experiment, testing and an investigative approach, students should be given the opportunity to develop their ability to solve problems related to the operations, maintenance and servicing of energy technology facilities. Practical exercises should give students the opportunity to develop technical knowledge, and manage technical equipment.

### **Teaching in the subject of energy technology should give students the opportunities to develop the following:**

- 1) Knowledge of different energy technology equipment.
- 2) Knowledge of the structure, functions and principles of different system solutions in energy technology.
- 3) Knowledge of various sources of energy and fuels, and also the properties of energy bearing media.
- 4) The ability to carry out tasks in different energy technology facilities, and also work with due regard to safety, quality and the environment.
- 5) The ability to optimise, and also carry out control and operating routines, and energy-saving measures in different energy facilities.
- 6) The ability to solve physical or chemical water problems through laboratory work.
- 7) The ability to handle materials and tools.

- 8) The ability to document and evaluate their work.
- 9) The ability to cooperate with others and use the language of the profession.
- 10) The ability to work in accordance with laws and other regulations.

### **Courses in the subject**

- Energy technology 1, 100 credits.
- Energy technology 2, 100 credits, which builds on the course, energy technology 1.
- Renewable energy, 100 credits, which builds on the course, energy technology 1, the course, forestry 1, or the course, plant cultivation 1.
- Water and process chemistry, 100 credits.

## Energy technology 1

The course, energy technology 1, covers points 1–10 under the heading Aim of the subject. The course covers basic knowledge in the subject.

### Core content

*Teaching in the course should cover the following core content:*

- Basic understanding of systems in applicable energy areas, and also effective management of energy.
- Energy content of different fuels.
- Renewable sources of energy: sun, wind, waves, heat pumps, energy gases, biofuels and alternative fuels for vehicles.
- Energy consumption in the EU.
- Process knowledge of nuclear power, hydroelectric power, thermal power, district heating and district cooling.
- Process knowledge of water purification for drinking water and contaminated water, and also environmental and recycling thinking.
- Handling, assembling, measuring and simpler maintenance of energy technology equipment.
- Safety regulations in the energy area.
- Measuring systems for energy and output, and also units and abbreviations for energy and output.
- Use and maintenance of equipment and tools.
- Safety thinking and professional ethics. Working environment and ergonomics.
- Laws and other regulations.

### Knowledge requirements

#### Grade E

Students give an account **in basic terms** of different equipment in energy technology systems. In addition, students give an account **in basic terms** of the build-up, function and principles of different system solutions in energy technology and different sources of energy. Students also describe **in basic terms** the properties of energy bearing media.

Students carry out with **some** skills and **in consultation** with the supervisor common, simple tasks in energy technology facilities, and achieve results that fulfil specified requirements with regard to safety, quality and the environment. In their work, students solve **with some certainty** simple problems in physics and water chemistry, through calculations and laboratory work. Students carry out **in consultation** with the supervisor **simple** control and operating routines by using energy technology equipment. Students use and maintain **in consultation** with the supervisor materials and tools in accordance with instructions and work descriptions.

Students document **with some certainty** their work, and evaluate it in **simple** assessments.

In their work, students cooperate with others and use **simple** professional language appropriate to the task. The work is carried out in accordance with laws and other regulations.

In consultation with the supervisor, students assess **with some certainty** their own ability and the requirements of the situation.

### **Grade D**

Grade D means that the knowledge requirements for grade E and most of C are satisfied.

### **Grade C**

Students give an account **in detail** of different equipment used in energy technology systems. In addition, students give an account **in detail** of the build-up, function and principles of different system solutions in energy technology and different sources of energy, **and also how they interact**. Students also describe **in detail** the properties of energy bearing media.

Students carry out with **good** skills and **after consultation** with the supervisor common simple tasks in energy technology facilities, and achieve results that fulfil specified requirements with regard to safety, quality and the environment. In their work, students solve **with some certainty** simple problems in physics and water chemistry, through calculations and laboratory work. Students carry out **in consultation** with the supervisor simple control and operating routines by using energy technology equipment. Students use and maintain **after consultation** with the supervisor materials and tools in accordance with instructions and work descriptions.

Students document **with certainty** their work and evaluate it in **simple** assessments.

In their work, students cooperate with others, and use **balanced** professional language appropriate to the task. The work is carried out in accordance with laws and other regulations.

In consultation with the supervisor, students assess **with some certainty** their own ability and the requirements of the situation.

### **Grade B**

Grade B means that the knowledge requirements for grade C and most of A are satisfied.

### **Grade A**

Students give an account **in detail and in a balanced way** of different equipment used in energy technology systems. In addition, students give an account **in detail and in a balanced way** of the

build-up, function and principles of system solutions in energy technology and different sources of energy, **and also how they interact**. Students also describe **in detail and in a balanced way** the properties of energy bearing media.

Students carry out with **very good** skills and **after consultation** with the supervisor common simple, **and also more advanced** tasks in energy technology facilities, and achieve results that fulfil specified requirements with regard to safety, quality and the environment. In their work, students solve **with certainty** simple problems in physics and water chemistry, through calculations and laboratory work. Students carry out **in a responsible way and after consultation** with the supervisor control and operating routines using energy technology equipment. Students use and maintain **after consultation** with the supervisor materials and tools in accordance with instructions and work descriptions.

Students document **with certainty** their work and evaluate it in **balanced** assessments.

In their work, students cooperate with others, and use **balanced** professional language **appropriate for the recipient and** the task. The work is carried out in accordance with laws and other regulations.

In consultation with the supervisor, students assess **with certainty** their own ability and the requirements of the situation.

## Energy technology 2

The course, energy technology 2, covers points 1–10 under the heading Aim of the subject. The course covers advanced knowledge in the subject.

### Core content

*Teaching in the course should cover the following core content:*

- Properties of media for distributing energy.
- General pump technology, laws of thermodynamics and hydrodynamics.
- General corrosion principles and properties of different materials.
- Key measures in the energy area e.g. force, pressure, temperature, energy, power and efficiency.
- Structure, function, operating principles, production conditions and environmental consequences for energy, environmental and water facilities.
- Maintenance routines in the energy area.
- Control and operating routines in different facilities.
- Safety regulations in the energy area.
- Calculations and applications of mechanics and thermodynamics in energy technology facilities.
- Optimisation of efficiency and quality of energy, environmental and water facilities.
- Use and maintenance of equipment and tools.
- Safety thinking and professional ethics.

### Knowledge requirements

#### Grade E

Students give an account **in basic terms** of the build-up, function and principles of different energy technology systems and different sources of energy. In addition, students describe **in basic terms** the properties of energy bearing media.

Students carry out with **some** skills and **in consultation** with the supervisor common tasks in energy technology facilities, and achieve results that fulfil specified requirements with regard to safety, quality and the environment. In their work, students solve **with some certainty** simple problems in physics and water chemistry, through calculations and laboratory work. Students carry out **in consultation** with the supervisor **simple** control and operating routines by using

energy technology equipment. Furthermore, students evaluate results in **simple** assessments, and propose energy-saving measures, and also optimise **in consultation** with the supervisor energy facilities. Students use and maintain **in consultation** with the supervisor materials and tools in accordance with instructions and work descriptions.

Students document **with some certainty** their work, and evaluate it in **simple** assessments.

In their work, students cooperate with others and use **simple** professional language appropriate to the task. The work is carried out in accordance with laws and other regulations.

In consultation with the supervisor, students assess **with some certainty** their own ability and the requirements of the situation.

### **Grade D**

Grade D means that the knowledge requirements for grade E and most of C are satisfied.

### **Grade C**

Students give an account **in detail** of the build-up, function and principles of different energy technology systems and different sources of energy. In addition, students describe **in detail** the properties of energy bearing media.

Students carry out with **good** skills and **after consultation** with the supervisor common tasks in energy technology facilities, and achieve results that fulfil specified requirements with regard to safety, quality and the environment. In their work, students solve **with some certainty** simple problems in physics and water chemistry, through calculations and laboratory work. Students carry out **in a responsible way and after consultation** with the supervisor control and operating routines using energy technology equipment. Furthermore, students evaluate results in **simple** assessments, and propose energy-saving measures, and also optimise **after consultation** with the supervisor energy facilities. Students use and maintain **after consultation** with the supervisor materials and tools in accordance with instructions and work descriptions.

Students document **with certainty** their work and evaluate it in **simple** assessments.

In their work, students cooperate with others, and use **balanced** professional language appropriate to the task. The work is carried out in accordance with laws and other regulations.

In consultation with the supervisor, students assess **with some certainty** their own ability and the requirements of the situation.

### **Grade B**

Grade B means that the knowledge requirements for grade C and most of A are satisfied.

### **Grade A**

Students give an account **in detail and in a balanced way** of the build-up, function and principles of different energy technology systems and different sources of energy. In addition, students describe **in detail and in a balanced way** the properties of energy bearing media.

Students carry out with **very good** skills and **after consultation** with the supervisor common tasks in energy technology facilities, and achieve results that fulfil specified requirements with regard to safety, quality and the environment. In their work, students solve **with certainty** simple problems in physics and water chemistry, through calculations and laboratory work. Students carry out **in a responsible way and after consultation** with the supervisor control and operating routines using energy technology equipment. Furthermore, students evaluate results in **balanced** assessments, and propose energy-saving measures, and also optimise **after consultation** with the supervisor energy facilities. Students use and maintain **after consultation** with the supervisor materials and tools in accordance with instructions and work descriptions.

Students document **with certainty** their work and evaluate it in **balanced** assessments.

In their work, students cooperate with others, and use **balanced** professional language **appropriate to the recipient** and the task. The work is carried out in accordance with laws and other regulations.

In consultation with the supervisor, students assess **with certainty** their own ability and the requirements of the situation.



## Renewable energy

The course, renewable energy, covers points 1–5 and 7–10 under the heading Aim of the subject.

### Core content

*Teaching in the course should cover the following core content:*

- The main components in various alternative energy facilities and their functions.
- Energy conversion and energy generation in the operation of different facilities.
- Fuel for renewable energy facilities and waste management for operating, safety and environmental considerations.
- Fuels and their properties, and combustion processes.
- Renewable sources of energy, e.g. bioenergy, solar energy, wind power and wave power. Natural sources of heat and heat pumps. Renewable energy for powering vehicles.
- Operating and maintenance routines for different types of facilities.
- Safety thinking and professional ethics.
- Use and maintenance of equipment and tools.
- Laws and other regulations applying to operations, the environment and safety in the use of renewable sources of energy and fuels.

### Knowledge requirements

#### Grade E

Students give an account **in basic terms** of the build-up, function and principles of different energy technology systems and different sources of energy. In addition, students describe **in basic terms** the properties of energy bearing media.

Students carry out with **some** skills and **in consultation** with the supervisor common tasks in energy technology facilities, and achieve results that fulfil specified requirements with regard to safety, quality and the environment. Students carry out **in consultation** with the supervisor **simple** control and operating routines by using energy technology equipment. Furthermore, students evaluate results in **simple** assessments, and propose energy-saving measures, and also optimise **in consultation** with the supervisor energy facilities. Students use and maintain **in consultation** with the supervisor materials and tools in accordance with instructions and work descriptions.

Students document **with some certainty** their work, and evaluate it in **simple** assessments.

In their work, students cooperate with others and use **simple** professional language appropriate to the task. The work is carried out in accordance with laws and other regulations.

In consultation with the supervisor, students assess **with some certainty** their own ability and the requirements of the situation.

### **Grade D**

Grade D means that the knowledge requirements for grade E and most of C are satisfied.

### **Grade C**

Students give an account **in detail** of the build-up, function and principles of different energy technology systems and different sources of energy. In addition, students describe **in detail** the properties of energy bearing media.

Students carry out with **good** skills and **after consultation** with the supervisor common tasks in energy technology facilities, and achieve results that fulfil specified requirements with regard to safety, quality and the environment. Students carry out **in a responsible way and after consultation** with the supervisor control and operating routines using energy technology equipment. Furthermore, students evaluate results in **simple** assessments, and propose energy-saving measures, and also optimise **after consultation** with the supervisor energy facilities. Students use and maintain **after consultation** with the supervisor materials and tools in accordance with instructions and work descriptions.

Students document **with certainty** their work and evaluate it in **simple** assessments.

In their work, students cooperate with others, and use **balanced** professional language appropriate to the task. The work is carried out in accordance with laws and other regulations.

In consultation with the supervisor, students assess **with some certainty** their own ability and the requirements of the situation.

### **Grade B**

Grade B means that the knowledge requirements for grade C and most of A are satisfied.

### **Grade A**

Students give an account **in detail and in a balanced way** of the build-up, function and principles of different energy technology systems and different sources of energy. In addition, students describe **in detail and in a balanced way** the properties of energy bearing media.

Students carry out with **very good** skills and **after consultation** with the supervisor common tasks in energy technology facilities, and achieve results that fulfil specified requirements with regard to safety, quality and the environment. Students carry out **in a responsible way and after consultation** with the supervisor control and operating routines using energy technology equipment. Furthermore, students evaluate results in **balanced** assessments, and propose energy-saving measures, and also optimise after consultation with the supervisor energy facilities. Students use and maintain **after consultation** with the supervisor materials and tools in accordance with instructions and work descriptions.

Students document **with certainty** their work and evaluate it in **balanced** assessments.

In their work, students cooperate with others, and use **balanced** professional language **appropriate to the recipient** and the task. The work is carried out in accordance with laws and other regulations.

In consultation with the supervisor, students assess **with certainty** their own ability and the requirements of the situation.

## Water and process chemistry

The course, water and process chemistry, covers points 2, 4 and 6–10 under the heading Aim of the subject. The course covers basic knowledge in the subject.

### Core content

*Teaching in the course should cover the following core content:*

- Basic chemistry, and also stoichiometric calculations in the water and environmental area.
- Chemical processes in connection with manufacturing processes.
- Corrosion with focus on water chemistry.
- Suitability of different types of water such as raw water.
- Mechanical, biological and chemical cleaning of raw water.
- Sampling, measuring and analysing, and also the use of measuring equipment in the water and environmental area.
- Handling chemicals in a safe and environmentally friendly way.
- Softening and total desalination.
- Requirements for boiler water, condensate and excess water.
- Use and maintenance of equipment and tools.
- Safety thinking and professional ethics.

### Knowledge requirements

#### Grade E

Students give an account **in basic terms** of sub-processes in manufacturing processes. In addition, students give an account **in basic terms** of the build-up, function and principles of different system solutions in energy technology.

Students carry out with **some** skills and **in consultation** with the supervisor **simple** sampling and analyses, and achieve results that fulfil specified requirements with regard to safety, quality and the environment. In their work, students solve **with some certainty simple** problems in physics and water chemistry, through calculations and laboratory work.

Students use and maintain **in consultation** with the supervisor materials and tools, and handle chemicals in accordance with instructions and work descriptions.

Students document **with some certainty** their work, and evaluate it in **simple** assessments.

In their work, students cooperate with others and use **simple** professional language appropriate to the task. The work is carried out in accordance with laws and other regulations.

In consultation with the supervisor, students assess **with some certainty** their own ability and the requirements of the situation.

### **Grade D**

Grade D means that the knowledge requirements for grade E and most of C are satisfied.

### **Grade C**

Students give an account **in detail** of sub-processes in manufacturing processes. In addition, students give an account **in detail** of the build-up, function and principles of different system solutions in energy technology.

Students carry out with **good** skills and **after consultation** with the supervisor sampling and analyses, and achieve results that fulfil specified requirements with regard to safety, quality and the environment. In their work, students solve **with responsibility and with some certainty** problems in physics and water chemistry, by means of calculations and laboratory work.

Students use and maintain **after consultation** with the supervisor materials and tools, and handle chemicals in accordance with instructions and work descriptions.

Students document **with certainty** their work and evaluate it in **simple** assessments.

In their work, students cooperate with others, and use **balanced** professional language appropriate to the task. The work is carried out in accordance with laws and other regulations.

In consultation with the supervisor, students assess **with some certainty** their own ability and the requirements of the situation.

### **Grade B**

Grade B means that the knowledge requirements for grade C and most of A are satisfied.

### **Grade A**

Students give an account **in detail and in a balanced way** of advanced sub-processes in manufacturing processes. In addition, students give an account **in detail and in a balanced way** of the build-up, function and principles of different system solutions in energy technology.

Students carry out with **very good** skills and **after consultation** with the supervisor advanced sampling and analyses, and achieve results that fulfil specified requirements with regard to safety, quality and the environment. In their work, students solve **with responsibility and with certainty, complex** problems in physics and water chemistry, by means of calculations and laboratory work.

Students use and maintain **after consultation** with the supervisor materials and tools, and handle chemicals in accordance with instructions and work descriptions.

Students document **with certainty** their work and evaluate it in **balanced** assessments.

In their work, students cooperate with others, and use **balanced** professional language **appropriate for the recipient and** the task. The work is carried out in accordance with laws and other regulations.

In consultation with the supervisor, students assess **with certainty** their own ability and the requirements of the situation.