Hanzehogeschool Groningen
University of Applied Sciences

European Master in Sustainable Energy System Management (MSc)

Short Module Descriptions Handbook
Core semester Hanze UAS
2021-2022

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Energy Academy Europe

EUROPEAN MASTER IN
SUSTAINABLE
ENERGY SYSTEM
MANAGEMENT
Coordinated by EUREC

Table of Contents

1. Short Module Descriptions Handbook

1.1. Introduction

The European Master in Sustainable Energy System Management (SESyM) programme is defined by ***Program Learning Outcomes*** and ***Module Learning Outcomes contained in (learning) Modules. See the Teaching and Examination Regulations on the Hanze UAS website.*** An overview of the modules of SESyM is given below. The modules are divided in CORE Modules, Specialization Semester modules and the Thesis module.

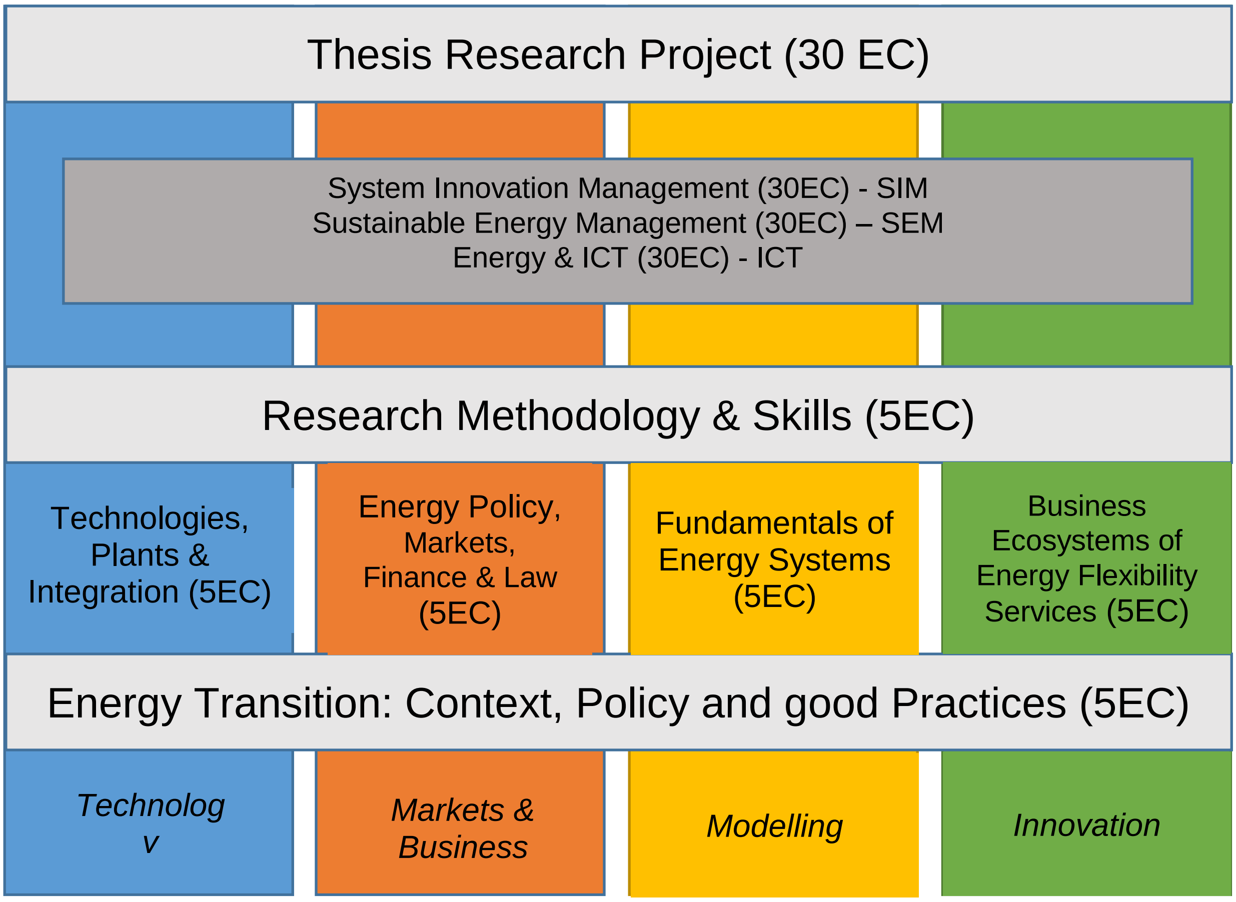

Figure 1: Figure 1: Overview of the SESyM master.

SESyM at Hanze UAS is defined by the following program learning outcomes.

1.2. Generic learning outcomes SESyM

- **Management (E1.1)***To be able to plan, develop, analyse and manage multi-disciplinary/-level/-dimensional energy transition projects within time, budgetary, quality and personnel constraints.*
- **Teamwork (E1.2)**To be able to work in (inter) national and multidisciplinary teams effectively and efficiently.

- **Creativity (E1.3)**To be able to use abstract, analytical thinking and creativity in the synthesis of ideas across disciplines.
- **Scientific Research (E1.4)**To be able to independently conduct scientific research on sustainable energy systems.
- **Communication (E1.5)***To be able to communicate professionally in English (oral and written) using modern (social media based) communication tools.*
- **Entrepreneurial (E1.6)***To be able to demonstrate an entrepreneurial attitude.*

1.3. Specific energy transition learning outcomes

- **Energy System Transition: Evaluation of Energy System Dynamics, Innovation, Business Plans/Cases, Models, Markets within Socio-Legal-Economic Contexts (E2.1)**
  To be able to analyse, design, assess, and implement:
  1. the interactions of technical, economic, business and legal/licensing aspects of the various components of the overall energy system and value chains at various levels of aggregation (E2.1.1)
  2. the role of energy policy, public decision making and stakeholder involvement (e.g public acceptance issues, licensing, environmental and social impact assessment) (E2.1.2)
  3. energy project business plans and related tools/techniques (e.g modelling, scenario planning, simulation, risk analysis, impact assessment) (E2.1.3)
  4. energy system features, boundary conditions (e.g. grid balancing: demand versus supply), energy market behaviour, and production technologies (E2.1.4)
- **Energy System Transition: Design and Assessment of Business Plans/Cases, Models & Scenarios for Integration & Optimisation and Market Management (E2.2)**
  To be able to analyse, design, assess and implement:
  1. constraint and context based business plans/cases using appropriate tools/models (E2.2.1)
  2. scenario plans for multi-criteria decision making assessing risk/return/uncertainty profiles (E2.2.2)
  3. models for efficiency and effectivity analysis (E2.2.3)
  4. optimisation tools and techniques applicable for business optimisation strategies (E2.2.4)

- **Energy System Transition: Innovative Project Implementation, Development & Management (E2.3)**
  To be able to develop, analyse and implement:
  1. system transition business cases and plans, taking into account (E2.3.1)
  2. project resource constraints (budget, information, human resources, time, quality), (E2.3.2) and
  3. monitoring tools for project assessment (E2.3.3).

The next chapters provide a short module description of all core modules.

2. CORE Hanze UAS

2.1. Energy Transition: context, policy, and good practice

Institute of Engineering **Subject:** *European MSc in Sustainable Energy System Management* *Winter Term*	**Category:** - *MSc Module* **Degree award:** - *MSc*
Emphases: -	**Sections:** -
Module reference number/Title: *Energy Transition: Context, Policy, good Practices*	
Duration: 6 weeks **Cycle:** once a year **Type of module:** mandatory **Level:** MM (MSc module) *This module should be taken in the 1st semester*	**Type of program:** Lectures and Tutorials **Language:** English **Attainable credit points:** 5 EC **Workload:** 140 hours **Required attendance:** 60 hours
Person responsible for the program: C.B. Vogt, PhD	**Person responsible for this module:** W.P. van der Gaast, PhD
Alternative person(s) responsible for this module: D. Tempelman, PhD	**Examiner(s):** All listed persons
Objective of the module: **The students will be able to** 1. Take perspectives on future developments **The students will have demonstrated knowledge and understanding of** - Students will be able to identify and prioritise (technology) solutions for sustainable, low-emission energy systems in light of countries' societal, economic and environmental strategies. - Students will have a clear understanding of energy system dynamics, including barriers and enablers for prioritised solutions. - Students will be able to develop a basic plan for implementing a sustainable energy solution at the	

scale of a community or a country, including a business plan and stakeholder consultation process.
- Students will understand effectiveness of energy and climate policy and what factors determine this.
- Students will be able to assess climate resilience of sustainable energy solutions in light of climate change impacts.
- Students will become acquainted with the different legal systems (common law, civil code) and how law functions within the European Union.
- Students will be able to identify different sources of law and the different disciplines of law (e.g. consumer law, contract law, administrative law).

Content of the module:

As introductory module for the Master Sustainable Energy System Management, module Energy Transition will provide a broad overview of aspects that relate to successful development and transfers of low or zero emission energy technologies, both in developed and developing countries. These aspects will, first, be technical by considering the technical potential for meeting global energy demand while striving for net zero greenhouse gas emissions globally by mid-century. Next, the module will focus on aspects related to affordability of these technology options, both in developed and developing countries, whereby it is, a.o., assessed whether and how the economic benefits of renewable energy technologies outweigh their costs. While the resulting economic potential is already a strong indicator of the feasibility of an energy technology in a country, its eventual potential depends on how well the technology is received by society and thus becomes socially acceptable.

After assessing tools and methods for determining a socially realistic potential for renewable and other low emission technology options, the module will turn towards implementation. A key insight to be obtained is that success of implementation depends largely on how well we understand the (market) systems for implementation. By analysing, characterising and attributing the enabling policy and business environment for a technology, including who are the key stakeholders in pursuing a technology, systemic barriers and enabler for technology implementation can be identified and addressed for more efficient (market) systems. Based on these insights – what are prioritised, socially realistic energy technologies and what needs to be done for their implementation at desired scales – policy targets and instruments can be formulated as concrete actions to shape energy and climate strategies. The module will highlight examples of the complexity of policy making. After all, policy making does not take place in laboratories, where contexts can be controlled, but are implemented in highly complex environments, where they co-exist with other policies, that target the same consumers and enterprises, possibly in contradictory ways. Let alone that EU Member States follow EU-level directives and must incorporate these in their national laws. The module will address these complexities by explaining potential policy interactions (e.g. between energy and climate policies) and how these can affect the effectiveness of individual policies.

Also, in the Module, an introduction into European law will be provided, for a better understanding of how EU-level energy and climate policy making works; a more detailed programme on European law will then follow in Module 3. Finally, Module 1 will extend the context for (renewable) energy decisions to climate resilience of energy systems. The rationale for adding the latter is the increasing importance of climate change adaptation. Naturally, SESyM has a focus on low-emission energy technologies which contribute to reducing greenhouse gas emissions. However, there is a growing concern that the effectiveness of low-emission energy systems can be affected by climate change impacts, such as solar PV becoming less efficient with higher temperature, wind turbines increasingly switched off due to heavier storms and small scale hydro plants threatened by lower water levels due to lower precipitation levels. Consequently, robust energy systems require consideration of climate change impacts and solutions to adapt to these.

Suggested reading:

- Net zero by 2050 – A roadmap for the Global Energy Sector, International Energy Agency, 2021, https://www.iea.org/reports/net-zero-by-2050
- Suggested papers will be provided during the module

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

Maximum number of students / selection criteria:

-

Types of examinations:

- Part 1: Written exam in Essay form

Examination periods:

- see exam table

Registration procedure:

Registration for SUVH20ETCPP, report and resit is mandatory and the responsibility of the student.

2.2. Technologies, Plants & Integration

Institute of Engineering **Subject**: *European MSc in Sustainable Energy System Management* *Winter Term*	**Category:** *- MSc Module* **Degree award:** *- MSc*
Emphases: -	**Sections:** -
Module reference number/Title: *Technologies, Plants & Integration*	
Duration: 6 weeks **Cycle:** once a year **Type of module:** mandatory **Level:** MM (MSc module) *This module should be taken in the 1st semester*	**Type of program:** Lectures, Tutorials, Laboratory **Language:** English **Attainable credit points:** 5 EC **Workload:** 140 hours **Required attendance:** 40 hours
Person responsible for the program: C.B. Vogt, PhD	**Person responsible for this module:** Dr.ir. J. Bekkering
Alternative person(s) responsible for this module: Dr.ir. B.M. Visser, dr.ir. J. Bekkering, dr. T. Dirksmeyer, dr. S. Barsali, dr. A.A. Bellekom, ir. A. De Ruijter	**Examiner(s):** All listed persons
Objective of the module: At the completion of this module the student should: **be able to**: 1) Judge the technical feasibility of a facility (e.g., hydro storage) and its contribution to the energy system. 2) Assess and explain grid balancing with technologies and plant designs at different scales. **have demonstrated knowledge and understanding of:** 3) Energy Basics 4) Sustainable Technologies and Economics 5) Current Energy Systems and Economics 6) Transport & Distribution Technologies and Economics 7) Balancing and Energy Storage	

Content of the module:

In this module the student will firstly acquire knowledge of physical aspects in relation to energy. Discussion of the fundamentals of fossil fuel and renewable energy technologies and energy carriers will follow. The student will also develop basic knowledge of the technical and economic issues relating to the planning and operation of power systems that use renewable energy sources. The influence of technology, cost and scale upon all items are discussed (e.g., after completing this module, the student must be able to judge the technical feasibility of wind energy and its contribution to the energy system and to make a rough cost/benefit analysis to evaluate the viability of such an idea). Gas and electricity grids are predominantly given separate consideration within this module.
The module content is divided in five main parts:

1. Energy Basics
2. Sustainable Technologies and Economics
3. Current Energy Systems (gas, electricity) and Economics
4. Transport & Distribution Technologies and Economics
5. Balancing and Energy Storage

Lab work and a visit provide 0.5 EC of the module.

Required literature:

- Blok, K., Nieuwlaar, E., *Introduction to Energy Analysis*, Second Edition, 2017, Routledge, available as e-book in Hanze library
- *Technologies, Plants and Integration at Different Scales*, readers/lecture notes, available on e-learning system

Suggested reading:

- McKay, D., *Sustainable Energy – without the hot air*, UIT Cambridge, England, 2009. (can be ordered, but is available as free pdf-download as well).

Comments:

Weblink:

Prerequisites for admission:

Helpful previous knowledge:

Associated with the module(s):

Maximum number of students / selection criteria: -

Types of examinations:

Item	*Group/Individual*	*Grade method*	*Second chance*
Visit	Individual	Presence/active attitude	Essay on topic of visit (2 pages), also to be done in case of absence
Lab work	Individual	Pass/Fail report	Extra assignment (also in case of no contribution)
Assignments (linked to capstone)	Group	Pass/Fail report	Extra assignment
Written exam (3 hours)	Individual	Scale 1 to 10. A grade ≥5.5 is pass	Resit

Examination periods: see exam table

Registration procedure: Registration for SUVH15TPI (written) exams and their resits is mandatory and the responsibility of the student.

2.3. Business Ecosystems of Energy Flexibility Services

Institute of Engineering **Subject:** *European MSc in Sustainable Energy System Management* *Winter Term*	**Category:** *- MSc Module* **Degree award:** *- MSc*
Emphases: -	**Sections:** -
Module reference number/Title: *Business Ecosystems of Energy Flexibility Services*	
Duration: 3 weeks **Cycle:** once a year **Type of module:** mandatory **Level:** MM (MSc Module) *This module should be taken in the 1st semester*	**Type of program:** Lectures, Tutorials. **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. W. Timmerman
Alternative person(s) responsible for this module:	**Examiner(s):** All listed Persons
Objective of the module: The student has achieved the following learning outcomes: **To be able to** 1. Model energy ecosystems 2. Assess the impact of the information services on the viability of the eco system 3. Design workflows delivering such services **To have demonstrated knowledge and understanding of** 4. Energy-related services required for viable decentralised energy ecosystems 5. Information services required to deploy the energy-related services 6. Business processes required to deliver these services	

Content of the module:

In this module the student will acquire knowledge concerning which new information services, based on potential flexibility assets, are needed to create a decentralized energy system. In addition he/she will also learn how these services can be developed and applied into a viable business eco-system.
The module is aimed at understanding the role of new information and flexibility services in decentralized energy systems.

The module starts with business modeling basics and the introduction of a tool for business modeling (e^3value). Next, the role of energy-related services, information services and business services in sustainable energy will be highlighted. With the introduction of decentral renewable resources advanced flexibility services will be needed to control and manage non-controllable generation, decentral demand-supply coordination, as well as the incorporation of advanced conversion and storage technologies. Energy-related services are crucial in this, but they cannot be deployed without adequate information support. Cases will be modelled, where flexibility (e.g. storage, conversion) is needed, and where such flexibility requires information services. In order to deliver more advanced services, several stakeholders have to be lined up in a business value network, and various business processes need to be developed. Accordingly, students will be introduced to business process management and business process modelling, as well as to the role of transactional systems and object models in support of business processes.

All components of the module will come together in a real-life case study that needs to be modelled and worked out into a viable energy eco-system.

Suggested reading:

Mandatory literature

1. Syllabus Business Process Modellling, transaction Processing and ERP
2. Dumas, M., La Rosa, M., Mendling, J., & Reijers, H. A. (2013). Fundamentals of business process management (pp. I-XXVII). Berlin: Springer (Chapter 1 & 3).
3. Timmerman, W.H. (2017). Facilitating the Growth of Local Energy Communities. PhD-thesis, University of Groningen. (Chapters 5 & 6)
4. White, S.A. (2004). Introduction to BPMN. BPTrends, White paper, IBM Corporation, July 2004.

What is a business model and what is a business ecosystem?

5. Moore, JF (1993). 'Predators and Prey: A New Ecology of Competition', Harvard Business Review, vol. 71, no. 3, pp. 75-86. Available from: buh.
6. Osterwalder, A & Pigneur, Y. (2005). 'Clarifying business models: origins, present, and future of the concept', Communications of AIS, vol. 2005, no. 16, pp. 1-25. Available from: buh.

Flexibility services and modelling

7. Burger, S., Chaves-Ávila, J.P., Batlle, C., and Pérez-Arriaga, I.J. (2017). A review of the value of aggregators in electricity systems. Renewable and Sustainable Energy Reviews, 77, 395–405
8. R.H. van der Burg, J.C. Wortmann, G.B. Huitema (2018). A business perspective on Energy System Flexibility: conceptualizing flexibility and flexibility services. Working paper (under review), Groningen: University of Groningen, Department of Operations.

Relationship between business models and information systems

9. Lankhorst, M. (2012), Enterprise Architecture at Work: Modelling, Communication and Analysis, Springer. (Chapter 1)
10. Henderson, J. C., & Venkatraman, N. (1992). Strategic alignment: a model for organizational transformation through information technology. Transforming organizations, 97-117.

What are business model techniques?

11. Gordijn, J, Akkermans, H & Van Vliet, H. (2000), 'Business modelling is not process modelling', in Conceptual modeling for e-business and the web, Springer, pp. 40-51.

Business model design

12. Gordijn, J & Akkermans, (2007). 'Business models for distributed generation in a liberalized market environment', Electric Power Systems Research, vol. 77, no. 9, pp. 1178-1188.
13. DSouza, A.D., Bouw, K., Velthuijsen, H., Huitema, G.B. , Wortmann, J.C. (2018). Designing viable multi-commodity energy business ecosystems: corroborating the business model design framework for viability. Journal of Cleaner Production, doi: 10.1016/j.jclepro. 2018.01.256.

Additional Literature

14. Wohed, P., van der Aalst, W. M., Dumas, M., ter Hofstede, A. H., & Russell, N. (2006). On the suitability of BPMN for business process modelling (pp. 161-176). Springer Berlin Heidelberg.
15. Weill, P & Vitale, MR 2002, 'What IT Infrastructure Capabilities are Needed to Implement E-Business Models?', MIS Quarterly Executive, vol. 1, no. 1.
16. Bouwman, H. & Ham, E. (2003). 'Designing metrics for business models describing Mobile services delivered by networked organisations', in Workshop on concepts, metrics & visualization, at the 16th Bled Electronic Commerce Conference eTransformation, Bled, Slovenia, Citeseer.

Comments:

-

Weblink:

-

Prerequisites for admission*:*

Helpful previous knowledge:

Associated with the module(s):

Maximum number of students / selection criteria:

Types of Examination

Report and Reflection

Examination periods:

see exam table

Registration procedure:

Registration for SUVH21BEEFS Peer Review and resit is mandatory and the responsibility of the student.

2.4. Energy Policy, Markets, Finance and Law

Institute of Engineering **Subject***: European MSc in Sustainable Energy System Management* *Winter Term*	**Category:** *- MSc Module* **Degree award:** *- MSc*
Emphases: -	**Sections:** -
Module reference number/Title: *Energy Policy, Markets, Finance and Law*	
Duration: 3 weeks **Cycle:** once a year **Type of module:** mandatory **Level:** MM (MSc module) *This module should be taken in the 1st semester*	**Type of program:** Lectures, Tutorials. **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. Daisy G. Tempelman, L.LM, Prof.dr. M. Mulder; Drs. B. ter Veer
Alternative person(s) responsible for this module:,	**Examiner(s):** All listed Persons

Objective of the module:
Upon completion of the module the student
Is able to:

1. Explain the basics on how energy markets function and what types of market failures can occur.
2. Use the basic insights from micro-economics, finance and international economics to discuss the way energy markets could be regulated
3. Perform investment analysis for investment decisions purpose, by choosing and applying the correct valuation models (e.g. NCW, DCF, IRR, and WACC) and to perform scenario analysis, sensitivity analysis and ratio analysis on the scientific models.
4. Identify valuation issues by collect and assess relevant data, analyze the relevant data and using the relevant data to develop a model.
5. Analyze and advise on financing requirements (e.g. divided policy) based on predictions about the exploitation and cash flows.
6. Evaluate a financing proposal after considering various possible forms of financing, taking into account the requirements of potential capital providers.
7. Identify the different sources of energy law, in particular with regard to European energy markets, such as the legislation of the clean energy package, climate package and so on.
   To analyse different developments in the energy markets from a legal perspective and identify legal bottlenecks, I.e. the development of the consumers' role or hydrogen as an alternative for natural gas.

Has demonstrated knowledge and understanding of: 1) The way different energy markets interact with each other. 2) The energy business environment in terms of markets, policies and economic mechanisms and institutions. 3) The role of technological options and aspects in energy system integration processes and energy transition. 4) The influence of energy law on the development of these energy markets.
Content of the module: **Energy Markets, Policies and Regulation (40 % content)** This module will provide the students with a thorough understanding of the functioning of energy markets, the underlying processes and stakeholder behaviour, and how energy markets interact with their policy, technology and societal context. The module will teach the student about the economic mechanisms that makes the various parts of the energy system to be aligned together. The module will discuss the concepts of liberalisation, regulation, restructuring and privatisation. Specific items to be addressed are: characteristics, role and functioning of different types of electricity and gas wholesale markets (forward, day-ahead, intraday and balancing markets), as well as energy retail markets. This module will also pay attention to the interaction between energy markets and environmental policies, such as the EU Emission Trading System (ETS) and policies to foster the supply by renewable energy sources, for instance by subsidies or green certificates Finally, the module will discuss the potential role of different technologies, as storage and power-to-gas, to deal with the impact of the growing supply from intermittent renewable energy sources on the stability of energy networks and markets. **Energy Finance (40% content)** The ‘Finance’ module is about the understanding that the innovations that are needed to realize the energy transition requires understanding of finance and how financial variables interplay with technical variables. Each of these financial variables may be closely related to technical variables, for instance the payback time of the project (the time needed to recover the investment) which is related to the total technical project costs, but also to energy prices and the costs of using the (existing) infrastructure. Investment opportunities are compared and assessed based on their expected capex and opex. Risk assessment and sensitivity analysis are also part of investment decisions. In this module, the students will learn how to apply different valuation methods to evaluate an investment project. The main aim of the module is to acquire hand-on experience in this area. In this module, we will use basic finance knowledge / methods, such as NPV, DCF, IRR, and WACC. The students learn to use these methods and to perform sensitivity analysis and ratio analysis considering alternatives and dependencies. This module aims at understanding and applying the basic finance concepts and furthermore the students can identify valuation issues by collecting and assessing relevant data, analyse the relevant data and using this to develop a valuation model. **Energy Law (20% content)** After the introductory course in the first course (introduction to law) students understand the functioning of different legal systems and are able to identify different legal disciplines. From this point, this course

continues by explaining how law is used as an instrument to regulate the markets. The first class will go more in depth on the developments in the European gas market and how national markets were liberalized. In achieving one internal market, national markets needed to be liberalized. There are also legal challenges with regard to the upcoming market for (green) hydrogen and the (missing) legal framework. The second class will be on the electricity market, the role of aggregators and energy communities. In this class some legal aspects with regard to wind energy, smart grids, smart metering will be discussed. The last class will go in more depth on the legal challenges a DSO is facing in this changing energy market and regulated area.

Mandatory reading

For the classes of Machiel Mulder the following literature is mandatory:

Chapter 3, 4, 5 and 8 of Machiel Mulder (2021), Regulation of the Energy Markets, Springer.
Online available (digital copy) via Hanze Library

For the classes of Bart ter Veer the following book is mandatory:

Principles of Corporate Finance, 12th Edition, By Richard Brealey and Stewart Myers and Franklin Allen.

For the classes of Daisy G. Tempelman the following literature is mandatory:

M. Roggenkamp, C. Redgwell, A. Rønne, and I. del Guayo, Energy Law in Europe: National, EU and International Regulation, third edition. The following pages are recommended reading material: Chapter 4, section F, J, K, N.

Additional reading material will be announced on Blackboard.

Comments:

-

Weblink:

-

Prerequisites for admission*:*

-

Helpful previous knowledge:

-

Associated with the module(s):

Maximum number of students / selection criteria:

Students will work in groups and be assessed by providing a full report covering the topics discussed in class. First of all, students need to discuss the topics discussed related to the first module (Energy Markets). In the context of a case study the market features are analysed considering supply, demand, market failures, taxation and subsidies and different types of support schemes. For the case study an investment project will be evaluated in accordance to the second module (Energy Finance). Also the (inter)national legal framework that is relevant for the case will be discussed (Energy law).

The assessment of the module:
Written assignment where the students demonstrate mastering of the contents of the course literature provided during the lectures (100% of the grade). This exam is divided over the three disciplines (40% Markets, 40% Finance, 20% Law). Every individual discipline should be assessed as sufficient.

Resit
If students do not hand in a sufficient report, the teachers will provide the group with feedback in order for the group to address the insufficient points.
Please note that the resit (second chance to hand in the report) can never lead to a grade higher than 7/10!

Examination periods:

see exam table

Registration procedure:

Registration for SUVH21MFL, (written) exams and their resits is mandatory and the responsibility of the student.

2.5. Fundamentals of Modelling Energy Systems

Institute for Engineering **Subject:** *European MSc in Sustainable Energy System Management* *Winter Term*	**Category:** - *MSc Module* **Degree award:** - *MSc*
Emphases: -	**Sections:** -
Module reference number/Title: *Fundamentals of Modelling Energy Systems*	
Duration: 3 weeks **Cycle:** once a year **Type of module:** mandatory **Level:** MM (MSc module) *This module should be taken in the 1st semester*	**Type of program:** Lectures, Tutorials **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:** F. Pierie, PhD; Ir. B. Kooi
Alternative person(s) responsible for this module: -	**Examiner(s):**

Objective of the Module:
After completion of the module the student is able to:

1. understand and apply the fundamentals of physical modelling to energy systems.
2. apply modelling techniques to design and create transparent models on energy systems and use them to simulate, analyse, and evaluate energy systems on efficiency, environmental impact and basic economics.
3. apply the Material and Energy Flow Analysis (MEFA) methodology and energy flow diagrams (Sankey) for analysing the environmental impact of energy systems.
4. understand the basics of the Life Cycle Assessment (LCA) methodology for analysing the environmental impact of energy systems and integrate LCA data in energy modelling.
5. apply methods for the validation and verification of created models.

Content of the module:

In this module, students acquire the fundamentals of modelling techniques and methods, applied to energy systems. These fundamentals will be explained using three methodologies namely, Material and Energy Flow Analysis (MEFA); Life Cycle Analysis (LCA); and validation and verification of models. The students apply the learned skills in Excel based models containing the aforementioned elements.

Within this module, the focus is on relationships between individual elements within energy systems, e.g. production, storage, conversion. The students program these relationships in a model and use the model to gain understanding and find optimal solutions, with respect to energy efficiency, environmental impacts, and basic economics (e.g. CAPEX and OPEX). Within this module both theory and practice (building an actual model) are integrated to give the students a fundamental understanding of energy systems and modelling thereof. On completion of this module the student will be able to construct a well-structured and transparent model, validate the model, run scenarios in the model, and draw conclusions from the model. The knowledge gained in this module forms a foundation on which the students can expand their modelling skills by using other specialized energy models while recalling the fundamentals of modelling.

To achieve the modules learning outcomes the students attend lectures on modelling theory, perform a written exam, and make a modelling assignment.

Suggested reading:

- Introduction to the biogas Simulator
- Pierie F, Bekkering J, Benders RMJ, van Gemert WJT, Moll HC. A new approach for measuring the environmental sustainability of renewable energy production systems: Focused on the modelling of green gas production pathways. Appl Energy 2016; 162: 131-8.
- Haberl H, Weisz H. The potential use of the Materials and Energy Flow Analysis (MEFA) framework to evaluate the environmental costs of agricultural production systems and possible applications to aquaculture 2007; FAO/WFT Expert Workshop. 24-28 April 20 (TRUNCATED).
- Haberl H, Fischer-Kowalski M, Krausmann F, Weisz H, Winiwarter V. Progress towards sustainability? What the conceptual framework of material and energy flow accounting (MEFA) can offer. Land Use Policy 2004; 21: 199-213.
- Introduction to the biogas Simulator
- Pierie F, van Someren CEJ, Benders RMJ, Bekkering J, van Gemert WJT, Moll HC. Environmental and energy system analysis of bio-methane production pathways: A comparison between feed stocks and process optimizations. Appl Energy 2015; 160: 456-66

Comments:

-

Weblink:

Prerequisites for admission:

-

Helpful previous knowledge:

-

Associated with the module(s):

Maximum number of students / selection criteria:

-

Types of examinations:

Exam type	Examining	Credits
1. Written exam	Course scientific content per block	2 credits
2. Assignment	Numerical Modelling	3 credits

Examination periods:

see exam table

Registration procedure:

2.6. Research Methodology & Skills

Institute for Engineering **Subject***: European MSc in Sustainable Energy System Management* *Winter Term*	**Category:** *- MSc Module* **Degree award:** *- MSc*
Emphases: -	**Sections:** -
Module reference number/Title: Research Methodology & Skills	
Duration: 10 weeks **Cycle:** once a year **Type of module:** mandatory **Level:** MM (MSc module) *This module should be taken in the 1st semester*	**Type of program:** Lectures, Tutorials, Project Work **Language:** English **Attainable credit points:** 5 EC **Workload:** 140 hours **Required attendance:** 50 hrs
Person responsible for the program: C.B. Vogt , PhD	**Person responsible for this module:** C. B. Vogt, PhD, Drs. J. J. A. Scheepens-Hasek
Alternative person(s) responsible for this module: Drs. J. J. A. Scheepens-Hasek	**Examiner(s):** All listed persons
Objective of the Module: At the end of the module the student is able to: 1. Communicate effectively orally, visually and writing at professional level to different target groups 2. Apply analytical and research methodologies effectively in assignments and case based projects 3. Participate effectively in an international and multidisciplinary team environment in different roles (e.g. project leader, project member) 4. Develop entrepreneurial skills	

Content of the module:

Reflective practitioner and transferable skills

A reflective practitioner is a professional with the ability to use transferable skills, see figure below. Reflective practice is a way of improving individual and organizational effectiveness. Reflective practice consists of “mindful consideration of one’s actions” (Osterman, 1990) in which the reasons and assumptions that drive one’s behavior are thoughtfully reflected on in the interest of improving one’s professional effectiveness. Preferably, appropriate scientific theories are also part of the reflection. Thought and action are thus integrated through reflection. Osterman describes the process as a “challenging, focused, and critical assessment of one’s behavior as a means toward the development of one’s “craftsmanship”. The student will develop learning skills to allow autonomous learning and develop research skills to define and execute a small research project with the intention to act as a capstone assignment of the Core. The capstone assignment is focused on technical, economical, business and social aspects of the transition of a community to a sustainable community based on knowledge and understanding acquired in the previous modules of the CORE program.

Suggested reading:

- Case Study Research (Design and Methods) (Robert K. Yin, 2014 SAGE, ISBN 978-1-4522-4256-9 (pbk)
- Research Methods for Business Students (Mark Saunders, Philip Lewis, Adrian Thornhill; Prentice Hall, ISBN 978-0-273-70148-4Link to MOOC Developing your research project: https://www.futurelearn.com/courses/research-project
- Link to MOOC working in Multidisciplinary teams: https://www.pok.polimi.it/courses/course-v1:Polimi+WMT101+2016_M12/about
- PPT slides

Comments: - **Weblink:** - **Prerequisites for admission***:* -	**Helpful previous knowledge:** - **Associated with the module(s):** - all previous CORE modules
Maximum number of students / selection criteria: - **Types of examinations:** The assessment is based on the thesis assessment procedure & products (i.e. performance, report and presentation) for a (small) real life research project. **Examination periods:** • End of Module, see exam table **Registration procedure:** Registration for SUVH19RMS, (written) exams and their resits is mandatory and the responsibility of the student.	

3. Hanze UAS Exam Table CORE 2021-2022

European Master in Sustainable Energy System Management Semester 1 (CORE)					2021-2022				
	Module Code	EC	Exam Type	Written Ex length (hrs)	Assessment Object	1st Exam date	2nd Exam Date	1st Examiner	2nd Examiner
Energy Transition: Context, Policy and good Practices	SUVH20ETCPP	5	O		Report			W. Vd Gaast	D. Tempelman
Technologies, Plants & Integration	SUVH15TPI	5	W	3	Computer exam	25-10-2021	22-11-21	J. Bekkering	M. Visser
Business Ecosystems of Energy Flexibility Services	SUVH21BEEFS	5	O		Presentation+ Peer Review			W. Timmerman	A. d'Souza/B. ter Veer
Energy Policy, Markets, Finance & Law	SUVH21MFL	5	O		Report			D. Tempelman	B. ter Veer
Fundamentals of Modelling Energy Systems	SUVH21FMES	5							
*Scientific Content	40%	*2*	W	1.5	Computer exam	6/12/21	17-1-22	F. Pierie	B. Kooi
*Numerical Modelling	60%	*3*	O		Model & Report			B. Kooi	F. Pierie
Research Methodology & Skills	SUVH19RMS	5							
* Research Methodology & Skills	100%	5	O		Report + Presentation			C. Vogt	J. Scheepens-Hasek
* Professional Skills	Pass or Fail	*0*	O		Personal Dev. Plan			J. Scheepens-Hasek	C. Vogt

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