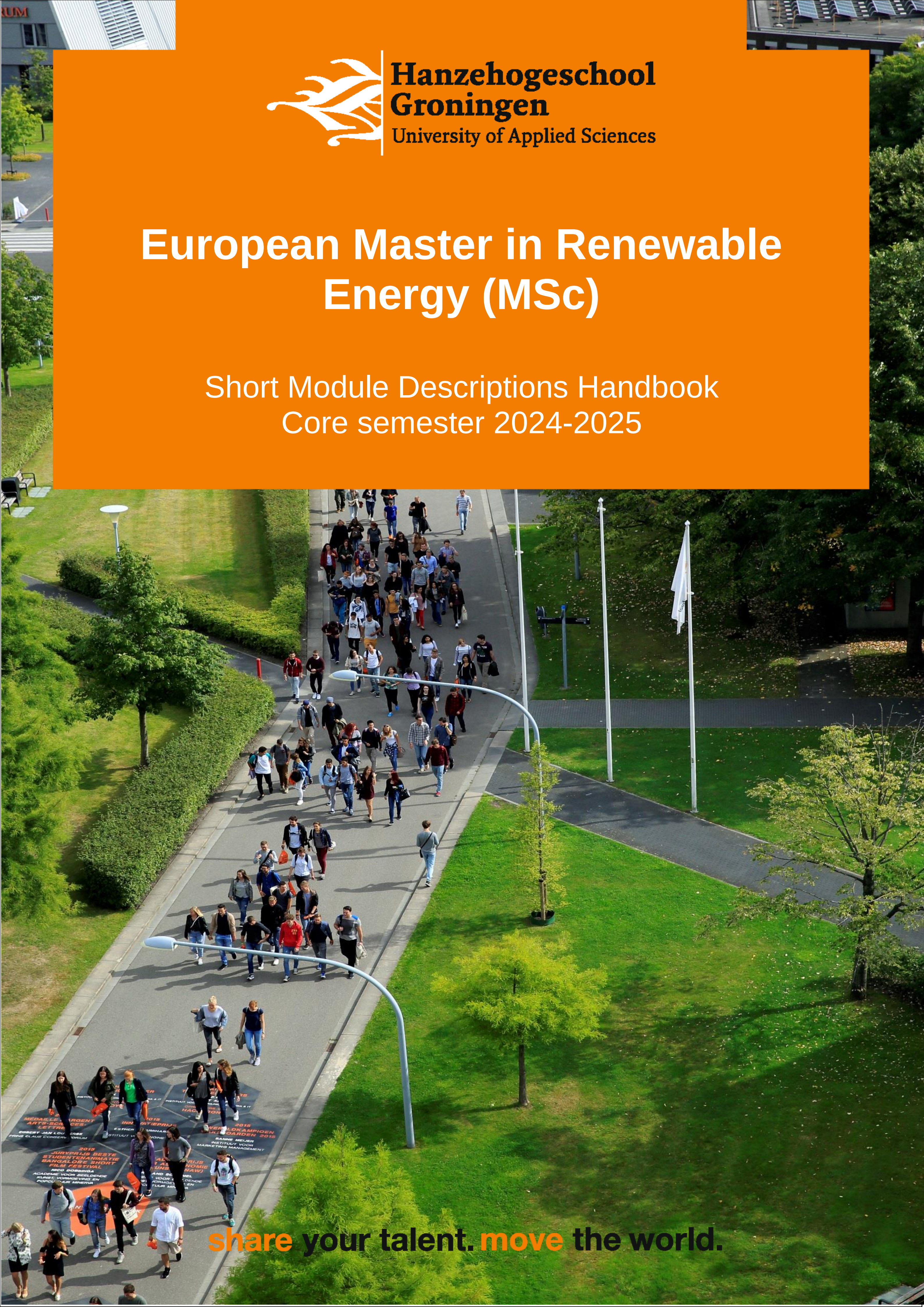
Hanzehogeschool Groningen
University of Applied Sciences

European Master in Renewable Energy (MSc)

Short Module Descriptions Handbook
Core semester 2024-2025



Energy

Energy Academy Europe

EUROPEAN MASTER IN RENEWABLE ENERGY

Coordinated by EUREC

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1. Short Module Descriptions Handbook

1.1. Introduction

The EMRE programme consists of three semesters of each 30ECTS (total 90 ECTS). During the first semester students are at Hanze UAS or a partner University, and the second (specialisation) semester is spent at one of the universities. During the third semester, students complete a thesis project.

First semester: Core
During the first or 'core' semester students acquire a solid foundation of the technical and engineering side of innovative energy system design and implementation. They also learn about their various interdisciplinary aspects and the socioeconomic issues surrounding these technologies. Theoretical courses are supported by laboratory workshops. Hanze UAS is one of the four European Universities where students can follow this core semester.

Second semester: Specialisation
In the second semester students will specialise in a technology of choice. During this semester, in-depth conceptual knowledge is accompanied by practical work and technically oriented company visits. Students can choose from six different specialisations. Sustainable Fuel Systems for Mobility is the specialisation semester given at Hanze UAS.

Third semester: Thesis
During the final semester, students apply their acquired knowledge and skills in a thesis project at a company,
4 a research laboratory or at a university. Students are expected to be in the lead, with a qualified person from
the specialisation university advising students on how to proceed in finding the best project to suit their
qualifications and expectations. At the end of the master's programme, students will defend their dissertation
at Hanze UAS in Groningen and present their final results to assessors form universities, during presentation
days in Brussels.

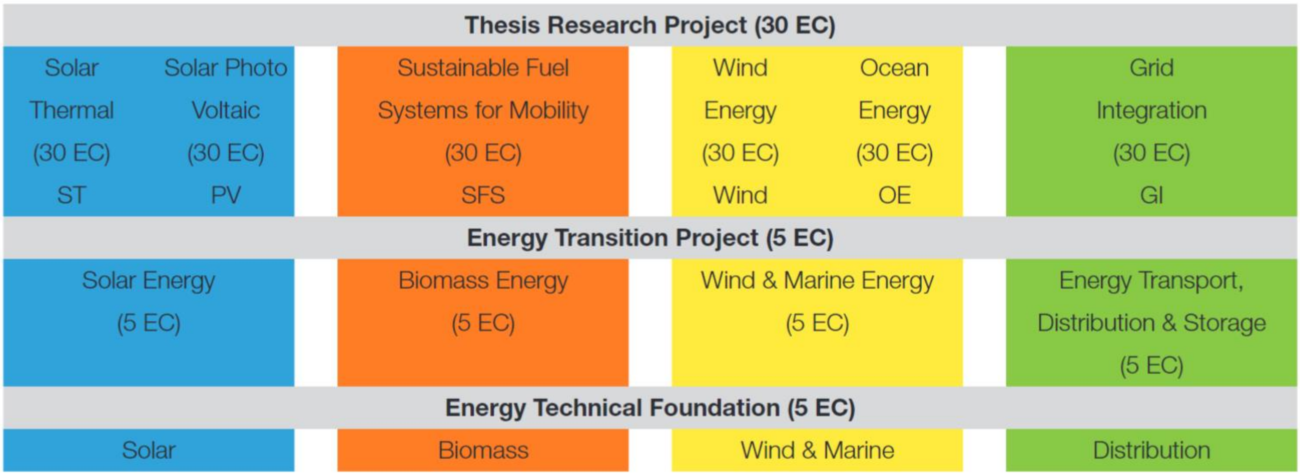

Figure 1: Overview of the EMRE modules.

1.2. Programme Learning Outcomes

For this programme, a total of 90 ECTS credits (30 for each semester of the course) within 16 months is required with a satisfactory level of achievement in all semesters to obtain the Master of Science degree. Therefore, EMRE at Hanze UAS is defined by the following programme learning outcomes.

1) ***Renewable Technology:***
   The EMRE graduate is competent in applying key technical features of prevailing renewable energy technologies, their integration in energy systems and their contribution in climate and resource issues.

2) ***Aspects of Renewable Technology implementation:***
   The EMRE graduate is competent to address relevant political, social, legal, environmental and economic aspects of renewable energy implementation.

3) ***Specialism:***
   The EMRE graduate is competent in in-depth knowledge and understanding of at least one of the specialisation fields: Photovoltaics, Wind Energy, Grid Integration, Solar Thermal, Ocean Energy, Sustainable Fuel Systems

4) ***Applied Scientific Research:***
   The EMRE graduate is competent in conducting applied research, by formulating a problem and knowledge gap, employing specific research methods, collecting relevant data, and drawing conclusions from the results achieved, showing a reflective and critical attitude towards the possibilities and limitations of the scientific methods used and the research outcomes.

5) ***Critical view:***
   The EMRE graduate is competent to critically assess (inter)national developments, trends and ideas in society, policy, and to translate these innovations in professional practice and scientific study.

6) ***Project work:***
   The EMRE graduate is competent to timely achieve set goals in a(n) (international, multicultural and) multidisciplinary (project) team.

7) ***Communication:***
   The EMRE graduate is competent to communicate in a clear and structured way in both written and oral form to the client and other stakeholders, and in English to the scientific community.

2. Short Module Description of all CORE Modules Hanze UAS

2.1. Energy Technical Foundation (ETF) - RWVM23ETF

Institute for Engineering **Subject:** *European MSc in Renewable Energy* *Winter Term*	**Category:** *MSc Module* **Degree award:** *MSc*
Emphases: -	**Sections:** -
Module reference number/Title: *Energy Technical Foundation*	
Duration: 3 weeks **Cycle:** once a year **Type of module:** mandatory **Level:** MM (MSc module) *This module should be taken in 1st semester*	**Type of program:** Lectures, Tutorials, Workshop **Language:** English **Attainable credit points:** 5 EC **Workload:** 140 hours **Required attendance:** 50 hours
Person responsible for the program: C.B. Vogt, PhD	**Person responsible for this module:** dr.ir. A.A. Bellekom
Alternative person(s) responsible for this module: dr. E.J. Hengeveld, dr.ir. J. Bekkering	**Examiner(s):** dr. E.J. Hengeveld, dr.ir. A.A. Bellekom, E.O.V. Tromp MSc, dr.ir. J. Bekkering Dr. Ir. Rosa Kappert
Objective of the module: At the completion of this topic the students understand the basics of - *analyse basic problems that involve energy/heat transfer, thermodynamics and fluid mechanics* - *simplify and analyse basic (three-phase) electric circuits* - *calculate electric power components* - *discuss characteristics of the electricity supply system* - *select and apply appropriate numerical and statistical modelling approaches and techniques, focussed on optimization, in a commonly used programming language*	

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- *assess the validity and reliability of research results (model, theory, data quality...), and discuss possible limitations*

Content of the module:

The technical foundation module consists of two separate courses.

1. Energy Basics/ Electrical Engineering (3EC)
   In the first weeks of the semester students refresh their knowledge of the fundamentals of energy and power, heat transfer, thermodynamics and fluid mechanics. Attention is paid to the fundamental aspects of electrical engineering. Among others, these aspects comprise matters like circuit analysis, electric power calculations, three phase systems and electricity supply. This course serves as an introduction to the technical modules.

2. Numerical Modelling (2 EC)
   In this course, the students are provided with an overview of different numerical methods that can be applied in the context of integrated energy systems. Specifically, data analysis methods, iterative and optimization methods will be discussed. For each of these methods the relevant properties will be studied. This information will allow the students to select appropriate methods to solve numerical problems based on the requirements dictated by the research context. An introduction to MATLAB and programming is also provided within this course.

Required reading:

- Bekkering, J. *Reader Energy Basics*
- Nahvi, M. and Edminster, J.A. (2018). *Schaum's Outlines, Electric Circuits.* Seventh edition. US: McGraw-Hill E-book accessible using https://hanze-on-worldcat-org.nlhhg.idm.oclc.org/oclc/1039825497
- Slides used during the lectures.

Suggested additional reading:

- Twidell, J. and Weir, T. (2015). *Renewable Energy Resources.* London, UK: Taylor & Francis Ltd
- Freris L. and Infield, D. (2020). *Renewable Energy in Power systems.* Chichester, UK: John Wiley & Sons Ltd.
- Reddy T.A. (2011). *Applied Data Analysis and modeling for Energy Engineers and Scientists.* Boston, MA: Springer.
- Montgomery D.G. and Runger G.C. (2014). *Applied Statistics and Probability for Engineers.* New York: John Wiley & Sons Inc.
- Venkataran P. (2009). *Applied Optimization with MATLAB Programming.* New York: John Wiley & Sons Inc.

Comments: - **Weblink:** - **Prerequisites for admission***:* -	**Helpful previous knowledge:** - **Associated with the module(s):** *All technology modules*

Maximum number of students / selection criteria:

-

Types of examinations:

- *Energy Basics & Electrical Engineering: Written Exam (3 EC)*
- *Numerical Modelling: Assignment (2 EC)*

Examination periods:

Week 4

Registration procedure:

OSIRIS: RWVM23ETF

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2.2. Energy Transition Project - RWVM23ETP

Institute for Engineering **Subject***: European MSc in Renewable Energy* *Winter Term*	**Category:** *MSc Module* **Degree award:** *MSc*
Emphases: -	**Sections:** -
Module reference number/Title: *Energy Transition Project*	
Duration: 3 weeks **Cycle:** once a year **Type of module:** mandatory **Level:** MM (MSc module) *This module should be taken in 1st semester*	**Type of program:** Lectures, Tutorials, Workshop **Language:** English **Attainable credit points:** 5 EC **Workload:** 140 hours **Required attendance:**
Person responsible for the program: C. Vogt, PhD	**Person responsible for this module:** Dr. E.J Hengeveld
Alternative person(s) responsible for this module: FJ Guzman Munoz,	**Examiner(s):** All listed persons
Objective of the module: At the completion of this module the students are competent: - in conducting applied research, by formulating a problem and knowledge gap, employing specific research methods, collecting relevant data, and drawing conclusions from the results achieved, showing a reflective and critical attitude towards the possibilities and limitations of the scientific methods used and the research outcomes. - in to timely achieve set goals in a(n) (international, multicultural and) multidisciplinary (project) team - to communicate in a clear and structured way in both written and oral form to the client and other stakeholders, and in English to the scientific community - in addressing (reflecting on) relevant political, social, legal, environmental and economic aspects of renewable energy implementation	

Content of the module:
This module consists of 2 courses:

1. Research Methodology and Research Project (5 EC) Research methodology is introduced with the aim to teach students how to design, conduct and report proper applied and design research results.
2. Professional Skills and Mentoring (Pass or Fail)
   The course Professional Skills and Mentoring covers the guidance in the personal professional development of the student, in presentation skills and in project based working. After this topic the student is able to make
   a. a reflection of the students professional development, which is discussed with his mentor. This reflection will be based on the PDCA-approach.
   b. a self-evaluation report and re-orientation, based on the student’s progress during the core semester.

Suggested reading:
- Reynolds, G. (2011) Presentation Zen: Simple Ideas on Presentation Design and Delivery (second edition).
- Berkely: New Riders
- Robert K. Yin; Case Study Research, Design and Methods, SAGE, 5th edition 2014 ISBN 978-1-4522-4256-9 (pbk)

Comments:
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Weblink:
-

Prerequisites for admission:
-

Helpful previous knowledge:
-

Associated with the module(s):
-

Maximum number of students / selection criteria:
-

Types of examinations:
- Assignment Research Report
- Professional Skills Personal Development Plan & Report

Examination periods:
-

Registration procedure:
OSIRIS RWVM23ETP

2.3. Biomass Energy - RWVM23BME

Institute for Engineering **Subject***: European MSc in Renewable Energy* *Winter Term*	**Category:** *MSc Module* **Degree award:** *MSc*
Emphases: -	**Sections:** -
Module reference number/Title: *Biomass Energy*	
Duration: 9 weeks **Cycle:** once a year **Type of module:** mandatory **Level:** MM (MSc module) *This module should be taken in 1st semester*	**Type of program:** Lectures, Tutorials, Workshop, Laboratory **Language:** English **Attainable credit points:** 5 EC **Workload:** 140 hours **Required attendance:** 50 hours
Person responsible for the program: C. Vogt, PhD	**Person responsible for this module:** Dr. F. Faber
Alternative person(s) responsible for this\ module:	**Examiner(s):** Dr. F. Faber
Objective of the module / skills: At the completion of this topic the students should know: - Energy contents and chemical reactions in carbon based chemistry - Basic concepts of microbial metabolism related to biofuel production At the completion of this topic the students should be able to: - Select appropriate methodologies for biomass energy conversion technologies - Design biomass conversion processes, with the emphasis on biological conversion processes, using bioreactors. - Calculate/model energy yield from different types of biomass. - Accurately perform experiments in a bio lab and measure, interpret and analyse data. - Write a scientific lab report based upon the combined experimental data, drawing appropriate conclusions linked to scientific literature.	

Content of the module:

With fossil fuel resources becoming limiting, a possible alternative for molecule-based energy carriers is the use of biomass (e.g., organic waste products)/ The module ‘Biomass Energy’ describes the various processes and techniques involved in conversion of the energy stored in organic material into various forms of usable bioenergy.

Present conversion techniques already show the ability to connect biofuels to the current infrastructure. However, the availability of biomass as well as the current conversion efficiencies of the various conversion techniques are not sufficient to replace fossil fuels.

Basic knowledge on chemical and biological conversion processes of biomass will lead to an integral approach, increasing the potentials for biomass in the fields of energy for the generation of renewable energy. The biomass conversion techniques described in the module ‘Biomass Energy’ might play just as an important role in the transition from fossil fuels to alternative energy sources as other fields of energy such as wind and solar energy. During the course various mathematical exercises will be done. This module contributes to the overall knowledge on renewable energy sources students acquire during the core of the MSc program.

The module ‘Biomass Energy’ covers energy conversion processes related to biomass. In the module students will gain basic knowledge of various biomass conversion processes (Theoretical part) and will apply this knowledge in a lab experiment producing biogas in a bioreactor (Laboratory part).

Suggested reading:

- Biofuels Engineering Process Technology (2008) Caye Drapcho, John Nghiem, Terry Walker (This will be freely available as PDF, for educational purposes)
- 12 Scientific articles:

- Ong et al (2019). Catalytic thermochemical conversion of biomass for biofuel production: A comprehensive review. Ren. Sust. Energy Reviews 113: 109266

- Tan et al (2016). Emerging technologies for the production of renewable liquid transport fuels from biomass sources enriched in plant cell walls. Open Access - Frontiers in Plant Science 2016 (7): Article 185

Comments: - **Weblink:** - **Prerequisites for admission***:* -	**Helpful previous knowledge:** - **Associated with the module(s):** Production of bioenergy (biogas) will have an integral approach with links to other modules. Obtaining data, but also proper handling of data, as instructed in 'Research Methodology and Research Project', should be applied during the practical execution of the Lab experiments.
Maximum number of students / selection criteria: **Types of examinations:** • Written Exam (3 EC) • Assignment (2 EC) **Examination periods:** End of the Module **Registration procedure:** OSIRIS: RWVM23BME	

2.4. Wind and Marine Energy - RWVM23WHE

Institute for Engineering **Subject**: *European MSc in Renewable Energy* *Winter Term*	**Category:** *MSc Module* **Degree award:** *MSc*
Emphases: -	**Sections:** -
Module reference number/Title: *Wind and Marine Energy*	
Duration: 9 weeks **Cycle:** once a year **Type of module:** mandatory **Level:** MM (MSc module) *This module should be taken in 1st semester*	**Type of program:** Lectures, Tutorials, Workshop, Laboratory **Language:** English **Attainable credit points:** 5 EC **Workload:** 140 hours **Required attendance:** 50 hours
Person responsible for the program: C. Vogt, PhD	**Person responsible for this module:** Dr. ir. G. Schepers
Alternative person(s) responsible for this module: Ir. W.J. Swart Ranshuysen Adema NC, Niels MSC.	**Examiner(s):** Dr. ir. G. Schepers; Ir W.J. Swart Ranshuysen Adema NC, Niels MCs

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Objective of the module:

After completion of the module the student is able to:

- Perform a resource assessment on basis of wind speed measurements (Application)
- Analyse and Interpret wind turbine performance measurements (Evaluation)
- Develop a mathematical/physical model to optimize a wind turbine design in terms of energy production, loads and costs (Application)
- Determine and examine acoustic noise levels on a wind turbine (Analysis)
- Assess in a qualitative. and where, possible quantitative way measurement and calculation errors with uncertainties (Evaluation)
- To understand the-state-of-the-art of marine energy and investigate the future potential of marine energy (Analysis)
- Report and present in group form, the results of experiments and analyses in a scientifically correct way

Content of the module:

In terms of scientific and technical contents this module will treat the following aspects of wind energy:

- Introduction into wind energy
  - The wind energy sector in a bird view: history, markets, scenario's and roadmaps,
  - Technological challenges and concepts
  - Off-shore wind energy versus on-shore wind energy
- Wind climate and resource assessment (measurements and modelling)
  Rotor design (aerodynamics, aero-elasticity, acoustics, costs)
- Introduction into Marine energy

Suggested reading:

- Twidell and Weir Chapters 7 (Wind Resource) and chapter 8 (Wind Power Technology) from Renewable Energy Resources, Routedge, 2015
- James F. Manwell Jon G. McGowan, Anthony L. Rogers Wind Energy Explained 2nd edition, Wiley and Sons, 2009.
- https://gwec.net/global-wind-report-2022/ Global wind energy status report
- https://iea-wind.org/ and IEA_Wind_TCP_Annual_Report_2021.pdf (iea-wind.org) *(wind energy developments in countries associated to IEA Wind, and a description of several research tasks)*
- G. van Kuik, J. Peinke, *Long-term Research Challenges in Wind Energy - A Research Agenda* by the European Academy of Wind Energy – 2016, Springer
- H.J.M. Beurskens et al *Converting Offshore Wind into electricity* The Netherlands Contribution to offshore wind knowledge, Eburon Academic Publishers, 2011
- The background material for hydro energy will be based on a collection of articles, e.g.
  - W.J.M. Batten et al: *Experimentally validated numerical method for the hydrodynamic design of horizontal axis tidal turbines* Ocean Engineering Vol. 34 Nr. 7, 2007,
- Garret and Cummins, *The efficiency of a turbine in a tidal channel,* J. Fluid Mech. (2007), vol. 588, pp. 243–251.

Comments:

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Weblink:

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Prerequisites for admission*:*

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Helpful previous knowledge:
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Associated with the module(s):
Wind energy is one of the largest growing renewable energy sources and it is expected to contribute significantly to the EU targets on renewable energies where it is generally produced in close vicinity to local populations. This necessitates a range of social, legal, economic , environmental and technical issues to be discussed and addressed. This underlines the strong link of the Wind Energy Module with the Energy Policy Module. Moreover, the scientific methodologies needed to carry out the module successfully is taught in the Research Project and Methodology. In this module aspects on data handling and error analysis are introduced, but also guidelines are provided to keep good lab notebooks and write lab reports. Topics such as Project Management and Presentations skills are introduced in the Research Project and Methodology module as well. More fundamental theoretical aspects on statistical analysis are taught in the numerical modelling module.

The 'capstone assignment' reflects the integrative nature of the European MSc in Renewable Energy. Students will obtain specific knowledge for the different parts of this assignment during the various technical modules. The assignment comprises the integration of various renewable energy production alternatives in a regional setting. The acquired theoretical knowledge and exercises on wind energy design and economics, will therefore be integrated in the 'capstone assignment'.

Maximum number of students / selection criteria:
16 -

Types of examinations:
- Written Exam
- Assignment
- Lab Report

Examination periods:
- End of Module

Registration procedure:
OSIRIS:
RWVM23WHE

2.5. Solar Energy - RWVM24SLE

Institute for Engineering **Subject:** *European MSc in Renewable Energy* *Winter Term*	**Category:** *MSc Module* **Degree award:** *MSc*
Emphases: -	**Sections:** -
Module reference number/Title: *Solar Energy*	
Duration: 9 weeks **Cycle:** once a year **Type of module:** mandatory **Level:** MM (MSc module) *This module should be taken in 1st semester*	**Type of program:** Lectures, Tutorials, Workshop, Practical work **Language:** English **Attainable credit points:** 5 EC **Workload:** 140 hours **Required attendance:** 50 hours
Person responsible for the program: C.B. Vogt, PhD	**Person responsible for this module:** dr.ir. A.A. Bellekom
Alternative person(s) responsible for this module: Prof. dr. A.W. Weeber (TNO), D. Kurstjens	**Examiner(s):** All listed Persons
Objective of the Module: After the completion of the module the student is able to: • simulate a basic PV system with commercial software, measure PV panel characteristics and analyse research PV data • understand, analyse and optimize the design and operation of solar cells, modules and systems, and of solar thermal energy systems • select, analyse, interpret and critically evaluate component specifications in the field of solar energy and present it in a clear, fact-based and convincing way • evaluate suitable solar energy technologies for different applications that require heat and electricity	

Content of the module:
In terms of scientific and technical contents this module will treat the following aspects of solar energy:
The solar resource: properties of sunlight, insolation (amount of sunlight available)
Solar energy conversion technologies compared (electricity, heat, fuels)

Photovoltaic conversion:
- the PV sector in a bird's eye view: general introduction to history, markets, scenarios, roadmaps, etc.
- basic conversion process and efficiency limitations;
- properties of semiconductors, semiconductor processing and basic semiconductor devices;
- basic solar cell design and operation, including current-voltage characteristics spectral response and quantum efficiency;
- efficiency determining factors, routes to (very) high efficiencies, Standard Test Conditions (STC-) and non-STC (i.e. field) operation;
- photovoltaics in practice: different technologies in lab and production (flat plate and concentrator), various device architectures;
- from cells to modules: module architectures, manufacturing, lifetime & reliability, efficiency definitions, field performance;
- from modules to systems: basic aspects of system design, systems losses and energy production (specific energy yield, performance ration, capacity factor, etc.)
- practical applications: examples of PV systems and their performance;
- economic aspects: system cost (price) components and their evolution, Levelized Cost of Energy(LCoE), grid parity and other indicators;
- environmental aspects: Life Cycle Analyses (LCA), energy pay-back time, materials availability (supply chain), Cradle-to-Cradle and design-for-recycling approaches.

Solar heat:
- general introduction to solar heat
- basic aspects and formulas of heat
- basic aspects of solar radiation
- short introduction to heating systems
- overview of solar thermal collectors
- overview of heat storage types
- short introduction to solar cooling
- short introduction to solar thermal electric power systems
-

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Suggested reading:

- Smets, A.H.M., Jäger, K., Isabella, O., van Swaaij, R.A.C.M.M. and Zeman, M. (2016). *Solar energy: the physics and engineering of photovoltaic conversion, technologies and systems.* UIT Cambridge.
- www.pveducation.org/pvcdrom is highly recommended.
- IEA (2011). *Solar Energy Perspectives*. https://www.iea.org/publications/freepublications/publication/Solar_Energy_Perspectives2011.pdf.
- IEA (2014). *Technology Roadmap - Solar Photovoltaic Energy.* http://www.iea.org/publications/freepublications/publication/TechnologyRoadmapSolarPhotovoltaicEnergy_2014edition.pdf
- Solar Power Europe (2020), EU Market Outlook for Solar Power 2020-2024, EU Market Outlook for Solar Power, 2020–2024 – SolarPower Europe
- IEA PVPS (2021), Snapshot of Global PV Markets 2021, Snapshot of Global PV Markets - 2020 (iea-pvps.org)
- GM Wilson et al (2019, open access), The 2020 photovoltaic technologies roadmap, J. Phys. D: Appl. Phys. 53 (2020) 493001, The 2020 photovoltaic technologies roadmap (oclc.org)
- ITRPV (2020), International Technology Roadmap for Photovoltaic (ITRPV) 2019 Results. ITRPV Roadmap Download - VDMA
- https://itrpv.vdma.org/web/itrpv/download
- *PVSyst 7 grid-connected tutorial.*
- https://www.pvsyst.com/wp-content/uploads/2020/10/PVsyst_Tutorials_V7_Grid_Connected.pdf

Comments:

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Weblink:

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Prerequisites for admission:

-

Helpful previous knowledge:

-

Associated with the module(s):

Solar energy, in its various forms, is a key component in the portfolio of technologies needed for the transition towards a (more) sustainable energy system. Moreover, PV is the most rapidly growing of all renewables and has reached high degrees of grid penetration in selected regions already. This necessitates a range of societal, regulatory, economic, environmental and technical issues to be discussed and addressed and underlines the strong link of the Solar Energy Module with Energy Technical Foundation Module. Moreover, the scientific and methodological basis used in the Solar Energy Module is taught in Energy Transition Project Module. Finally, being an integral part of the assessment, the skills obtained during the Academic writing and presenting course and the Media Lab are highly supportive to the Solar Energy Module.

Maximum number of students / selection criteria:

-

Types of examinations:

- Report SLE (4 EC)
- Assignment SLE (1 EC)

Examination periods:

-

Registration procedure:

OSIRIS: RWVM24SLE

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2.6. Energy Transport, Distribution & Storage - RWVM23ETDS

Institute for Engineering **Subject***: European MSc in Renewable Energy* *Winter Term*	**Category:** *MSc Module* **Degree award:** *MSc*
Emphases: -	**Sections:** -
Module reference number/Title: *Energy Transport, Distribution & Storage*	
Duration: 6 weeks **Cycle:** every year (first semester) **Type of module:** mandatory **Level:** MM (MSc module)	**Type of program:** Lectures, Tutorials, Lab work **Language:** English **Attainable credit points:** 5 EC **Workload:** 140 hours **Required attendance:** 50 hours
Person responsible for the program: Dr. C. Vogt	**Person responsible for this module:** C.E.J van Someren MSc.
Alternative person(s) responsible for this module: S.A. Dijk MSc., Dr. A. Perl, C.E.J van Someren MSc.	**Examiner(s):** S.A. Dijk MSc., dr. A. Perl, C.E.J. van Someren MSc.

Objective of the Module:

By completing the module the student demonstrates knowledge and understanding of:

1. structure and characteristics of electricity and gas grids
2. the characteristics of storage and the role of storage in flexible energy systems with integrated renewable energy technologies while maintaining demand and supply matches
3. developments in energy systems, focussing on power to gas/hydrogen

And is able to:

1. calculate the consequences of renewable energy penetration on the quality of gas and electricity, capacity of and congestion in (existing) electricity and gas grids and storage capacities
2. perform experiments in a chemical storage lab and analyse obtained data
3. systematically report experimental setup, method, results and conclusions in a lab report

Content of the module:

In this module students will learn the basics of electricity and natural gas infrastructures, from production, transport, distribution, storage, to demand. They will learn to assess the possibilities of the integration of renewables in existing energy infrastructures: congestion problems, maintaining quality and reliability of supply. The basics of heat grids is also covered. As such,
22 students will develop a systemic vision of energy systems.

Suggested reading:

- Freris L, Infield D, *Renewable energy in power systems*
- SBC Energy Institute, *Electricity storage factbook*, 2013
- Çengel YA, Boles MA, Kanoğlu M, *Thermodynamics – An engineering approach*, 9th edition, 2020, McGraw-Hill
- Scientific papers on storage systems and (bio)gas storage technologies will be announced.

Comments:

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Weblink:

-

Prerequisites for admission;

Helpful previous knowledge:

-

Associated with the module(s):

-

Maximum number of students / selection criteria:

-

Types of examinations:

- Assignment/report (4 EC)
- Lab work (1 EC)

Examination periods:

In-class presentation (week 2), resit (week 5)

Registration procedure:

OSIRIS: RWVM23ETDS

Other educational needs:

- Allowed calculators in exams: During the exams a basic, non-programmable calculator can be used (e.g. Casio FX 82 MS or Texas Instruments TI-30XB or TI 30XS Multiview)
- (Access to a) Windows computer with the specs listed in https://www.pvsyst.com/download-pvsyst/ is recommended for the solar lab (PVSyst)
- Computer should be capable to run MatLab for programming

3.Hanze UAS Core Exam Table 2024-2025

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European Master in Renewable Energy Semester 1 (CORE)				2024-25				Versie 13-07-2023	
	Module Code	EC	Exam Type (W/O)***	Written Ex Length (hrs)	Assessment Object	1st Exam Date	2nd Exam Date	1st examiner	2nd Examiner
Energy Technical Foundation	RWVM23ETF	**5**							
Theory Electrical Engineering + Energy Basics		*3*	**W**	**2**	**Written exam**	**25-09-2024**	**04-11-2024**	S. Bellekom	J. Bekkering
Assignment Numerical Modelling		*2*	O		Report			E.J. Hengeveld	S. Bellekom
Energy Transition Project	RWVM23ETP	**5**							
Assignment Capstone RM/RP	100%	*5*	O		Report			E.J. Hengeveld	FJ Guzman Munoz,
Professional Skills	**Pass or Fail**	*0*	O		Personal Development Plan				FJ Guzman Munoz,
BioMass Energy	RWVM23BME	**5**							
Theory	60%	*3*	**W**	**2**	**Written exam**	**25-11-2024**	**27/01/2025**	F. Faber	A. Perl
Assignment BME	40%	*2*	O		Report			F. Faber	A. Perl
Wind & Marine Energy	RWVM23WHE	**5**							
Theory	60%	*3*	**W**	**2**	**Computer exam**	**29-11-2024**	**28/01/2025**	G. Schepers	W. Swart Ranshuysen
Lab WHE	20%	*1*	O		Lab Report			W. Swart Ranshuysen	G. Schepers
Assignment WHE	20%	*1*	O		Report			G. Schepers	W. Swart Ranshuysen
Solar Energy	RWVM24SLE	**5**							
Theory	60%	*3*	**O**	**2**	**Report**			A. Weeber/D. Kurstjens	S. Bellekom
Lab SLE	20%	*1*	O		Oral & Report			S. Bellekom	A. Weeber
Assignment SLE	20%	*1*	O		Presentation			A. Weeber/ D. Kurstjens	S. Bellekom
Energy Transport, Distribution & Storage	RWVM23ETDS	**5**							

Assignment	80%	4	**O**	**2.5**	**Report**			S.A. Dijk	C. van Someren
Assignment	20%	*1*	O		Assignment			A. Perl	S.A. Dijk
Presentations			O					S.A. Dijk	C. van Someren

Contact data

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