technische universität
dortmund

MODULE HANDBOOK

M.Sc. Sustainable Energy and Hydrogen Infrastructures

Stand: 16.07.2025

Department of Spatial Planning

Overview

Module	Titel
1	Energy Systems
2	Renewable Energy Technologies
3	Hydrogen Technologies
4	Planning of Infrastructures
5	Smart Grids, Energy Storage and Sector Coupling
6	Spatial Planning
7	Sustainability and Circular Economy
8	Innovation and Technology Management
9	Practical Project
10	Master Thesis
CE	Compulsory Electives I - VII

Legend

E	*Exercise*	*(C)*	*Compulsory*	*D*	*Draft*
LE	*Lecture + Exercise*	*PJ*	*Project*	*SE*	*Seminar*
L	*Lecture*	*(CE)*	*Compulsory elective*	*LC*	*Lecture course*

Module 1: Energy Systems

Study programme: M.Sc. Sustainable Energy and Hydrogen Infrastructures

Frequency:	Duration:	Term:	CP:	Workload:
Winter	1 Semester	1. Term	5	150 h

1 Courses

Nr.	Lecture	Typ	LP	SWS
	A) Lecture	L (C)	2	2
	B) Exercise	E (C)	2	2
	Examination		1	

2 Language
English

3 Contents
The lecture deals with a wide variety of topics related to energy systems. Specifics of conventional and renewable energy supply are introduced and contrasted regarding the current state of energy supply, energy markets and the transportation of various energy carriers, with a focus on the situation in Germany.
In the corresponding exercise, mass and energy balancing is introduced and applied as a basis for calculations of energy efficiency, economics and environmental impacts of energy systems and energy system (optimization) models and simulations are applied.

4 Learning targets
The lecture covers a wide range of topics related to energy systems. Students will gain an understanding of the differences between conventional and renewable energy supply, analyzing the current state of energy supply, energy markets, and the transportation of various energy carriers, with a particular focus on Germany.

In the corresponding exercise, students will be introduced to mass and energy balancing as a fundamental method for evaluating energy efficiency, economic aspects, and environmental impacts of energy systems. Additionally, they will apply energy system optimization models and simulations to analyze and improve the performance of energy systems.

By the end of the course, students will be able to perform mass and energy balance calculations, assess the efficiency and sustainability of energy systems, and utilize modeling and simulation tools to optimize energy supply and distribution

5 Examinations
Module examination (graded)

6 Mode of assessment
Written exam (120 minutes) covering both the lectures and exercises

7 Requirements
No

8 Module application
Compulsory module in M.Sc. Sustainable Energy and Hydrogen Infrastructures

9 Module coordinator(s) and lecturer(s)
Prof. Dr. Christoph Wieland (UDE)

Department
Department of Spatial Planning (09)

Legend

E	*Exercise*	*(C)*	*Compulsory*	*D*	*Draft*
LE	*Lecture + Exercise*	*PJ*	*Project*	*SE*	*Seminar*
L	*Lecture*	*(CE)*	*Compulsory elective*	*LC*	*Lecture course*

Module 2: Renewable Energy Technologies

Study programme: M.Sc. Sustainable Energy and Hydrogen Infrastructures

Frequency:	Duration:	Term:	CP:	Workload:
Winter	1 Term	1. Term	5	150 h

1 Courses

Nr.	Lecture	Typ	CP	SWS
	A) Lecture	L (C)	2	2
	B) Exercise	E (C)	2	2
	Examination		1	

2 Language
English

3 Contents
Main content is the comparison of the properties, advantages and disadvantages of numerous renewable energy technologies, such as:
Thermal Solar Power Plants, Geothermal Power Plants, Biomass Plants, Hydropower Plants, Tidal and Wave Power Plants, Thermoelectric Generators, Nuclear Fusion, Wind Power Plants, Photovoltaic Systems, With respect to electrical understanding, the lecture will also deal with Hydrogen Converters, Power-to-X plants and Grid Integration.

4 Learning targets
After successfully completing the module, students will be able to:

- Independently analyze various renewable energy sources based on their technical characteristics, potentials, and application areas, by applying relevant theoretical and practical criteria, in order to develop strategic deployment scenarios for energy supply systems.
- Explain and compare renewable energy conversion concepts in detail by critically evaluating technological specifics and innovations, in order to make informed decisions regarding applicability and efficiency.
- Evaluate and plan the structure and grid connection of renewable power plants independently, by considering relevant technical standards, requirements, and factors affecting grid stability, in order to strategically solve challenges in system integration.
- Critically assess the challenges of integrating volatile renewable energy sources into existing energy systems, by identifying complex systemic interdependencies and developing solution strategies, in order to design reliable and sustainable grid concepts.

5 Examinations
Module examination: 2 partial performances (graded)

6 Mode of assessment
Partial examination 1, 30%: submission of a digital coursework assignment
Partial examination 2, 70%: written exam (60 minutes)

7 Requirements
No

8 Module application
Compulsory module in M.Sc. Sustainable Energy and Hydrogen Infrastructures

9 Module coordinator(s) and lecturer(s)
Prof. Dr. Jens Bockstette, (HSD)
Prof. Dr. Holger Wrede (HSD)

Department
Department of Spatial Planning (09)

Legend

E	*Exercise*	*(C)*	*Compulsory*	*D*	*Draft*
LE	*Lecture + Exercise*	*PJ*	*Project*	*SE*	*Seminar*
L	*Lecture*	*(CE)*	*Compulsory elective*	*LC*	*Lecture course*

Module 3: Hydrogen Technologies

Study programme: M.Sc. Sustainable Energy and Hydrogen Infrastructures

Frequency:	Duration:	Term:	CP:	Workload:
Winter	1 Term	1. Term	5	150 h

1 Courses:

Nr.	Lecture	Typ	CP	SWS
	A) Lecture	L (C)	2	2
	B) Exercise	E (C)	2	2
	Examination		1	

2 Language
English

3 Contents
Hydrogen technologies play a pivotal role in the global energy transition, offering a clean and versatile energy carrier across various sectors. The lecture covers hydrogen production methods, with a focus on electrolysis powered by renewable energy, transitioning from "grey" and "blue" to "green" hydrogen. It explores the challenges and solutions in hydrogen storage technologies, as well as the transport and distribution of hydrogen through pipelines and road networks. Applications are examined across industry (e.g., decarbonizing steel and chemicals), mobility (e.g., fuel cell vehicles), grid storage, power generation (e.g., hydrogen-fueled gas turbines) and households (e.g., hydrogen boilers), highlighting the cost, infrastructure and advancements required for widespread adoption. Finally, the lecture discusses opportunities and challenges of an international hydrogen economy, while envisioning its potential in achieving net-zero emissions.

4 Learning targets
After successfully completing the module, students will be able to:

- apply comprehensive, detailed knowledge on the hydrogen value chain, covering production, storage, transport, distribution,
- create a concept design for these hydrogen technologies, and critically assess the challenges and solutions for different application areas,
- develop strategies to the transition to low emission hydrogen in energy systems or industry, considering technical aspects as well as economic, political and infrastructural barriers to hydrogen adoption

5 Examinations
Module examination: 2 partial performances (graded)

6 Mode of assessment
Partial examination 1, 30%: submission of a digital coursework assignment
Partial examination 2, 70%: written exam (60 minutes)

7 Requirements
No

8 Module application
Compulsory module in M.Sc. Sustainable Energy and Hydrogen Infrastructures

9 Module coordinator(s) and lecturer(s)
Prof. Dr. Franziska Schaube (HSD)

Department
Department of Spatial Planning (09)

Legend

E	*Exercise*	*(C)*	*Compulsory*	*D*	*Draft*
LE	*Lecture + Exercise*	*PJ*	*Project*	*SE*	*Seminar*
L	*Lecture*	*(CE)*	*Compulsory elective*	*LC*	*Lecture course*

Module 4: Planning of Energy Infrastructures

Study programme: M.Sc. Sustainable Energy and Hydrogen Infrastructures

Frequency:	Duration:	Term:	CP:	Workload:
Winter	1 Term	1. Term	5	150 h

1 Courses

Nr.	Lecture	Typ	CP	SWS
	A) Lecture	L (C)	2	2
	B) Exercise	E (C)	2	2
	Examination		1	

2 Language
English

3 Contents
The lecture deals with the changing roles and challenges of various kinds of energy infrastructures in the course of the energy transition from fossil to renewable energy supply. It covers technical and economic aspects of the construction and maintenance of energy plants such as power plants, heating plants and hydrogen related equipment such as electrolysers as well as of energy infrastructures such as power, gas and heat grids. It also helps the students to critically reflect existing approaches to plan energy infrastructures and to compare several planning methods.
In the exercise, methods for cost and investment estimation as well as grid calculation approaches for several kinds of energy grids (power, gas, heat) are applied.

4 Learning targets
After successfully completing the module, the students will

- have comprehensive and detailed knowledge about the specific challenges of energy infrastructures in the context of the energy transition, especially
  - constraints with regard to land availability
  - spatial planning constraints
  - ecological constraints
- have specialized skills for energy grid calculation, grid planning and grid operation
- have extensive knowledge of planning approaches for energy plants and infrastructures
- know how to apply investment and cost estimation procedures for energy plants, infrastructures and hydrogen-related equipment even when facing incomplete information
- be able to develop and critically assess plant and process designs

5 Examinations
Module examination: 2 partial performances (graded)

6 Mode of assessment
Partial examination 1, 30%: submission of a digital coursework assignment
Partial examination 2, 70%: written exam (60 minutes)

7 Requirements
No

8 Module application
Compulsory module in M.Sc. Sustainable Energy and Hydrogen Infrastructures

9 Module coordinator(s) and lecturer(s)
Prof. Dr. Lars-Peter Lauven (TU Dortmund)

Department
Department of Spatial Planning (09)

Legend

E	*Exercise*	*(C)*	*Compulsory*	*D*	*Draft*
LE	*Lecture + Exercise*	*PJ*	*Project*	*SE*	*Seminar*
L	*Lecture*	*(CE)*	*Compulsory elective*	*LC*	*Lecture course*

Module 5: Smart Grids, Energy Storage and Sector Coupling

Study programme: M.Sc. Sustainable Energy and Hydrogen Infrastructures

Frequency:	Duration:	Term:	CP:	Workload:
Winter	1 Term	1. Term	5	150

1 Courses

Nr.	Lecture	Typ	CP	SWS
	A) Lecture	L (C)	2	2
	B) Exercise	E (C)	2	2
	Examination		1	

2 Language

English

3 Contents

Smart grids and sector coupling: Overview of electrical grids, definition of smart grids and importance for energy supply, components of smart grids on different voltage levels, smart metering (infrastructure) and use cases, communication technologies, consideration of smart grids in network planning process, reliability of smart grids (components), regulatory aspects of smart grids, comparison of different smart grid concepts, definition and significance of sector coupling for the energy transition, technologies and methods of sector coupling, comparison of sector coupling in different countries

Technologies of Large-Scale Energy Storage, such as Pumped Storage Power Plants, Compressed Air Energy Storage, Hydrogen Storage (Iron-Air Battery), Flywheel Storage, Battery Storage, Battery Storage Technologies (particularly Lithium-Ion Batteries, Sodium-Ion Batteries), Current State of the Art and Outlook

4 Learning targets

After successfully completing the module, students will be able to:

- Understand the challenges of implementing energy storage systems in modern energy infrastructure.
- Analyse and explain the structure and functionality of modern electrical grids and critically evaluate the role of smart grids in the context of a secure and sustainable energy supply.
- Characterize and assess key components of smart grids across different voltage levels, including their functions, applications and technological as well as regulatory challenges.
- Define and contextualize the concept of sector coupling within integrated energy systems and evaluate its strategic relevance for the decarbonization of energy supply
- Develop and apply advanced methods for integrating smart grids and sector coupling approaches into the planning, simulation and optimization of energy networks.
- Critically assess emerging trends and research directions in smart grids grids and sector coupling and formulate well-founded projections regarding their future impact on energy systems.
- Evaluate and compare large-scale energy storage technologies in terms of design principles, technical parameters, and system integration strategies.
- Analyse the operating principles and technical configurations of various energy storage systems and assess their suitability for specific application scenarios.
- Identify and reflect on the technical, economic and regulatory challenges associated with the implementation of energy storage systems in modern power infrastructure and propose solution approaches.

5 Examinations

Module examination (graded)

Legend

E	*Exercise*	*(C)*	*Compulsory*	*D*	*Draft*
LE	*Lecture + Exercise*	*PJ*	*Project*	*SE*	*Seminar*
L	*Lecture*	*(CE)*	*Compulsory elective*	*LC*	*Lecture course*

6	**Mode of assessment** Oral examination (30 min)	
7	**Requirements** No	
8	**Module application** Compulsory module in M.Sc. Sustainable Energy and Hydrogen Infrastructures	
9	**Module coordinator(s) and lecturer(s)** Prof. Dr. David Echternacht (HSD) Prof. Dr. Jens Bockstette (HSD)	**Department** Department of Spatial Planning (09)

Module 6: Spatial Planning

Study programme: M.Sc. Sustainable Energy and Hydrogen Infrastructures

Frequency:	Duration	Term:	CP:	Workload:
Summer	1 Term	2. Term	5	150 h

1 Courses

Nr.	Lecture	Typ	CP	SWS
	A) Lecture	L (C)	2	2
	B) Exercise	E (C)	2	2
	Examination		1	

2 Language
English

3 Contents
In the course of the ongoing energy transition, European countries such as Germany face challenges of planning in a multi-level governance system to address tasks such as sustainable infrastructure planning or energy security while delivering renewable energy targets. The course draws on examples from a range of urban development strategies and reflects on processes of multi-level governance in spatial planning policies as well as sectoral policies such as energy planning, heat planning etc. Therefore, principles and processes of urban and regional planning, urban regeneration and sustainable spatial transition will be discussed. The course addresses planning instruments at the different planning levels and the integration of sectoral plans into spatial plans, considers strategies and concepts for a sustainable future of cities and regions, analyses the impact of contemporary developments such as digitalisation on urban and regional planning, and reflects on the involved actors and governance constellation. The lecture strongly encourages critical reflections of planning approaches and of evaluation methods used in praxis.

4 Learning targets
The objective of the lecture is the introduction into the core elements of the spatial planning with examples from the German planning system. The students will get to know systems of spatial planning and the structure of the spatial observation as well as visions for spatial development for Germany and in Europe. The requirements of the energy transition for the implementation of planning concepts and its instruments will be a central part of the lecture. The principles and objectives of urban and regional planning in Germany will be discussed in comparison to other countries.

5 Examinations
Module examination: 2 partial performances (graded)

6 Mode of assessment
Partial examination 1, 30%: submission of a digital coursework assignment
Partial examination 2, 70%: written exam (60 minutes)

7 Requirements
No

8 Module application
Compulsory module in M.Sc. Sustainable Energy and Hydrogen Infrastructures

9 Module coordinator(s) and lecturer(s)
Prof. Dr. Frank Othengrafen

Department
Department of Spatial Planning (09)

Legend

E	*Exercise*	*(C)*	*Compulsory*	*D*	*Draft*
LE	*Lecture + Exercise*	*PJ*	*Project*	*SE*	*Seminar*
L	*Lecture*	*(CE)*	*Compulsory elective*	*LC*	*Lecture course*

Module 7: Sustainability and Circular Economy

Study programme: M.Sc. Sustainable Energy and Hydrogen Infrastructures

Frequency:	Duration	Term:	CP:	Workload:
Summer	1 Term	2. Term	5	150 h

1 Courses

Nr.	Lecture	Typ	CP	SWS
	A) Lecture	L (C)	2	2
	Examination		3	

2 Language
English

3 Contents
Topics of the lecture are sustainability and numerous aspects of circular economy systems. Economically and ecologically efficient configuration of processes aims to avoid, reduce, reuse, repair or recycle residues and decommissioned products and the disposal of wastes from an operational point of view. In a broader perspective, the 9R-Framework is introduced, also including rethinking the usage of resources or refusing their use altogether, refurbishing or repurposing old products and recovering wastes. Additional topics will be corporate social responsibility and an introduction to industrial ecology.

4 Learning targets
After successfully completing the module, students will be able to:

- have gained comprehensive knowledge about the various dimensions of sustainability and their relevance for energy systems and are able to classify them
- have detailed knowledge of the 9R-Framework and its associated challenges
- have specific knowledge of the elements of a life cycle analysis and are able to evaluate and critically discuss the results of such an analysis
- are able to solve sustainability evaluation problems by using multi-criteria decision support methods, even if the underlying information is incomplete
- are able to independently apply their technical knowledge in an environmentally oriented manner

5 Examinations
Module examination (graded)

6 Mode of assessment
Written exam (120 minutes)

7 Requirements
No

8 Module application
Compulsory module in M.Sc. Sustainable Energy and Hydrogen Infrastructures

9 Module coordinator(s) and lecturer(s)
Prof. Dr. Lars-Peter Lauven (TU Dortmund)

Department
Department of Spatial Planning (09)

Legend

E	*Exercise*	*(C)*	*Compulsory*	*D*	*Draft*
LE	*Lecture + Exercise*	*PJ*	*Project*	*SE*	*Seminar*
L	*Lecture*	*(CE)*	*Compulsory elective*	*LC*	*Lecture course*

Module 8: Strategic Technology and Innovation Management

Study programme: M.Sc. Sustainable Energy and Hydrogen Infrastructures

Frequency:	Duration	Term:	CP:	Workload:
Summer	1 Term	2. Term	5	150h

1 Courses

Nr.	Lecture	Typ	CP	SWS
	A) Lecture	L (C)	2	2
	B) Exercise	E (C)	2	2
	Examination		1	

2 Language
English

3 Contents
Today`s industrial economies are driven by the capacity of companies to innovate and the potential to push technological boundaries further. Innovation and technology management (ITM) is part of the strategic management discipline and thus from a strong entrepreneurial relevance. It covers the management of new technologies, products, services and entire business models, in order to strengthen the competitive power of a company.

This seminar covers an initial overview on content and relevance of ITM within the corporate field:

- Lecture 1: We will discuss basics such as underlying (innovation) management and strategy concepts, the differentiation between invention, imitation, and innovation, as well as between technology and innovation management. We also cover different types of innovation ranging from incremental to radical and from classical product to business model innovation.
- Lecture 2 (two appointments): We cover topics such as the analysis of the technological and market environment to identify relevant developments by using technology and market life cycle models. We further discuss the adoption of adequate innovation strategies, setting the frame for subsequent innovation activities.
- Lectures 3 to 6 (five appointments): We move deeper into selected topics regarding the innovation process, starting at the so called "fuzzy front end" up to the final product or service. Thereby, we discuss basic options and look into tools, methods, and processes of innovation search, selection, and implementation/ marketing.
- Lectures 7 to 12: Finally, we discuss organizational aspects such as knowledge management, innovation culture, measurement of innovation performance (lectures 7 to 9), as well as recent trends and methods in innovation management such as business model innovation and entrepreneurship, respectively (lecture 10-12).
- Final lectures: Discussion of open topics & final exam preparation

In sum, the course is working with input from and discussion of established theory and recent research (lecture slides and paper discussions by student groups/ in plenum), input from practice (in particular case studies and examples from practice) and interactive development of existing and own concepts (in-class group work and discussions).
The connected exercise will focus on one real life challenge of a company that a student group needs to solve based on the content of the lectures and own data collection and analysis. This problem-based approach will result in a solution presented to
the company at the end of the semester.

Legend

E	*Exercise*	*(C)*	*Compulsory*	*D*	*Draft*
LE	*Lecture + Exercise*	*PJ*	*Project*	*SE*	*Seminar*
L	*Lecture*	*(CE)*	*Compulsory elective*	*LC*	*Lecture course*

4	**Learning targets** After successfully completing the module, students will be able to: • will have a deep understanding on the relevance of innovation within firms, • know the basics about managing innovation and technology within corporations based on a systematic planning, implementation and controlling of innovation activities, • understand and recognize different situations and environments regarding technology and innovation and are able to derive specific managerial implications, and • are able to evaluate and use methods and tools of ITM purposefully. To acquire this knowledge and skill set, each class is built upon • Lecture and in-class exercise on/ discussions of theory, methods, and (case) examples • Paper-based case study analysis and discussion • Real life cases from partner companies	
5	**Examinations** Module examination: 2 partial performances (graded)	
6	**Mode of assessment** Partial examination 1, 30%: submission of a digital coursework assignment Partial examination 2, 70%: written exam (60 minutes)	
7	**Requirements** No	
8	**Module application** Compulsory module in M.Sc. Sustainable Energy and Hydrogen Infrastructures	
9	**Module coordinator(s) and lecturer(s)** Prof. Dr. Ellen Enkel (UDE)	**Department** Department of Spatial Planning (09)

Legend

E	*Exercise*	*(C)*	*Compulsory*	*D*	*Draft*
LE	*Lecture + Exercise*	*PJ*	*Project*	*SE*	*Seminar*
L	*Lecture*	*(CE)*	*Compulsory elective*	*LC*	*Lecture course*

Module 9: Practical Project

Study programme: M.Sc. Sustainable Energy and Hydrogen Infrastructures

Frequency:	Duration	Term:	CP:	Workload:
Summer	1 Term	2. Term	10	300 h

1 Courses

Nr.	Lecture	Typ	CP	SWS
	A) Project seminar	SE (C)	2	2
	B) Project	PJ (C)	6	6
	Examination		2	

2 Language
English

3 Contents
The Practical Project and the accompanying Project Seminar provide students with the opportunity to apply the theoretical knowledge acquired in previous modules in a practical, application-oriented context. Students are required to solve a given problem using the "Problem-Based Learning" (PBL) approach. The problem statement may either be research-focused, assigned by a department member of the program, or practice-oriented, conducted in collaboration with an industry partner associated with the EUREF- Campus. If students opt for a project with an industry partner, they will be assigned a mentor within the respective company to provide guidance and support throughout the project.
The Practical Project involves exploring modern energy systems with a focus on integrating smart technologies and sustainability principles. Students will gain training in technical skills such as energy system modeling, IoT applications, data analysis, and machine learning. They will study renewable energy technologies, smart grids, and energy storage systems, focusing on design, optimization, and practical applications. The program includes learning about energy efficiency, demand response strategies, and relevant policy and regulatory frameworks.
The Project Seminar is designed to accompany the Practical Project and takes place regularly over the course of the 8-week project phase. Students are expected to work on their project for two days per week either within a partner company or at a university research department. During the Project Seminar, the ongoing project work is scientifically reflected upon in collaboration with the supervising department. This enables students to progressively develop solutions to the assigned problem using the Problem-Based Learning methodology. In cases where students have not yet been introduced to the Problem-Based Learning approach in their previous studies, they will receive targeted guidance on the methodology during the seminar.
Through this process, students will also enhance their soft skills, such as communication and project management, while gaining hands-on experience through field visits. The goal is to provide practical experience, technical knowledge, and networking opportunities in the energy sector.
The project results and findings are to be compiled in a written report of 25 to 30 pages. This report should not only document the solution pathway but also provide a well-reasoned justification for the chosen approach.

Legend

E	*Exercise*	*(C)*	*Compulsory*	*D*	*Draft*
LE	*Lecture + Exercise*	*PJ*	*Project*	*SE*	*Seminar*
L	*Lecture*	*(CE)*	*Compulsory elective*	*LC*	*Lecture course*

4	**Learning targets** The Practical Project and Project Seminar enable students to apply theoretical knowledge from previous modules in a real-world, application-oriented context. Through the Problem-Based Learning (PBL) approach, students will develop problem-solving skills by analyzing complex challenges and structuring solutions in both academic and industry settings. They will gain technical expertise in modern energy systems, including energy system modeling, IoT applications, data analysis, and machine learning techniques. Additionally, students will deepen their understanding of renewable energy technologies, smart grids, and energy storage systems, focusing on their design, optimization, and practical implementation. A key aspect of the course is the analysis of policy and regulatory frameworks, equipping students with knowledge of relevant energy policies, regulations, and demand response strategies. Moreover, they will engage in research activities, analyze case studies, and develop functional prototypes to address energy-related challenges. The ability to reflect scientifically on project work and document findings in a structured and well-reasoned academic report will also be a crucial learning outcome. Beyond technical competencies, students will enhance their communication and project management skills by collaborating with industry partners and department members. Hands-on experience will be gained through industry cooperation, field visits, and networking opportunities within the energy sector. Ultimately, this course provides a comprehensive foundation in practical energy system applications, research methodologies, and professional skill development.	
5	**Examinations** Module examination (graded)	
6	**Mode of assessment** The module examination is a final report (25-30 pages) and an oral examination (30 min)	
7	**Requirements** No	
8	**Module application** Compulsory module in M.Sc. Sustainable Energy and Hydrogen Infrastructures	
9	**Module coordinator(s) and lecturer(s)** Module coordinator Prof. Dr. Lars-Peter Lauven	**Department** Department of Spatial Planning (09)

Legend

E	*Exercise*	*(C)*	*Compulsory*	*D*	*Draft*
LE	*Lecture + Exercise*	*PJ*	*Project*	*SE*	*Seminar*
L	*Lecture*	*(CE)*	*Compulsory elective*	*LC*	*Lecture course*

Module 10: Master Thesis

Study programme: M.Sc. Sustainable Energy and Hydrogen Infrastructures

Frequency:	Duration:	Term:	CP:	Workload:
Winter	1 Term	3. Term	20	600 h

1 Courses

Nr.	Lecture	Typ	CP	SWS

2 Language

English

3 Contents

The Master's thesis is a scientific work in the field of sustainable energy and hydrogen infrastructures. It may have a theoretical, empirical, or conceptual/technical focus. Students are encouraged to propose their own thesis topics.

The thesis should demonstrate that the student is capable of independently conducting research within a given period of four months, addressing a complex issue related to sustainable energy systems or hydrogen infrastructure in accordance with scientific standards and methodologies.

4 Learning targets

After successfully completing the module, students will be able to:

- possess a broad knowledge of energy science,
- have in-depth knowledge of sustainable energy, is production and distribution, and subject areas of the chosen study program,
- can independently work on a challenging scientific topic within a given deadline, taking into account relevant theories and applying scientific methods,
- are capable of presenting their results in writing in a manner that meets the criteria of scientific work, can orally present the approach and results of their work, and relate them to adjacent subject areas

5 Examinations

Credit points are awarded upon the successful completion of the master's thesis and the oral final examination.

6 Mode of assessment

Written master's thesis (max. 175.000 characters, without spaces) and the oral final examination (20 minutes)

7 Requirements

Examination rules

8 Module application

Compulsory module in M.Sc. Sustainable Energy and Hydrogen Infrastructures

9 Module coordinator(s) and lecturer(s)	Department
Prof. Dr. Lars-Peter Lauven	Department of Spatial Planning (09)

Legend

E	*Exercise*	*(C)*	*Compulsory*	*D*	*Draft*
LE	*Lecture + Exercise*	*PJ*	*Project*	*SE*	*Seminar*
L	*Lecture*	*(CE)*	*Compulsory elective*	*LC*	*Lecture course*

In Addition to studying Module 1 – 10 every student has to choose four Compulsury Electives (see following: CE I – CEIV) with a total of 20 CP. It is recommended to study one CE in the first semester, a second one in the second semester and another two CE in the third semester. The students are free to choose any of the following CE Modules.

Module CE I: Modern Project Management

Study programme: M.Sc. Sustainable Energy and Hydrogen Infrastructures

Frequency:	Duration:	Term:	CP:	Workload:
Summer	1 Term	2. Term	5	150 h

1 Courses

Nr.	Lecture	Typ	CP	SWS
	A) Lecture	L (CE)	2	2
	B) Exercise	E (CE)	2	2
	Examination		1	

2 Language
English

3 Contents
This module focuses on the core issues of modern project management and provides the fundamentals of project characteristics and project management approaches and core methods.

In this module the terms and meanings of traditional, agile and hybrid project management are introduced and elaborated.
Cases are analysed and discussed in order to develop an understanding of projects. The discussions contain the typical project constraints as scope, time, budget, stakeholders, risks, etc. as well as criteria for success and failure, project context and organization.
The module shows how projects can be organized also in an international environment.
The latest developments concerning traditional, agile und hybrid project management are taught.
The main trends in project management will be discussed and a link to the other modules and courses will be shown.

This module contains the following topics:

- Characteristics of projects
- Separation of projects, processes and operational work
- Different types of projects
- Success factors of projects
- Characteristics of Project Management
- Different approaches of Project Management (traditional, agile hybrid)
- Characteristics of International Project Management
- Project Management Elements (Scope, Time, Resources, Cost, Risks, Organisation, Stakeholders, Communication, etc.)
- Overview Project Management Methods (Project Canvas, Stakeholder register, Work Breakdown structure, Gantt Chart, Network diagram, Resource Plan, Resource Histogram, Cost Plan, Organizational Chart, Role Description, Responsibility Assignment Matrix, Communication Plan, ground rules, Risk register, User Stories, Backlogs, Agile Estimation Methods, Dailys, Reviews, Retrospectives, etc.)
- Trends in Project Management

4	**Learning targets** *Knowledge and Understanding:* After successfully completing the module, students will be able to: • describe the core issues of a project and various types of projects, • explain the difference between projects, processes, and operational work, • explain the concept of stakeholders and the roles of stakeholders in a project, • explain the different Project Management approaches (traditional, agile, hybrid), • explain the main management elements of Project Management (Scope, Time, Resources, Cost, Risks, Organisation, Stakeholders, Communication, etc.) • explain main Project Management frameworks as Waterfall, Scrum, Kanban, and Design Thinking • describe main characteristics of international Project Management • know the main trends in project management. *Application and Generation of Knowledge:* After successfully completing the module, students will be able to: • apply main methods of traditional and agile Project Management (e.g. Stakeholder Matrix and Stakeholder Register, Work Breakdown Structure, Network Diagram, Gantt Chart, Resource Histogram, Cost Histogram. Risk Register, Project Organisational Structure, Responsibility Assignment Matrix, User Stories, Backlogs, Agile Estimation Methods, Dailys, Reviews, Retrospectives, etc.) • differentiate and decide between the main Project Management approaches (traditional, agile, hybrid), • differentiate and decide between main Project Management frameworks as Waterfall, Scrum, Kanban, and Design Thinking • can apply different Project Management roles for different Project Management aproaches *Communication and Cooperation:* After successfully completing the module, students will be able to: • take into account the developments and trends in project management and balance them to the project approach • lead and coordinate teams in a results-oriented fashion, • present and defend team results in a complex environment, • handle complexities while working in project teams, • detect the HR competencies needed in a project or in an organization, • develop team competencies among the members. *Scientific Self-Understanding / Professionalism:* The students can manage and transform work or study contexts that are complex, unpredictable and require new strategic approaches, reflect operational challenges of a project and reflect own performance in a team.
5	**Examinations** Module examination: 3 partical performances (graded)
6	**Mode of assessment** 100% contributions within the course, thereof • 30 % Case Study (several parts of one case) (max. 10 written pages) • 30 % Tests (2 tests) (40 minutes) • 40 % Project assignment (10 written pages) and presentation (10 minutes)
7	**Requirements** No
8	**Module application** Compulsory Electives module in M.Sc. Sustainable Energy and Hydrogen Infrastructures

Legend

E	*Exercise*	*(C)*	*Compulsory*	*D*	*Draft*
LE	*Lecture + Exercise*	*PJ*	*Project*	*SE*	*Seminar*
L	*Lecture*	*(CE)*	*Compulsory elective*	*LC*	*Lecture course*

9	Module coordinator(s) and lecturer(s) Prof. Dr André Dechange (FH Dortmund)	Department Department of Spatial Planning (09)

Module CE II: Creative Design of New Products and Services

Study programme: M.Sc. Sustainable Energy and Hydrogen Infrastructures

Frequency:	Duration:	Term:	CP:	Workload:
Summer	1 Term	2. Term	5	150h

1 Courses

Nr.	Lecture	Typ	CP	SWS
	A) Lecture	L (CE)	2	2
	B) Exercise	E (CE)	2	2
	Examination		1	

2 Language

English

3 Contents

Students will engage deeply with the Design Thinking methodology, applying it hands-on to a specific practical case. Through distinct tasks students will navigate each step of the Design Thinking process. These tasks will be unified by a focus on the needs of a defined target group, which will be brought to life using personas.
The course will begin with an introduction to various creativity techniques, emphasizing Design Thinking, and will explore its fundamental concepts and unique characteristics. This exploration is particularly pertinent given the current and emerging business and societal challenges, for example in the energy sector. Students will investigate the broader context of creative design, the use of personas, agile development, and related design methods such as Agile UX.
Further, the course will cover the principles of creativity, the dynamics of creative processes, and the sources of requirement development. A deep dive into the psychological and social-psychological foundations of creative processes will be included, along with methods for idea visualization. The course will also focus on key Design Thinking methods such as prototyping, as well as the execution of user tests and evaluations to assess user acceptance.

4 Learning targets

In this course, students will gain a comprehensive understanding of creativity techniques, with a particular emphasis on their application for difficult challenges, for example in the energy sector. The course introduces students to the fundamentals of the Design Thinking process as a key creativity methodology. By the end of the course, students will be able to effectively apply Design Thinking to critically analyze customer needs, generate and structure innovative ideas, and derive actionable solutions. Students will also learn to adapt the Design Thinking approach to address various complex problem scenarios. This includes recognizing and managing the intricacies involved in these challenges. Furthermore, the course equips students with the skills to engage in discussions about business management issues, utilizing different creativity techniques. They will be able to evaluate the strengths and limitations of these methods, applying them strategically to foster innovation.

5 Examinations

Module examination: 5 partical performances (graded)

6 Mode of assessment

The module grade results from a portfolio of assignments max. 20 written pages. Students are required to apply the Design Thinking methodology to a specific problem. You will go through the various phases of the Design Thinking process to develop creative solutions, prototype them, and test user acceptance. (Problem Definition & Research 20%, Ideation & Creativity Techniques 20%, Prototyping 20%, User Testing & Feedback 20%, Final Presentation & Reflection 20%)

Legend

E	*Exercise*	*(C)*	*Compulsory*	*D*	*Draft*
LE	*Lecture + Exercise*	*PJ*	*Project*	*SE*	*Seminar*
L	*Lecture*	*(CE)*	*Compulsory elective*	*LC*	*Lecture course*

7	**Requirements** No	
8	**Module application** Compulsory Electives module in M.Sc. Sustainable Energy and Hydrogen Infrastructures	
9	**Module coordinator(s) and lecturer(s)** Prof. Dr. Sabine Baumann (HWR Berlin)	**Department** Department of Spatial Planning (09)

Module CE III: Design Thinking

Study programme: M.Sc. Sustainable Energy and Hydrogen Infrastructures

Frequency:	Duration:	Term:	CP:	Workload:
Summer	1 Term	2.Term	5	150 h

1 Courses

Nr.	Lecture	Typ	CP	SWS
	A) Lecture	L (CE)	2	2
	B) Exercise	E (CE)	2	2
	Examination		1	

2 Language

English

3 Contents

Changing customer needs, shortened product lifecycles, increasing speed of technological progress, and the emergence of boundary-spanning innovation efforts challenge the linear approach to new product development. As a result, firms and entrepreneurs are experimenting with a broad range of alternative development approaches, featuring more iterative and customer-centric methodologies. The focus of this module is on Design Thinking, a creative process aimed at solving complex problems and developing innovative solutions.
After a theoretical introduction to and discussion of concepts and approachaes, students apply knowledge in a workshop format. Students are then tasked with developing a innovative solutions to a current problem (e.g., frictions in current company solutions, societal challenges, environmental challenges) in teams using the design thinking method and following the multi-step, iterative process. At the end of the module, each team presents its innovative business solution in the form of an entrepreneurial pitch presentation.

This module contains the following topics:

- Introduction to Design Thinking
- Theoretical foundation
- Convergent and divergent thinking
- Prerequisites and principles for successful Design Thinking
- Desing Thinking process with different steps and methodologies

Legend

E	*Exercise*	(C)	*Compulsory*	D	*Draft*
LE	*Lecture + Exercise*	PJ	*Project*	SE	*Seminar*
L	*Lecture*	(CE)	*Compulsory elective*	LC	*Lecture course*

4	**Learning targets** *Knowledge and Understanding:* After successfully completing the module, students will be able to: • describe Design Thinking as a method for solving complex problems and developing innovative ideas, • explain the focus on people and integration of their needs in innovation processes, • explain the difference between convergent and divergent thinking and the need for iterative innovation approaches, • explain Design Thinking principles for effective innovation processes, • explain the main elements and different approaches and tools of an innovation process following Design Thinking. *Application and Generation of Knowledge:* After successfully completing the module, students will be able to: • apply Design Thinking tools and frameworks for understanding and solving customer problems, • apply the Design Thinking method to develop innovative solutions, • apply creativity tools and critical thinking for different phases of innovation processes, • solve complex problems from the customer's perspective. *Communication and Cooperation:* After successfully completing the module, students will be able to: • work in and coordinate diverse teams in a problem-solving context, • handle complexities while working in entrepreneurial teams, • develop competencies to manage creativity and dynamics among team members • communicate complex problems and solutions within teams, with externals, and in presentations. • present and defend team results in an entrepreneurial environment. *Scientific Self-Understanding / Professionalism:* The students can translate scientific conclusions in complex, undefined, open, and creative contexts and reflect on own performance in knowledge application, teamwork, and communication.	
5	**Examinations** Module examination: 2 partical performances (graded)	
6	**Mode of assessment** • 80% Project assignments (10 written pages) and presentations (10 minutes) • 20% Individual report (10 written pages)	
7	**Requirements** No	
8	**Module application** Compulsory Electives module in M.Sc. Sustainable Energy and Hydrogen Infrastructures	
9	**Module coordinator(s) and lecturer(s)** Prof. Dr. Steffen Strese (TU Dortmund)	**Department** Department of Spatial Planning (09)

Legend

E	*Exercise*	*(C)*	*Compulsory*	*D*	*Draft*
LE	*Lecture + Exercise*	*PJ*	*Project*	*SE*	*Seminar*
L	*Lecture*	*(CE)*	*Compulsory elective*	*LC*	*Lecture course*

Module CE IV: International Collaborative Skills

Study programme: M.Sc. Sustainable Energy and Hydrogen Infrastructures

Frequency:	Duration:	Term:	CP:	Workload:
Winter	1 Term	1. or 3. Term	5	150 h

1 Courses

Nr.	Lecture	Typ	CP	SWS
	A) Lecture	L (CE)	2	2
	B) Exercise	E (CE)	2	2
	Examination		1	

2 Language
English

3 Contents
The "International Collaborative Skills" lecture delves into the psychological foundations of intercultural competence and teamwork, with a specific focus on the energy sector. Students will explore models and theories that enhance intercultural sensitivity and adaptability, crucial for global energy projects. The course addresses diversity management, emphasizing the planning, composition, and effective management of mixed teams to optimize performance and satisfaction in energy initiatives. Managing virtual teams in the context of global energy market globalization is a key focus, with adapted workflow management systems used to coordinate complex, cross-border projects. Projects promoting global exchanges of sustainability ideas, such as those fostering collaboration among students from various countries, are particularly relevant for addressing environmental challenges within the energy sector. Research on digital teaching and learning competencies enhances digital education and student motivation, which are vital for training professionals in the rapidly evolving energy industry. Additionally, insights into occupational health, work-related stress, and the impact of digitalization on well-being are critical for maintaining workforce health and efficiency in demanding energy sector roles. This lecture prepares students for effective participation in and management of intercultural and virtual teams, equipping them with the skills needed for successful collaboration in the global energy sector.

4 Learning targets
The "International Collaborative Skills" lecture aims to equip students with key competencies for the global energy sector. Students will learn to understand the psychological foundations of intercultural competence and apply models and theories to enhance intercultural sensitivity and adaptability. The course focuses on developing skills in diversity management, including planning, composing, and managing mixed teams for optimal performance and satisfaction. It targets the ability to manage virtual teams effectively in a globalized energy market, using adapted workflow management systems for cross-border coordination. Additionally, students will engage in promoting the global exchange of sustainability ideas and enhancing digital education, which are vital for training professionals in the evolving energy industry. The lecture also emphasizes maintaining workforce health and well-being to ensure efficiency in demanding energy sector roles.

5 Examinations
Module examination (graded)

6 Mode of assessment
The module grade results from the written term paper of 20 pages on a case study.

7 Requirements
No

8 Module application
Compulsory Electives module in M.Sc. Sustainable Energy and Hydrogen Infrastructures

Legend

E	*Exercise*	*(C)*	*Compulsory*	*D*	*Draft*
LE	*Lecture + Exercise*	*PJ*	*Project*	*SE*	*Seminar*
L	*Lecture*	*(CE)*	*Compulsory elective*	*LC*	*Lecture course*

9	Module coordinator(s) and lecturer(s) N.N.	Department Department of Spatial Planning (09))

Module CE V: Planning and Implementing International Renewable Energy Projects

Study programme: M.Sc. Sustainable Energy and Hydrogen Infrastructures

Frequency:	Duration:	Term:	CP:	Workload:
Winter	1 Term	1. or. 3. Term	5	150 h

1 Courses

Nr.	Lecture	Typ	LP	SWS
	A) Lecture	L (CE)	2	2
	B) Exercise and tutorial	E (CE)	2	2
	Examination		1	

2 Language

English

3 Contents

Policy and legal aspects

- Motivation and triggers for the employment of renewable energy sources
- Framework for renewable energy projects and parameters influencing
- Support schemes for renewable energy projects
- Permitting and acceptance for renewable energy projects

Technical aspects

- Renewable energy technologies: basics and aspects of project planning, implementation and installation
- Energy storage technologies: basics and aspects of project planning, implementation and installation
- Grid-connected and off-grid energy systems with a combination of renewable energy and battery storage
- Load analysis and modelling

Project planning and implementation

- Evaluation and comparison of frameworks for the renewable energy business development
- International project experience and lessons learnt from wind farm and solar photovoltaics installations
- Aspects of project implementation (e.g. on-site inspection and preparation)
- Aspects of project installation (e.g. logistics, working safety, staff requirements)

Legend

E	*Exercise*	*(C)*	*Compulsory*	*D*	*Draft*
LE	*Lecture + Exercise*	*PJ*	*Project*	*SE*	*Seminar*
L	*Lecture*	*(CE)*	*Compulsory elective*	*LC*	*Lecture course*

4	**Learning targets** After successfully completing the module, students will be able to: • apply the basics of planning, implementation and installation of renewable energy projects • understand renewable energy and energy storage technologies for application in grid-connected and off-grid systems and their specific framework requirements • characterize a country's energy system and policy framework (country profile) • identify and analyse technical, legal and economic aspects and parameters for renewables projects in different countries • identify triggers and obstacles for the economic and technical feasibility of renewable energy projects By • investigating, analysing and evaluating the legal framework for renewable projects in different countries • investigating, analysing and evaluating the parameters influencing the technical and economical feasibility of international renewable energy projects • identifying obstacles and hurdles and developing measures how to reduce or mitigate them To • investigate, analyse and evaluate technical, legal and economic aspects and parameters influencing the technical and economical feasibility of international renewable energy projects • compare different countries´ frameworks and their impact on the planning, implementation and installation of international renewable energy projects	
5	**Examinations** Module examination: 4 partical performances (graded)	
6	**Mode of assessment** 100% contributions within the course, thereof • 35 % Framework analysis of a selected country (max. 10 written pages) • 10 % Test (30 min) • 35 % Project-based analysis of a selected renewables project in a selected country (max. 10 written pages) • 20 % Project presentations (10 minutes)	
7	**Requirements** No	
8	**Module application** Module examination (graded)	
9	**Module coordinator(s) and lecturer(s)** Prof. Dr. Thorsten Schneiders (TH Köln)	**Department** Department of Spatial Planning (09)

Legend

E	*Exercise*	*(C)*	*Compulsory*	*D*	*Draft*
LE	*Lecture + Exercise*	*PJ*	*Project*	*SE*	*Seminar*
L	*Lecture*	*(CE)*	*Compulsory elective*	*LC*	*Lecture course*

Module CE VI: Application of Smart Energy

Study programme: M.Sc. Sustainable Energy and Hydrogen Infrastructures

Frequency:	Duration:	Term:	CP:	Workload:
Summer	1 Term	2. Term	5	150 h

1 Courses

Nr.	Lecture	Typ	CP	SWS
	A) Lecture	L (CE)	2	2
	B) Exercise and tutorial	E (CE)	2	2
	Examination		1	

2 Language

English

3 Contents

Policy and legal aspects

- Motivation and triggers for the employment of smart energy: energy efficiency, grid management, digitaization of energy industry etc.
- Framework for smart energy projects and parameters influencing economic and technical viability
- Legal framework: triggers and hurdles for smart energy
- Economics aspects of smart energy: costs versus benefits
- Customers´perspective on smart energy: motivation, knowledge and acceptance

Technical aspects

- Components of energy systems: photovoltaics, energy storage, heating and cooling, electrical devices
- Smart home (special focus on radio-based smart home): components, different suppliers, programming logics
- Smart grids, virtual power plants and energy clusters
- Energy metering, smart metering and submetering
- Energy data analysis, investigation and improvement of load patterns
- Basics of logics to connect different components in an energy system (ITTT)
- Basics and aspects of project planning, implementation and installation of smart energy systems
- Basics of energy system modelling

Project planning and implementation

- Different customer groups (households, commerce, industry, public sector) and their specifics regarding smart energy
- Evaluation and comparison of frameworks for the smart energy applications and services
- Findings from research on smart energy
- Experience and lessons learnt from smart energy projects
- Aspects of project implementation (e.g. on-site inspection and preparation)
- Aspects of project installation (e.g. working safety, staff requirements)

4	**Learning targets** After successfully completing the module, students will be able to: • understand the technical basics of smart energy technologies (SET) and services (SES), e.g. smart grids and virtual power plants, smart metering, smart home and energy management systems, Vehicle to Home and Vehicle to Grid • characterize a suitable smart energy equipment for different use cases and customer groups (e.g. households, commerce, industry, public sector) • plan the application and the basic setup of SET and SES for customers • identify and analyse technical, legal and economic aspects and parameters for smart energy projects in different countries • identify triggers and obstacles for the economic and technical feasibility of smart energy projects, with special focus on the users´ viewpoint By • investigating, analysing and evaluating the market of different smart energy technologies from different suppliers (e.g. smart home, energy management systems) • investigating, analysing and evaluating the parameters influencing the technical and economical feasibility of the application of SET and SES (e.g. increase of energy efficiency, comfort, automation, safety) • identifying the relevant components of different energy systems (e.g. renewables, energy storage, power and heat supply, electric charging and electric vehicles) and other components (e.g. windows, doors) to be included in the smart energy setups • identifying obstacles and hurdles and developing measures how to reduce or mitigate them • identifying different use cases for SET and SES and the corresponding customers´ needs • carrying out case studies for SET and SES applications To • investigate, analyse and evaluate technical, legal and economic aspects and parameters influencing the technical and economical feasibility of smart energy applications • provide smart energy solutions for different use cases and different customer´s´groups
5	**Examinations** Module examination: 4 partical performances (graded)
6	**Mode of assessment** 100% contributions within the course, thereof • 30 % Case study 1 (max. 10 written pages) • 20 % Test (30 min) • 30 % Case study 2 (max. 10 written pages) • 20 % Project presentations (10 minutes)
7	**Requirements** No
8	**Module application** Compulsory Electives module in M.Sc. Sustainable Energy and Hydrogen Infrastructures
9	**Module coordinator(s) and lecturer(s)** Prof. Dr. Thorsten Schneiders (TH Köln) **Department** Department of Spatial Planning (09)

Legend

E	*Exercise*	*(C)*	*Compulsory*	*D*	*Draft*
LE	*Lecture + Exercise*	*PJ*	*Project*	*SE*	*Seminar*
L	*Lecture*	*(CE)*	*Compulsory elective*	*LC*	*Lecture course*

Module CE VII: Scientific Writing

Study programme: M.Sc. Sustainable Energy and Hydrogen Infrastructures

Frequency:	Duration:	Term:	CP:	Workload:
Winter	1 Term	1. or 3. Term	5	150 h

1 Courses

Nr.	Lecture	Typ	CP	SWS
	Seminar	SE(CE)	4	4
	Examination		1	

2 Language

English

3 Contents

This course provides students with essential skills for scientific research, writing, and presentation.

In Session 1, students will explore different types of scientific articles, conduct systematic literature searches using Mendeley, and format citations according to journal guidelines. The assessment includes a presentation with slides and citation exercises.

Session 2 focuses on the structure of a research article, covering key sections such as Introduction, Methods, Results, Discussion, and Conclusion. Students will apply this knowledge by creating a structured outline for their planned research paper.

In Session 3, students will learn to use R for statistical analysis, including descriptive statistics and various tests such as ANOVA. They will independently apply R code to analyze sample datasets and present their results.

Session 4 covers the creation and processing of figures. Students will program figures in R, refine them using image processing tools, and format them according to journal standards. The assessment includes presenting a properly formatted figure.

Finally, in Session 5, students will develop their scientific presentation skills, focusing on structuring talks, engaging with an audience, and handling questions effectively. They will practice delivering presentations and receive peer feedback.

This course equips students with the necessary tools to conduct and communicate scientific research effectively.

4 Learning targets

- Understand different types of scientific articles and their characteristics.
- Learn systematic literature search and management using Mendeley.
- Ability to create and format a literature reference list according to journal guidelines.
- Learn the structure of a research article (Introduction, Methods & Materials, Results, Discus sion, Conclusion).
- Transfer plans into the appropriate structure of a research article.
- Learn to create descriptive statistics using R.
- Apply R code independently for statistical analysis.
- Understand and perform various statistical tests (two-group comparison, comparison of three or more groups, mixed ANOVA).

5 Examinations

Module examination: 2 partical performances (graded)

Legend

E	*Exercise*	*(C)*	*Compulsory*	*D*	*Draft*
LE	*Lecture + Exercise*	*PJ*	*Project*	*SE*	*Seminar*
L	*Lecture*	*(CE)*	*Compulsory elective*	*LC*	*Lecture course*

6	**Mode of assessment** The assessment consists of a 20-page scientific paper and an oral presentation. The paper must include a comprehensive literature review, conducted using a reference management tool (e.g., Mendeley), with all sources properly cited in a consistent academic style (APA, Chicago, or Vancouver). The structure of the paper should follow standard scientific conventions, including a title page, abstract, introduction, methods, results, discussion, conclusion, and references. If applicable, data analysis should be performed, and results should be visualized using R, with figures formatted according to scientific journal standards. In addition to the written paper, students will deliver a 10–15-minute scientific presentation, using standalone slides to communicate their findings clearly and concisely. The presentation will be evaluated based on content clarity, scientific argumentation, presentation skills, and the ability to respond to audience questions. The written paper accounts for 80% of the final grade, while the presentation contributes 20%. This assessment method ensures that students develop both their scientific writing and presentation skills effectively	
7	**Requirements** No	
8	**Module application** Compulsory Electives module in M.Sc. Sustainable Energy and Hydrogen Infrastructures	
9	**Module coordinator(s)** Prof. Dr. Beate Brand-Saberi (RUB) Dr. Morris Gellisch (RUB)	**Department** Department of Spatial Planning (09)