BA&VET

Promoting permeability through dual bachelor's programs with integrated initial and further vocational training (BA&VET)

Co-funded by the Erasmus+ Programme of the European Union

# Result 4.1

# Concept, curricula and module handbook for three-cycle dual study program "Engineering in Management of Renewable Energy Technology in Buildings"

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English

## Contents

# Project Summary and Introduction

The word region is defined as "an area, especially part of a country or the world having definable characteristics but not always fixed boundaries"[1]. The Baltic Sea region (BSR) is particularly unique. While the Baltic Sea is the pivotal point defining much of the region's characteristics and challenges, the countries are also extremely different. Geographically, they are divided between Northern, Western and Central/Eastern Europe, historically, they have been shaped by the East-West divide after the second world war. Nevertheless, given their proximity to the Baltic Sea, they have much in common.

The EU has acknowledged this by issuing the very first macro-regional strategy, the EU Baltic Sea Region Strategy in 2009. As most countries boarding the Baltic Sea were by then EU member states, it can well be considered the EU's inland sea. The Baltic Sea Region must address current challenges, such as saving the seas, i.e. ensuring clear water, rich and healthy wildlife and clean and safe shipping. At the same time, there are opportunities for a prosperous region through co-operation measures to increase innovation, to deepen the internal market by improving transport systems, to connect energy markets and to jointly fight cross-border crime. This clearly distinguishes the Baltic Sea Region from other parts of the world.

Therefore, "BSR integration is best understood as the way that European integration has been translated into this region, further deepening and leveraging access to the rest of Europe and the markets that the EU provides"[2]

Over the past 25 years, this region has become a densely integrated, e.g. in the areas of trade, investment, labor mobility, transport and energy infrastructure as well as research collaboration. Furthermore, it demonstrates a broad landscape of robust cross-border organizations and collaborative efforts. Nevertheless, "companies do not look at the Baltic Sea Region as one integrated market in terms of their strategies. For most of them, the region remains a group of individually small markets within the EU, each with its different dynamics, rivals, and often even regulatory rules'"[3].

Keeping this in mind, the lack of comprehensive regional data collection is surprising. Therefore, as part of the Erasmus+ funded project "Promoting permeability through dual bachelor's programs with integrated initial and further vocational training" (BA&VET), an analysis of the region's demography, economy, and labour as well as education market has been conducted. The majority of the data is taken from the Eurostat database of the European Union. When needed additional sources, such as the OECD database have been consulted as well.

[1] Oxford Dictionary
[2] Skilling, David (2018). *The Baltic Sea Economies: Progress and Priorities*. Copenhagen: Baltic Development Forum, p.10.
[3] Ibid., p.11

## Project summary

Objectives: What do you want to achieve by implementing the project?

- Increasing permeability between vocational and higher education
- Recruiting universities for tasks of further education in climate and environ-mental protection
- Providing excellently qualified entrepreneurs, managers and skilled workers and reducing the shortage of skilled workers to meet the challenges in climate and environmental protection
- Strengthening the productivity of SMEs through innovation support and R&D projects
- Promoting cooperation between SMEs and colleges/universities

Implementation: What activities are you going to implement?

- Analyses economy, education and labour markets and qualification needs
- Creation of solution models for 4 project countries
- Development and implementation of Train the Trainer program
- Development and implementation of 2 dual three-stage Bachelor's degree programs and 2 further trainings in climate and environmental protection
- Implementation of R&D projects in SMEs
- Quality assurance for training measures and project implementation
- Dissemination, transfer of results and implementation consultation

Results: What project results and other outcomes do you expect your project to have?

- Result report of the analyses of the economy, education and labour markets and qualification needs
- Solution models for four project countries
- Complete train-the-trainer program
- Module manuals with all documentation for two dual three-stage Bachelor's programs in climate and environmental protection
- Two further education programs in climate and environmental protection
- R&D projects implemented in SMEs
- Quality manual and results reports
- Manual, result videos and broad regional transfer of results

## Objectives, results and target groups

The main objectives of the project are as follows:

a) Increasing the permeability between vocational education and training and higher education and thus promoting the attractiveness of vocational education and training

b) Strengthening the recruitment of colleges/universities for the important tasks of continuing education in climate and environmental protection

c) Providing highly qualified entrepreneurs, managers and skilled workers who, in addition to good theoretical knowledge, also have practical competences, skills and professional experience in climate and environmental protection and reducing the shortage of skilled workers to cope with the very large tasks in the energy, climate and environmental sector.

d) Attracting entrepreneurs and executives who have all the skills to successfully run a company and perform high-quality tasks in climate and environmental protection

e) Strengthening the productivity and competitiveness of enterprises through knowledge and technology transfer, promotion of innovation and implementation of manageable R&D projects

f) Promoting cooperation between SMEs and colleges/universities, strengthening colleges/universities to implement dual courses of study on climate and environmental protection, and promoting entrepreneurship in higher education.

In pursuit of these objectives, the following results will be achieved:

1. Analysis results on the economy, demography, education and labour markets as well as qualification needs in climate and environmental protection

2. Curriculum, Teaching materials, implementation report and evaluation concept and report for teacher training

3. Module handbooks with integrated continuing education, teaching materials, examination regulations, implementation reports as well as evaluation concept and reports for a three-stage dual Bachelor's degree program

- "Business Administration & Sustainable Management of SMEs"
- "Management of renewable building energy technology"

4. Concept for promoting innovation by SMEs and evaluation concept and report

5. Concept for innovation promotion of SMEs and R&D projects carried out for SMEs

6. Concepts and report for the evaluation and quality assurance of qualifications and R&D subsidies as well as project implementation, transfer of results, implementations and implementation consultations

The primary target groups of the project are:

a) School leavers who wish to combine vocational education and training with a bachelor's degree and thus receive excellent employment and professional career opportunities.

b) Students who are qualified in higher education and university and at the same time in a company and who are highly welcome in SMEs as managers and professionals or as independent entrepreneurs.

c) Owners, managers and specialists of SMEs who are qualified in continuing vocational training, acquire tailor-made competences and skills for high-quality activities in climate and environmental protection and achieve a recognized continuing vocational qualification.

d) SMEs that attract suitably qualified young entrepreneurs, managers and specialists, receive innovation funding and carry out R&D projects together with colleges/universities.

The project addresses the following secondary target groups (beneficiaries):

a) Colleges and universities which, in order to expand their educational opportunities in climate and environmental protection, receive all the documents and materials for two new dual bachelor's degree programs in order to meet the labour market needs and the conditions of SMEs in particular.

b) Chambers and other vocational training institutions which attract strong young people to vocational training, receive curricula for continuing vocational training modules for the qualification of SMEs and their staff, and cooperate intensively with col-leges/universities in teaching and innovation promotion.

c) Teachers, advisers and lecturers from chambers, other VET providers and colleges/universities who are qualified in Train the Trainer programs to provide high-quality further training, to carry out dual study courses in cooperation with companies as well as innovation promotion and R&D projects for SMEs at a high-quality level.

## About the study program " Engineering in Management of Renewable Energy Technology in Buildings "

A Bachelor's degree course in “Engineering in Management of Renewable Energy Technology in Buildings” has been developed, which also integrates initial and continuing vocational training and combines theory (learning at the university) with practice (learning in the company). This “trial” course of study is designed in such a way that

a) it can also be completed without initial vocational training.

b) the integrated continuing education program “Energy Service Manager/Energy Consultant” with a recognized continuing education qualification can also be carried out separately without studying.

Main modules of the developed study program were tested, evaluated and the entire study program was finalized based on the evaluation results. The concept and module handbook of the study program including the transition of the VET program form Result 4.1 Concept, curricula and module handbook for three-cycle dual study program "Engineering in Management of Renewable Energy Technology in Buildings". The trials, implementation report, evaluation concept and report are listed in Result 4.2 Evaluation, reports and qualified students of the degree program "Engineering in Management of Renewable Energy Technology in Buildings".

# Module Handbook

## Introduction

The climate change, lack of fossil combustibles, and pollution, particularly in the form of the greenhouse gas emissions, and the increasing use of renewable energy and improved energy efficiency as solutions to reach the climate goals of Agenda 2030 of UN, as well as goals of respective Agenda of EU, have been topics of discourse for years. In the beginning of 2022, the Russian attack to Ukraine has brough the dependency of EU on Russian energy products – gas, oil, coal, and electricity – as an emerging topic of European energy discourse. In the spring 2022, the European Commission, as a response to the hardships and global energy market disruption caused by Ukrainian war, launched REPowerEU programme. This programme supports activities aiming to save energy, to produce clean energy, and to diversify energy supplies of the European Union (European Commission, 2023).

In addition to REPowerEU -programme, European Commission has in December 2021 launched a proposal for revision of the Energy Performance of Buildings Directive. This revision has taken effect on 28th May 2024, thus, the revision 2018 of the directive is no longer valid. (European Commission, 2024). The new directive has an ambitious goal to reduce emissions of greenhouse gases caused by buildings with 60 percent by 2030 compared to year 2015. Directive also sets a binding target to decrease the average energy performance of the national residential building stock by 16% by 2030 in comparison to 2020, and by 20-22% by 2035, based on national trajectories, and defines an enhanced standard for new buildings to be zero-emission and the calculation of whole life-cycle carbon for new buildings. (European Commission, 2024b)

In July 2021, the European Commission launched a proposal to renew Energy efficiency Directive, as part of the ‘Fit for 55’ package. This proposal was supplemented by an additional proposal as part of the REPowerEU plan in May 2022. (European Commission, 2023b). The revised directive took effect on 20th September 2023.

The updated energy efficiency directive aims to establish legally binding goal to reduce the final energy consumption by 11.7% by 2030 compared to the 2020 reference scenario. This includes for each member of the European Union the requirement to define indicative national contribution based on objective criteria which reflects national circumstances. If the national contributions do not match to the EU target, an ambition gap mechanism is applied by the Commission. Each country should also increase annual energy savings step by step from 0.8 per cent (at present) to 1.3 per cent (2024-2025), then 1.5 per cent (2026-2027) and 1.9 per cent from 2028 onwards. This means an average of 1.49 per cent of new annual savings during the period from 2024 till 2030. When planning the savings and activities, vulnerable customers and social housing should be prioritised within the scope of their energy savings measures. In addition to this, an annual energy consumption reduction goal of 1.9% for the public sector should be introduced, including the obligatory annual 3% buildings renovation duty extended to all the levels of public administration. Directive also introduces a new approach, based on energy consumption, for business to have an energy management system or to carry out energy audits. Furthermore, a new obligation to monitor the energy performance of data centres, with an EU-level database collecting and publishing data, has been launched. Municipalities are enhanced to promote local heating and cooling plans, particularly in larger municipalities, and to increase the efficient energy use in heat and cold supply, also in district heating and cooling systems. (European Commission, 2023b).

As a part of the *Clean energy for all Europeans* package, that aims to help EU to meet the emissions reduction commitments stated in the Paris Agreement, the Renewable Energy Directive (2018/2001/EU) took effect in December 2018. The amending Directive EU/2023/2413 entered into force on 20 November 2023 with an 1,5-year period to transpose most of the directive's provisions into national legislation, and a shorter deadline of July 2024 for some provisions related to permitting for renewables. The renewed directive sets an overall European renewable energy target of 42,5 per cent by 2030, and an aim to reach proportion of 45 per cent. The directive also contains rules to ensure the use of renewable energy in the transport sector, and in heating and cooling. Common principles and rules for renewable energy support schemes, sustainability criteria for biomass and the right to produce and consume renewable energy and to establish renewable energy communities are set in the directive that, in addition to those, includes rules to remove barriers, to increase investments and to achieve cost reductions in renewable energy technologies, and to empower private citizens and organizations to participate in the move towards clean energy. (European Commission, 2023c)

The Renewable Energy Directive, recent Energy Efficiency Directive and Energy Performance of Buildings Directive are challenging the states, regions, municipalities, enterprises, and private persons. The demand for skilled persons who could conduct energy audits, advice in energy issues like renovations (European Commission, 2024) and measuring the energy consumption, and design new areal and municipal cooling and heating plans (European Commission, 2023b) will be increased, and in many of the member states, there may be a lack for skilled energy experts. Furthermore, small and medium-sized enterprises operating in the field of energy technology in buildings need employees with a wide range of qualifications and competences, particularly in the topics of renewable energy and energy saving.

The curriculum presented below, will on its part respond to the increasing demand for energy consultants and experts.

## Goals and target groups of the study program

The goal of this engineering degree program is to provide students, not only with technical knowledge and skills but also with methodological competences and personal practical and communication skills, which are essential professional competences.

In addition, some modules are also aimed at professionally qualified employees in companies who are interested in high-quality further training. For these employees, a qualification as an "energy consultant" would be conceivable. Modules 3.2, 3.3 and 3.7, which are listed later, play a particularly important role in this.

With the help of the competences described above, these target groups can support their company or organization to offer products and services that are competitive from a technical, ecological, and economic point of view, and that will apply to the newest and coming EU-requirements. Studying the course described below will give them capability to prepare analyses and concepts of solutions to technical and business problems based on latest scientific knowledge, and to take responsibility for their professional, social, and personal implementation.

The course focuses on the production and use of renewable energy and topics approaching energy efficiency in private residential buildings as well as commercial and public facilities. The energy systems in buildings will be approached as technical and functional systems designed to be used and maintained throughout their lifecycle, also considering the economic point of view.

The course approaches the topics, not only on point of view of technical expertise, but also from the perspectives of supporting and advising customers, designing and finding solutions to improve energy efficiency of buildings, and other respective professional areas and activities. The main benefits for the customer will be identified necessary actions and up-to-date functional knowledge on how to add the use value of the technology. The emphasis is on theoretical and practical process-oriented designing, implementing, and use of installations, as well as on finding and implementing measures to increase energy efficiency.

The study course "Management of Renewable Energy Technology in Buildings" provides the students with the following skills and knowledge:

- Understanding of technical, ecological, and economic challenges related to renewable energy and rational use of energy in buildings,
- Ability to develop and market an offer that requires intensive advisory in terms of products and services in the field of “renewable energy technologies in buildings” in an interdisciplinary manner,
- Technical and methodological competences enabling designing, implementation, launching, use and maintaining of interdisciplinary renewable energy solutions in buildings,
- Social and communication skills and capability to exchange specialist knowledge with experts, professionally lead employees, and advise clients in an interdisciplinary and professional manner,
- Technical and methodological competence to participate in the strategic development of corporate energy policy,
- Technical and methodological competence to participate in operational company management, and thus to perform economic and technical management tasks,
- Technical and methodological competences in designing operational energy efficient processes, in applying renewable energy technologies, in systematic recording and analyzing the obtained results, and in using these analyses in continuous improvement processes.

Interdisciplinary aspects are carried with through the whole course. Both renewable energy, energy efficiency and designing and communication topics are multi-disciplinary containing issues from technical sciences, natural sciences, linguistics, and social sciences. Business competences are implemented mainly in submodules of module 3.1a that is optional and aimed for those whose earlier studies do not cover these issues. The basic skills required for bachelor's degree in technology are implemented in submodules of module 3.1b and 3.2. Technical competences are implemented in modules 3.3 – 3.9. The practice at workplaces also supports the interdisciplinary nature of studies.

Scientific and methodological competences of students are supported by the basic interdisciplinary module 3.1.9 Research communication). Furthermore, they are promoted and required in modules 3.2 – 3.9. focused on both technical and interdisciplinary aspects.

## Content of the course

The "Management of renewable energy technologies in buildings" course consists of 33 compulsory and elective modules in total as well as a bachelor's thesis. The modules are grouped as follows (Table 1):

*Table 1: Modules of Bachelor's degree*

| **Year** | **1** | **2** | **3** | **4** | **Total** |
|---|---|---|---|---|---|
| 3.1a. General basic studies (Optional), 21 cu, see the curriculum below. | | | | | |
| 3.1b. General basic studies in engineering | 25 | | | | |
| 3.2 Professional basic studies | 4 | 7 | | | |
| 3.3 Basics of Energy, Environmental and Process Technology | | 7 | 7 | | |
| 3.4 Fluid Dynamics and Heat Transfer | | 15 | | | |
| 3.5 Renewable Energy | | | 20 | | |
| 3.6 Design of Renewable Energy Systems | | | 16 | | |
| 3.7 Energy efficiency in buildings and structures | | | 15 | 10 | |
| 3.8 Processes and Devices of Energy Production | | | | 15 | |
| 3.9 Carbon-neutral and sustainable societies | | | | 24 | |
| 3.10 Work placement 35 cu:s, included to the work at work place | 10 | 10 | 10 | 5 | |
| 3.11 Bachelor's Thesis | | | | 15 | |
| CU:s theory including thesis | 29 | 29 | 58 | 59 | 180 |
| Hours theory | 783 | 783 | 1566 | 1323 | 4455 |
| CU:s total including work placement | 39 | 39 | 68 | 64 | 215 |
| Hours total, out of which, 945 hours included to the work at work place (35 cu) | 1053 | 1053 | 1836 | 1728 | 5670 |

## Basic modules

As part of the basic modules, students acquire broad competencies in the field of scientific and application requirements in management and technology (Modules 3.1a (optional, compulsory for those who have not studied the respective topics during their earlier studies), 3.1b and 3.2). The basic interdisciplinary modules allow the acquisition of competences that contribute to the comprehensive understanding of practical solutions to problems. On the other hand, they establish the general foundation of methodological scientific work for the systematization and solving of practical problems. This contributes to the completion of master's programs possibly taking place after the completion of bachelor's studies.

## Occupational modules

The occupational modules 3.3-3.9 give students a multidisciplinary knowledge and skills they will need during their professional career. These modules also complete the management and societal skills established in the basic modules.

## Specialization modules related to energy (area of elective subjects)

To be able to deepen their knowledge of special issues in the energy field, students are encouraged to participate in optional modules offered (O1 – O4), depending on their individual interests.

## Share of the practical part

The practical parts consist of training at the workplace and reflections on practice (Practice reports).

## Reports on practice

Considering the specific requirements of a given company, four practice reports (one per year) should be prepared, focusing on management and technology, for a total of 35 CUs. The requirements to be met are listed in the preparation instructions for practice reports.

## Degree designation: Bachelor of Engineering

After completing the course, a Bachelor of Engineering in Management of Renewable Energy Technologies in Buildings -diploma is awarded (abbreviated as B. Eng.) The engineering qualifications framework was used to help understand the structure of the course. The modules can be assigned to the main areas of the qualifications framework as follows (Table 2).

*Table 2: Degree designation of the course*

| Basic area | Modules1 | CUs |
|---|---|---|
| Engineering, natural sciences, mathematics (at least 55 ECTS credits) | 3.1b, 3.2,3.3<br>3.1a (optional) | 50<br>21 |
| Economics, law, and social sciences (at least 45 ECTS credits) | 3.9<br>Included to other topics | 24<br>21 |

| | | |
|---|---|---|
| Professional topics (Renewable energy and energy efficiency specific issues) | 3.4, 3.5, 3.6, 3.7, 3.8 | 91 |
| Soft skills and foreign languages (at least 10 ECTS) | Included to 3.1a* and to 3.1b | 15 |
| Apprenticeships (at least 15 ECTS credits) | Included to the work at workplace | 35 |
| Thesis (at least 10 ECTS credits) | Bachelor's thesis | 15 |
| Total (Theory + thesis) | | 180 |
| Total including optional 3.1a (basic general knl.) | | 201 |
| Total (Theory + thesis + work placement) | | 215 |

*) Module 3.1a is an optional module for those who have not gained this knowledge during earlier training.

As it can be seen from the module assignment to the main areas of the qualification's framework in industrial engineering presented above, emphasizing occupational topics and requirements, the minimum scope of the basic areas is met. As a result, awarding a new graduation designation, i.e. B.Eng., is justified. Due to the multidisciplinary nature of studies, certain issues are included in many modules, thus, calculating sum of CUs from table above does not give the exact final sum of CUs given by graduation.

## Didactic concept

To meet current and future challenges in the field of renewable energy technology in buildings, graduates need a wide range of well-established scientific and practical competences, skills, and knowledge. The concept of dual studies is a didactic approach to the transfer of both practical skills and theoretical knowledge. The application presented below, with theoretical studies at the university of applied sciences, and vocational training in the workplace, is an example of how the studies might be implemented.

> Classes take place on average over three weekends per month (apart from periods free from classes). In addition, in the spring and autumn of the academic year, a full-time 14day block takes place at the vocational academy. In between individual classes, students participate in company apprenticeships. In addition, students are required to have self-studies during which they study independently, solve the assignments, and prepare themselves for exams. This form of organization allows students
>
> - to use the knowledge from their classes in practice,
> - to prepare for the classes,
> - and to draw conclusions from both class-learning and learning in practice as part of self-study.

To guarantee an intensive acquisition of competences, the courses are largely conducted in small groups of approx. 30 students. The lectures for larger groups are usually based on interactive discussion too. Lectures of smaller groups use collaborative methods that support participation, such as pair work, group work, and case studies. As a part of pair work and group work, students are encouraged to present and discuss experiences gained during their apprenticeships in the workplace, and in that way combine theory and practice with the help of a lecturer.

The interaction between apprenticeships and learning is largely ensured and guided by reflections on practice, written studies that are prepared as part of workplace learning. Reflections on practice are project works, aimed at discussing specific issues of operational practice, using specialized and methodological scientific competences acquired during the course. While preparing their reflections on practice, students are accompanied by a lecturer.

One part of the didactic concept is seminar classes. Small groups of students facilitate intensive dialogue with lecturers as part of discourse focused on the content related to the students' professional practice. Exercises, either individual or group work, enable the application and exploration of the didactic plan. Furthermore, case studies and related exercises are used to convey complex educational content and to learn holistic thinking that exceeds the borders of individual modules.

## Practical training

The practical training at workplaces is an important part of the studies. During the 4 years students are assumed to be able to work a total of 3550 hours. During the first two years the time for working is 1100 hours per year, and next two years 750 and 600 hours (Table 3). The decreased number of working hours is due to increased amount of theory studies.

*Table 3: Training at workplace*

| Year | 1 | 2 | 3 | 4 | Total |
|---|---|---|---|---|---|
| **Work and training at workplace** | 1100 h | 1100 h | 750 h | 600 h | 3550 h |

## Reflections on practice

The study plan also includes the preparation of four reflections on training at workplace (Reports on practice), 10, 10, 10 and 5 credits units (one for each academic year 1-4). These reports should contain a summary of their tasks and what they have learned during the practice. If the schedule allows, each student should give a brief presentation too. In addition to this, the thesis should also be based on practice and, in best case, reflects on practice by solving a problem found during the internships.

Reflections on practice are used to develop transfer and problem-solving competences by applying theory in the workplace and to promote students' social and communication competences through close coordination and cooperation with supervisors and employees, as well as clients in the company. Preparing and presenting the presentation develops student's communication skills.

Unlike the practical projects, a large part of the content/topics from the classes offered up to the exam is available for solving individual work-related problems. Reflections on practice take place in the internships at workplace and provide complementary self-study.

## Curriculum

The whole study programme consists of VET course giving a qualification of skilled worker / journeyman, Further VET course giving a qualification of Energy consultant, and Bachelor's studies giving a qualification of Bachelor of Engineering in Management of Renewable Energy in Buildings. The topics of Further VET are included into courses of Bachelor's degree.

## Summary of curriculum

*Table 4: Summary of curriculum*

| Year | 1 | 2 | 3 | 4 | Total |
|---|---|---|---|---|---|
| 1. VET-courses according to country-specific requirements<br>- Training at VET-institute<br>- Work and training at workplace | 500 h<br>1100 h | 500 h<br>1100 h | 750 h | 600 h | 1000 h<br>3550 h |
| 2. Further VET "Energy consultant" included to modules 3.2, 3.3 and 3.7 | | | | | |
| General basic studies (Optional), 21 cu, see the curriculum below. | | | | | |
| 3.1b. General basic studies in engineering | 25 | | | | 25 |
| 3.2 Professional basic studies | 4 | 7 | | | 11 |
| 3.3 Basics of Energy, Environmental and Process Technology | | 7 | 7 | | 14 |
| 3.4 Fluid Dynamics and Heat Transfer | | 15 | | | 15 |
| 3.5 Renewable Energy | | | 20 | | 20 |
| 3.6 Design of Renewable Energy Systems | | | 16 | | 16 |
| 3.7 Energy efficiency in buildings and structures | | | 15 | 10 | 25 |
| 3.8 Processes and Devices of Energy Production | | | | 15 | 15 |
| 3.9 Carbon-neutral and sustainable societies | | | | 24 | 24 |
| 3.10 Work placement 35 cu:s includes to the work at work place | | | | | |
| 3.11 Thesis | | | | 15 | 15 |
| CU:s | 29 | 29 | 58 | 64 | 180 |
| Hours | 783 | 783 | 1566 | 1728 | 4860 |
| Sum of hours | 2383 | 2383 | 2316 | 2328 | 9410 |
| CU:s Bachelor | 29 | 29 | 58 | 64 | 180 |

## Curriculum

| Module No. | Module | Credit Points during the academic year | | | | Total hours | | | Type of class | Examination performance of the module (duration in min) as well as Contribution to the total grade | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1. | 2. | 3. | 4. | Contact teaching | Self-studies | Total | Lectures (V), Practical studies (Ü), Seminars (S) | Exam type | Total grade |
| **1** | **VET-modules according to local requirements** | | | | | | | | | **Depending to country-specific requirements** | |
| **2** | **Main module: Further VET level, included into topics of Main module 3** | | | | | | | | | | |
| **2.1** | General subjects required for Bachelor's degree – if required in this phase, topics and hours according to national requirements | | | | | | | | | Depending to country-specific requirements | |
| **2.2** | **Further vocational training "Energy consultant"** | | | | | **199 - 219** | **151 - 191** | **350-410** | | | **11-13** |
| **2.2.1** | Communication | | 1 | | | 20 | 10 | 30 | V, Ü | Written exam, 60 min, | 1 |
| **2.2.2** | Professional skills | | | | | 179 - 199 | 141 - 181 | 320-380 | | | 10-12 |
| **2.2.2.1** | Motivation | | | | | 4 | 1 | 5 | V, Ü | Exercises done and accepted | 1 |
| **2.2.2.2** | Legislation and regulation, EU- and local level | | 1 | | | 20 | 5 | 25 | V, Ü | Written exam 120 min | |
| **2.2.2.3** | **Energy efficiency** | | 6 | | | 105 | 95 | 200 | V, Ü, [S] | Done and accepted exercises.<br>Written exams a' 60 or 120 min | 6 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **2.2.2.3.1** | Calculations and classifications | | 1 | | | 15 | 15 | 30 | Ü | Done and accepted exercises. | 1 |
| **2.2.2.3.2** | Insulation, avoiding the heat and cool leakages. | | 3 | | | 50 | 50 | 100 | V, Ü | Done and accepted exercises.<br>Written exam 120 min | 3 |
| **Module No.** | **Module** | **Credit Points during the academic year** | | | | **Total hours** | | | **Type of class** | **Examination performance of the module (duration in min) as well as Contribution to the total grade** | |
| | | 1. | 2. | 3. | 4. | Contact teachin g | Self-studies | Total | Lectures (V), Practical studies (Ü), Seminars (S) | Exam type | Total grade |
| **2.2.2.3.3** | Technology in buildings | | 1 | | | 15 | 15 | 30 | V, Ü | Written exam, 60 min | 1 |
| **2.2.2.3.4** | Designing the energy-efficient buildings | | 1 | | | 20 | 10 | 30 | V, Ü | Accepted assignment | 1 |
| **2.2.2.3.5** | Other issues according to local needs | | | | | 5 | 5 | 10 | V, Ü | Accepted assignment | |
| **2.2.2.4** | Renewable energy | | 2 | | | 30 | 20 | 50 | V, Ü | Written exam 120 min | 2 |
| **2.2.2.5** | Energy efficiency certificates | | 1 | | | 20 | 20 | 40 | V, Û | Accepted assignment | 1 |
| **2.2.2.6** | Carbon footprint (Optional) | | 2 | | | 20 | 40 | 60 | V, Ü | Accepted calculation exercises | [2] |
| **3** | **Main Module: Bachelor’s degree** | | | | | | | | | | |
| **3.1a** | **General basic studies** (Optional – aimed for those who have not studied these during their earlier studies, topics depending to country-specific regulation, e.g.:<br>1. Basic Use of Office<br>2. Starting Higher Education Studies<br>3. Effectual Entrepreneurship<br>4. Workplace Skills<br>5. Professional Communication | **11**<br>1<br>1<br>3<br>3 | **10**<br>3 | | | **300** | **267** | **567** | **V, Ü** | Examinations and accepted assignments and calculation exercises according to country-specific regulation and practices | **21** |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6. English for Working Life<br>7. Professional English Skills in Engineering<br>8. Basics of Project Activities) | 3 | <br><br>4<br>3 | | | | | | | | |
| **3.1b** | **General basic studies in engineering** | **25** | | | | **300** | **321** | **675** | | | **25** |
| **3.1.9** | Research Communication | 2 | | | | 30 | 24 | 54 | V, Ü | Accepted assignment | **2** |
| **Module No.** | **Module** | **Credit Points during the academic year** | | | | **Total hours** | | | **Type of class** | **Examination performance of the module (duration in min) as well as Contribution to the total grade** | |
| | | 1. | 2. | 3. | 4. | Contact teachin g | Self-studies | Total | Lectures (V), Practical studies (Ü), Seminars (S) | Exam type | Total grade |
| **3.1.10** | Mathematical Tools in Engineering | 3 | | | | 50 | 31 | 81 | V, Ü | Accepted exercise | **3** |
| **3.1.11** | Algebra | 4 | | | | 60 | 48 | 108 | V, Ü | Written exam 120 min | **4** |
| **3.1.12** | Geometry | 4 | | | | 60 | 48 | 108 | V, Ü | Written exam 120 min | **4** |
| **3.1.13** | Mechanics | 3 | | | | 50 | 31 | 81 | V, Ü | Written exam 120 min | **3** |
| **3.1.14** | Vibration, Wave and Nuclear Physics | 3 | | | | 50 | 31 | 81 | V, Ü | Written exam 120 min | **3** |
| **3.1.15** | Thermal Engineering and Fluid Dynamics | 3 | | | | 50 | 31 | 81 | V, Ü | Written exam 120 min | **3** |
| **3.1.16** | Physics Laboratory 1 | 2 | | | | 10 | 44 | 54 | Ü | Accepted assignment | **2** |
| **3.1.17** | Occupational Safety and First Aid | 1 | | | | 20 | 7 | 27 | V, Ü | Accepted assignment | **1** |
| **3.2** | **Professional basic studies** | **4** | **7** | | | | | | | | **11** |
| **3.2.1** | Introduction to 2D Modelling | 3 | | | | 30 | 51 | 81 | V, Ü | Accepted assignment | **3** |
| **3.2.2** | Basics of Chemistry | 1 | 4 | | | 80 | 55 | 135 | V, Ü | Written exam 120 min | **5** |
| **3.2.3** | Feasibility Calculations | | 3 | | | 51 | 30 | 81 | V, Ü | Written exam 120 min | **3** |
| **3.3** | **Basics of Energy, Environmental and Process Technology** | | **7** | **7** | | | | | | | **14** |
| **3.3.1** | Basic of Energy Technology | | | 4 | | 70 | 38 | 108 | V, Ü | Written exam 120 min | **4** |

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|---|---|---|---|---|---|---|---|---|---|---|---|
| **3.3.2** | Basics of Environmental Technology | | 4 | | | 70 | 38 | 108 | V, Ü | Written exam 120 min | **4** |
| **3.3.3** | Material and Energy Balances | | 3 | | | 60 | 21 | 81 | V, Ü | Written exam 120 min | **2** |
| **3.3.4** | Spreadsheet Applications and Technical Reports | | | 3 | | 41 | 40 | 81 | V, Ü | Written exam 120 min | **2** |
| **3.4** | **Fluid Dynamics and Heat Transfer** | | **15** | | | | | | | | **15** |
| **3.4.1** | Fluid Dynamics | | 4 | | | 70 | 38 | 108 | V, Ü | Written exam 120 min | **4** |
| **3.4.2** | Pumps, Fans and Compressors | | 3 | | | 34 | 20 | 81 | V, Ü | Written exam 120 min | **3** |
| **Module No.** | **Module** | **Credit Points during the academic year** | | | | **Total hours** | | | **Type of class** | **Examination performance of the module (duration in min) as well as Contribution to the total grade** | |
| | | 1. | 2. | 3. | 4. | Contact teaching | Self-studies | Total | Lectures (V), Practical studies (Ü), Seminars (S) | Exam type | Total grade |
| **3.4.3** | Heat Transfer Technology | | 5 | | | 80 | 55 | 135 | V, Ü | Written exam 120 min | **5** |
| **3.4.4** | Piping Systems | | 3 | | | 50 | 31 | 81 | V, Ü | Written exam 120 min | **3** |
| **3.5** | **Renewable Energy** | | | **20** | | | | | | | **20** |
| **3.5.1** | Solar Energy: 3 CU | | | 3 | | 50 | 31 | 81 | V, Ü | Written exam 120 min | **3** |
| **3.5.2** | Wind Energy: 3 CU | | | 3 | | 50 | 31 | 81 | V, Ü | Written exam 120 min | **3** |
| **3.5.3** | Bioenergy: 3 CU | | | 3 | | 50 | 31 | 81 | V, Ü | Written exam 120 min | **3** |
| **3.5.4** | Hydropower: 3 CU | | | 3 | | 50 | 31 | 81 | V, Ü | Written exam 120 min | **3** |
| **3.5.5** | Hydrogen Power: 3 CU | | | 3 | | 50 | 31 | 81 | V, Ü | Written exam 120 min | **3** |
| **3.5.6** | Renewable energy solutions in buildings 5 CU | | | 5 | | 80 | 55 | 135 | V, Ü | Written exam 120 min | **5** |
| **3.6** | **Design of Renewable Energy Systems** | | | **16** | | | | | | | **16** |
| **3.6.1** | Hybrid Heat Generation Systems | | | 4 | | 60 | 48 | 108 | V, Ü | Written exam 120 min | **4** |
| **3.6.2** | Design of a Biothermal Center | | | 4 | | 60 | 48 | 108 | V, Ü | Written exam 120 min | **4** |
| **3.6.3** | Design of a Solar Energy System | | | 4 | | 60 | 48 | 108 | V, Ü | Written exam 120 min | **4** |

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| **3.6.4** | Design of a Heat Pump System | | | 4 | | 60 | 48 | 108 | V, Ü | Written exam 120 min | **4** |
| **3.7** | **Energy efficiency in buildings and structures** | | | **15** | | **10** | | | | | **25** |
| **3.7.1** | Materials and components | | | 5 | | 70 | 65 | 135 | V, Ü, S | Written exam 120 min | **5** |
| **3.7.2** | Insulation | | | 5 | | 70 | 65 | 135 | V, Ü, S | Written exam 120 min | **5** |
| **3.7.3** | Appliances and equipment | | | 5 | | 70 | 65 | 135 | V, Ü, S | Written exam 120 min | **5** |
| **3.7.4** | Heat recovery | | | | 5 | 70 | 65 | 135 | V, Ü, S | Written exam 120 min | **5** |
| **3.7.5** | Special topics | | | | 5 | 50 | 85 | 135 | V, Ü, S | Written exam 120 min | **5** |
| **Module No.** | **Module** | **Credit Points during the academic year** | | | | **Total hours** | | | **Type of class** | **Examination performance of the module (duration in min) as well as Contribution to the total grade** | |
| | | 1. | 2. | 3. | 4. | Contact teachin g | Self-studies | Total | Lectures (V), Practical studies (Ü), Seminars (S) | Exam type | Total grade |
| **3.8** | **Processes and Devices of Energy Production** | | | | **15** | | | | | | **15** |
| **3.8.1** | Heat Pumps | | | | 3 | 50 | 31 | 81 | V, Ü | Written exam 120 min | **3** |
| **3.8.2** | Basics of Electrical Systems | | | | 3 | 50 | 31 | 81 | V, Ü | Written exam 120 min | **3** |
| **3.8.3** | Cooling Technology | | | | 3 | 50 | 31 | 81 | V, Ü | Written exam 120 min | **3** |
| **3.8.4** | Combustion Technology | | | | 3 | 50 | 31 | 81 | V, Ü | Written exam 120 min | **3** |
| **3.8.5** | Heat and Cold Distribution Systems | | | | 3 | 50 | 31 | 81 | V, Ü | Written exam 120 min | **3** |
| **3.9** | **Carbon-neutral and sustainable societies** | | | | **24** | | | | | | **24** |
| **3.9.1** | Environmental Legislation | | | | 5 | 90 | 45 | 135 | V, Ü, S | Written exam 120 min | **5** |
| **3.9.2** | Energy and Environmental Economy | | | | 5 | 90 | 45 | 135 | V, Ü, S | Written exam 120 min | **5** |
| **3.9.3** | Air Pollution Control | | | | 5 | 90 | 45 | 135 | V, Ü, S | Written exam 120 min | **5** |
| **3.9.4** | Life Cycle Assessment and Carbon Footprint | | | | 5 | 90 | 45 | 135 | V, Ü, S | Written exam 120 min | **5** |
| **3.9.5** | Energy Efficiency | | | | 4 | 70 | 38 | 108 | V, Ü, S | Written exam 120 min | **4** |

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| **3.10** | **WORK PLACEMENT included to the work and training at workplace** | | *10* | *10* | *10* | | 810 | 810 | Ü | Work placement reports, 1 / placement | 30 |
| **3.11** | **Thesis** | | | | **15** | 15 | 390 | 405 | Ü, S | Thesis can be evaluated according to local practices | **15** |
| **O1 - Option** | **Process and Control Technology** | | | | | | | | | | **0-19** |
| **O1.1** | Basics of Process Technology | | | | | | | | | | **4** |
| **O1.2** | Process Control | | | | | | | | | | **5** |
| **O1.3** | Industrial Processes | | | | | | | | | | **5** |
| **O1.4** | Modelling and Design of Processes | | | | | | | | | | **5** |
| **Module No.** | **Module** | **Credit Points during the academic year** | | | | **Total hours** | | | **Type of class** | **Examination performance of the module (duration in min) as well as Contribution to the total grade** | |
| | | 1. | 2. | 3. | 4. | Contact teaching | Self-studies | Total | Lectures (V), Practical studies (Ü), Seminars (S) | Exam type | Total grade |
| **O2 – option** | **Systems of the Centralized Energy Production** | | | | | | | | | | **0 - 21** |
| **O2.1** | Power Plant Technology and Regulations | | | | | | | | | | **3** |
| **O2.2** | Operation and Modelling of a Power Plant | | | | | | | | | | **4** |
| **O2.3** | Electrical and Automation Systems in a Power Plant | | | | | | | | | | **3** |
| **O2.4** | Steam Processes | | | | | | | | | | **3** |
| **O2.5** | Steam Boilers | | | | | | | | | | **3** |
| **O2.6** | Nuclear Energy | | | | | | | | | | **5** |
| **O3 – option** | **Environmental Technology** | | | | | | | | | | **0 - 10** |
| **O3.1** | Waste and Material Management in Circular Economy | | | | | | | | | | **5** |

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|---|---|---|---|---|---|---|---|---|---|---|---|
| **O3.2** | Contaminated Land and Recycling of Soil | | | | | | | | | | **5** |
| **O4 – option** | **Sustainable Society** | | | | | | | | | | **0 - 12** |
| **O4.1** | Healthy and Safe Work Environment | | | | | | | | | | **4** |
| **O4.2** | Built Environment and Spreading of Diseases | | | | | | | | | | **3** |
| **O4.3** | Quality Management and Management Systems | | | | | | | | | | **5** |
| **Note** | **It is recommended that student can have the optional courses O1 – O4 within the academic years 2-4 at any period. To avoid difficulties in offering these courses it is recommended that they were, if possible, self-study courses.** | | | | | | | | | | |

As a part of studies, students will be given the opportunity to take an 'Energy Consultant' further education examination. The content of the 'Energy Consultant' further education program is a part of the degree course.

Following modules of the degree program comprise the content of the 'Energy Consultant' further training course and must be completed to be able to take the corresponding further training examination:

- Legislation and regulations: 3.9.1
- Energy efficiency: 3.7.2, 3.7.3, 3.7.4
- Renewable energy: 3.5.6
- Energy efficiency certificates: 3.3.4, 3.9.5
- Carbon footprint (Optional): 3.9.4

Text indicates the module in curriculum of Energy Consultant and numeric notation indicates the resp. module in this curriculum. These modules are planned to be taught mainly during the third and fourth academic year. If an institute offering the training wants to give students an opportunity to take the 'Energy Consultant' further education examination as a milestone, order of modules can be changed.

## Entry requirements for trainings

In common, the entry requirements for trainings included in dual exam are:

- Vocational level
  - Requirements: Comprehensive school or respective, minimum of 8 or 9 classes / years, depending to country.
- Further vocational level
  - Requirements: Vocational qualification. In some countries and / or trainings certain work experience is required after graduation of vocational level. In some countries and some trainings, no entry requirements are set for further vocational training.
- University of Applied Sciences (UAS-level (Bachelor)
  - Vocational or further vocational qualification, or
  - other qualification of upper secondary school, e.g. senior high school, college, upper secondary general school, etc., depending to the education system of the country.

There may be country, branch- and qualification-specific exceptions, and restrictions.

In our curriculum, the alternatives could look like described in Figure 1. In two lower alternatives, the qualification gained from VET or further VET should be compatible with qualification gained from VET of our curriculum. Furthermore, in last case, the basic vocational studies learnt in vocational and further vocational studies must be included to curriculum for those coming from general upper secondary education. On the other hand, the basic mathematics, physics, and chemistry are not necessary, if they have been taught in secondary school. In topmost alternative, that is a default in our curriculum, we must consider, not only the mathematic, physics and chemistry that belongs to the requirements of bachelor's degree, but also basics of these subjects, commonly belonging to the requirements of general upper secondary school (senior high school, college, etc., depending to the country and culture), because, in common, topics taught in VET are more limited.

In this manual, the curriculum presented will follow the topmost alternative in Figure 1. Each school will be allowed to decide themselves, following the legislation of their country, whether they will permit students coming following the other two alternatives, and what are the requirements in such cases.

In this case, VET vocational skills are those required from junior electrician (or comparable vocational training), and further VET vocational skills are those required from senior electrician or craftsman in energy technology (or comparable further training). Due to the fact, that common vocational education does not always include necessary studies in nature sciences (Mathematics, physics, and chemistry), communication and languages, nor in liberal arts, these topics have been included into curriculum and put available for those aiming the bachelor's degree (M3.1a).

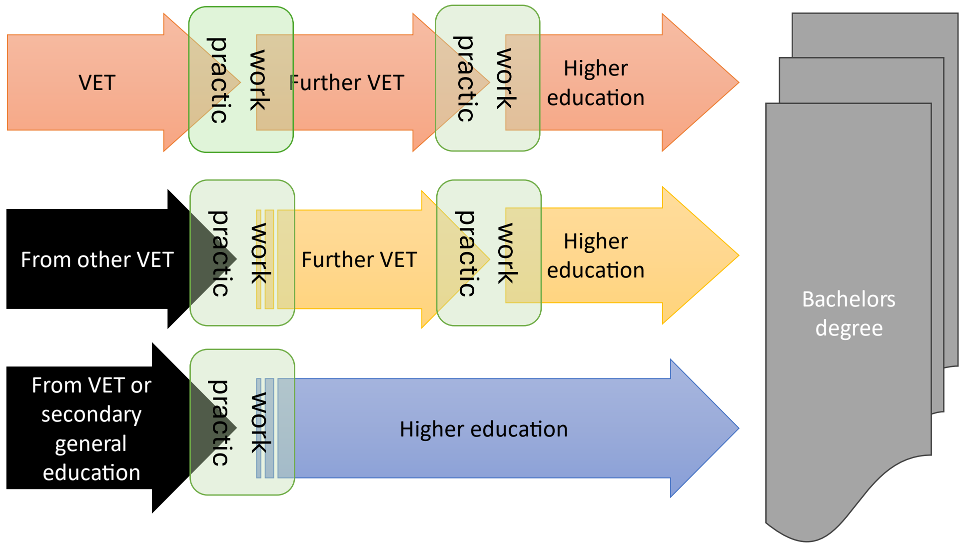


*Figure 1: Alternatives for training*

The Table 5 presents the recommendable goals and examples of contents of each obligatory module.

*Table 5: Contents of obligatory modules*

| | | |
|---|---|---|
| **Main module 3: HE level: Bachelor of engineering + optional professional topics**<br>Contents of studies and tips for study materials | | |
| Module | Topics | Notes |
| **BASIC STUDIES: Grey parts optional but obligatory for those who have not studied these issues earlier** | | |
| **M3.1a General Basic Studies:**<br>1. Basic Use of Office<br>2. Starting Higher Education Studies<br>3. Effectual Entrepreneur-ship<br>4. Workplace Skills<br>5. Professional Communi-cation<br>6. English for Working Life<br>7. Professional English Skills in Engineering<br>8. Basics of Project Activities | <br>Introduction to library use, information acquiring etc.<br>Basics of entrepreneurship and entrepreneurial thinking.<br>Legislation, rules, and social norms at workplace.<br>Different ways to communicate as professional.<br>Vocabulary and language needed in work life.<br>Technical vocabulary and language used in engineering.<br>Project management terms and principles | *Recognition of prior learning* - process, known also as accreditation of prior learning can be used to replace courses with respective knowledge and skills gained in other training. The knowledge gained should be at least at the same level than the courses that will be replaced.<br><br>The size and proportion of these basic study courses can be lower, or courses can be omitted if the same knowledge has been gained in previous studies (M1 or M2 during this dual programme). |

| | | |
|---|---|---|
| **3.1b General basic studies in engineering**<br>9. Research Communication<br>10. Mathematical Tools in Engineering<br>11. Algebra<br>12. Geometry<br>13. Mechanics<br>14. Vibration, Wave and Nuclear Physics<br>15. Thermal Engineering and Fluid Dynamics<br>16. Physics Laboratory<br>17. Occupational Safety and First Aid | Academic writing and communication, scientific ethics.<br><br>Mathematics and physics not studied in earlier stages but needed in this stage.<br><br>Must be done before laboratories. | Literature used in common bachelor's training.<br><br>Literature used in common Bachelor of engineering-training. Studies in algebra, geometry and physics must be technically oriented, and, if possible, weighting electronic calculations. |
| **M3.2 Professional Basic Studies, Compulsory**<br>1. Introduction to 2D Modelling<br>2. Basics of Chemistry<br>3. Feasibility Calculations | 2D-modeling with CAD-program. | |
| **PROFESSIONAL STUDIES 129** | | |
| **M3.3 Basics of Energy, Environmental and Process Technology, Compulsory**<br>1. Basic of Energy Technology<br>2. Basics of Environmental Technology<br>3. Material and Energy Balances<br>4. Spreadsheet Applications and Technical Reports | Different forms of energy, use, benefits, and disadvantages. Waste, wastewater and emission, preventing and processing.<br>Connections between material, energy, economy, and ecology, and calculations, e.g., coefficient of burning combustibles.<br>How to use spreadsheets in technical analyses and reports | Note: these topics can be replaced by Recognition of prior learning -process if they are taught in previous modules / stages.<br>Goal of this module is to give students abilities to study environmental and energy issues, and to produce technical analyses and reports |
| **M3.4 Fluid Dynamics and Heat Transfer, Compulsory**<br>1. Fluid Dynamics<br>2. Pumps, Fans and Compressors<br>3. Heat Transfer Technology<br>4. Piping Systems | Physical properties and behaviour of fluids in different circumstances.<br>The types, work principles, properties and use of different pumps, fans, and compressors.<br>Physical conditions of heat transfer, technologies used, loss and how to avoid it.<br>Different piping systems, their properties and use. | Goal: After this module a student understands behaviour of fluids in different conditions, knows, how pumps, fans and compressors work and where they can be used, understands the techniques of heat transfer, is aware of loss and knows how to avoid it, identifies different piping systems, knows their properties and how to use them. |
| **M3.5 Renewable Energy Compulsory** | Different forms of renewable energy, their availability, | Goal: After this module, student knows the possibilities |

| | | |
|---|---|---|
| 1. Solar Energy<br>2. Wind Energy<br>3. Bioenergy<br>4. Hydropower<br>5. Hydrogen Power<br>6. Renewable energy solutions in buildings | production, use, benefits, and disadvantages.<br>How the renewable energy solutions can be integrated into and used in buildings. | of renewable energy solutions, and can apply them in practice. Student also know, what kind of solutions can be integrated in buildings and how to use them.<br>Examples of materials<br>Examples of materials 2<br>Examples of materials 3 |
| **M3.6 Design of Renewable Energy Systems, Compulsory**<br>1. Hybrid Heat Generation Systems<br>2. Design of a Biothermal Center<br>3. Design of a Solar Energy System<br>4. Design of a Heat Pump System | Issues that should be considered when designing different renewable energy systems and systems using the energy produced by them, including occupational and fire risks.<br><br>It is recommended that there are several case examples and assignments during the courses. | Goal: After this module, student identifies different use cases, knows the requirement use cases set to energy systems and can design renewable energy system suitable for individual use case.<br><br>Examples of materials<br>Note: The whole range of materials contains issues usable in this module. |
| **M3.7 Energy efficiency in buildings and structures, Compulsory**<br>1. Materials and components<br>2. Insulation<br>3. Appliances and equipment<br>4. Heat recovery<br>5. Special topics | Issues that are affecting to energy efficiency of a building. U- and G-values, and how to calculate them, properties of different materials, structures and appliances, and their impact on energy efficiency. Methods of heat recovery, and how to use them. Regional and/or country-specific topics. | Goal: Student knows the structural issues that are affecting to energy efficiency of a building and can calculate buildings energy efficiency based on drawings and construction descriptions in accordance with local requirements.<br>Examples of materials |
| **M3.8 Processes and Devices of Energy Production, Compulsory**<br>1. Heat Pumps<br>2. Basics of Electrical Systems<br>3. Cooling Technology<br>4. Combustion Technology<br>5. Heat and Cold Distribution Systems | Common energy production processes and devices and technology used to produce both conventional and renewable and clean energy usable in buildings, including electricity, heat, and cool. | Goal: Student knows technologies used, identifies their impacts on environment, and recognizes suitable and recommendable energy forms for each case and building.<br>Examples of materials |
| **M3.9 Carbon-neutral and sustainable societies, Compulsory**<br>1. Environmental Legislation<br>2. Energy and Environmental Economy<br>3. Air Pollution Control | History of concept "sustainability", and its most important milestones (e.g., Rome summit, Brundtland's committee, Stockholm summit, Rio Summit, General assembly of UN 2015), concept of sustainability, contents of SDGs including targets and indicators, latest EU Directives | Goals: Student understands the concepts of sustainability and sustainable development and is aware of the diversity of concepts. Student knows the path of energy efficiency regulation from SDGGs and directives to local regulation. Student knows the requirements of legislation and |

| | | |
|---|---|---|
| 4. Life Cycle Assessment and Carbon Footprint<br>5. Energy Efficiency | and programmes approaching energy efficiency and renewable energy, and local legislation and regulation, concept of life cycle, methods of LCA, energy efficiency assessment and energy efficiency certificates. | can conduct life cycle assessment, carbon footprint and energy efficiency calculations and write energy efficiency certificates according to country-specific requirements.<br>Examples of materials<br>See also the materials of WP4A7 |
| **M3.10 WORK PLACEMENT Compulsory** | | Note: In dual model this can be a part of work at workplace |
| **M3.11 Bachelor's thesis, Compulsory** | | Note: It is recommended, that the bachelor's thesis should be started as early as possible during the studies. Despite of this the finishing of thesis can be delayed due to e.g. the theme of thesis, or personal reasons. |
| **O1: Process and Control Technology, optional.**<br>• Basics of Process Technology<br>• Process Control<br>• Industrial Processes<br>• Modelling and Design of Processes | | Note: These optional modules can be defined according to country- and university-specific needs and requirements. The aim of these modules is to give students an opportunity to specialize to certain field. |
| **Systems of the Centralized Energy Production, Optional**<br>• Power Plant Technology and Regulations<br>• Operation and Modelling of a Power Plant<br>• Electrical and Automation Systems in a Power Plant<br>• Steam Processes<br>• Steam Boilers<br>• Nuclear Energy | | |
| **Environmental Technology, Optional**<br>• Waste and Material Management in Circular Economy<br>• Contaminated Land and Recycling of Soil | | |
| **Sustainable Society, Optional** | | |

| | | |
|---|---|---|
| • Healthy and Safe Work Environment<br>• Built Environment and Spreading of Diseases:<br>• Quality Management and Management Systems | | |

## Examples of materials

The purpose of these materials is to offer an example of available material both for teacher to support his / her work, and for student to support self-learning. In description of modules there are links to certain subchapters below, but it should be borne in mind that suitable materials for every module can be found from other subchapters too, without forgetting the links, sources, and further materials of each site and article. Thus, keep your mind open and have a look at the whole material.

**Designing and installing PV systems**

https://www.energy.gov/eere/solar/solar-photovoltaic-system-design-basics

https://www.energy.gov/eere/solar/photovoltaic-system-design-and-energy-yield (See the additional resources in the end of the page)

https://energysavingtrust.org.uk/advice/solar-panels/

https://www.electricaltechnology.org/2020/07/design-and-installation-of-solar-pv-system.html

https://arka360.com/ros/safety-guidance-when-installing-solar/

https://www.energy.gov/energysaver/planning-home-solar-electric-system

https://www.electrical-installation.org/enwiki/PhotoVoltaic_(PV)_installation

https://www.geogreenpower.com/solar-panels/ultimate-guide-to-installing-solar-panels-for-your-property/ (Downloadable guide, requires your e-mail)

https://www.fluke.com/en/learn/blog/safety/targeting-safety-in-photovoltaic-system-installation-and-maintenance

https://energyresearch.ucf.edu/consumer/solar-technologies/install-solar-electric/

Note: Check always the instructions and requirements of local authorities.

**Fire protection of PV systems**

https://www.nrel.gov/docs/fy19osti/68415.pdf

https://www.tuvsud.com/en-us/services/risk-management/fire-protection-engineering/photovoltaic-rooftop-panels

https://www.nfpa.org/for-professionals/training-for-me/electrical-training/photovoltaic-and-energy-storage-systems-online-training-series https://www.thefpa.co.uk/news/photovoltaics-and-fire

https://fsri.org/research/firefighter-safety-and-photovoltaic-systems

https://www.energy.gov/eere/solar/articles/assessing-fire-risks-photovoltaic-systems-and-developing-safety-concepts-risk

**Building-integrated PV-systems**

State-of-the-Art Technologies for Building-Integrated Photovoltaic Systems

Review on the progress of building-applied/integrated photovoltaic system

Review of technological design options for building integrated photovoltaics (BIPV)

A Holistic Approach for Design and Assessment of Building-Integrated Photovoltaics Systems

Application of Building Integrated Photovoltaic (BIPV) in Net-Zero Energy Buildings (NZEBs)

A review on building-integrated photovoltaic/thermal systems for green buildings

**Renewable energy in buildings**

Use of renewable energy sources for heating buildings

Renewable energy resources and multi-energy hybrid systems for urban buildings in Nordic climate

Exergy and Exergy-Economic Approach to Evaluate Hybrid Renewable Energy Systems in Buildings

Adoption of Renewable Energy Systems in common properties of multi-owned buildings: Introduction of 'Energy Entitlement'

Renewable Energies and Architectural Heritage: Advanced Solutions and Future Perspectives

Design, Project, and Realization of a Prototype of an Energy-efficient Prefabricated House IDA I. using Renewable Energy Sources.

**Energy efficiency of buildings**

Energy efficiency in sustainable buildings: a systematic review with taxonomy, challenges, motivations, methodological aspects, recommendations, and …

A review on zero energy buildings–Pros and cons

Estimating building energy efficiency from street view imagery, aerial imagery, and land surface temperature data

A statistical analysis of life cycle assessment for buildings and buildings' refurbishment research

Assessing Efficiency and Environmental Performance of a Nearly Zero-Energy University Building's Energy System in Norway

Energy Performance of Buildings Directive

ISO 52000-1:2017 Energy performance of buildings

Energy Efficiency Assessment for Buildings Based on the Generative Adversarial Network Structure

Energy Audits – Improve your buildings energy efficiency

https://www.designingbuildings.co.uk/wiki/Energy_audit Note the links and related articles too.

Building Energy Performance Assessment - Support Website ...

Energy Assessments and Benchmarking – an example of New York.

Understanding energy ratings and performance values (U- and G -values)

G-value in buildings / U-values in buildings

Energy assessment of advanced and switchable windows for less energy-hungry buildings in the UK

Passive mitigation of overheating in Finnish apartments under current and future climates

Passive Building Energy Saving: Building Envelope Retrofitting Measures to Reduce Cooling Requirements for a Residential Building in an Arid Climate

**Energy certificates**

Certificates and inspections - Energy - European Commission

Energy performance certificate

ENERGY STAR Certification for Buildings

Policy Pathway - Energy Performance Certification of ...

Energy Certifications in Architecture: 14 Examples Worldwide

What is Energy Performance Certificate (EPC) for Buildings?

Does Energy Star Certification Reduce Energy Use in Commercial Buildings?

Automated energy performance certificate based urban building energy modelling approach for predicting heat load profiles of districts

Note: The texts above are different ways to approach assessment methods and energy certificates. Always refer to assessment methods and certificate requirements valid in your country and region.

**Carbon-neutral and sustainable societies**

Design and Implementation of a Futuristic EV Energy Trading System (FEETS) Connected with Buildings, PV, and ESS for a Carbon-Neutral Society

Progress, challenge and significance of building a carbon industry system in the context of carbon neutrality strategy

Sustainable development economy and the development of green economy in the European Union

Reconciling welfare policy and sustainability transition–A case study of the Finnish welfare state

Changing values of millennials and centennials towards responsible consumption and sustainable society

Sustainable Societies – Follow the links, read the materials, good site e.g., for self-learning.

Strategies to achieve a carbon neutral society: a review

Global Trends and Policies on Carbon Neutrality and Digitalization

Sustainability solutions

**Life cycle assessment (LCA) and methods**

Circular building assessment

Life Cycle Assessment of Buildings: A Practice Guide

Life-cycle assessment for green building experts

Model for Life Cycle Assessment (LCA) of buildings  - downloads automatically

https://energysavingtrust.org.uk/advice/solar-panels/

https://www.designingbuildings.co.uk/wiki/Life_cycle_assessment

**Energy production**

Concepts and definitions

How electricity is generated

Energy Processes, Systems and Equipment

Methods of Generating Electricity Targeted for younger but can be useful in some cases.

Electricity Production and Distribution

Energy Processes, Systems and Equipment Note: See all the papers and articles.

Energy system Part of IEA's wide web materials, suitable for self-learning.

Techno-economic assessment of green hydrogen production by an off-grid photovoltaic energy system

Low-carbon economic dispatch of integrated energy system containing electric hydrogen production based on VMD-GRU short-term wind power prediction

Combined Heat and Power (CHP) Partnership

Renewable Energy and Electricity

Hydrogen Production Processes - Hydrogen Production – Hydrogen Delivery – Hydrogen Storage

Fuel Cells

Summary of scientific articles approaching electricity production

Summary of scientific articles approaching energy production

Energy loss (See also the other chapters and links to further materials.)

**New ideas and technologies**

Textile-Triboelectric nanogenerators (T-TENGs) for wearable energy harvesting devices

Revolutionizing Solar Energy with AI-Driven Enhancements in Photovoltaic Technology

An energy-efficient plasma methane pyrolysis process for high yields of carbon black and hydrogen

**Occupational safety**

Control of Hazardous Energy

Hazardous energy control programmes

**Energy issues in common** and particularly from point of view of sustainable rural development projects

Basic energy concepts

Energy concerns and the project cycle

Economics of energy in agriculture and rural development projects

Comparison of energy alternatives for small-scale irrigation

Agro-forestry, a new fashion of old tradition?

Appendices

**Various links**

Note: some of these links may already be in ordered list above. Furthermore, it is worth noting, that some of the publications below referring to EU-directives have been done on point of view of the revisions 2018 of the directives, and new instructions basing on revisions 2023 of the directives are probably under work at the moment. Thus, follow the branch and development!

Energy Efficiency Directive, updated 20th September 2023 http://data.europa.eu/eli/dir/2023/1791/oj

Energy Performance of Buildings Directive http://data.europa.eu/eli/dir/2024/1275/oj

Renewable Energy Directive https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32018L2001 and amending directive http://data.europa.eu/eli/dir/2023/2413/oj

Energy efficient building directory of EU https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficient-buildings_en

Use of Renewable Energy in Buildings https://www.intechopen.com/chapters/73187

5 Renewable Energy Sources that are going to impact the Building Industry in the Future https://www.re-thinkingthefuture.com/architects-lounge/a334-5-renewable-energy-sources-that-are-going-to-impact-the-building-industry-in-the-future/

Building integrated renewable energy systems (RES) https://www.matchup-project.eu/solutions/internet-of-things/

Sustainable energy in buildings https://klima.praha.eu/en/sustainable-energy-and-buildings.html

Assessment of renewable energy… https://eprints.gla.ac.uk/260000/1/260000.pdf

Performance assessment and optimization… https://www.researchgate.net/profile/Maria-Ferrara-6/publication/339879574_Performance_assessment_and_optimization_of_a_solar_cooling_system_to_satisfy_Renewable_Energy_Ratio_RER_requirements_in_multi-family_buildings/links/60a3df7792851ccae9e8b80e/Performance-assessment-and-optimization-of-a-solar-cooling-system-to-satisfy-Renewable-Energy-Ratio-RER-requirements-in-multi-family-buildings.pdf

Embedding energy optimization in organizations: A case study of a Swiss decentralized renewable energy system https://www.sciencedirect.com/science/article/pii/S0378778820334964/pdfft?md5=d8fe242439a1b8baf69b2f1954c93dc0&pid=1-s2.0-S0378778820334964-main.pdf

Review of technological design options for building integrated photovoltaics (BIPV) https://www.sciencedirect.com/science/article/pii/S0378778819339155/pdfft?md5=b549e73205d707f95847cebf75aaf2bc&pid=1-s2.0-S0378778819339155-main.pdf

Analysis of cooling load on commercial building in UAE climate using building integrated photovoltaic façade system https://www.academia.edu/download/92930974/j.solener.2020.02.06220221023-1-gmr2qs.pdf

Holistic economic analysis of building integrated photovoltaics (BIPV) system: Case studies evaluation https://www.sciencedirect.com/science/article/pii/S0378778819315907/pdfft?md5=2adaaa1693619bd05fc0d9a693e67390&pid=1-s2.0-S0378778819315907-main.pdf

Sustainable design of geothermal energy systems for electric power generation using life cycle optimization https://aiche.onlinelibrary.wiley.com/doi/am-pdf/10.1002/aic.16898

Renewable energy systems for building heating, cooling and electricity production with thermal energy storage https://www.sciencedirect.com/science/article/pii/S1364032122004592/pdfft?md5=78c5cb56d1c2644e7cf5f054bcdf43b0&pid=1-s2.0-S1364032122004592-main.pdf

Design, Development and Testing Plan for Energy Efficiency Algorithms Related to Building-Integrated Cooling, Heating, and Power Systems https://www.osti.gov/servlets/purl/1996377

Optimum design of hybrid wind/PV energy system for remote area https://www.sciencedirect.com/science/article/pii/S2090447919301017/pdfft?md5=540e35d7f0f4f2b882bd1b939fd22711&pid=1-s2.0-S2090447919301017-main.pdf

Power-to-hydrogen as seasonal energy storage: an uncertainty analysis for optimal design of low-carbon multi-energy systems https://www.sciencedirect.com/science/article/pii/S0306261920307091/pdfft?md5=43f8a2787c531ea1b8e6d985519e4fec&pid=1-s2.0-S0306261920307091-main.pdf

Optimizing design and dispatch of a renewable energy system https://www.sciencedirect.com/science/article/am/pii/S0306261921000829

Users in the design of Hydrogen Energy Systems: A systematic review https://www.sciencedirect.com/science/article/am/pii/S0360319920307801

Trends in design of distributed energy systems using hydrogen as energy vector: A systematic literature review https://www.sciencedirect.com/science/article/am/pii/S0360319918330970

Recommendations for energy storage compartment used in renewable energy project https://www.sciencedirect.com/science/article/pii/S2666202722000465/pdfft?md5=cf66d81e8bf75905de1e484b7ff0de2d&pid=1-s2.0-S2666202722000465-main.pdf

Renewable energy – powering a safer future https://www.un.org/en/climatechange/raising-ambition/renewable-energy

Renewable hydrogen: what are the benefits for the EU? https://www.europarl.europa.eu/topics/en/article/20210512STO04004/renewable-hydrogen-what-are-the-benefits-for-the-eu#:~:text=Its%20use%20for%20energy%20purposes,can%20be%20repurposed%20for%20hydrogen

## Notes for the teachers

The material enclosed is an example showing how the topics of this course could be presented. Each teacher should adjust this to the circumstances of his own country, considering the local regulation the level and skills of the trainees, and the study programme of the students; are they studying construction, finishing, plumber, some examples to be given. Each programme may require different weightings and highlights, and it is on the responsibility of each teacher to consider these special needs. The number of usable materials is big, and in every module, only some examples has been enclosed, thus, it is recommended, that when choosing the final materials, also examples of other modules would be considered.

## Target group

The primary target group of the training is young people with exam from lower secondary school having interest in energy branch and energy efficiency. The secondary target group is people who are already working in the branch, and who want to develop their skills and knowledge of energy issues.

During the implementation of the curriculum, a decision should be made: Will there be only beginners in the training or will trainer / school allow students to come straight to the second or even third stage, and if, how could / should we ensure that they have knowledge, skills and qualifications required in the stage they are coming. Furthermore, the programme has been divided into three stages, journeyman's examination, further vocational training, and bachelor's degree. Will only those, gained the journeyman's qualification in this programme, be allowed to continue the next stage, or are other students having the appropriate qualification, allowed to study the next stage too.

## Overlapping contents of Module 2 and Module 3

Although the contents of submodule 2.2.2 (Energy consultant) and some submodules of module 3 are partially overlapping, it is on teacher's responsibility to evaluate, whether the knowledge and skills gained in module 2.2.2 and during the work experience are close enough to that required in module 3 so that these parts of module 3 could be replaced by using the *accreditation of prior learning* -process, if such a process is in use.

## Work required

In the curriculum, the average work required by each module is measured in units used in educational level in question to make it easier for teachers to plan the practical application. In VET level, the used unit is ECVET and in higher education level ECTS credit units (abbreviated in this presentation as CU) has been used. 60 ECVETs responds studies of one year, and one ECTS credit unit equals 27 hours workload. The curriculum consists of modules and submodules with various size. Depending to national weightings and requirements, size, order, and weights of submodules can be changed inside each module. However, it is not recommended to change the submodules between modules.

## Apprentice / practical parts

It has been assumed, that the apprentice periods belonging to the Bachelor's degree will be done during the work at workplace -phases. If this is not possible, e.g., student has come from upper secondary school direct to Bachelor's degree, the work learning periods must be arranged in some other way.

## Teaching methods

Teachers are encouraged to use varying methods containing e.g.:

- Self-learning
- Lectures,
- Visiting lecturers,

- Construction site visits,
- On-line studies,
- Videos approaching the topics (Reliability of the source must be evaluated),
- Individual studies,
- Assignments, and
- Reporting and presenting the work done at workplaces.

Cooperation with the local experienced industry practitioners is highly recommended. All modules can be studied individually, so the modules can be offered also via open studies to all companies and organizations operating at the construction and finishing branches, who intend to develop their skills in using the modern information technology in their business.

## Contents of the curriculum

The regulations, circumstances and qualification requirements are quite different in different BSR-countries, thus, the curriculum and material has been written as a form of framework inside which the local actors should modify the contents of modules according to their own regulations and local requirements, without forgetting the needs of different study programmes. By using innovative, problem-based, and experiential educational approaches, teacher will be able to help students to become experts who are able to acquire, create, implement, use, and advice effective energy saving methods.

The overall objectives of the curriculum are:

- The student deepens his/her knowledge about sustainability and energy issues.
- The student understands the regulatory framework and knows the essential contents of legislation on the energy sector on the point of view of both industry and consumers.
- The student can explain specific terms that relate to sustainability, energy efficiency, and renewable energy, and their use in the context of buildings,
- The student understands the importance of energy issues and knows how to improve the energy efficiency of buildings and how to utilize renewable energy in buildings,
- The student deepens his/her knowledge about sustainability, energy, and energy efficiency.

The curriculum is divided into modules and submodules. Each submodule and main modules 1 and 2 can be replaced with studies, knowledge and skills gained earlier, although it is not recommended to use this process with modules containing essential skills on point of view of qualification targeted. Teacher and education institute have the duty and right to evaluate whether the skills and knowledge or studies are adequate considering the requirements of the qualification, and student's capability to participate in further studies basing to this knowledge.

## About the links

In the curriculum, there are mostly bookmarks to the topic-specific link lists at the end of the document. These lists are neither absolute nor exclusive. Each teacher can search and use materials that are more compatible with the requirements of his/her country and/or training.

The links to materials have been tested during the period November 2023 – August 2024. However, the links may be changed and deleted very fast; thus, it is recommended that links which will be given to students should be checked at the beginning of each course. Some of the links may be behind the paywall and require agreement between the educational institute and publisher to be available. In such case, contact your librarians. Some of the links refer to documents that have been written for commercial or political purposes. The authors of this document do not take a stand for or against any product, and the research results and opinions found in the links are also the responsibility of the original authors of the documents in question.

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